

FABRICS & SEWING II

A year of real textile history and real making for grades 6–8: the gin and the mills, the polymer chemists, the patent wars of the sewing machine and Butterick’s tissue patterns, each story followed by the fiber science, the arithmetic of yardage, gauge and seam allowances, and a real project sewn, crocheted, knitted or upholstered by the student’s own hands.

Fabrics & Sewing II follows cloth from the fiber to the finished garment at a middle-school depth. The student studies the structure of cotton, wool, silk and the synthetic polymers; meets the mills of Arkwright, Slater and Lowell and reads thread count and fabric weight like a buyer; masters the hand stitches, closures and mending that keep a wardrobe alive; services and sews on a machine, installing a zipper and building a lined bag; crochets and knits in the round, resizing patterns with gauge arithmetic; sews lined curtains, a pieced quilt top and a re-covered chair seat for a real room; and finishes the year by reading a commercial pattern, sewing a garment and building a historical costume piece. Each unit is built on real people and real moments: Eli Whitney and the gin, Wallace Carothers and nylon, the mill girls of Lowell, the sewing-machine patent pool of 1856, Whitcomb Judson and Gideon Sundback’s zipper, Ebenezer Butterick’s graded tissue patterns and the embroiderers of the Bayeux Tapestry.

Every lesson follows the same path. First comes **the story**. Then **how they figured it out**: the problem, the attempts, the breakthrough. Then **the fabric science** (or **the craft**): what is happening in the fiber, the yarn, the fabric or the stitch, with the real vocabulary and the real arithmetic — yardage, fullness, thread count, gauge, cost per yard and seam-allowance math. Last, **let’s sew**: the student makes something real and useful, records it in a sewing notebook, and improves it on the next round.

Sewing here is skill, stewardship and service. Students learn to make and mend rather than discard, to judge fabric and price with a clear eye, and to give: a crocheted hat for a hospital, a mended garment returned to its owner, a costume for the church play. Scripture runs through the year, from the spinners and embroiderers of the tabernacle to the capable woman of Proverbs 31 and the seamless coat woven from the top throughout. The year ends

with a family sewing fair, where the student shows the year's work, explains one technique, wears one piece and gives one away. *Fabricando fit faber*: by making, one becomes a maker.

Who it is for: Written for students in grades 6–8 (about ages 11–14), the middle of the band in mind. A student ready for this course can thread a needle, tie a knot, sew a running stitch and backstitch, and work carefully for 45 minutes; *Fabrics & Sewing I* is the natural preparation, but a careful beginner can start here, taking Unit 3 slowly. Fractions, multiplication and simple division are used throughout for yardage, gauge and seam-allowance math. A parent or responsible adult stays at home and on call for every session, checks the student off on the machine and the iron before solo use, and stands beside the student for the staple gun and nearby for the rotary cutter. To begin, buy a basic sewing kit (needles, thread, pins, a pincushion, a seam ripper), fabric shears, a tape measure, worsted-weight yarn, a 5 mm (H-8) crochet hook, US 8 (5 mm) straight and 16-inch circular knitting needles, and fabric as each pattern card lists it. A sewing machine is required in Unit 4 and useful afterward; borrowing one from a relative or a friend at church is perfectly fine.

32 lessons in 8 units · Every lesson has a video (links printed in each lesson), a picture study, a sewing project and notebook practice · Online: schoollaunch.org/courses/sewing/grades-6-8/

COURSE GUIDE

Most videos come from trusted public and teaching sources: museums and historic sites, university and extension channels, the official channels of sewing-machine and yarn companies, and careful sewing, quilting, crochet, knitting and upholstery teachers chosen lesson by lesson. Every video was previewed for content, accuracy, safe practice and modest dress. Some channels end with an invitation to subscribe or a mention of their other videos or products; you can stop the video when the teaching ends. Many lessons ask the student to watch once all the way through and then again with the work in hand, pausing after each step.

HOW TO USE THIS COURSE

1. **The weekly rhythm.** The year has 32 lessons, one a week, in two sessions. Session 1 (about 50–60 minutes) is the warm-up, the video, the teaching and the picture study. Session 2 (50–90 minutes, depending on the project) is the sewing project: do the math, cut, make, test, count the needles and pins back in, clean up and record. In the last week of each unit, add a third session for the unit review and the unit challenge.
2. **A leveled course.** Fabrics & Sewing II serves the whole grades 6–8 band. A sixth grader may make the smaller version of a project and take two weeks where needed; an eighth grader should take every “older students” extension, do all the arithmetic without help and aim for store-quality finishing. The course can also stretch over two years with the student redoing favorite projects at a higher standard.
3. **An adult supervises all sewing tool use.** A parent or responsible adult is in the home and checks in during every session, and **counts needles and pins out and back in with the student at the start and end of every session.** Needles and pins live in a pincushion or magnetic dish, never in the mouth or clothes; a dropped needle stops the work until it is found, with a magnet if needed. Keep needles, pins, buttons, beads and loose yarn away from babies, toddlers and pets.
4. **The grades 6–8 safety ladder.** Students at this level may use the sewing machine on their own once an adult has watched them sew safely (hands flat, fingers an inch from the needle, foot off the pedal when threading or adjusting, never sewing over pins), and the iron on their own after the same check: upright on its heel between presses, cord out of the way, unplugged when done, a press cloth and the right setting for the

fiber. The rotary cutter is used with an adult nearby, always on a cutting mat, cutting away from the body, blade closed every time it is set down. The staple gun (Unit 7) is used only with an adult beside the student and with safety glasses on. The seam ripper rips away from the hand, toward a pin. Burn tests of fibers are done only by an adult while the student watches and records.

5. **Story, then science, then sewing.** The core ideas are written to the student. *The story* and *How they figured it out* tell what happened; *The fabric science* (or *The craft*) explains the fiber, the fabric or the technique at a middle-school depth, including the arithmetic; *Let's sew* names the project and the one skill to do well and safely. Have the student explain each section back, including the math, before sewing.
6. **Do the math first.** Nearly every project begins with a measurement and a calculation: finished size plus seam allowances, rod width times fullness, stitches per inch times inches around. The student writes the math in the notebook before cutting, and checks it with the parent when fabric is expensive. Measure twice, cut once.
7. **Picture study.** Each lesson has one painting, historic photograph, patent drawing or piece of needlework tied to the lesson. Look at it quietly for two minutes, put it away, and have the student tell everything he or she remembers; then bring it back and work through the "look for" items and questions.
8. **The sewing notebook.** One notebook or binder for the year. Every project gets a page: date, the math, a fabric swatch or stitch sample, a sketch or photo, what went wrong, and one sentence beginning "Next time I will...". Unit 1 adds a fiber-study section and Unit 2 a swatch-and-numbers section; keep them going all year. Make it, record it, improve it.
9. **Supplies and cost.** The projects use ordinary fabric-store and craft-store supplies plus the family rag bag: old shirts, sheets, jeans, pillowcases and towels. Read the pattern card a few days ahead, do the yardage math and gather what you need; several lessons have the student compare cost per yard before buying. A sewing machine is required only in Unit 4; every machine project in Units 4, 7 and 8 also gives a hand-sewn option (backstitch) for families without one.
10. **Optional books and tools.** Some units list free guides, museum pages and simple tools. They are extras. Every project can be made without them.
11. **Unit review and unit challenge.** Each unit ends with a review worth 100 points, including two or three short calculations worked out on paper and one or two short written answers, and a unit challenge: something real made and recorded, from a

fiber report and a seam-finish sample book to a zippered bag, a resized hat, lined curtains, a quilted piece and a garment worn at the sewing fair. Keep the challenge pages and photographs in a folder for the year.

12. **The family sewing fair.** In the last week the student lays out the year's work with a card for each piece, explains one technique with the math behind it, wears one garment or costume, and gives one piece away with a note.

SCOPE AND SEQUENCE

UNIT 1 • WEEKS 1–4

Where Cloth Comes From

Fiber science at depth: cotton and the gin with its honest history, the scale-and-crimp structure of wool and why it felts, sericulture and the Silk Road, and the polymer chemistry of nylon, polyester and spandex, with a cost-per-yard study, wet felting and an adult-run burn test recorded like a lab.

- 1.1 King Cotton and the Gin
- 1.2 Wool Science: Scales, Crimp and Felt
- 1.3 Silk and the Silk Road
- 1.4 Polymers: Nylon, Polyester and Spandex

UNIT 2 • WEEKS 5–8

Fabric Up Close

From mill to fabric: Arkwright, Slater and the Lowell mill girls, drop-spindle spinning, the three weaves and grain and bias, thread count and fabric weight read with a buyer's eye, and the seam finishes that stop fraying, ending with a seam-finish sample book.

- 2.1 The Mill: Arkwright, Slater and Lowell
- 2.2 Weaves and Grain
- 2.3 Thread Count, Fabric Weight and What They Mean
- 2.4 Finishing Edges: Hems, Zigzag, Serger and French Seams

UNIT 3 • WEEKS 9–12

Hand Stitching

Hand skills that keep a wardrobe alive: the hemming stitches, hand-worked buttonholes and closures, darning and patching, and the embroidery of the Bayeux Tapestry, ending with a mended garment and an embroidered hoop.

- 3.1 Stitches That Hold: The Hemming Stitches
- 3.2 Closures: Buttons, Buttonholes, Snaps and Hooks
- 3.3 Mending and Patching
- 3.4 Embroidery and Crewel: The Bayeux Tapestry

UNIT 5 • WEEKS 17–20

Crochet

Crochet beyond the basics: the taller stitches and gauge-swatch math, working in the round from an adjustable ring, reading symbol charts, and a crocheted hat sized by arithmetic and given away.

- 5.1 Crochet Stitches and Gauge
- 5.2 Working in the Round
- 5.3 Reading Charts: Symbols and the Granny Square
- 5.4 Crochet for Others: Dorcas and the Warm Hat

UNIT 4 • WEEKS 13–16

Machine Sewing

The sewing machine mastered: the 1856 patent pool and machine maintenance, curved seams with clipping and notching, Judson and Sundback's zipper, and a lined tote with boxed corners, ending with a machine-sewn bag collection.

- 4.1 Howe, Singer and the Patent War
- 4.2 Seams and Seam Allowances: Curves and Circles
- 4.3 Zippers: Judson's Clasp Locker and Sundback's Fastener
- 4.4 A Machine-Sewn Tote with Boxed Corners

UNIT 6 • WEEKS 21–24

Knitting

Knitting beyond the basics: ribbing, knitting in the round on circular needles, resizing a pattern with gauge and yarn-weight math, and William Lee's stocking frame to the modern knitting machine, ending with a finished, blocked hat.

- 6.1 Knit and Purl Together: Ribbing
- 6.2 Knitting in the Round: A Hat on Circular Needles
- 6.3 Gauge, Yarn Weight and Pattern Math
- 6.4 Lee's Stocking Frame to the Knitting Machine

UNIT 7 • WEEKS 25–28

Home Sewing: Pillows, Drapes & Furniture Covers

Sewing for a real room: window measurement and fullness-and-yardage math, lined rod-pocket curtains, rotary-cut patchwork and a quilted table runner, and a re-covered chair seat with the staple gun used safely, ending with a finished piece installed at home.

- 7.1 Measuring a Room and a Window
- 7.2 Lining and Drapes
- 7.3 Quilting: The Pieced Block and the Rotary Cutter
- 7.4 Slipcovers and Upholstery

UNIT 8 • WEEKS 29–32

Design, Clothing & Costumes

Design and clothing: the design principles and a fabric board, Butterick's tissue patterns and pajama pants sewn from a commercial pattern, a historical costume piece built from research, and a final piece of the student's own design shown at the family sewing fair.

- 8.1 Design Principles: Line, Shape, Color and Texture
- 8.2 Commercial Patterns: Butterick's Tissue and Pajama Pants
- 8.3 Historical Costume: Colonial Williamsburg's Tailors and Milliners
- 8.4 Clothing That Fits Its Purpose and the Sewing Fair

WEEKLY PACING CALENDAR

WEEK	PLAN
1	• Session 1: Lesson 1.1 King Cotton and the Gin: warm-up, video, teaching and picture study • Session 2: Lesson 1.1 sewing project and sewing notebook <i>Two sessions a week is the usual rhythm: one to learn, one to sew. Younger children can split a long session in two. Leave the project out where it can be picked up again during the week.</i>
2	• Session 1: Lesson 1.2 Wool Science: Scales, Crimp and Felt: warm-up, video, teaching and picture study • Session 2: Lesson 1.2 sewing project and sewing notebook
3	• Session 1: Lesson 1.3 Silk and the Silk Road: warm-up, video, teaching and picture study • Session 2: Lesson 1.3 sewing project and sewing notebook
4	• Session 1: Lesson 1.4 Polymers: Nylon, Polyester and Spandex: warm-up, video, teaching and picture study • Session 2: Lesson 1.4 sewing project and sewing notebook • Session 3: Unit 1 review and unit challenge

WEEK	PLAN
5	• Session 1: Lesson 2.1 The Mill: Arkwright, Slater and Lowell: warm-up, video, teaching and picture study • Session 2: Lesson 2.1 sewing project and sewing notebook
6	• Session 1: Lesson 2.2 Weaves and Grain: warm-up, video, teaching and picture study • Session 2: Lesson 2.2 sewing project and sewing notebook
7	• Session 1: Lesson 2.3 Thread Count, Fabric Weight and What They Mean: warm-up, video, teaching and picture study • Session 2: Lesson 2.3 sewing project and sewing notebook
8	• Session 1: Lesson 2.4 Finishing Edges: Hems, Zigzag, Serger and French Seams: warm-up, video, teaching and picture study • Session 2: Lesson 2.4 sewing project and sewing notebook • Session 3: Unit 2 review and unit challenge
9	• Session 1: Lesson 3.1 Stitches That Hold: The Hemming Stitches: warm-up, video, teaching and picture study • Session 2: Lesson 3.1 sewing project and sewing notebook
10	• Session 1: Lesson 3.2 Closures: Buttons, Buttonholes, Snaps and Hooks: warm-up, video, teaching and picture study • Session 2: Lesson 3.2 sewing project and sewing notebook
11	• Session 1: Lesson 3.3 Mending and Patching: warm-up, video, teaching and picture study • Session 2: Lesson 3.3 sewing project and sewing notebook
12	• Session 1: Lesson 3.4 Embroidery and Crewel: The Bayeux Tapestry: warm-up, video, teaching and picture study • Session 2: Lesson 3.4 sewing project and sewing notebook • Session 3: Unit 3 review and unit challenge
13	• Session 1: Lesson 4.1 Howe, Singer and the Patent War: warm-up, video, teaching and picture study • Session 2: Lesson 4.1 sewing project and sewing notebook
14	• Session 1: Lesson 4.2 Seams and Seam Allowances: Curves and Circles: warm-up, video, teaching and picture study

WEEK	PLAN
	Session 2: Lesson 4.2 sewing project and sewing notebook
15	- Session 1: Lesson 4.3 Zippers: Judson's Clasp Locker and Sundback's Fastener: warm-up, video, teaching and picture study - Session 2: Lesson 4.3 sewing project and sewing notebook
16	- Session 1: Lesson 4.4 A Machine-Sewn Tote with Boxed Corners: warm-up, video, teaching and picture study - Session 2: Lesson 4.4 sewing project and sewing notebook - Session 3: Unit 4 review and unit challenge
17	- Session 1: Lesson 5.1 Crochet Stitches and Gauge: warm-up, video, teaching and picture study - Session 2: Lesson 5.1 sewing project and sewing notebook
18	- Session 1: Lesson 5.2 Working in the Round: warm-up, video, teaching and picture study - Session 2: Lesson 5.2 sewing project and sewing notebook
19	- Session 1: Lesson 5.3 Reading Charts: Symbols and the Granny Square: warm-up, video, teaching and picture study - Session 2: Lesson 5.3 sewing project and sewing notebook
20	- Session 1: Lesson 5.4 Crochet for Others: Dorcas and the Warm Hat: warm-up, video, teaching and picture study - Session 2: Lesson 5.4 sewing project and sewing notebook - Session 3: Unit 5 review and unit challenge
21	- Session 1: Lesson 6.1 Knit and Purl Together: Ribbing: warm-up, video, teaching and picture study - Session 2: Lesson 6.1 sewing project and sewing notebook
22	- Session 1: Lesson 6.2 Knitting in the Round: A Hat on Circular Needles: warm-up, video, teaching and picture study - Session 2: Lesson 6.2 sewing project and sewing notebook
23	- Session 1: Lesson 6.3 Gauge, Yarn Weight and Pattern Math: warm-up, video, teaching and picture study - Session 2: Lesson 6.3 sewing project and sewing notebook

WEEK	PLAN
24	• Session 1: Lesson 6.4 Lee's Stocking Frame to the Knitting Machine: warm-up, video, teaching and picture study • Session 2: Lesson 6.4 sewing project and sewing notebook • Session 3: Unit 6 review and unit challenge
25	• Session 1: Lesson 7.1 Measuring a Room and a Window: warm-up, video, teaching and picture study • Session 2: Lesson 7.1 sewing project and sewing notebook
26	• Session 1: Lesson 7.2 Lining and Drapes: warm-up, video, teaching and picture study • Session 2: Lesson 7.2 sewing project and sewing notebook
27	• Session 1: Lesson 7.3 Quilting: The Pieced Block and the Rotary Cutter: warm-up, video, teaching and picture study • Session 2: Lesson 7.3 sewing project and sewing notebook
28	• Session 1: Lesson 7.4 Slipcovers and Upholstery: warm-up, video, teaching and picture study • Session 2: Lesson 7.4 sewing project and sewing notebook • Session 3: Unit 7 review and unit challenge
29	• Session 1: Lesson 8.1 Design Principles: Line, Shape, Color and Texture: warm-up, video, teaching and picture study • Session 2: Lesson 8.1 sewing project and sewing notebook
30	• Session 1: Lesson 8.2 Commercial Patterns: Butterick's Tissue and Pajama Pants: warm-up, video, teaching and picture study • Session 2: Lesson 8.2 sewing project and sewing notebook
31	• Session 1: Lesson 8.3 Historical Costume: Colonial Williamsburg's Tailors and Milliners: warm-up, video, teaching and picture study • Session 2: Lesson 8.3 sewing project and sewing notebook

WEEK	PLAN
32	• Session 1: Lesson 8.4 Clothing That Fits Its Purpose and the Sewing Fair: warm-up, video, teaching and picture study • Session 2: Lesson 8.4 sewing project and sewing notebook • Session 3: Unit 8 review and unit challenge <i>Last week. Hold a family sewing fair: the student sets out the year's finished pieces with a card for each, shows how to do one skill, shows the sewing notebook, and gives one piece away as a gift.</i>

MATERIALS

Sewing notebook (any notebook or a binder with page protectors)

One for the whole year: the math for every project, fabric swatches, stitch samples, sketches, photographs and “next time I will...” notes. Clear tape or a glue stick for swatches.

A basic sewing kit

Hand-sewing needles (sharps sizes 5–9, embroidery needles, a darning needle), a needle threader, all-purpose thread in several colors, embroidery floss, a thimble, dressmaker pins with ball heads, sewing clips, a seam ripper, and a pincushion or magnetic dish for the needle-and-pin count.

Fabric shears, small thread scissors, paper scissors and a seam gauge

Keep the shears for fabric only. A 6-inch seam gauge with a sliding marker makes hems and seam allowances fast and accurate.

A 60-inch tape measure, a yardstick or long ruler, and tailor's chalk or washable markers

Used constantly: bodies, windows, chairs, yardage and pattern layouts all get measured this year.

A rotary cutter, cutting mat and clear acrylic ruler (Unit 7; optional elsewhere)

A 45 mm rotary cutter, an 18 × 24 inch mat and a 6 × 24 inch ruler make patchwork accurate. Used with an adult nearby, always on the mat, blade closed every time it is set down. Fabric shears work for every project if you skip the rotary cutter.

Cotton fabric, muslin and the family rag bag

Quilting cotton and muslin for samples, bags, curtains and patchwork; old jeans, shirts, sheets and pillowcases for mending practice, linings and costume pieces. Prewash fabric for anything that will be washed later.

Yarn, a crochet hook and knitting needles

Worsted-weight (#4) yarn in wool or acrylic plus cotton yarn for dishcloth-weight projects; a 5 mm (H-8) crochet hook; US 8 (5 mm) straight needles and a 16-inch US 8 circular needle; a large-eye yarn needle; stitch markers.

An iron, an ironing board and a press cloth

Students at this level iron on their own after an adult check: upright on its heel between presses, the right setting for the fiber, a press cloth over anything synthetic or delicate, unplugged when done.

A sewing machine with spare needles and bobbins (required in Unit 4; useful in Units 7–8)

Any working home machine with a straight stitch and a zigzag, plus a zipper foot for Unit 4. Borrowing one from a relative or a friend at church is fine. Every machine project also has a hand-sewn option.

A staple gun and safety glasses (Unit 7 only)

For the chair-seat project, used only with an adult beside the student and safety glasses on. A hand-sewn cushion-cover option is given for families who skip it.

A magnifying glass or linen tester, a kitchen scale, a calculator and a camera or phone

For counting threads per inch, weighing fabric and yarn, checking the gauge and yardage math, and photographing finished projects for the notebook and the fair.

GRADING

Grades come mostly from the sewing projects and the sewing notebook, because sewing is learned by making, recording and trying again. The arithmetic counts: a project page without its measurements and math is incomplete. A project with crooked seams that is honestly recorded and then redone with one improvement earns full credit.

PART	%
Sewing projects (effort, safety, accuracy of the math, neatness and the improve round)	40
Sewing notebook (math, swatches, stitch samples, sketches, next-time notes)	20
Unit reviews	15
Unit challenges	25

Scale: A 90–100, B 80–89, C 70–79, D 60–69. Below 60: redo the project or review with help until it is solid.

- Grade the maker, not only the thing made. Did the student measure and calculate before cutting, follow the safety ladder, count needles and pins, record honestly, clean up and try an improvement?
- A notebook page earns full marks when it has a date, the measurements and math, a swatch or sample, a sketch or photo, and one sentence about what to change next time.
- A project with crooked seams that is honestly recorded and redone earns full credit. Every sewer has unpicked a seam and sewn it again.
- Calculations on unit reviews earn full points only with the work shown; a right answer with no work earns half.
- Never grade or comment on anyone's body or size. When bodies are measured in Unit 8, measurements are written for fit only.

A NOTE TO PARENTS

You do not need to be a seamstress or a tailor to teach this course. At this level your main jobs are the safety check-offs, the math check and good questions. Watch the student thread the machine and sew a seam before signing off on solo use; do the same for the iron; stand beside them for the staple gun and stay nearby for the rotary cutter. When a project begins, ask to see the measurements and the math before the scissors come out. Then ask the two questions every good sewing teacher asks: “What do you think will happen?” and “How could we make it better?”

Expect seams unpicked and sewn again, a gauge swatch that lies, and a zipper that goes in twice. That is the craft being learned. The course is built so that a recorded mistake and a second try earn full credit, and so that the student finishes the year able to mend, to read a pattern, to figure yardage and cost, and to sew a garment from start to finish.

Many of the projects are meant to be given away: a crocheted hat for a hospital or shelter, a mended garment returned good as new, a costume for the church play, a quilted runner for a grandmother's table. Cloth is a quiet way to love people, as it was for

Dorcas and for the women whose wise hearts spun for the tabernacle. We hope your family finds that a needle and thread are good tools for serving others.

WHERE CLOTH COMES FROM

Every piece of cloth you own began as a fiber: a hair thinner than a pencil line, grown on a plant, grown on an animal, unwound from a cocoon, or drawn out of a vat in a chemical plant. In Fabrics & Sewing I you met these fibers; this year you will study them the way a textile buyer does. You will look at the structure of the cotton fiber and the scales and crimp of wool, learn why wool felts in hot water and why that is sometimes exactly what you want, follow silk from the mulberry leaf to the Silk Road, and meet the chemists who learned to build fibers molecule by molecule.

You will also start handling the numbers that every sewer uses: fabric width, price per yard, and cost per project. By the end of the unit you will have wet-felted real wool, hemmed a scarf edge by hand, watched an adult run a burn test and recorded it like a lab scientist, and written a fiber report that would do a fabric store proud.

PREREQUISITES

- Can thread a needle, tie a knot and sew a running stitch and backstitch (Fabrics & Sewing I, or practice Unit 3 skills early)
- Can multiply and divide with decimals and work with simple fractions of an inch
- Knows the needle-and-pin count rule from the course introduction

MASTERY CHECKLIST

- ☐ I can name the main natural and synthetic fibers, where each comes from, and one strength and one weakness of each.
- ☐ I can explain why wool felts: scales, crimp, heat, water and rubbing.
- ☐ I can tell how silk is produced and how silk-making spread from China to the West.
- ☐ I can explain what a polymer is and how a synthetic fiber is spun through a spinneret.
- ☐ I can figure the cost per yard of a fabric and compare two fabrics of different widths and prices.
- ☐ I can record a fiber test honestly: what we did, what I saw, what it means.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **A linen tester or folding magnifier:** A small fold-up magnifier that sits on the fabric, sold at fabric and hobby stores. Used all year for looking at fibers, weaves and threads per inch. A plain magnifying glass works too.
- **A kitchen scale that reads grams:** For weighing swatches, yarn and fabric in this unit and in Unit 2. Any inexpensive digital kitchen scale works.
- **National Cotton Council: The Story of Cotton:** Free. A plain, factual walk through how cotton is grown, ginned, spun and woven, from the people who market American cotton.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

1.1 King Cotton and the Gin	2 sessions of 50–60 minutes
1.2 Wool Science: Scales, Crimp and Felt	2 sessions of 50–60 minutes
1.3 Silk and the Silk Road	2 sessions of 50–60 minutes
1.4 Polymers: Nylon, Polyester and Spandex	2 sessions of 50–60 minutes

1.1 KING COTTON AND THE GIN

OBJECTIVES

- Tell how Eli Whitney's cotton gin (1793, patented 1794) worked and what it changed, including its sad effect on slavery, honestly and briefly.
- Tell how the mechanical cotton picker of John and Mack Rust in the 1930s–1940s changed the harvest again.
- Compare cotton fabrics by weight and weave, and compute and compare cost per yard.

Warm-up. Go to your closet with a notebook. Read the fiber-content labels of ten garments and tally the fibers you find. How many are all cotton? How many are blends? Guess before you count: which fiber will be most common? Were you right?

WATCH

Eli Whitney Cotton Gin - How it works

Cotton Lessons • 2:26

<https://www.youtube.com/watch?v=Ur-IssVtWnI>

WHEN TO WATCH

After the story, before the fabric study. Watch the teeth pull the fiber through the grate and leave the seeds behind; that one motion is the whole invention.

Note: An old black-and-white educational film re-creating a hand-cranked gin in use, from a small channel that posts cotton history clips; there is no narration to preview, only the machine at work.

BACKUP VIDEO

Eli Whitney's Invention

NBC News Learn • 2:23

<https://www.youtube.com/watch?v=LiuYxA7JDx4>

With a parent, after the teaching.

KEY TERMS

boll

The seed pod of the cotton plant. When it ripens it splits open, showing the white fiber packed around the seeds.

staple

The length of a fiber. Upland cotton has a staple of about 1 inch; long-staple cottons such as Pima run 1 $\frac{3}{8}$ inches or more and make smoother, stronger thread.

cost per yard

The price of fabric for one running yard off the bolt. To compare fabrics fairly you must also look at the width of the bolt.

gin

Short for “engine”: a machine with toothed cylinders that pulls cotton fiber through a grate too narrow for the seeds, separating fiber from seed.

bale

The big pressed block in which cotton is shipped. An American bale weighs about 480 pounds (218 kg).

CORE IDEAS

The story. In 1793 a young Connecticut schoolmaster named Eli Whitney was staying at Mulberry Grove, a Georgia farm, when he heard planters complain that upland cotton was nearly worthless: a worker cleaning it by hand could pull the sticky green seeds out of only about a pound of fiber a day. Whitney built a machine he called a cotton gin — “gin” is just short for engine. Toothed cylinders grabbed the fiber and pulled it through slots in a grate too narrow for the seeds to follow; a brush swept the cleaned fiber off the teeth. One small, hand-cranked box could clean fifty pounds a day. Whitney received his patent on March 14, 1794, though copies of his simple machine spread faster than he could ever collect his fees.

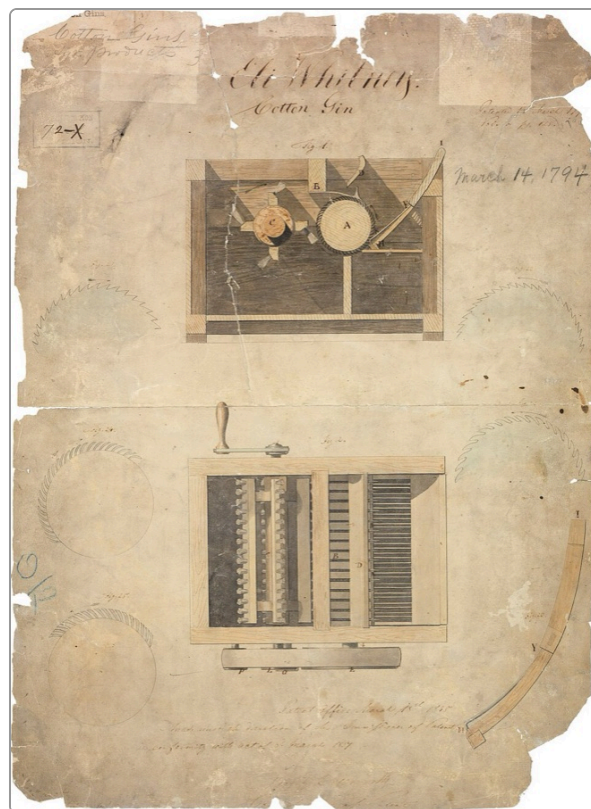
How they figured it out, and what it cost. The gin made cotton suddenly profitable, and the South planted it everywhere; by the 1850s people said “Cotton is King.” But this must be told honestly: the fieldwork of planting, hoeing and picking was still done by hand, and planters forced enslaved people to do it. Instead of fading away, as some founders had hoped, slavery in the American South grew enormously in the years after the gin — one clever machine, built to save labor, ended up binding millions of people more

tightly in bondage until slavery was abolished at the end of the Civil War in 1865. Picking itself was not mechanized until the twentieth century: two Texas brothers, John and Mack Rust, built a working spindle picker in the 1930s, and after further engineering by the big equipment companies, machines were picking most American cotton by the 1960s. Today one picker does the work of hundreds of hands.

The fabric science. A cotton fiber is a single plant cell, almost pure cellulose, that grows like a hollow tube on the seed and collapses into a flat, twisted ribbon when the boll dries. Those natural twists are why cotton spins so well: the fibers grip each other. Cotton is soft, absorbent, cool to wear and easy to wash hot, but it wrinkles, shrinks if it is not preshrunk, and dries slowly. The same fiber becomes very different fabrics depending on the yarn and weave: airy voile, smooth broadcloth, soft flannel, sturdy canvas and heavy denim are all cotton. Sewers compare them by weight (a quilting cotton weighs about 4 ounces per square yard; denim runs 10 to 14) and by price. Here is the buyer's math: fabric is sold by the running yard, but bolts come in different widths, usually 44 inches or 60 inches. A yard of 60-inch fabric contains $60 \times 36 = 2,160$ square inches; a yard of 44-inch fabric only $44 \times 36 = 1,584$. So a 60-inch fabric at \$11 a yard can be a better buy than a 44-inch fabric at \$9: divide price by square inches and see.

Let's study. Today's project is a **cotton study** for your notebook: six cotton swatches weighed, examined and labeled, and a cost-per-yard comparison worked out like a buyer. Your one skill: compare fabrics with numbers, not guesses.

PICTURE STUDY



Eli Whitney's Cotton Gin Patent Drawing, Eli Whitney (drawing restored for the U.S. Patent Office), Patented March 14, 1794; this restored drawing about 1841–1845 · Ink and watercolor on paper · National Archives, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

A patent drawing is a working picture: it must show another mechanic exactly how the machine is built. Whitney's original papers burned in the Patent Office fire of 1836, so after Congress ordered the lost records restored, the office made careful replacement drawings like this one from surviving copies. Look at it the way an inventor would.

Look closely

- Find the large cylinder marked A in the top drawing. Its teeth grab the cotton fiber and pull it toward the grate.
- In the bottom drawing, find the row of teeth and the slotted grate beside them. Why can the fiber pass through the slots but not the seeds?
- Find the smaller cylinder with brushes (marked C in the top drawing). What job does it do after the fiber comes through?

- Find the crank handle. Who or what turned it, and how fast could one person clean cotton with it compared with picking seeds by hand?
- Look at the separate drawings of saw teeth around the edges. Why would the inventor draw the shape of the teeth so carefully?

Talk about it

1. Why does a patent require a drawing and not just a written description?
2. The gin cleaned cotton about fifty times faster than a person. Why did a labor-saving machine end up increasing slavery instead of reducing work? Say it in your own words.
3. If you invented something useful, what would you draw first: the whole machine or the one part that makes it work?

Safety first. A parent or responsible adult supervises all sewing tool use in this course, and the needle-and-pin count opens and closes every session. Today uses fabric shears and a seam ripper: shears are carried closed and points down and passed handle first, and the ripper rips away from your hand. Keep swatches and pins away from little brothers and sisters.

SEWING PROJECT

A Cotton Study and a Cost-per-Yard Comparison

A good sewer knows cotton the way a cook knows flour: by name, weight and feel. You will build a six-swatch cotton study for your notebook, weigh the swatches to rank the fabrics, and then do the arithmetic a careful buyer does before the scissors ever touch the bolt.

You will need

- Fabric shears and paper scissors
- A ruler or quilting ruler and a washable marker
- A kitchen scale that reads grams (or a postal scale)
- A magnifying glass or linen tester
- Clear tape or a glue stick, and your sewing notebook
- A calculator

SIX-SWATCH COTTON STUDY PAGES

Finished size: two notebook pages of six 4 × 4 in (10 × 10 cm) swatches · About 60 minutes

Fabric and notions

- 6 cotton fabrics, about 4 × 4 inches each, as different as you can find: muslin or quilting cotton, flannel, denim (an old pant leg), T-shirt knit, canvas or duck, and terry cloth or corduroy — the rag bag supplies most of these
- 2 notebook pages or cardstock sheets
- A store receipt, website printout or shelf-tag note with the price and width of at least two cotton fabrics (gather on a family errand or online with a parent)

How to make it

1. Cut each fabric into a true 4 × 4 inch square. Measure and mark before you cut; a crooked swatch gives a wrong weight.
2. Weigh each swatch in grams and write the weight on a sticky note on the swatch.
3. Rank the six swatches from lightest to heaviest. Since every swatch is the same size, the weights compare the fabrics fairly — this is exactly why mills quote fabric weight in ounces per square yard.
4. Look at each swatch with the magnifier. Which are woven (threads crossing over and under) and which are knit (little loops)? Which have a brushed, fuzzy surface?
5. Tape each swatch into the notebook with a label: fabric name, weight in grams, woven or knit, and one job this fabric is best for.
6. Now the buyer's math. Fabric A: \$9.00 a yard, 44 inches wide. Fabric B: \$11.00 a yard, 60 inches wide. Compute square inches per yard (width × 36), then price ÷ square inches. Which costs less per square inch of fabric?
7. Do the same arithmetic for the two real prices you gathered, and write a sentence: which is the better buy, and why?
8. Finish the page with one paragraph: where cotton comes from, one strength, one weakness, and the year of Whitney's patent.

Fabric check: All-cotton fabrics work best for this study; check the labels, because many “denim” and “flannel” items are blends. A blend is fine for one swatch if you label its true content. Prewashed fabric from the rag bag weighs true; brand-new fabric carries sizing (a starch) that adds a little weight.

Steps

1. **Count out.** Needle-and-pin count, even on a no-sewing day — pins hold the swatch stacks.
2. **Predict first.** Before weighing, line up the six swatches in your guessed order, lightest to heaviest. Write the guess down.
3. Make the study pages from the pattern card.
4. **Check your prediction.** How many swatches did you place correctly? Which fooled you, and why — fluffiness, thickness, tight weave?
5. **Count in and clean up.** Pins back in the cushion, threads and trimmings in the trash, shears away.
6. **Improve it.** Add a seventh swatch of the strangest cotton you can find (seersucker, gauze, velveteen) and fit it into your ranking.

Tips

- If your scale will not read a single light swatch, weigh all six together, then five, then four; the differences give each swatch’s weight.
- Convert once and be done: 1 ounce $\approx$ 28.35 grams. A 4×4 inch swatch is $1/81$ of a square yard, so $\text{grams} \times 81 \div 28.35 \approx \text{ounces per square yard}$.
- Older students: compute ounces per square yard for all six swatches and check them against the ranges in the lesson.

Check your work

- ☐ My six swatches are true 4-inch squares, weighed and labeled.
- ☐ I can compare two fabrics of different widths by price per square inch and name the better buy.
- ☐ I wrote the gin’s story in one honest paragraph, including what it meant for enslaved people.

SEWING NOTEBOOK

1. Draw the cotton gin in cutaway: hopper, toothed cylinder, grate, brush. Arrows for the fiber’s path and the seeds’ dead end.

2. Make a cost-per-yard table with columns for price, width, square inches and price per 100 square inches, filled in for the fabrics you compared.
3. Tape in a few cotton fibers pulled from a cotton ball and stretch one beside a line you draw exactly 1 inch long: that is a staple length.

From history. Whitney never grew rich from the gin — courts and copying ate his profits — so he turned to making firearms for the government and became one of the fathers of interchangeable parts, an idea that would one day make sewing machines affordable too. The two inventions bracket this course: the gin fed the mills, and interchangeable parts built the machines in Unit 4.

COMMON MISTAKES

- Comparing fabric prices without comparing widths. A cheap narrow fabric can cost more per square inch than a dearer wide one.
- Cutting swatches by eye. Unequal squares make the weights meaningless; measure and mark first.
- Writing “cotton is the good fiber.” Cotton wrinkles, shrinks and dries slowly; every fiber has strengths and weaknesses, which is why blends exist.

Make it a game • Price-Tag Showdown. Your parent writes five made-up bolt tags, each with a price and a width (say \$6 at 44 in, \$8 at 60 in). On “go,” both of you race to rank them from best buy to worst by price per square inch, calculators allowed. Compare answers and defend your math. Loser cuts the next set of swatches.

Scripture. “Consider the lilies of the field, how they grow; they toil not, neither do they spin: And yet I say unto you, That even Solomon in all his glory was not arrayed like one of these.” (Matthew 6:28-29, KJV)

Jesus points at a plant and calls its clothing finer than a king’s. A cotton boll is that kind of quiet glory: God grows the fiber; people only gin, spin and weave it.

1.2 WOOL SCIENCE: SCALES, CRIMP AND FELT

OBJECTIVES

- Describe the structure of a wool fiber: protein, overlapping scales, crimp and lanolin, and connect each feature to something wool does.
- Explain why wool felts in hot water with soap and rubbing, and why a wool sweater must be washed cool and gently.
- Wet-felt a firm wool ball or felted soap bar using heat, soap and friction on purpose.

Warm-up. Find something wool in the house (a sweater, a blanket, a dress sock) and something cotton. Pull one fiber or a bit of fuzz from each, hold them to the light, and stretch them gently. Which fiber looks wavy? Which springs back? Breathe on both through your fist: which feels warmer?

WATCH

What Happens to My Wool Sweater in the Washer?

SciShow · 2:27

<https://www.youtube.com/watch?v=sSQLulfD618>

WHEN TO WATCH

After the fabric science, before you felt on purpose. It shows the cause of the shrinking — the scales — in two and a half minutes.

BACKUP VIDEO

Wet Felting Tutorial for Beginners: How to Wet Felt Wool Fabric // Wet Felting Techniques

AB Crafty · 8:18

<https://www.youtube.com/watch?v=3lxCDkh-evs>

Before Session 2, with your roving and towel laid out. It felts a flat piece; your ball uses the same layering and rubbing.

KEY TERMS

keratin

The protein that wool, hair, horn and fingernails are made of. Wool is a protein fiber; cotton is a plant-cellulose fiber.

scales

Overlapping plates on the surface of a wool fiber, like shingles on a roof. They all point toward the tip of the fiber.

crimp

The natural wave in a wool fiber. Fine merino wool can have dozens of waves per inch. Crimp traps air and makes wool springy.

lanolin

The natural grease on a sheep's fleece that sheds rain. It is washed out of the fleece (scoured) and sold for hand creams and ointments.

felting

Locking wool fibers permanently together with moisture, heat, soap and rubbing, so the scales catch and the fibers cannot slide back.

CORE IDEAS

The story. Every family that has ever washed clothes has a version of this story: a fine wool sweater goes into a hot machine wash and comes out the size of a doll's jacket, dense as a board. For centuries, though, makers have run that same accident on purpose. Hatmakers felted wool into firm hat bodies; Central Asian herding families still felt fleece into thick panels for their round tents; boiled-wool slippers and mittens keep northern feet and hands warm. One process, ruined sweater or warm tent, depending on whether you meant to do it.

How they figured it out. Shepherding peoples likely met felt before they met weaving: fleece that is trodden, dampened and worked — even wool padding in a shoe — mats into solid cloth all by itself. The wool trade grew into serious science. Breeders selected sheep for finer and finer fiber: today a fiber's thickness is measured in microns (thousandths of a millimeter). Fine merino runs about 17 to 24 microns; a human hair is roughly 70. The finer and crimpier the fiber, the softer the yarn — and the more easily it felts, which is why your finest sweaters carry the sternest care labels.

The fabric science. Under a microscope a wool fiber looks like a tiny shingled roof rolled into a tube: overlapping **scales**, all pointing toward the tip. Warm water makes the scales lift; soap lets fibers slide; rubbing pushes them past each other. Each fiber can slide tip-first but the raised scales catch like barbs when it tries to slide back. Millions of one-way slides later, the fibers are locked in a tangle that can never be undone: felt. The **crimp** springs the tangle tight. This also explains wool's everyday manners: crimp traps still air, so wool insulates even when damp; the fiber's core can drink in about a third of its own weight in moisture vapor before the fabric feels wet; and the scales grab dye deeply. Cotton has no scales, which is why your T-shirts survive the hot wash that shrinks a sweater. So the care rule writes itself: wash wool cool, with gentle soap, squeezing instead of wringing, and dry it flat.

Let's felt. You will **wet-felt a firm ball** (or cover a bar of soap in felt, making a scrubbing washcloth and soap in one). Your one skill: control the felting — gentle at first so the layers hold together, firm later so the ball hardens — and write down what changed the moment you added hot water.

PICTURE STUDY



Shearing Sheep, Jean-François Millet, about 1852–1853 • Oil on canvas • Museum of Fine Arts, Boston

Image: [Wikimedia Commons](#), public domain

Millet painted the farm people of Barbizon, France, doing real work with dignity. Here two workers shear a sheep the old way: hand shears, a steady grip and long practice. A good shearer takes the fleece off in one connected piece, like helping the sheep out of a coat it will grow again by winter.

Look closely

- Find the hand shears. How are they different from scissors?
- Look at the fleece folding back off the sheep's side. Why does it come away as one blanket-like piece instead of loose tufts?
- Find the second worker's hands. What is his job, and why does shearing take two people here?
- Look at the sheep itself. Does it seem hurt or calm? Shearing is a haircut, not an injury — and a sheep needs it every year.

Talk about it

1. A fleece can weigh several pounds and is full of lanolin grease when it comes off. List the steps between this barn and a ball of knitting yarn.
2. Why would a painter choose farm work as a serious subject for a large painting?
3. The shearer's own clothes are probably wool. What would she notice about her skirt on a damp day that a cotton skirt would not do?

Safety first. Count needles and pins out and back in, though today's tools are mostly a bowl and a towel. The felting water should be hot from the tap, not boiling — comfortable for your hands with a brief dip. Wipe up splashes so the floor is not slippery, and keep loose roving away from babies, toddlers and pets.

SEWING PROJECT

Wet-Felt a Ball or a Felted Soap

Today you run the sweater accident on purpose and watch the science happen under your own hands. A felted ball makes a dryer ball (toss two or three in the dryer to soften clothes without chemicals), a pincushion core or a juggling ball; felted soap is a bar of soap in a built-on washcloth, a favorite gift. Both are the same lesson: scales, heat, soap, friction.

You will need

- A bowl of hot tap water and a bowl of cold water
- A towel on the table and an old washboard-textured surface if you have one (a sushi mat or bubble wrap works)
- A bar of soap for felted soap, or a drop of dish soap for the ball
- A kitchen scale and your notebook

FELTED WOOL BALL (OR FELTED SOAP BAR)

Finished size: one ball about 2 inches (5 cm) across, or one covered soap bar · About 45 minutes

Fabric and notions

- About ½ ounce (15 g) of 100% wool roving — it must be real wool, not acrylic “craft fiber,” and not “superwash” wool, which is treated so it cannot felt
- Optional: a thin top layer of colored roving for pattern
- For felted soap: one bar of soap, any plain kind
- Hot tap water, a little soap, a towel

How to make it

1. Weigh your roving and write the weight down; you will weigh the finished ball too.
2. Pull (never cut) the roving into palm-width tufts. Pulling keeps the fiber ends soft and open so the layers can grab each other.
3. Wind tufts into a loose ball, each layer crossing the one beneath at a right angle, until it is half again as big as you want — felting shrinks it. For felted soap, wrap the bar the same way, crossing layers, until the soap disappears.
4. Dip the ball briefly in hot water, add one drop of soap to your palms, and cup it gently — barely touching — rolling it ten slow circles. Press too hard now and the layers shove apart into wrinkles.
5. As the surface starts to hold together and feel like one skin, roll with a little more weight. Re-dip in hot water whenever it cools.
6. Now work in earnest: firm rolling in your palms, a minute at a time, dipping alternately in hot and cold water. The shock of hot-to-cold speeds the felting. Feel it hardening.

7. The ball is done when it is firm to a hard squeeze, nothing shifts, and no fibers lift away when you rub it. Rinse it clean (for the ball; soap stays soapy), squeeze in the towel and dry it on a rack for a day or two.
8. Weigh the dry ball and measure it. Compare with your starting notes: what did water and work change?

Fabric check: Only untreated 100% wool felts: read the roving label, and avoid anything marked superwash or machine-washable. Corriedale and similar medium wools felt fast and make a sturdy ball; fine merino felts smoother but needs patience. If anyone in the family is sensitive to wool, this is a good project to make as a gift and work with dry hands rinsed after.

Steps

1. **Count out** your pins and needle, out of habit, even today.
2. **Run a control.** Before you start, set aside one dry tuft of roving. At the end, compare it with the felted surface under the magnifier and tape both into the notebook.
3. Make the ball or soap from the pattern card.
4. **Record like a scientist.** Note the minute when the loose fluff first became one “skin,” and what you had just changed (water temperature? pressure?).
5. **Count in and clean up.** Wipe the table and floor dry; wool fuzz goes in the trash, not the drain.
6. **Improve it.** Make a second ball with a colored pattern layer, or felt a matched set of three dryer balls as a gift.

Tips

- If the ball grows whiskery cracks, you pressed hard too early. Patch with a thin wisp of roving, wet it and start gently again.
- Cold-rinse, then hot-dip, then roll: the temperature swing is your friend; wool’s scales open in warmth.
- Felted soap note: it lathers right through the wool, and the cover shrinks snug as the soap wears down.

Check your work

- ☐ My ball is firm, smooth and will not pull apart.
- ☐ I can explain felting with four words: scales, heat, soap, friction.

- ☐ I recorded weights and times, and I can say why a sweater must never go in a hot wash.

SEWING NOTEBOOK

1. Draw one wool fiber magnified: the shingle-like scales pointing toward the tip, and the crimp waves. Beside it, draw a smooth cotton ribbon for contrast.
2. Tape in your dry roving tuft and a trimmed wisp from the felted surface, labeled before and after.
3. Write a three-line care label for an imaginary wool sweater, in your own words, that a younger child could follow.

From history. Legend says felt was discovered by travelers who padded their sandals with wool, and the walking did the rest — told as legend, it is at least good science: moisture, heat and friction are exactly the recipe. What is sober fact is that felt tents, boots and saddle blankets kept whole peoples alive on cold plains long before anyone there wove cloth.

COMMON MISTAKES

- Buying superwash wool or acrylic roving and concluding that felting is a myth. Treated and synthetic fibers have no working scales.
- Rubbing hard from the first minute, which shoves the layers into cracks and lumps. Whisper first, work later.
- Winding all the layers in the same direction, so the ball felts into a spiral with weak seams. Cross every layer.
- Wringing the finished ball like a dishcloth. Squeeze it in a towel and let it dry round.

Make it a game • Fiber in the Dark. Your parent collects six fabric scraps — at least one wool, one cotton, one synthetic — and hands them to you behind your back or under a cloth. By feel alone, sort wool from not-wool and say which clue decided you: warmth, spring, fuzz. Score a point per correct call, then swap roles with new scraps.

Scripture. “He giveth snow like wool: he scattereth the hoar frost like ashes.” (Psalm 147:16, KJV)

The psalmist reaches for wool to describe snow: thick, white, soft and warm-looking. God wrapped sheep in the very picture of a blanket, and lets us borrow it.

1.3 SILK AND THE SILK ROAD

OBJECTIVES

- Describe sericulture: the silkworm's life, the mulberry leaf, the cocoon and the reeling of the filament.
- Tell how silk and silk-making traveled west, including the account of the monks who brought silkworm eggs to Emperor Justinian around A.D. 552.
- Sew a hand-rolled hem, the classic edge finish for fine scarves and handkerchiefs.

Warm-up. Find the shiniest fabrics in the house: a necktie, a scarf, a blouse lining, a ribbon. Tilt each one under the light. Which shines in a soft, deep way and which in a hard, glassy way? Read the labels: which are silk, and which polyester? Feel each between two fingers and compare the sound it makes when it rubs.

WATCH

The mystery of silk: a brief global history of the remarkable material

Victoria and Albert Museum • 7:52

<https://www.youtube.com/watch?v=KbsS5IVHqqo>

WHEN TO WATCH

After the story, before the picture study. Watch for the microscope view of the filament and the sericulture section around the three-minute mark.

BACKUP VIDEO

Traditional Silk-Making - From AMNH's Silk Road Exhibition

American Museum of Natural History • 3:06

<https://www.youtube.com/watch?v=IFo3SxqH2-A>

Watch a real sericulturist reel filament off cocoons in hot water — three minutes, start to thread.

KEY TERMS

sericulture

The raising of silkworms on mulberry leaves to produce silk. From the Latin *sericum*, silk.

filament

A fiber of continuous, unbroken length, like reeled silk or extruded nylon. The opposite of a staple fiber, which is short and must be spun.

sericin

The natural gum that glues the cocoon together. Hot water softens it so the filament can be unwound; boiling it away later gives silk its full softness and sheen.

cocoon

The case the silkworm spins around itself from one continuous filament of silk, often 600 to 900 meters long — more than a thousand yards in fine cocoons.

reeling

Unwinding the filaments from softened cocoons, several together, onto a turning wheel to make raw silk thread.

CORE IDEAS

The story. China kept the secret of silk for something like two thousand years. The old Chinese legend credits Empress Leizu with discovering it when a cocoon dropped into her hot tea and unraveled into shining thread — a legend, told as one, but it remembers something true: hot water really is the key that unlocks a cocoon. Caravans carried finished silk west across deserts and mountains on the routes we now call the Silk Road, and in Rome silk sold for fabulous prices, but the worm itself stayed home; exporting eggs or mulberry seeds was said to be punishable by death. Then, around A.D. 552, the historian Procopius records, two monks came to the Emperor Justinian in Constantinople. They had lived in the East and knew the whole art. Justinian sent them back, and they returned with silkworm eggs hidden — so the story goes — inside their hollow walking canes. From those smuggled eggs grew the silk industry of the Byzantine Empire, and in time, of Italy and France.

How they figured it out. Sericulture is farming at the scale of an insect. The silk moth, *Bombyx mori*, has been domesticated so long it can no longer fly; it depends entirely on its keepers. The caterpillars hatch from eggs smaller than poppy seeds and eat chopped

white-mulberry leaves day and night for about a month, multiplying their weight thousands of times and molting four times. Then each one spins its cocoon in two or three days, swinging its head in figure-eights, laying out one continuous double filament glued with sericin. Most cocoons are then steamed or placed in hot, not quite boiling, water, which softens the gum before the moth can break the filament by emerging; a portion are set aside to hatch and lay the next generation's eggs. A worker finds the loose end of each cocoon with a little brush and reels five to ten filaments together into one strand of raw silk. It takes roughly 2,500 cocoons to make one pound of silk — which is why silk has never been cheap, and why the secret was worth guarding.

The fabric science. Silk, like wool, is a protein fiber — but it is smooth, with no scales, so it cannot felt, and it is one of the strongest natural fibers there is: for its weight, a silk filament can take a pull comparable to a steel wire's. The filament is a smooth triangular prism, and that cross-section is the secret of silk's light: flat surfaces bounce light back in a soft, deep luster instead of the hard sparkle of round synthetic filaments. Silk is cool in summer, warm in winter, takes dye gloriously — and has real weaknesses: sunlight slowly weakens it, perspiration can stain it, and a hot iron scorches it (use the silk setting and a press cloth). Because every inch is precious, silk edges are traditionally finished with the narrowest hem there is: the **hand-rolled hem**, in which your fingers roll the raw edge twice around itself into a tube narrower than 1/8 inch, caught down with tiny slip stitches.

Let's sew. You will sew a **hand-rolled hem** along at least one edge of a scarf or handkerchief square. Your one skill: roll a little, stitch a little — never flatten the roll, never let the stitches show more than a pin-dot on the front.

PICTURE STUDY



Court Ladies Preparing Newly Woven Silk (detail), Attributed to Emperor Huizong of Song, after Zhang Xuan, early 12th century · Ink, color and gold on silk (detail of a handscroll) · Museum of Fine Arts, Boston

Image: [Wikimedia Commons](#), public domain

This handscroll was painted in China about nine hundred years ago, copying an even older painting. The whole scroll shows women finishing new silk: pounding it to soften it, sewing, and here, stretching and ironing a long bolt. Read a handscroll like a story, scene by scene; this is one scene.

Look closely

- Find the long white bolt of silk. How many hands does it take to keep it taut, and why must it be pulled tight to be pressed?
- Find the long-handled pan the lady in orange holds. It is filled with hot coals: an iron. What do our irons share with it, and what have we added?
- Find the round brazier at the right. What is it for?
- Find the small girl in pink ducking under the cloth. What does she add to the picture?

- Look at the painted gowns. The artist painted silk clothing on silk cloth. Where do the gowns seem to shine or float?

Talk about it

1. Count the jobs being done in this one scene. Why would finishing silk be shared by several people?
2. Why would an emperor bother to copy and keep a painting of women working cloth?
3. Your iron has a silk setting. What would happen to this bolt if the coals were too hot?

Safety first. Count needles and pins out and back in; a fine needle in a slippery fabric escapes easily, so park it in the pincushion every time you pause. You may iron your scarf edges yourself once an adult has checked you off on the iron: silk setting, a press cloth, iron upright on its heel between presses, unplugged when done.

SEWING PROJECT

A Hand-Rolled Hem Scarf or Handkerchief

The rolled hem is the signature of fine sewing: Parisian scarf makers still finish the edges of their best silk squares by hand. You will roll and stitch at least one edge of a square — silk if the rag bag or thrift store offers an old silk scarf or blouse to cut, fine cotton lawn or a cotton handkerchief if not. The skill transfers exactly.

You will need

- A fine, short hand-sewing needle (sharps size 9–11) and a pincushion
- Fine thread to match (fine cotton or all-purpose polyester)
- Small sharp scissors; fabric shears for cutting the square
- An iron and press cloth (adult check-off), a ruler and a washable marker

ROLLED-HEM SQUARE

Finished size: one square, 12 × 12 in to 16 × 16 in (30–40 cm) · About 60 minutes for one edge; finish the other edges through the week

Fabric and notions

- 1 square of lightweight fabric with cleanly cut edges: silk from an old scarf or blouse, cotton lawn, voile or a fine handkerchief cotton
- Fine matching thread, about 1 yard per edge, used single
- No pins in the roll itself — fingers do the holding

How to make it

1. Cut the square on the straight grain: pull one thread gently across the fabric and cut along the empty line it leaves. A rolled hem needs a clean, straight, unfrayed edge.
2. Press the square flat. Trim any whiskers of fray with sharp scissors.
3. Thread the needle with about 18 inches of single thread and knot it. Hide the knot inside the first roll at a corner.
4. Moisten your finger and thumb very slightly, and roll the first inch of the raw edge toward you, twice around, into a tube about $\frac{1}{8}$ inch (3 mm) thick. Hold the roll between your left thumb and finger (reverse if left-handed).
5. Slip-stitch the roll: take up two or three threads of the flat fabric just below the roll, then slide the needle through the top of the roll $\frac{1}{4}$ inch along. Pull gently until the stitch almost disappears.
6. Roll the next inch, stitch the next $\frac{1}{4}$ -inch stitches, and settle into the rhythm: roll a little, stitch a little. Do not roll ahead more than an inch or the tube flattens.
7. At the corner, fold the next edge's first roll over the finished one and take two tiny stitches through both to lock it.
8. Press the finished edge lightly, roll and all — do not iron it flat. Admire it against a store-bought scarf edge.

