ASVAB · UNITS 1–10 · QUICK REFERENCE

ASVAB Review (CAT-ASVAB · Paper · PiCAT)

Grades 10–12+ | 8 pages

All nine subtests in test order, the AFQT and line scores from public information, mechanical diagrams, test-day strategy and 32 original practice items. Not affiliated with or endorsed by the Department of Defense. No official test items are used.

1 The test · 2 Scores · 3 AR: word problems · 4 AR: rates & ratios · 5 MK: numbers · 6 MK: algebra · 7 MK: geometry · 8 Word Knowledge · 9 Paragraphs · 10 GS: life · 11 GS: chemistry · 12 GS: physics · 13 GS: earth & space · 14 Electronics · 15 Auto · 16 Shop · 17 MC: machines · 18 MC: fluids · 19 Assembling Objects · 20 Test day · 21 Practice

1 THE ASVAB AT A GLANCE

nine tests, two formats

The nine subtests in test order

Subtest (code)	What it covers	Paper: items / min	CAT: items / min	Paper pace	See
General Science (GS)	life, physical, earth and space science	25 / 11	15 / 12	26 s	§10–§13
Arithmetic Reasoning (AR)*	word problems, no calculator	30 / 36	15 / 55	72 s	§3–§4
Word Knowledge (WK)*	word meanings and synonyms	35 / 11	15 / 9	19 s	§8
Paragraph Comprehension (PC)*	short reading passages	15 / 13	10 / 27	52 s	§9
Mathematics Knowledge (MK)*	high-school math	25 / 24	15 / 31	58 s	§5–§7
Electronics Information (EI)	circuits, parts, safety	20 / 9	15 / 10	27 s	§14
Auto & Shop Information (AS)	cars, tools, shop practice	25 / 11	AI 10 / 7 + SI 10 / 6	26 s	§15–§16
Mechanical Comprehension (MC)	forces, machines, fluids	25 / 19	15 / 22	46 s	§17–§18
Assembling Objects (AO)	how parts fit together	25 / 15	15 / 18	36 s	§19
Total, paper		**225 / 149**			

* AFQT subtests. CAT limits are without tryout questions. Source: officialasvab.com, What to Expect (Oct 2026).

CAT or paper?

- **CAT-ASVAB** (at MEPS or a MET site): adaptive, one item at a time; **no skipping, no going back**.
- **Paper**: one booklet for all; skip and review **within** a subtest only.
- **PiCAT**: a one-time CAT at home, confirmed by a supervised Verification Test.
- **Student ASVAB** (at school): career exploration; no AO.

Guessing

- **Paper**: wrong answers cost nothing; fill every bubble.
- **CAT**: rushed guesses at the end cost points; keep a steady pace.

⚠ Read this first

- **Not affiliated with or endorsed by the Department of Defense.** All practice is original; check rules at officialasvab.com.

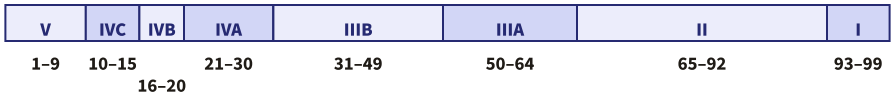
MEMORY TRICK

Nine words, test order

Good **A**nswers **W**in; **P**ractice **M**akes **E**very **A**pplicant **M**ore **A**ble: GS, AR, WK, PC, MK, EI, AS, MC, AO.

2 SCORES: THE AFQT AND LINE SCORES

eligibility, then job fit



AFQT categories by percentile, from Category I (highest) to V. Source: officialasvab.com, Understanding Scores.

The AFQT box

- Not a separate test: a score built from **AR, MK, WK and PC**.
- WK + PC form **VE** (Verbal Expression); DoD gives **AFQT = 2VE + AR + MK**.
- A **percentile, 1–99**, against a 1997 sample of 18- to 23-year-olds: a 62 ties or beats 62 % of them; it is **not** 62 % correct.
- The AFQT decides who may **enlist**; each branch sets its own minimum.

