Young Engineers I: Builders

Name _____ Date _____

Young Engineers I: Builders · Printables pack

This pack has everything to print for the year: the safety pages, Engineer’s Notebook pages, the nine lab sheets with parts lists, rough costs, supervision levels and blank data tables, and every unit test, the midterm and the final, with answer keys at the back.

Supervision levels

- 🟢 Adult nearby: in the house, checks in at the start and end.
- 🔵 Adult present: in the room or at the field the whole time.
- 🔴 Adult hands-on: the adult does the marked steps.

Scripture for each unit (KJV)

1. **Luke 14:28**: “For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it?”
2. **Psalm 19:1**: “The heavens declare the glory of God; and the firmament sheweth his handywork.”
3. **Proverbs 24:16**: “For a just man falleth seven times, and riseth up again:”
4. **Psalm 8:3**: “When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained;”
5. **Psalm 19:3**: “There is no speech nor language, where their voice is not heard.”
6. **Exodus 31:3**: “And I have filled him with the spirit of God, in wisdom, and in understanding, and in knowledge, and in all manner of workmanship,”
7. **Proverbs 22:29**: “Seest thou a man diligent in his business? he shall stand before kings; he shall not stand before mean men.”
8. **Job 28:10**: “He cutteth out rivers among the rocks; and his eye seeth every precious thing.”
9. **Genesis 2:15**: “And the LORD God took the man, and put him into the garden of Eden to dress it and to keep it.”

Safety Pages

Name _____ Date _____

Young Engineers I: Builders · Read together before the first lab; post in your work area

Read this page with your student before the first lab. Every lab in the course is marked with one of three supervision levels:

- 🟢 Adult nearby: in the house, checks in at the start and end.
- 🔵 Adult present: in the room or at the field the whole time.
- 🔴 Adult hands-on: the adult does the marked steps.

General shop rules

- Safety glasses on for every build and test, for everyone nearby too.
- Tie back long hair; no loose sleeves or dangling cords near tools or spinning parts.
- Ask before using any sharp or power tool; an adult does all cutting with craft knives for grades 3–5.
- Keep a first-aid kit and a fire extinguisher (or a bucket of sand) where you build.

Rockets

- Follow the NAR Model Rocket Safety Code for every motor-powered flight. Only certified, commercially made motors, never altered; never make propellant.
- An adult buys, stores and installs every motor and igniter, and holds the launch key. Grades 3–5 fly only air-powered (stomp) rockets.
- Ceiling for this track: up to F/G-class model rocket motors, flown by the adult as the flier of record and within the motor's labeling and state law. High-power rocketry is out of scope.
- Misfire: remove the safety key or disconnect the battery and wait 60 seconds. Stand back at least 15 ft for D and smaller motors and 30 ft for larger ones. Wind no more than 20 mph; no dry grass at the pad.
- Water rockets: only undamaged bottles, a pressure limit set by the adult, eye protection, nobody over the rocket.

Batteries

- Grades 3–5 use AA, AAA, C and D cells only. Keep button cells and magnets away from small children because swallowing them is a medical emergency.
- LiPo/Li-ion: balance charger on the right setting, fire-safe surface or LiPo bag, never unattended, never a swollen, dented or hot pack; store at storage voltage; recycle at a drop-off (EPA: Used Lithium-Ion Batteries).
- Fuse every battery near its positive terminal. Never short the terminals.

Electrical

- Students work only on low-voltage DC: 12 V solar, and at most 36 V nominal for the high-school EV.
- No student work on 120 V household wiring or on inverter AC output. Use inverter outlets only through plug-in devices. Never back-feed a house circuit.
- An adult makes all LiFePO4/Li-ion battery terminal connections in Grades 9–12 labs.

Vehicles

- The electric soapbox runs on a closed private course only, never streets or sidewalks. Helmet, gloves and closed shoes; mechanical brakes that work with power off; a kill switch and main fuse tested every session; top speed limited to about 15 mph.

Vacuum, magnets, digging and radio

- Vacuum: thick-wall plastic only, never glass; eye protection; no more than −80 kPa gauge.
- Neodymium magnets pinch and shatter; keep them away from pacemakers, phones and cards.
- Digging: tabletop or sandbox scale only. Never dig a pit or tunnel a person could enter.
- Radio: listening needs no license; transmitting on ham bands requires an FCC license. Keep all antennas far from power lines.

Labs, Supervision and Rough Costs

Name _____ Date _____

Young Engineers I: Builders · Plan purchases for the year

Lesson	Lab	Supervision	Cost
Unit 1 · 1.4	Paper Tower Challenge	🟢 Adult nearby	about $6
Unit 2 · 2.4	Stomp Rocket Fin Test	🟢 Adult nearby	about $26
Unit 3 · 3.4	Egg Parachute Drop	🟢 Adult nearby	about $4
Unit 4 · 4.4	Whirl-a-Ball and ISS Watch	🟢 Adult nearby	about $1
Unit 5 · 5.4	String Phone and Crystal Radio	🟢 Adult nearby	about $21
Unit 6 · 6.4	Homopolar Motor	🔵 Adult present	about $6
Unit 7 · 7.4	Rubber-Band Car Challenge	🟢 Adult nearby	about $22
Unit 8 · 8.4	Sandbox Tunnel Test	🟢 Adult nearby	about $1
Unit 9 · 9.4	Pizza-Box Solar Oven	🔵 Adult present	about $16

Rough total for the year: about $103 per family, less if you reuse parts or borrow tools (a multimeter, for example, serves Units 6–9). Optional kits are listed on each unit page. School Launch is independent and free.