Fabric check: Lightweight, crisp fabrics roll best: cotton lawn, voile, fine broadcloth, real silk twill or habotai. Avoid stretchy knits, loose gauze and anything heavier than a shirt; thick fabric will not roll under $\frac{1}{8}$ inch. Polyester “silky” fabric can be used, but it fights your fingers — slippery and springy — so save it for your second square. Prewash cotton; press silk with a dry iron on the silk setting.

Steps

1. **Count out** your needle; fine needles hide in carpet better than any other size.

2. **Practice the roll dry.** Before threading anything, practice rolling the edge with your fingers along the whole first side until the motion feels natural.
3. Sew the hem from the pattern card, one full edge in Session 2.
4. **Measure your invisibility.** Flip the edge over: on the front, your stitches should show as dots no bigger than a pin head, about ¼ inch apart. Count visible stitches per 3 inches and write it down.
5. **Count in and clean up.** Needle in the cushion, clippings in the trash.
6. **Improve it.** Finish the remaining edges over the week; by the fourth edge, time yourself and compare speed and neatness with edge one.

Tips

- Barely damp fingertips grip the fabric; wet fingers stain silk. Keep a damp sponge beside you instead of licking your fingers.
- If your roll keeps unrolling, your edge was cut on a slant. Re-trim on the pulled-thread line.
- Older students: try the second edge with the roll away from you, the way professional finishers roll — many find it faster.

Check your work

- ☐ I can keep a rolled hem under ⅛ inch thick for a full edge.
- ☐ My stitches barely show on the front.
- ☐ I can retell the journey of silk from the mulberry leaf to Justinian's Constantinople.

SEWING NOTEBOOK

1. Draw the silkworm's month in a strip: egg, caterpillar on a mulberry leaf, cocoon, moth — and mark where the reeler interrupts the circle for most cocoons.
2. Tape in a 2-inch sample of your rolled hem practice (or a close-up drawing) beside a store scarf edge, and write one sentence comparing them.
3. Map the Silk Road in one line across a page: Chang'an, the deserts, Samarkand, Baghdad, Constantinople, Rome — and mark where the eggs finally crossed in 552.

From history. Silk was so valuable in Rome that the writer Pliny the Elder complained about the fortunes that flowed east every year for silk and other luxuries, and for centuries it moved along the caravan routes beside spices, glass and paper. The German geographer Ferdinand von Richthofen gave those old routes the romantic name “Silk Road” only in 1877 — the name is newer than the sewing machine.

COMMON MISTAKES

- Rolling a long stretch ahead and then stitching: the roll flattens and uncoils. Roll an inch, stitch an inch.
- Pulling the slip stitches tight. The thread should settle the roll, not strangle it into a pucker.
- Cutting the square off-grain so the edge frays faster than you can roll it. Pull a thread and cut on its line.
- Ironing the finished roll flat and losing the round, corded look that makes the hem beautiful.

Make it a game • Cocoon Relay. Each player winds one long piece of thread or fine yarn around a cotton-ball “cocoon” until it is covered. Trade cocoons, then race to find the loose end and reel it off onto a pencil without breaking the thread or dropping the ball. A snapped thread means stop, tie a knot and lose five seconds — real reelers kept filaments whole.

Scripture. “She maketh herself coverings of tapestry; her clothing is silk and purple.” (Proverbs 31:22, KJV)

The capable woman of Proverbs 31 is praised, not scolded, for fine cloth: silk and purple were the best materials of her day, handled with skill and without waste.

1.4 POLYMERS: NYLON, POLYESTER AND SPANDEX

OBJECTIVES

- Explain what a polymer is and how Wallace Carothers's team at DuPont made nylon, the first fully synthetic fiber, in 1935.
- Describe melt spinning through a spinneret, and define moisture regain and what it predicts about comfort and drying time.
- Run a fair fiber investigation — stretch, dry time and an adult-run burn test — and write it up as a one-page lab report.

Warm-up. Gather five garments whose labels name a synthetic: polyester, nylon, acrylic or spandex (check athletic wear, fleece, socks and swim or rain gear). Which synthetic shows up most? Find the garment with the smallest percentage listed — why would a maker add just 5% of a fiber?

WATCH

How Nylon Was Discovered - Christmas Lectures with George Porter

The Royal Institution · 4:00

<https://www.youtube.com/watch?v=1fnHKatL-68>

WHEN TO WATCH

After the story. Watch the nylon rope trick: a thread of brand-new polymer pulled straight out of the beaker where two liquids meet.

Note: A 1976 Christmas Lecture at London's Royal Institution — molecule models, beakers and a live audience of children.

KEY TERMS

polymer

A giant molecule built by linking thousands of small molecules (monomers) into a chain, like paper clips into a necklace. Cellulose and silk protein are natural polymers; nylon and polyester are built in a factory.

melt spinning

Making fiber by melting polymer chips, pumping the liquid through a spinneret, and cooling the streams into continuous filaments, which are then stretched (drawn) to line up the chains and multiply the strength.

wicking

Moving liquid along the outside of fibers and through the gaps between them, the way athletic shirts spread sweat out to dry — different from absorbing it inside the fiber.

spinneret

A metal plate pierced with tiny holes through which melted or dissolved polymer is forced, hardening into filaments. Named for the silk-spinning organ of the silkworm and spider.

moisture regain

The percentage of its dry weight in water vapor a fiber takes up from ordinary air. Wool is about 15%, cotton about 8%, nylon about 4%, polyester under one percent.

CORE IDEAS

The story. In 1928 the DuPont company hired a brilliant, modest Iowa-born chemist named Wallace Carothers away from Harvard to lead something new: pure research into how molecules join. His team asked a simple, deep question — could people build giant chain molecules on purpose, the way nature builds cellulose and silk protein? By 1930 they had helped prove that polymers really are long chains, and had made neoprene, a synthetic rubber. On February 28, 1935, after years of near misses, the team drew out a polyamide they called nylon 6-6: the first strong, usable fiber made entirely from laboratory chemicals — at the time, materials derived from coal, air and water. Nylon toothbrush bristles appeared in 1938; nylon stockings went on sale across America on May 15, 1940, and sold out almost everywhere. Within two years the same fiber was

needed for parachutes and ropes in the Second World War. Carothers himself, sadly, did not live to see nylon in the stores: he had long battled depression and died in 1937. His chemistry went on without him and changed every closet in the world.

How they figured it out. The key was patience with water. The team built polyamides by joining an acid and an amine end to end, over and over — but every join squeezed out a water molecule, and leftover water broke the chains short. Carothers's group invented ways to pull the water out as it formed, so the chains could grow thousands of links long. Then came the famous moment of play: in 1930 a researcher, Julian Hill, working with one of the group's early polyesters, dipped a glass rod into the syrupy polymer and walked backward down the hall, drawing out a thread that kept getting stronger as it stretched. The stretching — **drawing** — was a discovery in itself: pulling lines the polymer chains up side by side so they grip each other along their whole length, and the fiber's strength multiplies. Polyester followed in 1941, when the English chemists John Rex Whinfield and James Tennant Dickson built a polymer from different links; and in 1958 the DuPont chemist Joseph Shivers perfected spandex, a stretchy polymer that snaps back like rubber but survives washing — the 5% in your warm-up labels.

The fabric science. A modern plant melts polymer chips and pumps the liquid through a **spinneret**; the hair-thin streams cool into endless filaments, are drawn, and are either used smooth or chopped into short staple and spun like cotton. Now the numbers that explain how synthetics behave. **Moisture regain** is how much water vapor a fiber takes into itself from the air, as a percentage of its dry weight: wool about 15%, cotton about 8%, nylon about 4%, polyester less than one percent. Low regain cuts both ways. Polyester will not soak up sweat, so the fiber dries almost instantly and a rain jacket stays light — but the moisture has to go somewhere, so polyester athletic cloth is engineered to **wick**, spreading sweat along the outside of its fibers to evaporate, and polyester holds odors more than cotton does. Synthetics shrug off wrinkles and abrasion; nylon is outstandingly strong and elastic. Their shared weakness is heat: these are meltable plastics, which is why your iron has synthetic settings at the cool end and why a potholder must never be polyester. No fiber is the villain and none is the saint: the skill is matching the fiber to the job.

Let's investigate. You will run a **fiber investigation**: a stretch test and a timed dry test that you do yourself, and a burn test that **an adult performs** while you observe and record. Burning a snippet is the classic shop method for identifying a mystery fiber:

plant fibers burn like paper and leave soft ash; protein fibers sizzle and smell like burned hair; synthetics shrink from the flame and melt into a hard bead. Your one skill: write it up as a fair test — same size samples, same conditions, honest results.

PICTURE STUDY



Wallace Carothers in the laboratory, Unknown photographer for DuPont, about 1930 · Black-and-white photograph · Hagley Museum and Library, Wilmington, Delaware

Image: [Wikimedia Commons](#), public domain

Here is Wallace Carothers at his bench at DuPont, stretching a strip of material, the kind of simple pull test his group used on its new polymers. Notice that the man who filled the world's closets with new fiber worked in a plain room with glassware, a notebook and endless patience.

Look closely

- Find his hands. What is he testing about the material at this exact moment?
- Look at the bench: flasks, clamps, rubber tubing. Which pieces are for heating, and which for catching what boils off? Remember that removing water was the whole trick of nylon.

- He works in a suit and tie, the lab dress of his day. What do chemists wear now instead, and why is it safer?
- Find any sign of the fiber future in this picture. There is none — it looks like any chemistry bench. Great changes can start quietly.

Talk about it

1. Carothers was hired to do pure research: to understand molecules first and find products later. Why might that order work better than hunting straight for a product?
2. A stretch test with two hands, like his, is still a fiber test you can do. What did stretching teach his team about polymer chains?
3. What would you ask Carothers if you could visit this room for five minutes?

Safety first. The burn test is performed only by an adult: a ½-inch snippet held in metal tweezers over a metal pan or the kitchen sink, a cup of water standing by, hair tied back, sleeves pushed up, window cracked for the smell. The student observes from an arm's length and records. Never test a fabric while anyone wears it, and never burn more than a snippet; synthetic drips are hot and sticky.

SEWING PROJECT

The Fiber Investigation and Lab Report

Fabric stores sell mystery fabric; rag bags are full of lost labels. Today you learn the tests that identify a fiber and — just as important — the habit of writing an investigation up fairly. You will test four known fibers first, so that someday you can face an unknown one with a filled-in answer key of your own making.

You will need

- Metal tweezers, a metal pie pan or the kitchen sink, and a cup of water (adult's burn-test station)
- A spray bottle or bowl of water, a clothesline or hanger and clothespins, and a timer
- A ruler, the kitchen scale, your notebook and a pencil
- Fabric shears for cutting samples

FOUR-FIBER TEST CARD AND LAB REPORT

Finished size: one notebook spread: a 4-row test table plus a one-page report · About 75 minutes, including drying time you can spend writing

Fabric and notions

- 4 known samples, each cut as a 3 × 3 in square plus a ½-inch snippet: cotton (an old T-shirt or muslin), wool (a worn sock or sweater scrap), polyester (fleece or lining), nylon (an old stocking, rain-jacket scrap or ribbon)
- Optional fifth sample: a 50/50 cotton-polyester blend, tested last as a puzzle
- Masking-tape labels for every sample — label before testing, not after

How to make it

1. Rule a table in your notebook: rows for the four fibers, columns for stretch, wet feel, minutes to dry, burn observations (adult), and the smell and residue.
2. **Stretch test (you):** pull each 3-inch square gently between your hands and let go. Score each fiber 0–3 for stretch and 0–3 for spring-back. Nylon and anything with spandex will surprise you.
3. **Dry race (you):** wet all four squares thoroughly, squeeze each exactly twice, weigh each if you like, and pin them to the line at the same minute. Check every 10 minutes and record when each feels dry. While you wait, write the history paragraph of your report: Carothers, 1935, and one sentence each for polyester 1941 and spandex 1958.
4. **Burn test (adult performs; you observe from arm's length):** the adult holds each ½-inch snippet in tweezers, brings it to a match or lighter flame over the pan, and withdraws it. You record: does it burn or melt? Keep burning when the flame leaves? What is the smell — paper, burned hair, sweetish chemical? What remains — soft gray ash or a hard bead?
5. Let the beads cool completely in the pan before anyone touches them; tape the cotton ash page-side only, and describe the beads in words (melted beads can stay sharp — do not tape them in).
6. Fill the table in ink and circle the one result that most surprised you.
7. Write the lab report on the facing page: what we tested, how we kept it fair (same sizes, same squeezes, same line), results, and a conclusion matching

each fiber to one job it earns — and one job it should never do (polyester potholder!).

8. If you cut the mystery blend: test it last and write which parents it behaves like, and why a blend might be the point.

Fabric check: Use only 100% known-fiber samples for the four test rows — read labels carefully, since blends will blur every result (save them for the puzzle round). Old, washed fabric tests truest. If wool bothers someone's skin, handle the wool square by its corners; the burn test is the adult's hands in any case.

Steps

1. **Count out pins** (for the clothesline) and your labeling supplies.
2. **Set the stations:** wet-test by the sink, drying line where air moves, and the adult's burn station with pan, tweezers and water cup — nothing else on that counter.
3. Run the investigation from the pattern card, in order: stretch, dry race, burn test.
4. **Honesty check.** If a result disagrees with the lesson (your cotton out-dried your polyester?), do not erase it — write it down and hunt the reason. Was the “cotton” a blend? Was one square thicker?
5. **Count in and clean up.** Pins in, line down, the adult wets the burn residue before it goes in the trash, window open until the smell clears.
6. **Improve it.** Later this month, test one true unknown from the rag bag against your answer key and add its row to the table.

Tips

- Smell is the most reliable burn clue: paper for plants, burned hair for proteins, sweet chemical for synthetics. Have the adult waft, never inhale close.
- Equal squeezing matters more than equal wetting in the dry race; count your squeezes out loud.
- Older students: add a warmth test — wrap two jars of equally hot tap water, one in the wool square, one in the polyester, and record the temperatures after 15 minutes.

Check your work

- ☐ My table has every cell filled in from observation, not from the book.
- ☐ I can name the burn signs of plant, protein and synthetic fibers — and I know the adult runs that test.

- ❑ My report says how the test was kept fair, and matches each fiber to a right job and a wrong one.

SEWING NOTEBOOK

1. Draw a polymer as a paper-clip chain across the whole page width; label one clip “monomer” and the chain “polymer,” and draw a second chain below it drawn out straight and packed beside a third, labeled “after drawing: chains aligned, fiber strong.”
2. Draw the spinneret as a showerhead extruding threads, with the cooling and drawing steps labeled.
3. Tape in your four labeled dry-race squares once fully dry, ranked fastest to slowest, with their times.

From history. At the 1939 New York World’s Fair, DuPont introduced nylon stockings to the public with great fanfare, and in the first year on sale Americans bought tens of millions of pairs. When the war effort took every pound of nylon for parachutes, cords and tires in 1942, women famously painted seams up the backs of their bare legs — and when nylons returned in 1945–46, newspapers reported lines around the block.

COMMON MISTAKES

- Treating synthetics as fake or lesser fibers. A parachute, a climbing rope and a rain jacket are nylon and polyester for unbeatable reasons.
- Treating naturals as always better. A cotton tent packed away wet can mildew and rot; a cotton potholder, though, is the only safe kind — match fiber to job.
- Testing different-sized samples and trusting the comparison anyway. Fair tests are the whole craft of science.
- Anyone but the adult touching the burn test, or burning more than a snippet. One flaming inch of fabric is a lesson; more is a hazard.

Make it a game • Fiber Detective. Your parent secretly picks one fiber — cotton, wool, silk, nylon, polyester or spandex — and answers only yes or no. You get ten questions drawn from this unit (Does it felt? Regain over 5%? Would it melt?) to name the fiber. Then switch roles. Three rounds each; fewest questions used wins the magnifier crown.

UNIT 1 REVIEW

Answer in complete sentences unless the question asks for a list or a calculation. For calculations, show every step of your math — a right answer with no work earns half. The review is worth 100 points.

1. 8 pts

Name the four sources of fibers studied in this unit (two natural kingdoms, one insect, one laboratory) and give one example fiber from each.

2. 8 pts

Explain in two or three sentences how Whitney's gin worked, and state plainly what it did to cotton farming and to slavery in the American South.

3. 10 pts

Calculate. Fabric A costs \$9.00 a yard and is 44 inches wide. Fabric B costs \$11.00 a yard and is 60 inches wide. Compute the square inches in one yard of each, then the price per 100 square inches of each (round to the nearest cent). Which is the better buy?

4. 8 pts

Why does wool felt? Name the four ingredients of felting and tell what the scales do.

5. 8 pts

Your favorite wool sweater must be washed. Write the three-line care instruction, and explain which part of the fiber each rule protects you from.

6. 8 pts

Tell the story of how silkworm eggs reached the West around A.D. 552, and name the historian who recorded it and the emperor who received them.

7. 10 pts

Calculate. It takes about 2,500 cocoons to make one pound of silk, and each cocoon's filament is about 700 meters long. About how many cocoons for a 4-ounce silk scarf, and about how many total meters of filament is that?

8. 8 pts

What is a polymer, and what did the drawing (stretching) step do that made nylon strong?

9. 10 pts

Calculate. Moisture regain: a dry wool sample weighs 40 grams (regain about 15%) and a dry polyester sample weighs 40 grams (regain about 0.5%). About how many grams of water vapor does each hold in ordinary air, and what does the difference mean for a rainy hike?

10. 8 pts

An adult runs a burn test on a mystery snippet: it shrinks from the flame, melts, smells sweetish and leaves a hard bead. Mystery snippet two burns steadily, smells like paper and leaves soft gray ash. Identify each fiber family, and name two safety rules of the burn test.

11. 7 pts

Written answer. “Natural fibers are good and synthetic fibers are bad.” In four or five sentences, correct this sentence with at least two facts on each side.

12. 7 pts

Written answer. Choose one person from this unit — Whitney, Carothers, Whinfield and Dickson, or the reeling women of the silk scroll — and write four sentences on what problem they faced and what patience had to do with the solution.

UNIT CHALLENGE: THE FIBER REPORT AND SWATCH STUDY

Assemble the unit’s work into a fiber study worthy of a fabric counter: at least ten labeled swatches (your six cottons plus wool, silk or fine lawn, and two synthetics), each with fiber, source, one strength, one weakness and a fair-test observation; your felting before-and-after samples; your rolled hem; and the burn-test table with the adult’s initials beside it.

Then write a one-page report on the fiber of your choice — field or flock or lab to finished fabric — with at least three true dates or numbers in it, and finish with a cost-per-yard comparison of two real fabrics you would actually buy for a named project.

LOOK FOR	WHAT IT MEANS
Ten labeled swatches	At least ten swatches, correctly identified, each with source, a strength, a weakness and one observed (not copied) fact.
The arithmetic	The cost-per-yard comparison is computed correctly with widths accounted for, and the chosen buy is defended in a sentence.
The report	One page, in order, with at least three accurate dates or numbers (patent years, regain percentages, cocoon counts) woven in naturally.
Fair testing and honesty	Tests used same-size samples and same conditions; surprising results are recorded, not erased; the burn test is initialed by the adult who ran it.
Safety and improvement	Needle-and-pin counts every session, the burn-test rules followed exactly, and one item from the unit redone better with the change noted.

ANSWER KEY

1. Plants (cotton, also flax); animals (wool, also alpaca or mohair); the silkworm (silk); and the laboratory or chemical plant (nylon, polyester, spandex, acrylic).
2. Toothed cylinders pulled the fiber through a slotted grate too narrow for the seeds, and a brush swept the fiber off; one hand-cranked gin cleaned about fifty pounds a day instead of one. Cotton became hugely profitable, planting exploded, and slavery, instead of fading, grew enormously because the field work was still forced hand labor.
3. A: $44 \times 36 = 1,584$ sq in; $\$9.00 \div 15.84 \approx \$0.57$ per 100 sq in. B: $60 \times 36 = 2,160$ sq in; $\$11.00 \div 21.60 \approx \$0.51$ per 100 sq in. Fabric B is the better buy even though its price per yard is higher.
4. Scales, plus heat, water/soap and rubbing (friction). Warm water lifts the overlapping scales; rubbing slides fibers tip-first past each other; the raised scales catch like barbs so fibers cannot slide back, locking the wool into felt. (Accept “moisture, heat, soap, friction acting on the scales.”)
5. Wash cool (heat lifts the scales), with gentle soap and gentle squeezing — no wringing or machine agitation (rubbing drives the one-way slide of the scales), and dry flat (a wet sweater’s weight stretches it). All three rules exist to keep the scales from felting and the crimp from distorting.
6. Two monks who had lived in the East told the Emperor Justinian in Constantinople that they knew the art of silk; he sent them back, and they smuggled silkworm eggs out — the story says inside their hollow canes. The historian Procopius recorded it, and Byzantine silk-making grew from those eggs.
7. 4 ounces is $\frac{1}{4}$ pound, so $2,500 \div 4 = 625$ cocoons. $625 \times 700 \text{ m} = 437,500$ meters of filament (about 437 km). Accept answers in that range with the work shown.
8. A polymer is a giant chain molecule made of thousands of small repeated units linked together. Drawing the new filament stretched it so the chains lined up side by side along the fiber; aligned chains grip each other along their whole length, multiplying strength.
9. Wool: $40 \times 0.15 = 6$ g. Polyester: $40 \times 0.005 = 0.2$ g. Wool carries real moisture inside the fiber yet still insulates when damp; polyester takes in almost nothing, so it dries very fast and a wet jacket stays light. (Both facts are useful on a hike; the point is matching fiber to job.)
10. Snippet one is a synthetic (polyester or nylon family); snippet two is a plant fiber (cotton or linen family). Safety: only an adult performs it; tiny snippet in metal

tweezers over a metal pan or sink; water standing by; hair tied back; let melted beads cool untouched.

11. A fair answer names synthetic strengths (nylon's strength and elasticity; polyester's quick drying, wrinkle and abrasion resistance; spandex's stretch) and synthetic weaknesses (melting in heat, holding odors, low absorbency), plus natural strengths (cotton's softness and absorbency; wool's warmth even when damp; silk's strength and luster) and natural weaknesses (cotton wrinkles and shrinks; wool can felt; silk weakens in sun). Conclusion: the craft is matching the fiber to the job.
12. Open answer; look for a correctly named problem (seeds in fiber; water breaking polymer chains; stiff gummed silk) and a true detail of the patient work (years of trials, removing water as it formed, reeling filament by filament, pounding and ironing the cloth).

FABRIC UP CLOSE

In Unit 1 you studied fibers. Now you will follow them through the two great steps that turn fiber into fabric: **spinning**, which twists short fibers into yarn, and **weaving** (or knitting), which crosses yarns into cloth. You will meet the men who moved spinning and weaving out of the cottage and into the mill: Richard Arkwright with his water frame, Samuel Slater who carried the secret to Rhode Island in his head, Edmund Cartwright and his power loom, and the young women of the Lowell mills. You will also hear plainly about the children who worked in the mills, and how photographs and new laws changed that.

Then you will read fabric the way a buyer and a dressmaker do. You will find the grain and the bias and measure how much each stretches, count threads per inch with a magnifier, weigh fabric to find its grams per square meter, and learn why a huge thread-count number on a package can mislead. Last, you will learn to stop a raw edge from fraying, from the pinked edge and zigzag to the serger and the French seam, and you will build a seam-finish sample book that you will use for the rest of the year.

PREREQUISITES

- Can name the main natural and synthetic fibers and one strength and weakness of each (Unit 1)
- Can measure to the nearest $\frac{1}{8}$ inch and multiply and divide decimals
- Uses fabric shears safely: carried closed, points down, passed handle first
- For Lesson 2.4: has been checked off by an adult on the sewing machine and the iron, or sews by hand

MASTERY CHECKLIST

- ☐ I can explain how a spindle or a spinning machine drafts fibers and puts twist into them, and I can spin and ply a short yarn on a drop spindle.
- ☐ I can tell how Arkwright, Slater and the Lowell mills changed cloth-making, and tell honestly about child labor in the mills and how the laws changed.
- ☐ I can name plain, twill and satin weaves, and find the lengthwise grain, the crosswise grain and the bias on any woven fabric.
- ☐ I can figure thread count by counting threads per inch in both directions, and figure grams per square meter from a weighed swatch.
- ☐ I can finish a raw edge four ways and sew a French seam.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **A top-whorl drop spindle and 2 ounces of wool roving:** A simple wooden spindle of about 1 ounce is ideal for a beginner. You can also make one from a $\frac{3}{8}$ -inch dowel, a small cup hook and an old CD (see Lesson 2.1). Medium wools such as Corriedale draft easily.
- **A 1-inch (25 mm) bias tape maker:** A small metal tool that folds a fabric strip into bias tape as you pull it under the iron. Used in Lesson 2.2; the tape can also be folded by hand with a ruler and pins.
- **Pinking shears:** Shears with zigzag blades that leave a fray-resistant edge. Helpful for Lesson 2.4 but optional; a zigzag or overcast stitch does the same job.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

2.1 The Mill: Arkwright, Slater and Lowell	2 sessions of 50–60 minutes
2.2 Weaves and Grain	2 sessions of 50–60 minutes
2.3 Thread Count, Fabric Weight and What They Mean	2 sessions of 50–60 minutes
2.4 Finishing Edges: Hems, Zigzag, Serger and French Seams	2 sessions of 50–60 minutes

2.1 THE MILL: ARKWRIGHT, SLATER AND LOWELL

OBJECTIVES

- Tell how Richard Arkwright's water frame (1769), Samuel Slater's mill at Pawtucket (1790–1793) and the Lowell mills (1820s–1840s) moved spinning and weaving from the home into the factory.
- Tell plainly how children worked in the mills, how Lewis Hine's photographs showed it, and how laws changed it.
- Explain drafting and twist, and spin and ply a short length of wool yarn on a drop spindle.

Warm-up. Untwist the end of a piece of yarn or string until it falls apart into loose fibers. Now try to pull the loose fibers apart, then pull a twisted part apart. Which is stronger? Next, look at the end of a piece of sewing thread under a magnifier. How many strands are twisted together? Which way do they slant, like the middle of a letter S or a letter Z?

WATCH

The Massachusetts Mill Workers, Lowell National Historical Park

Prairie Public · 6:31

<https://www.youtube.com/watch?v=zSVk6axNHkQ>

WHEN TO WATCH

After the story. A park ranger walks you through the Boott Cotton Mills, with the looms running, the boardinghouses, and photographs of the mill girls and child workers.

Note: A public-television segment filmed at Lowell National Historical Park. It includes Lewis Hine's photographs of child mill workers and a photograph of a strike; talk about them together.

BACKUP VIDEO

Spinning on a Drop Spindle

Schacht Spindle · 12:26

<https://www.youtube.com/watch?v=mae2CAkrZDo>

Before Session 2, with your spindle and roving in hand. Watch the leader, the fiber preparation and the “park and draft” method, pausing after each part to try it.

KEY TERMS

drafting

Drawing fibers out from a mass of roving so that only a thin, even stream of them passes into the twist.

singles and ply

A singles is one spun strand. Plying twists two or more singles together in the opposite direction, making a balanced, stronger yarn.

twist

The turning that locks fibers together into yarn. Yarn spun clockwise has a Z twist; yarn spun counterclockwise has an S twist.

water frame

Richard Arkwright's spinning machine, patented in 1769 and driven by a water wheel, that drew cotton out between pairs of rollers and twisted it into strong yarn.

mill girl

One of the young women, most from New England farms, who worked in the Lowell textile mills in the 1820s–1840s and lived in company boardinghouses.

wraps per inch (WPI)

The number of times a yarn wraps side by side around a ruler in one inch. It tells how thick the yarn is.

CORE IDEAS

The story. For thousands of years every thread in the world was spun by hand, on a spindle or a spinning wheel, mostly by women in their homes. In 1769 **Richard Arkwright**, an English barber and wig-maker turned inventor, patented a spinning machine that drew cotton out between pairs of rollers turning at different speeds and then twisted it. It was too heavy to turn by hand, so in 1771 he built a mill at Cromford beside a stream and turned it with a water wheel: the **water frame**. Britain guarded these machines jealously and forbade skilled mill workers to leave the country. But a young apprentice named **Samuel Slater**, who had learned the machines in a mill at Belper, memorized them and sailed for America in 1789. In Pawtucket, Rhode Island, with the merchant Moses Brown and his partners, Slater rebuilt Arkwright's machines from memory and began spinning cotton yarn in 1790; the mill he built there in 1793 still stands. A generation later **Francis Cabot Lowell** studied British power looms on a visit to England, and his company opened a mill at Waltham, Massachusetts, in 1814 that did both spinning and weaving under one roof. After his death the company's investors built a whole new mill town on the Merrimack River and named it **Lowell**.

How they figured it out, and what it cost. The Lowell mills hired young women from New England farms, many between fifteen and twenty-five, who lived in company boardinghouses under strict rules and sent their wages home or saved them for school. Their days were long, about twelve to fourteen hours, six days a week, in rooms loud with looms and full of cotton dust. Some wrote poems and essays for their own magazine, the *Lowell Offering*. Lucy Larcom began work in a Lowell mill at eleven, changing bobbins, and later became a teacher and writer. That points to a harder truth: from Slater's first mill, where most of the workers were children between seven and twelve, until the early 1900s, children worked in American textile mills. Beginning in 1908 the photographer **Lewis Hine** traveled to mills for the National Child Labor Committee and photographed child spinners and doffers, often writing down their names and ages. His pictures helped convince Americans to act. States passed school

and child-labor laws, and in 1938 the federal Fair Labor Standards Act set sixteen as the usual minimum age for factory work. Machines made cloth cheap for everyone; it took decades and many people's work to make the mills fair to children.

The fabric science. Whether the spinner is a girl with a spindle or a mill full of frames, spinning is two actions. **Drafting** pulls a few fibers at a time out of a soft rope of roving, so the yarn is thin and even. **Twist** locks the drafted fibers together: twisted fibers press against each other, and friction holds them so tightly that the yarn can be far stronger than any single fiber. Spin clockwise and the fibers slant like the middle of a **Z**; counterclockwise, like an **S**. A single strand has a lively twist that wants to kink back on itself, so spinners **ply** two singles together in the opposite direction; the twists balance and the yarn lies calm. Spinners measure yarn with numbers. **Wraps per inch** tells thickness: about 9 WPI is a worsted (#4) weight, and about 12 WPI is a lighter DK. Yardage tells length: if 10 grams of your yarn measures 18 yards, then a 1-ounce (28-gram) bundle will make about $28 \div 10 \times 18 \approx 50$ yards.

Let's spin. You will spin a singles yarn on a drop spindle, ply two strands together, set the twist, and measure your yarn's WPI and yardage. The one skill to do well is the **park and draft**: spin the spindle, park it between your knees, draft the fibers smoothly, then let the twist run up. Your first yarn will be lumpy. Every spinner's was.

PICTURE STUDY



Addie Card, 12 Years Old, Spinner in Cotton Mill, North Pownal, Vermont, Lewis Hine, 1910 · Gelatin silver photograph (National Child Labor Committee) · National Gallery of Art, Washington, D.C.; other prints at the Library of Congress

Image: [Wikimedia Commons](#), public domain

Lewis Hine photographed this girl in a Vermont cotton mill in 1910. His note on the photograph says that she was twelve years old, that the other girls said she was ten, and that she had started work during the school vacation and now meant to stay. Pictures like this one were printed in pamphlets and shown at meetings, and they helped persuade Americans to pass child-labor laws.

Look closely

- Find the spinning frame beside her. Count the spindles you can see in one row. Each one is twisting a yarn at the same time.
- Look at the bobbins of yarn on the frame. What was her job when one ran full or a yarn broke?
- Look at her clothes, her bare feet and the floor. What would it be like to stand there for a twelve-hour shift?

- Hine stood her in front of the long row of machines and close to the camera. What does that choice make you notice?

Talk about it

1. Hine was not making art for a museum. He was showing people something true they had not seen. What did he want them to do?
2. How is her work like your drop spindle, and how is it different?
3. What do you think Addie Card would have chosen if she could have gone to school instead?

Safety first. A parent or responsible adult supervises all sewing tool use, and the needle-and-pin count opens and closes the session. A drop spindle swings near the floor: clear the space around you, keep it away from little children and pets, and keep loose roving out of reach of babies. If you make your own spindle, an adult does any drilling or cutting of the dowel.

SEWING PROJECT

Spin and Ply a Two-Ply Yarn on a Drop Spindle

You will turn a handful of fluffy wool roving into real yarn with nothing but a stick, a weight and your hands, the way spinners did for thousands of years before Arkwright. Then you will ply it, set the twist in warm water, and measure it with the same numbers a yarn company prints on its labels.

You will need

- A top-whorl drop spindle, or a homemade one: a 12-inch length of $\frac{3}{8}$ -inch dowel, a small cup hook screwed into one end, and an old CD fitted about 1 inch below the hook (a rubber grommet or a wrap of tape holds it)
- Small scissors and a ruler marked in inches
- A kitchen scale that reads grams
- A toilet-paper tube or an empty spool for winding the singles
- A bowl of warm water and a towel

TWO-PLY HANDSPUN WOOL YARN

Finished size: About 15–30 yards (14–27 m) of two-ply yarn, enough for a bookmark, a cord or a sample swatch ·
About 2 hours over two sessions

Fabric and notions

- 1 ounce (28 g) of wool roving or combed top, divided into two equal halves of 14 g each
- An 18-inch (46 cm) leader of plain wool yarn
- Optional: a second color of roving for the second strand, so you can see the ply

How to make it

1. Tie the leader to the spindle shaft just above the whorl, wrap it around the shaft a few times, bring it up and hook it once around the cup hook.
2. Pull (do not cut) a strip of roving about as thick as your finger. Gently tug it lengthwise in small sections all along its length to loosen the fibers (pre-drafting).
3. Fluff the end of the leader and overlap it with the fluffy end of the roving. Spin the spindle clockwise with your right hand and let a little twist run into the overlap until the two are joined.
4. **Park and draft:** spin the spindle clockwise, then catch it between your knees so it stops. Pinch the yarn with your front hand; with your back hand, draw back about 2 inches of fibers. Slide the front hand back and let the twist run up into the drafted fibers. Repeat.
5. When the yarn reaches the floor, unhook it, wind it onto the spindle shaft above the whorl, hook it again and keep going. Spin half of the roving (14 g).
6. Wind the first singles off onto a tube. Spin the second half the same way.
7. **Ply:** tie the two singles together to the leader and spin the spindle counterclockwise, letting the two strands twist around each other. Stop when the plied yarn looks even and does not kink when you let it hang in a loop.
8. Wind the yarn off around your hand and elbow into a loose skein. Tie it loosely in two places. Soak it in warm water for 10 minutes, squeeze it in a towel, and hang it to dry with a light weight (a clothespin) at the bottom.

9. When it is dry, measure the length (count wraps around a 1-yard ruler or the back of a chair you have measured), weigh it, and find its wraps per inch.

Fabric check: Use 100% wool roving or combed top from a sheep breed with medium-length fibers (Corriedale, Romney or a blend sold for beginners): it drafts smoothly and holds twist well. Avoid very short fibers (cotton) and very slippery ones (silk, alpaca) for a first yarn. Superwash wool spins fine but feels slick. If wool bothers someone's skin, spin a soft acrylic or bamboo top instead, which is harder to draft but works.

Steps

1. **Count out.** Count needles and pins out even on a spinning day; the yarn needle for the skein ties is part of the count.
2. **Practice first.** Before using the spindle, “drop” nothing: just practice drafting with your hands, pulling a thin, even stream of fibers from the roving without twist, for five minutes.
3. Spin and ply your yarn from the pattern card.
4. **Test it.** Break-test a 6-inch piece of singles and a 6-inch piece of plied yarn by hanging a cup on each and adding pennies until it breaks. Record the penny count for each.
5. **Measure it.** Record yards, grams, wraps per inch, and yards per ounce (yards ÷ grams × 28).
6. **Count in and clean up.** Roving bits in the trash, spindle on a shelf, yarn needle back in the cushion.
7. **Improve it.** Spin a second, thinner yarn and compare its wraps per inch with your first.

Tips

- If the yarn breaks, the fibers did not get enough twist before you drafted further. Overlap the broken ends, fluff them and let twist run in again.
- If the yarn kinks into knots, there is too much twist: draft a little more fiber before you let the twist run up.
- Younger students: use only the park-and-draft method and spin a short length. Older students: try spinning continuously without parking, and compare the WPI of your singles with a commercial yarn.

Check your work

- ☐ I can explain drafting and twist and show the park-and-draft method.

- ☐ I spun and plied a yarn, set its twist, and recorded its yardage, weight and wraps per inch.
- ☐ I can tell the story of Slater and the Lowell mills, including the truth about child labor and how laws changed.

SEWING NOTEBOOK

1. Tape in 4 inches of your singles and 4 inches of your plied yarn, and label the Z twist and the S twist.
2. Make a table for your yarn: grams, yards, yards per ounce, wraps per inch, and the penny break test for singles and plied yarn.
3. Draw a timeline from 1769 to 1938 with five events from this lesson.

From history. Slater's Mill in Pawtucket is now part of Blackstone River Valley National Historical Park, and the Boott Cotton Mills in Lowell are part of Lowell National Historical Park, where a weave room of working looms still runs for visitors. Lucy Larcom described her childhood in the mills in her book *A New England Girlhood* (1889).

COMMON MISTAKES

- Letting the twist run into the roving before you draft. The fibers lock and will not pull out. Keep your front hand pinched until you have drafted.
- Spinning the ply in the same direction as the singles. The yarn gets tighter and kinkier instead of balancing. Ply in the opposite direction.
- Thinking the old mills were simply good or simply bad. They made cloth cheap and gave many young women wages, and they also used children for long hours. Both are true.

Make it a game • Penny Break Challenge. Each player twists a 6-inch length of yarn from loose roving with fingers only, as tightly or loosely as they choose. Hang each from a paper cup handle and take turns adding pennies one at a time. The yarn that holds the most pennies wins. Then explain why the winning twist held.

Scripture. “She layeth her hands to the spindle, and her hands hold the distaff.” (Proverbs 31:19, KJV)

The distaff held the fiber and the spindle twisted it: the same two jobs, drafting and twist, that your hands do today and that Arkwright's rollers did by water power.

2.2 WEAVES AND GRAIN

OBJECTIVES

- Tell how Edmund Cartwright's power loom (1785) began to move weaving into the mill.
- Identify plain, twill and satin weaves, and find the lengthwise grain, crosswise grain and bias on a woven fabric.
- Measure how much a fabric stretches on each grain, and cut and fold bias strips into bias tape.

Warm-up. Find a pair of jeans, a cotton sheet or shirt, and something shiny like a satin ribbon or a jacket lining. With a magnifier, look for the pattern of threads. On which one do the threads go simply over one, under one? On which do you see a diagonal line? On which do long threads float across the top? Now pull a square of cotton straight along its edge, then corner to corner. Which way stretches?

WATCH

What is the grain of fabric? What is the grainline? And how to find and use it! - Sewing Terminology

Evelyn Wood · 8:24

<https://www.youtube.com/watch?v=xmkkfsYfYko>

WHEN TO WATCH

After “The fabric science.” Pause when she shows the lengthwise grain, the crosswise grain and the bias, and find each one on your own scrap.

Note: A home dressmaker explains grain with a woven plaid and a paper pattern.

BACKUP VIDEO

How to Use a Bias Tape Maker

National Sewing Circle · 6:01

<https://www.youtube.com/watch?v=7bMmyUX5W5Q>

Before you make your bias tape in Session 2. Watch how she cuts the strips, feeds the tool and presses.

KEY TERMS

warp and weft

The warp yarns run the length of the fabric and are held tight on the loom; the weft yarns cross them from side to side.

lengthwise grain

The direction of the warp, parallel to the selvage. It stretches least and is the “straight grain” on a pattern’s grainline arrow.

bias

Any direction diagonal to the grain. The true bias is at 45 degrees, and it stretches the most.

selvage

The firm, finished edge along each side of woven fabric, where the weft turns back. It never frays.

crosswise grain

The direction of the weft, from selvage to selvage. It stretches a little more than the lengthwise grain.

twill and satin

Twill weaves pass over two or more yarns and step over one each row, making diagonal lines (denim, gabardine). Satin weaves float a yarn over four or more, making a smooth, shiny face.

CORE IDEAS

The story. In the summer of 1784 an English clergyman named **Edmund Cartwright** fell into conversation with some Manchester men about Arkwright’s spinning mills. Soon, they said, there would be more yarn than all the hand-weavers in England could weave, and no one could build a machine to weave it. Cartwright had never seen anyone weave, but he thought that if a machine could play chess, as people claimed, it could surely weave. In 1785 he patented a **power loom**. His first one was so clumsy that it took two strong men to work it, and he spent years and his own fortune improving it. Other inventors kept improving power looms after him, and by the 1820s and 1830s mills in Britain and New England held long rows of them, like the looms that still run in the Boott Cotton Mills at Lowell.

How they figured it out. A hand-weaver and a power loom do the same three motions over and over. **Shedding** lifts some warp yarns and leaves others down, opening a gap called the shed. **Picking** throws the shuttle through the shed, laying one weft yarn (a pick). **Beating** pushes that pick tight against the cloth with a comb-like reed. Which warp

yarns are lifted for each pick decides the weave. Lift every other yarn, then the opposite ones, and you get **plain weave**: muslin, broadcloth, canvas. Lift two and lower one, shifting one step each row, and the crossings line up into a diagonal: **twill**, as in denim and gabardine, which drapes well and hides dirt. Let a yarn float over four or more before it goes under, and you get **satín**, smooth and shiny because long floats reflect light, but easy to snag.

The fabric science. Every woven fabric has **grain**. The warp was held under tension on the loom and is usually the stronger, more tightly twisted yarn, so the **lengthwise grain**, parallel to the selvage, barely stretches. The **crosswise grain** gives a little more. But pull on the **bias**, at 45 degrees, and the little squares between the yarns lean over into diamonds, and the cloth stretches a lot. That is why pattern pieces are laid with the grainline arrow parallel to the selvage, so clothes hang straight; and it is why strips cut on the bias bend smoothly around curves without puckering, which makes them perfect for binding an edge. Bias math: a square of fabric 18 inches on a side has a diagonal of about $18 \times 1.414 \approx 25\frac{1}{2}$ inches. If you cut the whole square into 2-inch bias strips, you get about $18 \times 18 \div 2 = 162$ inches of strip, about $4\frac{1}{2}$ yards, minus a little for the short corners and the joining seams.

Let's sew. First you will run a **grain stretch test** on three strips of the same fabric. Then you will cut bias strips, join them with diagonal seams, and fold them into **bias tape** with a bias tape maker and the iron. The one skill to do well is **cutting on the true bias**: fold the fabric so the crosswise edge lies along the selvage, and cut along the fold line.

PICTURE STUDY



Weaver Facing Right, Vincent van Gogh, 1884 · Oil on canvas · Painted in Nuenen, the Netherlands
Image: [Wikimedia Commons](#), public domain

In 1883 and 1884 Vincent van Gogh lived in the Dutch village of Nuenen, where many families still wove linen and cotton cloth at home on big wooden hand looms. He drew and painted the weavers again and again, making dozens of pictures of them in less than a year. The loom is so large it almost swallows the man inside it.

Look closely

- Find the strip of cloth stretched across the loom. Which yarns are the warp, and where would the weft go in?
- Find the weaver's hands and the beam in front of him. The beater, or reed, swings toward him to pack each new pick tight. Where would it be?
- Look at the size of the loom compared with the man. Why must a loom be so heavy and solid?
- Look at the floor and the walls. What does the room tell you about where this weaver lived and worked?

Talk about it

1. When this was painted, power looms had already filled the mills of England and America for decades. Why might village weavers still work by hand?
2. Van Gogh painted the loom more carefully than the weaver's face. What does that tell you about what interested him?
3. If you could ask this weaver one question about his work, what would it be?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. You may use the iron on your own once an adult has checked you off: set it to cotton, keep fingers back from the hot plate and the bias tape maker's metal tip, which gets hot, set the iron upright on its heel between presses, and unplug it when you finish. Cut bias strips with fabric shears, or with a rotary cutter only with an adult nearby, on a mat, cutting away from you and closing the blade every time you set it down.

SEWING PROJECT

The Grain Stretch Test and Homemade Bias Tape

You will prove with a ruler that woven fabric behaves differently in three directions, and then put the stretchiest direction to work by making your own bias tape, the binding you will use on a potholder, a bag or a garment later in the year.

You will need

- Fabric shears (or a rotary cutter, mat and ruler with an adult nearby)
- A clear ruler, a yardstick and chalk or a washable marker
- Pins, a pincushion, a hand-sewing needle or a sewing machine
- A 1-inch (25 mm) bias tape maker, or a ruler and pins for folding by hand
- An iron and ironing board (after your adult check-off)
- A heavy book or a 1-pound bag of beans and two binder clips for the stretch test

SINGLE-FOLD BIAS TAPE FROM A FAT QUARTER

Finished size: About 3½–4 yards (3.2–3.7 m) of 1-inch (25 mm) single-fold bias tape, plus three test strips · About 90 minutes

Fabric and notions

- 1 fat quarter (18 × 22 in, 46 × 56 cm) of quilting cotton, prewashed and pressed
- For the stretch test: three strips of the same fabric, each 1 × 10 in (2.5 × 25 cm): one cut on the lengthwise grain, one on the crosswise grain, one on the true bias
- Thread to match
- A piece of cardboard about 3 × 6 in to wind the finished tape on

How to make it

1. **Stretch test:** clip the top of each test strip to the edge of a table so it hangs down. Mark a line 8 inches below the clip. Clip the bag of beans to the bottom for one minute and measure how far the line moved, to the nearest $\frac{1}{8}$ inch. Record all three.
2. Trim the fat quarter to an 18-inch square. Fold one corner over so the crosswise edge lies exactly along the selvage edge: the fold is the true bias. Press the fold lightly and cut along it.
3. Using the cut edge as your guide, mark parallel lines 2 inches apart with a ruler and chalk. Cut along the lines. (Strips are 2 inches wide because a 1-inch bias tape maker folds a 2-inch strip.)
4. Trim both ends of every strip on the straight grain, so each end is a slanted parallelogram end.
5. Join strips end to end: lay two ends right sides together at a right angle, overlapping so the $\frac{1}{4}$ -inch seam line runs from notch to notch. Sew a $\frac{1}{4}$ -inch seam by hand with a backstitch or by machine.
6. Press each joining seam open and trim the little points that stick out.
7. Feed the end of the strip into the wide end of the bias tape maker, wrong side up, and pull it out the narrow end with a pin. The tool folds both raw edges to the middle.
8. Slowly slide the tool along the strip, pressing the folded tape with the iron just behind it. Keep your fingers on the tool's handle, away from the iron.
9. Wind the finished tape onto the cardboard as you go. Measure the total length.

Fabric check: Use a firmly woven, light- to medium-weight cotton such as quilting cotton, broadcloth or a cotton shirt; it folds crisply and holds a pressed crease. Prewash it so the tape will not shrink later on the project it binds. Avoid knits (they have no true bias), slippery polyester satins and loosely woven fabrics, which fray in the tool. A plaid or stripe shows the bias beautifully because the lines run diagonally on the tape.

Steps

1. **Count out needles and pins.**
2. **Predict first.** Before the stretch test, guess the order of the three strips from least to most stretch, and guess by how many eighths of an inch.
3. Run the stretch test and make the bias tape from the pattern card.
4. **Check the math.** Predicted length from the lesson: about 162 inches from an 18-inch square, before seams and trimming. Compare with your measured length and explain the difference.
5. **Curve test.** Lay your bias tape around the rim of a plate, then try a 2-inch strip cut on the straight grain. Which lies flat?
6. **Count in and clean up.** Unplug the iron and set it on its heel to cool; pins and needle back in the cushion; save strips longer than 6 inches.
7. **Improve it.** Make a second roll with a plaid or striped fabric and compare how the joining seams look.

Tips

- If the strip will not feed into the tool, trim the end into a point.
- Stretch the bias strip as little as you can while pressing. Bias stretches easily, and stretched tape becomes narrow and wavy.
- Older students: fold your single-fold tape in half again and press to make double-fold binding, and figure how much binding a 9-inch-square potholder needs ($4 \times 9 + 6$ inches for corners and joining = 42 inches).

Check your work

- ☐ I can find the lengthwise grain, crosswise grain and true bias, and I measured how much each stretched.
- ☐ I can name plain, twill and satin weaves and spot each one with a magnifier.
- ☐ I made at least 3 yards of even, well-pressed bias tape, and I used the iron safely.

SEWING NOTEBOOK

1. Draw a plain weave, a twill and a satin on graph paper, coloring the warp one color and the weft another. Label each and tape in a swatch of each if you can find them.
2. Record the stretch test in a table: grain, starting mark, stretched mark, stretch in inches.
3. Draw a square of fabric with arrows for the lengthwise grain, crosswise grain and bias, and write the bias-strip math.

From history. Twill weaves are very old. Fragments of twill cloth more than two thousand years old have been found in salt mines in Austria and in burials across Europe and Asia. Denim, a cotton twill, was a work cloth for generations before it became an everyday fabric.

COMMON MISTAKES

- Cutting a “bias” strip by guessing the angle. A strip cut at 30 degrees twists and puckers. Fold the crosswise edge to the selvage to find the true 45 degrees.
- Joining bias strips straight across instead of on the diagonal. The seam makes a hard lump in the binding. Join at a right angle so the seam runs diagonally.
- Pulling bias tape while pressing it, so it shrinks narrow and ripples. Guide it; do not stretch it.

Make it a game • Weave Detective. Gather ten fabrics from around the house: towels, jeans, sheets, ribbons, coats. Take turns with your parent picking one, looking at it with a magnifier, and calling “plain,” “twill,” “satin” or “knit.” A correct call scores a point; a correct call of where the selvage or bias is scores a bonus. First to eight wins.

Scripture. “now the coat was without seam, woven from the top throughout.” (John 19:23, KJV)

Christ’s coat was not cut and sewn from pieces; it was woven in one piece on the loom. The soldiers knew it was too fine to tear.

2.3 THREAD COUNT, FABRIC WEIGHT AND WHAT THEY MEAN

OBJECTIVES

- Tell how Antonie van Leeuwenhoek, a Delft cloth merchant who checked fabric with magnifying lenses, went on to build microscopes.
- Count warp ends and weft picks per inch with a magnifier, and figure thread count.
- Weigh a measured swatch and figure fabric weight in grams per square meter and ounces per square yard, and explain what thread count does and does not tell you.

Warm-up. Find the package or label of a set of sheets, or look up one sheet set online with a parent. What thread count does it claim? What fiber? Does it say “single-ply” or “2-ply”? Now feel two old sheets or pillowcases in your home. Which feels smoother? Which is heavier? Write down your guess about which has the higher thread count.

WATCH

Buying Fabric Online? The Secret Is... GSM!

Evelyn Wood · 13:14

https://www.youtube.com/watch?v=p_vnwgtJLz4

WHEN TO WATCH

After “The fabric science.” Watch until she has shown the fabric-weight scale and compared the light and heavy fabrics in her hands; the end is about shopping online and can be skipped.

Note: A home dressmaker explains grams per square meter with real fabrics, from lightweight lawn to heavy linen.

KEY TERMS

ends and picks

Ends are warp yarns; picks are weft yarns. Ends per inch plus picks per inch is the thread count.

ply

The number of strands twisted together in one yarn. A 2-ply yarn is still one yarn and should be counted once.

ounces per square yard

The American way to give fabric weight. To convert, divide GSM by 33.9.

thread count

The number of yarns in one square inch of woven fabric, counting both directions. A sheet with 150 ends and 150 picks per inch has a thread count of 300.

GSM

Grams per square meter, the weight of fabric. Lawn may be 70 GSM; quilting cotton about 140; denim 350 or more.

linen tester

A small folding magnifier with an opening of exactly $\frac{1}{4}$ inch, $\frac{1}{2}$ inch or 1 inch, made for counting threads in cloth.

CORE IDEAS

The story. In 1654 a young man named **Antonie van Leeuwenhoek** opened a shop in Delft, Holland, selling cloth, ribbons and buttons. He had trained in a linen-draper's shop in Amsterdam, where merchants checked the quality of linen by looking at it through a magnifying glass and counting the threads. A tightly woven, even cloth with many fine threads was worth more than a coarse, loose one, and a draper who could not judge it would be cheated. Leeuwenhoek became fascinated by lenses. He learned to grind and polish tiny glass beads into lenses far stronger than any draper's glass, and set them in little brass plates. Through them, in the 1670s, he became the first person to see and describe bacteria and the tiny living creatures in a drop of pond water, and one of the first to see blood cells, which he called "animalcules," and he reported them in letters to the Royal Society in London. A cloth merchant's habit of looking closely opened up a whole hidden world.

How they figured it out. Cloth buyers still use Leeuwenhoek's first method. A **linen tester** is a folding magnifier with a square opening, often exactly $\frac{1}{4}$ inch or 1 inch. Lay it on the fabric, count the warp ends across the opening, then the weft picks, and multiply up to a full inch. Add the two directions and you have the **thread count**. For sheets, the

number became a selling point: a higher count usually means finer yarns packed more closely, so the sheet feels smoother. But some sellers learned to make the number look bigger by using thin **plied** yarns and counting each ply separately, so a fabric with 300 real yarns per square inch was sold as “600” or more. The Federal Trade Commission has advised sellers that a plied yarn counts as one yarn. A 300-count sheet of good long-staple cotton can be smoother and longer-lasting than a “1,000-count” sheet of weak plied yarns.

The fabric science. Thread count tells you how closely woven a fabric is. It does not tell you the fiber, how long the fibers were, how well the yarn was spun, or how heavy the fabric is. Fabric weight does. To find it, cut a swatch exactly 10 cm × 10 cm (that is 1/100 of a square meter) and weigh it in grams. Multiply by 100: a 1.4-gram swatch is **140 GSM**. To change GSM to ounces per square yard, divide by 33.9: $140 \div 33.9 \approx 4.1$ oz/yd². Lightweight voile and lawn run about 60–90 GSM; shirting and quilting cotton about 110–150; canvas and denim 250–450. Now the counting math. If you count 38 ends in a ¼-inch opening, there are $38 \times 4 = 152$ ends per inch. If you count 34 picks in ¼ inch, there are 136 picks per inch. Thread count: $152 + 136 = 288$. Notice the two directions are not equal; most fabrics have more ends than picks.

Let’s investigate. You will count threads and weigh swatches of three or four fabrics from home, figure each one’s thread count and GSM, and decide which numbers best predict how the fabric feels and wears. The one skill to do well is **accurate counting**: count each direction twice, in two different places, and use the average.

PICTURE STUDY



Portrait of Antonie van Leeuwenhoek, Jan Verkolje, about 1680–1686 · Oil on canvas · Rijksmuseum, Amsterdam

Image: [Wikimedia Commons](#), public domain

Jan Verkolje painted Leeuwenhoek in Delft when he was about fifty and already famous for his discoveries with the microscope. He is shown as a gentleman of learning, but he never forgot his start as a cloth merchant. Look at how many kinds of cloth the painter shows.

Look closely

- Find the lace at his neck and cuffs. Good lace like this was made thread by thread. How would a magnifier help you judge it?
- Find the dividers in his hand. Measuring tools mattered to a cloth merchant and to a scientist. What would he measure?
- Look at his loose brown robe. How does the painter show that it is soft, heavy cloth?
- Find the papers and the inkstand. Leeuwenhoek wrote hundreds of letters about what he saw. What would you write about after looking at fabric through a lens?

Talk about it

1. Leeuwenhoek's cloth-trade habit of counting threads led him to discoveries in science. What everyday skill of yours might lead somewhere surprising?
2. Why would a cloth merchant need to be able to judge a fabric with his own eyes rather than trust the seller?
3. If you could show Leeuwenhoek one modern fabric, which would you choose and why?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Cut swatches with fabric shears, carried closed and points down. Cut only from fabrics your parent has said you may cut: old sheets, worn shirts and scraps, never a good sheet from the closet.

SEWING PROJECT

The Thread Count and Fabric Weight Investigation

You will become a fabric inspector like Leeuwenhoek in his Delft shop. With a magnifier, a ruler and a kitchen scale, you will measure three or four real fabrics and test whether the numbers on a label tell the truth about the cloth.