Army line scores (goarmy.com)

Army line score	Subtests
Clerical (CL)	VE + AR + MK
Combat (CO)	VE + AS + MC
Electronics (EL)	GS + AR + MK + EI
Field Artillery (FA)	AR + MK + MC
General Maintenance (GM)	GS + AS + MK + EI
General Technical (GT)	VE + AR
Mechanical Maintenance (MM)	AS + MC + EI
Skilled Technical (ST)	GS + VE + MC + MK

Air Force MAGE areas (airforce.com)

Air Force area	Subtests
Mechanical (M)	AR + AS + MC + VE
Administrative (A)	MK + VE
General (G)	AR + VE
Electronics (E)	AR + EI + GS + MK

Other branches use their own combinations.

⚠ No honest AFQT from a practice test

- Practice tests lack official scaling. Track **raw scores** by subtest (21/30).

3 ARITHMETIC REASONING: WORD PROBLEMS

plan, estimate, then compute

Three moves

- Read the **last line first**: what number, in what unit?
- Picture the story: equal groups → ×; sharing → ÷; "how many more" → −; combining → +.
- **Estimate** before you compute. Wrong choices are often off by 10 or are the halfway number.

Mental math (no calculator)

- 7 × 48 = 7 × 50 − 7 × 2 = **336**
- × 5: × 10, then halve: 5 × 86 = **430**
- × 25: × 100, then ÷ 4: 25 × 36 = **900**
- 15 % = 10 % + half of that: 15 % of $46 = 4.60 + 2.30 = **$6.90**

Know these by heart

Fraction	Decimal	Percent
$\frac{1}{2}$	0.5	50 %
$\frac{1}{3}$	0.333…	33⅓ %
$\frac{2}{3}$	0.666…	66⅔ %
$\frac{1}{4}$	0.25	25 %
$\frac{3}{4}$	0.75	75 %
$\frac{1}{5}$	0.2	20 %
$\frac{1}{8}$	0.125	12.5 %
$\frac{3}{8}$	0.375	37.5 %

Percent problems WORKED

$64 jacket, 25 % off, then 5 % tax: 64 × 0.75 = 48; 48 × 1.05 = **$50.40**

pay 75 %, then 105 %

Rent rises from $800 to $860: 60 ÷ 800 = **7.5 %**

change ÷ original

$2,400 at 4 % simple interest for 18 months: 2,400 × 0.04 × 1.5 = **$144**

I = Prt; months ÷ 12

⚠ Traps

- Discounts in a row don't add: 20 % off, then 10 % off, is **28 %** off (0.8 × 0.9 = 0.72).
- 5 % is 0.05, not 0.5.
- Use only the numbers the question needs.

4 ARITHMETIC REASONING: RATES, RATIOS & AVERAGES

d = rt, parts, means

Rules that solve most AR

Idea	Rule
Distance	**d = rt**; t = d ÷ r; r = d ÷ t
Toward each other	closing speed = **sum** of the speeds
Chasing	closing speed = **difference**
Average speed	**total distance ÷ total time**
Work	add the **rates**: $\frac{1}{a}+\frac{1}{b}=\frac{1}{t}$
Ratio a : b	the whole has a + b parts
Mean	total ÷ count; missing value = needed total − known
Overtime	1.5 × rate on hours over 40
Simple interest	I = principal × rate × time (years)

Traps: change minutes to hours first (20 min = $\frac{1}{3}$ h). In 3 : 5 the smaller share is $\frac{3}{8}$ of the whole. Lengths × k make areas × k^2.

Rates and work WORKED

Trucks 330 mi apart drive toward each other at 50 and 60 mph: 330 ÷ 110 = **3 h**

sum

A car leaves 1 h after a 45 mph bus and drives 60 mph: 45 ÷ 15 = **3 h**

difference

120 mi out at 60 mph, back at 40 mph: 240 ÷ (2 + 3) = **48 mph**

not 50

Pumps fill a tank in 6 h and 3 h: $\frac{1}{6}+\frac{1}{3}=\frac{1}{2}$, so **2 h**