Engineer’s Notebook Page

Name _____ Date _____

Young Engineers I: Builders · Copy as many as you need

Test Log

Name _____ Date _____

Young Engineers I: Builders · Any experiment

Trial	Variable changed	Setting	Result	Units	Notes

Lab Sheet 1.4: Paper Tower Challenge

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🟢 Adult nearby: in the house, checks in at the start and end.

Rules: 20 sheets of paper, 1 m of tape, 30 minutes, and the tower must stand alone for 30 seconds.

Parts list

Part	Rough cost	Have it?
Printer paper (20 sheets)	$1	
Masking tape	$3	
Meter stick or tape measure	$2	
Timer	on hand	
Estimated total	**about $6**	

Steps

1. Draw two tower ideas in your notebook.
2. Pick one and build it.
3. Measure its height. Count to 30: did it stand?
4. Write what to change, then build version 2.
5. Share your best tower and its height with your family.

Data

Version	Height (cm)	Stood 30 s?	What I changed

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Two drawings ☐ Two measured heights ☐ One change written down

Lab Sheet 2.4: Stomp Rocket Fin Test

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🟢 Adult nearby: in the house, checks in at the start and end.

Same rocket body, three different fin designs. Which flies farthest?

Parts list

Part	Rough cost	Have it?
Stomp launcher (kit or DIY bottle and PVC)	$20	
Paper and tape	$2	
Card stock for fins	$1	
Measuring tape	on hand	
Safety glasses	$3	
Estimated total	**about $26**	

Steps

1. Roll a paper tube around the launch tube; tape it; add a cone nose.
2. Make fins: three small, three big, four big.
3. Launch each design three times at the same angle and the same stomp.
4. Measure each distance. Find the average for each design.
5. Pick the winner and say why you think it won.

Data

Fin design	Flight 1 (m)	Flight 2 (m)	Flight 3 (m)	Average (m)

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Safety glasses on ☐ Nobody in front of the launcher ☐ Averages found

Lab Sheet 3.4: Egg Parachute Drop

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🟢 Adult nearby: in the house, checks in at the start and end.

Which canopy size lands the egg safely and slowest?

Parts list

Part	Rough cost	Have it?
Plastic grocery bags	on hand	
String	$1	
Paper cup and tape	$1	
Raw eggs (or a small bag of rice to start)	$2	
Stopwatch	on hand	
Estimated total	**about $4**	

Steps

1. Cut a small (30 cm) and a big (60 cm) square canopy.
2. Tie four equal strings from the corners to the cup.
3. An adult drops each from the same height (a deck or a stair landing).
4. Time each fall three times. Find the average.
5. Did the egg survive? Write what you would change.

Data

Canopy	Fall 1 (s)	Fall 2 (s)	Fall 3 (s)	Egg OK?

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Same height every drop ☐ Averages found ☐ Egg result written

Lab Sheet 4.4: Whirl-a-Ball and ISS Watch

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🟢 Adult nearby: in the house, checks in at the start and end.

Part A outdoors in the daytime; Part B on a clear evening with your family.

Parts list

Part	Rough cost	Have it?
Soft ball (tennis ball in a sock)	on hand	
1 m of strong string	$1	
NASA Spot the Station (free)	on hand	
Notebook and flashlight	on hand	
Estimated total	**about $1**	

Steps

1. Swing the ball in a flat circle above your head in an open yard.
2. Count how many circles in 10 seconds when the string is short, then long.
3. Look up the next ISS pass with an adult.
4. Go outside early, look the right way, and watch for a bright, steady dot moving fast with no blinking lights.
5. Write the time you saw it and how many minutes it lasted.

Data

String	Circles in 10 s	ISS date	Time seen	Minutes visible

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Clear space around you ☐ Circles counted ☐ ISS time written down

Lab Sheet 5.4: String Phone and Crystal Radio

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🟢 Adult nearby: in the house, checks in at the start and end.

Part A: how far can a string phone work? Part B: build a crystal radio and log stations.

Parts list

Part	Rough cost	Have it?
Two paper cups and 10 m of string	$1	
Crystal radio kit	$20	
Long wire antenna (included or 10 m of wire)	on hand	
Notebook	on hand	
Estimated total	**about $21**	

Steps

1. Poke a hole in each cup, tie the string, and pull it tight.
2. Test at 2 m, 5 m and 10 m. Does a loose string work?
3. Build the crystal radio with an adult reading the steps.
4. String the antenna wire high indoors or along a fence.
5. Turn the dial slowly and write down every station you hear.

Data

Test	Length (m)	Could you hear?	Station or notes

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ String tested at three lengths ☐ Radio built ☐ Stations written down

Lab Sheet 6.4: Homopolar Motor

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🔵 Adult present: in the room or at the field the whole time.

Make the wire spin, then test which shape spins fastest.

Parts list

Part	Rough cost	Have it?
AA cell	$1	
Small round neodymium magnet (the cell stands on it)	$3	
Bare copper wire, about 30 cm	$2	
Pliers	on hand	
Estimated total	**about $6**	

Steps

1. Stand the AA cell (+ end up) on the magnet.
2. Bend the wire into a heart or a spiral. It touches the top of the cell and lightly brushes the magnet.
3. Let go and watch it spin! Hold it only a few seconds.
4. Try three shapes. Count turns in 5 seconds for each.
5. Draw your best shape in your notebook.