You will need

- A linen tester, or a magnifying glass and a ruler marked in sixteenths of an inch
- A pin or needle for pointing at threads as you count (counted out and back in)
- A kitchen scale that reads to 0.1 gram if possible
- Fabric shears, a ruler in centimeters, and a washable marker
- A calculator and your notebook

FABRIC INSPECTOR'S REPORT CARD

Finished size: One notebook page with 3–4 labeled swatches and a table of measurements · About 75 minutes

Fabric and notions

- 3 or 4 woven fabrics: an old cotton sheet or pillowcase, a cotton shirt, a handkerchief or lawn scrap, and a heavier fabric such as denim or canvas

- From each fabric: one swatch cut exactly 10 × 10 cm (about 4 × 4 in) on the grain
- Optional: a scrap of a sheet whose package listed a thread count, to check the claim

How to make it

1. Mark and cut a 10 × 10 cm square from each fabric, on the grain. Measure twice. Label each with masking tape.
2. Weigh each square in grams. Multiply by 100 to find GSM. Divide GSM by 33.9 to find ounces per square yard.
3. Lay the linen tester on the first swatch with one side along a warp yarn. Using a pin as a pointer, count the warp ends across the opening. Count again in another place.
4. Turn the tester 90 degrees and count the weft picks the same way.
5. Multiply each count up to one inch (× 4 for a ¼-inch opening, × 2 for a ½-inch opening). Add ends and picks per inch to find the thread count.
6. Pull out one yarn from the edge of each swatch and untwist it under the magnifier. Is it single or plied? Record it.
7. Repeat for every swatch. Fill in the table: fabric, GSM, oz/yd², ends per inch, picks per inch, thread count, single or plied.
8. Rank the fabrics by feel (smoothest to roughest) and by your numbers. Which number matched the feel best?

Fabric check: Choose woven fabrics only: knits have loops, not ends and picks, and cannot be counted this way. Cotton and linen are easiest to count because their yarns are clear. Very fine fabrics (above about 200 ends per inch) are hard to count with a hand lens; count them in a ⅛-inch space and multiply by 8. Wash and dry fabrics first so sizing does not add weight.

Steps

1. **Count out** needles and pins, including the pin pointer.
2. **Predict first.** Before measuring, rank your fabrics from lowest to highest thread count and lightest to heaviest. Write it down.
3. Measure each fabric from the pattern card.
4. **Honesty check.** If two counts in different places differ by more than 4, count a third time and average all three.

5. **Label check.** If you have a sheet with a printed thread count, compare your count with the claim. If it is far higher than your count, are the yarns plied?
6. **Count in and clean up.** Pins and needles back in the cushion; save the swatches for your notebook.
7. **Improve it.** Add a fifth fabric that surprised you, such as flannel or a fine handkerchief, and place it in your ranking.

Tips

- A dark fabric is easier to count on white paper; a light fabric is easier on dark paper.
- Count in groups of five with the pin, the way you tally on paper. It keeps you from losing your place.
- Older students: compute cost per square meter for two sheet sets, using the price and the size printed on each package, and compare it with their thread counts.

Check your work

- ☐ I counted ends and picks per inch accurately and figured thread count.
- ☐ I weighed measured swatches and figured GSM and ounces per square yard.
- ☐ I can explain why a plied yarn should be counted once, and why thread count alone does not tell you how good a fabric is.

SEWING NOTEBOOK

1. Tape in your swatches with the full table of measurements beside them.
2. Draw what you saw through the lens for two fabrics: the grid of ends and picks, one fine and one coarse.
3. Write a three-sentence “buyer’s rule” for choosing sheets, using what you found.

From history. Leeuwenhoek and the painter Johannes Vermeer were both born in Delft in the autumn of 1632, and after Vermeer died, Leeuwenhoek was appointed to settle his estate. Leeuwenhoek’s best surviving microscopes magnify about 250 to 270 times with a single lens no bigger than a pinhead.

COMMON MISTAKES

- Counting only one direction and calling it the thread count. Thread count is ends plus picks.

- Weighing a swatch that is not exactly 10×10 cm. A swatch 1 cm too big on each side weighs 21 percent more.
- Believing that bigger is always better. Above about 400, high numbers usually mean thin plied yarns, not a better sheet.

Make it a game • Thread Count Challenge. You and your parent each get the same three fabric scraps and a magnifier. On “go,” count the threads in a $\frac{1}{4}$ -inch space in both directions on each scrap and figure the thread count. Closest to the average of three careful recounts wins the round. Best of three rounds; the loser weighs the next set of swatches.

2.4 FINISHING EDGES: HEMS, ZIGZAG, SERGER AND FRENCH SEAMS

OBJECTIVES

- Explain why cut woven edges fray and how each edge finish stops it.
- Tell how Joseph Merrow's overedge machines of the 1880s led to the modern serger.
- Sew a seam-finish sample book: raw, pinked, zigzagged or overcast, turned-and-stitched, bias-bound and French seam.

Warm-up. Turn three store-bought garments inside out: a T-shirt, a button-up shirt and a pair of pajama pants or a dress. Look at the seams. Which are wrapped in loops of thread? Which are folded and stitched? Which have the raw edges hidden inside a little tube? Which garment do you think will last longest?

WATCH

How to Sew a French Seam | Professional Seam Finish for Delicate Fabrics

Made to Sew · 7:51

<https://www.youtube.com/watch?v=fhogUaCBJOE>

WHEN TO WATCH

Before Session 2. Watch once all the way through, then again with two scraps in hand, pausing after the first seam, the trim and the press.

Note: A sewing teacher shows each step close up at the machine. She guides the fabric with her hands flat, well back from the needle.

BACKUP VIDEO

Stitch Type 504: Overlock Stitch in Slow Motion

Groz-Beckert · 2:26

<https://www.youtube.com/watch?v=KMrST6jPR7s>

After the story. A needle maker's slow-motion animation shows how a serger's needle and two loopers wrap the edge in thread while a knife trims it.

KEY TERMS

raw edge

A cut edge of fabric that has not been finished. On woven fabric it frays as the cut yarns work loose.

serger (overlock)

A machine that sews a seam, trims the edge with a knife and wraps it in loops of thread, all in one pass, using three to five threads.

pinking

Cutting an edge in a zigzag with pinking shears, so the short yarn ends fray less.

seam finish

Any way of treating the raw edges inside a seam so they do not fray: pinking, zigzag, serging, binding or enclosing them.

French seam

A seam sewn twice: first wrong sides together, then trimmed, folded and sewn right sides together, so the raw edges are sealed inside a narrow tube.

CORE IDEAS

The story. Inside every garment is a record of how well it was made. For centuries the answer to a fraying edge was handwork: tailors and seamstresses turned edges under and hemmed them, or wrapped them in tiny overcast stitches, one by one, inside every seam. That was slow, and factory clothing of the 1800s often had raw edges that frayed apart in the wash. In the 1880s, in Connecticut, **Joseph Merrow**, whose family ran a knitting mill, invented machines that could stitch over the edge of fabric, wrapping it in loops of thread at high speed. The Merrow company went on making overedge machines for factories, and their great-grandchildren are the **sergers** (called overlockers in Britain) used in clothing factories and home sewing rooms today. Look inside almost any T-shirt and you will find a serged seam.

How they figured it out. Sewers learned to match the finish to the fabric and the job. **Pinking** is quick and works on firm cottons that fray little. A **zigzag** or overcast stitch along the edge holds the yarn ends down and works on almost anything. A **turned-and-stitched** edge folds $\frac{1}{4}$ inch under and stitches it, which is neat on light fabrics. A **bound** edge wraps bias tape around it, beautiful for unlined jackets. And the **French seam**, the dressmaker's favorite for sheer and light fabrics, sews the seam twice so the raw edges

are locked inside a tube about $\frac{1}{4}$ inch wide. A serger does in one pass what takes two or three steps by hand, but every one of these finishes can be done on a home machine or by hand.

The fabric science. When you cut woven cloth, you cut through hundreds of yarns. Nothing holds their short ends in place, so washing, rubbing and pulling work them loose: that is fraying. Loosely woven fabrics and slippery filament yarns fray fastest; tightly woven cotton frays slowly. Knits barely fray at all because their loops interlock, but they can run. Each finish fights fraying a different way: pinking shortens the loose ends; zigzag and serging tie them down with thread; turning and binding hide them; French seams seal them in. The seam allowance must leave room for the finish. A French seam on a $\frac{5}{8}$ -inch (1.5 cm) seam allowance uses it like this: first seam at $\frac{3}{8}$ inch, trim to $\frac{1}{8}$ inch, then the second seam at $\frac{1}{4}$ inch. Check: $\frac{3}{8} + \frac{1}{4} = \frac{5}{8}$ inch. If your pattern gives only a $\frac{1}{2}$ -inch allowance, sew the first seam at $\frac{1}{4}$ inch and the second at $\frac{1}{4}$ inch.

Let's sew. You will make a **seam-finish sample book**: six samples on matching cards, each a real seam with a different finish, labeled with its name, when to use it and how long it took. The one skill to do well is the **French seam**: trim the first seam close and press it crisply before you sew the second, so no whiskers poke through.

PICTURE STUDY



The Young Seamstress, Jozef Israëls, about 1880 · Oil on canvas

Image: [Wikimedia Commons](#), public domain

Jozef Israëls was a Dutch painter of fishing families and working people in their homes. Here a young seamstress sits close to the only window, because in the days before electric light every stitch depended on daylight. Her whole attention is in her hands.

Look closely

- Find the window and follow the light to her hands and her sewing. Why does she sit exactly there?
- Look at the white cloth in her lap. Is she sewing a long seam, a hem or a small piece?
- Look at how she bends toward the work. What does her posture tell you about how fine the stitches are?
- Look at the dark room around her. What did the painter leave out, and what did he keep?

Talk about it

1. Before sewing machines and sergers, how long might it take to finish every seam of a shirt by hand?
2. What finish do you think she would choose for a fine white linen shirt, and why?
3. Why might a painter choose quiet, ordinary work like this as a subject?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. At the machine, keep hands flat and fingers at least an inch from the needle, take your foot off the pedal before threading or changing the stitch, and pull each pin before it reaches the presser foot. Use the iron only after your adult check-off, set upright between presses, and unplugged when done. Only an adult uses a serger at this level; you may watch and guide the fabric with the adult beside you if your family owns one.

SEWING PROJECT

A Seam-Finish Sample Book

You will sew six real seams and finish each one a different way, then mount them as pages of a little book you will open again and again this year whenever you have to choose how to finish a seam.

You will need

- A sewing machine with a zigzag stitch, or hand-sewing needles for the hand-finish options
- Fabric shears, pinking shears (optional) and small thread snips
- Pins, a pincushion, a seam gauge and a ruler
- An iron and ironing board (after your adult check-off)
- Six pieces of cardstock, a hole punch and a ribbon or two rings for the book

SIX-PAGE SEAM-FINISH SAMPLE BOOK

Finished size: Six seam samples, each about 5 × 6 in (13 × 15 cm), mounted on cardstock pages · About 2 hours over two sessions

Fabric and notions

- 12 rectangles of light- to medium-weight woven cotton, each 3 × 6 in (7.5 × 15 cm), so each sample is two pieces seamed along the 6-inch side
- Optional: 2 rectangles of a sheer or lightweight fabric (voile or lawn) for a second French seam
- About 8 inches of your bias tape from Lesson 2.2
- All-purpose thread in a color that shows on the fabric, so the stitches can be seen

How to make it

1. Pin each pair of rectangles right sides together along one 6-inch edge (except the French seam pair). Sew five seams with a $\frac{5}{8}$ -inch (1.5 cm) seam allowance, backstitching at each end. Press each seam flat, then press it open or to one side as the finish needs.
2. **Sample 1, raw:** leave the edges unfinished. This is your control.
3. **Sample 2, pinked:** trim each edge of the seam allowance with pinking shears, cutting off as little as possible.
4. **Sample 3, zigzag:** set a medium zigzag (about 3 mm wide, 2 mm long). Sew along each raw edge so the right swing of the needle just goes off the edge. (By hand: overcast stitches $\frac{1}{4}$ inch apart.)
5. **Sample 4, turned and stitched:** press the seam open. Fold each raw edge $\frac{1}{8}$ – $\frac{1}{4}$ inch under and stitch close to the fold.
6. **Sample 5, bound:** press both allowances to one side, trim them to $\frac{3}{8}$ inch, and wrap them in bias tape. Stitch through all layers close to the tape's inner edge.
7. **Sample 6, French seam:** pin the pair *wrong* sides together. Sew at $\frac{3}{8}$ inch. Trim the allowance to $\frac{1}{8}$ inch. Press the seam to one side, then fold the fabric right sides together along the seam and press so the seam is exactly on the fold. Sew at $\frac{1}{4}$ inch, enclosing the raw edges. Press the finished tube to one side.
8. Glue or stitch each sample to a cardstock page. Label it: name, best fabrics, time it took, and a strength and weakness.
9. Punch the pages and tie them into a book.

Fabric check: Use a firmly woven cotton or cotton blend such as quilting cotton, broadcloth or an old cotton shirt; the same fabric for all six makes the comparison fair. Prewash it. Voile or lawn shows off a French seam beautifully but slips more: pin closely. Avoid knits for this project, because they do not fray and the comparison will not show. If you have only one color, use thread that contrasts so you can see the stitches.

Steps

1. **Count out needles and pins.**
2. **Practice first.** Sew a 6-inch practice seam at exactly $\frac{5}{8}$ inch using the seam guide on the needle plate, and measure it in three places.
3. Sew the six samples from the pattern card.
4. **Fray test.** Cut one extra pair of each of samples 1–3, put them in a mesh laundry bag, and wash and dry them three times with the family laundry. Compare the edges and record the results with a 0–5 fray score.
5. **Time each finish** and record the minutes; the fastest is not always the best.
6. **Count in and clean up.** Pins and needles counted in, iron unplugged and on its heel, machine unplugged and covered, floor swept with a magnet.
7. **Improve it.** Redo the finish you liked least, and add a seventh page with a finish you see in a store garment (a flat-felled seam from a pair of jeans, for example).

Tips

- Trim the first pass of a French seam very close, $\frac{1}{8}$ inch or less. Any whiskers left will peek out of the finished seam.
- For a zigzag finish, sew on the seam allowance only, not through the garment.
- Younger students: make four samples (raw, pinked, zigzag or overcast, French seam). Older students: add a flat-felled seam and a Hong Kong (bound) seam.

Check your work

- ☐ I can explain why woven edges fray and how each finish stops it.
- ☐ I sewed six seam samples with accurate seam allowances and labeled each one.
- ☐ My French seam is narrow and even, with no raw threads showing.

SEWING NOTEBOOK

1. Draw a cross-section of a French seam, step by step: first seam, trim, fold, second seam. Label the measurements.

2. Record the fray test: before and after drawings or photos of samples 1–3 and their fray scores.
3. Copy the inside seams of one store-bought garment and name each finish.

From history. A serger usually needs no bobbin. Its upper and lower **loopers** carry thread around the edge of the fabric and lock with the needle thread, while a knife trims the edge just ahead of the needle. Home sergers became common in American sewing rooms in the 1980s, about a hundred years after Mallow's first overedge machines.

COMMON MISTAKES

- Sewing the first pass of a French seam right sides together. The raw edges end up on the outside. Start *wrong* sides together.
- Zigzagging so far from the edge that the threads still fray beyond the stitching. Let the right swing of the needle fall just off the edge.
- Choosing a French seam for a thick fabric. It turns into a hard ridge. Use it on light and sheer fabrics.

Make it a game • Seam Finish Match-Up. Your parent writes six fabrics on cards (sheer curtain, denim jeans, T-shirt knit, cotton pajamas, wool jacket, silk scarf) and you write six finishes on other cards. Race the timer to match each fabric to its best finish and say why. Score a point for each match your parent agrees with; argue for any your parent questions.

UNIT 2 REVIEW

Answer in complete sentences unless the question asks for a calculation or a show-me. For calculations, show every step of your math; a right answer with no work earns half. The review is worth 100 points.

1. (8 pts)

Name the two actions in all spinning, and tell what each one does to the fibers.

2. (8 pts)

Put these in order and give the date or decade of each: the Lowell mills; Arkwright's water frame patent; Slater begins spinning in Pawtucket; the Fair Labor Standards Act.

3. (8 pts)

Written answer. In four or five sentences, tell who Lewis Hine was, what he photographed, and what changed because of photographs like his.

4. (10 pts)

Calculate. A spinner's 12-gram skein of handspun measures 22 yards. How many yards would a 100-gram bundle of the same yarn make? A hat pattern needs 180 yards. Is 100 grams enough?

5. (8 pts)

Describe plain, twill and satin weave, and give one fabric made in each.

6. (8 pts)

Show me. Using a square scrap of woven fabric, show your parent the selvage (or tell where it would be), the lengthwise grain, the crosswise grain and the true bias, and pull on each to show which stretches most.

7. (10 pts)

Calculate. With a $\frac{1}{4}$ -inch linen tester you count 44 warp ends and 37 weft picks. What is the thread count? The package says "600 thread count, 2-ply." Could this be the same fabric? Explain.

8. 10 pts

Calculate. A 10×10 cm swatch of denim weighs 3.9 grams. What is its weight in GSM and in ounces per square yard (round to one decimal)?

9. 8 pts

What does thread count tell you about a fabric, and what does it not tell you? Name at least three things it leaves out.

10. 7 pts

Why does woven fabric fray? Name four seam finishes and tell how each one stops fraying.

11. 8 pts

Calculate. Your pattern has a $\frac{5}{8}$ -inch seam allowance and you want a French seam with a finished width of $\frac{1}{4}$ inch. At what width do you sew the first seam? How much do you trim it to? Show that the seams add up to $\frac{5}{8}$ inch.

12. 7 pts

Written answer. Choose Leeuwenhoek or Cartwright. In four sentences, tell what problem he faced in the cloth trade and what came of his patient work.

UNIT CHALLENGE: THE FABRIC BOOK: SWATCHES, NUMBERS AND FINISHES

Build a fabric reference book for the rest of the year. It holds your handspun yarn with its numbers, your three grain test strips and a length of your bias tape, your thread-count and GSM report card with its swatches, and your seam-finish sample book.

Add one page that ties it together: choose one real item in your home (a sheet, a shirt, a tote bag) and describe it completely in this unit's language: fiber, yarn (single or plied), weave, grain of the main pieces, thread count, GSM and seam finishes. Show your measurements and math.

LOOK FOR	WHAT IT MEANS
Complete samples	Yarn, grain strips, bias tape, counted and weighed swatches, and at least five seam finishes are all present and labeled.
The arithmetic	Yardage, thread count, GSM and ounces per square yard are computed correctly with the work shown.

LOOK FOR	WHAT IT MEANS
Workmanship	Seams sewn at accurate allowances; French seam narrow with no whiskers; bias tape even and pressed.
The item description	One real item is described accurately in fiber, yarn, weave, grain, count, weight and finish.
Safety and improvement	Needle-and-pin count every session; machine and iron used safely; one sample redone better with the change noted. A crooked first try honestly recorded and redone earns full credit.

ANSWER KEY

1. Drafting draws a few fibers out of the roving into a thin, even stream. Twist locks the drafted fibers together so friction holds them; the twisted yarn is far stronger than any single fiber.
2. Arkwright's water frame, 1769; Slater begins spinning in Pawtucket, 1790; the Lowell mills, 1820s–1840s; the Fair Labor Standards Act, 1938.
3. Lewis Hine was a photographer who worked for the National Child Labor Committee from 1908. He traveled to textile mills and other workplaces and photographed children at work, often writing down their names and ages, like twelve-year-old Addie Card at her spinning frame in 1910. His photographs showed Americans what many had not seen. They helped convince people to pass state school and child-labor laws, and in 1938 the Fair Labor Standards Act set sixteen as the usual minimum age for factory work.
4. $22 \div 12 \approx 1.83$ yards per gram. $1.83 \times 100 \approx 183$ yards (or $22 \times 100 \div 12 = 183\frac{1}{3}$). 183 yards is just enough for 180 yards, with about 3 yards to spare, which is very close; a careful knitter would spin a little extra.
5. Plain: each weft goes over one warp and under one (muslin, broadcloth, canvas). Twill: each weft goes over two or more and under one or more, stepping one yarn each row so the crossings make diagonal lines (denim, gabardine). Satin: yarns float over four or more before going under, making a smooth, shiny face (satin ribbon, lining satin).
6. Parent checks: the lengthwise grain runs parallel to the selvage and stretches least; the crosswise grain runs selvage to selvage and stretches a little; the true bias is at 45 degrees (found by folding the crosswise edge to the selvage) and stretches most.
7. Ends per inch: $44 \times 4 = 176$. Picks per inch: $37 \times 4 = 148$. Thread count: $176 + 148 = 324$. If every yarn is 2-ply and each ply was counted separately, the seller could double it to about 648 and call it "600." Counting each plied yarn once, as the FTC advises, the true thread count is about 324, so it could be the same fabric with a misleading label.
8. $3.9 \times 100 = 390$ GSM. $390 \div 33.9 \approx 11.5$ oz/yd².
9. It tells how many yarns are packed into a square inch, so how closely the fabric is woven. It does not tell the fiber, the fiber length (staple), how well the yarn is spun, whether the yarns are plied, the weave, the weight or how the fabric was finished.
10. Cutting leaves short yarn ends with nothing holding them, and washing and rubbing work them loose. Pinking shortens the loose ends into points; zigzag or overcast stitching ties them down with thread; serging trims and wraps them in thread loops;

turned-and-stitched or bound edges hide them; a French seam seals them inside a tube.

11. Sew the first seam at $\frac{3}{8}$ inch, trim it to about $\frac{1}{8}$ inch, and sew the second seam at $\frac{1}{4}$ inch. $\frac{3}{8} + \frac{1}{4} = \frac{3}{8} + \frac{2}{8} = \frac{5}{8}$ inch.
12. Open answer. Leeuwenhoek: a cloth merchant needed to judge fabric by counting threads through a lens; he ground ever-better lenses and became the first to see bacteria and blood cells. Cartwright: spinning mills made more yarn than hand-weavers could weave; he patented a power loom in 1785 and spent years improving it, and power looms filled the mills. Look for a correctly named problem and a true detail.

HAND STITCHING

A sewing machine is fast, but some jobs are still done best by hand: a hem that disappears on the outside of a pair of trousers, a buttonhole that will not fray, a darn in the heel of a wool sock, a patch on the knee of your jeans, an embroidered picture. In this unit you will learn the hand stitches that keep a family's clothes in use for years, and you will practice them on real garments, not just samples.

You will meet the soldiers who carried a little sewing kit called a “housewife” to mend their own uniforms, the tailors of a Dutch workshop in 1661, the families of wartime Britain who were told to “make do and mend,” and the embroiderers who stitched the story of 1066 onto a strip of linen more than two hundred feet long. Along the way you will do the arithmetic of hems, button spacing and patch sizes, and you will finish the unit with a mended garment and an embroidered hoop.

PREREQUISITES

- Can thread a needle, tie a knot and sew a running stitch and backstitch (Fabrics & Sewing I, or practice before Lesson 3.1)
- Can measure to the nearest $\frac{1}{8}$ inch and add and subtract fractions of an inch
- Knows the needle-and-pin count and keeps needles in a pincushion
- Can use the iron after an adult check-off (Lesson 2.2)

MASTERY CHECKLIST

- ☐ I can sew a backstitch, slip stitch, catch stitch and blind hem stitch, and choose the right one for a job.
- ☐ I can measure, mark and hand-hem a pair of pants or a skirt so the stitches barely show.
- ☐ I can figure buttonhole length and button spacing, and work a buttonhole by hand.
- ☐ I can sew on a button with a thread shank, a snap and a hook and eye.
- ☐ I can darn a hole in a knitted sock and patch a woven garment, and explain why a patch must be preshrunk.
- ☐ I can tell how the Bayeux Tapestry was made and embroider with stem stitch and laid-and-couched filling.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **A darning egg or darning mushroom:** A smooth wooden form that holds a sock heel or toe taut while you darn. A smooth light bulb (cold and unplugged), a tennis ball or an orange works too.
- **A 6- or 7-inch embroidery hoop, crewel needles and a few colors of crewel or tapestry wool:** For Lesson 3.4. Medium-weight linen or cotton twill for the ground fabric. Six-strand embroidery floss works if you cannot find wool.
- **A 6-inch seam gauge:** A small metal ruler with a sliding marker, for marking even hems, buttonhole lengths and button spacing quickly.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

3.1 Stitches That Hold: The Hemming Stitches	2 sessions of 50–60 minutes
3.2 Closures: Buttons, Buttonholes, Snaps and Hooks	2 sessions of 50–60 minutes
3.3 Mending and Patching	2 sessions of 50–60 minutes
3.4 Embroidery and Crewel: The Bayeux Tapestry	2 sessions of 50–60 minutes

3.1 STITCHES THAT HOLD: THE HEMMING STITCHES

OBJECTIVES

- Tell how soldiers of the 1860s carried a “housewife” sewing kit and mended their own clothes.
- Sew the backstitch, slip stitch, catch stitch and blind hem stitch, and tell when to use each.
- Measure, mark and hand-hem a real pair of pants or a skirt, with stitches that barely show on the outside.

Warm-up. Look at the bottom hem of a pair of dress pants or a skirt, a pair of jeans and a T-shirt. On which one can you see a row of stitching from the outside? On which can you see only tiny dots, or nothing at all? Turn them inside out and look at how each hem is held. Which one do you think was sewn partly by hand?

WATCH

HOW TO FIX DRESS PANTS HEM | Blind Stitch | Invisible Hemming Trousers - Repair Hem by Hand

Sewing at Home Mom · 6:18

https://www.youtube.com/watch?v=AxB_cm6jxe0

WHEN TO WATCH

Before Session 2, with your own pants or skirt beside you. Watch once through, then again, pausing after each few stitches to copy how she catches only a thread or two of the outer fabric.

Note: Hands only, sewing a real trouser hem. The description has shopping links you can ignore.

BACKUP VIDEO

How to Sew A Catch Stitch

Professor Pincushion · 4:26

<https://www.youtube.com/watch?v=JP-HE1DNO8>

For the catch-stitch sample, or if you are hemming a knit or a heavy fabric.

KEY TERMS

hem allowance

The amount of fabric turned up at the bottom of a garment to make the hem, often 1½ to 2 inches on pants and skirts.

blind hem stitch

A hemming stitch worked just under the edge of the hem allowance, catching one or two threads of the outer fabric, so the stitches are hidden on both sides.

housewife

A small roll-up sewing kit, said by soldiers as “hussif,” carried by soldiers and travelers with needles, thread, buttons and a scrap of cloth.

slip stitch

A nearly invisible stitch in which the needle slides inside a fold and catches only a thread or two of the fabric beside it.

catch stitch

A crisscross stitch worked from left to right (for right-handers) that holds a hem flat while letting it stretch a little. Good for knits and heavy fabrics.

CORE IDEAS

The story. In the American Civil War, a soldier on either side had no one to mend his uniform but himself. Many carried a small roll of cloth called a **housewife** (soldiers said “hussif”): a pocket for needles and pins, a few skeins of thread wound on a card, spare buttons, and a scrap of wool for patching, all rolled up and tied with a tape. Many were sewn by mothers, sisters and wives and given as a parting gift, sometimes with a name or a Bible verse stitched inside. Around the campfire, men who had never sewn at home learned to put a button back on, close a split seam with a backstitch and turn up a ragged trouser hem. Museums still keep housewives that came home from the war, worn soft from use.

How they figured it out. Over centuries, sewers worked out a small family of stitches, each for a different job. The **backstitch** is the strongest hand stitch, because each stitch doubles back into the last; use it for seams. The **slip stitch** hides inside a fold; use it to close an opening or hold a folded edge. The **blind hem stitch** is worked between the hem allowance and the garment, catching only one or two threads of the outer fabric, so from the outside the hem looks unsewn. The **catch stitch** crisscrosses like a row of little X’s;

because it can stretch, it holds hems on knits and on heavy wool without pulling. A good hemmer keeps her stitches loose: a hem pulled tight makes little dimples, called puckers, that show on the outside.

The fabric science. A hem has two jobs: it finishes the raw edge so it cannot fray, and it adds a little weight so the garment hangs straight. The arithmetic comes first. Suppose your pants are 2 inches too long and you want a 1½-inch hem. Mark the new **fold line** 2 inches above the old hem fold. Measure 1½ inches below the fold line for the hem allowance, plus ¼ inch to turn under, and trim the rest. So you keep $1\frac{1}{2} + \frac{1}{4} = 1\frac{3}{4}$ inches below the fold. For an invisible hem the stitches should be about $\frac{3}{8}$ to $\frac{1}{2}$ inch apart: a pant leg 17 inches around, stitched every $\frac{1}{2}$ inch, takes $17 \div \frac{1}{2} = 34$ stitches. Wide legs take more. And because a pant leg is usually a little narrower at the hem than higher up, a deep hem can be too tight to lie flat when turned up; that is one reason trouser hems are seldom more than 2 inches.

Let's sew. First you will sew a **stitch sampler** of the four hand stitches on two scraps. Then you will hem a real garment: a pair of pants or a skirt that is too long, or one whose hem has come down. The one skill to do well is the **blind hem stitch**: pick up only one or two threads of the outer fabric, and leave the thread relaxed.

PICTURE STUDY



Girl Sewing (Pige, der syr), Anna Ancher, between 1877 and 1902 · Oil on canvas

Image: [Wikimedia Commons](#), public domain

Anna Ancher lived her whole life in the fishing village of Skagen, at the northern tip of Denmark, and painted the women and girls of the village in their homes. She loved the way sunlight came through a window and filled a quiet room. Here a girl sews a white garment, perhaps hemming it, close to the light.

Look closely

- Find the white cloth in her lap. Which hand holds the needle, and which holds the work?
- Look at how close she holds the work to her eyes. What does that tell you about the size of her stitches?
- Follow the light from the window. Where is it brightest, and why did she sit there?
- Look at the colors: blue dress, white cloth, golden light. Where does your eye go first?

Talk about it

1. If she is hemming the white cloth, which of this lesson's stitches might she be using?
2. How is sewing by a sunny window like sewing under a good lamp at home today?
3. Ancher painted ordinary work as something beautiful. What ordinary work in your home would make a good painting?

Safety first. A parent or responsible adult supervises all sewing tool use, and the needle-and-pin count opens and closes every session. Park your needle in the pincushion whenever you stop, never in the garment or the arm of the couch. If you use the seam ripper to take out an old hem, rip away from your hand, toward a pin. Press the finished hem yourself after your adult iron check-off, with a press cloth on dark or synthetic fabric.

SEWING PROJECT

Hand-Hem a Pair of Pants or a Skirt

You will measure, mark, trim and hand-hem a real garment, the same job tailors and dry cleaners are paid to do every day. First you will warm up with a four-stitch sampler.

You will need

- Hand-sewing needles (sharps, size 7–9), a thimble and a pincushion
- Thread matched to the garment (a shade darker hides better than a shade lighter)
- A seam ripper, small scissors and fabric shears
- Pins, a seam gauge, a tape measure and tailor's chalk or a washable marker
- An iron, ironing board and press cloth (after your adult check-off)

BLIND-HEMMED PANT LEGS (OR SKIRT HEM)

Finished size: One garment hemmed to the right length, with a 1½-inch (4 cm) hem · About 60–90 minutes

Fabric and notions

- One pair of woven pants or a woven skirt that is too long or has a fallen hem (cotton twill, wool, polyester suiting or a blend)
- For the sampler: two scraps of medium-weight woven cotton, each about 6 × 8 in (15 × 20 cm)
- Matching all-purpose thread, about 2 yards for a pair of pants

How to make it

1. **Sampler:** on the scraps, sew a 3-inch row of backstitch, then fold one edge under $\frac{1}{4}$ and 1 inch and slip-stitch it, catch-stitch a second folded edge, and blind-hem a third. Label each.
2. **Measure:** put on the pants with the shoes you will wear. A parent folds one leg under until it just touches the top of the shoe in front, and pins it. Measure from the old fold to the new one and write the number down.
3. Take the pants off. Use the seam ripper to remove the old hem stitches (ripping away from your hand). Press out the old fold.
4. Mark the new fold line all around each leg with chalk, measuring the same distance from the old fold in several places.
5. Measure $1\frac{3}{4}$ inches below the fold line ($1\frac{1}{2}$ -inch hem + $\frac{1}{4}$ inch to turn under) and mark a cutting line. Cut off the extra with shears.
6. Turn the raw edge under $\frac{1}{4}$ inch and press. Then turn the hem up along the fold line, matching the side seams, pin, and press the bottom fold crisply.
7. Thread a single strand about 24 inches long and knot it. Start at an inside seam, hiding the knot inside the hem.
8. **Blind hem:** fold the hem edge back about $\frac{1}{4}$ inch. Take a tiny stitch, one or two threads, in the pant leg; then move $\frac{3}{8}$ – $\frac{1}{2}$ inch to the left (for right-handers) and take a small stitch in the hem allowance. Repeat all the way around, keeping the thread relaxed.
9. Knot off inside the hem at the seam. Check the outside: you should see only tiny dots or nothing. Press the hem from the inside with a press cloth.

Fabric check: Woven fabrics of medium weight, such as cotton twill, chino, wool flannel or polyester suiting, are easiest to blind-hem because a stitch can catch a single yarn. Jeans are too thick for an invisible hand hem: hem

them by machine or with a backstitch. For knit pants or skirts, use the catch stitch so the hem can stretch. Choose a garment the family actually needs hemmed; a thrift-store pair is perfect practice.

Steps

1. **Count out needles and pins.**
2. **Practice first.** Sew the four-stitch sampler and have a parent check that the blind hem is invisible from the front before you touch the real garment.
3. Hem the garment from the pattern card.
4. **Count your stitches.** Count the stitches around one leg and divide the leg's circumference by that number to find your average spacing. Was it between $\frac{3}{8}$ and $\frac{1}{2}$ inch?
5. **Wear test.** Wear the garment for a day. Did any stitch pull loose or pucker?
6. **Count in and clean up.** Needles and pins in the cushion, iron unplugged and on its heel, scraps saved.
7. **Improve it.** Hem a second garment for someone else in the family.

Tips

- Use a single thread for hemming, not doubled; a doubled thread tangles and shows more.
- Wax or press your thread (run it over a bit of beeswax, or press it with a warm iron) so it does not knot.
- Younger students: hem a skirt or a pair of pajama pants with a slip stitch. Older students: hem a lined skirt or a pair of wool trousers, and catch-stitch the lining hem separately.

Check your work

- ☐ I can sew a backstitch, slip stitch, catch stitch and blind hem stitch and tell what each is for.
- ☐ I measured, marked and cut a hem allowance accurately and both legs match.
- ☐ My hem stitches barely show on the outside and do not pucker.

SEWING NOTEBOOK

1. Tape in your four-stitch sampler and label each stitch with its job.

2. Draw a cross-section of a hem: the garment, the fold line, the hem allowance, the $\frac{1}{4}$ -inch turn-under and where the blind stitches go. Write your measurements on it.
3. Write a list of what you would put in your own “housewife” sewing kit, and why.

From history. Sailors in the age of sail were famous needleworkers. Each man kept a “ditty bag” of needles, palm thimble and twine, and sailors made and mended their own clothes, hammocks and sails. Some passed long voyages embroidering pictures of their ships.

COMMON MISTAKES

- Measuring the new length without the shoes that will be worn. The hem ends up too short or too long.
- Pulling every stitch tight. The hem puckers into little dimples on the outside. Leave the thread relaxed.
- Taking big bites of the outer fabric. Each stitch shows as a line. Catch only one or two threads.

Make it a game • Invisible Stitch Contest. You and your parent each blind-hem 4 inches on a folded scrap of the same fabric, with thread that matches. Swap scraps, set a timer for one minute, and count how many stitches you can find on the outside of the other person’s hem. Fewest visible stitches wins; break ties by the evenness of spacing.

3.2 CLOSURES: BUTTONS, BUTTONHOLES, SNAPS AND HOOKS

OBJECTIVES

- Tell how buttons with buttonholes changed clothing in the Middle Ages, and how a tailor's workshop of 1661 made and finished garments by hand.
- Figure a buttonhole's length from the button and space buttons evenly along an opening.
- Work a buttonhole by hand, and sew on a button with a thread shank, a snap and a hook and eye.

Warm-up. Go to the coat closet and the dresser and find five different closures: buttons, snaps, hooks and eyes, zippers, toggles, hook-and-loop tape, ties. For each one, ask: Is it strong? Is it quick? Does it show? Which would be best on a baby's clothes, a winter coat and a shirt collar?

WATCH

How to sew a hand-sewn buttonhole Easy to understand with illustrations

Minoru Sews · 5:48

https://www.youtube.com/watch?v=jBowd_m6rkg

WHEN TO WATCH

Before Session 2. Watch the whole buttonhole once with no sound needed; the drawings show where each stitch goes. Then watch the button part, from 3:37, as you sew your own.

Note: Hands only, with drawn diagrams over the fabric. The teacher makes a keyhole (eyelet) buttonhole and then a button with a thread shank.

KEY TERMS

buttonhole stitch

A stitch that forms a little knot (purl) at the edge of the slit with every stitch, packing tightly so the cut edge cannot fray.

thread shank

A short stem of wrapped thread between a flat button and the fabric, which leaves room for the layer of fabric that buttons over it.

hook and eye

A small metal hook and a loop (straight bar or round eye) sewn on opposite sides of an opening, used at waistbands and necklines.

bar tack

A few stitches laid across the end of a buttonhole and covered with tight stitches, so the slit cannot tear further.

snap (press stud)

A two-part metal closure, a ball and a socket, sewn to each side of an opening and pressed together.

CORE IDEAS

The story. Buttons are thousands of years old, but for most of that time they were ornaments, or they fastened through a loop of cord. In Europe in the 1200s, tailors began cutting **buttonholes** and binding their edges with stitches, and suddenly a garment could be closed snugly down the front and along the sleeve. Clothes could now be fitted to the body instead of hanging loose or being laced. By the 1600s, a tailor's shop was a busy place of hand-sewing. In the picture for this lesson, painted in Leiden, Holland, in 1661, the tailor and his workers sit cross-legged on a big table under the window to get the best light, sewing the seams, hems and buttonholes of a garment by hand while a woman of the house stands by with a pail. Every buttonhole on every coat in Europe was worked by hand until sewing machines learned to make them in the late 1800s.

How they figured it out. A slit cut in woven cloth frays at once, so tailors bound the edges with the **buttonhole stitch**. Each stitch passes through the fabric beside the slit, and the needle passes through a loop of the thread before it is pulled snug, so a tiny knot (called the purl) sits right on the cut edge. Packed side by side, these knots form a hard, firm edge that protects the cloth for years. The ends are strengthened with a **bar tack** so

the slit cannot tear when the button pulls. Buttons themselves were sewn on with a **thread shank**, a little stem that leaves room for the layer of fabric that goes over the button. Later inventions added other closures: the hook and eye for waistbands, and the metal **snap**, patented in Europe in the 1880s, which needs no hole at all.

The fabric science. Closures need careful arithmetic. A buttonhole must be long enough for the button's width *and* thickness: **buttonhole length $\approx$ diameter + thickness**. A $\frac{5}{8}$ -inch (15 mm) button that is $\frac{1}{8}$ inch thick needs a buttonhole about $\frac{5}{8} + \frac{1}{8} = \frac{3}{4}$ inch long. A domed or shanked button needs more. Buttons are spaced evenly. Suppose a shirt front is 20 inches long and you place the top button 1 inch below the neck and the bottom one 3 inches above the hem. The distance between them is $20 - 1 - 3 = 16$ inches. For 5 buttons there are 4 spaces, so $16 \div 4 = 4$ **inches** between buttons. Buttonholes on a shirt front run lengthwise; on a coat front, crosswise, because the pull of the button runs sideways and a crosswise hole lets the button sit at its end without distorting the opening. Finally, interfacing or a double layer of fabric under every buttonhole keeps it firm.

Let's sew. You will make a **closure sampler card**: a hand-worked buttonhole with its matching button sewn on with a thread shank, a snap and a hook and eye, all on a doubled piece of fabric. Then you will put your skills to work on a real garment that is missing a button or a snap. The one skill to do well is the **buttonhole stitch**: stitches the same depth, packed close, each knot sitting right on the edge.

PICTURE STUDY



The Tailor's Workshop, Quiringh van Brekelenkam, 1661 · Oil on canvas · Rijksmuseum, Amsterdam

Image: [Wikimedia Commons](#), public domain

Quiringh van Brekelenkam painted ordinary Dutch workshops and homes in the city of Leiden. Tailors really did sit cross-legged on their tables, close to the window, so that the work lay in their laps in the best light. Everything in this picture, from the coats on the wall to the yellow cloth in the master's hands, was cut and sewn by hand.

Look closely

- Find the tailor in the broad hat. Is he sitting on the table or at it? Why would a tailor work up on the table, close to the window?
- Look for their needles and the garments in their laps. What parts of a coat might they be sewing?
- Find the clothes hanging on the wall and the yellow cloth in the master's hands. Are they finished, or waiting to be worked on?
- Look at the floor under the table. What has fallen there, and what does it tell you about the work?

Talk about it

1. Every buttonhole on a 1661 coat was worked by hand. How long do you think a coat with twenty buttonholes took?
2. Why might a tailor have helpers and apprentices instead of working alone?
3. What would a tailor's shop look like today, and what would be the same?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Cut buttonhole slits with small sharp scissors or a seam ripper, pointing away from your hand, with a pin across each end as a stop so the blade cannot slip through. Keep loose buttons, snaps and hooks in a closed dish, away from babies, toddlers and pets, who can swallow them.

SEWING PROJECT

A Closure Sampler Card and a Real Repair

You will make one of each of the four common hand-sewn closures on a sample card you can keep in your sewing notebook, then fix a real garment that needs a closure.

You will need

- Hand-sewing needles (sharps size 7–9), a thimble and a pincushion
- Buttonhole twist, topstitching thread or doubled all-purpose thread
- Small sharp scissors or a seam ripper, and pins
- A seam gauge, a ruler and a washable marker
- A toothpick or a second pin (to space the thread shank)

CLOSURE SAMPLER CARD

Finished size: One 6 × 8 in (15 × 20 cm) doubled sampler with four closures · About 90 minutes

Fabric and notions

- Two pieces of firm woven cotton (broadcloth, shirting or quilting cotton), each 6 × 8 in, pressed and placed one on top of the other
- Optional: a 2 × 3 in piece of fusible interfacing for under the buttonhole (an adult or the checked-off student fuses it with the iron)

- One flat two- or four-hole button about $\frac{5}{8}$ in (15 mm) across
- One size 2 or 3 sew-on snap and one hook and eye
- Thread: about 1 yard of buttonhole twist and 1 yard of all-purpose thread

How to make it

1. Measure the button's diameter and thickness. Add them to find the buttonhole length and write it down.
2. Mark the buttonhole line on the doubled fabric, at least $\frac{3}{4}$ inch from any edge. Mark both ends with short crossing lines.
3. **Outline:** with a single all-purpose thread, sew a rectangle of tiny running stitches about $\frac{1}{8}$ inch from the line on all sides. This holds the layers and gives a guide.
4. Put a pin across each end of the line as a stop. Carefully cut the slit along the line with sharp scissors or a seam ripper, pointing away from you.
5. **Buttonhole stitch:** with buttonhole twist, bring the needle up just outside the outline. Insert it into the slit and up again beside the last stitch; before pulling snug, pass the needle through the loop of thread at the eye, so a little knot sits on the cut edge. Pack the stitches close down one side.
6. At the end, fan five to seven stitches around the curve (or make a bar tack), then work back up the other side. Finish the far end with a bar tack: three long stitches across the end, covered with tight buttonhole stitches.
7. **Button:** mark the button's place through the buttonhole. Lay a toothpick across the button and sew over it through the holes six to eight times. Remove the toothpick, lift the button, wrap the thread around the stitches under it three or four times to make the shank, and knot off underneath.
8. **Snap:** sew the ball half on the overlapping layer with four or five stitches through each hole; mark the socket's place exactly under it and sew it on the same way.
9. **Hook and eye:** sew the hook $\frac{1}{8}$ inch in from one edge, stitching through each loop and over the neck of the hook to hold it flat; sew the eye on the opposite side so the edges meet when hooked.

Fabric check: Use a firm, closely woven cotton for the sampler; loose weaves fray at the slit before you can bind it. A layer of interfacing or a second layer of fabric under the buttonhole is essential. Buttonhole twist or topstitching

thread makes the purled edge stand up beautifully; doubled all-purpose polyester thread works too. Avoid knits for a first buttonhole: they stretch and ripple.

Steps

1. **Count out** needles, pins and the small parts: button, snap pieces, hook and eye.
2. **Practice first.** Work ten buttonhole stitches along the folded edge of a scrap, with no slit, until each little knot sits on the fold.
3. Make the closure sampler card from the pattern card.
4. **Strength test.** Button and unbutton your sampler twenty times. Does the buttonhole edge stay firm? Does the button stay tight?
5. **Real repair.** Find a family garment with a missing button, snap or hook and fix it, matching the thread and the original stitching.
6. **Count in and clean up.** Count needles, pins and every small part back into the dish.
7. **Improve it.** Work a second buttonhole and compare the evenness of the two.

Tips

- Keep every buttonhole stitch the same depth, about $\frac{1}{8}$ inch. Mark a line with chalk if it helps.
- If the slit frays as you work, brush a tiny line of clear fray-check liquid along it (an adult opens it) and let it dry before you stitch.
- Younger students: make the button, snap and hook first and save the buttonhole for last. Older students: work a keyhole buttonhole like the one in the video, with a small round eyelet at one end for a shanked coat button.

Check your work

- ☐ I figured the buttonhole length from the button and the spacing for a row of buttons.
- ☐ My buttonhole stitches are packed close with the knots on the edge, and both ends are secure.
- ☐ I sewed a button with a shank, a snap and a hook and eye, and I made one real repair.

SEWING NOTEBOOK

1. Tape in your closure sampler card, or photograph it, and label each closure.
2. Draw the buttonhole stitch in three steps with arrows: needle in, thread loop around the needle, pull to form the knot on the edge.
3. Plan the buttons for a shirt front of your own measurement: show the length, the top and bottom positions, the number of spaces and the spacing math.

From history. Tailors traditionally sat cross-legged on their worktables for hours, which is why sitting cross-legged was long called sitting “tailor fashion.” The muscle along the thigh that lets you cross your legs this way is even named the sartorius, from the Latin *sartor*, a tailor.

COMMON MISTAKES

- Cutting the slit before stitching the outline. The layers shift and fray. Stitch the outline first, then cut.
- Making the buttonhole only as long as the button’s width. A thick button will not fit. Add the thickness.
- Sewing a flat button tight to the fabric with no shank. The garment puckers when buttoned. Leave room and wrap a shank.

Make it a game • Button Spacing Race. Your parent names an opening length and a number of buttons (say 18 inches and 6 buttons, with the top and bottom buttons 1 inch from each end). Race to figure the spacing on paper, then mark it on a strip of paper with a ruler. Check each other’s math. Fastest correct answer earns a point; first to five wins.

3.3 MENDING AND PATCHING

OBJECTIVES

- Explain Jesus’s saying about new cloth on an old garment (Mark 2:21) and why a patch must be preshrunk.
- Tell how families in wartime Britain were taught to “make do and mend,” and why mending is good stewardship.
- Darn a hole in a knitted sock and patch a woven garment by hand.

Warm-up. Go through the family mending pile (or ask a parent for three worn things): a sock with a thin heel, a pair of jeans with a worn knee, a shirt with a small tear. For each, decide: Can it be mended? Would it be better to darn, patch or stitch it closed? Which mend would show, and does that matter for this garment?

WATCH

How to Repair a Hole in a Sock with Darning

Professor Pincushion · 4:58

https://www.youtube.com/watch?v=yi_J8YeQkww

WHEN TO WATCH

Before you darn. Watch the long running stitches go up and down first, then the weaving across; pause after each part and look at your own sock.

BACKUP VIDEO

How to Patch Jeans Without a Sewing Machine

WonderFil Specialty Threads · 3:15

<https://www.youtube.com/watch?v=XweldFH-IOI>

Before you patch your jeans. A thread company’s teacher pins a patch behind a torn knee and stitches it by hand.

KEY TERMS

darning

Mending a hole by weaving new yarn across it: first a row of threads in one direction, then weaving over and under them in the other.

patch

A piece of fabric sewn over or under a hole or worn spot to cover and strengthen it.

rent

An old word for a tear or rip in cloth, as in Mark 2:21.

darning egg

A smooth wooden egg or mushroom shape slipped inside a sock to hold the worn part taut while you darn.

preshrink

To wash and dry fabric before sewing so it shrinks first, not after it is sewn to something.

CORE IDEAS

The story. Jesus once told a short parable about mending: “No man also seweth a piece of new cloth on an old garment: else the new piece that filled it up taketh away from the old, and the rent is made worse” (Mark 2:21). Everyone listening knew exactly what He meant. New wool or linen that had never been washed would shrink the first time the garment was washed, pulling hard on the old, softened cloth around it and tearing a bigger hole. Mending was ordinary family work in His day, as it was for nearly everyone until very recently. During the Second World War, when Britain rationed clothing from 1941, the government printed a booklet called *Make Do and Mend* (1943) that taught families to darn socks, patch elbows, turn worn collars and remake old clothes into new ones. In America the same spirit was summed up in a saying: “Use it up, wear it out, make it do, or do without.”

How they figured it out. Over centuries, menders learned which repair fits which damage. A thin or holey spot in a **knit**, like a sock heel, is **darned**: the mender rebuilds the fabric by weaving new yarn back and forth across the hole, over a darning egg that holds it smooth. A tear or worn spot in a **woven** fabric, like a knee of jeans, is **patched**: a piece of similar fabric is placed behind or on top and stitched around its edges. A clean

rip along a seam is simply sewn closed again with a backstitch. Good menders always started early, while a hole was small, because “a stitch in time saves nine.”

The fabric science. Mark 2:21 is real textile science. Many fibers shrink the first time they are washed: the stretched yarns relax back toward their natural length, and cotton and wool can shrink several percent. Put an unshrunk patch on a garment that has already shrunk, and the patch shrinks alone and pulls the stitches and the old cloth apart. So menders **preshrink** every patch by washing and drying it first, and they choose a patch of similar weight and fiber so it wears at the same rate. Patch math: a patch must reach beyond the worn area into strong cloth, at least $\frac{3}{4}$ to 1 inch on every side. For a worn spot 2×3 inches, the patch shows $2 + 1 + 1 = 4$ inches by $3 + 1 + 1 = 5$ inches; add $\frac{1}{4}$ inch on each side to turn under, and you cut it $4\frac{1}{2} \times 5\frac{1}{2}$ inches. A darn reaches past the hole too, about $\frac{1}{2}$ inch onto good knitting, so the new yarn anchors in fabric that will not give way.

Let's sew. You will **darn a sock** and **patch a woven garment**, real items from your family's mending pile, and return them to their owners ready to wear. The one skill to do well is **reaching sound fabric**: every darn and patch extends past the damage into strong cloth.

PICTURE STUDY



The Net Menders (Die Netzflickerinnen), Max Liebermann, 1887–1889 · Oil on canvas · Hamburger Kunsthalle, Hamburg, Germany

Image: [Wikimedia Commons](#), public domain

Max Liebermann painted the fishing families of Katwijk, on the Dutch coast. After each voyage the nets came back torn, and the women spread them out on the dunes and mended them knot by knot, because a fisherman with a torn net caught nothing. Mending here was not a hobby; it kept the whole village fed.

Look closely

- Find the long nets spread across the grass. How far into the distance do they go?
- Find the women kneeling and sitting. How do they hold the net while they work on it?
- Look at the young woman in front. What is she carrying, and what is the wind doing to her skirt and apron?
- Look at the sky and the empty dunes. What kind of weather do the menders work in?

Talk about it

1. A net mender rebuilds the missing knots and meshes, much as a darning rebuilds a knitted hole. How are their jobs alike?
2. Why did a fishing village need every woman's mending skill?
3. What things in your home would be worth mending instead of replacing?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Darning needles are long and blunt but still sharp enough to hurt: park yours in the cushion every time you stop. Never mend a garment while someone is wearing it. If you press the patch, use your iron check-off rules and a press cloth.

SEWING PROJECT

Darn a Sock and Patch a Garment

You will rebuild a worn sock heel by weaving and put a hand-sewn patch on a pair of jeans or another woven garment. Both go back into someone's drawer ready to wear.

You will need

- A darning needle (long, large eye) and a sharp hand-sewing needle, a thimble and a pincushion
- A darning egg, darning mushroom or a smooth substitute (a tennis ball or an orange)
- Small scissors, fabric shears, pins and a ruler
- Tailor's chalk and an iron with a press cloth (after your check-off)

WOVEN SOCK DARN AND HAND-SEWN UNDERPATCH

Finished size: One darned sock and one patched garment · About 2 hours over two sessions

Fabric and notions

- A wool or cotton sock with a hole or thin spot no bigger than about 1 inch across

- Darning yarn or fingering-weight wool or cotton yarn close to the sock's color and weight, about 3 yards
- A pair of jeans or another woven garment with a worn knee or a small tear
- A preshrunk patch of similar fabric (an old pair of jeans is perfect), cut to your patch math
- All-purpose thread to match the garment, about 1½ yards

How to make it

1. **Darn:** slip the darning egg into the sock under the hole. With chalk or by eye, mark a rectangle about ½ inch beyond the hole on every side.
2. Thread the darning needle with a single strand of yarn; do not knot it. Starting in good knitting at one corner, run tiny stitches up and down across the rectangle, leaving a little loop at each turn so the darn can stretch. Across the hole, lay the yarn straight across from edge to edge, close together.
3. Turn the sock a quarter turn. Now weave across those threads, over one and under one, back and forth, pushing each row close to the last with the needle, again starting and ending in good knitting.
4. Leave 2-inch tails and weave them in on the inside. Take out the egg and gently stretch the darn.
5. **Patch:** measure the worn area on the jeans. Add 1 inch on every side for the patch's showing size, plus ¼ inch to turn under, and cut the preshrunk patch.
6. Trim loose threads from the hole, but do not cut away good cloth. Turn the garment inside out. Pin the patch behind the hole, right side of the patch facing the inside of the garment (so it shows through the hole), with its edges turned under ¼ inch and pressed.
7. With a sharp needle and doubled thread, whipstitch or slip-stitch the turned edges of the patch to the garment all around, catching only the inner layer where you can.
8. Turn the garment right side out. Turn the raw edges of the hole under slightly and slip-stitch them to the patch. For extra strength, run rows of

small running stitches across the worn area, $\frac{1}{4}$ inch apart, through both layers.

9. Press with a press cloth (after your check-off).

Fabric check: Match the mending material to the garment: wool yarn for wool socks and cotton for cotton, so the darn shrinks and wears at the same rate. Always preshrink the patch: wash and dry it with hot settings first, just as Mark 2:21 warns. Denim from an old pair of jeans is ideal for jeans; a lighter cotton for shirts. A patch that is heavier than the garment will make the area stiff and pull. If wool socks are scratchy for someone, darn a cotton one instead.

Steps

1. **Count out needles and pins.**
2. **Practice first.** Darn a $\frac{1}{2}$ -inch hole cut in an old cotton sock or a scrap of knit fabric stretched over the egg before darning the real sock.
3. Darn the sock and patch the garment from the pattern card.
4. **Shrink test.** Cut two 4×4 inch squares from new, unwashed cotton fabric. Wash and dry one with the family laundry. Measure it again. How much did it shrink, in inches and percent?
5. **Wear test.** Give the mended items back. After a week of wearing and one wash, check both mends and record what held and what did not.
6. **Count in and clean up.** Count needles and pins in; yarn ends in the trash.
7. **Improve it.** Darn a second sock, or try a visible decorative patch on a pair of play jeans.

Tips

- Do not pull darning yarn tight. A tight darn makes a hard lump that rubs a blister.
- Darn a thin spot before it becomes a hole; it is much quicker.
- Younger students: do the patch first, then darn a small hole in a thick cotton sock. Older students: darn a hole in a hand-knitted wool sweater or hat, matching the color.

Check your work

- ☐ I can explain Mark 2:21 as fabric science, and why every patch is preshrunk.
- ☐ My darn reaches into good knitting on every side and lies smooth and flexible.

- My patch reaches at least $\frac{3}{4}$ inch into strong fabric and is sewn securely, and I returned both items to their owners.

SEWING NOTEBOOK

1. Draw the two stages of a darn: the lengthwise rows, then the crosswise weaving.
2. Show your patch math for the real garment: worn area, showing size, cutting size.
3. Record the shrink test: before and after measurements and the percent of shrinking (change $\div$ original $\times$ 100).

From history. Darning eggs were once found in nearly every home, made of wood, stone, glass or china. Some families darned over a smooth, round gourd. Darning samplers, small squares of linen worked with practice darns in different patterns, were made by schoolgirls in the 1700s and 1800s, and museums still keep them.