add rates

Ratios, proportions, means WORKED

Split $720 in the ratio 3 : 5: one part = 720 ÷ 8 = 90, so **$270 and $450**

8 parts

5 cups serve 8; for 20: $5\times\frac{20}{8}$ = **12.5 cups**

scale

Scores 84, 90, 78; for a mean of 85 on four tests: 340 − 252 = **88**

work back

46 h at $18, time and a half over 40: 720 + 6 × 27 = **$882**

only 6 h at 1.5×

5 MATH KNOWLEDGE: NUMBERS & EXPONENTS

factors, powers, roots

Primes, GCF, LCM

- A **prime** has exactly two factors. Under 30: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29. **1 is not prime.**
- Not prime: 51 = 3 × 17, 57 = 3 × 19, 91 = 7 × 13.
- GCF(24, 36) = **12**; LCM(24, 36) = **72**. The GCF is never bigger than the smaller number.

MEMORY TRICK **PEMDAS (Traditional)**

Please **E**xcuse **M**y **D**ear **A**unt **S**ally: parentheses, exponents, then × and ÷ left to right, then + and − left to right.

Exponent rules

Rule	Example
$a^m \cdot a^n = a^{m+n}$	$x^5 \cdot x^3 = x^8$
$a^m \div a^n = a^{m-n}$	$x^7 \div x^2 = x^5$
$(a^m)^n = a^{mn}$	$(x^3)^4 = x^{12}$
$(ab)^n = a^n b^n$	$(2x)^3 = 8x^3$
$a^0 = 1$	$7^0 = 1$
$a^{-n} = \frac{1}{a^n}$	$2^{-3} = \frac{1}{8}$

Squares to know: $11^2 = 121$, $12^2 = 144$, $13^2 = 169$, $14^2 = 196$, $15^2 = 225$. Cubes: $2^3 = 8$, $3^3 = 27$, $4^3 = 64$, $5^3 = 125$.

Roots, order, notation WORKED

$\sqrt{72} = \sqrt{36}\cdot\sqrt{2}$ = **$6\sqrt{2}$** *pull out a square*

$\sqrt{12}+\sqrt{27} = 2\sqrt{3}+3\sqrt{3}$ = **$5\sqrt{3}$** *like roots add*

18 − 4 × 3 + 6 ÷ 2 = 18 − 12 + 3 = **9** *× ÷ before + −*

-3^2 = **−9**, but $(-3)^2$ = **9** *the square hits 3 only*

0.00052 = **5.2×10^{-4}**; $(4\times10^3)(3\times10^5)$ = **1.2×10^9**

scientific notation

6 MATH KNOWLEDGE: ALGEBRA

solve, factor, check

Equations and inequalities WORKED

$4x - 7 = 2x + 9 \rightarrow 2x = 16 \rightarrow$ **$x = 8$**

collect x on one side

$\frac{x}{3} + 2 = 7 \rightarrow \frac{x}{3} = 5 \rightarrow$ **$x = 15$**

undo + first, then ÷

$-2x + 5 > 13 \rightarrow -2x > 8 \rightarrow$ **$x < -4$**

divide by a negative: flip

$|x - 2| = 5 \rightarrow x - 2 = 5$ or $-5 \rightarrow$ **$x = 7$ or -3**

two cases

Multiplying and factoring

Pattern	Example
FOIL	$(x + 3)(x - 5) = x^2 - 2x - 15$
Common factor	$6x^2 + 9x = 3x(2x + 3)$
Difference of squares	$x^2 - 49 = (x + 7)(x - 7)$
Trinomial	$x^2 + 7x + 12 = (x + 3)(x + 4)$
Perfect square	$(x - 4)^2 = x^2 - 8x + 16$

Traps: $-(x - 3) = -x + 3$; $x^2 = 25$ gives $x = 5$ **or** -5.