Data

Shape	Turns in 5 s	Notes

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Adult present ☐ Short runs only ☐ Three shapes tested

Lab Sheet 7.4: Rubber-Band Car Challenge

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🟢 Adult nearby: in the house, checks in at the start and end.

Which car goes farther? Which goes faster?

Parts list

Part	Rough cost	Have it?
Cardboard, straws, 4 bottle caps, 2 skewers	$1	
Rubber bands	$1	
Battery kit car	$20	
Tape measure and stopwatch	on hand	
Estimated total	**about $22**	

Steps

1. Build the chassis and axles; hook the rubber band to the back axle.
2. Wind 10 turns. Measure the distance three times.
3. Change one thing (wheels, band, weight) and test again.
4. Time the battery car over 5 m. Find its speed.
5. Write which car won and why.

Data

Car	Distance (m)	Time (s)	Speed (m each s)	Change

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Three runs each ☐ One change written down ☐ Speed found

Lab Sheet 8.4: Sandbox Tunnel Test

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🟢 Adult nearby: in the house, checks in at the start and end.

Does a lining keep a tunnel from caving in?

Parts list

Part	Rough cost	Have it?
Sandbox or a tub of damp sand	on hand	
Paper towel tubes	on hand	
Spoon and a plastic cup	on hand	
Index card	on hand	
Ping-pong ball and a bendy straw	$1	
Estimated total	**about $1**	

Steps

1. Pack damp sand into a big mound.
2. Dig tunnel A through it with a spoon. Push a paper tube into tunnel B as you dig.
3. Roll a marble through each one. Gently tap the mound 10 times. Which tunnel stays open?
4. Do the card-and-cup trick over the sink.
5. Blow up through the bendy straw and float the ping-pong ball.

Data

Tunnel	Length (cm)	Open after taps?	Notes

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Both tunnels the same length ☐ Results written down ☐ Both demos tried

Lab Sheet 9.4: Pizza-Box Solar Oven

Name _____ Date _____

Young Engineers I: Builders · Build-and-test lab

Supervision: 🔵 Adult present: in the room or at the field the whole time.

How hot can you get it? How long to melt a s'more?

Parts list

Part	Rough cost	Have it?
Pizza box	on hand	
Aluminum foil	$2	
Clear plastic wrap	$2	
Black paper	$1	
Oven thermometer	$6	
S'mores ingredients	$5	
Estimated total	**about $16**	

Steps

1. Cut a flap in the lid; line it with foil to reflect sunlight in.
2. Line the bottom with black paper; seal a plastic-wrap window over the opening.
3. Set the oven in full sun, prop the flap and aim it at the Sun.
4. Write the temperature every 10 minutes.
5. Time how long the chocolate takes to melt. Present your oven and data at Launch Day.

Data

Time (min)	Temperature (°F)	Sun or clouds

Design cycle. Ask · Imagine · Plan · Build · Test · Improve · Share

Problem and constraints:

My prediction:

What I will change next time and why:

Check

☐ Temperatures written every 10 minutes ☐ Melt time found ☐ Presentation given

Unit 1 Test: Thinking Like an Engineer

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. A build needs rubber bands ($1), straws ($1) and paper cups ($8). What is the total cost?

2. Design A flew 38 m. Design B flew 5 m. How much farther did Design A fly?

3. A water rocket flew 6 meters. How many centimeters is that? (1 m = 100 cm)

4. Design A flew 26 m. Design B flew 15 m. How much farther did Design A fly?

5. A build needs tape ($9), straws ($7) and glue stick ($2). What is the total cost?

6. Design A flew 21 m. Design B flew 14 m. How much farther did Design A fly?

7. A water rocket flew 22 meters. How many centimeters is that? (1 m = 100 cm)

8. Design A flew 49 m. Design B flew 40 m. How much farther did Design A fly?

Unit 2 Test: How Rockets Fly

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. Design A flew 24 m. Design B flew 13 m. How much farther did Design A fly?

2. A water rocket flew 17 meters. How many centimeters is that? (1 m = 100 cm)

3. One rocket carries 20 small satellites. How many satellites do 4 rockets carry?

4. Three test flights went 12 m, 16 m and 17 m. What is the average (mean) distance?

5. Design A flew 59 m. Design B flew 53 m. How much farther did Design A fly?

6. A water rocket flew 7 meters. How many centimeters is that? (1 m = 100 cm)

7. One rocket carries 10 small satellites. How many satellites do 3 rockets carry?

8. Three test flights went 7 m, 4 m and 10 m. What is the average (mean) distance?

Unit 3 Test: Reusable Rockets and Landing

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. A build needs craft sticks ($2), balloons ($6) and straws ($6). What is the total cost?

2. Design A flew 73 m. Design B flew 20 m. How much farther did Design A fly?

3. Three test flights went 13 m, 13 m and 10 m. What is the average (mean) distance?

4. Three test flights went 8 m, 10 m and 9 m. What is the average (mean) distance?

5. A build needs rubber bands ($6), craft sticks ($9) and tape ($9). What is the total cost?

6. Design A flew 90 m. Design B flew 21 m. How much farther did Design A fly?

7. Three test flights went 11 m, 11 m and 20 m. What is the average (mean) distance?

8. Three test flights went 6 m, 8 m and 7 m. What is the average (mean) distance?

Unit 4 Test: Satellites and Orbits

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 12 hours?

2. One rocket carries 10 small satellites. How many satellites do 4 rockets carry?

3. A toy solar panel is 6 cm long and 9 cm wide. What is its area?

4. A satellite goes once around Earth every 100 minutes. How many trips around does it make in 30 hours?

5. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 3 hours?