COMMON MISTAKES

- Cutting the hole “neater” before patching. That makes it bigger. Trim loose threads only.
- Using a new, unwashed patch. It shrinks and tears the old cloth, just as Mark 2:21 says.
- Starting and ending the darn right at the edge of the hole, in weak knitting. The darn pulls out. Anchor it $\frac{1}{2}$ inch into good fabric.

Make it a game • Mend It or End It. Your parent describes ten damaged items, one at a time (a sock with a dime-sized hole, jeans torn across the whole knee, a shirt missing a button, a split seam, a rag already worn through in five places). For each, you have ten seconds to call “darn,” “patch,” “stitch,” “button” or “rag bag” and give one reason. A correct call with a good reason scores a point.

Scripture. “No man also seweth a piece of new cloth on an old garment: else the new piece that filled it up taketh away from the old, and the rent is made worse.” (Mark 2:21, KJV)

Jesus used a mending lesson every listener understood to teach something deeper. The fabric science behind it, unshrunk cloth pulling on old, is why every careful mender preshrinks a patch.

3.4 EMBROIDERY AND CREWEL: THE BAYEUX TAPESTRY

OBJECTIVES

- Tell what the Bayeux Tapestry shows, how and when it was made, and why it is really an embroidery.
- Work the stem stitch and the laid-and-couched (Bayeux) stitch with wool on linen.
- Design and embroider a small Bayeux-style picture in a hoop.

Warm-up. Look closely at something embroidered in your home: a pillowcase, a jacket logo, a baby blanket, a handkerchief. Is the picture woven into the cloth, printed on it, or stitched on top? How can you tell? Turn it over and look at the back.

WATCH

How is the Bayeux Tapestry still here after 1000 years?

The British Museum • 3:00

<https://www.youtube.com/watch?v=NPYXkP1Fb1I>

WHEN TO WATCH

After the story. A short animated history of how the embroidery was made of wool on linen and how it survived wars and moves for nearly a thousand years.

Note: An animation from the British Museum, drawn in the style of the embroidery. It includes small cartoon battle scenes.

BACKUP VIDEO

Master the Bayeux Stitch in 5 Minutes

Marion's World • 4:47

<https://www.youtube.com/watch?v=9bZ8zrfsOhs>

Before Session 2, with your hoop ready. An embroiderer shows the laid threads, the crossing threads and the small couching stitches up close.

KEY TERMS

embroidery

Decorating fabric by stitching designs onto it with a needle and thread or yarn.

crewel

Embroidery worked with fine, two-ply wool yarn (crewel wool), usually on linen.

laid and couched work (Bayeux stitch)

A filling stitch: long threads are laid side by side across a shape, then held down by crossing threads tacked with tiny stitches.

tapestry

A picture woven into the cloth on a loom, with the weft yarns making the design. The Bayeux “Tapestry” is not one; it is embroidered.

stem stitch

An outline stitch in which each stitch overlaps the last by half, making a smooth, rope-like line.

CORE IDEAS

The story. In 1066 Duke William of Normandy crossed the English Channel with an army, defeated King Harold at the Battle of Hastings, and became King William I of England. Within a few years, probably in the 1070s, someone ordered a long picture of the whole story to be made. Most historians think it was commissioned by William’s half-brother, Bishop Odo of Bayeux, and stitched in England, perhaps at Canterbury, by skilled English embroiderers. The finished work is a strip of linen about 230 feet (70 m) long and only about 20 inches (50 cm) tall, telling the story in more than fifty scenes with Latin words above them: the oath, the ships being built and hauled to sea, horses stepping off the boats, the feast, the battle. Its decorated borders run above and below the whole length. It has been kept in the town of Bayeux, in Normandy, since at least 1476, when it was listed among the cathedral’s treasures.

How they figured it out. It is called a tapestry, but it is not one. A true tapestry is **woven**, with the picture made by the weft yarns. The Bayeux Tapestry is **embroidered**: wool yarns stitched onto plain linen cloth that had already been woven. The embroiderers used only about ten colors of wool dyed with plants: reds, yellows, several greens and

blues. They outlined the figures with **stem stitch** and filled the shapes with **laid and couched work**: long threads laid side by side across a shape, held down by threads crossing them, which were tacked down with tiny stitches. This is so typical of the work that embroiderers now call it the **Bayeux stitch**. It was a clever choice: almost all the wool lies on the front of the cloth, so it saved costly yarn and kept the long strip light enough to roll.

The fabric science. Crewel wool is a fine, two-ply yarn; its slight fuzz grips the linen so stitches stay put. Linen is the classic ground fabric because its strong, smooth flax yarns hold the weight of the wool without sagging. Work in a hoop to keep the fabric taut, so long laid threads lie flat. The arithmetic: cut your ground fabric at least 2 inches larger than the hoop on every side, so a 6-inch hoop needs a square of $6 + 2 + 2 = 10$ inches. Work with lengths of wool no longer than about 18 inches, because wool drawn through linen again and again wears thin. A filled shape takes far more yarn than its outline: laying threads $\frac{1}{8}$ inch apart across a shape 2 inches wide and 1 inch tall takes $1 \div \frac{1}{8} = 8$ laid threads of 2 inches each, or 16 inches of yarn, before the crossing threads and the couching.

Let's sew. You will design a small picture in the style of the Bayeux Tapestry, a ship, a horse, a tree or a building, and embroider it in a hoop with stem stitch outlines and Bayeux-stitch filling. The one skill to do well is **even laying**: lay the long threads close and parallel, with no gaps and no overlaps.

PICTURE STUDY



The Bayeux Tapestry: The Horses Leave the Ships (Scene 39), English embroiderers, probably for Bishop Odo of Bayeux, about 1070s · Wool embroidery on linen · Bayeux Museum, Bayeux, Normandy, France

Image: [Wikimedia Commons](#), public domain

After crossing the Channel, William's army landed at Pevensey on the south coast of England. The Latin words say, "Here the horses leave the ships." Every line and color you see was stitched by hand in wool, nearly a thousand years ago, on a strip of linen about 20 inches tall.

Look closely

- Find the outlines of the men and the ship. These are stem stitch. Can you see that each line is made of slanting little stitches?
- Find the filled areas of color: the horse's body, the stripes of the ship. These are laid and couched work. Which way do the laid threads run?
- Count the colors of wool in this scene. How many can you find?
- Look at the borders above and below. What animals and patterns fill them?

Talk about it

1. Why would the embroiderers choose a stitch that leaves almost all the wool on the front of the linen?
2. This picture tells a story without many words. How does the stitcher show that the horse is jumping?
3. If you embroidered one scene from your own family's history, what would it be?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Crewel needles are sharp: keep yours in the pincushion or parked in the edge of the hoop fabric while you plan, never in your mouth. Keep loose wool ends away from babies and pets. If you transfer your design with an iron-on pen, use your iron check-off rules.

SEWING PROJECT

A Bayeux-Style Embroidery in a Hoop

You will design and stitch a small picture with the same two stitches the embroiderers of 1070 used, in wool on linen. It can be framed in its hoop and hung, or given as a gift.

You will need

- A 6- or 7-inch embroidery hoop
- Crewel needles, size 18–22, a thimble and a pincushion
- Small embroidery scissors and fabric shears
- A pencil, paper, and a water-soluble fabric pen or a sharp pencil for tracing
- A sunny window or a light box for tracing the design

BAYEUX-STITCH HOOP PICTURE

Finished size: One picture about 4 × 4 in (10 × 10 cm) in a 6-inch (15 cm) hoop · About 3 hours over two sessions and the week

Fabric and notions

- A 10 × 10 in (25 × 25 cm) square of medium-weight linen or linen-look cotton, prewashed and pressed

- Crewel wool or tapestry wool in 4–6 colors, about 3–5 yards of each (six-strand cotton floss, using three strands, works too)
- Your design, drawn on paper the size of the hoop's inside

How to make it

1. Draw a simple design inside a 4-inch circle: a ship with a striped hull, a horse, a tree or a small church, with large, simple shapes to fill and strong outlines, like the figures in the Bayeux Tapestry.
2. Tape the design to a sunny window, tape the linen over it, and trace the lines lightly with the fabric pen.
3. Put the linen in the hoop, centered, and tighten it until the fabric is drum-tight. Leave the screw at the top.
4. **Lay:** thread an 18-inch length of wool. Starting at one edge of a shape, bring the needle up on the outline and take it down on the opposite outline, laying a long thread across. Come back up right beside it on the same side you went down (so the back has only tiny stitches) and lay the next thread close beside the first. Fill the whole shape.
5. **Cross:** in the same or a contrasting color, lay threads across the laid ones at right angles, about $\frac{1}{4}$ inch apart.
6. **Couch:** with tiny stitches, tack each crossing thread down to the fabric every $\frac{1}{4}$ inch, catching it at each spot where it crosses the laid threads.
7. **Outline:** outline each filled shape with stem stitch: come up on the line, go down $\frac{1}{4}$ inch ahead, come up halfway back beside the stitch (always on the same side), and repeat.
8. Add details in stem stitch: ropes, a mast, a mane, waves.
9. Remove the pen lines with a damp cloth. Re-tighten the hoop, trim the linen to 1 inch beyond the hoop, and gather it at the back with a running stitch to finish it for hanging.

Fabric check: Linen or a firm linen-cotton blend is the right ground: its strong yarns hold the wool without puckering. Prewash it so it does not shrink later. Crewel wool or tapestry wool grips the linen and fills shapes quickly; cotton floss is smoother and slides more. Avoid stretchy or thin fabrics, which pucker when the laid threads are pulled. For someone sensitive to wool, use cotton floss throughout.

Steps

1. **Count out** needles and pins.
2. **Practice first.** On a scrap of linen in the hoop, stitch a 1-inch square of laid and couched work and a 3-inch line of stem stitch, curving it around a circle.
3. Embroider your picture from the pattern card.
4. **Yarn count.** Before starting each filled shape, estimate the yarn it needs with the lesson's math; afterward, compare with what you actually used.
5. **Back check.** Turn the hoop over. On laid work, the back should show only tiny stitches at the edges of each shape. Is it so?
6. **Count in and clean up.** Needles and pins in the cushion; wool ends in the trash; hoop stored loosened.
7. **Improve it.** Stitch a second small scene to make a two-picture "strip," telling a story from your family or from the Bible.

Tips

- Lay long threads loosely, so they lie flat. Pulled tight, they pucker the linen.
- Lay threads in the direction that follows the shape: lengthwise along a ship's hull, across a horse's body.
- Younger students: fill one shape and outline the rest. Older students: use the embroiderers' trick of changing the color of laid threads within one shape, as in the striped hulls of the ships.

Check your work

- ☐ I can explain why the Bayeux Tapestry is really an embroidery, and tell what it shows and when it was made.
- ☐ My laid threads are even and close, and my couching holds them flat.
- ☐ My stem stitch outlines are smooth and the back is neat.

SEWING NOTEBOOK

1. Draw your design full size with each color labeled and each shape marked "laid" or "stem."
2. Draw the three steps of laid-and-couched work and the steps of stem stitch with arrows.

3. Write the hoop and yarn arithmetic for your piece: fabric size, estimated and actual yarn.

From history. In 1729 scholars published drawings of part of the Bayeux Tapestry, and its fame spread across Europe. In the 1880s, a group of embroiderers in Leek, England, led by Elizabeth Wardle, stitched a full-size copy, which is still displayed in the English town of Reading.

COMMON MISTAKES

- Carrying the wool across the back from one side of a shape to the other. That doubles the yarn used and loosens the work. Come up beside where you went down.
- Using a very long length of wool to save threading. It wears thin and frays. Use 18 inches or less.
- Loosening the hoop. Slack fabric makes laid threads sag. Tighten it before each session.

Make it a game • Stitch the Story. Your parent reads aloud a short Bible story or family story. In five minutes, you draw it as three Bayeux-style scenes in a strip, with a one-line Latin or English caption above each. Then take turns guessing which stitch you would use for each shape. Earn a point for each scene your parent can “read” without being told.

Scripture. “Them hath he filled with wisdom of heart, to work all manner of work, of the engraver, and of the cunning workman, and of the embroiderer, in blue, and in purple, in scarlet, and in fine linen, and of the weaver” (Exodus 35:35, KJV)

God named the embroiderer among the skilled workers of the tabernacle and gave them “wisdom of heart” for the work. Embroidery is a gift to be used with care.

UNIT 3 REVIEW

Answer in complete sentences unless the question asks for a calculation or a show-me. For calculations, show every step; a right answer with no work earns half. The review is worth 100 points.

1. (8 pts)

Name the four hand stitches from Lesson 3.1 and give one job each does best.

2. (10 pts)

Calculate. A skirt is 3 inches too long. You want a 2-inch hem with $\frac{1}{4}$ inch turned under. How far above the old fold is the new fold line? How much fabric do you keep below the new fold line? If the hem edge is 40 inches around and you stitch every $\frac{1}{2}$ inch, how many stitches is that?

3. (8 pts)

Show me. On a folded scrap, sew 2 inches of blind hem stitch and 2 inches of catch stitch while your parent watches.

4. (10 pts)

Calculate. A coat button is 1 inch across and $\frac{1}{4}$ inch thick. How long should the buttonhole be? The coat front is 24 inches; the top button is 2 inches from the top and the bottom button is 4 inches from the bottom. With 4 buttons, how far apart are they?

5. (8 pts)

Why does a buttonhole need the buttonhole stitch rather than a plain overcast stitch, and what does a bar tack do?

6. (8 pts)

What is a thread shank, and why does a flat button on a coat need one?

7. (8 pts)

Written answer. Explain Mark 2:21 as fabric science in three or four sentences.

8. **10 pts**

Calculate. A worn spot on a knee is 3 inches wide and 2½ inches tall. The patch must reach 1 inch into strong fabric on every side, and you need ¼ inch on every side to turn under. What size do you cut the patch?

9. **7 pts**

When should you darn, and when should you patch? Give an example of each.

10. **8 pts**

Why is the Bayeux Tapestry not really a tapestry? Name the two stitches its makers used and what each was for.

11. **7 pts**

Give three facts about the Bayeux Tapestry: what it shows, about when it was made, and its size or materials.

12. **8 pts**

Written answer. In four or five sentences, explain why mending is good stewardship, using one example from this unit's history (the housewife kit, *Make Do and Mend*, or the net menders).

UNIT CHALLENGE: THE MENDING BASKET AND THE EMBROIDERED HOOP

Show the unit's hand skills on real things: the garment you hemmed, the sock you darned and the garment you patched (or photographs of them being worn), your closure sampler card with the real repair you made, and your finished Bayeux-style embroidery.

Add a notebook page called "My Mending Record": for each real mend, write what was wrong, which stitch or method you chose and why, the measurements and math, how long it took, and how it held up after a week of wear and one washing.

LOOK FOR	WHAT IT MEANS
Real mending	At least three real family items mended (a hem, a darn or patch, a closure) and returned to use.
Workmanship	Hems barely show and do not pucker; buttonhole edge is firm and even; darns and patches reach strong fabric; embroidery is even and flat.

LOOK FOR	WHAT IT MEANS
The arithmetic	Hem allowances, button spacing, buttonhole length and patch size are figured correctly with the work shown.
Record and improvement	The mending record is complete, including how each mend wore, and one piece is redone or a second mend made better. A crooked first try honestly recorded and redone earns full credit.
Safety	Needle-and-pin count every session; seam ripper used away from the hand; small parts kept from little children; iron used by the check-off rules.

ANSWER KEY

1. Backstitch: strong seams. Slip stitch: closing openings and holding folded edges invisibly. Blind hem stitch: invisible hems on pants and skirts. Catch stitch: hems on knits and heavy fabrics, because it stretches.
2. The new fold line is 3 inches above the old fold. Keep $2 + \frac{1}{4} = 2\frac{1}{4}$ inches below the new fold line and cut off the rest. $40 \div \frac{1}{2} = 80$ stitches.
3. Parent checks: blind hem stitches catch only one or two threads of the outer fabric and barely show; catch stitches form even crisscrosses; thread is relaxed with no puckers; needle parked in the cushion between stitches.
4. Buttonhole: $1 + \frac{1}{4} = 1\frac{1}{4}$ inches. Distance from top button to bottom button: $24 - 2 - 4 = 18$ inches. 4 buttons have 3 spaces: $18 \div 3 = 6$ inches apart.
5. The buttonhole stitch forms a little knot (purl) right on the cut edge with every stitch; packed together they make a firm edge that protects the cut yarns from fraying and wear. A bar tack is a few stitches across the end of the buttonhole, covered with tight stitches, that keep the slit from tearing further when the button pulls.
6. A short stem of thread wrapped between the button and the fabric. It leaves room for the thick layer of fabric that buttons over the button, so the garment closes smoothly without puckering or pulling the button off.
7. New, unwashed cloth shrinks the first time it is washed as its stretched yarns relax. The old garment has already shrunk and softened. When a new patch shrinks, it pulls on the old cloth around it and tears it, making the hole (the rent) worse. That is why menders preshrink every patch and choose a similar fabric.
8. Showing size: $3 + 1 + 1 = 5$ inches wide; $2\frac{1}{2} + 1 + 1 = 4\frac{1}{2}$ inches tall. Add $\frac{1}{4} + \frac{1}{4} = \frac{1}{2}$ inch each way to turn under: cut $5\frac{1}{2} \times 5$ inches.
9. Darn a hole or thin spot in a knit, like a sock heel or a sweater elbow, by weaving new yarn across it. Patch a tear or worn area in a woven fabric, like the knee of jeans, by sewing a piece of similar fabric behind or over it.
10. A tapestry is woven, with the picture made by the weft. The Bayeux Tapestry is embroidered: wool stitched onto plain woven linen. Stem stitch made the outlines and details; laid and couched work (Bayeux stitch) filled the shapes with color.
11. It tells the story of William of Normandy's conquest of England, ending with the Battle of Hastings in 1066. It was made about the 1070s, probably in England for Bishop Odo. It is about 230 feet (70 m) long and 20 inches (50 cm) tall, wool embroidery on linen in about ten colors. (Any three accurate facts.)

12. Open answer. Look for: mending keeps useful things in use, saves money and materials, and cares for what God has given; one true historical example (Civil War soldiers mending their own uniforms from a housewife kit; Britain's 1943 *Make Do and Mend* booklet during clothes rationing; Katwijk women mending nets so the fishermen could fish); and a personal application.

MACHINE SEWING

In Fabrics & Sewing I you met Elias Howe's needle and Isaac Singer's lockstitch. This year you will take charge of the sewing machine itself. You will hear how Howe, Singer and their rivals fought one another in court for years until, in 1856, they agreed to share their patents in one of the first patent pools in American history. Then you will learn to care for a machine the way a mechanic does: cleaning out lint, oiling where the manual says, and choosing and changing needles.

With a clean, well-tuned machine, you will sew the seams that turn flat cloth into three-dimensional things: curves that must be clipped and notched, a circle set into a tube, a zipper, and boxed corners that give a bag its depth. Each project begins with arithmetic: seam allowances, circumference, zipper length and box depth. By the end of the unit you will have a lined drawstring bag, a zippered pencil case and a lined tote with boxed corners. If your family has no machine, one can often be borrowed from a relative or a friend at church; every project also gives a hand-sewn option with backstitch.

PREREQUISITES

- Can thread a sewing machine, wind a bobbin and sew a straight seam at a $\frac{5}{8}$ -inch seam allowance (Fabrics & Sewing I, or practice with an adult first)
- Has been watched sewing safely by an adult and checked off for solo machine use: hands flat, fingers an inch from the needle, foot off the pedal when threading or adjusting, pins pulled before the foot
- Has been checked off for the iron (Lesson 2.2)
- Can work with fractions of an inch and multiply by 3.14 with a calculator

MASTERY CHECKLIST

- ☐ I can tell how Howe, Singer and the other makers fought over patents and formed the Sewing Machine Combination in 1856.
- ☐ I can clean and oil a sewing machine following its manual, and choose and change a needle by size and type.
- ☐ I can sew $\frac{5}{8}$ -, $\frac{1}{2}$ - and $\frac{1}{4}$ -inch seam allowances accurately and clip, notch, grade and understitch curved seams.
- ☐ I can figure the circumference of a circle and set a circular base into a tube.
- ☐ I can install a zipper with a zipper foot in a lined pouch.
- ☐ I can sew boxed corners and figure how boxing changes a bag's width and height.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **Your sewing machine's manual:** Every machine is cleaned, oiled and threaded a little differently. If the paper manual is lost, most makers post manuals for their models on their own websites; search with the model number on the machine's label.
- **A pack of universal machine needles, size 80/12 and 90/14, and a zipper foot:** Use the needle size each project names. A zipper foot that fits your machine is needed for Lesson 4.3.
- **A small lint brush and sewing-machine oil:** Many machines come with both. Use only clear sewing-machine oil, never kitchen or motor oil, and only where your manual shows.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

4.1	Howe, Singer and the Patent War	2 sessions of 50–60 minutes
4.2	Seams and Seam Allowances: Curves and Circles	2 sessions of 60–90 minutes
4.3	Zippers: Judson’s Clasp Locker and Sundback’s Fastener	2 sessions of 60–90 minutes
4.4	A Machine-Sewn Tote with Boxed Corners	2 sessions of 60–90 minutes

4.1 HOWE, SINGER AND THE PATENT WAR

OBJECTIVES

- Tell how Elias Howe's 1846 patent, Isaac Singer's 1851 machine and their lawsuits led to the Sewing Machine Combination of 1856.
- Name the parts of a machine that need cleaning and oiling, and read needle sizes in both numbering systems.
- Clean, oil (as the manual directs) and change the needle on a sewing machine, and keep a maintenance log.

Warm-up. With the machine unplugged, look at it from every side. Find the model name and number. Find the spool pin, the tension dial, the take-up lever, the presser foot, the needle clamp screw, the needle plate, the feed dogs, the bobbin and the hand wheel. Which part do you think gathers the most lint? Write down your guess.

WATCH

HOW TO CLEAN AND OIL YOUR SEWING MACHINE

[MySewBliss](#) · 5:21

<https://www.youtube.com/watch?v=ilZul3Be1XI>

WHEN TO WATCH

Before Session 2, with your own machine unplugged in front of you and its manual open. Your machine may open differently; follow your manual where they differ.

Note: A sewing teacher removes the needle plate and bobbin case, brushes out lint and adds a drop of oil where her machine's manual shows.

BACKUP VIDEO

How To: Change Needle on Sewing Machine (Sewing for Beginners)

[Made to Sew](#) · 2:28

<https://www.youtube.com/watch?v=oAMdMyDK8sw>

Just before you change your needle: which way the flat side faces, how far up to push it, and how to tighten the clamp.

KEY TERMS

patent

A government grant that gives an inventor the sole right to make and sell an invention for a set number of years, in exchange for publishing how it works.

patent pool

An agreement among owners of related patents to share them with each other and divide the license fees.

feed dogs

The small toothed bars under the presser foot that move up, back and down to pull the fabric through the machine.

infringement

Using someone's patented invention without permission or payment.

needle size

Given two ways, as in 80/12: the European number (80) is the blade's thickness in hundredths of a millimeter; the American number (12) is an older scale. Bigger numbers are thicker needles.

maintenance log

A written record of when a machine was cleaned and oiled and when its needle was changed.

CORE IDEAS

The story. On September 10, 1846, a Boston machinist named **Elias Howe** received a patent for a sewing machine that used a needle with its eye near the point and a shuttle underneath, locking two threads together: the **lockstitch**. He could not find buyers in America, went to England, and came home poor. Meanwhile other inventors were building machines, and in 1851 **Isaac Merritt Singer** patented a sturdy, practical machine with a straight up-and-down needle, a presser foot to hold the cloth, and a foot treadle, and he sold it with tireless advertising. Howe discovered that Singer and others were using his ideas and sued them for **infringement**. In 1854 a court ruled in Howe's favor, and Singer had to pay him. But every maker held some patents of his own, and soon the leading companies were suing one another so constantly that newspapers called it the "Sewing Machine War." Lawyers were growing rich while the machines stayed expensive.

How they figured it out. In 1856, at a meeting in Albany, New York, a lawyer named Orlando Potter, president of the Grover and Baker company, proposed a way out. Singer,

Wheeler and Wilson, and Grover and Baker would put their key patents together in one **pool**, along with Howe's. Any of them could use all the pooled patents, and any other company that wanted to build machines could buy a license. Each machine sold paid a fee, and Howe received a royalty on every machine for as long as his patent lasted. The **Sewing Machine Combination** ended the lawsuits, made Howe a wealthy man, and let the companies spend their money on factories instead of courts. It lasted until the last pooled patent expired in 1877, and by then sewing machines were made by the hundreds of thousands and had become ordinary furniture in American homes.

The fabric science. A machine that makes a thousand stitches a minute needs care. Every stitch rubs tiny bits of fiber off the thread and the fabric, and this **lint** packs into the feed dogs and the bobbin area, where it soaks up oil and slows the machine. So, with the machine **unplugged**, sewers remove the needle plate and bobbin case and brush the lint out (blowing into the machine just pushes lint deeper). Then they put one drop of sewing-machine oil only where the manual shows, because many newer machines need none. The **needle** matters too: a dull or bent needle skips stitches and snags fabric. Needles come in sizes like 70/10, 80/12 and 90/14. The European number is the thickness in hundredths of a millimeter, so an 80 needle is 0.80 mm thick and a 90 is 0.90 mm. Use thin needles for fine fabrics and thick ones for denim and canvas. Many sewers change the needle after about 6 to 8 hours of sewing: if you sew 45 minutes twice a week, that is 1½ hours a week, so $6 \div 1\frac{1}{2} = \text{about every 4 weeks}$.

Let's sew. You will give your family's machine a **tune-up**: clean it, oil it if its manual says to, change the needle, test the stitch on a scrap, and start a maintenance log. The one skill to do well is to **work only with the machine unplugged** and to follow the manual for your own machine, step by step.

PICTURE STUDY



Singer's Sewing Machines: In the Home, In the Factory, Advertising poster for the Singer Manufacturing Company, about 1892 · Color lithograph poster · Bibliothèque nationale de France, Paris

Image: [Wikimedia Commons](#), public domain

By the 1890s, after the patent war was over, the Singer company sold sewing machines all over the world and advertised them with bright posters like this one. The poster makes one simple point: the same kind of machine works in a family's parlor and in a busy factory.

Look closely

- Find the machine in the home at the top. Look for the treadle, the hand wheel, and the gold decorations on the black arm.
- Find the rows of machines in the factory below. How are the workers arranged?
- Compare the woman at home with the factory workers. What is different about how they sew?
- Look at the lettering and colors. What does the poster want you to remember?

Talk about it

1. Why would a sewing-machine company want to sell to both homes and factories?

2. After 1856, the makers stopped spending money on lawsuits. How might that have helped families buy machines?
3. If you made a poster for your family's sewing machine, what would it say?

Safety first. A parent or responsible adult supervises all sewing tool use, and you count needles and pins out and back in. **Unplug the machine** before you open it, clean it, oil it or change the needle, and keep your foot off the pedal. Put the old needle straight into a needle-disposal tin or a sealed jar, never loose in the trash. Use only sewing-machine oil, only where the manual shows, and wipe up any extra.

SEWING PROJECT

Sewing Machine Tune-Up and Maintenance Log

You will clean, oil and re-needle your family's machine and prove it sews well with a test seam. Then you will begin a maintenance log that you will keep for the rest of the year.

You will need

- The sewing machine and its manual
- A small screwdriver that fits the needle-plate screws (often supplied with the machine)
- A lint brush or a clean, soft paintbrush, and a pipe cleaner
- Sewing-machine oil (only if the manual calls for it) and a soft cloth
- A new universal needle, size 80/12, and a needle-disposal tin or small jar
- Two 6 × 10 in (15 × 25 cm) scraps of medium-weight cotton for the test seam

MACHINE TUNE-UP

Finished size: One clean, oiled, re-needled machine and a test-stitch sample · About 45–60 minutes

Fabric and notions

- One new needle, universal 80/12 (or the size your next project needs)
- A few drops of sewing-machine oil, only if your manual shows oiling points
- Two cotton scraps and all-purpose thread for the test seam

- A page in your notebook ruled for the maintenance log: date, what was done, needle size, notes

How to make it

1. Turn off and **unplug** the machine. Remove the thread from the needle and take out the bobbin.
2. Raise the needle to its highest point with the hand wheel. Loosen the needle clamp screw and remove the old needle. Drop it straight into the disposal tin.
3. Remove the presser foot. Unscrew or unclip the needle plate as the manual shows, and set the screws in a dish.
4. Lift out the bobbin case (if your machine has a removable one). Brush the lint from the feed dogs, the bobbin area and the case with the brush. Use a pipe cleaner for corners. Do not blow into the machine.
5. Wipe the bobbin area with a soft cloth. If the manual shows oiling points, put **one drop** of sewing-machine oil at each one. Turn the hand wheel by hand a few times to spread it, and wipe off any extra.
6. Replace the bobbin case, needle plate and presser foot.
7. Insert the new needle with its flat side facing the direction your manual shows (on most home machines, the back), push it up as far as it will go, and tighten the clamp screw.
8. Plug in, rethread the machine and bobbin, and sew a test seam on the scraps (first on a folded scrap to catch any extra oil). Check both sides of the stitching.
9. Write the date, the work done and the needle size in the maintenance log.

Fabric check: Test the machine on a medium-weight woven cotton such as quilting cotton or muslin, folded double, so you can judge the stitch on both sides. Use a light-colored scrap first, in case a drop of oil comes through, and do not sew your project until a clean scrap stays clean. Use the needle type that matches the fabric of your next project: universal for wovens, ballpoint (jersey) for knits, denim or jeans needles for heavy cotton.

Steps

1. **Count out** needles and pins, including the new machine needle.
2. **Read first.** Read the cleaning and oiling pages of your machine's manual, and mark each oiling point (or note that there are none).

3. Tune up the machine from the pattern card.
4. **Before and after.** Sew a test seam before cleaning and another after. Compare the sound, the smoothness and the stitches. Did anything improve?
5. **Needle study.** Look at the old needle and the new one with a magnifier. Is the old point dull, burred or bent?
6. **Count in and clean up.** Old needle in the disposal tin, screws back in the machine, lint in the trash, oil capped and stored.
7. **Improve it.** Make a reminder chart: when to clean, when to change the needle, and which needle for which fabric.

Tips

- Take a photo with a phone at each step of taking the machine apart. Then you can put it back exactly.
- If the stitches loop on the underside after you rethread, the top thread is probably not in the take-up lever or between the tension discs. Rethread with the presser foot up.
- Younger students: an adult opens the needle plate while you brush and change the needle. Older students: clean the machine on your own after the adult check, and keep a running log of sewing hours.

Check your work

- ☐ I can tell the story of the Sewing Machine War and the 1856 Combination.
- ☐ I cleaned the machine with it unplugged, oiled only where the manual shows, and changed the needle correctly.
- ☐ I can read a needle size like 90/14 and choose a needle for a fabric.

SEWING NOTEBOOK

1. Draw the bobbin area of your machine and label the feed dogs, needle plate, bobbin case and any oiling points.
2. Start the maintenance log, with a column for hours sewn.
3. Make a timeline: 1846, 1851, 1854, 1856, 1877, with one sentence for each.

From history. Elias Howe earned well over a million dollars in royalties before his patent expired in 1867. During the Civil War he enlisted as a private in a Connecticut regiment, and he is remembered for helping to pay his regiment when the government's payments were late.

COMMON MISTAKES

- Working on the machine while it is plugged in. One bump of the pedal can drive the needle down. Unplug it first.
- Oiling everywhere, or using household oil. Extra oil drips onto fabric and gums up the machine. One drop of sewing-machine oil, only where the manual shows.
- Putting the needle in backward or not pushing it all the way up. The machine skips stitches or the needle hits the plate.

Make it a game • Name That Part. With the machine unplugged, your parent points to a part and starts a ten-second count. Name the part and say what it does. Then switch: you point, your parent names. Score a point for each correct answer; bonus points for naming which parts need cleaning or oil according to your manual.

4.2 SEAMS AND SEAM ALLOWANCES: CURVES AND CIRCLES

OBJECTIVES

- Sew accurate seams at $\frac{5}{8}$ -, $\frac{1}{2}$ - and $\frac{1}{4}$ -inch allowances and explain where each is used.
- Clip, notch, grade and understitch curved seams so they lie flat.
- Figure a circle's circumference and sew a lined drawstring bag with a circular base.

Warm-up. Find a baseball, a round cushion or a drawstring bag with a round bottom, and a shirt with a collar. Look at where a curved piece meets a straight one. Is the seam smooth or puckered? Now turn the shirt collar inside out if you can: what has been done to the seam allowance inside the curve?

WATCH

When, Why and How to Clip, Trim, Notch and Grade Seam Allowances When Sewing

Sewing with Londa • 9:24

<https://www.youtube.com/watch?v=OS7FB5-6Ahl>

WHEN TO WATCH

After “The fabric science.” Watch with two curved scraps in hand, pausing after she shows clipping an inward curve and notching an outward one.

Note: A longtime sewing teacher shows each cut close up with sample pieces.

BACKUP VIDEO

Drawstring Bag with Circle Bottom | Sewing How to from Whitney Sews

Whitney Sews • 6:47

<https://www.youtube.com/watch?v=kqtcUiEnihQ>

Before Session 2. Watch how she pins the circle into the tube, matching quarter marks, then sews it with the circle on the bottom.

KEY TERMS

seam allowance

The fabric between the stitching and the cut edge: $\frac{5}{8}$ inch (1.5 cm) on most commercial garment patterns, $\frac{1}{2}$ inch on many bags and home items, $\frac{1}{4}$ inch in quilting.

notch

A small wedge cut out of the seam allowance of an outward (convex) curve, so the extra fabric does not bunch when turned.

understitch

A line of stitching through a facing or lining and the seam allowances, close to the seam, that keeps the lining from rolling to the outside.

clip

A small straight cut into the seam allowance of an inward (concave) curve, almost to the stitching, so it can spread and lie flat.

grade

To trim the layers of a seam allowance to different widths, so they make a gradual slope instead of a thick ridge.

circumference

The distance around a circle: π (about 3.14) times the diameter.

CORE IDEAS

The story. Every baseball used in the major leagues today is still sewn by hand. Its cover is two pieces of leather shaped like a figure eight, or like a peanut. Neither piece is round, but when their curved edges are sewn together, they wrap a sphere perfectly. Each ball is closed with **108 double stitches** of red waxed thread, worked by a skilled stitcher with two needles. The design has been used since the 1800s because it solves a hard sewing problem: how to make flat material curve in two directions at once. Every sewer meets the same problem in smaller ways: the curve of a collar, the round bottom of a bag, the armhole of a shirt.

How they figured it out. When you sew two curves together, one edge is usually curving outward (convex) and the other inward (concave), and their seam allowances do not match in length. On an **inward curve**, the cut edge is shorter than the stitching line; when the seam is turned, the allowance must stretch, so sewers **clip** it with small cuts nearly to the stitching and it spreads open like a fan. On an **outward curve**, the cut edge is longer than the stitching; when turned, the extra fabric bunches up, so sewers **notch**

out little wedges to remove it. Where several layers stack up, they **grade** the allowances to different widths, and on a facing or lining they **understitch** so the lining stays hidden. Tighter curves need cuts closer together.

The fabric science. Accuracy begins with the seam allowance. Most sewing-machine needle plates are engraved with lines at $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$ and $\frac{3}{4}$ inch (and some at 1.0, 1.5 and 2.0 cm). Keep the cut edge on the line, not the needle, in view. For a circle-bottomed bag, the math matters. The circumference of a circle is $\pi \times \text{diameter}$. If you want a finished base 6 inches across, its circumference is $3.14 \times 6 \approx 18.84$ inches. The tube that joins it must be exactly that long around at the stitching line, plus a seam allowance at each end of its side seam: with $\frac{1}{2}$ -inch allowances, cut the body $18.84 + \frac{1}{2} + \frac{1}{2} \approx 19.84$, about **19 $\frac{7}{8}$ inches** wide. The base piece is cut with a $\frac{1}{2}$ -inch allowance all around, so its diameter is $6 + \frac{1}{2} + \frac{1}{2} = \textbf{7 inches}. Fold both into quarters and mark them; matching the quarter marks spreads the curve evenly.$

Let's sew. First you will sew a **curved-seam practice card**: one inward curve clipped and one outward curve notched. Then you will make a **lined drawstring bag with a round base**. The one skill to do well is **sewing the circle into the tube**: sew slowly with the circle on the bottom, stopping often with the needle down to smooth the next inch.

PICTURE STUDY



A Sewing School (En syskole), Anna Ancher, 1909 · Oil on canvas

Image: [Wikimedia Commons](#), public domain

Anna Ancher painted this sewing school in her village of Skagen, Denmark, in 1909. Girls sit around a sunny room with their work while the teacher moves from one to another, checking their stitches. In many towns, girls (and some boys) learned to sew in small classes like this one.

Look closely

- Find the teacher. What is she looking at, and what might she be explaining?
- Count the students. How many are sewing, and how many are watching?
- Look at where the light falls. Why are the students placed near the window?
- Look at the girls' hands. Are they sewing straight seams or something curved, like a sleeve or a cap?

Talk about it

1. What is easier about learning to sew in a group, and what is harder?
2. If you were the teacher, what would you check first on a student's curved seam?

3. Who could you teach a sewing skill to this year?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. You may sew on your own after your machine check-off: hands flat and fingers an inch from the needle, especially on curves where you are tempted to push close; foot off the pedal while you lift the foot to turn the work; pull each pin before it reaches the foot. Clip and notch with small sharp scissors, pointing away from the stitching and your fingers.

SEWING PROJECT

A Lined Drawstring Bag with a Round Base

You will figure the size of a circle and a tube to fit it, sew a curved-seam practice card, and then make a fully lined drawstring bag with a flat, round bottom that stands up on a shelf: good for yarn, marbles, a lunch or a gift.

You will need

- Sewing machine with a universal 80/12 needle, or a hand needle for backstitch
- Fabric shears, small sharp scissors, pins and a pincushion
- A compass, or a plate or bowl 7 inches across, a ruler, a tape measure and chalk
- An iron, ironing board and press cloth
- A safety pin or bodkin for threading the cord
- A calculator

LINED ROUND-BOTTOM DRAWSTRING BAG

Finished size: About 6 in (15 cm) across and 10 in (25 cm) tall · About 2–3 hours over two sessions

Fabric and notions

- Outer fabric, about $\frac{1}{3}$ yard of 44-inch quilting cotton or canvas: **body** $19\frac{7}{8} \times 11$ in (50.5 × 28 cm), cut 1; **base** circle 7 in (18 cm) across, cut 1
- Lining fabric, about $\frac{1}{3}$ yard of quilting cotton: body $19\frac{7}{8} \times 11$ in, cut 1; base circle 7 in across, cut 1

- For the practice card: two 5 × 7 in scraps
- 1¼ yards (114 cm) of cord or ribbon, ¼ inch wide
- All-purpose thread to match

How to make it

1. **Practice card:** draw a 4-inch-wide curve on two layers of scrap. Sew along it with a ½-inch allowance. On the inward side, clip every ½ inch nearly to the stitching; on another sample, notch the outward curve. Turn and press both and compare with an unclipped curve.
2. Mark the base circles with a compass set to 3½ inches (or trace a 7-inch plate) and cut them. Fold each into quarters and snip tiny marks in the allowance at the folds.
3. Fold each body piece in half, right sides together, matching the 11-inch ends. On the outer body only, sew the side seam with a ½-inch allowance, but leave a ¾-inch gap starting 1½ inches below the top edge for the cord opening. Sew the lining's side seam the same way but leave a 4-inch gap in the middle for turning. Press seams open.
4. Fold each tube flat with the seam at one side and mark the quarter points at the bottom edge with snips.
5. With right sides together, pin the outer base into the outer tube, matching the quarter marks, then pinning between them. Sew with the circle on the bottom, ½-inch allowance, going slowly and smoothing the next inch with the needle down. Do the same with the lining.
6. Notch the base allowances every ½ inch, cutting close to, not through, the stitching.
7. Turn the outer bag right side out. Slide it inside the lining (lining wrong side out), right sides together, matching side seams and top edges. Sew all around the top with a ½-inch allowance.
8. Pull the outer bag out through the gap in the lining. Slip-stitch or edge-stitch the lining gap closed. Push the lining inside the bag and press the top edge.
9. **Casing:** topstitch two lines around the bag, one just above and one just below the ¾-inch cord gap, making a channel. Thread the cord through with a safety pin and knot the ends.

Fabric check: Use a firmly woven, medium-weight cotton for the outer bag (quilting cotton, canvas, twill or denim) so the round base holds its shape; a lighter cotton is fine for the lining. Prewash both. Avoid knits and slippery fabrics, which stretch as you ease the circle in. For a firmer base, fuse a 6-inch circle of interfacing to the outer base before sewing (an adult or the checked-off student uses the iron).

Steps

1. **Count out needles and pins.**
2. **Do the math first.** Choose your own base size (5, 6 or 7 inches finished) and figure the body width and the base cutting size. Have a parent check it before you cut.
3. Sew the practice card and then the bag from the pattern card.
4. **Fit test.** Before sewing the outer base, pin it in and measure: does the tube fit around the circle with no extra and no pulling?
5. **Stand test.** Set the finished bag on a table. Does the base sit flat and round? If it puckers, which part of the circle had too much or too little fabric?
6. **Count in and clean up.** Count pins in, unplug the iron and machine, and sweep for pins with a magnet.
7. **Improve it.** Make a second bag at a different size, figuring the new math yourself, and give one away.

Tips

- Stay-stitch the bottom edge of the tube $\frac{3}{8}$ inch from the edge and clip it every $\frac{1}{2}$ inch before pinning; it will spread to fit the circle easily.
- Sew circles slowly, at half speed, lifting the foot (needle down) every inch to straighten the fabric under it.
- Younger students: make a 5-inch base and hand-sew the circle with a backstitch. Older students: add a boxed lining pocket or a contrasting band at the top.

Check your work

- ☐ I can sew at $\frac{5}{8}$, $\frac{1}{2}$ and $\frac{1}{4}$ inch accurately and explain where each is used.
- ☐ I clipped inward curves and notched outward curves so they lie flat.
- ☐ I figured the circumference and body width correctly, and my round base sits flat.

SEWING NOTEBOOK

1. Tape in your curved-seam practice card and label clip, notch and the unclipped curve.
2. Write your bag math: base diameter, circumference, body width, base cutting size.
3. Draw a baseball's two figure-eight pieces and explain why two curved pieces can cover a sphere.

From history. The number π has been studied since ancient times. The Bible describes Solomon's great bronze basin as ten cubits across with a line of thirty cubits to measure around it (1 Kings 7:23), about three times the width, which is close to 3.14. Builders and sewers have been using that relationship ever since.

COMMON MISTAKES

- Clipping through the stitching. The seam opens. Stop $\frac{1}{8}$ inch before the stitches.
- Forgetting to add the side-seam allowances to the body width. The tube is too small for the base.
- Sewing the circle with the tube on the bottom. The tube's extra fabric gets pushed into pleats. Keep the circle on the bottom against the feed dogs.

Make it a game • Circle Math Relay. Your parent names a base diameter for a round-bottom bag (5, 6, 7 or 8 inches). Race to figure the circumference, the body width with two $\frac{1}{2}$ -inch allowances, and the base cutting size. Check each other with the calculator; then draw the base on paper with a string compass. Fastest correct answer scores a point.

4.3 ZIPPERS: JUDSON’S CLASP LOCKER AND SUNDBACK’S FASTENER

OBJECTIVES

- Tell how Whitcomb Judson’s clasp locker (1893) and Gideon Sundback’s hookless fastener (1913) led to the modern zipper.
- Explain how a zipper’s teeth and slider work, and choose a zipper by length and type.
- Install a zipper with a zipper foot in a lined pencil case.

Warm-up. Find three zippers at home: on a coat, a bag and a pair of pants. Look at each with a magnifier. Are the teeth metal, molded plastic or a plastic coil? Slowly zip one up and watch the slider. What happens to the teeth inside it? Find the small metal “stops” at each end. What would happen without them?

WATCH

How to sew a lined Zipper Pouch--great for Beginners!

MADE Everyday · 12:55

<https://www.youtube.com/watch?v=i1AsfZRYIRM>

WHEN TO WATCH

Before Session 2, once all the way through. Then again with your pieces cut, pausing after each zipper side and after she opens the zipper before the final seam.

Note: A sewing teacher makes a lined zipper pouch step by step. She moves the slider out of the way of the foot while sewing; do the same with the needle down and the foot up.

BACKUP VIDEO

The Zipper: Where did it come from? | Stuff of Genius

HowStuffWorks · 1:33

<https://www.youtube.com/watch?v=LMM3Dn0joDU>

After the story, for a quick, lighthearted animated retelling of Howe, Judson and Sundback.

KEY TERMS

teeth (elements)

The small interlocking pieces on each side of a zipper. Each tooth has a bump on top and a hollow underneath that cup into the teeth on the other side.

zipper tape

The woven fabric strips the teeth are attached to; you sew through the tape, not the teeth.

zipper foot

A narrow presser foot that sits to one side of the needle, so you can stitch close to the zipper teeth.

slider

The Y-shaped part that moves along the zipper; its wedge pushes the teeth apart or its angled channels press them together.

stop

A small metal or plastic piece at the top and bottom of a zipper that keeps the slider from running off.

CORE IDEAS

The story. In the 1890s, buttoning a pair of high boots could mean doing up twenty or thirty tiny buttons with a hook. A Chicago inventor named **Whitcomb Judson** thought there must be a better way, and in 1893 he received patents for a “clasp locker,” a row of hooks and eyes that a slider could lock together. Judson started a company to make it, but his fastener jammed and popped open, and it sold poorly. The company hired a young engineer named **Gideon Sundback**, who had come to America from Sweden. Sundback worked on the problem for years. In 1913 he built the “Hookless Fastener No. 2,” with small, matching cup-shaped teeth, and he received a patent for his separable fastener in 1917. He also designed a machine to make it. In 1923 the B. F. Goodrich Company used the fastener on rubber overshoes and named them “Zippers,” after the zipping sound. The name stuck to the fastener, and by the 1930s zippers were going into jackets, trousers and bags.

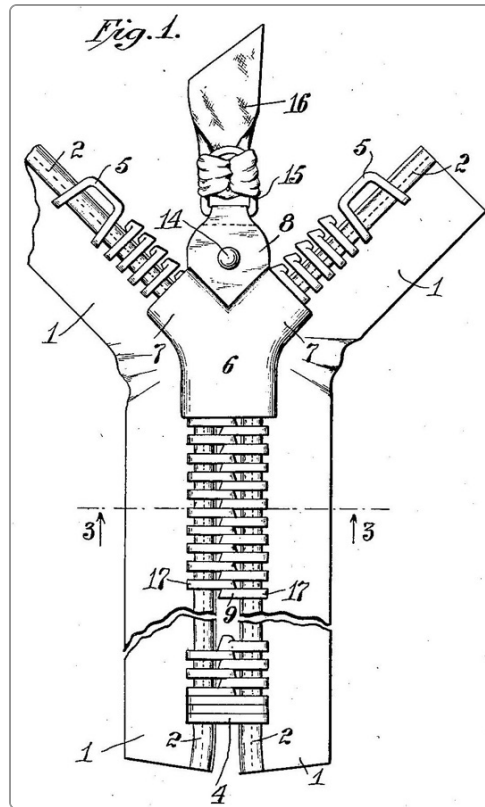
How they figured it out. Judson’s hooks had to catch on eyes, and anything that caught could also uncatch. Sundback’s great idea was to make every tooth the same: each has a small bump (a scoop) on top and a matching hollow underneath. The teeth on the two tapes are offset by half a tooth, so when the slider presses them together, the bump of

each tooth nests into the hollow of the tooth above it on the other side, locking like a row of stacked spoons. A pull on the closed zipper cannot separate them, because the teeth are held by their neighbors. Only the slider's wedge, bending the two rows apart at an angle, can open them again.

The fabric science. Zippers come in three common types. **Metal** teeth are strongest (jeans, coats). **Molded plastic** teeth are light and come in many colors (jackets). **Coil** zippers, a spiral of nylon or polyester, are flexible and can be shortened by sewing over them, which makes them best for pouches and dresses. Never iron a coil zipper on high heat: it is made of meltable polymer. **Zipper math:** a zipper is sold by the length of its teeth, from stop to stop. For a pouch, choose a zipper at least as long as the pouch's opening. For a pencil case that finishes $9 \times 4\frac{1}{2}$ inches, with $\frac{1}{2}$ -inch seam allowances, cut each outer and lining piece $9 + \frac{1}{2} + \frac{1}{2} = 10$ **inches** wide by $4\frac{1}{2} + \frac{1}{2} + \frac{1}{2} = 5\frac{1}{2}$ **inches** tall, and use a 9-inch or longer coil zipper. A longer coil zipper can be cut to length after its ends are sewn across.

Let's sew. You will make a **lined zippered pencil case**. The one skill to do well is **stitching close and straight beside the teeth** with the zipper foot, moving the slider out of the way with the needle down and the foot up.

PICTURE STUDY



Sundback's Separable Fastener Patent Drawing, Gideon Sundback, Patented March 20, 1917 · Ink patent drawing (U.S. Patent 1,219,881) · U.S. Patent and Trademark Office records

Image: [Wikimedia Commons](#), public domain

This drawing is from the patent that Gideon Sundback received in 1917 for his “separable fastener,” the zipper we still use. Like Whitney’s cotton gin drawing, it shows another mechanic exactly how to build the invention. Every numbered part is described in the written patent.

Look closely

- Find the two tapes (marked 1) and the rows of teeth on their edges.
- Find the slider (marked 6) and its pull tab at the top. How does its shape open the teeth above it and close them below?
- Look at the teeth below the slider. How do the two sides fit together?
- Find the bottom of the drawing. What holds the two tapes together there?

Talk about it

1. Why did Sundback make every tooth the same shape instead of using hooks and eyes like Judson?

2. Compare this drawing with a real zipper. What is the same after more than a hundred years?
3. What everyday fastener would you like to improve, and how?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Sew slowly near the zipper: if the needle hits a metal tooth or a stop it can break, so turn the hand wheel by hand across the zipper ends. Use the zipper foot only as your manual shows, adjusting it with the machine unplugged or the power off. Press near a coil zipper only with a low iron and a press cloth.

SEWING PROJECT

A Lined Zippered Pencil Case

You will figure your cutting sizes, install a coil zipper between an outer fabric and a lining, and finish a pencil case with boxed or flat corners. It is the same method used for cosmetic bags, first-aid pouches and many store-bought cases.

You will need

- Sewing machine with a zipper foot and a universal 80/12 needle (or hand-sewing needle for backstitch)
- Fabric shears, small scissors, pins or sewing clips, and a pincushion
- A ruler, chalk and a seam gauge
- An iron and press cloth (low setting near the zipper)
- A chopstick or point turner

LINED ZIPPERED PENCIL CASE

Finished size: About $9 \times 4\frac{1}{2}$ in (23×11.5 cm) finished · About 2 hours

Fabric and notions

- Outer fabric: 2 pieces $10 \times 5\frac{1}{2}$ in (25.5×14 cm) of quilting cotton, canvas or denim
- Lining: 2 pieces $10 \times 5\frac{1}{2}$ in of quilting cotton
- Optional: 2 pieces of fusible fleece or medium interfacing, $9 \times 4\frac{1}{2}$ in, for body

- One 9-inch (23 cm) or longer coil (nylon) zipper
- All-purpose thread to match; optional 3-inch loop of ribbon for a pull tab

How to make it

1. If using interfacing, center and fuse it to the wrong side of each outer piece with a press cloth.
2. Lay one outer piece right side up. Lay the zipper on it face down, its tape edge along the top 10-inch edge. Lay a lining piece on top, right side down, edges matching. Clip the three layers.
3. Put on the zipper foot. Sew along the top edge about $\frac{1}{4}$ inch from the teeth (on the tape). When you reach the slider, stop with the needle down, lift the foot, slide the slider behind the needle, lower the foot and finish.
4. Fold the outer and lining away from the zipper, wrong sides together, and press with a low iron and press cloth, keeping the iron off the teeth.
5. Repeat for the other side of the zipper with the second outer and lining pieces.
6. Topstitch $\frac{1}{8}$ inch from the fold along both sides of the zipper, if you like, for a crisp edge.
7. **Open the zipper halfway.** (Otherwise you cannot turn the case.) Fold so the two outer pieces are right sides together and the two lining pieces are right sides together, with the zipper teeth pointing toward the lining.
8. Sew all the way around with a $\frac{1}{2}$ -inch allowance, sewing slowly across the zipper ends (turn the hand wheel by hand there), and leave a 3-inch gap in the bottom of the lining.
9. Trim the zipper tape ends, clip the corners, and turn the case right side out through the gap and the zipper. Push out the corners. Sew the lining gap closed and push the lining inside.

Fabric check: Medium-weight cotton, canvas or denim makes a sturdy outer case; quilting cotton is fine for the lining. Prewash fabrics. Use a nylon coil zipper for this project: it can be sewn across and trimmed, unlike a metal zipper, which can break a needle. Keep the iron low near the coil, which can melt. Avoid stretchy and slippery fabrics, which ripple along the zipper.

Steps

1. **Count out needles and pins.**

2. **Do the math.** Choose your finished size (for a ruler, a phone or crayons) and figure the cutting sizes and zipper length before you cut.
3. **Practice first.** Sew 4 inches of a zipper to a scrap with the zipper foot, moving the slider once.
4. Make the pencil case from the pattern card.
5. **Zip test.** Open and close the zipper 25 times. Does the slider catch on the fabric anywhere? If so, that stitching was too close to the teeth.
6. **Count in and clean up.** Pins counted in; trimmed zipper ends in the trash (they are sharp-edged); iron and machine unplugged.
7. **Improve it.** Make a second case with boxed corners or a different size, and give it to someone who needs one.

Tips

- Baste the zipper to the outer piece with a few hand stitches or glue-stick it before machine sewing, so it does not shift.
- Start with the zipper a little longer than the pouch. You can sew across the coil and trim the extra.
- Younger students: make a smaller 7-inch case with flat corners. Older students: add boxed corners (Lesson 4.4) or a fabric tab at each zipper end.

Check your work

- ☐ I can tell how Judson and Sundback developed the zipper and explain how the teeth lock.
- ☐ I figured my cutting sizes and zipper length from the finished size.
- ☐ My zipper is stitched straight and close, opens smoothly, and the lining is neat.

SEWING NOTEBOOK

1. Draw three zipper teeth from each side, showing how the bump of one nests in the hollow of the next.
2. Write the cutting math for your case and for one other size you might make.
3. Make a timeline: Judson 1893, Sundback 1913, patent 1917, “Zipper” overshoes 1923.

From history. Elias Howe, of sewing-machine fame, received a patent in 1851 for an “automatic, continuous clothing closure,” but he never built or sold it. Gideon Sundback spent the rest of his working life in northwestern Pennsylvania, improving zipper-making machines, and he helped start a zipper company in Canada.

COMMON MISTAKES

- Sewing the final seam with the zipper closed. The case cannot be turned right side out. Open it halfway first.
- Sewing right on top of the teeth, so the slider jams. Stay on the tape, about ¼ inch from the teeth.
- Running the machine fast across a metal stop. The needle can break. Turn the hand wheel by hand there.

Make it a game • Zipper Timeline Shuffle. Write five cards: Howe’s 1851 closure patent, Judson’s 1893 clasp locker, Sundback’s 1913 fastener, his 1917 patent, and the 1923 “Zipper” overshoes. Shuffle them and race the timer to lay them in order and tell one fact about each. Then race to find and name the teeth, slider, tape and stops on three zippers in the house.

4.4 A MACHINE-SEWN TOTE WITH BOXED CORNERS

OBJECTIVES

- Tell how Paul, Aquila and Priscilla supported themselves as tentmakers (Acts 18:3), and why heavy cloth needs strong seams.
- Explain boxed corners and figure how a box depth changes a bag's width and height.
- Sew a fully lined tote bag with boxed corners and sturdy straps.

Warm-up. Find a paper grocery bag, a cloth tote and a backpack. Look at the bottom of each. Is it flat, or does it have a depth? Measure the depth. Fold the paper bag flat and open it again: where do the corners fold? Now turn a store tote inside out and find how its corners were sewn.

WATCH

How to Make a Simple Reversible Lined Tote Bag

Notches Sewing · 5:42

<https://www.youtube.com/watch?v=UxdyjDymh-k>

WHEN TO WATCH

Before Session 2. Watch once through, then again as you cut, pausing at the straps, the boxed corners and the turning.

Note: Her measurements are metric and a little different from ours; follow the pattern card. She cuts with a rotary cutter, which you use only with an adult nearby, or use shears.

BACKUP VIDEO

Boxing Corners for an Easy Tote Bag Tutorial

Kiley's Quilt Room · 2:50

<https://www.youtube.com/watch?v=T0BU4LyEI18>

Just before you box your corners: how to flatten the corner into a triangle with the seams matched, measure, mark and sew across.