Systems, substitution, words WORKED

$x + y = 10$ and $x - y = 4$: add $\rightarrow 2x = 14 \rightarrow$ **$x = 7$, $y = 3$**

elimination

$a = 3$, $b = -2$: $a^2 - 2ab = 9 + 12 =$ **21**

parentheses for negatives

"Five less than twice a number is 17": $2n - 5 = 17 \rightarrow$ **$n = 11$**

"less than" reverses order

7 MATH KNOWLEDGE: GEOMETRY & GRAPHS

angles, area, slope

Formulas

Shape	Formula	Shape	Formula	Solid	Formula
Rectangle	$A = lw$; $P = 2l + 2w$	Trapezoid	$A = \frac{1}{2}(b_1 + b_2)h$	Box	$V = lwh$
Triangle	$A = \frac{1}{2}bh$	Circle	$A = \pi r^2$	Cube	$V = s^3$; surface $6s^2$
Parallelogram	$A = bh$		$C = 2\pi r = \pi d$	Cylinder; cone	$V = \pi r^2 h$; $V = \frac{1}{3}\pi r^2 h$

Angles and triangles

- Straight line **180°**; right angle **90°**; vertical angles are equal.
- A triangle's angles add to **180°**; any polygon: **(n − 2) × 180°**.
- **$a^2 + b^2 = c^2$** for a right triangle; triples 3-4-5, 5-12-13, 8-15-17 (and multiples).

Geometry WORKED

Legs 9 and 12: $c = \sqrt{(81 + 144)} =$ **15** *3-4-5 × 3*

$r = 5$: $A = 25\pi \approx$ **78.5**; $C = 10\pi \approx$ **31.4** *$\pi \approx 3.14$*

Box 4 × 3 × 2.5 ft: $V =$ **30 ft³** *lwh*

Hexagon: $(6 - 2) \times 180 =$ **720°**; each angle **120°**

regular

Coordinates and quadratics

Tool	Formula
Slope	$m = \frac{y_2 - y_1}{x_2 - x_1}$
Line	$y = mx + b$ (b = y-intercept)
Distance	$\sqrt{((x_2 - x_1)^2 + (y_2 - y_1)^2)}$
Midpoint	$(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2})$
Quadratic formula	$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$

(1, 2) to (4, 8): slope **2**, distance **$3\sqrt{5}$**, midpoint **(2.5, 5)**. Perpendicular slopes: 2 and −½.

8 WORD KNOWLEDGE

word parts, clues, habits

Word parts for unknown words

Part	Meaning	Example	Part	Meaning	Example
bene-	good	benefit	chron	time	chronological
mal-	bad	malfunction	dict	say	predict
circum-	around	circumference	spect	look	inspect
contra-, anti-	against	contradict	port	carry	portable
sub-	under	submerge	ject	throw	eject
trans-	across	transport	scrib, script	write	inscribe
pre-	before	preview	ver	true	verify
post-	after	postpone	-ous	full of	courageous
un-, in-, im-	not	impossible	-ify	to make	simplify

Method

- **Cover the choices.** Say what the word means in your own words.
- A word alone: put it in a phrase you know ("a **placid** lake" → calm).
- **Swap test**: put your choice in the sentence. Same meaning? Keep it.
- **Traps:** a same-topic word (*arid* means dry, not desert); look-alikes (**eminent**, famous, vs **imminent**, about to happen).

Context clues

Clue	Signal	Example (meaning)
Definition	is, means, or	an **arid**, or very dry, valley (dry)
Contrast	but, unlike, although	Unlike his **gregarious** sister, Paul sat alone (sociable)
Example	such as, like	**Fragile** items such as eggs and glass (easily broken)

Build a word bank

- Ten new words a day beat a night of cramming.
- Card: word in front; meaning, sentence and synonym on the back. **Recall before you flip.**

9 PARAGRAPH COMPREHENSION

read the question first

Six question types

Question type	What to do
Main idea or best title	umbrella test: it must cover every sentence
Stated detail	find the key word; read its whole sentence
Sequence	follow time words (first, before, after)
Inference	one small step you can point to in the text
Word in context	swap each choice into the sentence
Author's purpose	inform, explain, persuade or entertain?

Wrong-answer patterns

- **Too narrow**: one true detail. **Too broad**: bigger than the passage.
- **True but not stated**: real-world fact the passage never says.
- **Twisted**: the passage's words, rearranged. **Too far**: a bold leap.

Pace

- Paper: about **52 s** per question; the CAT allows 27 min for 10.
- Read the question stem, then the passage once, then the choices.
- Answer from the passage, not from what you already know.

Try it (original passage)

"Before a painter rolls a single coat, most of the job is done. Walls are washed, holes are filled and sanded, and edges are taped. Paint over dust or grease peels within months; paint on a clean, smooth wall can last ten years."