6. One rocket carries 60 small satellites. How many satellites do 5 rockets carry?

7. A toy solar panel is 6 cm long and 10 cm wide. What is its area?

8. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 3 hours?

Unit 5 Test: Radio and Communication

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. One rocket carries 30 small satellites. How many satellites do 2 rockets carry?

2. A water rocket flew 27 meters. How many centimeters is that? (1 m = 100 cm)

3. A satellite goes once around Earth every 120 minutes. How many trips around does it make in 30 hours?

4. A water rocket flew 17 meters. How many centimeters is that? (1 m = 100 cm)

5. One rocket carries 60 small satellites. How many satellites do 2 rockets carry?

6. A water rocket flew 18 meters. How many centimeters is that? (1 m = 100 cm)

7. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 6 hours?

8. A water rocket flew 14 meters. How many centimeters is that? (1 m = 100 cm)

Unit 6 Test: Electric Motors and Batteries

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. Each AA cell gives 1.5 volts. You line up 4 cells end to end (in series). How many volts is that?

2. A small motor runs on 3 volts and uses 2 amps. Power (watts) = volts × amps. How many watts does it use?

3. Each AA cell gives 1.5 volts. You line up 5 cells end to end (in series). How many volts is that?

4. Each AA cell gives 1.5 volts. You line up 6 cells end to end (in series). How many volts is that?

5. Each AA cell gives 1.5 volts. You line up 6 cells end to end (in series). How many volts is that?

6. A small motor runs on 12 volts and uses 1 amps. Power (watts) = volts × amps. How many watts does it use?

7. Each AA cell gives 1.5 volts. You line up 5 cells end to end (in series). How many volts is that?

8. Each AA cell gives 1.5 volts. You line up 4 cells end to end (in series). How many volts is that?

Unit 7 Test: Building an Electric Vehicle

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?

2. A toy car rolls 27 meters in 9 seconds. How many meters does it go each second?

3. A toy car rolls 70 meters in 7 seconds. How many meters does it go each second?

4. A toy car rolls 54 meters in 9 seconds. How many meters does it go each second?

5. Each AA cell gives 1.5 volts. You line up 7 cells end to end (in series). How many volts is that?

6. A toy car rolls 56 meters in 7 seconds. How many meters does it go each second?

7. A toy car rolls 35 meters in 7 seconds. How many meters does it go each second?

8. A toy car rolls 35 meters in 5 seconds. How many meters does it go each second?

Unit 8 Test: Tunnels and Tube Travel

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. A model tunnel will be 50 cm long. You have dug half of it. How many centimeters have you dug?

2. A model tunnel will be 48 cm long. You have dug half of it. How many centimeters have you dug?

3. Design A flew 87 m. Design B flew 31 m. How much farther did Design A fly?

4. A model tunnel will be 74 cm long. You have dug half of it. How many centimeters have you dug?

5. A model tunnel will be 94 cm long. You have dug half of it. How many centimeters have you dug?

6. A model tunnel will be 20 cm long. You have dug half of it. How many centimeters have you dug?

7. Design A flew 31 m. Design B flew 23 m. How much farther did Design A fly?

8. A model tunnel will be 78 cm long. You have dug half of it. How many centimeters have you dug?

Unit 9 Test: Solar Power and the Capstone

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. A toy solar panel is 10 cm long and 6 cm wide. What is its area?

2. A toy solar panel is 7 cm long and 5 cm wide. What is its area?

3. A small motor runs on 12 volts and uses 3 amps. Power (watts) = volts × amps. How many watts does it use?

4. A solar oven started at 10:00 and the cookie was done 4 hours and 25 minutes later. How many minutes is that in all?

5. A toy solar panel is 4 cm long and 12 cm wide. What is its area?

6. A toy solar panel is 7 cm long and 4 cm wide. What is its area?

7. A small motor runs on 12 volts and uses 5 amps. Power (watts) = volts × amps. How many watts does it use?

8. A solar oven started at 10:00 and the cookie was done 2 hours and 20 minutes later. How many minutes is that in all?

Midterm Exam

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. A build needs string ($9), markers ($7) and paper cups ($6). What is the total cost?

2. Design A flew 82 m. Design B flew 30 m. How much farther did Design A fly?

3. A water rocket flew 22 meters. How many centimeters is that? (1 m = 100 cm)

4. Design A flew 36 m. Design B flew 29 m. How much farther did Design A fly?

5. Design A flew 79 m. Design B flew 8 m. How much farther did Design A fly?

6. A water rocket flew 4 meters. How many centimeters is that? (1 m = 100 cm)

7. One rocket carries 30 small satellites. How many satellites do 6 rockets carry?

8. Three test flights went 10 m, 12 m and 11 m. What is the average (mean) distance?

9. A build needs string ($9), glue stick ($4) and balloons ($8). What is the total cost?

10. Design A flew 64 m. Design B flew 28 m. How much farther did Design A fly?

11. Three test flights went 12 m, 13 m and 5 m. What is the average (mean) distance?

12. Three test flights went 13 m, 12 m and 8 m. What is the average (mean) distance?

13. A satellite goes once around Earth every 120 minutes. How many trips around does it make in 30 hours?

14. One rocket carries 30 small satellites. How many satellites do 5 rockets carry?

15. A toy solar panel is 14 cm long and 8 cm wide. What is its area?

16. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 9 hours?