KEY TERMS

boxed corner

A bag corner flattened into a triangle and sewn straight across, giving the bag a flat bottom with depth.

topstitch

A visible line of stitching on the right side, close to an edge, that holds layers flat and adds strength.

reinforcement

Extra stitching (such as a box with an X) where straps meet the bag, because that is where the load pulls hardest.

box depth

The width of the bag's flat bottom from front to back, equal to the length of the line sewn across the corner.

canvas (duck)

A heavy, tightly woven plain-weave cotton used for bags, tents and sails.

CORE IDEAS

The story. When the apostle Paul came to the city of Corinth, he met a Jewish couple named Aquila and Priscilla who had recently come from Rome. “Because he was of the same craft, he abode with them, and wrought: for by their occupation they were tentmakers” (Acts 18:3). Paul supported himself with his hands while he preached, so that no one could say he was teaching for money. Tents in his day were made of leather or of heavy cloth woven from goats’ hair, cut into panels and sewn together with strong seams that could stand wind, rain and the weight of the tent itself. It was hard, skilled work with a needle and an awl. Paul wrote later that he had worked “night and day” so as not to be a burden to the churches (1 Thessalonians 2:9).

How they figured it out. Anyone who sews things that carry weight, a tent, a sail, a saddlebag or a tote bag, learns the same lessons. Use a heavy, tightly woven cloth. Make seams that cannot pull apart, with a strong stitch and enough seam allowance. Put extra stitching where the load pulls hardest. And give the thing **shape**: a flat bag holds little, but a bag with a flat bottom and depth stands up and holds much more. Sewers found a simple way to turn a flat bag into a boxy one without cutting a separate bottom panel: the **boxed corner**. Flatten each bottom corner into a triangle, sew straight across it, and the flat bag opens into a box.

The fabric science. Here is the boxed-corner math. Flatten a corner so the side seam lies exactly on top of the bottom seam, making a point. Measure from the point toward the bag, and draw a line straight across where the triangle is as wide as the box depth you want. For a 4-inch depth, the line is 4 inches long, and it falls 2 inches from the point (half the depth). Sewing it takes half the depth from each side of the bag's width and half from its height. So a bag that is 16 inches wide and 15 inches tall when flat becomes about $16 - 4 = 12$ inches wide, $15 - 2 = 13$ inches tall, and 4 inches deep. Strap math: a strap cut 4 inches wide, folded in half and then with both edges folded to the middle, finishes 1 inch wide and four layers thick, strong enough for books.

Let's sew. You will sew a **fully lined tote** with boxed corners and reinforced straps, sturdy enough for library books or groceries. The one skill to do well is **matching the corner seams** exactly before you sew across, so the box is square and the bag stands straight.

PICTURE STUDY



Portugal (Vianna): Singer Advertising Card, Published by the Singer Manufacturing Company, 1892 • Color lithograph trade card

Image: [Wikimedia Commons](#), public domain

In 1892 the Singer company printed a set of advertising cards showing families from many countries in their regional dress, each with a Singer machine. This one shows a young couple from Viana do Castelo in northern Portugal. The cards were meant to show that the same sturdy machine was at home all over the world.

Look closely

- Find the treadle under the table. How did the sewer make the machine run without electricity?
- Look at the woman's skirt. How many different colored patches or panels can you count? Could it have been sewn on a machine like this?
- Find the white cloth under the needle. Where are her hands?
- Look at the young man's sash and jacket. What sewing skills went into his clothes?

Talk about it

1. Why would a company want people in many countries to see someone like themselves at a sewing machine?
2. A treadle machine can sew canvas and heavy cloth. What could a family in 1892 make with it to earn money, as Paul earned his living by tentmaking?
3. What would a card showing your family at your sewing machine look like?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Use a 90/14 or denim needle for canvas, and sew slowly over thick strap layers, turning the hand wheel by hand if the machine strains, rather than pushing the fabric. Keep fingers an inch from the needle and pull pins (or use clips) before the foot. If you cut with a rotary cutter, do it only with an adult nearby, on a mat, cutting away from you, blade closed every time you set it down.

SEWING PROJECT

A Lined Tote Bag with Boxed Corners

You will cut, sew and box a lined tote that stands up on its own and carries real weight. Make one for yourself and, if you can, a second to give.

You will need

- Sewing machine with a 90/14 universal or denim needle (or hand needle and strong thread for backstitch)
- Fabric shears (or rotary cutter, mat and ruler with an adult nearby)
- Pins or sewing clips, a ruler, chalk and a seam gauge
- An iron, ironing board and press cloth
- A tape measure and a calculator

LINED BOXED-CORNER TOTE

Finished size: About 12 in wide × 13 in tall × 4 in deep (30 × 33 × 10 cm), with 24-inch straps · About 2½–3 hours over two sessions

Fabric and notions

- Outer fabric: $\frac{3}{4}$ yard (69 cm) of 44-inch canvas, duck, denim or home-décor cotton. Cut 2 body pieces 17 × 16 in (43 × 41 cm) and 2 straps 4 × 25 in (10 × 64 cm)
- Lining: $\frac{1}{2}$ yard (46 cm) of quilting cotton. Cut 2 pieces 17 × 16 in
- Heavy-duty or all-purpose polyester thread
- Optional: an inside pocket, 8 × 12 in of lining fabric folded to 8 × 6 in

How to make it

1. **Straps:** fold each strap in half lengthwise and press. Open it, fold both long edges to the center crease and press, then fold on the center again so the edges are hidden. Topstitch $\frac{1}{8}$ inch from both long edges. Each strap is now 1 × 25 in.
2. **Optional pocket:** fold the pocket in half, right sides together, sew around with $\frac{1}{2}$ -inch allowance leaving a gap, turn, press, and topstitch it to the center of one lining piece 3 inches below the top, along its sides and bottom.
3. Place the outer pieces right sides together. Sew the two sides and the bottom with a $\frac{1}{2}$ -inch allowance, backstitching at each end. Do the same with the lining, but leave a 5-inch gap in the bottom seam for turning. Press seams open.

4. **Box the corners:** at one bottom corner of the outer bag, pull the front and back apart and flatten the corner into a triangle with the side seam exactly on top of the bottom seam (feel and pin through both). Measure 2 inches from the point and draw a line straight across: it should be 4 inches long. Sew on the line, backstitching. Trim $\frac{1}{2}$ inch beyond the stitching. Repeat on all four corners (outer and lining).
5. Turn the outer bag right side out. Pin each strap end to the top edge of the outer bag, raw edges matching, 3 inches in from each side seam, the strap hanging down along the bag (not twisted). Baste them in place $\frac{1}{4}$ inch from the edge.
6. Slip the outer bag (right side out) inside the lining (wrong side out), right sides together, matching side seams. The straps are sandwiched between. Pin or clip around the top and sew with a $\frac{1}{2}$ -inch allowance.
7. Pull the outer bag out through the gap in the lining. Sew the gap closed by machine close to the edge or by slip stitch. Push the lining into the bag.
8. Press the top edge so the lining does not show from the outside. Topstitch $\frac{1}{4}$ inch from the top edge all around.
9. **Reinforce:** where each strap meets the top, sew a small box with an X through it for strength, going slowly.

Fabric check: Choose a heavy, tightly woven outer fabric, cotton canvas, duck, denim or home-décor weight cotton, so the tote holds its shape and carries weight; quilting cotton alone is too soft for a working tote. Prewash both fabrics so the lining and outer shrink together. A polyester-cotton canvas resists wrinkles and dries quickly. Avoid knits and slippery fabrics. Use a 90/14 or denim needle; a fine needle will bend in canvas.

Steps

1. **Count out needles and pins.**
2. **Do the math first.** Decide your finished width, height and depth, and figure the cutting size: flat width = finished width + depth; flat height = finished height + half the depth; then add $\frac{1}{2}$ inch of seam allowance to each edge. Have a parent check it.
3. **Practice first.** Box one corner on a folded scrap and measure the depth you get.
4. Sew the tote from the pattern card.

5. **Load test.** Fill the tote with books, weighing it on a bathroom scale, adding a book at a time up to 10 pounds. Lift it by the straps ten times. Check the straps and seams for any pulled stitches.
6. **Count in and clean up.** Pins counted in; rotary cutter blade closed and put away; iron and machine unplugged.
7. **Improve it.** Sew a second tote as a gift, with one improvement: a pocket, a contrasting bottom panel or longer straps.

Tips

- Press every seam before you sew across it. It makes the corners line up and the bag look professional.
- Use clips instead of pins on thick canvas; pins bend and are hard to push through.
- Younger students: make a smaller 10 × 10 × 3 inch tote and hand-sew it with a backstitch if needed. Older students: add a zippered inside pocket using Lesson 4.3.

Check your work

- ☐ I can explain how boxed corners give a bag depth and figure the new width and height.
- ☐ My corners are square, the side and bottom seams match, and the bag stands up.
- ☐ My straps are reinforced and the tote held a real load without a stitch giving way.

SEWING NOTEBOOK

1. Draw a boxed corner step by step: the flat corner, the triangle, the line, the finished box. Write the measurements.
2. Show the cutting-size math for your tote, and for one other tote you might make.
3. Record the load test: weight carried and what you checked afterward.

From history. Sailmakers once sewed huge canvas sails entirely by hand, pushing heavy needles through many layers with a leather “sailmaker’s palm” strapped to the hand. Many still sew the corners and edges of sails by hand today, because hand stitches can be pulled tighter than machine stitches.

COMMON MISTAKES

- Not lining up the side seam on the bottom seam before sewing across. The corner twists and the bag leans.
- Pinning straps twisted or pointing up instead of down. When the bag is turned, they are twisted or caught inside. Pin them hanging down along the bag.
- Forgetting that boxing makes the bag smaller. Add the depth to the flat width before you cut.

Make it a game • Box It Right. Your parent names a finished tote size, such as 14 wide, 12 tall and 5 deep. Race to figure the cutting size of each body piece with ½-inch seam allowances. Check each other’s math. Then fold a sheet of paper into a bag with boxed corners of the depth you figured. A correct answer and a standing paper bag scores a point.

Scripture. “And because he was of the same craft, he abode with them, and wrought: for by their occupation they were tentmakers.” (Acts 18:3, KJV)

Paul, Aquila and Priscilla worked with heavy cloth and strong seams to earn their bread. A well-made bag is a small piece of the same honest craft.

UNIT 4 REVIEW

Answer in complete sentences unless the question asks for a calculation or a show-me. For calculations, show every step; a right answer with no work earns half. The review is worth 100 points.

1. (8 pts)

What was the “Sewing Machine War,” and how did the Sewing Machine Combination of 1856 end it?

2. (8 pts)

List the steps of cleaning a sewing machine, and name two things you must never do.

3. (8 pts)

Calculate. A needle is labeled 100/16. How thick is its blade in millimeters? Is it thicker or thinner than an 80/12? Which would you choose for denim and which for a cotton shirt?

4. (8 pts)

Explain the difference between clipping and notching. Which goes on an inward curve, and which on an outward curve? Why?

5. (10 pts)

Calculate. You want a round-bottom bag with a finished base 8 inches across, with ½-inch seam allowances. What is the circumference of the base? How wide do you cut the body (including both side-seam allowances)? What diameter do you cut the base circle?

6. (8 pts)

Who were Whitcomb Judson and Gideon Sundback, and what did each contribute to the zipper?

7. (8 pts)

Why must you open the zipper partway before sewing the final seam of a lined pouch, and why do you sew on the tape and not the teeth?

8. (10 pts)

Calculate. A tote measures 18 inches wide and 16 inches tall when flat (after seams). You box the corners to a 6-inch depth. How far from the point do you draw the line? What are the finished width, height and depth?

9. (8 pts)

Show me. Sew a 6-inch seam on two scraps at exactly $\frac{5}{8}$ inch, then a second at $\frac{1}{4}$ inch, using the machine's guides. Have your parent measure each in three places.

10. (8 pts)

Name three ways to make a tote strong enough to carry weight.

11. (8 pts)

Written answer. In four sentences, tell what Acts 18:3 says about Paul, Aquila and Priscilla, and what a tentmaker had to know about cloth and seams.

12. (8 pts)

Why do many sewers change the machine needle after 6–8 hours of sewing? If you sew 2 hours a week, about how often is that?

UNIT CHALLENGE: THE MACHINE-SEWN BAG COLLECTION

Show the unit's machine work: your round-bottom drawstring bag, your zippered pencil case and your lined tote, together with your curved-seam practice card and your machine maintenance log.

On a notebook page for each bag, include the cutting math, a fabric swatch, the needle size you used, a photo, and one honest note on what you would change. Give at least one of the bags away, and write who received it and why.

LOOK FOR	WHAT IT MEANS
The arithmetic	Circumference, cutting sizes, zipper length and boxed-corner dimensions are figured correctly with the work shown.
Workmanship	Seams at accurate allowances; curves clipped or notched and smooth; zipper straight and working; boxed corners square; straps reinforced.
Machine care	The machine was cleaned, oiled as the manual directs and re-needled, and the log is kept up.

LOOK FOR	WHAT IT MEANS
Safety	Machine unplugged for every adjustment; fingers an inch from the needle; pins pulled before the foot; iron and rotary cutter used by the rules; needle-and-pin count every session.
Giving and improvement	At least one bag given away; one item remade better with the change noted. A crooked first try honestly recorded and redone earns full credit.

ANSWER KEY

1. After Howe's 1846 patent and Singer's 1851 machine, Howe sued Singer and others for infringement and won in 1854, and the leading makers kept suing each other over their own patents. In 1856 Singer, Wheeler and Wilson, and Grover and Baker pooled their patents with Howe's: each could use them all, other makers bought licenses, and Howe received a royalty on each machine. The lawsuits ended.
2. Unplug it; remove the thread, bobbin, needle, presser foot and needle plate; lift out the bobbin case; brush lint from the feed dogs and bobbin area; oil only where the manual shows, one drop; reassemble; insert a new needle correctly; rethread and test on a scrap. Never work on it plugged in; never blow lint into it or use household oil (or oil where the manual does not show).
3. 100 hundredths of a millimeter = 1.00 mm. It is thicker than an 80/12 (0.80 mm). Use the 100/16 for denim and the 80/12 for a cotton shirt.
4. Clipping is a straight cut nearly to the stitching; it goes on an inward (concave) curve, whose cut edge is shorter than the stitching line, so the allowance can spread open when turned. Notching cuts out a small wedge; it goes on an outward (convex) curve, whose cut edge is longer, so the extra fabric does not bunch when turned.
5. Circumference = $3.14 \times 8 \approx 25.12$ inches. Body width = $25.12 + \frac{1}{2} + \frac{1}{2} \approx 26.12$, about $26\frac{1}{8}$ inches. Base circle = $8 + \frac{1}{2} + \frac{1}{2} = 9$ inches across.
6. Judson, a Chicago inventor, patented the clasp locker in 1893, a hook-and-eye fastener closed by a slider, which jammed and sold poorly. Sundback, a Swedish-born engineer at Judson's company, designed matching cup-shaped teeth that nest together (the Hookless Fastener No. 2, 1913; patented 1917) and a machine to make them: the modern zipper.
7. The pouch is turned right side out through the open zipper; if it is closed, you cannot turn it. Sewing on the tape about $\frac{1}{4}$ inch from the teeth leaves room for the slider; stitching on or too close to the teeth makes the slider catch or jam and can break the needle.
8. The line is 6 inches long, drawn $6 \div 2 = 3$ inches from the point. Width: $18 - 6 = 12$ inches. Height: $16 - 3 = 13$ inches. Depth: 6 inches.
9. Parent checks: each seam stays within about $1/16$ inch of its allowance at all three points; backstitched at both ends; hands flat and fingers an inch from the needle; pins pulled before the foot.
10. Any three: a heavy, tightly woven fabric such as canvas or denim; straps folded to four layers and topstitched; reinforcing boxes with an X where straps join the bag;

backstitching at the start and end of every seam; a lining; a correct heavy needle and good thread; enough seam allowance.

11. Open answer. Look for: Paul stayed and worked with Aquila and Priscilla in Corinth because they shared the craft of tentmaking; he supported himself by his hands while he preached; tents were made of leather or heavy goats'-hair cloth; a tentmaker needed strong cloth, strong seams, and extra strength where the load and the wind pulled hardest.
12. A needle dulls, burrs or bends with use, causing skipped stitches, snags and broken threads. At 2 hours a week, $6 \div 2 = 3$ to $8 \div 2 = 4$, so about every 3 to 4 weeks.

CROCHET

In Fabrics & Sewing I you learned to chain, single crochet and make a granny square. This year you will add the taller stitches, the half double and the treble, and learn the most important number in all of crochet: **gauge**, the number of stitches and rows in 4 inches. With gauge and a little arithmetic you can make a hat fit a real head, a blanket come out the size you planned, and a coaster lie perfectly flat.

You will meet the women of Ireland who crocheted lace to feed their families during the famine of the 1840s, learn why crocheted circles grow by six stitches a round, read patterns drawn in symbols instead of words, and finish the unit by crocheting a warm hat to give to someone who needs one, as Dorcas made coats and garments for the widows of Joppa.

PREREQUISITES

- Can make a slip knot, chain, single crochet and double crochet (Fabrics & Sewing I, or practice before Lesson 5.1)
- Can measure to the nearest $\frac{1}{8}$ inch and divide with decimals
- Knows the abbreviations ch, sc, dc, sl st and st

MASTERY CHECKLIST

- ☐ I can work sc, hdc, dc and tr and tell how tall each is and how many turning chains it needs.
- ☐ I can crochet a gauge swatch, measure stitches and rows per 4 inches, and change my hook to match a pattern's gauge.
- ☐ I can figure how many stitches I need for a hat or blanket from gauge and measurements.
- ☐ I can start a circle with an adjustable ring and explain why a flat circle increases by the same number of stitches each round.
- ☐ I can read a crochet symbol chart and a written pattern and work from either.
- ☐ I can crochet a hat that fits and give it to someone who needs it.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **Craft Yarn Council: Crochet Chart Symbols and Abbreviations**: Free. The standard symbols used in crochet charts, with the matching abbreviations, from the yarn industry's standards group. Good for Lesson 5.3.
- **Crochet hooks in sizes G-6 (4 mm), H-8 (5 mm) and I-9 (5.5 mm)**: Having three neighboring sizes lets you change hooks to match gauge. A set of aluminum hooks costs little.
- **Stitch markers and a 4-inch gauge ruler**: Locking stitch markers (or bits of contrasting yarn) mark the start of each round. A gauge ruler has a 4-inch window for counting stitches and rows; a plain ruler works too.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

5.1 Crochet Stitches and Gauge	2 sessions of 50–60 minutes
5.2 Working in the Round	2 sessions of 50–60 minutes
5.3 Reading Charts: Symbols and the Granny Square	2 sessions of 50–60 minutes
5.4 Crochet for Others: Dorcas and the Warm Hat	2 sessions of 60–90 minutes

5.1 CROCHET STITCHES AND GAUGE

OBJECTIVES

- Tell how crochet lace helped Irish families earn a living during the famine of the 1840s.
- Work single, half double, double and treble crochet, and compare their heights and turning chains.
- Crochet and measure gauge swatches, and use gauge to figure the stitch count for a hat.

Warm-up. Find any crocheted or knitted item at home: a hat, a dishcloth, a blanket. Lay a ruler on it and count how many stitches fit in 2 inches. Now try the same on a different item. Are the numbers the same? What do you think makes them different?

WATCH

Learn to Crochet | How to Make & Measure a Gauge Swatch

Yarnspirations · 3:17

<https://www.youtube.com/watch?v=AnT89huAi6E>

WHEN TO WATCH

After “The fabric science,” with your first swatch and a ruler in hand. Pause as she counts the stitches and the rows and count yours the same way.

Note: From the yarn company behind Red Heart, Caron and Bernat. Hands only, with captions.

BACKUP VIDEO

Half Double Crochet (HDC) Stitch in Rows | Beginners Tutorial

Hooked by Robin · 6:55

<https://www.youtube.com/watch?v=3oQeg-EP7b4>

Before you start your hdc swatch: a slow, close-up lesson on the half double crochet, row by row.

KEY TERMS

gauge

The number of stitches and rows in a measured space, usually 4 inches (10 cm). It depends on the yarn, the hook and the crocheter's hands.

treble crochet (tr)

Yarn over twice, insert, pull up a loop (4 loops), then yarn over and pull through two loops three times. About three times as tall as sc.

Irish crochet

A crocheted lace of separate motifs (roses, leaves, shamrocks) joined by a mesh background, made in Ireland from the 1840s in imitation of costly needle lace.

half double crochet (hdc)

Yarn over, insert the hook, yarn over and pull up a loop (3 loops on hook), yarn over and pull through all 3. It is between sc and dc in height.

turning chain

Chains made at the start of a row to bring the hook up to the height of the new stitches: usually 1 for sc, 2 for hdc, 3 for dc and 4 for tr.

CORE IDEAS

The story. In 1845 a blight struck the potato crop in Ireland, and for several years the potatoes rotted in the fields. Millions of poor families had depended on them for food. In the years of the Great Famine, about a million people died and more than a million left Ireland. In those terrible years, some women found that a crochet hook could help. Fine lace was costly and fashionable, but true needle lace took months to make. Crocheters learned to imitate it with fine cotton thread and a tiny steel hook, making roses, leaves and shamrocks and joining them with a crocheted mesh. Teachers, including nuns in convent schools and a rector's wife named Cassandra Hand in the town of Clones, taught girls and women the craft, and merchants sold their lace in Dublin, London and beyond. A family that could crochet could earn money for food. "Irish crochet" became famous, and it is still made today.

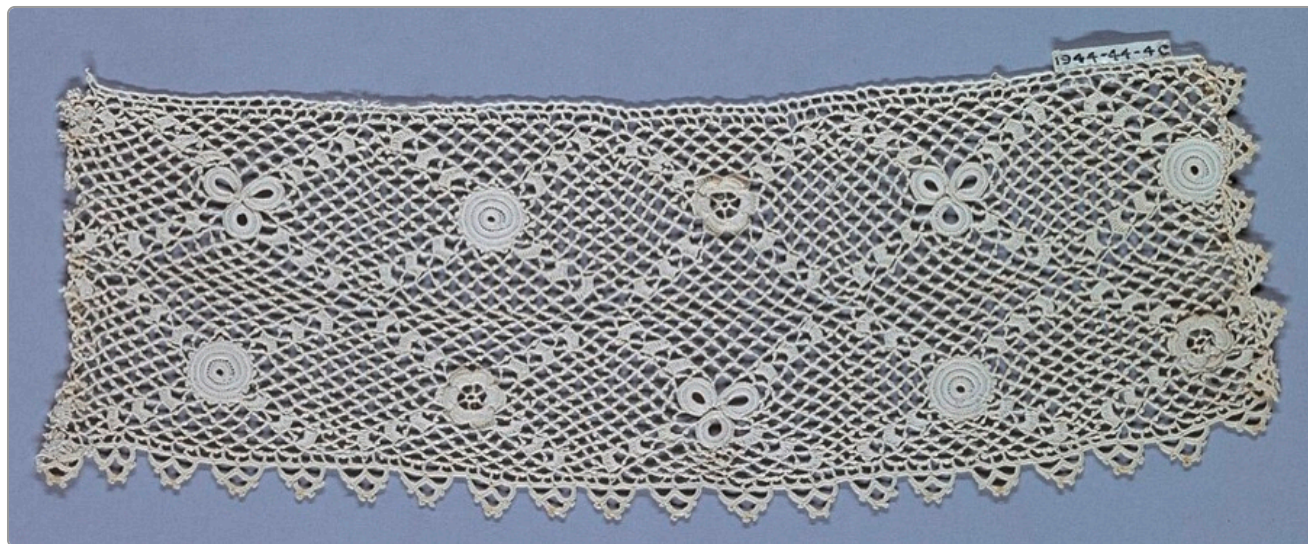
How they figured it out. The Irish lace-makers had to match each other's work exactly, because motifs made by many hands were joined into one collar or cuff. A collar made of roses that were each a little too big would not fit. So every worker had to use the same

thread, the same hook and the same tension. That is the idea of **gauge**. Two crocheters using the same pattern and the same yarn can make hats of very different sizes if one crochets tightly and the other loosely. Patterns therefore print a gauge, such as “14 sc and 16 rows = 4 inches,” and careful crocheters make a small **gauge swatch** first. If the swatch has too many stitches per 4 inches, their stitches are too small: they change to a larger hook. Too few stitches: a smaller hook.

The fabric science. The taller stitches are made by wrapping the yarn around the hook more times before working off the loops. A single crochet stands about as tall as it is wide. A half double is about one and a half times as tall, a double about twice, and a treble about three times. Taller stitches make a looser, more flexible fabric that grows faster and drapes more; shorter stitches make a firmer, denser fabric. Here is the gauge arithmetic. Suppose your swatch has 14 hdc in 4 inches: that is $14 \div 4 = 3.5$ **stitches per inch**. A hat should fit snugly, about 1 to 2 inches smaller than the head it is for. For a head that measures 21 inches around, aim for about 19½ inches: $3.5 \times 19.5 = 68.25$, so start with **68 stitches**. If the pattern needs a multiple of 4, round to 68; a multiple of 6, round to 66.

Let's crochet. You will crochet **three gauge swatches** with the same yarn and hook, one each in sc, hdc and dc, measure them, and then use your numbers to plan a hat for a real person. The one skill to do well is **even tension**: let the yarn run through your fingers at the same tightness for every stitch.

PICTURE STUDY



Irish Crochet Lace Cuffs, Unknown Irish lace-makers, 19th century · Crocheted linen thread · Cooper Hewitt, Smithsonian Design Museum, New York
Image: [Wikimedia Commons](#), public domain

These cuffs, once sewn to the sleeves of a dress, were crocheted in Ireland in the 1800s from fine white linen thread. Each rose and shamrock was made separately, and then a mesh was crocheted between them to join them into one piece of lace. Look closely: every loop was made with a hook thinner than a sewing needle.

Look closely

- Find a rose. Can you see that its petals stand up in layers, one round on top of another?
- Find the four-leafed shamrock shapes. How many can you count on this strip?
- Look at the mesh between the motifs. Each opening is a little chain loop. Are the loops all the same size?
- Find the pointed edge along one side. How might the lace-maker have finished it?

Talk about it

1. Why would every lace-maker working on one collar need the same gauge?
2. This lace was made by poor women to earn money for their families. How does knowing that change the way you see it?

3. What small motif would you choose if you designed a piece of lace for your family?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including your yarn needle. Crochet hooks are blunt, but keep them and loose yarn away from babies, toddlers and pets, and never leave a long strand of yarn where a little child could wrap it around his or her neck. Sit with good posture and a good light, and rest your hands every 20 minutes.

SEWING PROJECT

Gauge Swatches and a Hat Plan

You will make three small swatches in three different stitches and measure each one like a pattern designer. Then you will use your own gauge to plan a hat for a real person, the hat you may make in Lesson 5.4.

You will need

- A 5 mm (H-8) crochet hook, plus a 4.5 mm (7) or 5.5 mm (I-9) if you need to change
- A yarn needle (counted with the pins), small scissors and a ruler or gauge ruler
- Stitch markers or safety pins
- A soft tape measure and a calculator

THREE GAUGE SWATCHES (SC, HDC, DC)

Finished size: Three swatches, each about 5 × 5 in (13 × 13 cm) · About 90 minutes

Fabric and notions

- About 60 yards (55 m) of smooth, light-colored worsted-weight (#4) wool or acrylic yarn
- The same yarn and hook for all three swatches, so the only change is the stitch

How to make it

1. **Single crochet swatch:** chain 21. Sc in the second chain from the hook and in each chain across (20 sc). Ch 1, turn. Sc in each stitch across. Repeat until the swatch is about 5 inches tall. Fasten off.
2. **Half double swatch:** chain 22. Hdc in the third chain from the hook and in each chain across (20 hdc). Ch 2, turn. Hdc in each stitch across. Repeat until about 5 inches tall. Fasten off.
3. **Double crochet swatch:** chain 23. Dc in the fourth chain from the hook and in each chain across (20 dc). Ch 3, turn. Dc in each stitch across (the turning chain does not count as a stitch in this pattern). Repeat until about 5 inches tall. Fasten off.
4. Lay each swatch flat without stretching it. Place two pins exactly 4 inches apart across the middle, away from the edges. Count the stitches between the pins, including half stitches.
5. Place two pins 4 inches apart up and down the middle and count the rows between them.
6. Record each swatch: stitches per 4 inches, rows per 4 inches, stitches per inch ($\div 4$) and rows per inch.
7. **Hat plan:** with permission, measure the head of the person you will make a hat for, around the forehead and just above the ears. Subtract 1½ inches for a snug fit. Multiply by your hdc stitches per inch. Round to a convenient number. Write it down for Lesson 5.4.
8. Tag each swatch with a slip of paper: stitch, hook size, yarn and gauge.

Fabric check: Use a smooth, light-colored worsted-weight wool or acrylic so you can see and count each stitch. Fuzzy, dark or novelty yarns hide stitches and make gauge impossible to read. Cotton yarn works but stretches less, so its gauge differs from wool's. If wool bothers anyone, use acrylic. Always swatch in the same yarn you will use for the real project.

Steps

1. **Count out** your yarn needle and any pins.
2. **Predict first.** Before measuring, guess which swatch will have the most rows in 4 inches and which the fewest. Write your guess.
3. Make and measure the three swatches from the pattern card.

4. **Hook test.** Make one more sc swatch, 10 stitches wide, with a hook one size larger. How much did your stitches per 4 inches change?
5. **Compare.** Trade swatches with a parent or sibling who crochets the same pattern with the same hook. Are your gauges the same?
6. **Count in and clean up.** Yarn needle and pins back in the cushion; yarn ends in the trash.
7. **Improve it.** If your stitches were uneven, make the hdc swatch again, keeping a steady tension, and compare the new gauge.

Tips

- Measure in the middle of the swatch, never at the edges, which are always a little uneven.
- Wash and dry a wool swatch the way you will wash the finished hat before measuring it for a careful project; wool can grow or shrink a little.
- Younger students: make the sc and dc swatches only. Older students: add a treble crochet swatch (chain 24, tr in the fifth chain from the hook, ch 4 to turn) and find how many sc rows equal one tr row.

Check your work

- ☐ I can work sc, hdc and dc with the right turning chain for each.
- ☐ I measured stitches and rows per 4 inches accurately on three swatches.
- ☐ I used my gauge to figure the starting stitch count for a hat for a real person.

SEWING NOTEBOOK

1. Tape in your three swatches with their gauge tags.
2. Draw the four stitches side by side (sc, hdc, dc, tr) to show their heights, with the number of yarn-overs each needs.
3. Write your hat plan with every step of the math shown.

From history. Crocheted lace “collars” and “cuffs” were sewn on and taken off dresses so they could be washed separately. Irish crochet was so admired that it was sold across Europe and America, and pieces made by Irish women in the 1800s are kept today in museums in Dublin, London and New York.

COMMON MISTAKES

- Skipping the swatch and starting the hat. The hat comes out a size too big or too small. Swatch first.
- Measuring a swatch while stretching it, or at its edges. Lay it flat and measure the middle.
- Forgetting that the turning chain may or may not count as a stitch. Read the pattern; count your stitches every row.

Make it a game • Gauge Detective. Your parent crochets or knits a few rows with an unknown hook or needle (or picks a finished item from the house). You measure its stitches per inch and guess what size hook or needle and what yarn weight made it. Then your parent tells you. Close guesses score a point; exact ones score two. Switch roles.

5.2 WORKING IN THE ROUND

OBJECTIVES

- Tell what historians know and do not know about where crochet began, and why some old stories are legends.
- Start a circle with an adjustable ring and explain why a flat circle of sc increases by six stitches each round.
- Crochet a set of round coasters (or a small lamb for a Nativity set) in the round.

Warm-up. Draw three circles on paper, one inside the other, 1 inch, 2 inches and 3 inches across. Lay a string around each and measure it. How much longer is each circle than the one inside it? Is the difference the same each time?

WATCH

[SO EASY!] How to Crochet the Magic Ring / Magic Loop - CROCHET BITES 01

TL Yarn Crafts · 2:52

<https://www.youtube.com/watch?v=5uN9TQID6gU>

WHEN TO WATCH

Before Session 2. Watch once, then again with your yarn and hook, pausing after she wraps the ring and after she pulls it closed.

Note: A crochet teacher shows the adjustable ring close up and finishes a small round motif.

BACKUP VIDEO

How to Crochet Little Sheep for the Nativity: Create Easy and Beautiful Animals | GretaWings

GretaWings DIY · 38:52

<https://www.youtube.com/watch?v=9tc75LB7CjA>

Only if you choose the lamb option. It is long; watch one body part at a time as you crochet it.

KEY TERMS

working in the round

Crocheting in circles around a center instead of back and forth in rows.

adjustable ring

A loop of yarn worked into and then pulled tight, so the center of a circle closes with no hole. Many patterns and videos call it a “magic ring.”

increase (inc)

Two stitches worked into the same stitch, adding one stitch to the round.

decrease (sc2tog)

Two stitches worked together into one, taking away one stitch.

amigurumi

A Japanese word for small stuffed animals or dolls crocheted or knitted in tight rounds.

CORE IDEAS

The story. Where did crochet come from? The honest answer is that no one knows for sure. The word is French for “little hook.” Old books sometimes said that nuns in the Middle Ages invented it, or that it came from Arabia, China or South America, but these are legends: no one has found clear proof of crochet as we know it from before about 1800. What historians have found is that in the 1820s, 1830s and 1840s, European magazines and little pattern books began printing instructions for crochet, and it spread quickly because it needed only one cheap tool and a ball of thread. It is a good lesson in history: a story repeated many times is not the same as a fact proved by evidence.

How they figured it out. Crocheters soon discovered that crochet works beautifully in the round. Start a few stitches into a ring, work around and around, and add stitches as you go, and you make a flat circle: a coaster, a rug, the top of a hat. But how many stitches should you add? Too few and the circle cups up into a bowl. Too many and it ruffles like a skirt. Experienced crocheters found a simple rule for single crochet: **start with 6 stitches and add 6 more every round:** 6, 12, 18, 24, 30, 36. Stop adding stitches and the sides go straight up into a tube; take stitches away and the tube closes. With those three moves, increase, work even and decrease, you can shape a ball, a hat or a little stuffed lamb.

The fabric science. Why six? Each round of single crochet adds about one stitch-height to the circle's radius. The circumference of a circle is $2 \times \pi \times \text{radius}$, so each round makes the edge about $2 \times 3.14 \approx 6.3$ stitch-heights longer. Because a single crochet is about as tall as it is wide, the edge needs about **6 more stitches** each round to lie flat. Double crochet is about twice as tall, so a flat dc circle usually adds **12 stitches** a round. To spread the increases evenly, each round has one more plain stitch between increases: round 3 is (1 sc, inc) $\times$ 6; round 4 is (2 sc, inc) $\times$ 6; round 5 is (3 sc, inc) $\times$ 6. Notice the pattern: in round n , there are $n - 2$ plain stitches between increases, and $6 \times n$ stitches in all.

Let's crochet. You will crochet a set of **four round coasters** in cotton yarn, about 4 inches across, starting each with an adjustable ring. Older students may instead (or also) crochet a small **lamb** for a Nativity set or a Christmas gift. The one skill to do well is **counting every round**: put a marker in the first stitch of each round and count your stitches before you start the next one.

PICTURE STUDY



Young Woman Crocheting at the Window, Rudolf Epp, before 1910 · Oil on canvas · Private collection

Image: [Wikimedia Commons](#), public domain

Rudolf Epp was a German painter who often showed the people of farmhouses and villages at their work. Here a young woman sits in the light of the only window to crochet. Look at how the painter leads your eye through the shadowy room straight to her hands.

Look closely

- Find her hands and the work in her lap. Which hand holds the hook?
- Look at the window, with its small panes, curtains and plants. How much light comes in?
- Find the stool, the cupboard and the floor. What do they tell you about this household?
- Look at the work. Is it a long strip, a round piece or something else?

Talk about it

1. Why would someone in this house crochet near the window rather than at the table in the middle of the room?
2. What might she be making? What would be most useful in a farmhouse like this?
3. How is your own crochet corner like hers, and how is it different?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including the yarn needle and stitch markers. If you make the lamb, use **safety eyes only for older children and adults**, or embroider the eyes with yarn for any toy that might be given to a child under three; small parts and loose stuffing are a choking hazard.

SEWING PROJECT

A Set of Round Coasters (or a Nativity Lamb)

You will crochet four flat, round coasters in cotton yarn, each from an adjustable ring, using the six-stitch rule. Together they make a gift set. If you choose, you may also crochet a small lamb in the round.

You will need

- A 4.5 or 5 mm (7 or H-8) crochet hook
- Stitch markers or bits of contrasting yarn
- A yarn needle (counted) and small scissors
- For the lamb option: a little polyester fiberfill and black embroidery floss or yarn for the face

SINGLE-CROCHET ROUND COASTERS

Finished size: Four coasters, each about 4 in (10 cm) across · About 30–40 minutes per coaster

Fabric and notions

- About 80 yards (73 m) of worsted-weight (#4) 100% cotton yarn, about 20 yards per coaster
- Two colors if you like: change color at the start of any round

How to make it

1. **Round 1:** make an adjustable ring. Ch 1 (does not count as a stitch). Work 6 sc into the ring. Pull the tail to close the ring. Place a marker in the first stitch. (6 sc)
2. **Round 2:** 2 sc in each stitch around. (12 sc)
3. **Round 3:** (1 sc, inc) around: that is, sc in the next stitch, then 2 sc in the next, six times. (18 sc)
4. **Round 4:** (2 sc, inc) around. (24 sc)
5. **Round 5:** (3 sc, inc) around. (30 sc)
6. **Round 6:** (4 sc, inc) around. (36 sc)
7. **Round 7:** (5 sc, inc) around. (42 sc) Move the marker up each round and count your stitches before you go on.
8. Slip stitch into the next stitch. Fasten off. Weave in the ends on the back with the yarn needle, going in three directions so they stay put.
9. Lay the coaster flat and measure it. If it cups, your next coaster needs a slightly looser tension or larger hook; if it ruffles, a tighter tension or smaller hook. Make three more.

Fabric check: Use 100% cotton yarn for coasters: cotton absorbs drips from a cold glass and is safe under a hot mug, while acrylic can melt under a very hot pot and does not soak up water. Worsted-weight cotton (the dishcloth kind) is ideal. For the lamb, use soft white wool or acrylic yarn and polyester fiberfill; since the lamb is a toy, not a hot pad, synthetics are fine.

Steps

1. **Count out** your yarn needle and markers.
2. **Practice first.** Make three adjustable rings with 6 sc and pull each closed until no hole shows. Then pull them out and use the yarn.
3. Make the coasters from the pattern card.
4. **Flat test.** After each round, lay the coaster on the table. Write down whether it lies flat, cups or ruffles.
5. **Math check.** Predict the stitch count for round 10 using the $6 \times n$ rule, and the diameter of a 10-round coaster if 7 rounds made 4 inches. Then check by crocheting it if you have yarn.
6. **Count in and clean up.** Yarn needle and markers in their place; trimmed ends in the trash.
7. **Improve it.** Make a matching double-crochet coaster that adds 12 stitches a round, and compare it with the sc coasters.

Tips

- Count stitches every round. One missed increase in round 3 shows up as a lump in round 7.
- To keep a circle round instead of hexagonal, move the increases a little each round: in round 5, for example, start with 1 sc, inc, then (3 sc, inc) five times, then 2 sc.
- **Lamb option** (older students): body: adjustable ring, 6 sc; work rounds of increases to 24 sc; work even 5 rounds; decrease (2 sc, sc2tog) around; stuff; decrease to close. Make a small head the same way to 18 sc, and four little legs of 6 sc worked for 4 rounds. Sew the parts together and embroider the face.

Check your work

- ☐ I can make an adjustable ring that closes with no hole.
- ☐ I can explain why sc circles add 6 stitches a round and dc circles about 12.

- ☐ My coasters lie flat and are all close to the same size.

SEWING NOTEBOOK

1. Draw a circle chart of rounds 1–7 with the stitch count of each round, and write the $6 \times n$ rule.
2. Draw three coasters: one flat, one cupped, one ruffled, and label why each happened.
3. Tape in one finished coaster or a photograph, with its diameter and yardage.

From history. Crocheters in the 1800s used fine steel hooks and cotton thread for lace, and thicker bone or wooden hooks for wool. The aluminum and plastic hooks most people use today came into common use in the 1900s.

COMMON MISTAKES

- Losing count of where the round starts. Always use a marker and move it up each round.
- Pulling the adjustable ring closed before the first round is complete. Work all 6 sc first, then close it.
- Believing every story you read about crochet's origin. Look for evidence; legends can be told as legends.

Make it a game • Round Count Race. Your parent calls out a round number for a flat single-crochet circle (say round 8). Race to say how many stitches it has ($6 \times$ the round number) and how many plain stitches go between increases (the round number minus 2). Then check by crocheting the first three rounds on time. Three correct answers in a row wins.

5.3 READING CHARTS: SYMBOLS AND THE GRANNY SQUARE

OBJECTIVES

- Read crochet symbols for chain, slip stitch, sc, hdc, dc and tr, and follow a round chart.
- Translate a symbol chart into a written pattern with standard abbreviations.
- Crochet four or more granny squares from a chart and join them into a blanket section, figuring the yarn for a full blanket.

Warm-up. Look at road signs, a map key or the symbols on a clothing care label. How can a picture tell you what to do without words? Now try to draw a little picture that means “single crochet” and one that means “double crochet.” What would make them easy to tell apart?

WATCH

HOW to READ CROCHET CHARTS and SYMBOLS by Naztazia

[naztazia](#) · 5:10

<https://www.youtube.com/watch?v=rRM5C7C2sFI>

WHEN TO WATCH

After “How they figured it out.” Watch with the Craft Yarn Council symbol page or the chart on your pattern card beside you, pausing at each symbol to find it on your chart.

Note: A crochet teacher shows each symbol and then works rows and rounds from a chart, hands only.

KEY TERMS

symbol chart

A drawing of a crochet pattern in which each stitch is shown by a symbol in the place it goes.

written pattern

The same instructions in words and abbreviations, such as “ch 3, 2 dc in ring, ch 2.”

chain space (ch-sp)

The gap made under a chain. Granny squares are built by working clusters of dc into chain spaces.

cluster

A group of stitches worked into the same place, such as the 3-dc groups of a granny square.

join as you go

Connecting a new square to a finished one by slip-stitching into its chain spaces during the last round.

CORE IDEAS

The story. For most of the 1800s and 1900s, crochet patterns in England and America were printed in words, with abbreviations to save space: “ch 3, 2 dc in ring, ch 2, 3 dc in ring.” But words only help people who read the same language. In Japan, crochet pattern books became famous for patterns drawn almost entirely in symbols, and crocheters around the world found they could make a Japanese design without knowing a word of Japanese. Today the **Craft Yarn Council**, the American yarn industry’s standards group, publishes a standard set of symbols and abbreviations, so that a chart drawn in one country can be read in another. A symbol chart is like a map: it shows not only what to do but where to do it.

How they figured it out. Chart symbols are drawn to look like the stitches. A **chain** is a small oval. A **slip stitch** is a dot. A **single crochet** is a plus sign or an X, short like the stitch. A **half double** is a T. A **double crochet** is a taller T with one slash across its stem, one slash for each yarn-over; a **treble** has two slashes. In a round chart, you begin at the center and read counterclockwise (for right-handed crocheters), round by round, the way you work. Rows are read from the bottom up, alternating right to left and left to right. Most charts number each round or row, and many color alternate rounds so they are easy to follow.

The fabric science. The granny square shows how geometry and crochet fit together. Its four corners each get **two clusters with a chain-2 space between**, so the square grows outward at each corner and stays flat and square. Along each side it gains one cluster per round. Now the blanket arithmetic. Suppose each finished square is 5 inches across and uses about 15 yards of yarn. A small lap blanket 40×50 inches needs $40 \div 5 = 8$ squares across and $50 \div 5 = 10$ squares down: **80 squares**. The yarn: $80 \times 15 = 1,200$ yards, plus

about 10% for joining and the border, about 1,320 yards. If a skein holds 220 yards, you need $1,320 \div 220 = 6$ skeins.

Let's crochet. You will crochet at least **four granny squares from a symbol chart**, then join them into a blanket section; the family can keep adding squares through the year toward a blanket for someone in need. The one skill to do well is **reading the chart round by round**: put your finger on the round you are working and say each symbol as you make it.

PICTURE STUDY



Girl Crocheting (Häkelndes Mädchen), Max Handrick, early 20th century · Watercolor over pencil · Private collection

Image: [Wikimedia Commons](#), public domain

This is a watercolor, painted quickly with transparent washes over a pencil drawing. The painter Max Handrick caught a girl pausing in her crochet and looking up, perhaps at someone who has just come into the room. Her hands still hold the hook and the work.

Look closely

- Find her hands. How does she hold the hook and the work while she pauses?

- Look at the size of the piece in her hands. Could it be a single square or a motif?
- Look at her pinafore and skirt. Which parts did the painter finish carefully, and which did he leave loose and sketchy?
- Look at her face. What do you think she is looking at?

Talk about it

1. When you stop crocheting partway through a round, how do you find your place again? How does a chart help?
2. Why might a painter choose the moment when someone stops working instead of the moment of working?
3. If many people each made a few squares, what could they make together?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including the yarn needle. Keep yarn balls and loose ends away from babies, toddlers and pets. Take a short break to stretch your hands and eyes every 20 minutes of chart reading.

SEWING PROJECT

Granny Squares from a Chart, Joined into a Blanket Section

You will work granny squares from a symbol chart, write the same pattern out in words, and join your squares into a section that can grow into a blanket to give away.

You will need

- A 5 mm (H-8) crochet hook
- A yarn needle (counted) and small scissors
- Stitch markers, a ruler and a calculator
- The chart below drawn by hand (or printed from the Craft Yarn Council symbols page) on graph paper

CLASSIC FOUR-ROUND GRANNY SQUARE

Finished size: Four or more squares, each about 5 in (13 cm) across, joined into a 10 × 10 in (or larger) section ·
About 30–40 minutes per square, plus joining

Fabric and notions

- About 15 yards (14 m) of worsted-weight (#4) yarn per square, in two to four colors
- Extra yarn of one color for joining, about 10 yards

How to make it

1. **Draw the chart.** In the center, a ring. Round 1: a chain of 3 (counts as dc) and 2 dc, then three more groups of 3 dc around the ring, with ch 2 (two ovals) between groups. Rounds 2–4: in each corner space, two groups of 3 dc with ch 2 between; along the sides, one group of 3 dc in each side space with ch 1 between.
2. **Round 1:** adjustable ring (or ch 4, sl st to join). Ch 3, 2 dc in ring, ch 2. (3 dc in ring, ch 2) three times. Sl st to top of the first ch-3. Pull the ring closed. (4 clusters)
3. **Round 2:** sl st into the next 2 dc and into the corner ch-2 space. Ch 3, (2 dc, ch 2, 3 dc) in the same space. Ch 1. *(3 dc, ch 2, 3 dc) in the next corner space, ch 1; repeat from * twice. Sl st to the top of the ch-3. (8 clusters)
4. **Round 3:** change color if you like by joining the new yarn in any corner space. Ch 3, (2 dc, ch 2, 3 dc) in the same corner. *Ch 1, 3 dc in the side ch-1 space, ch 1, (3 dc, ch 2, 3 dc) in the next corner; repeat from * twice, ch 1, 3 dc in the last side space, ch 1, sl st to join. (12 clusters)
5. **Round 4:** same as round 3, with 2 side clusters on each side. (16 clusters)
Fasten off and weave in ends.
6. **Write it out:** in your notebook, translate your chart into a full written pattern with standard abbreviations, round by round.
7. Make at least three more squares the same size.
8. **Join:** lay two squares right sides together. With the joining yarn and the yarn needle, whipstitch through the back loops of the matching stitches along one side. Join squares into a 2 × 2 block, then work one round of sc around the whole block, with 3 sc in each corner.

Fabric check: Worsted-weight acrylic is ideal for a blanket that will be washed often and given away: it is soft, warm, colorfast and machine-washable. Wool blends are warmer but need gentle washing. Use the same weight of yarn for every square so they come out the same size. Smooth yarn shows the clusters clearly; avoid fuzzy novelty yarns for a first chart.

Steps

1. **Count out** your yarn needle and markers.
2. **Practice first.** Read the chart aloud round by round with your finger, saying each stitch, before picking up the hook.
3. Make and join the squares from the pattern card.
4. **Size test.** Measure each finished square. Do they match within $\frac{1}{4}$ inch? If not, which round is different?
5. **Blanket plan.** Measure one square and the yarn it used (unravel a test square and measure, or weigh: grams of one square $\div$ grams per skein $\times$ yards per skein). Figure the squares and skeins for a 36×48 inch blanket.
6. **Count in and clean up.** Yarn needle back in the cushion, ends trimmed and in the trash.
7. **Improve it.** Draw a chart for a five-round square and crochet it from your own chart.

Tips

- Count the clusters on each side at the end of every round: round 3 has 2 per side between corners plus the corners.
- Weave in ends as you go, after each square, rather than leaving dozens for the end.
- Younger students: make two squares and join them. Older students: learn “join as you go” and attach each new square during its last round.

Check your work

- ☐ I can read the symbols for ch, sl st, sc, hdc, dc and tr and follow a round chart.
- ☐ I translated a chart into a written pattern with correct abbreviations.
- ☐ My squares match in size and are joined neatly, and I figured the yarn for a full blanket.

SEWING NOTEBOOK

1. Draw the symbol key: ch, sl st, sc, hdc, dc, tr, with each abbreviation beside it.
2. Draw your granny-square chart and, beside it, the written pattern.
3. Write the blanket plan: size, squares across and down, total squares, yards, skeins.

From history. Granny squares were being made in the late 1800s, and in hard times many families pieced blankets from leftover yarn, a few squares at a time. Because each square is small, a whole church group or family can work on one blanket together.

COMMON MISTAKES

- Reading a round chart in the wrong direction. Right-handed crocheters read counterclockwise; left-handed, clockwise.
- Working the side clusters into the tops of the stitches instead of into the chain spaces. The square buckles. Look for the spaces.
- Forgetting the ch 2 in the corners. The square curls instead of lying flat.

Make it a game • Symbol Speed Read. Your parent draws ten crochet symbols on cards (ch, sl st, sc, hdc, dc, tr, and a few groups like 3 dc in one space). Flip them one by one. Say the name and abbreviation as fast as you can. Then race again, this time crocheting each one on a practice chain. Beat your own time to win.

5.4 CROCHET FOR OTHERS: DORCAS AND THE WARM HAT

OBJECTIVES

- Tell the story of Dorcas (Acts 9:36-39) and how her garments showed her love for the widows of Joppa.
- Size a hat from gauge and head measurements, and figure the diameter of a flat crown from its circumference.
- Crochet a hat in the round and give it to someone who needs one.

Warm-up. Measure around three heads in your family (with permission), just above the ears and across the forehead. Write the numbers down for fit only. Now look at a hat that fits someone well. Measure it around without stretching. How much smaller is the hat than the head?

WATCH

30 Minute Crochet Beanie for Beginners | Quick Easy Pattern

Sigoni Macaroni · 9:19

<https://www.youtube.com/watch?v=vPqvRbaIW0>

WHEN TO WATCH

Before Session 2. She makes a quick hat in super bulky yarn in the round from the top down. Your hat uses worsted yarn and your own stitch count, but the method is the same: increase until the crown is the right size, then work even.

Note: A crochet designer's quick, clear tutorial with captions for each round.

BACKUP VIDEO

HOW TO CROCHET THE EASIEST HAT EVER | Beginners Crochet Hat | Adult Unisex Hat | Crochet Ribbed Hat

JMCrochet · 9:55

<https://www.youtube.com/watch?v=fclihHsYBF8>

If you would rather make a hat without increasing in the round: a ribbed rectangle sewn into a tube and gathered at the top.

KEY TERMS

crown

The top of a hat. A crocheted crown is a flat circle worked in increasing rounds.

work even

Crocheting rounds with no increases or decreases, so the sides go straight down.

negative ease

Making a hat a little smaller than the head, usually 1 to 2 inches, so the stretchy fabric holds snugly.

brim

The bottom band of a hat, often worked in a firmer stitch or ribbing so it holds snugly.

Tabitha (Dorcas)

A disciple in Joppa “full of good works and almsdeeds” (Acts 9:36). Tabitha is her Aramaic name and Dorcas her Greek name; both mean “gazelle.”

CORE IDEAS

The story. In the town of Joppa, on the coast of Israel, lived a woman named Tabitha, called in Greek **Dorcas**. Acts tells us she was “full of good works and almsdeeds which she did” (Acts 9:36). When she fell sick and died, the believers sent for the apostle Peter. When he came, “all the widows stood by him weeping, and shewing the coats and garments which Dorcas made, while she was with them” (Acts 9:39). Her love had taken the form of real clothing for real people. Peter knelt and prayed, and God raised her to life. For centuries since, church sewing groups called “Dorcas societies” have met to make clothes and blankets for the poor, and many still do.

How they figured it out. Making for others takes thought as well as skill. Dorcas made coats and garments that the widows could wear and that would last. Crocheters who give hats today ask the same questions. Who will wear this hat: a child, a grown man, a newborn? What will keep them warm and comfortable? Can it be washed easily? Many hospitals, shelters, crisis pregnancy centers and missions gladly accept warm hats, but many have rules, such as machine-washable yarn, no pom-poms on baby hats, or certain sizes, so a wise giver asks first. Then the maker uses gauge and measurement to make it fit, so the gift is truly useful.

The fabric science. A top-down crocheted hat starts as a flat circle (the crown) and, once the circle is wide enough, stops increasing and works even so the sides go straight down. How wide must the crown be? Its circumference should equal the hat's finished size. For a child's hat of 18 inches around: $\text{diameter} = \text{circumference} \div \pi = 18 \div 3.14 \approx 5.7$ inches. For an adult hat of 20 inches: $20 \div 3.14 \approx 6.4$ inches. Stitch count: with a gauge of 3.5 hdc per inch, a 20-inch hat needs $3.5 \times 20 = 70$ stitches around. In a flat hdc circle that adds 10 stitches a round (hdc is about $1\frac{1}{2}$ times as tall as wide, so roughly $6 \times 1.5 \approx 9$ to 10), the rounds go 10, 20, 30, 40, 50, 60, 70: seven rounds. Then work even until the hat is $7\frac{1}{2}$ to 8 inches from the top for an adult, or about 7 inches for a child.

Let's crochet. You will crochet a **warm hat** sized for a real person or for the place that will receive it, and give it away with a short note. The one skill to do well is **measuring as you go**: lay the crown flat and measure it before you stop increasing.

PICTURE STUDY



Girls Crocheting in Knokke, Max Schlichting, 1892 · Oil on canvas · Private collection

Image: [Wikimedia Commons](#), public domain

The German painter Max Schlichting painted these two girls in the village of Knokke, on the coast of Belgium, in 1892. They work outdoors on a summer day, the

older one standing, the younger one sitting in the grass with bright red yarn. Children like these often crocheted and knitted useful things for their own families and neighbors.

Look closely

- Find the red work in the younger girl's lap. What might it become?
- Find the older girl's hands. Is she crocheting, knitting or doing something else?
- Look at the orchard, the house and the light. What season is it?
- Look at the distance between the two girls. Is one teaching the other?

Talk about it

1. Why might two sisters or friends crochet together outdoors?
2. Who in your life could use something warm that you could make?
3. What does it mean to make something for someone else rather than for yourself?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including the yarn needle. Ask before measuring anyone's head, and write measurements down for fit only. For hats meant for babies, follow the receiving hospital's or center's rules: soft machine-washable yarn, no pom-poms, buttons or loose ties, which can be choking or strangling hazards.

SEWING PROJECT

A Warm Crocheted Hat to Give Away

You will crochet a hat from the top down in half double crochet, sized by your own gauge from Lesson 5.1, and give it to someone who needs it, along with a short note.

You will need

- A 5 mm (H-8) crochet hook (or the hook that gave you your gauge)
- Stitch markers, a yarn needle (counted) and small scissors
- A tape measure, a calculator and your gauge notes from Lesson 5.1

TOP-DOWN HALF-DOUBLE-CROCHET HAT

Finished size: Adult size about 20 in (51 cm) around and 8 in (20 cm) tall; child size about 18 in around and 7 in tall ·
About 3–4 hours over two sessions and the week

Fabric and notions

- About 150–200 yards (137–183 m) of worsted-weight (#4) yarn: soft acrylic or a machine-washable wool blend
- Written plan: your gauge in hdc per inch, the hat size, the crown diameter and the stitch count

How to make it

1. **Round 1:** make an adjustable ring. Ch 2 (does not count as a stitch). Work 10 hdc in the ring. Sl st to the first hdc to join. Pull the ring closed. Place a marker. (10)
2. **Round 2:** ch 2, 2 hdc in each stitch around. Join. (20)
3. **Round 3:** ch 2, (hdc, inc) around. Join. (30)
4. **Round 4:** ch 2, (2 hdc, inc) around. Join. (40)
5. **Rounds 5–7:** keep adding one more plain stitch between increases each round: (3 hdc, inc), (4 hdc, inc), (5 hdc, inc). (50, 60, 70) Stop at the round closest to your planned stitch count.
6. Lay the crown flat and measure across. It should be close to your planned diameter (for example 6.4 inches for a 20-inch hat). If it is too small, add another increase round; if too big, take out a round.
7. **Work even:** ch 2, hdc in each stitch around, join. Repeat until the hat measures 7 inches from the top for an adult (6 for a child).
8. **Brim:** work 3 or 4 rounds of sc (ch 1, sc in each stitch, join), which pulls the edge in a little and makes it snug.
9. Fasten off and weave in all ends securely. Try it on the intended person, or measure it against your plan.