Main idea: preparation decides how long paint lasts. *Edges are taped* is too narrow. **Inference:** skipping the washing means earlier peeling.

10 GENERAL SCIENCE: LIFE SCIENCE

cells, body, heredity, ecology

Cells

Cell part	Job
nucleus	holds DNA; directs the cell
mitochondria	release energy from food
ribosomes	build proteins
cell membrane	controls what enters and leaves
chloroplasts (plants)	photosynthesis
cell wall (plants)	rigid support
vacuole	stores water and food

Photosynthesis: CO_2 + water + light → sugar + O_2.
Respiration: sugar + O_2 → CO_2 + water + energy.

Body systems

System	Main parts and job
circulatory	heart, blood, vessels: carry O_2 and food
respiratory	lungs, alveoli: swap O_2 and CO_2
digestive	stomach, small intestine (absorbs most nutrients)
nervous	brain, spinal cord, nerves: signals
skeletal, muscular	support and movement
immune	white blood cells fight germs
endocrine	glands make hormones

Arteries carry blood **away** from the heart; veins return it. Red cells carry O_2; platelets clot.

Heredity

- Each parent gives one allele. **Tt × Tt** → TT, Tt, Tt, tt: **3 of 4** show the dominant trait.
- Human body cells: 23 pairs, **46 chromosomes**. Mendel worked it out with pea plants.
- DNA bases pair **A–T** and **C–G**.

Ecology

- Producers (plants) → herbivores → carnivores. Food-web arrows point **to the eater**.
- Only about 10 % of the energy passes up each level.
- **Decomposers** (fungi, bacteria) return nutrients to the soil.
- Kingdom, phylum, class, order, family, genus, species: "**K**ing **P**hilip **C**ame **O**ver **F**or **G**ood **S**oup" (Traditional).

11 GENERAL SCIENCE: MATTER & CHEMISTRY

atoms, elements, reactions

The atom

- **Protons** (+) and **neutrons** (0) in the nucleus; **electrons** (−) around it.
- Atomic number = protons (it names the element). Neutrons = mass number − atomic number.
- Isotopes: same element, different neutrons. Ions: atoms that gained or lost electrons.

Chemistry WORKED

Carbon-14: 6 protons; 14 − 6 = **8 neutrons**

pH 3 vs pH 5: 10^2 = **100 times** more acidic

60 g in 20 cm^3: D = **3 g/cm^3**; it sinks

Symbols to know

Symbol	Element	Symbol	Element
Na	sodium	H	hydrogen
K	potassium	He	helium
Fe	iron	C	carbon
Cu	copper	N	nitrogen
Ag	silver	O	oxygen
Au	gold	Cl	chlorine
Pb	lead	Ca	calcium
Hg	mercury	Ne	neon

Rows are periods; columns are groups that act alike. Noble gases (last column) hardly react.

Changes and properties

- **Physical**: melting, freezing, boiling, dissolving, sublimation (dry ice). **Chemical**: new color, gas, solid or heat and light.
- Balanced: $2H_2 + O_2 \rightarrow 2H_2O$ (4 H and 2 O on each side). Mass is conserved.
- **Density** D = m ÷ V; denser than water (1 g/cm^3) sinks.
- **pH** 7 neutral; below is acid, above is base. Each step is **× 10**.

12 GENERAL SCIENCE: PHYSICS

motion, energy, heat, waves

Newton's laws

- **1st (inertia):** objects keep doing what they are doing unless a net force acts.
- **2nd:** F = ma. **Weight** W = mg; on the Moon mass stays, weight drops.
- **3rd:** every action has an equal and opposite reaction (a rocket pushes gas down; gas pushes it up).

Physics WORKED

10 → 30 m/s in 5 s: a = 20 ÷ 5 = **4 m/s²**

1,200 kg × 3 m/s² = **3,600 N** — *F = ma*

Double the speed → **4 ×** the KE — *v is squared*

440 Hz × 0.78 m ≈ **343 m/s** — *sound in air*

Formulas

Quantity	Formula
Speed	d ÷ t
Acceleration	(final v − starting v) ÷ t
Force	F = ma
Kinetic energy	KE = ½mv²
Potential energy	PE = mgh
Work; power	W = Fd; P = W ÷ t
Waves	v = fλ

Free fall: g ≈ 9.8 m/s² (often rounded to 10).