Final Exam

Name _____ Date _____

Young Engineers I: Builders · Show your work and units

1. A build needs straws ($8), craft sticks ($8) and string ($8). What is the total cost?

2. Design A flew 33 m. Design B flew 12 m. How much farther did Design A fly?

3. A water rocket flew 21 meters. How many centimeters is that? (1 m = 100 cm)

4. Design A flew 73 m. Design B flew 70 m. How much farther did Design A fly?

5. Design A flew 56 m. Design B flew 14 m. How much farther did Design A fly?

6. A water rocket flew 28 meters. How many centimeters is that? (1 m = 100 cm)

7. One rocket carries 20 small satellites. How many satellites do 9 rockets carry?

8. Three test flights went 14 m, 9 m and 13 m. What is the average (mean) distance?

9. A build needs rubber bands ($1), balloons ($1) and markers ($8). What is the total cost?

10. Design A flew 89 m. Design B flew 35 m. How much farther did Design A fly?

11. Three test flights went 15 m, 12 m and 15 m. What is the average (mean) distance?

12. Three test flights went 5 m, 3 m and 10 m. What is the average (mean) distance?

13. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 6 hours?

14. One rocket carries 24 small satellites. How many satellites do 6 rockets carry?

15. A toy solar panel is 7 cm long and 9 cm wide. What is its area?

16. A satellite goes once around Earth every 120 minutes. How many trips around does it make in 6 hours?

17. One rocket carries 24 small satellites. How many satellites do 5 rockets carry?

18. A water rocket flew 10 meters. How many centimeters is that? (1 m = 100 cm)

19. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 24 hours?

20. A water rocket flew 7 meters. How many centimeters is that? (1 m = 100 cm)

21. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?

22. A small motor runs on 6 volts and uses 5 amps. Power (watts) = volts × amps. How many watts does it use?

23. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?

24. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?

Unit 1 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. A build needs rubber bands ($1), straws ($1) and paper cups ($8). What is the total cost?
   $10
   1. Add the prices: 1 + 1 + 8 = 10
   2. The parts cost $10.

2. Design A flew 38 m. Design B flew 5 m. How much farther did Design A fly?
   33 m
   1. Subtract: 38 − 5 = 33

3. A water rocket flew 6 meters. How many centimeters is that? (1 m = 100 cm)
   600 cm
   1. Multiply by 100: 6 × 100 = 600

4. Design A flew 26 m. Design B flew 15 m. How much farther did Design A fly?
   11 m
   1. Subtract: 26 − 15 = 11

5. A build needs tape ($9), straws ($7) and glue stick ($2). What is the total cost?
   $18
   1. Add the prices: 9 + 7 + 2 = 18
   2. The parts cost $18.

6. Design A flew 21 m. Design B flew 14 m. How much farther did Design A fly?
   7 m
   1. Subtract: 21 − 14 = 7

7. A water rocket flew 22 meters. How many centimeters is that? (1 m = 100 cm)
   2,200 cm
   1. Multiply by 100: 22 × 100 = 2200

8. Design A flew 49 m. Design B flew 40 m. How much farther did Design A fly?
   9 m
   1. Subtract: 49 − 40 = 9

Unit 2 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. Design A flew 24 m. Design B flew 13 m. How much farther did Design A fly?
   11 m
   1. Subtract: 24 − 13 = 11

2. A water rocket flew 17 meters. How many centimeters is that? (1 m = 100 cm)
   1,700 cm
   1. Multiply by 100: 17 × 100 = 1700

3. One rocket carries 20 small satellites. How many satellites do 4 rockets carry?
   80 satellites
   1. Multiply: 4 × 20 = 80

4. Three test flights went 12 m, 16 m and 17 m. What is the average (mean) distance?
   15 m
   1. Add the flights: 12 + 16 + 17 = 45
   2. Divide by the number of flights: 45 ÷ 3 = 15

5. Design A flew 59 m. Design B flew 53 m. How much farther did Design A fly?
   6 m
   1. Subtract: 59 − 53 = 6

6. A water rocket flew 7 meters. How many centimeters is that? (1 m = 100 cm)
   700 cm
   1. Multiply by 100: 7 × 100 = 700

7. One rocket carries 10 small satellites. How many satellites do 3 rockets carry?
   30 satellites
   1. Multiply: 3 × 10 = 30

8. Three test flights went 7 m, 4 m and 10 m. What is the average (mean) distance?
   7 m
   1. Add the flights: 7 + 4 + 10 = 21
   2. Divide by the number of flights: 21 ÷ 3 = 7

Unit 3 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. A build needs craft sticks ($2), balloons ($6) and straws ($6). What is the total cost?
   $14
   1. Add the prices: 2 + 6 + 6 = 14
   2. The parts cost $14.

2. Design A flew 73 m. Design B flew 20 m. How much farther did Design A fly?
   53 m
   1. Subtract: 73 − 20 = 53

3. Three test flights went 13 m, 13 m and 10 m. What is the average (mean) distance?
   12 m
   1. Add the flights: 13 + 13 + 10 = 36
   2. Divide by the number of flights: 36 ÷ 3 = 12

4. Three test flights went 8 m, 10 m and 9 m. What is the average (mean) distance?
   9 m
   1. Add the flights: 8 + 10 + 9 = 27
   2. Divide by the number of flights: 27 ÷ 3 = 9

5. A build needs rubber bands ($6), craft sticks ($9) and tape ($9). What is the total cost?
   $24
   1. Add the prices: 6 + 9 + 9 = 24
   2. The parts cost $24.