Fabric check: Choose a soft, warm, machine-washable yarn: acrylic, or a superwash wool blend. Many charities ask for washable yarn because hats go through hot laundries. Avoid scratchy wool for someone with sensitive skin, and avoid fuzzy novelty yarns for baby hats, which can shed. Use a darker or medium color for hats for adults; it hides wear.

Steps

1. **Count out your yarn needle and markers.**

2. **Ask first.** With a parent, contact the place that will receive your hat (a shelter, a crisis pregnancy center, a hospital, a mission or a neighbor) and write down its rules and the sizes it needs.
3. **Do the math.** Write the hat size, the crown diameter ($\text{circumference} \div 3.14$) and the stitch count ($\text{stitches per inch} \times \text{circumference}$) before you begin.
4. Crochet the hat from the pattern card.
5. **Fit check.** Measure the hat flat and stretched. Is it 1 to 2 inches smaller than the head size (or the size requested)?
6. **Give it.** Wash it if the charity asks, attach a note with the fiber and care (“Machine wash cool”), and give it in person if you can.
7. **Count in and clean up.** Yarn needle and markers counted in; ends trimmed and thrown away.

Tips

- Use a marker in the first stitch of every round; hats in the round love to lose their beginnings.
- If your gauge is 3 stitches per inch, use the same rounds but stop at 60; if 4 per inch, continue to 80 (add a round of (7 hdc, inc)).
- Younger students: make the child size. Older students: make two hats, an adult and a child size, and add a round of front-post/back-post ribbing for the brim.

Check your work

- ☐ I figured my hat’s stitch count and crown diameter from gauge and measurements.
- ☐ My crown lies flat, my sides are straight, and the hat fits the size I planned.
- ☐ I asked the receiving place’s rules and gave the hat away with a note.

SEWING NOTEBOOK

1. Write your full hat plan: head size, finished size, gauge, crown diameter, stitch count, rounds.
2. Copy Acts 9:39 and write who received your hat and one sentence about why you made it.
3. Draw the hat from the side and from the top, with measurements.

From history. In the 1800s, women in many English and American churches organized “Dorcas societies” that met to sew, knit and mend clothing for the poor. The name came straight from Acts 9, and some of these groups have met for well over a hundred years.

COMMON MISTAKES

- Making the hat exactly the size of the head. It slides down over the eyes. Use 1 to 2 inches of negative ease.
- Increasing too long, so the crown ruffles, or too short, so it is a cone. Measure the crown flat.
- Giving without asking. A gift the receiver cannot use is not much help. Ask what is needed first.

Make it a game • Hat Math Race. Your parent names a person (Grandpa, a baby, a cousin) and a head size. You race to figure the finished hat size, the crown diameter and the stitch count at 3.5 stitches per inch. Check each other’s math with the calculator. Each correct answer scores a point; first to five wins and picks whose hat to make next.

Scripture. “and all the widows stood by him weeping, and shewing the coats and garments which Dorcas made, while she was with them.” (Acts 9:39, KJV)

The widows did not show Peter a list of Dorcas’s kind words; they showed him the clothes she had made. Love can be measured in stitches.

UNIT 5 REVIEW

Answer in complete sentences unless the question asks for a calculation or a show-me. For calculations, show every step; a right answer with no work earns half. The review is worth 100 points.

1. (8 pts)

Put these stitches in order from shortest to tallest and give the usual turning chain for each: dc, sc, tr, hdc.

2. (8 pts)

What is gauge, and what should you do if your swatch has more stitches per 4 inches than the pattern asks for? Fewer?

3. (10 pts)

Calculate. Your swatch has 13 hdc in 4 inches. You are making a hat for a head 22 inches around with $1\frac{1}{2}$ inches of negative ease. How many stitches do you need? Round to the nearest multiple of 10.

4. (8 pts)

Written answer. In four or five sentences, tell how crochet helped Irish families during the famine of the 1840s.

5. (8 pts)

Why does a flat circle of single crochet add about 6 stitches each round? What happens if you add fewer? More?

6. (8 pts)

Calculate. In a flat sc circle that starts with 6 stitches and adds 6 every round, how many stitches are in round 9? How many plain stitches come between increases in that round?

7. (8 pts)

Show me. Make an adjustable ring with 6 sc, close it with no hole, and work round 2 while your parent watches.

8. **8 pts**

Draw or describe the chart symbols for chain, slip stitch, sc, hdc, dc and tr.

9. **10 pts**

Calculate. Granny squares are 6 inches across and each uses 20 yards. How many squares are needed for a blanket 42×54 inches? How many yards, adding 10% for joining and border? How many 200-yard skeins?

10. **8 pts**

Calculate. A hat must be 19 inches around. What should the diameter of its flat crown be (round to one decimal)?

11. **8 pts**

Written answer. What does Acts 9:39 tell us about Dorcas? Name two things a careful maker asks before crocheting a hat to give away.

12. **8 pts**

What do historians know, and not know, about where crochet came from? Why should a legend be told as a legend?

UNIT CHALLENGE: THE CROCHET SET: SWATCHES, SQUARES AND A GIFT

Show the unit's crochet: your three gauge swatches with their tags, your set of coasters (or lamb), your joined granny squares, and a photograph of the hat you gave away, with your hat plan.

On a notebook page, write one of your patterns completely in both forms, as a symbol chart and as a written pattern with abbreviations, and record what each piece taught you about gauge and counting.

LOOK FOR	WHAT IT MEANS
The arithmetic	Gauge, stitch counts, crown diameter and blanket yardage figured correctly with the work shown.
Workmanship	Even tension; circles lie flat; squares match in size; the hat fits its intended size; ends woven in securely.
Pattern reading	One pattern correctly written both as a chart and in standard abbreviations.

LOOK FOR	WHAT IT MEANS
Giving	The receiving place's rules were asked and followed, and the hat was given with a note.
Record and improvement	Swatches tagged; flat-test notes kept; one piece remade better with the change noted. A crooked first try honestly recorded and redone earns full credit.

ANSWER KEY

1. sc (ch 1), hdc (ch 2), dc (ch 3), tr (ch 4).
2. Gauge is the number of stitches and rows in a measured space, usually 4 inches. More stitches than the pattern means your stitches are too small: use a larger hook. Fewer stitches means they are too big: use a smaller hook.
3. Stitches per inch: $13 \div 4 = 3.25$. Hat size: $22 - 1\frac{1}{2} = 20\frac{1}{2}$ inches. $3.25 \times 20.5 = 66.6$ stitches. Nearest multiple of 10: 70 (or 60 is too small), so 70 stitches.
4. When the potato crop failed from 1845, many poor Irish families lost their main food, and about a million people died. Fine lace was valuable, and crocheters learned to imitate costly needle lace with fine thread and a small hook. Teachers such as nuns in convent schools and Cassandra Hand in Clones taught women and girls the craft. Merchants sold the lace in Dublin, London and beyond, and the money helped families buy food. Irish crochet became famous and is still made today.
5. Each round adds about one stitch-height to the radius, and circumference = $2 \times \pi \times$ radius, so the edge grows by about $2 \times 3.14 \approx 6.3$ stitch-heights; since sc is about as wide as it is tall, about 6 more stitches are needed. Fewer increases make the circle cup into a bowl; more make it ruffle.
6. $6 \times 9 = 54$ stitches. Plain stitches between increases: $9 - 2 = 7$, so the round is (7 sc, inc) six times.
7. Parent checks: 6 sc worked into the ring before closing; the center closes with no hole; round 2 has 12 sc with 2 in each stitch; a marker shows the first stitch.
8. Chain: small oval. Slip stitch: dot (or small filled oval). sc: plus sign or X. hdc: T. dc: tall T with one slash across the stem. tr: tall T with two slashes.
9. $42 \div 6 = 7$ across; $54 \div 6 = 9$ down; $7 \times 9 = 63$ squares. $63 \times 20 = 1,260$ yards; plus 10% (126) = 1,386 yards. $1,386 \div 200 = 6.93$, so 7 skeins.
10. Diameter = circumference $\div \pi = 19 \div 3.14 \approx 6.1$ inches.
11. The widows showed Peter the coats and garments Dorcas had made while she was with them; her love took the form of real, useful clothing. A careful maker asks who will wear it (size and age), what the receiving place needs or allows (washable yarn, no pom-poms on baby hats, sizes), and makes it fit by gauge and measurement.
12. The word is French for “little hook.” No one has found clear evidence of crochet as we know it from before about 1800; patterns began appearing in European magazines in the 1820s–1840s. Stories that medieval nuns invented it, or that it came from a particular far-off land, are unproved legends. A legend should be told as a

legend because truth matters: a story repeated many times is not the same as a fact proved by evidence.

KNITTING

In Fabrics & Sewing I you learned to cast on, knit, purl and bind off, and you met William Lee and his stocking frame. This year you will put knit and purl together into ribbing, knit in the round on circular needles, and learn to work with gauge so you can change a pattern to fit a different yarn or a different person.

You will meet Jedediah Strutt, whose ribbing machine made his fortune (and whose mill trained Samuel Slater), the schoolchildren who knitted socks for soldiers in 1917 and 1918, the knitting teacher Elizabeth Zimmermann, who taught knitters to make their own patterns from arithmetic, and the framework knitters of Nottingham. By the end of the unit you will have knitted a ribbed cowl, a hat in the round, and a headband resized for a different yarn, and you will have finished and blocked your hat like a professional.

PREREQUISITES

- Can cast on, knit, purl and bind off on straight needles (Fabrics & Sewing I, or practice before Lesson 6.1)
- Can read the knitting abbreviations k, p, st, k2tog and rep
- Can measure gauge (Lesson 5.1) and multiply and divide decimals

MASTERY CHECKLIST

- ☐ I can knit k1p1 and k2p2 ribbing and explain why ribbing stretches and pulls in.
- ☐ I can knit in the round on a 16-inch circular needle without twisting the cast-on, and decrease for a crown.
- ☐ I can measure knitting gauge and use it to figure cast-on numbers and to resize a pattern for a different yarn.
- ☐ I can name the Craft Yarn Council's yarn weights and tell which needle sizes go with them.
- ☐ I can tell how William Lee's stocking frame (1589) led to modern knitting machines.
- ☐ I can finish a knitted piece: weave in ends and wet-block it.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **Craft Yarn Council: Standard Yarn Weight System**: Free. A chart of yarn weights 0–7 with the usual gauge ranges and needle and hook sizes for each.
- **A 16-inch US 8 (5 mm) circular needle and a set of US 8 double-pointed needles**: For the hat in Lessons 6.2 and 6.4. The double-pointed needles (or a long circular needle for the long-circular method) are needed for the top of the crown.
- **Stitch markers, a yarn needle and blocking pins**: Ring markers (one in a different color for the beginning of the round), a large-eye yarn needle for weaving in ends, and rust-proof pins for blocking.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

6.1 Knit and Purl Together: Ribbing	2 sessions of 50–60 minutes
6.2 Knitting in the Round: A Hat on Circular Needles	2 sessions of 60–90 minutes
6.3 Gauge, Yarn Weight and Pattern Math	2 sessions of 50–60 minutes
6.4 Lee’s Stocking Frame to the Knitting Machine	2 sessions of 60–90 minutes

6.1 KNIT AND PURL TOGETHER: RIBBING

OBJECTIVES

- Tell how Jedediah Strutt’s “Derby rib” machine (1759) made ribbed stockings by machine.
- Knit k1p1 and k2p2 ribbing and explain why ribbing is stretchy.
- Figure a cast-on for a ribbed cowl that is a multiple of the rib pattern, and knit the cowl.

Warm-up. Find the cuffs of a sweatshirt, the top of a sock and the bottom of a knitted sweater. Stretch each one and let go. What happens? Look closely with a magnifier: can you see columns that stand up and columns that sink down? Count how many columns are in each “up” group.

WATCH

2x2 Rib Stitch Knitting Pattern for Beginners (2 Row Repeat)

Studio Knit · 2:34

<https://www.youtube.com/watch?v=GLkVP77eg0c>

WHEN TO WATCH

Before Session 2. Watch once, then knit along with your swatch, pausing each time she moves the yarn between the needles from back to front or front to back.

Note: Hands only, with the pattern written on screen.

BACKUP VIDEO

How to Do a 2x2 Ribbing in the Round | Circular Knitting

Howcast · 3:55

<https://www.youtube.com/watch?v=A3IUfb5BFTg>

If you knit your cowl in the round, or before Lesson 6.2: a knitting teacher shows k2p2 rib on a circular needle.

KEY TERMS

ribbing

Knitting in which columns of knit stitches alternate with columns of purl stitches, such as k1p1 or k2p2. It is very stretchy and pulls in.

multiple

The number of stitches one repeat of a pattern takes. A cast-on must be a multiple of it (plus any extra edge stitches) for the pattern to come out even.

mattress stitch

An invisible seam for joining knitted edges, worked by catching the bars between stitches on each side in turn.

k2p2

Knit 2, purl 2, repeated across. Worked over a multiple of 4 stitches (plus 2 on flat pieces, to make both edges match).

stockinette

Knit every stitch on the right side and purl every stitch on the wrong side (or knit every round in the round). Smooth Vs on the front; it curls at the edges.

CORE IDEAS

The story. In the 1700s, gentlemen and ladies wore knitted stockings, and most were made on **stocking frames**, machines descended from William Lee's invention of 1589. But a stocking frame could make only plain knitting, with all the stitches facing one way. Ribbed stockings, which hugged the leg and stayed up, still had to be made by hand or with slow tricks. In Derbyshire, England, a farmer's son named **Jedediah Strutt**, working with his brother-in-law, a hosier, worked out an attachment, a second row of needles set at right angles to the first, that could make purl stitches between the knit ones. He patented his "**Derby rib**" machine in 1759. Ribbed stockings could now be made quickly and cheaply, and Strutt grew prosperous. He became Richard Arkwright's partner and built cotton mills at Belper, where a young apprentice named **Samuel Slater** learned the trade before carrying it to America (Lesson 2.1).

How they figured it out. Strutt understood what every hand knitter knows: a **purl** stitch is simply the back of a knit stitch. On the front of a knit stitch you see a V; on the front of a purl stitch you see a little bump. If you put knit and purl stitches side by side in the same row, and then on the next row knit the knits and purl the purls, the knit stitches

stack into columns that stand forward, and the purl stitches stack into columns that sink back. That is **ribbing**. Hand knitters do it by moving the yarn to the front before each purl and to the back before each knit; Strutt's machine did it with its second bed of needles.

The fabric science. Ribbing is stretchy because of its shape. The knit columns and purl columns lie on different levels, so at rest the fabric folds like an accordion and the purl columns hide behind the knit ones. Pull it sideways and it opens flat; let go and it springs back. That is why ribbing is used for cuffs, collars, waistbands and hat brims. It also pulls in: a ribbed piece is narrower than stockinette with the same number of stitches. Ribbing arithmetic: k2p2 needs a multiple of 4. For a cowl knit flat with gauge of 5 stitches per inch in relaxed ribbing, a cowl 24 inches around needs $5 \times 24 = 120$ stitches. Is 120 a multiple of 4? Yes: $120 \div 4 = 30$ repeats. Knitting flat, add 2 so both edges begin and end with k2: cast on **122**.

Let's knit. You will knit a **ribbed cowl** in k2p2, knit flat and seamed with mattress stitch, or knit in the round if you are ready. The one skill to do well is **reading your knitting**: look at each stitch on the left needle; if it shows a V, knit it, and if it shows a bump, purl it.

PICTURE STUDY



The Knitting Girl, William-Adolphe Bouguereau, 1884 · Oil on canvas · Private collection

Image: [Wikimedia Commons](#), public domain

The French painter William-Adolphe Bouguereau often painted country children of Brittany and the south of France with careful, lifelike detail. This girl sits on a wall in the open air, knitting as she watches over something, perhaps animals or the family's washing. Many country children knitted whenever their hands were otherwise free.

Look closely

- Find her needles and the dark yarn. How many needles can you see?
- Look at how she holds her hands and the yarn. Is she looking at her work?
- Look at her clothes: the blouse, the laced bodice, the skirt. Which might have been knitted, woven or sewn?
- Look at the bucket and the landscape. What work might she be doing besides knitting?

Talk about it

1. Experienced knitters can knit without looking. How does the feel of knit and purl stitches help?
2. Why might a country girl in the 1880s knit stockings instead of buying them?
3. Where do you like to knit, and why?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including the yarn needle. Knitting needles are pointed: carry them points down in a bag or case, never in a pocket, and do not leave them on chairs where someone could sit on them. Keep yarn away from babies, toddlers and pets.

SEWING PROJECT

A Ribbed Cowl

You will knit a warm, stretchy cowl in k2p2 ribbing, figuring your cast-on from your own gauge, and seam it with an invisible mattress stitch.

You will need

- US 8 (5 mm) straight needles, or a 24-inch circular needle used flat
- A yarn needle (counted), scissors and stitch markers
- A tape measure and a calculator

K2P2 RIBBED COWL

Finished size: About 24 in (61 cm) around and 8 in (20 cm) tall, relaxed · About 5–7 hours over the week

Fabric and notions

- About 180–220 yards (165–200 m) of worsted-weight (#4) wool or wool-blend yarn
- Your gauge in k2p2 rib, measured relaxed, from a 4-inch swatch

How to make it

1. **Swatch:** cast on 22 stitches. Row 1: k2, *p2, k2; repeat from * to the end. Row 2: p2, *k2, p2; repeat from *. Repeat these two rows for 4 inches. Lay flat without stretching and measure stitches per inch.

2. **Figure the cast-on:** stitches per inch $\times$ 24, rounded to the nearest multiple of 4, plus 2. (At 5 stitches per inch: $120 + 2 = 122$.)
3. Cast on loosely with the long-tail cast-on.
4. **Row 1 (right side):** k2, *p2, k2; repeat from * to the end.
5. **Row 2:** p2, *k2, p2; repeat from * to the end.
6. Repeat rows 1 and 2 until the piece measures 8 inches. Count your stitches every few inches.
7. Bind off loosely in pattern: knit the knits and purl the purls as you bind off, so the edge stays stretchy.
8. Fold the piece so the two short ends meet, right side out. Sew them together with mattress stitch, catching one bar on each side in turn and gently pulling the yarn to close the seam.
9. Weave in all ends on the inside, through the purl columns, so they cannot be seen.

Fabric check: Use a smooth, light-colored worsted wool or wool blend so the knit and purl columns show clearly and the ribbing springs back; wool's crimp makes ribbing especially elastic. Acrylic works and is washable but is less springy. Avoid cotton for ribbing (it stretches out and stays stretched) and fuzzy yarns (they hide the stitches). For a wool-sensitive person, use a soft acrylic or merino superwash.

Steps

1. **Count out** needles and the yarn needle.
2. **Practice first.** Knit 6 rows of k1p1 and 6 rows of k2p2 on your swatch. Which looks neater? Which stretches more?
3. Knit the cowl from the pattern card.
4. **Stretch test.** Measure the cowl relaxed and stretched as far as it comfortably goes. By what percent does it stretch? $(\text{stretched} - \text{relaxed}) \div \text{relaxed} \times 100$.
5. **Compare.** Knit 10 rows of stockinette on your swatch with the same number of stitches. Measure its width against the ribbing. How much does the ribbing pull in?
6. **Count in and clean up.** Needles in their case, yarn needle in the cushion, ends trimmed and thrown away.
7. **Improve it.** Make a second cowl in k1p1 or in a different yarn as a gift.

Tips

- When you change from knit to purl, the yarn goes between the needles to the front; from purl to knit, between the needles to the back. Not over the needle: that makes an extra stitch.
- Bind off with a needle one or two sizes larger if your bind-off is tight.
- Younger students: knit a 6-inch-tall cowl or a pair of ribbed wrist warmers. Older students: knit the cowl in the round on a 16-inch circular needle, casting on a multiple of 4 with no extra 2.

Check your work

- ☐ I can read my stitches and knit the knits and purl the purls.
- ☐ I figured my cast-on from gauge as a multiple of 4, plus 2 for flat knitting.
- ☐ My ribbing is even, my bind-off stretches, and my seam is nearly invisible.

SEWING NOTEBOOK

1. Draw a cross-section of k2p2 ribbing, showing the knit columns forward and the purl columns back, relaxed and stretched.
2. Write your cast-on math step by step.
3. Tape in your swatch with k1p1, k2p2 and stockinette sections labeled and measured.

From history. Strutt's partner in the Derby rib patent was his brother-in-law, William Woollat. Strutt went on to become a leading mill owner, and his family's cotton mills along the River Derwent are now part of the Derwent Valley Mills World Heritage Site, along with Arkwright's mill at Cromford.

COMMON MISTAKES

- Wrapping the yarn over the needle instead of bringing it between the needles when switching. This adds stitches and makes holes.
- Casting on a number that is not a multiple of 4 (plus 2). The ribs do not line up at the edges.
- Binding off too tightly, so the edge will not stretch. Bind off loosely, in pattern.

Make it a game • Knit or Purl? Your parent knits a swatch with a hidden pattern of knit and purl stitches (a letter or a checkerboard). Without being told the pattern, you “read” the knitting row by row and draw it on graph paper, marking each V or bump. Score a point for each row you read correctly. Then switch roles.

6.2 KNITTING IN THE ROUND: A HAT ON CIRCULAR NEEDLES

OBJECTIVES

- Tell how American knitters, including schoolchildren, knitted socks and other garments for soldiers in 1917–1918, and why socks are knitted in the round.
- Cast on and join in the round on a 16-inch circular needle without twisting.
- Figure a hat cast-on from gauge and knit a hat with a ribbed brim and stockinette body.

Warm-up. Turn a store-bought knitted hat, a sock and a sweater sleeve inside out. Can you find a seam up the side? A hat or sock with no seam was knitted in the round, as a tube. Why would a knitter want a sock with no seam?

WATCH

HOW TO KNIT IN THE ROUND for Beginners (Step-by-Step)

Sheep & Stitch · 12:47

https://www.youtube.com/watch?v=mO-w_N5CFZk

WHEN TO WATCH

Before Session 2, with your circular needle and yarn in hand. Pause after she checks that the cast-on is not twisted, and again after she joins the round.

Note: A knitting teacher shows casting on, joining without a twist and the first rounds, with tips for common mistakes.

BACKUP VIDEO

The EASIEST Way to Knit a Hat Crown

B.Hooked Knitting · 3:33

<https://www.youtube.com/watch?v=ny3M87ITj-4>

When you reach the crown in Lesson 6.4: how to keep knitting the decreases when the 16-inch needle becomes too long.

KEY TERMS

circular needle

Two short needle tips joined by a flexible cable. A 16-inch circular needle is the right length for a hat.

join in the round

Knitting the first cast-on stitch after the last one, so the row becomes a circle.

twisted cast-on

A mistake in which the cast-on edge spirals around the needle before joining, so the knitting becomes a twisted tube that cannot be fixed without starting over.

beginning-of-round marker

A stitch marker (often a different color) placed at the start of the round so you can count rounds.

negative ease

Making a hat smaller than the head, usually about 10 percent, so the stretchy fabric holds it in place.

CORE IDEAS

The story. In 1917, when the United States entered the First World War, the American Red Cross asked people at home to knit warm things for soldiers and sailors: socks, sweaters, scarves, helmets (caps that covered the head and neck) and wristlets. Posters said “Our Boys Need Sox: Knit Your Bit.” Women, men and children knitted on trains, at church, in schools and at meetings. Schoolchildren in Junior Red Cross groups learned to knit and turned in thousands of finished pieces. Socks were the most needed of all, because soldiers in muddy trenches suffered terribly from cold, wet feet. And socks were knitted **in the round**, on four or five double-pointed needles, so that there was no seam to rub a blister on a long march.

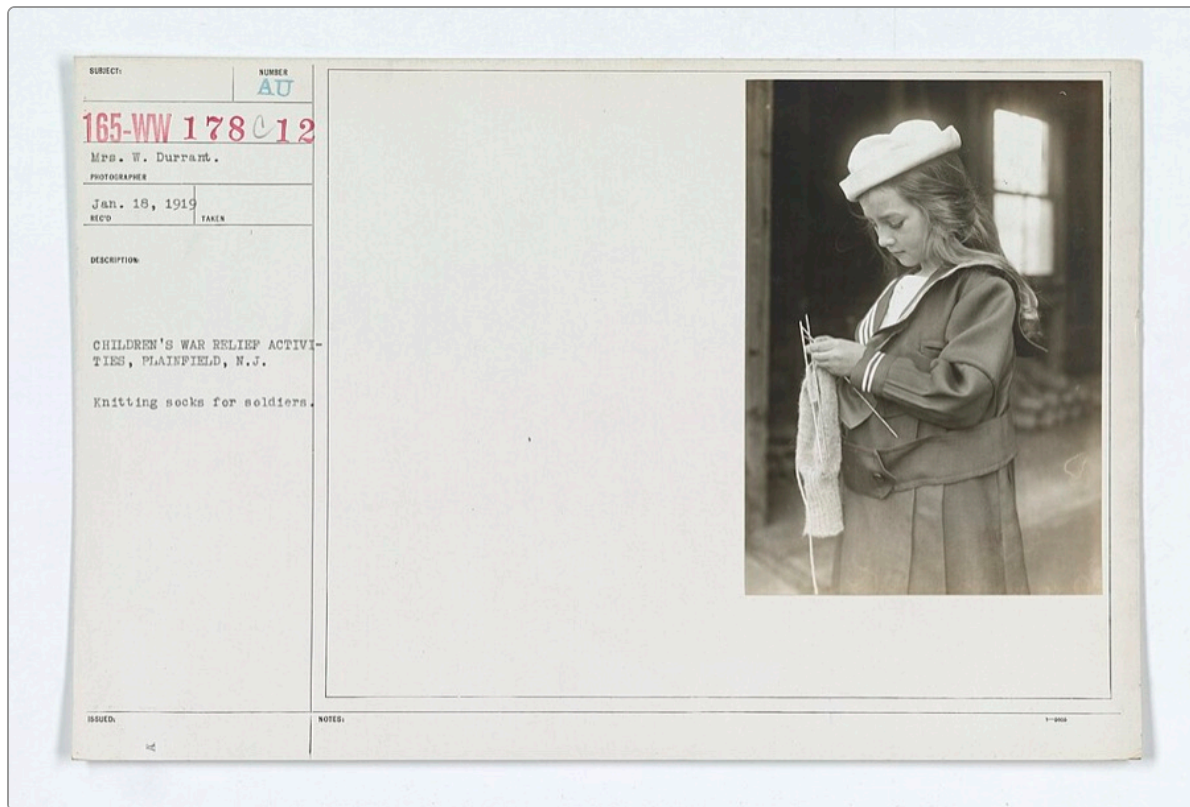
How they figured it out. Knitting in the round is very old. Some of the oldest known knitted objects are colorful cotton socks from Egypt, made about a thousand years ago, knitted as tubes. Knitters worked out that a tube needs no seam, and that in the round you never have to turn the work: you simply knit round and round. The **right side always faces you**, so stockinette, which flat knitters make by knitting one row and purling the next, is made in the round by knitting every round. For a long time knitters used sets of

double-pointed needles. In the 1900s, flexible **circular needles** made tubes as wide as a hat or a sweater easy to knit, and today a 16-inch circular needle is the standard tool for a hat.

The fabric science. A hat must be a little smaller than the head so it stays on: about 10 percent less, called **negative ease**. Hat arithmetic: suppose your stockinette gauge on US 8 needles is 4.5 stitches per inch, and the head measures 22 inches around. Hat circumference: $22 - 2 = 20$ inches. Stitches: $4.5 \times 20 = 90$. For the crown decreases in Lesson 6.4, the number must be a multiple of 8, and for the k2p2 brim a multiple of 4. The nearest multiple of 8 to 90 is **88** ($88 \div 8 = 11$, and $88 \div 4 = 22$, so it works for both). Height: an adult hat is about 8 to 8½ inches from brim to crown, with the last 2 inches used by the crown decreases, so you knit straight to about 6 inches.

Let's knit. You will knit the brim and body of a **hat in the round** on a 16-inch circular needle: about 2 inches of k2p2 ribbing, then stockinette to about 6 inches. (You will knit the crown and finish the hat in Lesson 6.4.) The one skill to do well is **joining without a twist**: lay the needle on the table and make sure every cast-on bump sits on the inside of the circle before you knit the first stitch.

PICTURE STUDY



Knitting Socks for Soldiers, Plainfield, New Jersey, Mrs. W. Durrant, photographer (U.S. Signal Corps collection), 1917–1918 · Black-and-white photograph · National Archives, College Park, Maryland

Image: [Wikimedia Commons](#), public domain

During the First World War, the government collected photographs of Americans helping at home. This card from the National Archives records a girl in Plainfield, New Jersey, knitting a sock for a soldier. The typed label is part of the record: notice the photographer's name and the date.

Look closely

- Find the sock. Can you see that it is a tube on several needles, knitted in the round?
- Count the needles you can see. Why would a sock need more than two?
- Look at her face and hands. Is she concentrating, or does she look relaxed?
- Read the typed labels on the card. What do they tell you that the photograph alone does not?

Talk about it

1. Why were socks the most needed knitted item for soldiers in the trenches?

2. A girl your age knitting socks for men she would never meet: what does that tell you about her and her town?
3. Who could you knit for today?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including the yarn needle and markers. Circular needle tips are pointed: put point protectors or a rubber band on the tips when you stop, and store the needle in a bag. Keep long yarn and markers away from little children and pets.

SEWING PROJECT

A Knitted Hat, Part 1: Brim and Body in the Round

You will figure your hat size from gauge, cast on, join in the round and knit the ribbed brim and stockinette body of a hat. In Lesson 6.4 you will knit the crown and finish it.

You will need

- A 16-inch US 8 (5 mm) circular needle (or the size that gives your gauge)
- One beginning-of-round marker in a different color and 7 plain markers (for Lesson 6.4)
- A yarn needle (counted), scissors, a tape measure and a calculator

RIBBED-BRIM STOCKINETTE HAT (BRIM AND BODY)

Finished size: Adult hat about 20 in (51 cm) around; child size about 18 in (46 cm) around · About 4–6 hours over the week

Fabric and notions

- About 180–200 yards (165–183 m) of worsted-weight (#4) wool, wool blend or soft acrylic
- Your stockinette gauge in stitches per inch, from a swatch knit in the round or flat

How to make it

1. **Figure the cast-on:** stitches per inch $\times$ (head size – 2 inches), rounded to the nearest multiple of 8. (Example: $4.5 \times 20 = 90 \rightarrow 88$.) Child size: $4.5 \times 18 = 81$

→ 80.

2. Cast on that number with the long-tail cast-on, loosely.
3. Lay the needle on the table. Spread the stitches around the cable so the cast-on bumps all face the inside of the circle. Check twice that nothing is twisted.
4. Place the beginning-of-round marker on the right needle tip. Knit the first stitch on the left tip, pulling the yarn snug: you have joined the round.
5. **Brim:** *k2, p2; repeat from * around. Repeat this round until the brim measures 2 inches (or 3 inches for a fold-up brim).
6. **Body:** knit every stitch, every round. Slip the marker each time you pass it.
7. Continue until the hat measures 6 inches from the cast-on edge for an adult (5 inches for a child), measured flat.
8. Leave the stitches on the needle and stop here until Lesson 6.4.

Fabric check: Choose a soft, smooth worsted wool or wool blend: wool is warm even when damp and its elasticity helps a hat hold its shape. Superwash wool or acrylic is easier to wash and is often preferred for gifts. Avoid cotton (heavy and stretches out) and very fuzzy yarns for a first hat. A light or medium color makes stitches easier to see.

Steps

1. **Count out** needles, markers and the yarn needle.
2. **Do the math.** Write the head size, the hat size, your gauge and the cast-on, with the multiple-of-8 check.
3. **Practice first.** Cast on 24 stitches on the circular needle and practice joining without a twist. Knit 3 rounds, then pull it out.
4. Knit the brim and body from the pattern card.
5. **Gauge check.** After 2 inches of stockinette, measure your gauge on the hat itself. Is it what you planned? If it is off by more than half a stitch per inch, ask a parent whether to start over with a different needle.
6. **Count in and clean up.** Point protectors on, markers counted, yarn needle in the cushion.
7. **Improve it.** Note any spot where the join made a gap and how you would close it next time (knit the first and last cast-on stitches together, or tighten the tail when weaving in).

Tips

- To close the little gap at the join, cast on one extra stitch, and knit it together with the first stitch when you join.
- If the 16-inch needle feels crowded, push the stitches onto the cable and pull them up to the tips a few at a time.
- Younger students: make the child size. Older students: add stripes of a second color in the body, carrying the unused color up the inside at the beginning of the round.

Check your work

- ☐ I figured my cast-on from gauge with negative ease, as a multiple of 8.
- ☐ I joined in the round without twisting.
- ☐ My brim and body are even, and I checked my gauge on the hat itself.

SEWING NOTEBOOK

1. Write your hat math: head size, hat size, gauge, cast-on, multiple check, heights.
2. Draw the difference between knitting flat (turn, knit, purl) and in the round (knit, knit, knit) for stockinette.
3. Copy Proverbs 31:21 and write who your hat is for.

From history. Red Cross instructions of 1917 and 1918 gave exact patterns and sizes for socks, sweaters and helmets so that every piece sent overseas would fit and be useful. Knitters who did not follow the pattern sometimes had their work sent back to be done again.

COMMON MISTAKES

- Twisting the cast-on when joining. Check before the first stitch; a twist cannot be fixed later.
- Purling every other round, as in flat knitting. In the round, stockinette is knit every round.
- Forgetting to slip the beginning-of-round marker, and losing count of rounds.

Make it a game · Twist or No Twist? Your parent casts on a short round on a circular needle, sometimes twisting it on purpose. You have five seconds to look and call “twist” or “no twist.” Then switch. Five rounds each; the most correct calls wins. Finish by joining your own cast-on perfectly while your parent watches.

Scripture. “She is not afraid of the snow for her household: for all her household are clothed with scarlet.” (Proverbs 31:21, KJV)

The capable woman had warm clothing ready before winter came. A hat knitted in October is ready for the first snow.

6.3 GAUGE, YARN WEIGHT AND PATTERN MATH

OBJECTIVES

- Tell how Elizabeth Zimmermann taught knitters to plan garments with gauge and simple percentages.
- Name the Craft Yarn Council's yarn weights and match yarns to needle sizes and gauges.
- Resize a simple pattern for a different yarn weight by recalculating stitches, rows and yardage, and knit the resized piece.

Warm-up. Gather three or four different yarns from the house or the store shelf (with the labels). Read each label: the weight number or name, the yards, the grams, and the suggested needle size and gauge. Line them up from thinnest to thickest. Which label gives the most yards per gram?

WATCH

How to Measure Gauge | Knitting

Howcast • 3:23

<https://www.youtube.com/watch?v=FckflcDU52o>

WHEN TO WATCH

After “The fabric science,” with a swatch and a ruler or gauge tool in hand. Count your own swatch as she counts hers.

Note: A knitting teacher with a degree in crafts education explains why gauge matters and measures a swatch with a gauge tool.

BACKUP VIDEO

How to Measure & Determine Your Gauge in Knitting - Beginner Knitting Tutorial #10

Yarnspirations • 1:38

<https://www.youtube.com/watch?v=A2t-akQf-nA>

A short captioned review of measuring stitches and rows and what to do if your gauge is off.

KEY TERMS

yarn weight

The thickness of a yarn. The Craft Yarn Council numbers them 0 (lace) through 7 (jumbo); worsted is #4, bulky is #5.

yardage

The length of yarn in a skein, printed on the label with its weight in grams. Yards per gram tells how thick a yarn is.

stitch gauge and row gauge

Stitches per inch across, and rows per inch up. Both matter when resizing.

resize

To recalculate a pattern's numbers for a different gauge or size.

percentage system

Elizabeth Zimmermann's method of planning a sweater: measure the body, figure the number of stitches with gauge, and make every other part a set percentage of that number.

CORE IDEAS

The story. **Elizabeth Zimmermann** (1910–1999) was born in England, grew up in Europe, and moved to the United States, where she raised her family in Wisconsin and became one of the best-known knitting teachers in America. She was frustrated that knitters followed printed patterns line by line without understanding them, and gave up when their yarn or their size did not match. In books such as *Knitting Without Tears* (1971) and in a television series, she taught them instead to think. Knit a swatch, measure your gauge, measure the person, multiply, and you can make a sweater fit anyone with any yarn. For sweaters she used a simple “percentage system”: the body stitches are 100 percent, and the sleeves, the neck and the cuffs are set percentages of that number. Knitters loved her calm, practical, cheerful advice: if you made a mistake, she said, you could probably fix it.

How they figured it out. The key is that a pattern's numbers all come from its gauge. A pattern that says “cast on 100 stitches” was written for a certain number of stitches per inch. If your yarn is thicker and makes fewer stitches per inch, 100 stitches will make a bigger piece. So you work backward: find the **finished size** the pattern wants (stitches ÷ the pattern's gauge), then multiply by **your** gauge. Do the same for rows, or simply knit

to the measurement in inches. Yarn companies help by printing a suggested gauge and needle on every label, and the **Craft Yarn Council** publishes a standard chart of yarn weights from 0 to 7, so that “worsted” or “#4” means about the same thing on every brand.

The fabric science. Here is pattern math. A headband pattern says: “Gauge 5 stitches per inch in garter stitch. Cast on 20 stitches. Knit until the piece measures 19 inches.” The finished width is $20 \div 5 = 4$ **inches**. You have bulky yarn that knits at 3.5 stitches per inch. To make the same 4-inch width: $4 \times 3.5 = 14$ **stitches**. The length is given in inches, so it does not change. Yardage changes too: thicker yarn has fewer yards per gram but each stitch uses more yarn. A simple way to estimate is to weigh your swatch: if a 4×4 inch swatch of your yarn weighs 8 grams, a headband of 4×19 inches has $76 \div 16 = 4.75$ swatches’ worth, about $4.75 \times 8 = 38$ **grams**. Read the yards per gram on the label to change that to yards.

Let’s knit. You will **resize a headband (ear-warmer) pattern** for a different yarn weight, write out your new pattern, and knit it. The one skill to do well is **trusting the math**: measure your swatch honestly, calculate before you cast on, and check your width after a few inches.

PICTURE STUDY



Girl Knitting (Strickendes Mädchen), Rudolf Epp, before 1910 · Oil on canvas · Private collection
Image: [Wikimedia Commons](#), public domain

Rudolf Epp painted many scenes of village homes in southern Germany. Here a young woman knits at the table, her yarn in a bowl beside her, her cat keeping her company. Notice how much knitting she has done: a long piece hangs from her needles.

Look closely

- Find the bowl of yarn on the table. Why might a knitter keep the yarn in a bowl?
- Look at the knitting hanging from her needles. Is it long and narrow, like a stocking, or wide?
- Find the cat. Why do knitters sometimes have trouble with cats?
- Look at the flowers, the pictures on the wall and her clothes. What do they tell you about her home?

Talk about it

1. This knitter had no printed patterns or yarn labels. How might she have known how many stitches to cast on?

2. What would you knit if you had a whole winter evening and a bowl of yarn?
3. How would you explain gauge to her?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including the yarn needle. Carry and store needles points down in a case; use point protectors when you stop. Keep yarn away from babies, toddlers and pets, and keep cats from playing with your yarn and needles.

SEWING PROJECT

A Resized Garter-Stitch Headband

You will take a headband pattern written for one yarn weight, resize it for a different yarn using your own gauge, write out your new pattern, and knit a warm ear-warmer headband with it.

You will need

- Needles to suit your yarn (see the Craft Yarn Council chart): US 6–8 for worsted, US 9–11 for bulky
- A yarn needle (counted), scissors, a ruler and a kitchen scale
- A calculator and the original pattern (below)

GARTER-STITCH EAR-WARMER HEADBAND (RESIZED)

Finished size: About 4 in (10 cm) wide and 19 in (48 cm) long before seaming, to fit a head about 20–21 in around ·
About 3–4 hours

Fabric and notions

- **The original pattern:** worsted-weight (#4) yarn on US 8 (5 mm) needles, gauge 5 stitches per inch in garter stitch. Cast on 20. Knit every row until the piece measures 19 inches. Bind off. Sew the short ends together.
- **Your yarn:** any weight from DK (#3) to bulky (#5), about 50–80 yards (46–73 m). Wool or a wool blend is warmest.
- Your own gauge, measured on a 4-inch garter-stitch swatch in your yarn

How to make it

1. **Swatch:** cast on 16 stitches in your yarn and knit 4 inches of garter stitch (knit every row). Measure stitches per inch.
2. Weigh the swatch in grams and write it down.
3. **Resize:** original width = $20 \div 5 = 4$ inches. Your cast-on = $4 \times$ your stitches per inch, rounded to a whole number.
4. **Estimate yarn:** headband area = $4 \times 19 = 76$ square inches. Swatch area = $4 \times 4 = 16$ square inches. Grams needed = $76 \div 16 \times$ swatch grams. Check that your skein has enough.
5. Write your new pattern in your notebook in the same form as the original, with your yarn, needles, gauge and cast-on.
6. Cast on and knit every row. After 2 inches, measure the width. It should be close to 4 inches.
7. Knit until the piece measures 19 inches (or 1 to 2 inches less than the head it is for, stretched snugly around).
8. Bind off loosely. Sew the short ends together with mattress stitch or whipstitch.
9. **Optional twist:** before sewing, fold one end in half lengthwise and wrap it around the other, then sew, for a pinched “turban” front.

Fabric check: Use a wool or wool-blend yarn for warmth and spring; garter stitch in wool lies flat and holds its shape. Acrylic is fine and washable. Avoid cotton (it stretches and is cold when damp) and slippery yarns like bamboo for a headband, which will not stay put. Choose a yarn weight different from the original so the resizing really matters.

Steps

1. **Count out** needles and the yarn needle.
2. **Read the labels.** Copy the weight number, yards, grams and suggested gauge from your yarn label. Is your swatch gauge close to the label's?
3. **Resize** and knit the headband from the pattern card.
4. **Check the math.** Weigh the finished headband. How close was your yarn estimate?
5. **Compare.** If someone in the family knits the original in worsted, lay the two side by side. Are they the same size?

6. Count in and clean up. Needles in the case, yarn needle in the cushion.

7. Improve it. Resize the same pattern for a child's head (about 18 inches) and write that pattern too.

Tips

- Always measure gauge in the stitch the pattern uses: garter stitch has a different gauge from stockinette.
- Round your cast-on to a whole number; for patterns with a repeat, round to the nearest multiple of the repeat.
- Younger students: resize only the width and knit the headband. Older students: resize the hat from Lesson 6.2 for bulky yarn, with the multiple-of-8 rule.

Check your work

- ☐ I measured my gauge honestly and resized the cast-on correctly.
- ☐ I estimated the yarn I needed from my swatch's weight.
- ☐ My headband came out close to the planned width and fits.

SEWING NOTEBOOK

1. Make a yarn-weight chart: numbers 0–7, names, a typical gauge and needle size for each, and a 2-inch sample of any you own.
2. Write the original pattern and your resized pattern side by side, with all the math.
3. Record the yarn estimate and the actual weight of the finished headband.

From history. Elizabeth Zimmermann's daughter, Meg Swansen, continued her mother's teaching and publishing. Zimmermann's books are still in print, and knitters still use her percentage system and her famous seamless designs.

COMMON MISTAKES

- Changing yarn without changing the numbers. A pattern written for worsted made in bulky comes out much too big.
- Measuring gauge on a tiny swatch or at the edges. Knit at least 4 inches and measure the middle.
- Forgetting that a yarn label's gauge is only a suggestion. Your own swatch is the truth.

Make it a game • Pattern Converter. Your parent writes five quick pattern lines, each with a gauge and a cast-on (for example, “5 stitches per inch, cast on 30”). You are given a new gauge for each (such as 3.5 stitches per inch). Race to convert each cast-on, rounding to whole stitches. Check together. Each correct conversion scores a point; beat your time on a second round.

6.4 LEE'S STOCKING FRAME TO THE KNITTING MACHINE

OBJECTIVES

- Tell how William Lee invented the stocking frame in 1589 and how framework knitting grew into the modern knitting machine.
- Explain how a machine's needles, sinkers and presser form loops, and compare its speed with hand knitting.
- Knit the crown decreases of a hat, weave in the ends and wet-block the finished hat.

Warm-up. Look at a machine-knitted sock or T-shirt with a magnifier, and then at a piece of hand knitting. Can you see the same V-shaped stitches in both? Which stitches are smaller and more even? Guess how many stitches are in one sock and how long it would take you to knit it by hand.

WATCH

Framework Knitting

Wendy Freer • 7:52

<https://www.youtube.com/watch?v=oWfzzfjMa6k>

WHEN TO WATCH

After the story. One of the few people who still know how to work an old hand frame knits on it row by row in his workshop; watch the bearded needles, the sinkers dropping between them and the presser bar.

Note: A short film made for the Leicestershire Industrial History Society, posted on a small channel. The framework knitter explains each motion as he works.

BACKUP VIDEO

How to Block Knits

Interweave Craft • 1:23

<https://www.youtube.com/watch?v=hEc3LTx1e0Y>

Before you block your hat in Session 2: soak, squeeze in a towel, and lay flat to dry.

KEY TERMS

stocking frame

William Lee's knitting machine of 1589, worked by hand and foot, with a row of hooked needles that made a whole row of loops at once.

sinker

A thin metal plate that pushes the yarn down between two needles to form a loop.

blocking

Wetting a finished knitted piece and letting it dry flat in its final shape, so the stitches even out and it holds its size.

bearded needle

A needle with a long, springy hook (the beard) that a presser bar closes so the old loop can slide over it. Lee's frame used bearded needles.

latch needle

A needle with a tiny hinged latch that closes the hook by itself. Patented by Matthew Townsend of Leicester in 1849, it made fast knitting machines possible.

CORE IDEAS

The story. In 1589, in the village of Calverton near Nottingham, England, a clergyman named **William Lee** built a machine that could knit. Every stocking in England was then knitted by hand, one stitch at a time. Lee's **stocking frame** held a row of hooked needles side by side and made a whole row of loops at once. An old story says he was inspired by watching a woman knit; whether or not that is true, he spent years perfecting it. Lee asked Queen Elizabeth I for a patent, but she refused. Some accounts say she worried that his frame would take work from the many people who knitted by hand, and wished he had made finer silk stockings. Lee took his frames to France, where he died about 1614. His brother James brought the frames back to England, and **framework knitting** grew into a great trade in Nottingham, Leicester and Derby.

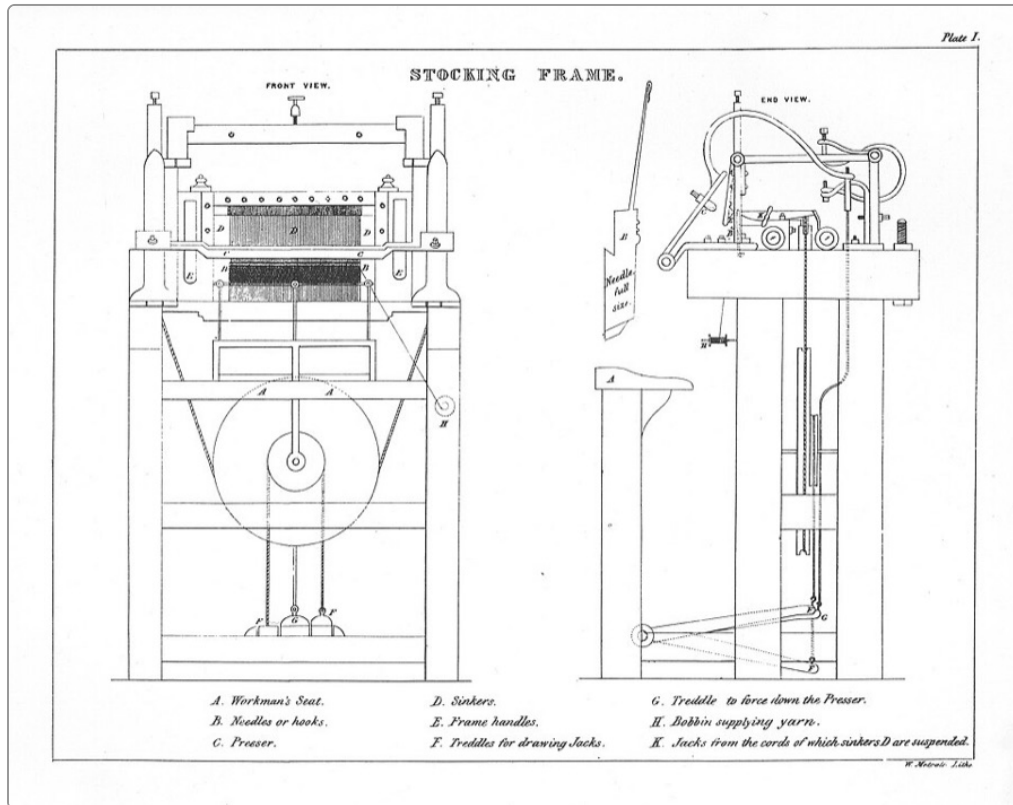
How they figured it out. Lee's frame imitated the hand knitter's loop, but for a whole row at once. The knitter laid the yarn across the needles; thin metal plates called **sinkers** dropped between the needles and pushed the yarn into loops; the new loops were drawn under the needles' springy hooks (called **beards**); a **presser bar** closed the beards so the old loops could slide over them and off; and a new row was done. A skilled framework

knitter could make about ten times as many stitches a minute as a fast hand knitter. Inventors kept improving the machine: Strutt's rib attachment (1759), circular knitting machines in the 1800s, and in 1849 Matthew Townsend's **latch needle**, whose little latch closes the hook by itself. Today's computer-controlled circular knitting machines use latch needles and can knit a whole sock in a few minutes. Framework knitters' lives were often hard, with long hours and low pay, and in 1811–1816 some angry workers, called Luddites, broke frames at night; in time new laws and new industries changed the trade.

The fabric science. Machine or hand, every knitted fabric is made of loops drawn through loops. The **gauge** of a knitting machine is how close its needles are, and it decides how fine the fabric is: a sock machine may have more than a hundred needles around a cylinder a few inches across. A hand-knitted hat must be shaped by hand. Crown arithmetic: with 88 stitches and 8 decrease points, round 1 is *k9, k2tog* around ($88 - 8 = 80$). Each decrease round removes 8 stitches: 80, 72, 64, 56, 48, 40, 32, 24, 16, 8. That is 10 decrease rounds. If you knit a plain round between decrease rounds for the first half, the crown is rounder; then decrease every round at the top. Finally, **blocking**: wool fibers relax and even out when they are wet, so a soaked and gently shaped hat dries with smooth, even stitches.

Let's knit. You will finish your hat from Lesson 6.2: knit the **crown decreases**, switching to double-pointed needles (or the long-circular method) when the stitches no longer fit the 16-inch needle, close the top, weave in the ends and **wet-block** it. Then give it away or wear it. The one skill to do well is **counting each decrease round** so the crown spirals evenly.

PICTURE STUDY



Stocking Frame: Front View and End View, W. Metcalfe, lithographer, for William Felkin's history of the hosiery trade, 1867 · Lithograph technical drawing · From William Felkin, *A History of the Machine-Wrought Hosiery and Lace Manufactures* (1867)

Image: [Wikimedia Commons](#), public domain

This drawing was made in 1867 for a history of the knitting trade, to show how a hand frame of the kind Lee invented worked. Like a patent drawing, it labels every part with a letter, and the key below tells what each one does.

Look closely

- Find A, the workman's seat. Where would the framework knitter sit, and where would his feet go?
- Find B, the needles or hooks, and the small drawing of one needle at full size. Can you see its hooked beard?
- Find D, the sinkers, and C, the presser. What job does each do in making a row of loops?
- Find F and G, the treddles. Why would a knitter use his feet as well as his hands?

Talk about it

1. How is this frame like your hand knitting, and how is it different?
2. Why do you think a whole trade grew up around machines like this in Nottingham and Leicester?
3. If you could ask a framework knitter one question, what would it be?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in, including double-pointed needles (they are easy to lose) and blocking pins. Use lukewarm water and a gentle wool wash for blocking, never hot water, which can felt wool (Lesson 1.2). Dry the hat flat away from direct heat.

SEWING PROJECT

A Knitted Hat, Part 2: Crown, Finishing and Blocking

You will shape the top of your hat with evenly spaced decreases, close it, weave in the ends invisibly and block it so the stitches even out. Then it is ready to wear or to give.

You will need

- Your hat on the 16-inch circular needle from Lesson 6.2
- A set of US 8 double-pointed needles, or a 32-inch or longer US 8 circular needle for the long-circular method
- 7 plain stitch markers and the beginning-of-round marker
- A yarn needle (counted), scissors, a towel, a basin and wool wash or gentle soap
- A balloon or a plate (optional, for shaping)

RIBBED-BRIM STOCKINETTE HAT (CROWN AND FINISHING)

Finished size: One finished hat, about 20 in (51 cm) around and 8–8½ in (20–22 cm) tall · About 2–3 hours, plus a day for drying

Fabric and notions

- Your hat in progress, about 6 inches tall
- The rest of your yarn (about 30 yards for the crown)

How to make it

1. **Set up:** on the next round, place a marker after every 11 stitches (for 88 stitches; after every 10 for 80), so there are 8 sections.
2. **Decrease round:** *knit to 2 stitches before the marker, k2tog, slip marker; repeat from * around. (8 stitches decreased.)
3. **Plain round:** knit all stitches.
4. Repeat these two rounds until 48 stitches remain (40 for the child size).
5. Now work the decrease round every round until 8 stitches remain.
6. When the stitches are too few to stretch around the 16-inch needle, move them onto double-pointed needles (about a third on each of three needles) or onto a long circular for the long-circular method, and continue.
7. **Close the top:** cut the yarn, leaving an 8-inch tail. Thread it on the yarn needle, pass it through the 8 remaining stitches as you slip them off the needles, pull tight, and take the tail to the inside.
8. **Weave in ends:** on the inside, run each tail through the backs of stitches for 2 inches in one direction and back the other way. Trim close.
9. **Block:** soak the hat in lukewarm water with a little wool wash for 15 minutes. Squeeze (do not wring), roll in a towel and press out the water. Shape it over a balloon or lay it flat, and let it dry completely.

Fabric check: Block wool and wool blends in lukewarm water with gentle wool wash, never hot water and never in the dryer, which can felt or shrink them. Superwash wool and acrylic can be washed in the machine on gentle, but still dry flat; acrylic can be “steam blocked” only by an adult with a hovering steam iron, because high heat can melt it.

Steps

1. **Count out** needles, markers, the yarn needle and pins.
2. **Do the math.** Write the stitch count after every decrease round before you start. Check it as you knit.
3. Finish and block the hat from the pattern card.
4. **Speed comparison.** Time yourself knitting one plain round of your hat. Count the stitches. How many stitches a minute do you knit? A modern sock machine can knit thousands. About how many times faster is it than you?
5. **Measure it.** Measure the hat before and after blocking. Did it change?

6. **Count in and clean up.** Double-pointed needles counted (they hide in couch cushions), markers in their box, basin rinsed.

7. **Give it.** Give the hat to the person you measured it for, or to a shelter or mission that needs hats, with a note about its fiber and care.

Tips

- When you move to double-pointed needles, knit the stitches directly off the circular needle onto each double-pointed needle in turn.
- Pull the first stitch on each double-pointed needle snug to avoid a “ladder” of loose stitches at the joins.
- Younger students: knit the child size and use the long-circular method if double-pointed needles feel awkward. Older students: knit a matching pair of mittens or a second hat with a striped crown.

Check your work

- ☐ I can tell how Lee’s stocking frame worked and how the latch needle led to modern knitting machines.
- ☐ My crown decreases are even and the top is closed neatly with no hole.
- ☐ My ends are woven in invisibly, the hat is blocked, and it fits.

SEWING NOTEBOOK

1. Draw a bearded needle and a latch needle and show how each closes its hook.
2. Write the crown chart: the stitch count after each decrease round.
3. Record your stitches per minute and the hat’s measurements before and after blocking.

From history. The Framework Knitters Museum in Ruddington, near Nottingham, keeps a row of working hand frames in the workshops where knitters once made stockings, and volunteers still knit on them for visitors.

COMMON MISTAKES

- Decreasing every round from the start. The crown comes to a sharp point. Alternate plain and decrease rounds at first.
- Leaving the top unsecured. Pull the tail through all stitches twice and fasten it inside.

- Blocking wool in hot water or putting it in the dryer. The hat can shrink or felt.

Make it a game • Be the Knitting Machine. Line up five or more family members as “needles,” each holding a loop of yarn. One person is the “sinker” who lays the yarn across all the needles, and everyone pulls a new loop through their old loop at the same moment on “Press!” Time a row. Then time one person knitting the same number of stitches by hand. Which was faster, and why?

UNIT 6 REVIEW

Answer in complete sentences unless the question asks for a calculation or a show-me. For calculations, show every step; a right answer with no work earns half. The review is worth 100 points.

1. (8 pts)

What is ribbing, and why does it stretch and spring back?

2. (8 pts)

Who was Jedediah Strutt, what did his 1759 patent do, and how is he connected to Samuel Slater?

3. (10 pts)

Calculate. Your k2p2 gauge is 5.5 stitches per inch. You want a cowl 26 inches around, knit flat. How many stitches do you cast on?

4. (8 pts)

Show me. Cast on 24 stitches on a circular needle and join in the round without a twist while your parent watches. Knit 2 rounds of k2p2.

5. (10 pts)

Calculate. Your stockinette gauge is 4 stitches per inch. A head measures 21 inches. Using 2 inches of negative ease, how many stitches do you cast on for a hat that needs a multiple of 8?

6. (8 pts)

Why were socks for soldiers in 1917–1918 knitted in the round, and how is stockinette worked differently in the round than flat?

7. (10 pts)

Calculate. A pattern was written for 5 stitches per inch and says to cast on 30 stitches. Your yarn knits at 4 stitches per inch. How wide is the original piece? How many stitches will you cast on to make it the same width?

8. 8 pts

Who was Elizabeth Zimmermann, and what did she teach knitters to do instead of following patterns blindly?

9. 8 pts

Name the Craft Yarn Council weight number of worsted yarn and of bulky yarn. What is the lowest number and the highest?

10. 8 pts

Describe how William Lee's stocking frame made a row of loops. Why was it important?

11. 7 pts

Calculate. A hat has 96 stitches and 8 decrease points. How many stitches remain after 5 decrease rounds? How many decrease rounds until 8 stitches remain?

12. 7 pts

What is blocking, and why must wool be blocked in lukewarm water and dried flat?

UNIT CHALLENGE: THE KNITTED SET: COWL, HAT AND HEADBAND

Show the unit's knitting: your ribbed cowl, your finished and blocked hat, and your resized headband, with the swatch for each.

On a notebook page for each piece, write the pattern you followed or made, your gauge, all the math (cast-on, multiples, crown chart, resizing, yarn estimate), and one honest note about what you would change. Give at least one piece away and write who received it.

LOOK FOR	WHAT IT MEANS
The arithmetic	Gauge measured honestly; cast-ons, multiples, crown decreases and resizing figured correctly with the work shown.
Workmanship	Even tension; ribs line up; no twist at the join; even crown; ends woven in invisibly; hat blocked.
Fit	The cowl, hat and headband come out close to the planned sizes and fit the people they were made for.

LOOK FOR	WHAT IT MEANS
Giving	At least one piece given away, with a note on fiber and care.
Record and improvement	Patterns and math recorded; one piece remade or improved with the change noted. A crooked first try honestly recorded and redone earns full credit.

ANSWER KEY

1. Ribbing alternates columns of knit and purl stitches (k1p1, k2p2). The knit columns stand forward and the purl columns sink back, so at rest the fabric folds like an accordion; pulled sideways it opens flat, and let go it springs back.
2. A Derbyshire inventor who patented the Derby rib attachment for the stocking frame in 1759, which let the machine make ribbed stockings by adding purl stitches. He became Arkwright's partner and built mills at Belper, where Samuel Slater was an apprentice before taking mill spinning to America.
3. $5.5 \times 26 = 143$. The nearest multiple of 4 is 144. Add 2 for flat knitting: cast on 146.
4. Parent checks: all cast-on bumps face the inside before joining; the beginning-of-round marker is placed; the ribs line up (knit above knit, purl above purl); the yarn moves between the needles.
5. $21 - 2 = 19$ inches. $4 \times 19 = 76$. 76 is exactly halfway between the multiples of 8 on either side, 72 and 80: choose 80 for a little more room or 72 for a snugger fit. Accept either with the work and reasoning shown.
6. In the round a sock is a seamless tube, so no seam rubs a blister on long marches in wet boots. Flat, stockinette is knit one row and purl the next; in the round the right side always faces you, so you knit every round.
7. Original width: $30 \div 5 = 6$ inches. Your cast-on: $6 \times 4 = 24$ stitches.
8. A knitting teacher and author (1910–1999), author of *Knitting Without Tears* (1971), who taught knitters to knit a swatch, measure gauge and the person, and calculate their own numbers, using her percentage system so a garment would fit with any yarn.
9. Worsted is #4; bulky is #5. The system runs from 0 (lace) to 7 (jumbo).
10. Yarn was laid across a row of bearded needles; sinkers pushed it down between the needles into loops; the loops were drawn under the beards; a presser bar closed the beards so the old loops slid over and off. It made a whole row at once, about ten times faster than hand knitting, and began machine knitting (1589).
11. Each round removes 8: $96 - 5 \times 8 = 56$ stitches. From 96 to 8: $(96 - 8) \div 8 = 11$ decrease rounds.
12. Blocking is wetting a finished piece and letting it dry in its final shape so the stitches even out. Wool must be kept from hot water and agitation, which can felt and shrink it, and dried flat so its wet weight does not stretch it.

HOME SEWING: PILLOWS, DRAPES & FURNITURE COVERS

This unit brings your sewing into every room of the house. You will measure a room and its windows like a professional workroom, figure fullness, hems and yardage, and sew a curtain panel and then a pair of lined drapes for a real window. You will learn why good drapes are lined, and you will test it with a flashlight and a thermometer.

Then you will cut patchwork with a rotary cutter and a ruler, as modern quilters do, piece and quilt a table runner, and finish the unit as an upholsterer, re-covering a footstool or chair seat with foam, batting and fabric while an adult stands beside you at the staple gun. You will meet the keepers of the standard yard, the photographers who recorded American quilts in the hard years of the 1930s, and the upholsterers of eighteenth-century Paris. A sewing machine makes these projects faster, but each one can also be sewn by hand with a backstitch; if your family has no machine, one can often be borrowed from a relative or a friend at church.

PREREQUISITES

- Sews accurate $\frac{1}{2}$ -, $\frac{5}{8}$ - and $\frac{1}{4}$ -inch seams and has been checked off for solo machine and iron use (Unit 4)
- Can hand-hem with a blind hem or slip stitch (Unit 3)
- Can measure in feet, inches and fractions of an inch and multiply and divide fractions
- Knows the needle-and-pin count and the safety ladder for the rotary cutter and staple gun

MASTERY CHECKLIST

- ☐ I can measure a room and a window, draw them to scale, and figure the cutting size and yardage of curtains with fullness, hems and headings.
- ☐ I can sew a tab-top or rod-pocket curtain panel and a pair of lined drapes for a real window.
- ☐ I can explain what lining does for drapes and prove it with a light and temperature test.
- ☐ I can use a rotary cutter safely with an adult nearby, cut accurate strips and squares, and piece with a $\frac{1}{4}$ -inch seam.
- ☐ I can layer, quilt and bind a table runner, and figure the binding I need.
- ☐ I can name the layers of an upholstered seat and re-cover a footstool or chair seat, with an adult beside me at the staple gun.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **A rotary cutter (45 mm) with a safety-closing blade, an 18 × 24 inch self-healing mat and a 6 × 24 inch quilting ruler:** For Lesson 7.3. Used only with an adult nearby, always on the mat, cutting away from the body, with the blade closed every time it is set down. Fabric shears work for every project if you skip it.
- **A 25-foot retractable steel tape measure and a sturdy step stool:** For measuring windows and rooms. An adult holds the stool or does the high measuring.
- **A manual staple gun with 3/8-inch staples, safety glasses and a staple remover:** For Lesson 7.4. Used only with an adult beside the student and safety glasses on.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

7.1 Measuring a Room and a Window	2 sessions of 60–90 minutes
7.2 Lining and Drapes	2 sessions of 60–90 minutes
7.3 Quilting: The Pieced Block and the Rotary Cutter	2 sessions of 60–90 minutes
7.4 Slipcovers and Upholstery	2 sessions of 60–90 minutes

7.1 MEASURING A ROOM AND A WINDOW

OBJECTIVES

- Tell how the yard became a standard measure, from the legends about it to the exact definition of 1959.
- Measure a room and a window, draw a floor plan to scale, and figure curtain cutting sizes with fullness, side hems, heading and bottom hem.
- Figure yardage for a curtain and sew a tab-top curtain panel for a real window.

Warm-up. Choose one room. Without a tape measure, guess its length and width in feet and the width of its biggest window in inches. Write your guesses. Now pace the room heel to toe and count. Last, measure with a tape. How close were your guesses? Which method would you trust to buy fabric?

WATCH

Measuring Your Windows For Curtain Length & Width Made Simple

Half Price Drapes · 2:27

<https://www.youtube.com/watch?v=aXcx6BG1tdQ>

WHEN TO WATCH

After “The fabric science,” with your own tape measure and notebook. Pause after the width and after the length and measure your window the same way.

Note: From a curtain company’s channel; it teaches measuring and does not pitch a product. He measures the width with extra on each side and the length from the rod.

KEY TERMS

standard

An official object or definition that fixes exactly how long a unit is, so that a yard means the same everywhere.

scale drawing

A drawing in which every real distance is shrunk by the same amount, such as $\frac{1}{4}$ inch on paper for every foot in the room.

fullness

How many times wider the curtain fabric is than the rod or window: $1\frac{1}{2}$ for a flat look, 2 to $2\frac{1}{2}$ for soft, full folds.

heading

The top of a curtain where it hangs from the rod: a rod pocket, tabs, rings or pleats.

cut length

The finished length plus the fabric needed for the heading and the bottom hem.

yardage

How many yards of fabric to buy: cut length $\times$ number of widths, divided by 36, plus a little extra.

CORE IDEAS

The story. How long is a yard? English legend says that King Henry I, in the 1100s, declared it the distance from his nose to the thumb of his outstretched arm. That is a legend, but it remembers something true: early measures came from bodies, and bodies differ. So kingdoms made **standards**, metal bars kept by the government, against which merchants' yardsticks could be checked. In 1834 a great fire burned the Houses of Parliament in London and damaged the official standard yard and pound. Scientists spent years making careful new standards, and Parliament made the new Imperial Standard Yard law in 1855; copies were sent to other countries, including the United States. Finally, in 1959, the United States, Britain and other nations agreed to define the yard exactly as **0.9144 meter**, which makes one inch exactly **2.54 centimeters**. Every tape measure in your house is checked, in the end, against that agreement. Fabric stores, curtain makers and builders all depend on it.

How they figured it out. Curtain makers learned that a window is measured for the **rod**, not the glass. The rod usually reaches 3 to 6 inches past the window frame on each side, so the curtains can be pushed open off the glass, and sits 4 to 6 inches above the frame. Width is measured along the rod; length from the rod (or the top of the rings) to where the curtain should end: the sill, just below the sill (an apron length), or $\frac{1}{2}$ inch above the floor. They learned to **measure twice**, in more than one place, because old windows and floors are rarely perfectly square, and to write every number down at once. Then they drew a **scale drawing** of the room, so they could see where furniture, doors and radiators would be in the way.

The fabric science. Curtain arithmetic, step by step. Suppose the rod is **48 inches** and you want a fullness of 2: you need $48 \times 2 = \mathbf{96 \text{ inches}}$ of finished width, as two panels of

48 inches. Each panel needs side hems of 1 inch doubled (2 inches per side, 4 inches total): cut width $48 + 4 = 52$ inches. A 54-inch home-décor fabric cuts one panel per width. For length: finished length 63 inches; tab-top heading adds $\frac{1}{2}$ inch for the top seam; double 3-inch bottom hem adds 6 inches: cut length $63 + \frac{1}{2} + 6 = 69\frac{1}{2}$ inches. Two panels: $2 \times 69\frac{1}{2} = 139$ inches $\div 36 = 3.86$ yards; round up and buy **4 yards**. If the fabric has a pattern that repeats, add one repeat per panel so the panels match. Cost: at \$12.98 a yard, $4 \times 12.98 = \$51.92$.

Let's sew. You will draw your room to scale, measure a real window, write a complete cut plan, and sew **one tab-top curtain panel** (or a pair for a narrow window). The one skill to do well is **accurate measuring and marking**: measure twice, write it down, and check your cut plan with a parent before the fabric is cut.

PICTURE STUDY



Girl Reading a Letter at an Open Window, Johannes Vermeer, about 1657–1659 · Oil on canvas ·
Gemäldegalerie Alte Meister, Dresden, Germany
Image: [Wikimedia Commons](#), public domain

Vermeer painted the quiet rooms of Delft homes, filled with light from tall windows. Here a girl reads a letter by an open window. Notice the fabrics: a red

curtain at the window, a big green curtain hanging on a rod right across the front of the picture, and a heavy carpet on the table. In Vermeer's day curtains were costly, and they kept out drafts as well as sunlight.

Look closely

- Find the green curtain at the right. Find its rod at the top. How is the curtain hung from the rod?
- Look at the folds of the green curtain. Is it hanging with a lot of fullness or a little? How can you tell?
- Find the red curtain over the window. Why might a family hang a curtain over a window that opens?
- Look at the leaded glass panes. Count the rows. How might you measure a window like this for a curtain?

Talk about it

1. Vermeer painted the green curtain as if it were hanging in front of the painting itself. Why do you think he did that?
2. What jobs does a curtain do besides looking beautiful?
3. If you were sewing a curtain for this window, what measurements would you take first?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Measure high windows from a sturdy step stool only with an adult holding it, or let the adult measure while you write. Long panels are heavy at the machine: support the fabric on a table so its weight does not drag your hands toward the needle, keep fingers an inch from the needle, and pull pins before the foot. Press long hems with the iron cord out of the walkway.

SEWING PROJECT

A Room Plan and a Tab-Top Curtain Panel

You will measure a room and draw it to scale, measure a window and write a complete cut plan with yardage and cost, and then sew a tab-top curtain panel that hangs on a real rod.

You will need

- A steel tape measure and a 60-inch sewing tape measure
- Graph paper, a ruler and a pencil ($\frac{1}{4}$ -inch squares make an easy $\frac{1}{4}$ inch = 1 foot scale)
- A sewing machine (or hand-sewing needle for backstitch), fabric shears, pins or clips
- A yardstick and chalk, a seam gauge, an iron and ironing board
- A calculator

UNLINED TAB-TOP CURTAIN PANEL

Finished size: One panel 48 in wide $\times$ 63 in long finished (for half of a 48-inch rod at 2 $\times$ fullness); change the sizes to fit your window · About 3 hours over two sessions

Fabric and notions

- Main fabric for one panel: cut 52 $\times$ 69½ in (132 $\times$ 177 cm); 2 yards (183 cm) of 54-inch light- to medium-weight cotton or linen blend
- Facing strip for the top: 52 $\times$ 4 in (132 $\times$ 10 cm), from the same fabric
- Tabs: 7 strips, each 4 $\times$ 8 in (10 $\times$ 20 cm), from the same fabric (about $\frac{1}{4}$ yard)
- All-purpose thread to match

How to make it

1. **Measure and plan:** measure the rod length and the finished length you want, twice each. Write your cut plan: panel width = (rod $\times$ fullness $\div$ number of panels) + 4 inches; cut length = finished length + $\frac{1}{2}$ + 6 inches. Have a parent check it.
2. Prewash and press the fabric. Square one end by pulling a thread or using a carpenter's square, mark the panel with chalk and a yardstick, and cut it.
3. **Side hems:** fold each long edge 1 inch to the wrong side and press, then 1 inch again and press. Stitch close to the inner fold.
4. **Tabs:** fold each tab strip in half lengthwise, right sides together, and sew the long edge with a $\frac{1}{2}$ -inch seam. Turn it right side out, center the seam on the back and press. Fold each tab in half to make a loop 3½ inches long.

5. Pin the tabs to the top edge of the panel on the right side, raw edges matching and loops pointing down: one at each end, $\frac{1}{2}$ inch in from the side hems, and the others evenly spaced between. (For 7 tabs on 48 inches, about $7\frac{1}{2}$ inches apart.)
6. **Facing:** press under $\frac{1}{2}$ inch on one long edge of the facing strip. Lay the facing on the panel top, right sides together, over the tabs, raw edges matching, with 1 inch extra at each end. Sew across the top with a $\frac{1}{2}$ -inch seam.
7. Turn the facing to the back, folding the extra ends under to line up with the side hems. Press, and stitch along the facing's lower fold, catching the tabs at the top.
8. **Bottom hem:** fold the bottom edge up 3 inches and press, then 3 inches again. Measure in several places so it is even. Stitch close to the inner fold, or blind-hem it by hand.
9. Press the finished panel and hang it on the rod. Spread the tabs evenly.

Fabric check: Choose a light- to medium-weight woven cotton, linen or cotton-linen blend that drapes softly and presses well; home-décor cottons 54 inches wide are easiest. Prewash it, because cotton and linen shrink and a curtain that shrinks after washing ends up too short. Avoid stretchy knits and slippery sheers for a first panel. Polyester resists sun-fading and wrinkles; press it on a low setting with a press cloth.

Steps

1. **Count out** needles and pins.
2. **Room plan.** Draw the room on graph paper at $\frac{1}{4}$ inch = 1 foot: walls, doors, windows (with their widths), and the main furniture. Mark where the curtain will hang.
3. **Cut plan.** Write the window measurements, the fullness, the cutting sizes, the yardage and the cost of the fabric you choose. A parent checks it before cutting.
4. Sew the panel from the pattern card.
5. **Hang test.** Hang the panel and measure the finished length at both edges and the middle. Is it within $\frac{1}{2}$ inch of your plan?
6. **Count in and clean up.** Pins and needles counted in; iron unplugged and on its heel; scraps saved for tabs and patchwork.

7. **Improve it.** Write what you would change for the matching second panel (more fullness, longer tabs, a deeper hem), and sew it if the window needs a pair.

Tips

- Lay long fabric out on a clean floor or a large table with a sheet under it to mark and cut. Never let a long panel hang off the sewing table while you sew; it pulls your seam crooked.
- Use a carpenter's square or the corner of a cutting mat to make sure the ends are cut at right angles.
- Younger students: make a short café or valance panel (for example 36 × 18 inches finished) by the same steps. Older students: sew the pair and add a contrasting band at the bottom.

Check your work

- ☐ I measured my room and window twice, drew them to scale and wrote a correct cut plan with yardage and cost.
- ☐ My side and bottom hems are straight and even and my tabs are evenly spaced.
- ☐ My panel hangs within ½ inch of the planned length.

SEWING NOTEBOOK

1. Tape in your scale drawing of the room, with the window and curtain marked.
2. Write the full cut plan: rod, fullness, panel width, cut length, yardage, cost.
3. Write how the yard was standardized, with the dates 1834, 1855 and 1959.

From history. Since 1959, the U.S. inch has been defined as exactly 2.54 centimeters. Surveyors in the United States, however, kept using a slightly different “survey foot” for land measurement until it was officially retired at the end of 2022.

COMMON MISTAKES

- Measuring the glass instead of the rod. Curtains are sized to the rod and where they should hang.
- Forgetting the heading and the hems in the cut length. The curtain ends up several inches short.
- Cutting before checking the math. Curtain fabric is expensive; a parent checks the cut plan first.

Make it a game • Guess the Window. Each player secretly guesses the width and height of five windows or doors in the house, in inches. Then measure each one together. Score the difference between guess and measurement; lowest total wins. Finish by figuring the curtain cut width for the winner's favorite window at 2× fullness.

7.2 LINING AND DRAPES

OBJECTIVES

- Tell how the tabernacle’s door hanging was made in layers of fine work (Exodus 26:36), and how upholsterers lined bed and window hangings.
- Explain four things a lining does for drapes, and test them with light and temperature.
- Figure the sizes of face fabric and lining, and sew a pair of lined rod-pocket drapes for a real window.

Warm-up. Find a lined curtain or drape in your house (or a lined jacket). Hold it up to a window or a lamp. How much light comes through compared with a single layer of cotton? Feel the edge: how is the lining joined to the front? Look at the hem: is the lining shorter than the front?

WATCH

How to make basic lined curtains

Adrian Birtwell · 12:24

<https://www.youtube.com/watch?v=Yrg5vI6m0Ug>

WHEN TO WATCH

After “The fabric science.” Watch the measuring and cutting part first, then watch the sewing and hand-hemming part again before Session 2.

Note: A curtain workroom teacher from an English curtain company makes a lined curtain step by step. She uses an industrial machine and finishes the hem by hand. Her heading is a gathered tape; ours is a rod pocket.

BACKUP VIDEO

Sewing a simple lined curtain by Debbie Shore

Debbie Shore · 18:08

https://www.youtube.com/watch?v=tmKz2_KTEcU

Another clear demonstration of a lined curtain, with the measuring formula on screen. Watch the part where she cuts the lining smaller than the face fabric.

KEY TERMS

face fabric

The decorative fabric on the room side of a curtain.

lining

A plain fabric sewn behind the face fabric to protect it, block light, add body and help insulate.

blackout lining

A lining coated or woven so densely that it blocks nearly all light.

interlining

A soft middle layer, often flannel, between face and lining, for extra warmth and fullness.

drapes (draperies)

Heavier, usually lined curtains, often floor-length, that can be drawn closed.

sag

How much a curtain droops or grows in length over time as the fabric relaxes; lining and good grain help prevent it.

CORE IDEAS

The story. When God gave Moses the pattern of the tabernacle, the doorway of the tent was closed with “an hanging for the door of the tent, of blue, and purple, and scarlet, and fine twined linen, wrought with needlework” (Exodus 26:36), and over the whole tent went layer upon layer of coverings: goats’ hair, rams’ skins dyed red, and badgers’ skins (Exodus 26:7, 14). The fine work was on the inside; the tough layers on the outside protected it from sun, wind and sand. Thousands of years later, the upholsterers of Europe made bed hangings and window curtains the same way. In the 1700s, French upholsterers lined the great curtains around beds with plain linen or silk, so that the costly face fabric would not fade and the sleeper would be shielded from drafts and light. The plate from Diderot’s *Encyclopédie* in this lesson shows the bed and window hangings an upholsterer’s shop made.

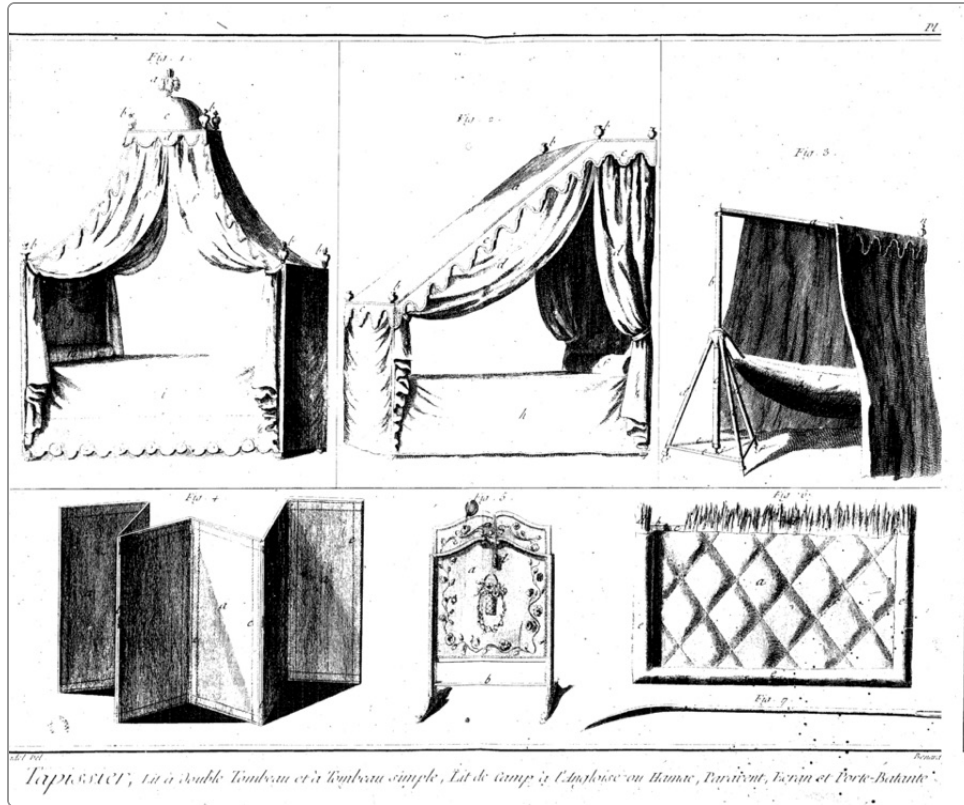
How they figured it out. Experience taught curtain makers what a lining does. First, it **protects**: sunlight fades dyes and weakens fibers, especially cotton, linen and silk, and the lining takes the sun instead. Second, it **blocks light**: two layers let through far less light than one, and a blackout lining nearly all of it. Third, it **insulates**: a layer of still air trapped between face and lining slows the cold that comes off window glass in winter. Fourth, it adds **body**, so the drapes hang in fuller, more even folds. Workrooms also

learned to cut the lining a little narrower and shorter than the face fabric, so the lining never peeks around the edges from the front.

The fabric science. Lined drape arithmetic for a 48-inch rod at $2\frac{1}{2}$ fullness, two panels, floor length. Finished width needed: $48 \times 2\frac{1}{2} = 120$ inches, so each panel is 60 inches wide finished. Face fabric: add $1\frac{1}{2}$ inches for each side turn-back: cut **63 inches** wide (so 54-inch fabric needs a second width seamed in; many workrooms use $1\frac{1}{2}$ widths per panel). For a simpler window, use fullness 2: 48 inches per panel, cut 51 inches wide from one 54-inch width. Lining: cut 3 inches narrower than the face, so the face wraps $1\frac{1}{2}$ inches around to the back on each side. Length for a finished 84-inch drape with a 3-inch rod pocket and a 4-inch double hem: face cut length = $84 + 3 + \frac{1}{2} + 8 = 95\frac{1}{2}$ **inches**; lining cut length = $84 + 3 + \frac{1}{2} + 4 - 1 = 90\frac{1}{2}$ **inches**, because the lining has a smaller hem and ends 1 inch above the face. Two face panels: $2 \times 95\frac{1}{2} = 191$ inches $\div 36 \approx 5.3$, buy **$5\frac{1}{2}$ yards**. Two lining panels: $181 \div 36 \approx 5.03$, buy **$5\frac{1}{4}$ yards**.

Let's sew. You will sew a **pair of lined rod-pocket drapes** for a real window (or a shorter lined pair for a small window), then test them against your unlined panel from Lesson 7.1. The one skill to do well is **keeping the lining hidden**: measure the side turn-backs and the lining hem in several places so they are even all the way down.

PICTURE STUDY



The Upholsterer: Beds with Hangings, a Field Bed, Screens and a Swinging Door, Engraved plate from Diderot and d'Alembert's *Encyclopédie*, Plates published 1762–1772 · Engraving · *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*, Paris

Image: [Wikimedia Commons](#), public domain

In the 1700s the French writers Denis Diderot and Jean d'Alembert published a huge encyclopedia that explained every trade with engraved plates. This plate comes from the section on the *tapissier*, the upholsterer, who made bed curtains, window hangings, screens and padded doors. Every curtain shown here would have been lined.

Look closely

- Find the curtains around the beds. How do they hang from the canopy? Can you see where they are gathered and where they fall in folds?
- Find the curtains drawn back. What holds them open?
- Find the folding screen and the small fire screen. What were they for in a cold, drafty house?
- Find the padded door with a diamond pattern. What would padding do on a door?

Talk about it

1. Bed curtains kept sleepers warm in rooms without central heating. How is a lined drape like a bed curtain?
2. Why do you think the encyclopedia's makers drew trades so carefully?
3. What in your home is lined, padded or layered to keep out cold or light?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Long, heavy panels must be supported on a table at the machine and the ironing board so their weight never pulls your hands toward the needle or the iron. Use a step stool only with an adult holding it, and let an adult install any rod that needs a drill or screws.

SEWING PROJECT

A Pair of Lined Rod-Pocket Drapes

You will figure the face and lining sizes, sew the lining to the face so it is hidden, make a rod pocket and hems, and hang the pair. Then you will test what the lining does.

You will need

- A sewing machine (or hand needle for backstitch), fabric shears, pins or clips and a pincushion
- A yardstick, a seam gauge, chalk and a 60-inch tape measure
- An iron, ironing board and press cloth
- A curtain rod (an adult installs it) and a step stool held by an adult
- A flashlight and a kitchen or outdoor thermometer for the tests

LINED ROD-POCKET DRAPES (PAIR)

Finished size: Two panels, each 48 in wide × 63 in long finished, for a 48-inch rod at 2× fullness; change the sizes for your window · About 4–5 hours over two sessions and the week

Fabric and notions

- Face fabric: 2 panels cut 51 × 74½ in (130 × 189 cm): 4¼ yards of 54-inch medium-weight cotton, linen blend or home-décor fabric

- Lining: 2 panels cut $48 \times 69\frac{1}{2}$ in (122×177 cm): 4 yards of 54-inch cotton sateen or polyester-cotton drapery lining (or blackout lining)
- All-purpose polyester thread to match the face fabric

How to make it

1. **Plan:** write your face and lining cut sizes. Face length = finished length + 3 (rod pocket) + $\frac{1}{2}$ + 8 (double 4-inch hem). Lining = 3 inches narrower and 5 inches shorter than the face. Have a parent check.
2. Prewash both fabrics and press. Cut the face panels and lining panels on grain.
3. **Hem first:** on each face panel, turn up 4 inches at the bottom and press, then 4 inches again; stitch or blind-hem. On each lining panel, turn up 2 inches, then 2 inches again, and stitch.
4. Lay a face panel right side up. Lay the lining on it right side down, with its top edge 1 inch below the face's top edge and its hem 1 inch above the face's hem. Line up one long edge of the lining with one long edge of the face and pin. Sew with a $\frac{1}{2}$ -inch seam from the top of the lining down to 6 inches above the lining's hem.
5. Shift the lining over to match the other long edge (the face will bubble in the middle because it is 3 inches wider). Pin and sew the second side the same way.
6. Turn the panel right side out. Center the lining so $1\frac{1}{2}$ inches of face fabric shows on the back along each side. Press the sides crisply.
7. Finish the hem corners by hand: fold the loose face fabric in at the bottom corners and slip-stitch the edges so no raw edge shows.
8. **Rod pocket:** at the top, fold the face fabric's extra inch down over the lining and press. Then fold down another $3\frac{1}{2}$ inches over the lining and press. Stitch close to the lower fold, and again 1 inch below the top fold if you want a small ruffle (header) above the rod.
9. Press the panel, slide both panels onto the rod and hang. Arrange the folds evenly and let them hang a few days.

Fabric check: Choose a medium-weight, closely woven face fabric (cotton, linen blend or home-décor weight) and a lining made for curtains: cotton sateen, polyester-cotton or blackout lining. Prewash both, since face and lining that shrink differently will pucker. Cut both exactly on grain, or the drapes will twist as they hang. Avoid knits and

very heavy upholstery fabrics. Press synthetics and blackout lining only on a low setting with a press cloth; blackout coatings can melt.

Steps

1. **Count out** needles and pins.
2. **Practice first.** Make a 12 × 15 inch lined sample by the same steps to practice the side turn-backs and corners.
3. Sew the drapes from the pattern card.
4. **Light test.** In a dark room, shine a flashlight through one layer of your face fabric, then through the lined drape. Describe or photograph the difference.
5. **Warmth test.** On a cold day, place a thermometer between the window and an unlined panel, and another between the window and the lined drape, both closed for 30 minutes. Record the temperatures on the room side of each.
6. **Count in and clean up.** Count pins and needles; unplug the iron and the machine; fold away the stool.
7. **Improve it.** Note anywhere the lining shows from the front, and how you would measure or press it next time.

Tips

- Sew the side seams with the lining on top, so you can see that it is not twisting.
- Weight the bottom corners with a coin or a drapery weight tucked inside the hem so the drapes hang straight.
- Younger students: line a short café curtain using the same method. Older students: add an interlining of cotton flannel for a winter drape.

Check your work

- ☐ I figured face and lining cut sizes correctly and had them checked before cutting.
- ☐ My lining is hidden from the front, with even 1½-inch turn-backs on both sides.
- ☐ I tested and recorded what the lining did for light and warmth.

SEWING NOTEBOOK

1. Draw a cross-section of a lined drape: face, lining, side turn-backs, rod pocket, two hems.

2. Write your cut plan for face and lining with all the arithmetic.
3. Record the light and warmth tests, and copy Exodus 26:36.

From history. Before central heating, heavy lined curtains around beds were common in Europe and early America. A curtained bed was almost a little room of its own, and in a cold farmhouse it could be the warmest place in the house.

COMMON MISTAKES

- Cutting the lining the same size as the face. It shows around the edges. Cut it 3 inches narrower and shorter.
- Letting the long panel hang off the table while sewing. The seam wanders and your hands get pulled. Support the fabric.
- Using unshrunk fabric. After washing, the face and lining shrink differently and the drape puckers.

Make it a game • Layer Detective. Your parent gathers six pieces of fabric of different weights, and a flashlight. In a dark room, you stack and test them in pairs, predicting which pair lets through the least light. Score a point for each correct prediction. Then build the best two-layer “drape” and the best three-layer one.

Scripture. “And thou shalt make an hanging for the door of the tent, of blue, and purple, and scarlet, and fine twined linen, wrought with needlework.” (Exodus 26:36, KJV)

The door hanging of the tabernacle was beautiful needlework, protected by tough coverings outside. A lined drape follows the same wise pattern: fine work, protected.

7.3 QUILTING: THE PIECED BLOCK AND THE ROTARY CUTTER

OBJECTIVES

- Tell how photographers of the Farm Security Administration recorded quilts in the 1930s and 1940s, and how the rotary cutter (1979) changed quilting.
- Use a rotary cutter safely with an adult nearby, and cut accurate strips and squares with a ruler and mat.
- Piece, quilt and bind a table runner, figuring squares, strips and binding.

Warm-up. Lay a quilt (or a patchwork pillow) on the floor. Measure one square or block. Count the blocks across and down and figure the quilt's size. Measure it to check. Now look closely at the seams: are the corners matched? Find where the binding is joined.

WATCH

Zig Zag Charm Pack Table Runner

Missouri Star · 15:55

https://www.youtube.com/watch?v=-i_RVyvlxXM

WHEN TO WATCH

Before Session 2. Watch how Jenny Doan lays out squares, sews rows, presses and quilts. Our runner is set in straight rows rather than her zig-zag, but every step is the same.

Note: From the Missouri Star Quilt Company. She cuts with a rotary cutter, as our students do only with an adult nearby, blade closed whenever it is set down.

BACKUP VIDEO

Rotary Cutter Safety | National Quilter's Circle

National Quilters Circle · 1:45

<https://www.youtube.com/watch?v=3iKDArMS7y4>

Watch before you touch the rotary cutter: how the blade guard works and why it closes every time the cutter is set down.

KEY TERMS

rotary cutter

A round blade on a handle, rolled along a ruler on a self-healing mat to cut fabric accurately. Its guard must be closed whenever it is not cutting.

subcut

Cutting a long strip into squares or rectangles.

binding

A folded strip of fabric sewn around the edge of a quilt to cover the raw edges.

width of fabric (WOF)

A strip cut from selvage to selvage, usually about 42 inches of usable width on quilting cotton.

quilt sandwich

The three layers of a quilt: top, batting and backing, held together by quilting stitches or ties.

stitch in the ditch

Quilting right in the seam line between patches, so the stitching hides.

CORE IDEAS

The story. In the 1930s and early 1940s, the U.S. government's Farm Security Administration sent photographers across the country to record how farm families were living through the hard years of drought and the Depression. Photographers such as Russell Lee, Marion Post Wolcott and Arthur Rothstein photographed families at work and at home, and again and again quilts appeared in their pictures: quilts on beds, quilts on clotheslines, quilts being made at quilting frames. In April 1939 Russell Lee photographed a family of berry pickers near Hammond, Louisiana, who had hung a pieced fan quilt across a doorway to divide their quarters from another family's. A quilt was a blanket, a wall, a door and a piece of beauty in a poor home. Those photographs, now kept at the Library of Congress, are some of the best records we have of everyday American quilts.

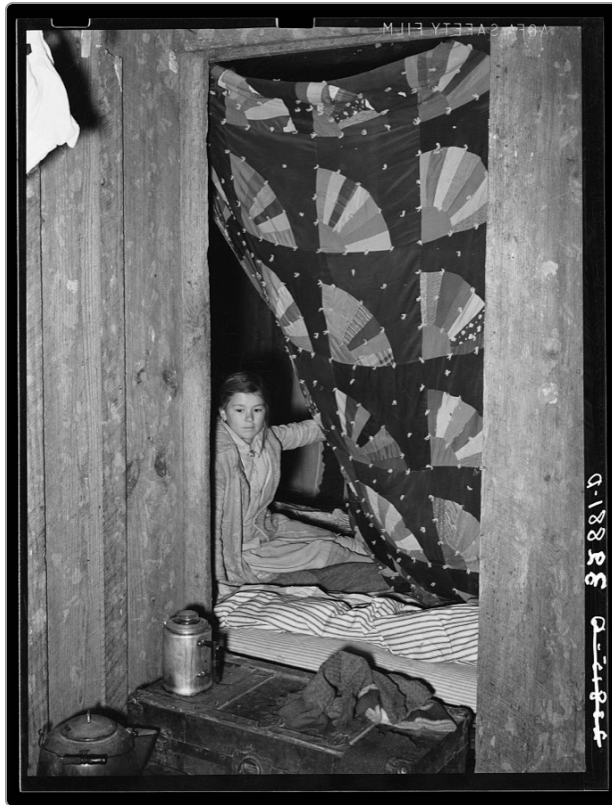
How they figured it out. For generations, quilters cut every piece with scissors around a cardboard template, one at a time. In 1979 the Japanese company Olfa, already known for its snap-off utility knives, brought out a **rotary cutter**: a round blade on a handle. Rolled along a thick acrylic ruler on a self-healing mat, it could cut through several layers of fabric at once in a perfectly straight line. Quilters quickly worked out **strip piecing**: cut long strips across the width of the fabric, then subcut them into squares, or

sew strips together first and subcut the sewn sets. Work that once took days took hours, and accuracy improved. But the blade is razor sharp, so quilters also learned firm rules: close the blade every time you set it down, cut away from your body, keep your other hand flat on the ruler with fingertips away from the edge, and stand to cut.

The fabric science. Quilting runs on the $\frac{1}{4}$ -inch seam. Runner arithmetic: our runner is 3 squares across and 9 down, each square finishing at 4 inches, so it finishes at $3 \times 4 = 12$ inches by $9 \times 4 = 36$ inches. Each square is cut $4 + \frac{1}{4} + \frac{1}{4} = 4\frac{1}{2}$ inches. We need $3 \times 9 = 27$ squares. A 42-inch strip $4\frac{1}{2}$ inches wide gives $42 \div 4\frac{1}{2} = 9.33$, so **9 squares per strip**, and 27 squares need **3 strips**. Backing and batting are cut 2 inches bigger on every side: 16×40 inches. Binding goes around the perimeter: $2 \times (12 + 36) = 96$ inches, plus about 10 inches for corners and the join: 106 inches. Strips $2\frac{1}{2}$ inches wide across the fabric give about 42 inches each, so $106 \div 42 = 2.5$: cut **3 strips**. Cotton batting is best for a runner, because a hot dish could melt polyester.

Let's sew. You will rotary-cut, piece, quilt and bind a **table runner**, a gift for a grandparent's or a neighbor's table. The one skill to do well is **safe, accurate rotary cutting**: stand, hold the ruler firmly with your fingers away from the edge, cut away from you, and close the blade every single time.

PICTURE STUDY



Quilt Hung Across a Doorway, Berry Pickers' Quarters near Hammond, Louisiana, Russell Lee (Farm Security Administration), April 1939 · Black-and-white photograph · Library of Congress, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

Russell Lee took this photograph of migrant berry pickers near Hammond, Louisiana, in 1939. Two families shared a small building, and one hung a quilt across the doorway between their quarters. The pieced quilt, with its fan blocks, gave both families a little privacy and a little beauty.

Look closely

- Find one fan block. How many blades (wedges) does each fan have?
- Look at the dark sashing between the blocks. What does it do for the design?
- Look at the rough boards of the walls and doorway. What does the quilt add to this room?
- Find the small round dots or knots across the quilt. Could this quilt be tied rather than quilted?

Talk about it

1. How many uses for a quilt can you find in this photograph?

2. Why do you think the government wanted pictures like this taken?
3. What would you want a quilt you make to be used for?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. **Use the rotary cutter only with an adult nearby**, only on the cutting mat, standing up, cutting away from your body, with your other hand flat on the ruler and fingertips back from its edge; **close the blade every time you set it down**, even for a second, and store it out of reach of children. Machine-quilt slowly with hands flat on either side of the foot.

SEWING PROJECT

A Pieced and Quilted Table Runner

You will rotary-cut 27 squares, piece them into a runner with $\frac{1}{4}$ -inch seams, layer it with cotton batting and backing, quilt it with straight lines, and bind the edges.

You will need

- A 45 mm rotary cutter with a safety guard, a self-healing mat and a 6 × 24 inch ruler (adult nearby), or fabric shears and a 4½-inch cardboard template
- A sewing machine with a $\frac{1}{4}$ -inch foot or a tape guide (and a walking foot if you have one)
- Pins or clips, safety pins for basting, an iron and ironing board
- A hand-sewing needle for finishing the binding

THREE-BY-NINE PATCHWORK TABLE RUNNER

Finished size: About 12 × 36 in (30 × 91 cm) finished · About 5–6 hours over two sessions and the week

Fabric and notions

- Squares: 27 squares cut 4½ × 4½ in (11.4 cm) from three 4½-inch strips across the width of quilting cotton (three $\frac{1}{8}$ -yard pieces, or scraps)
- Backing: one piece of quilting cotton 16 × 40 in (41 × 102 cm), about $\frac{1}{2}$ yard
- Batting: one piece of thin cotton batting 16 × 40 in
- Binding: three strips 2½ in × width of fabric (about $\frac{1}{4}$ yard)
- Neutral cotton thread

How to make it

1. **Square the fabric:** fold each fabric selvage to selvage and lay it on the mat. With an adult nearby, trim one edge straight with the ruler square to the fold. Close the blade.
2. **Cut strips:** lay the ruler's 4½-inch line on the clean edge and cut a 4½-inch strip. Close the blade. Cut three strips in all (more if mixing fabrics).
3. **Subcut:** turn each strip sideways, trim the selvage, and cut 4½-inch squares, closing the blade between cuts when you move your hands. You need 27.
4. Lay out the squares in 9 rows of 3 and arrange the colors until you like it. Photograph the layout.
5. Sew each row of 3 with a ¼-inch seam. Press the seams of odd rows to the left and even rows to the right so they nest.
6. Sew the rows together, pinning at each seam so the corners match. Press. The top should measure 12½ × 36½ in.
7. **Sandwich:** lay the backing right side down, smooth the batting on it, and center the top right side up. Pin every 4 inches with safety pins.
8. **Quilt:** stitch in the ditch along every long seam and across every row seam, starting in the middle and working out, at a slow speed. Trim the batting and backing even with the top.
9. **Bind:** join the binding strips end to end with diagonal seams; press in half lengthwise. Sew to the front edge with a ⅜-inch seam, mitering each corner. Fold to the back and slip-stitch by hand.

Fabric check: Use 100% quilting cotton for the top, backing and binding: it presses crisply, cuts accurately and does not stretch. Use cotton batting, not polyester, because a hot dish set on a polyester runner can melt it. Prewash all fabrics if you will wash the runner, and press them with a little spray starch for accurate cutting. Avoid knits and loosely woven fabrics, which stretch and slide under the ruler.

Steps

1. **Count out needles, pins and safety pins. Check the rotary cutter:** the adult shows that the guard opens and closes.
2. **Practice first.** With the adult beside you, cut five 2-inch strips from a scrap, closing the blade after each, until your strips measure 2 inches at both ends.

3. **Seam test.** Sew two 2½-inch squares together and measure: the result should be exactly 4½ inches wide. Adjust your guide until it is.
4. Make the runner from the pattern card.
5. **Corner check.** Count how many of the 16 inside corners match within ⅛ inch.
6. **Count in and clean up.** Rotary cutter closed and put away by the adult; pins and safety pins counted; scraps saved.
7. **Give it.** Give the runner with a card saying it is cotton and can hold a warm dish.

Tips

- Cut with firm, even pressure in one pass. If a thread did not cut, close the blade, lift the ruler only after checking, and recut the spot.
- A walking foot keeps the three layers from shifting while you quilt.
- Younger students: cut squares with shears around a template and tie the layers instead of quilting. Older students: add a 2-inch border and figure the new binding length.

Check your work

- ☐ I used the rotary cutter safely every time: adult nearby, standing, cutting away, blade closed whenever it was set down.
- ☐ My squares are accurate, my seams are ¼ inch, and most corners match.
- ☐ I figured the strips, squares, backing and binding correctly, and my binding is smooth with mitered corners.

SEWING NOTEBOOK

1. Color your runner layout on graph paper.
2. Write the runner math: finished size, cut size, squares per strip, strips, binding length.
3. Write the rotary cutter rules in your own words and sign them.

From history. The Library of Congress holds about 175,000 Farm Security Administration and Office of War Information negatives, and anyone can view and download many of them free from its website. Searching them for “quilt” brings up hundreds of photographs.

COMMON MISTAKES

- Setting the rotary cutter down with the blade open, even for a moment. Close it every time.
- Cutting toward your body or with your fingers at the ruler's edge. Cut away, fingers back.
- Using a $\frac{5}{8}$ -inch seam instead of $\frac{1}{4}$ inch. The runner comes out too small.

Make it a game • Strip Math Sprint. Your parent names a square size and a number of squares (say $3\frac{1}{2}$ -inch squares, 40 of them). Race to figure the cut size, squares per 42-inch strip and the number of strips. Check together with a ruler. A correct answer scores a point; first to five chooses the runner's colors.

7.4 SLIPCOVERS AND UPHOLSTERY

OBJECTIVES

- Tell how the upholsterer's trade worked in eighteenth-century Paris and London, and what the Encyclopédie shows of it.
- Name the layers of an upholstered seat (frame, webbing or board, padding, batting, cover) and figure the cover size.
- Re-cover a footstool or dining-chair seat with an adult beside you at the staple gun, or sew a fitted slipcover.

Warm-up. With an adult, turn over a footstool, ottoman or dining chair. Look for staples, tacks, cambric (the thin black cloth underneath) and screws. Press the top: how thick is the padding? Measure the top and the thickness and write them down.

WATCH

Upholster a Footstool Lesson with Evelyn Bouma

[CreativFestival](#) · 4:13

<https://www.youtube.com/watch?v=BaWYP5O0K0M>

WHEN TO WATCH

After “The fabric science.” Watch the order of layers (foam, batting, fabric) and how she pulls the fabric from the middle of each side before the corners.

Note: An experienced upholstery teacher demonstrates at a sewing and craft show, with a helper; the hall is busy in the background.

BACKUP VIDEO

How to Reupholster a Footstool - Simple

[thegreenworkbench](#) · 6:27

<https://www.youtube.com/watch?v=xPM3rbhtCoU>

A second footstool shown from start to finish: removing the old cover, cutting new foam and stapling the new fabric.

KEY TERMS

upholsterer (tapissier)

A craftsman who pads and covers furniture and makes curtains and hangings. The French word is *tapissier*.

foam density

How firm upholstery foam is. Seats need high-density foam that springs back; soft foam flattens quickly.

slipcover

A sewn, removable cover shaped to fit a piece of furniture.

webbing

Strong woven bands stretched across a frame to hold up the padding.

cambric (dust cover)

A thin, usually black fabric stapled under a seat to hide the raw edges and keep dust in.

double rub

One back-and-forth rub in a wear test. Fabrics for seats should take 15,000 double rubs or more.

CORE IDEAS

The story. In the 1700s the upholsterer was one of the most important craftsmen in a fine house. In Paris he was called the *tapissier*; in London, the “upholder.” He did far more than cover chairs: he made bed hangings and window curtains, padded walls and doors, stuffed mattresses, and often arranged the furnishing of whole rooms. The great French *Encyclopédie* of Denis Diderot and Jean d’Alembert, whose plates were published between 1762 and 1772, showed the upholsterer’s shop in detail: in the plate for this lesson, workers sit sewing at a table, a porter carries rolled mattresses up the stairs, and finished armchairs, a sofa and bed hangings fill the room. Customers came to choose fabrics and order work for their homes.

How they figured it out. Upholsterers built a seat in layers, each with a job. A **frame** of wood carried the load. **Webbing** of strong woven jute or linen was stretched tight across the frame. On it went **padding**: in those days curled horsehair, wool or vegetable fiber, stitched into shape; today, usually foam. A layer of **batting** softened the edges, and the **cover fabric** was pulled tight over all and fastened underneath with tacks, today with staples. They learned to pull from the **center of each side** outward, balancing front against back and left against right, so the cover lies smooth with the grain straight, and to fold corners neatly.

The fabric science. Seat fabric takes hard wear, so upholstery fabrics are tested with a rubbing machine. Fabrics for chairs used every day should take at least about **15,000 double rubs**; heavy-duty fabrics take 30,000 or more. Tightly woven cotton canvas, twill, denim and polyester or cotton blends wear well; loose weaves snag. Cover arithmetic: measure the seat top and add the thickness of the padding on each side, plus 3 inches on each side to wrap underneath and staple. For a footstool top 14 × 18 inches with 2-inch foam: width $14 + 2 + 2 + 3 + 3 = 24$ inches; length $18 + 2 + 2 + 3 + 3 = 28$ inches. Batting: the top plus the padding on each side plus 1 inch: $14 + 4 + 2 = 20$ by $18 + 4 + 2 = 24$ inches. If a print must be centered, buy extra so the motif sits in the middle.

Let's sew. You will **re-cover a footstool or a dining-chair seat**: measure, cut, layer and pull the fabric smooth while an adult stands beside you and you staple (or the adult staples). Families without a seat to re-cover can sew a **fitted slipcover** for a footstool or cushion instead. The one skill to do well is **even tension from the center out**.

PICTURE STUDY



The Upholsterer: Inside a Shop, Engraved plate from Diderot and d'Alembert's *Encyclopédie*, Plates published 1762–1772 · Engraving · Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, Paris

Image: [Wikimedia Commons](#), public domain

This plate from the *Encyclopédie* shows the inside of a Paris upholsterer's shop in the 1760s. Small letters on the objects match a key in the book. Upholsterers made everything soft in a fine house: chairs, sofas, mattresses, bed hangings and curtains.

Look closely

- Find the women sewing at the table. What might they be sewing for the shop?
- Find the upholstered sofa and the armchairs. Can you see where the fabric is pulled smooth over the padding?
- Find the stacks of mattresses and the porter on the stairs. What is he carrying?
- Find the two customers at the left. What do you think they have come to order?

Talk about it

1. How many different trades or jobs can you find happening in this one shop?
2. Which things in this shop would still be made by an upholsterer today?
3. If you ran an upholstery shop, what would your first project be?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. **The staple gun is used only with an adult beside you and safety glasses on;** keep your free hand well away from the staple path, point it only at the work, and lock it when you set it down. Pull old staples with pliers away from your face, wearing safety glasses, and drop each one in a jar. An adult cuts foam and removes and replaces any screws.

SEWING PROJECT

Re-cover a Footstool or Chair Seat (or Sew a Slipcover)

You will take apart an old seat, measure and cut new foam, batting and fabric, and pull the new cover tight with an adult beside you at the staple gun. If you have no seat to re-cover, sew a fitted slipcover instead (see the tips).

You will need

- A manual staple gun with $\frac{3}{8}$ -inch staples and safety glasses (with an adult beside you)
- A flat screwdriver and needle-nose pliers for old staples, and a jar
- Fabric shears, a yardstick, chalk and a tape measure
- A screwdriver to remove the seat (adult)
- An electric knife or long serrated knife for foam (adult only)

RE-COVERED FOOTSTOOL TOP

Finished size: One footstool top about 14 × 18 in (36 × 46 cm); change the sizes for your seat • About 2–3 hours

Fabric and notions

- Cover fabric cut 24 × 28 in (61 × 71 cm): $\frac{3}{4}$ yard of 54-inch upholstery-weight fabric, canvas, twill or denim
- High-density upholstery foam 2 in (5 cm) thick, cut 14 × 18 in by an adult (only if the old foam is flat)
- Polyester or cotton upholstery batting cut 20 × 24 in
- Black cambric or plain cotton for the underside, 13 × 17 in
- About 80 staples, $\frac{3}{8}$ inch

How to make it

1. An adult removes the top from the stool. Draw or photograph how the old cover is fastened and folded at the corners.
2. With safety glasses on and an adult beside you, pull out the old staples with the screwdriver and pliers, dropping each in the jar. Save the old cover as a pattern.
3. Measure the top and the foam. Write the cover and batting sizes. Press and cut the fabric, centering any motif.
4. Lay the fabric right side down on a clean table, then the batting, then the foam, then the board top-side down.
5. Pull the fabric over the center of one long side and staple once (with the adult beside you). Pull the opposite side firmly and staple its center. Do the same with the two short sides.

6. Work out from each center toward the corners, staples about 1½ inches apart, pulling evenly so the top has no wrinkles. Stop 2 inches from each corner.
7. **Corners:** pull the corner point straight onto the board and staple it. Fold each side in like wrapping a present, trim extra bulk (adult or student with shears), and staple.
8. Staple the cambric underneath, turning its edges under ½ inch.
9. An adult reattaches the top to the stool.

Fabric check: Choose a firmly woven upholstery-weight fabric (canvas, duck, twill, denim, chenille or a home-décor fabric rated for 15,000 or more double rubs). Avoid stretchy knits and loose weaves, which sag and snag, and thin quilting cotton, which wears through. Dark colors and busy prints hide spills. Polyester batting is fine under a seat cover because no heat touches it. Check that stripes run straight before the first staples go in.

Steps

1. **Count out** needles and pins, and set the staple jar on the table.
2. **Practice first.** Wrap a hardcover book in a scrap with batting, folding the corners like a present, until they are smooth.
3. **Staple practice.** With the adult beside you and safety glasses on, staple a scrap to a board ten times, holding your other hand well away.
4. Re-cover the top from the pattern card.
5. **Wrinkle check.** Look across the top in low light. If there are pulls or wrinkles, the adult helps remove a few staples and you re-stretch.
6. **Count in and clean up.** Staple gun locked and put away by the adult; every old staple in the jar; floor swept with a magnet.
7. **Improve it.** Re-cover a second seat to match, or add piping to a slipcover.

Tips

- **Slipcover option:** measure the top (for example 14 × 18) and the side height (for example 6 inches). Cut a top piece 15 × 19 in (½-inch seams) and a side band 6½ in tall by $2 \times (14 + 18) + 1 = 65$ inches long. Sew the band into a ring, pin it around the top, matching corners, and sew. Hem the bottom edge ½ inch, or thread elastic through a casing so it hugs the stool.
- Pull firmly but evenly. Pulling one side harder than the other twists the stripes.

- Younger students: choose fabric, measure and fold corners while the adult staples. Older students: re-cover a drop-in dining chair seat with a centered print.

Check your work

- ☐ I can name the layers of an upholstered seat and figure the cover and batting sizes.
- ☐ My top is smooth with straight grain and neat corners.
- ☐ I followed the staple-gun rules exactly: adult beside me, safety glasses on, free hand away, gun locked when set down.

SEWING NOTEBOOK

1. Draw a cross-section of the seat: board or webbing, foam, batting, cover, staples, cambric.
2. Write the cover and batting arithmetic for your seat.
3. Draw the corner fold in four steps.

From history. Old upholstery was often stuffed with curled horsehair, which springs back for decades. Upholsterers taking apart an antique chair sometimes find the original horsehair, newspaper from a hundred years ago, or the signature of an earlier upholsterer under the cover.

COMMON MISTAKES

- Stapling all of one side first. The fabric pulls crooked. Staple the center of each side first.
- Cutting the cover without adding padding thickness and wrap allowance. It will not reach underneath.
- Holding the fabric right where the staple will go. Keep your free hand well away from the staple path.

Make it a game • Layer Order Race. Your parent writes the layers of an upholstered seat on cards (frame, webbing, foam, batting, cover, cambric, staples) and shuffles them. Race the timer to lay them in order from the bottom up and say each one's job. Then figure the cover size for a seat your parent names. Beat your time on a second round.