6. Design A flew 90 m. Design B flew 21 m. How much farther did Design A fly?
   69 m
   1. Subtract: 90 − 21 = 69

7. Three test flights went 11 m, 11 m and 20 m. What is the average (mean) distance?
   14 m
   1. Add the flights: 11 + 11 + 20 = 42
   2. Divide by the number of flights: 42 ÷ 3 = 14

8. Three test flights went 6 m, 8 m and 7 m. What is the average (mean) distance?
   7 m
   1. Add the flights: 6 + 8 + 7 = 21
   2. Divide by the number of flights: 21 ÷ 3 = 7

Unit 4 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 12 hours?
   8 orbits
   1. Change hours to minutes: 12 × 60 = 720
   2. Divide by the minutes per orbit: 720 ÷ 90 = 8

2. One rocket carries 10 small satellites. How many satellites do 4 rockets carry?
   40 satellites
   1. Multiply: 4 × 10 = 40

3. A toy solar panel is 6 cm long and 9 cm wide. What is its area?
   54 square cm
   1. Area = length × width
   2. 6 × 9 = 54

4. A satellite goes once around Earth every 100 minutes. How many trips around does it make in 30 hours?
   18 orbits
   1. Change hours to minutes: 30 × 60 = 1800
   2. Divide by the minutes per orbit: 1800 ÷ 100 = 18

5. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 3 hours?
   2 orbits
   1. Change hours to minutes: 3 × 60 = 180
   2. Divide by the minutes per orbit: 180 ÷ 90 = 2

6. One rocket carries 60 small satellites. How many satellites do 5 rockets carry?
   300 satellites
   1. Multiply: 5 × 60 = 300

7. A toy solar panel is 6 cm long and 10 cm wide. What is its area?
   60 square cm
   1. Area = length × width
   2. 6 × 10 = 60

8. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 3 hours?
   2 orbits
   1. Change hours to minutes: 3 × 60 = 180
   2. Divide by the minutes per orbit: 180 ÷ 90 = 2

Unit 5 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. One rocket carries 30 small satellites. How many satellites do 2 rockets carry?
   60 satellites
   1. Multiply: 2 × 30 = 60

2. A water rocket flew 27 meters. How many centimeters is that? (1 m = 100 cm)
   2,700 cm
   1. Multiply by 100: 27 × 100 = 2700

3. A satellite goes once around Earth every 120 minutes. How many trips around does it make in 30 hours?
   15 orbits
   1. Change hours to minutes: 30 × 60 = 1800
   2. Divide by the minutes per orbit: 1800 ÷ 120 = 15

4. A water rocket flew 17 meters. How many centimeters is that? (1 m = 100 cm)
   1,700 cm
   1. Multiply by 100: 17 × 100 = 1700

5. One rocket carries 60 small satellites. How many satellites do 2 rockets carry?
   120 satellites
   1. Multiply: 2 × 60 = 120

6. A water rocket flew 18 meters. How many centimeters is that? (1 m = 100 cm)
   1,800 cm
   1. Multiply by 100: 18 × 100 = 1800

7. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 6 hours?
   4 orbits
   1. Change hours to minutes: 6 × 60 = 360
   2. Divide by the minutes per orbit: 360 ÷ 90 = 4

8. A water rocket flew 14 meters. How many centimeters is that? (1 m = 100 cm)
   1,400 cm
   1. Multiply by 100: 14 × 100 = 1400

Unit 6 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. Each AA cell gives 1.5 volts. You line up 4 cells end to end (in series). How many volts is that?
   6.0 volts
   1. In series, the volts add: 4 × 1.5
   2. 4 × 1.5 = 6.0

2. A small motor runs on 3 volts and uses 2 amps. Power (watts) = volts × amps. How many watts does it use?
   6 watts
   1. Watts = volts × amps
   2. 3 × 2 = 6

3. Each AA cell gives 1.5 volts. You line up 5 cells end to end (in series). How many volts is that?
   7.5 volts
   1. In series, the volts add: 5 × 1.5
   2. 5 × 1.5 = 7.5

4. Each AA cell gives 1.5 volts. You line up 6 cells end to end (in series). How many volts is that?
   9.0 volts
   1. In series, the volts add: 6 × 1.5
   2. 6 × 1.5 = 9.0

5. Each AA cell gives 1.5 volts. You line up 6 cells end to end (in series). How many volts is that?
   9.0 volts
   1. In series, the volts add: 6 × 1.5
   2. 6 × 1.5 = 9.0

6. A small motor runs on 12 volts and uses 1 amps. Power (watts) = volts × amps. How many watts does it use?
   12 watts
   1. Watts = volts × amps
   2. 12 × 1 = 12

7. Each AA cell gives 1.5 volts. You line up 5 cells end to end (in series). How many volts is that?
   7.5 volts
   1. In series, the volts add: 5 × 1.5
   2. 5 × 1.5 = 7.5

8. Each AA cell gives 1.5 volts. You line up 4 cells end to end (in series). How many volts is that?
   6.0 volts
   1. In series, the volts add: 4 × 1.5
   2. 4 × 1.5 = 6.0

Unit 7 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?
   12.0 volts
   1. In series, the volts add: 8 × 1.5
   2. 8 × 1.5 = 12.0

2. A toy car rolls 27 meters in 9 seconds. How many meters does it go each second?
   3 m each second
   1. Speed = distance ÷ time
   2. 27 ÷ 9 = 3

3. A toy car rolls 70 meters in 7 seconds. How many meters does it go each second?
   10 m each second
   1. Speed = distance ÷ time
   2. 70 ÷ 7 = 10