UNIT 7 REVIEW

Answer in complete sentences unless the question asks for a calculation or a show-me. For calculations, show every step; a right answer with no work earns half. The review is worth 100 points.

1. (7 pts)

How was the yard defined exactly in 1959, and how many centimeters is one inch?

2. (10 pts)

Calculate. A rod is 40 inches. You want 2 panels at a fullness of $2\frac{1}{2}$, each with 4 inches of side hems. How wide do you cut each panel?

3. (10 pts)

Calculate. Finished length 72 inches, rod pocket 3 inches plus $\frac{1}{2}$ inch turn-under, double 4-inch hem. What is the cut length? How many yards for 2 panels (round up to the nearest $\frac{1}{4}$ yard)? At \$14.50 a yard, what does it cost?

4. (8 pts)

Name four things a lining does for drapes.

5. (7 pts)

Why is the lining cut narrower and shorter than the face fabric?

6. (8 pts)

Show me. With an adult beside you, show the rotary cutter rules by cutting one $2\frac{1}{2}$ -inch strip from a scrap.

7. (10 pts)

Calculate. A runner is 4 squares across and 10 down, each finishing at 3 inches. What is its finished size? What size do you cut each square? How many squares come from one 42-inch strip, and how many strips do you need?

8. (8 pts)

Calculate. How much binding does a 12×30 inch runner need, adding 10 inches? How many 42-inch strips?

9. 7 pts

Why is cotton batting, not polyester, used in a table runner or potholder?

10. 8 pts

Name the layers of an upholstered seat from the bottom up.

11. 10 pts

Calculate. A chair seat is 16×17 inches with $1\frac{1}{2}$ -inch foam. With 3 inches on each side to wrap underneath, what size do you cut the cover?

12. 7 pts

Written answer. In three or four sentences, tell what the Farm Security Administration photographs show about quilts in the 1930s, or what an eighteenth-century upholsterer did.

UNIT CHALLENGE: A FINISHED ROOM PROJECT

Finish and install at least two pieces for real rooms in your home or a gift recipient's: your curtain panel or lined drapes, your table runner, and your re-covered seat or slipcover.

Make a notebook spread for each: the room plan or measurements, the cut plan with yardage and cost, a fabric swatch with the reason you chose it, before-and-after photographs, and one honest note about what you would change.

LOOK FOR	WHAT IT MEANS
Measured and planned	Rooms, windows, runner and seat measured twice; cut plans, yardage and cost figured correctly and checked before cutting.
Workmanship	Straight, even hems; lining hidden; $\frac{1}{4}$ -inch seams with matched corners; smooth binding; smooth, wrinkle-free seat cover.
Fabric choice	Each fabric suits its job (drapery weight, cotton batting near heat, upholstery weight for seats), with the reason written down.
Safety	Rotary cutter with an adult nearby and blade closed every time; staple gun with an adult beside and safety glasses; machine and iron rules; needle-and-pin count every session.

LOOK FOR	WHAT IT MEANS
Record and improvement	Photographs in place and one change made or planned. A crooked first try honestly recorded and redone earns full credit.

ANSWER KEY

1. In 1959 the yard was defined as exactly 0.9144 meter, which makes one inch exactly 2.54 centimeters.
2. $40 \times 2\frac{1}{2} = 100$ inches finished; $\div 2$ panels = 50 inches each; $+ 4 = 54$ inches cut width per panel.
3. $72 + 3 + \frac{1}{2} + 8 = 83\frac{1}{2}$ inches. $2 \times 83\frac{1}{2} = 167$ inches $\div 36 = 4.64$ yards, so buy $4\frac{3}{4}$ yards. $4.75 \times \$14.50 = \$68.88$ (68.875).
4. It protects the face fabric from sun fading and weakening; blocks light; insulates by trapping air against the cold glass; adds body so the drapes hang in fuller, even folds. (Also hides the back of the face fabric and seams.)
5. So the face fabric wraps around to the back along the sides (about $1\frac{1}{2}$ inches each side) and the lining hem ends above the face hem; then the lining never shows from the front.
6. Adult checks: student stands, uses a mat and ruler, keeps fingers flat and back from the ruler's edge, cuts away from the body in one pass, closes the blade immediately when done, and the strip measures $2\frac{1}{2}$ inches at both ends.
7. Finished: $4 \times 3 = 12$ inches by $10 \times 3 = 30$ inches. Cut squares $3\frac{1}{2}$ inches. $42 \div 3\frac{1}{2} = 12$ squares per strip. 40 squares $\div 12 = 3.33$, so 4 strips.
8. $2 \times (12 + 30) = 84 + 10 = 94$ inches. $94 \div 42 = 2.24$, so 3 strips.
9. A hot dish can melt polyester batting; cotton does not melt.
10. Frame (or board) with webbing; padding or foam; batting; cover fabric; with a cambric dust cover stapled underneath.
11. $16 + 1\frac{1}{2} + 1\frac{1}{2} + 3 + 3 = 25$ inches; $17 + 1\frac{1}{2} + 1\frac{1}{2} + 3 + 3 = 26$ inches. Cut 25×26 inches.
12. Open answer. FSA: photographers such as Russell Lee recorded farm and migrant families in the Depression, and their pictures show quilts used as bedding, doors, walls and decoration in poor homes, made from scraps; the photographs are kept at the Library of Congress. Upholsterer: the tapissier or upholder padded and covered chairs and sofas, made mattresses, bed hangings and curtains, and furnished whole rooms, as the Encyclopédie plates show.

DESIGN, CLOTHING & COSTUMES

This last unit puts everything together. You will learn the principles designers use, line, shape, color, texture and proportion, and plan one garment on paper with a fabric board. You will read a commercial pattern envelope the way dressmakers have since Ebenezer Butterick sold the first graded paper patterns in the 1860s, and you will sew a pair of elastic-waist pajama pants from a real pattern.

Then you will step back two hundred and fifty years into the shops of Colonial Williamsburg's tailors and milliners and build a historical costume piece for a history day, a play or a Christmas pageant. Last, you will sew a garment or costume of your own design that fits its purpose and its wearer, and hold a family sewing fair: you will show the year's work, explain one technique with the math behind it, wear one piece and give one away. Measuring for clothes is always done over light clothing by a parent (for older students, a mother for a daughter and a father for a son), and the numbers are written down for fit only.

PREREQUISITES

- Sews accurate seams at $\frac{5}{8}$ inch, finishes seams and hems, and is checked off for solo machine and iron use (Units 2–4)
- Can figure yardage and cutting sizes from measurements (Unit 7)
- Can sew a casing and thread elastic or a drawstring (Units 4 and 7)

MASTERY CHECKLIST

- ☐ I can name the elements of design and use the color wheel to choose a color scheme for a garment that fits its occasion.
- ☐ I can read a pattern envelope, choose a size by measurement, find my yardage, and lay out and cut a pattern on grain with notches marked.
- ☐ I can sew elastic-waist pajama pants from a commercial pattern.
- ☐ I can research a historical garment from good sources and make a costume piece for a history day, a play or a pageant.
- ☐ I can plan and sew a garment or costume of my own design, with ease for movement, and make a test version first if it must fit closely.
- ☐ I can show my year's work at a sewing fair, explain one technique with its math, and give one piece away.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **A beginner commercial pattern for elastic-waist pants (marked “easy” or “beginner”):** Any of the major pattern companies’ easy pajama-pant patterns works. Buy it by the hip measurement, and look for one that includes several sizes so the family can use it again.
- **A color wheel:** A cardboard color wheel from an art or craft store, or one drawn and painted by hand in Lesson 8.1.
- **Colonial Williamsburg Foundation: historic trades:** Free pages and videos on the Foundation’s own website and YouTube channel about the tailors, milliners, weavers and other tradespeople who work in the historic area, useful for Lesson 8.3.

Not required. Every project in this unit works with ordinary fabric-store supplies. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

8.1 Design Principles: Line, Shape, Color and Texture

2 sessions of 50–60 minutes

8.2 Commercial Patterns: Butterick’s Tissue and Pajama Pants

2 sessions of 60–90 minutes

8.3 Historical Costume: Colonial Williamsburg’s Tailors and Milliners

2 sessions of 60–90 minutes

8.4 Clothing That Fits Its Purpose and the Sewing Fair

2 sessions of 60–90 minutes

8.1 DESIGN PRINCIPLES: LINE, SHAPE, COLOR AND TEXTURE

OBJECTIVES

- Tell how Isaac Newton arranged the colors of the spectrum in a circle (1704), and how the color wheel helps designers choose colors.
- Name the elements of design (line, shape, color, texture, proportion) and how each changes the look and use of a garment.
- Plan one garment for a real occasion on a design page with a fabric board, and figure its cost.

Warm-up. Lay out five garments from your closet on a bed. For each, name its main color, its texture (smooth, nubby, soft, crisp), and the strongest line you see (stripes, seams, a row of buttons). Which would you wear to church, to a hike and to a history day? Why?

WATCH

Using a Color Wheel to Choose Quilt Colors | National Quilters Circle

National Quilters Circle • 8:51

<https://www.youtube.com/watch?v=hLHoFJSEGRg>

WHEN TO WATCH

After “How they figured it out,” with a color wheel in hand. Pause at each color scheme and find it on your own wheel.

Note: A quilting teacher explains complementary, analogous and other color schemes with a color wheel. The same schemes work for garments.

KEY TERMS

line

The direction the eye travels in a garment: seams, stripes, edges, a row of buttons. Vertical lines lead the eye up and down; horizontal lines lead it across.

shape (silhouette)

The outline of a garment, such as straight, A-line or full.

hue, value and intensity

Hue is the color's name; value is how light or dark it is; intensity is how bright or dull it is.

complementary and analogous

Complementary colors sit opposite each other on the color wheel (blue and orange). Analogous colors sit next to each other (blue, blue-green, green).

texture

How a fabric feels and looks: smooth, crisp, soft, nubby, shiny or dull.

proportion

How the parts of a design compare in size, such as the depth of a hem band to the length of a skirt.

CORE IDEAS

The story. In the 1660s a young Cambridge scholar named **Isaac Newton** darkened his room, let a single beam of sunlight through a hole in the shutter, and passed it through a glass prism. The white light spread into a band of colors on the far wall: red, orange, yellow, green, blue, indigo and violet. Then he sent the colors through a second prism and turned them back into white light. Newton showed that white light is made of all the colors together. In his book *Opticks* (1704), he drew the colors around a **circle**, joining red back around to violet, so that he could show how colors mix. That circle is the grandfather of the color wheel that artists, quilters and dressmakers use today.

How they figured it out. Painters and dyers built on Newton's circle to make color wheels for mixing paints and dyes, with the primary colors red, yellow and blue spaced around it and the colors that mix from them in between. Designers noticed that some arrangements on the wheel nearly always look pleasing. **Analogous** colors, side by side on the wheel, look calm and harmonious. **Complementary** colors, opposite each other, make each other look brighter and bolder. A **monochromatic** scheme uses one hue in light and dark values. Designers also learned that every garment is a set of choices: its **line** (stripes and seams that lead the eye), its **shape**, its **texture**, and its **proportion**. And good design always begins with the question: where will this be worn, and what must it do?

The fabric science. Color in cloth comes from dyes that absorb some wavelengths of light and reflect others: a red shirt reflects red light and absorbs most of the rest. Texture changes color too: a smooth satin reflects light in a sheen and looks brighter; a nubby wool scatters light and looks softer and darker, even in the same dye. That is why

designers make a **fabric board** with real swatches, not just colored pencils. A design is also a budget. Suppose your garment needs $2\frac{1}{4}$ yards of a cotton at \$9.99 a yard, $\frac{1}{2}$ yard of a contrast at \$11.49 a yard, and 1 yard of elastic at \$1.29: $2.25 \times 9.99 = \$22.48$; $0.5 \times 11.49 = \$5.75$; plus \$1.29; total \$29.52, before tax.

Let's design. You will make a **design page and fabric board** for the garment or costume you will sew in Lesson 8.4: its occasion and wearer, a sketch from the front and back, a color scheme marked on a color wheel, real swatches, the notions, and a cost estimate. The one skill to do well is **designing for the occasion**: comfortable, modest, suitable and practical for where it will be worn.

PICTURE STUDY



The Millinery Shop, Edgar Degas, about 1879–1886 · Oil on canvas · Art Institute of Chicago

Image: [Wikimedia Commons](#), public domain

Edgar Degas visited the hat shops of Paris many times and painted the milliners who made and trimmed hats by hand. Here a milliner studies a hat she is finishing. The hats on their stands fill the front of the picture like a bouquet of color and texture.

Look closely

- Find the colors of the hats: yellow, peach, green, turquoise. Which pairs sit near each other on a color wheel, and which sit opposite?
- Find the textures: feathers, ribbons, straw, flowers. How did Degas make each one look different?
- Look at the milliner's dress. Why might Degas have painted it in a quiet olive green?
- Follow the lines of the hat stands. Where do they lead your eye?

Talk about it

1. A milliner chose colors, textures and trims for each hat. What would she ask a customer first?
2. Which hat would you choose, and for what occasion?
3. How can you use color and texture in your own garment design?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Cut swatches with fabric shears carried closed and points down. If you paint a color wheel, cover the table and wash brushes in water only; keep paint and glue away from babies and pets.

SEWING PROJECT

A Design Page and Fabric Board

You will plan one garment or costume for a real occasion: who will wear it, where, and why; what it will look like; what colors and fabrics; and what it will cost. You will sew it in Lesson 8.4.

You will need

- Drawing paper, pencils, colored pencils and a fine black pen
- A color wheel (store-bought or painted)
- Fabric swatches from the scrap bag or fabric store (ask for free swatches or buy small cuts)
- Cardstock or poster board, glue stick and fabric shears
- A calculator

DESIGN PAGE AND FABRIC BOARD

Finished size: One notebook spread: a design page and a fabric board · About 90 minutes

Fabric and notions

- 3–5 fabric swatches, each about 2 × 3 in: the main fabric, a contrast, a lining or facing if needed
- Samples of notions: a button, a piece of elastic or ribbon, thread
- Price notes for each fabric and notion (from a store visit or a website with a parent)

How to make it

1. **Purpose:** at the top, write the occasion, the wearer, and three things the garment must do (for example: keep warm on a fall hike, wash easily, let you climb).
2. **Sketch:** draw the garment front and back on a simple hanger or on a dress form outline, not a fashion figure. Label the main seams, closures and trims.
3. **Lines and shape:** label the main line (vertical stripes, a yoke, a row of buttons) and the silhouette.
4. **Color scheme:** mark your colors on the color wheel and name the scheme (analogous, complementary, monochromatic).
5. **Fabric board:** glue swatches on cardstock: main, contrast, lining. Beside each, write the fiber, weight (light, medium, heavy), care and why it suits the job.

6. **Notions:** tape on samples or list them: thread, elastic, buttons, zipper, interfacing.
7. **Yardage and cost:** estimate the yardage from a similar pattern's envelope or from your own measurements, and figure the total cost.
8. **Review:** show the page to a parent. Is the design modest, suitable for the occasion and within the budget? Revise if needed.

Fabric check: Choose fabrics that suit the use: cotton and linen for warm weather and easy washing; wool or fleece for warmth; firmly woven fabrics for costumes that take rough wear on stage. For a first garment, a stable woven cotton is easiest. Avoid sheer, very slippery or very stretchy fabrics unless the design truly needs them, and hold light-colored fabrics up to a window to be sure they are opaque enough.

Steps

1. **Count out needles and pins.**
2. **Study first.** Find three garments in your house in three different color schemes and name each scheme.
3. Make the design page and fabric board from the pattern card.
4. **Texture test.** Lay two swatches of the same color but different textures side by side in daylight. Which looks brighter? Why?
5. **Budget check.** If the cost is over your budget, find one change that saves money (a cheaper fabric, a simpler closure, fabric from a thrifted sheet or curtain).
6. **Count in and clean up.** Shears put away; scraps saved.
7. **Improve it.** Draw a second color scheme for the same design, and choose between them by asking your family which they like best.

Tips

- Draw on a simple croquis of a dress form or a hanger rather than a fashion figure. The design is about the garment.
- Vertical lines tend to lead the eye up and down; horizontal bands lead it across. Use them to show off a design detail you like.
- Younger students: design an apron or a costume piece. Older students: design a full garment, with a lining and a closure.

Check your work

- ☐ I can name the elements of design and three color schemes.

- ☐ My design page shows the purpose, front and back views, a color scheme and a fabric board with fiber notes.
- ☐ My cost estimate is figured correctly and the design suits its occasion.

SEWING NOTEBOOK

1. Tape in your design page and fabric board.
2. Paint or color a 12-part color wheel and label primary, secondary and tertiary colors.
3. Copy Genesis 3:21 and write one sentence about clothing as a gift and a covering.

From history. Newton's circle had seven colors because he compared the spectrum to the seven notes of a musical scale. Many later color wheels use twelve: three primary colors, three secondary colors mixed from them, and six tertiary colors between.

COMMON MISTAKES

- Designing first and asking where it will be worn last. Start with the occasion and the wearer.
- Choosing fabric from a picture online without feeling it. Texture and weight change everything; get a swatch.
- Forgetting the cost of notions and thread in the budget.

Make it a game • Color Scheme Snap. Your parent holds up two or three fabric scraps or paint chips at a time. Be the first to call the scheme: “complementary,” “analogous,” “monochromatic” or “none.” Then name an occasion where that combination would look right. A correct call and a good occasion score a point each.

Scripture. “Unto Adam also and to his wife did the LORD God make coats of skins, and clothed them.” (Genesis 3:21, KJV)

The first garments in Scripture were made by God Himself, to cover and protect. Good design still begins with what a garment is for.

8.2 COMMERCIAL PATTERNS: BUTTERICK'S TISSUE AND PAJAMA PANTS

OBJECTIVES

- Tell how Ebenezer and Ellen Butterick began selling graded paper patterns in 1863.
- Read a pattern envelope: choose the size by body measurement, find the yardage, and identify grainlines, notches, fold lines and cutting layouts.
- Cut and sew elastic-waist pajama pants from a commercial pattern.

Warm-up. Look at a pattern envelope (from the store or a pattern company's website). Find the front picture, the size chart, the yardage chart, the notions list and the line drawings on the back. What size would fit you by the chart? Is it the same as the size on your store-bought clothes?

WATCH

How to Read and Understand the Envelope Back of a Simplicity Pattern

Simplicity Video • 1:55

<https://www.youtube.com/watch?v=q7YIfFD8bAQ>

WHEN TO WATCH

After “How they figured it out,” with your own pattern envelope in hand. Pause on each section (description, notions, body measurements, yardage, finished measurements) and find it on yours.

Note: From a pattern company's official channel. The envelope is shown up close with each section circled.

BACKUP VIDEO

Cutting Out sewing pattern on fabric

Let's Learn To Sew • 7:47

<https://www.youtube.com/watch?v=ioLMA3N230U>

Before you cut. Watch her lay the tissue on the folded fabric, pin along the grainline, and cut around the notches.

KEY TERMS

graded pattern

A pattern made in a range of sizes, each scaled up or down from a base size by set amounts.

grainline arrow

A long arrow on each pattern piece that must lie parallel to the selvage, so the piece is cut on the straight grain.

place on fold

A bracket arrow showing that an edge of the piece goes exactly on the fold of the fabric, so it is cut double width with no seam.

pattern envelope

The package of a commercial pattern, with pictures and line drawings, a body-measurement chart, yardage, notions and finished measurements.

notch

A small triangle on the edge of a pattern piece, cut outward, that shows which points match when pieces are sewn together.

ease

The extra room a garment has beyond the body measurement, for movement (wearing ease) or for style (design ease).

CORE IDEAS

The story. In the early 1860s, **Ebenezer Butterick** was a tailor in Sterling, Massachusetts. Home sewers at that time could buy patterns, but most came in only one size, and a woman had to enlarge or shrink them for her family by guesswork. Butterick's wife, **Ellen**, is said to have suggested that patterns be made in a set of sizes. In 1863 they began cutting graded patterns from stiff paper, first for men's and boys' shirts, and soon switched to light tissue paper, which could be folded small and mailed. The patterns sold so well that in 1864 Butterick moved to New York, and within a few years his company was selling millions of patterns a year through stores and catalogs, followed by a fashion magazine, *The Delineator*. For the first time, a family anywhere in America could sew a garment in the right size from a printed pattern.

How they figured it out. Pattern makers had to solve two problems. First, how to make one design fit many people. They measured many bodies and set up **size charts**: each size is a set of body measurements, and the pattern pieces are **graded** larger or smaller by set amounts at each seam. Second, how to tell a home sewer exactly what to do. Every pattern piece carries symbols: a **grainline arrow**, **notches** for matching, **place-on-fold**

brackets, and the cutting line for each size. The envelope lists the yardage for each size and fabric width, and the instruction sheet shows **layouts**, maps of where each piece goes on the fabric. Pattern sizes are chosen by your **body measurements**, not by the size you buy in stores, which is why they often differ.

The fabric science. Pants are sized by the **hip measurement** (around the fullest part), since that is where they must fit. The pattern adds **ease**: the envelope's "finished measurements" show how much. If your hip is 36 inches and the finished pajama-pant hip is 44 inches, there is $44 - 36 = 8$ **inches** of ease, generous room to move and sleep. Elastic for the waist is usually cut about 2 to 3 inches less than the waist measurement, plus 1 inch to overlap: for a 28-inch waist, $28 - 2 + 1 = 27$ **inches**. Grain matters: if the grainline arrow is off by even a little, the pant legs twist after washing. So measure from each end of the arrow to the selvage; the two distances must match. Yardage: if the chart says $2\frac{1}{4}$ yards of 45-inch fabric for your size, at \$8.99 a yard the fabric costs $2.25 \times 8.99 = \$20.23$.

Let's sew. You will sew a pair of **elastic-waist pajama pants** from a commercial pattern: choose the size, lay out and cut, mark notches, sew the inseams, crotch seam and casing, insert the elastic and hem. The one skill to do well is **laying out on grain**: measure from both ends of every grainline arrow to the selvage before you pin.

PICTURE STUDY



E. Butterick & Co.'s Quarterly Report of New York Fashions, Fall 1870, E. Butterick & Co. (lithograph), 1870 · Color lithograph poster · Library of Congress, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

Butterick's company printed big posters like this one each season to show the patterns it sold. Shopkeepers hung them in their stores so customers could choose a style and buy the paper pattern to sew at home. Every garment shown here could be made from a Butterick pattern.

Look closely

- Count the different garments for women, girls and boys. How many patterns might this one poster be advertising?
- Look at the long skirts and their trims: ruffles, pleats and bands. Which would take the most fabric?
- Find the children. How are their clothes like the grown-ups' clothes, and how are they different?
- Read the words at the bottom. Where were Butterick's sales rooms?

Talk about it

1. Why would a family in 1870 buy a pattern instead of a finished dress?
2. How did patterns in many sizes help families who lived far from a city dressmaker?
3. What is the same about choosing a pattern today and choosing one in 1870?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Body measurements are taken over light clothing by a parent (for older students, a mother for a daughter and a father for a son) and written down for fit only. Cut with shears on a large table or a clean floor with the fabric supported; if you use a rotary cutter, an adult is nearby and the blade closes every time it is set down. At the machine, keep fingers an inch from the needle and pull pins before the foot.

SEWING PROJECT

Elastic-Waist Pajama Pants from a Pattern

You will read a real pattern envelope, choose your size by measurement, lay out and cut on grain, and sew a pair of comfortable pajama pants: the first full garment of the year.

You will need

- A beginner commercial pattern for elastic-waist pants (pajama or lounge pants)
- A sewing machine (or hand needle and backstitch), fabric shears, pins and pattern weights
- A tape measure, a ruler, tailor's chalk and a seam gauge
- An iron and ironing board
- A safety pin or bodkin for the elastic

ELASTIC-WAIST PAJAMA PANTS

Finished size: One pair, sized by hip measurement from the pattern envelope · About 4–5 hours over two sessions and the week

Fabric and notions

- Woven cotton flannel, broadcloth or quilting cotton: the yardage on your pattern envelope for your size and fabric width (often 2–2¾ yards of 44/45-inch fabric)
- 1-inch (25 mm) non-roll elastic: waist measurement – 2 in + 1 in overlap
- All-purpose thread to match
- Pattern pieces: front and back pant legs (cut 2 of each), and any separate casing piece the pattern includes

How to make it

1. **Measure:** a parent measures your waist and hip over light clothing. Write them down. On the envelope chart, choose the size by the hip measurement. Note the yardage for that size.
2. Prewash and dry the fabric as you will wash the pants; press it. Fold it selvage to selvage, right sides together.
3. Cut out your size's pattern pieces on the cutting line (or trace them so other sizes are saved). Press the tissue with a cool, dry iron.
4. Lay the pieces as the layout diagram shows. For each, measure from both ends of the grainline arrow to the selvage and adjust until they match. Pin or weight them.
5. Cut carefully, cutting the notches outward. Mark the front and back pieces with chalk on the wrong side so you do not mix them up (the back crotch curve is deeper).
6. Follow the instruction sheet: usually sew the inseam of each leg, then turn one leg right side out and slip it inside the other, right sides together, and sew the crotch seam from front waist to back waist, matching notches. Sew the crotch curve twice for strength and clip the curve.
7. Finish the seam allowances with zigzag or another finish from Lesson 2.4.
8. **Casing:** fold the waist edge under ¼ inch, then under 1¼ inches, and stitch near the lower fold, leaving a 2-inch gap at the back. Thread the elastic through, try the pants on, overlap the elastic ends 1 inch and sew them securely. Close the gap.
9. **Hem:** try them on, mark the length, and sew a double-fold hem. Press.

Fabric check: Choose a soft, stable woven cotton: flannel for winter, broadcloth or quilting cotton for warm weather. Prewash, because cotton flannel can shrink a great deal. Avoid knits for a first pattern unless the pattern is made for knits, and avoid slippery fabrics. Check the print direction: one-way prints must point the same way on all pieces, which may need extra yardage. A plaid needs extra yardage and careful matching; save it for a second pair.

Steps

1. **Count out** needles and pins.
2. **Read first.** Read the whole instruction sheet once before cutting, and circle your size's layout.
3. **Ease check.** Compare your hip measurement with the envelope's finished hip. Write the ease.
4. Sew the pants from the pattern card and the instruction sheet.
5. **Fit test.** Try them on: can you sit, kneel and climb stairs comfortably? Note anything you would change.
6. **Count in and clean up.** Pins counted; tissue folded back into the envelope with notes on your size; iron and machine unplugged.
7. **Improve it.** Sew a second pair as a gift, with one change: pockets, a contrast cuff or a drawstring.

Tips

- Write on the envelope which size you cut and what you changed. Next time you will not have to work it out again.
- Mark the back of each leg with a safety pin; front and back look alike but are not.
- Younger students: sew pajama shorts from the same pattern. Older students: add side-seam pockets or a contrast band at the hem.

Check your work

- ☐ I chose my size by hip measurement, found my yardage and figured the ease.
- ☐ I laid out every piece on grain and cut the notches outward.
- ☐ My pants have strong, finished seams, an even casing and hems, and they fit comfortably.

SEWING NOTEBOOK

1. Draw and label the pattern symbols: grainline, notches, place on fold, cutting line, seam line.
2. Copy your size, measurements, ease, yardage, elastic length and cost.
3. Tape in a swatch of your fabric and write how it shrank when prewashed.

From history. Early Butterick patterns were not printed: the tissue pieces were cut out and stacked, and the instructions were punched holes and notches. Printed tissue patterns, with lines and instructions on every piece, came later in the 1900s.

COMMON MISTAKES

- Choosing the pattern size by store-bought size. Use the body-measurement chart.
- Skipping the grainline check. The legs twist after the first wash.
- Mixing up front and back legs. The back crotch curve is deeper; label each piece.

Make it a game • Pattern Symbol Hunt. Your parent hides pattern pieces (or drawings of them) around the room. Race to find each one and call out every symbol on it: grainline, notch, place on fold, size lines. Score a point for each symbol named correctly; bonus for saying what it means at the machine.

Scripture. “She maketh fine linen, and selleth it; and delivereth girdles unto the merchant.” (Proverbs 31:24, KJV)

The capable woman made clothing well enough to sell to merchants. The Buttericks too turned a sewing skill into a family business that served households everywhere.

8.3 HISTORICAL COSTUME: COLONIAL WILLIAMSBURG'S TAILORS AND MILLINERS

OBJECTIVES

- Tell how tailors and milliners worked in eighteenth-century Williamsburg, Virginia, and what an ordinary colonial outfit included.
- Research a historical garment from good sources (museums, historic sites, portraits) and plan it for a history day, play or pageant.
- Sew a historical costume piece: a mob cap, a work apron or a simple tunic.

Warm-up. Look at a portrait or a historic-site photograph of people in colonial clothing. List every garment you can see, from the head down: cap or hat, neckerchief, shirt or shift, waistcoat, coat, apron, petticoat, breeches, stockings, shoes. Which ones do you think were made at home and which by a tradesman?

WATCH

18th-Century Tailoring in Colonial Williamsburg

Colonial Williamsburg · 6:45

<https://www.youtube.com/watch?v=J0mM5lsnC-c>

WHEN TO WATCH

After the story. Watch how the tailors cut with big shears, sew sitting cross-legged on the board, and press with a heavy iron.

Note: From the Colonial Williamsburg Foundation. It tells honestly that some Virginia tailors were enslaved and shows an old newspaper notice; talk about it together.

BACKUP VIDEO

How to Sew a Classic Mop Cap

YouCanSew by ModestyMatters · 10:00

<https://www.youtube.com/watch?v=v6fbRsChkrg>

Before you sew the mob cap. Watch how she cuts the circle, sews the casing and draws up the elastic.

KEY TERMS

tailor

In the 1700s, a tradesman who made men's coats, waistcoats and breeches, and women's riding habits and stays.

mantua-maker

A dressmaker who made women's gowns in the 1700s.

waistcoat

A sleeveless or sleeved garment worn by men over the shirt and under the coat; today called a vest in America.

milliner

A shopkeeper who sold and made caps, aprons, cloaks, trims and accessories, and often fabric and ready-made small goods.

mob cap

A soft cap of linen or cotton gathered around the head with a frill, worn indoors by women and girls in the 1700s and early 1800s.

primary source

Evidence from the time itself: a portrait, a surviving garment, a newspaper notice, a shop account book.

CORE IDEAS

The story. In the 1700s, Williamsburg was the capital of the colony of Virginia, a busy town of shops, taverns and craftsmen. Most clothing was made to order. A man went to a **tailor** for his coat, waistcoat and breeches; a woman went to a **mantua-maker** for a gown and to a **milliner** for caps, aprons, handkerchiefs, cloaks and trims, many of them imported from London. Families sewed their own shirts, shifts, caps and aprons at home, and mended everything. Today the Colonial Williamsburg Foundation has rebuilt and restored the town, and in its tailor shop and its millinery and mantua-making shop, trained tradespeople still sew by hand with eighteenth-century tools and methods, learning from surviving garments, account books and newspaper notices. Some of Williamsburg's tailors and seamstresses were enslaved; their skill is part of the town's history, and the historians there tell it.

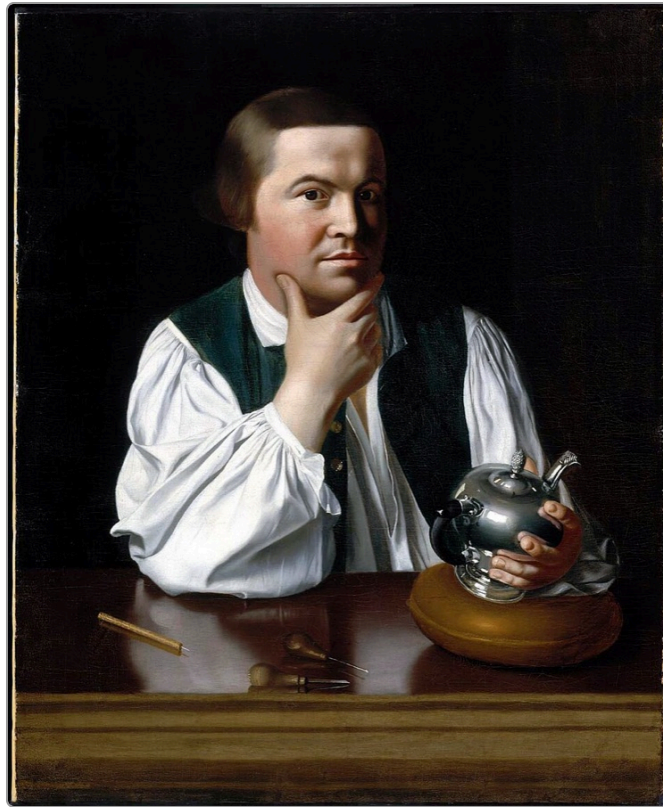
How they figured it out. How do historians know what colonial clothes looked like and how they were made? They use **primary sources**. Surviving garments in museums show the seams, stitches and fabrics. Portraits, such as John Singleton Copley's painting of the Boston silversmith Paul Revere in his shirtsleeves and waistcoat, show how clothes were

worn. Shop account books record what tailors charged and how much fabric they used. Newspaper notices advertised imported goods. Craftspeople then test their ideas by making the garments by hand. A careful costume maker does the same: research first, from good sources, then sew.

The fabric science. Colonial clothes were made mostly of **linen**, **wool** and some **cotton** and **silk**. Linen was cool, strong and washable, so it was used for shirts, shifts, caps and aprons that touched the skin and were washed often; wool, warm even when damp, was used for coats, waistcoats and petticoats. For a costume today, a plain cotton or linen-look cotton works for caps and aprons. Mob cap arithmetic: a cap for a head 21 inches around is cut as a circle about **22 inches across**. The circumference of that circle is $3.14 \times 22 \approx 69$ inches, which is gathered down to fit the head. Draw the elastic casing about 3 inches in from the edge, leaving a 3-inch frill. Elastic: head circumference – 2 inches + 1 inch overlap = $21 - 2 + 1 = 20$ **inches**. A work apron for a boy's tradesman costume: a rectangle 18×24 inches, hemmed, with ties of 1×30 inches, about $\frac{3}{4}$ yard of canvas or linen.

Let's sew. You will research and sew one **historical costume piece** for a history day, a play or a Christmas pageant: a **mob cap**, a colonial **work apron**, or a simple **Roman or Bible-times tunic**. The one skill to do well is **even gathering**: divide the edge and the casing into quarters and match them, so the gathers spread evenly all the way around.

PICTURE STUDY



Paul Revere, John Singleton Copley, 1768 · Oil on canvas · Museum of Fine Arts, Boston

Image: [Wikimedia Commons](#), public domain

John Singleton Copley painted the Boston silversmith Paul Revere in 1768, seven years before his famous ride. Instead of a fine coat, Revere is shown in his working clothes: a full linen shirt and a waistcoat, with a teapot he is making and his engraving tools. It is one of the best pictures we have of everyday colonial men's clothing.

Look closely

- Look at the shirt sleeves. How full are they? How do you think a linen shirt like this was cut?
- Find the waistcoat. Count the buttons you can see. Was it sewn by a tailor or at home?
- Find the shirt's neckband and cuffs. Where are they gathered?
- Find the tools on the table. Why did Copley show Revere as a working craftsman?

Talk about it

1. What primary-source facts about colonial clothing can you learn from this portrait?
2. If you were making a colonial costume for a history day, which garments would you copy from this picture?
3. Why would a craftsman be proud to be painted in his working clothes?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Costumes for children's plays must be safe to move in: no long cords around the neck, no trailing hems to trip on, and fabrics kept away from candles and stage lights. Measuring is done over light clothing by a parent, for fit only. Keep loose elastic, buttons and trims away from little children.

SEWING PROJECT

A Historical Costume Piece

You will research one historical garment from at least two good sources, plan it, and sew it for a real event: a history day, a living-history visit, a Christmas pageant or a church play.

You will need

- A sewing machine (or hand needle and backstitch), fabric shears, pins and a pincushion
- A tape measure, a string-and-pencil compass (or a large plate) and chalk
- An iron and ironing board
- A safety pin or bodkin for elastic

COLONIAL MOB CAP (OR TRADESMAN'S APRON)

Finished size: One cap to fit a head about 21 in (53 cm) around; change the sizes to fit · About 2 hours

Fabric and notions

- **Mob cap:** one 22-inch (56 cm) circle of white or natural cotton, cotton lawn or linen: $\frac{2}{3}$ yard of 44-inch fabric
- $\frac{1}{4}$ -inch elastic, 20 in (head – 2 in + 1 in overlap), or a cotton tape drawstring

- Optional: 70 in of narrow lace or a 1-inch bias strip for the edge
- **Apron option:** one rectangle 18 × 24 in of linen, canvas or heavy cotton, plus two ties 3 × 31 in (folded to 1 × 30 in)
- Thread to match

How to make it

1. **Research:** find two sources showing your garment (a museum collection page, a historic site, a portrait) and note its fabric, color and shape.
2. **Cut the circle:** fold the fabric in quarters. Tie a string 11 inches long to a pencil, hold the other end at the folded corner, and draw a quarter-circle. Cut through all layers. Unfold: a 22-inch circle.
3. **Edge:** finish the outer edge with a narrow double-fold hem ($\frac{1}{8}$ inch, then $\frac{1}{8}$ inch), or bind it with bias tape, or add a narrow lace by zigzag.
4. **Casing line:** fold the circle in quarters and mark the folds with pins. Draw a circle 3 inches in from the edge with chalk.
5. **Casing:** cut a bias strip 1 inch wide and about 52 inches long ($3.14 \times 16 + 2$), press its edges under $\frac{1}{4}$ inch, and stitch it to the wrong side of the cap along both edges, centered over the chalk line, leaving a 1-inch opening.
6. Thread the elastic through the casing with a safety pin. Overlap the ends 1 inch and stitch them securely.
7. Even out the gathers so the quarter pins are spaced evenly around the head. Stitch the casing opening closed.
8. **Apron option:** double-hem all four edges of the rectangle $\frac{1}{2}$ inch; sew the ties to the top corners; for a tradesman's apron, add a 6 × 8 inch pocket on the front.
9. Try the piece on with the rest of the costume and adjust.

Fabric check: Use white or natural cotton, cotton lawn or linen for a mob cap, as colonial women did; a smooth cotton sheet works. Use linen, canvas or heavy cotton in brown, natural or blue-check for a tradesman's apron. Prewash so the costume can be washed after the event. Avoid shiny synthetic "costume satin" for a historical piece; it looks wrong and frays and slides. Keep all costume fabrics away from candles.

Steps

1. **Count out needles and pins.**

2. **Research page.** In your notebook, write your two sources and sketch what they show.
3. **Practice first.** Sew a 10-inch test casing on a scrap and thread elastic through it.
4. Sew the costume piece from the pattern card.
5. **Accuracy check.** Compare your finished piece with your sources. What is the same? What did you change for modern fabric or time, and why?
6. **Count in and clean up.** Pins counted; elastic scraps away from little children.
7. **Wear it.** Wear or lend the piece at a history day, a play or a pageant, and photograph it.

Tips

- Gathering is easiest with elastic; a drawstring of cotton tape is more historical and adjustable.
- Colonial caps were often tied with a ribbon over the casing; add one for a finished look.
- Younger students: make the apron. Older students: make a full colonial or Bible-times costume with two or three pieces, or a shepherd's tunic and sash for the Christmas pageant.

Check your work

- ☐ I researched my garment from at least two good sources and recorded them.
- ☐ My circle, casing and elastic measurements were figured correctly, and the gathers are even.
- ☐ My costume piece is safe to wear on stage and fits its wearer.

SEWING NOTEBOOK

1. Write your research page: two sources, sketches, fabric notes.
2. Write the cap or apron arithmetic.
3. Copy 1 Samuel 2:19 and write who will wear your costume and for what event.

From history. Colonial Williamsburg's historic-trades apprentices train for several years, as eighteenth-century apprentices did. The milliners and mantua-makers there study surviving gowns and caps in the Foundation's collections and sew reproductions entirely by hand.

COMMON MISTAKES

- Making a costume from guesses or a film instead of good sources. Look at real garments and portraits.
- Drawing the casing circle unevenly. The frill is wide on one side and narrow on the other. Measure in from the edge in many places.
- Using a cord around a child's neck. Use elastic or ties that release easily.

Make it a game • Source Detective. Your parent shows you five pictures of costumes: some from museums or portraits, some from cartoons or films. For each, decide “primary source” or “not a primary source” and say how you know. Then name one garment from a primary source you could sew. A correct call with a good reason scores a point.

Scripture. “Moreover his mother made him a little coat, and brought it to him from year to year, when she came up with her husband to offer the yearly sacrifice.” (1 Samuel 2:19, KJV)

Each year Hannah measured her growing son with her eyes and her heart and made him a new coat. A costume made for someone else is a small piece of that same love.

8.4 CLOTHING THAT FITS ITS PURPOSE AND THE SEWING FAIR

OBJECTIVES

- Explain wearing ease and design ease, and why a test garment (a muslin) is made for anything that must fit closely.
- Sew a garment or costume of your own design that fits its wearer and its purpose.
- Hold a family sewing fair: display the year's work, explain one technique with its math, wear one piece and give one away (Colossians 3:12).

Warm-up. Put on a coat or jacket and do five things: reach up high, hug yourself, sit down, bend to tie a shoe and raise your hand. Where does it pull? Now measure the coat across the back and compare it with a parent's measurement of your back. How much extra room (ease) does the coat have?

WATCH

What is Ease? Understand Ease in a Dressmaking Pattern

Made to Sew • 6:10

<https://www.youtube.com/watch?v=PCByJe5cgTc>

WHEN TO WATCH

After “How they figured it out.” Watch with your design page from Lesson 8.1 and decide how much ease your garment needs.

Note: A sewing teacher explains wearing ease and design ease with patterns and a dress form.

BACKUP VIDEO

How To Sew a Muslin - Overview and Pattern Adjustments

Professor Pincushion • 3:30

<https://www.youtube.com/watch?v=o6Mlaasy3Ck>

If your design must fit closely (a vest, a fitted tunic): why and how to make a test version first in cheap fabric.

KEY TERMS

wearing ease

The minimum extra room a garment needs beyond the body measurement so you can breathe, sit and move.

design ease

Extra room added for style, such as the fullness of a gathered skirt or a loose tunic.

muslin (toile)

A test version of a garment sewn in cheap fabric to check the fit before cutting the real fabric.

fitness for purpose

How well a garment does the job it is for: warmth, movement, washing, modesty, the occasion.

display card

A small card shown beside a finished piece at the fair, telling its name, fiber, skills used, time spent and one fact or measurement.

CORE IDEAS

The story. Paul wrote to the church at Colossae: “Put on therefore, as the elect of God, holy and beloved, bowels of mercies, kindness, humbleness of mind, meekness, longsuffering” (Colossians 3:12). He used the picture of getting dressed to describe a Christian’s character: we are to clothe ourselves in kindness and humility as surely as we put on a coat each morning. All year you have seen people who did exactly that with real cloth: Dorcas sewing garments for widows, Hannah making Samuel’s little coat every year, the Irish lace-makers feeding their families, the children who knitted socks for soldiers. The last lesson of the year brings your own work together, made to fit and made to serve, at a **family sewing fair**.

How they figured it out. Tailors and dressmakers learned long ago that a garment must fit its **wearer** and its **purpose**. A coat for a farmer must let him lift and reach; a costume for a shepherd in a Christmas pageant must let a child kneel at the manger and not trip on the hem; an apron must be easy to wash. So they planned **ease**: **wearing ease** for movement and **design ease** for style. And for anything that must fit closely, they first sewed a **muslin** (toile) in cheap cloth, pinned and marked the changes on it, and only then cut the costly fabric. Modern dressmakers still do the same.

The fabric science. Ease arithmetic. A loose pullover tunic for a chest of 30 inches might have 6 inches of ease: finished chest 36 inches, so the front and back are each 18 inches wide plus seam allowances: $18 + \frac{5}{8} + \frac{5}{8} = 19\frac{1}{4}$ inches. A gathered elastic-waist skirt uses design ease: its fabric is $1\frac{1}{2}$ to 2 times the hip measurement so it slips over the hips and falls in soft folds. For a hip of 34 inches at $1\frac{3}{4}$ times: $34 \times 1.75 = 59.5$ inches of finished width, as two panels each $29\frac{3}{4} + 1\frac{1}{4}$ for seams = **31 inches** wide. Skirt length: waist to mid-calf (for example 27 inches) + $1\frac{1}{2}$ inches for the casing + 2 inches for the hem = **$30\frac{1}{2}$ inches**. Elastic: waist – 2 inches + 1 inch overlap. Fitness for purpose also means modesty and practicality: choose a length, a neckline and a fabric that suit the occasion and let the wearer move freely and comfortably.

Let's sew. You will sew the garment or costume you designed in Lesson 8.1: a gathered skirt, a pullover tunic, an apron, or a costume for a play, sized with ease to fit its wearer, and then hold the **sewing fair**. The one skill to do well is **checking fit before finishing**: baste or pin the main seams, try it on, move in it, and adjust before the final stitching and hems.

PICTURE STUDY



Two Little Girls Being Taught How to Sew, Anna Ancher, about 1910 · Oil on canvas

Image: [Wikimedia Commons](#), public domain

Anna Ancher, who painted the sewing girl and the sewing school earlier this year, painted this teacher showing two little girls how to sew. The skill is passing from one generation to the next, by a sunny window, hands to hands.

Look closely

- Find the white sewing in the woman's hands. What is she showing the girls?
- Look at the girls' faces and how close they stand. What does that tell you about the lesson?
- Look at the sunlight and the leaf shadows on the wall. How do they make the room feel?
- Look at the woman's red sweater. Was it knitted or sewn?

Talk about it

1. Who taught you to sew this year? Whom could you teach next?
2. At your sewing fair, which skill would you show a younger child first?
3. How is teaching someone to sew a way of "putting on kindness"?

Safety first. A parent or responsible adult supervises all sewing tool use; count needles and pins out and back in. Fittings are done over light clothing with a parent (for older students, a mother for a daughter and a father for a son), and pins are placed carefully with the wearer standing still; remove the garment before stitching. At the fair, keep needles, pins, irons and the machine put away or attended, and keep small items away from little visitors.

SEWING PROJECT

A Garment of Your Own Design and the Family Sewing Fair

You will sew the garment or costume from your design page, fitted and finished, then set out the year's work at a family sewing fair, explain one technique, wear one piece and give one away.

You will need

- Your design page and fabric board from Lesson 8.1
- A sewing machine (or hand needle and backstitch), shears, pins, a tape measure and chalk
- An iron and ironing board
- Index cards or cardstock for display cards, and a table for the fair

YOUR OWN DESIGN (SAMPLE: GATHERED ELASTIC-WAIST SKIRT)

Finished size: One garment to fit its wearer; the sample skirt is mid-calf length for a 34-inch hip · About 4–6 hours over two sessions and the week, plus the fair

Fabric and notions

- Sample skirt: 2 panels each $31 \times 30\frac{1}{2}$ in (79×77 cm) of woven cotton, about 2 yards of 44-inch fabric (figure your own sizes from your measurements)
- 1-inch (25 mm) elastic: waist – 2 in + 1 in overlap
- Thread to match; optional trim or a contrast hem band
- For a tunic or costume: the sizes from your design page, with ease, and cheap muslin or an old sheet for a test version if it must fit closely

How to make it

1. **Measure and figure:** a parent measures the wearer over light clothing. Write the measurements and add ease: for the sample skirt, panel width = $(\text{hip} \times 1.75 \div 2) + 1\frac{1}{4}$ in; length = waist to mid-calf + $3\frac{1}{2}$ in.
2. Prewash, press and cut the panels on grain.
3. Sew the two side seams with a $\frac{5}{8}$ -inch allowance, right sides together. Finish the seams (zigzag or French seams).
4. **Fit check:** pin a $1\frac{1}{4}$ -inch fold at the waist, slip the skirt on over light clothing, and check that it slides over the hips and that the length is right. Adjust.
5. **Casing:** press the top edge under $\frac{1}{4}$ inch, then $1\frac{1}{4}$ inches. Stitch near the lower fold, leaving a 2-inch gap. Thread the elastic, overlap and stitch it, and close the gap. Spread the gathers evenly.

6. **Hem:** mark the length evenly all around (a parent can measure up from the floor), press up $\frac{1}{2}$ inch and then $1\frac{1}{2}$ inches, and stitch or blind-hem.
7. Optional: add a contrast band, pockets in the side seams, or a trim from your design.
8. Press the finished garment and try it on: sit, kneel, walk up stairs.
9. **Display card:** write the name, fiber, skills used, time spent and one measurement or calculation.

Fabric check: Choose a woven cotton, linen blend or rayon challis that gathers softly and suits the occasion: a cotton print for everyday, a soft wool blend for winter, a sturdy cotton for a costume. Hold light fabrics up to a window to be sure they are opaque enough, and line or choose another fabric if they are. Prewash to prevent shrinking. Avoid stiff fabrics that gather into bulk at the waist, and slippery fabrics for a first garment.

Steps

1. **Count out needles and pins.**
2. **Test first.** For a fitted design, sew a muslin in cheap fabric, try it on and mark changes before cutting the real fabric.
3. Sew your garment from your design and the pattern card.
4. **Purpose test.** Wear it for the activity it was designed for (church, a play rehearsal, a hike) and write what worked and what did not.
5. **Prepare the fair.** Gather the year's finished pieces. Write a display card for each. Choose one technique to show (a French seam, a darn, an adjustable ring, a boxed corner) and practice explaining its math.
6. **Hold the fair.** Invite family, grandparents or friends. Show the pieces, show your technique, wear one piece, show your sewing notebook, and give one piece away with a note.
7. **Count in and clean up.** Count every needle and pin in, unplug the iron and machine, and store your work for next year.

Tips

- Arrange the fair table by unit, from fibers to garments, so visitors can see how the year grew.
- Let a younger child try a simple stitch on a scrap with a large needle while you watch closely.

- Younger students: sew an apron or a costume piece from your design. Older students: sew a lined vest, a fitted tunic with a muslin first, or a full costume for the church play.

Check your work

- ☐ I figured my garment's sizes from measurements with the right ease, and checked the fit before finishing.
- ☐ My garment fits its wearer and its purpose and is neatly finished.
- ☐ I held the sewing fair, explained one technique with its math, wore one piece and gave one away.

SEWING NOTEBOOK

1. Write your garment's measurements, ease and cutting arithmetic, and how the fit test went.
2. Make a "skills I learned this year" page, with one line for each unit.
3. Copy Colossians 3:12 and write who received your gift and what you wrote in the note.

From history. Agricultural fairs in nineteenth-century America often had a "domestic manufactures" hall where women and girls showed quilts, knitting, linens and garments and won ribbons. 4-H clothing clubs carried on the tradition in the 1900s, and many county fairs still have a sewing exhibit today.

COMMON MISTAKES

- Cutting the garment without adding ease. It fits standing still but pulls when you sit or reach.
- Skipping the fit check before finishing. A hem or casing is much harder to change once it is sewn.
- Waiting until the morning of the fair to make display cards. Write each card as you finish each piece.

Make it a game • Sewing Fair Quiz Show. At the fair, visitors draw questions from a bowl about the year (What does a serger do? Why preshrink a patch? How many stitches in round 5 of a sc circle?). You answer and show the piece that goes with it. Every correct answer earns the visitor a button or a yarn scrap prize; every question you cannot answer goes on your list for next year.

Scripture. “Put on therefore, as the elect of God, holy and beloved, bowels of mercies, kindness, humbleness of mind, meekness, longsuffering;” (Colossians 3:12, KJV)

Paul tells believers to dress their hearts as carefully as their bodies. A year of sewing for others is practice in putting on kindness.

UNIT 8 REVIEW

Answer in complete sentences unless the question asks for a calculation or a show-me. For calculations, show every step; a right answer with no work earns half. The review is worth 100 points.

1. (8 pts)

Name the five elements of design from Lesson 8.1 and give an example of each in a garment.

2. (7 pts)

What are complementary and analogous colors? Give an example of each.

3. (10 pts)

Calculate. A design needs $2\frac{1}{2}$ yards of fabric at \$7.98 a yard, $\frac{3}{4}$ yard of contrast at \$10.40 a yard, and 1 yard of elastic at \$1.59. What is the total cost?

4. (8 pts)

Who were Ebenezer and Ellen Butterick, and what did they begin selling in 1863?

5. (8 pts)

Show me. Lay a pattern piece on folded fabric and show your parent how you put it on grain.

6. (10 pts)

Calculate. Your hip is 38 inches and the pattern's finished hip for your size is 46 inches. How much ease is there? Your waist is 30 inches. How long do you cut the waist elastic (waist – 2 + 1 overlap)?

7. (8 pts)

Why are pants patterns chosen by the hip measurement and not by store-bought size?

8. (8 pts)

Written answer. What is a primary source? Name three kinds that historians and costume makers use to learn about colonial clothing.

9. **10 pts**

Calculate. A mob cap is cut as a circle 24 inches across. What is its circumference (use 3.14)? The casing is 3 inches in from the edge; what is the diameter of the casing circle and its length?

10. **7 pts**

What is the difference between wearing ease and design ease?

11. **8 pts**

Calculate. A gathered skirt uses 2 times the hip measurement. The hip is 36 inches and there are two panels, each with $1\frac{1}{4}$ inches for seams. How wide is each panel? If the length is 26 inches plus $1\frac{1}{2}$ inches for the casing and 2 inches for the hem, what is the cut length?

12. **8 pts**

Written answer. In four or five sentences, describe your sewing fair plan (or what happened at it): which pieces you showed, the technique you explained with its math, what you wore, and what you gave away and to whom.

UNIT CHALLENGE: THE FAMILY SEWING FAIR

Hold the sewing fair: lay out every finished piece from the year with a display card for each, wear your own-design garment or costume, show one technique and explain its math, show your sewing notebook, and give one piece away with a note.

In your notebook, include your design page and fabric board, your pajama-pant pattern notes, your costume research page, a photograph of the fair table, and a final page called “Skills I learned this year,” with one sentence for each unit and one thing you want to make next.

LOOK FOR	WHAT IT MEANS
Design and fit	The own-design garment matches its design page, fits its wearer with appropriate ease, is modest and suits its occasion.
Workmanship	Pieces on grain, seams finished, casings and hems even, gathers spread evenly, pressed and neat.
The arithmetic	Cost, ease, elastic, circle and panel calculations correct with the work shown; one technique explained clearly at the fair.

LOOK FOR	WHAT IT MEANS
Display and record	A display card for every piece; notebook complete, with the year's skills page.
Giving and safety	One piece given away with a note; tools attended or put away during the fair; needle-and-pin count every session.

ANSWER KEY

1. Line (stripes, seams, a row of buttons), shape or silhouette (A-line, straight, full), color (hue, value, intensity), texture (smooth cotton, nubby wool, shiny satin), proportion (a hem band's depth compared with the skirt's length).
2. Complementary colors are opposite each other on the color wheel, such as blue and orange or red and green. Analogous colors are next to each other, such as blue, blue-green and green.
3. $2.5 \times 7.98 = \$19.95$; $0.75 \times 10.40 = \$7.80$; + \$1.59. Total $\$19.95 + \$7.80 + \$1.59 = \$29.34$.
4. Ebenezer Butterick was a tailor in Sterling, Massachusetts; his wife Ellen is said to have suggested patterns in a range of sizes. In 1863 they began selling graded paper patterns (soon of tissue paper), first for men's and boys' shirts, so home sewers could make garments in the right size; the business moved to New York in 1864 and grew huge.
5. Parent checks: the grainline arrow is parallel to the selvage, measured from both ends of the arrow to the selvage with equal distances; place-on-fold edges sit exactly on the fold; notches will be cut outward.
6. Ease: $46 - 38 = 8$ inches. Elastic: $30 - 2 + 1 = 29$ inches.
7. Pants must fit over the hips, the widest part, so the hip measurement decides the size; pattern sizes follow body-measurement charts, which often differ from ready-to-wear sizes, so choosing by store size can give the wrong fit.
8. A primary source is evidence made at the time being studied. Examples: surviving garments in museums, portraits such as Copley's Paul Revere (1768), shop account books, newspaper notices and advertisements, letters and diaries.
9. Circumference: $3.14 \times 24 = 75.36$ inches. Casing circle diameter: $24 - 3 - 3 = 18$ inches; length $3.14 \times 18 = 56.52$ inches.
10. Wearing ease is the minimum extra room needed to breathe, sit and move; design ease is extra room added for style, such as the fullness of a gathered skirt or a loose tunic.
11. $36 \times 2 = 72$ inches $\div 2 = 36$ inches; + $1\frac{1}{4} = 37\frac{1}{4}$ inches per panel. Cut length: $26 + 1\frac{1}{2} + 2 = 29\frac{1}{2}$ inches.
12. Open answer. Look for: a list of pieces by unit, one technique explained with correct arithmetic, one garment or costume worn, one piece given away with a named recipient, and a connection to making for others (Colossians 3:12, Dorcas, Hannah).