4. A toy car rolls 54 meters in 9 seconds. How many meters does it go each second?
   6 m each second
   1. Speed = distance ÷ time
   2. 54 ÷ 9 = 6

5. Each AA cell gives 1.5 volts. You line up 7 cells end to end (in series). How many volts is that?
   10.5 volts
   1. In series, the volts add: 7 × 1.5
   2. 7 × 1.5 = 10.5

6. A toy car rolls 56 meters in 7 seconds. How many meters does it go each second?
   8 m each second
   1. Speed = distance ÷ time
   2. 56 ÷ 7 = 8

7. A toy car rolls 35 meters in 7 seconds. How many meters does it go each second?
   5 m each second
   1. Speed = distance ÷ time
   2. 35 ÷ 7 = 5

8. A toy car rolls 35 meters in 5 seconds. How many meters does it go each second?
   7 m each second
   1. Speed = distance ÷ time
   2. 35 ÷ 5 = 7

Unit 8 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. A model tunnel will be 50 cm long. You have dug half of it. How many centimeters have you dug?
   25 cm
   1. Half means divide by 2: 50 ÷ 2 = 25

2. A model tunnel will be 48 cm long. You have dug half of it. How many centimeters have you dug?
   24 cm
   1. Half means divide by 2: 48 ÷ 2 = 24

3. Design A flew 87 m. Design B flew 31 m. How much farther did Design A fly?
   56 m
   1. Subtract: 87 − 31 = 56

4. A model tunnel will be 74 cm long. You have dug half of it. How many centimeters have you dug?
   37 cm
   1. Half means divide by 2: 74 ÷ 2 = 37

5. A model tunnel will be 94 cm long. You have dug half of it. How many centimeters have you dug?
   47 cm
   1. Half means divide by 2: 94 ÷ 2 = 47

6. A model tunnel will be 20 cm long. You have dug half of it. How many centimeters have you dug?
   10 cm
   1. Half means divide by 2: 20 ÷ 2 = 10

7. Design A flew 31 m. Design B flew 23 m. How much farther did Design A fly?
   8 m
   1. Subtract: 31 − 23 = 8

8. A model tunnel will be 78 cm long. You have dug half of it. How many centimeters have you dug?
   39 cm
   1. Half means divide by 2: 78 ÷ 2 = 39

Unit 9 Test Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. A toy solar panel is 10 cm long and 6 cm wide. What is its area?
   60 square cm
   1. Area = length × width
   2. 10 × 6 = 60

2. A toy solar panel is 7 cm long and 5 cm wide. What is its area?
   35 square cm
   1. Area = length × width
   2. 7 × 5 = 35

3. A small motor runs on 12 volts and uses 3 amps. Power (watts) = volts × amps. How many watts does it use?
   36 watts
   1. Watts = volts × amps
   2. 12 × 3 = 36

4. A solar oven started at 10:00 and the cookie was done 4 hours and 25 minutes later. How many minutes is that in all?
   265 minutes
   1. 4 hours = 4 × 60 = 240 minutes
   2. 240 + 25 = 265

5. A toy solar panel is 4 cm long and 12 cm wide. What is its area?
   48 square cm
   1. Area = length × width
   2. 4 × 12 = 48

6. A toy solar panel is 7 cm long and 4 cm wide. What is its area?
   28 square cm
   1. Area = length × width
   2. 7 × 4 = 28

7. A small motor runs on 12 volts and uses 5 amps. Power (watts) = volts × amps. How many watts does it use?
   60 watts
   1. Watts = volts × amps
   2. 12 × 5 = 60

8. A solar oven started at 10:00 and the cookie was done 2 hours and 20 minutes later. How many minutes is that in all?
   140 minutes
   1. 2 hours = 2 × 60 = 120 minutes
   2. 120 + 20 = 140

Midterm Exam Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. A build needs string ($9), markers ($7) and paper cups ($6). What is the total cost?
   $22
   1. Add the prices: 9 + 7 + 6 = 22
   2. The parts cost $22.

2. Design A flew 82 m. Design B flew 30 m. How much farther did Design A fly?
   52 m
   1. Subtract: 82 − 30 = 52

3. A water rocket flew 22 meters. How many centimeters is that? (1 m = 100 cm)
   2,200 cm
   1. Multiply by 100: 22 × 100 = 2200

4. Design A flew 36 m. Design B flew 29 m. How much farther did Design A fly?
   7 m
   1. Subtract: 36 − 29 = 7

5. Design A flew 79 m. Design B flew 8 m. How much farther did Design A fly?
   71 m
   1. Subtract: 79 − 8 = 71

6. A water rocket flew 4 meters. How many centimeters is that? (1 m = 100 cm)
   400 cm
   1. Multiply by 100: 4 × 100 = 400

7. One rocket carries 30 small satellites. How many satellites do 6 rockets carry?
   180 satellites
   1. Multiply: 6 × 30 = 180

8. Three test flights went 10 m, 12 m and 11 m. What is the average (mean) distance?
   11 m
   1. Add the flights: 10 + 12 + 11 = 33
   2. Divide by the number of flights: 33 ÷ 3 = 11

9. A build needs string ($9), glue stick ($4) and balloons ($8). What is the total cost?
   $21
   1. Add the prices: 9 + 4 + 8 = 21
   2. The parts cost $21.

10. Design A flew 64 m. Design B flew 28 m. How much farther did Design A fly?
    36 m
    1. Subtract: 64 − 28 = 36

11. Three test flights went 12 m, 13 m and 5 m. What is the average (mean) distance?
    10 m
    1. Add the flights: 12 + 13 + 5 = 30
    2. Divide by the number of flights: 30 ÷ 3 = 10

12. Three test flights went 13 m, 12 m and 8 m. What is the average (mean) distance?
    11 m
    1. Add the flights: 13 + 12 + 8 = 33
    2. Divide by the number of flights: 33 ÷ 3 = 11

13. A satellite goes once around Earth every 120 minutes. How many trips around does it make in 30 hours?
    15 orbits
    1. Change hours to minutes: 30 × 60 = 1800
    2. Divide by the minutes per orbit: 1800 ÷ 120 = 15

14. One rocket carries 30 small satellites. How many satellites do 5 rockets carry?
    150 satellites
    1. Multiply: 5 × 30 = 150

15. A toy solar panel is 14 cm long and 8 cm wide. What is its area?
    112 square cm
    1. Area = length × width
    2. 14 × 8 = 112

16. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 9 hours?
    6 orbits
    1. Change hours to minutes: 9 × 60 = 540
    2. Divide by the minutes per orbit: 540 ÷ 90 = 6

Final Exam Key

Name _____ Date _____

Young Engineers I: Builders · Answers with steps

1. A build needs straws ($8), craft sticks ($8) and string ($8). What is the total cost?
   $24
   1. Add the prices: 8 + 8 + 8 = 24
   2. The parts cost $24.

2. Design A flew 33 m. Design B flew 12 m. How much farther did Design A fly?
   21 m
   1. Subtract: 33 − 12 = 21

3. A water rocket flew 21 meters. How many centimeters is that? (1 m = 100 cm)
   2,100 cm
   1. Multiply by 100: 21 × 100 = 2100

4. Design A flew 73 m. Design B flew 70 m. How much farther did Design A fly?
   3 m
   1. Subtract: 73 − 70 = 3

5. Design A flew 56 m. Design B flew 14 m. How much farther did Design A fly?
   42 m
   1. Subtract: 56 − 14 = 42

6. A water rocket flew 28 meters. How many centimeters is that? (1 m = 100 cm)
   2,800 cm
   1. Multiply by 100: 28 × 100 = 2800

7. One rocket carries 20 small satellites. How many satellites do 9 rockets carry?
   180 satellites
   1. Multiply: 9 × 20 = 180

8. Three test flights went 14 m, 9 m and 13 m. What is the average (mean) distance?
   12 m
   1. Add the flights: 14 + 9 + 13 = 36
   2. Divide by the number of flights: 36 ÷ 3 = 12

9. A build needs rubber bands ($1), balloons ($1) and markers ($8). What is the total cost?
   $10
   1. Add the prices: 1 + 1 + 8 = 10
   2. The parts cost $10.

10. Design A flew 89 m. Design B flew 35 m. How much farther did Design A fly?
    54 m
    1. Subtract: 89 − 35 = 54

11. Three test flights went 15 m, 12 m and 15 m. What is the average (mean) distance?
    14 m
    1. Add the flights: 15 + 12 + 15 = 42
    2. Divide by the number of flights: 42 ÷ 3 = 14

12. Three test flights went 5 m, 3 m and 10 m. What is the average (mean) distance?
    6 m
    1. Add the flights: 5 + 3 + 10 = 18
    2. Divide by the number of flights: 18 ÷ 3 = 6

13. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 6 hours?
    4 orbits
    1. Change hours to minutes: 6 × 60 = 360
    2. Divide by the minutes per orbit: 360 ÷ 90 = 4

14. One rocket carries 24 small satellites. How many satellites do 6 rockets carry?
    144 satellites
    1. Multiply: 6 × 24 = 144

15. A toy solar panel is 7 cm long and 9 cm wide. What is its area?
    63 square cm
    1. Area = length × width
    2. 7 × 9 = 63

16. A satellite goes once around Earth every 120 minutes. How many trips around does it make in 6 hours?
    3 orbits
    1. Change hours to minutes: 6 × 60 = 360
    2. Divide by the minutes per orbit: 360 ÷ 120 = 3

17. One rocket carries 24 small satellites. How many satellites do 5 rockets carry?
    120 satellites
    1. Multiply: 5 × 24 = 120

18. A water rocket flew 10 meters. How many centimeters is that? (1 m = 100 cm)
    1,000 cm
    1. Multiply by 100: 10 × 100 = 1000

19. A satellite goes once around Earth every 90 minutes. How many trips around does it make in 24 hours?
    16 orbits
    1. Change hours to minutes: 24 × 60 = 1440
    2. Divide by the minutes per orbit: 1440 ÷ 90 = 16

20. A water rocket flew 7 meters. How many centimeters is that? (1 m = 100 cm)
    700 cm
    1. Multiply by 100: 7 × 100 = 700

21. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?
    12.0 volts
    1. In series, the volts add: 8 × 1.5
    2. 8 × 1.5 = 12.0

22. A small motor runs on 6 volts and uses 5 amps. Power (watts) = volts × amps. How many watts does it use?
    30 watts
    1. Watts = volts × amps
    2. 6 × 5 = 30

23. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?
    12.0 volts
    1. In series, the volts add: 8 × 1.5
    2. 8 × 1.5 = 12.0

24. Each AA cell gives 1.5 volts. You line up 8 cells end to end (in series). How many volts is that?
    12.0 volts
    1. In series, the volts add: 8 × 1.5
    2. 8 × 1.5 = 12.0