Heat and waves

- Heat flows hot → cold by **conduction** (contact), **convection** (moving fluid) and **radiation** (waves, even through space).
- Sound needs matter (about 340 m/s in air, faster in water and steel); light crosses a vacuum at about 186,000 mi/s.
- Higher frequency = higher pitch; bigger amplitude = louder.
- Spectrum, long to short waves: radio, microwave, infrared, visible, ultraviolet, X-ray, gamma.

13 GENERAL SCIENCE: EARTH & SPACE

rocks, weather, the sky

Rocks

Rock	How it forms	Examples
Igneous	molten rock cools	granite (slow), basalt, obsidian (fast)
Sedimentary	layers pressed and cemented	sandstone, shale, limestone; most fossils
Metamorphic	changed by heat and pressure	marble (from limestone), slate (from shale)

Mohs hardness: talc 1, gypsum 2, calcite 3, fluorite 4, apatite 5, feldspar 6, quartz 7, topaz 8, corundum 9, diamond 10.

Inside Earth and weather

- Crust, mantle, liquid outer core, solid inner core.
- Air: about 78 % nitrogen, 21 % oxygen. Weather happens in the **troposphere**; ozone sits in the stratosphere.
- Low pressure brings clouds and storms; high pressure, fair skies. Cold fronts are fast and stormy.
- Tools: **barometer** (pressure), **anemometer** (wind speed), **hygrometer** (humidity).

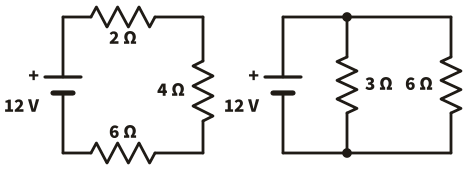
Sun, Earth, Moon

- Planets from the Sun: Mercury, Venus, Earth, Mars, Jupiter (largest), Saturn, Uranus, Neptune.
- **Seasons** come from the 23.5° **tilt** of Earth's axis, not its distance from the Sun.
- Solar eclipse: the Moon blocks the Sun. Lunar eclipse: Earth's shadow falls on the Moon.

"While the earth remaineth, seedtime and harvest, and cold and heat, and summer and winter, and day and night shall not cease" (Genesis 8:22, KJV).

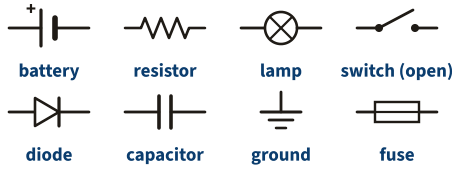
14 ELECTRONICS INFORMATION

Ohm's law to safety



series **parallel**

Series: R = 2 + 4 + 6 = 12 Ω, so I = 12 ÷ 12 = 1 A and the drops are 2, 4 and 6 V. Parallel: R = 2 Ω, I = 6 A (4 A + 2 A).



Schematic symbols. A meter: ammeter in series, voltmeter in parallel (across the part).

MEMORY TRICK **Color code in order**

Better **B**e **R**eady **O**r **Y**our **G**reat **B**ig **V**enture **G**oes **W**rong: black, brown, red, orange, yellow, green, blue, violet, gray, white.

Formulas

Rule	Formula
Ohm's law	V = IR; I = V ÷ R; R = V ÷ I
Power	P = VI = I²R = V² ÷ R
Series	$R = R_1 + R_2 + \ldots$; same current
Parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$; same voltage
Two in parallel	$R = \frac{R_1 R_2}{R_1 + R_2}$
Transformer	$\frac{V\ out}{V\ in} = \frac{turns\ out}{turns\ in}$

Parallel total is less than the smallest branch. 1 mA = 0.001 A; 1 kΩ = 1,000 Ω.

Electronics WORKED

60 W lamp on 120 V: I = 60 ÷ 120 = **0.5 A**; R = **240 Ω** — *P = VI*

250 mA through 40 Ω: V = 0.25 × 40 = **10 V** — *mA → A*

120 V, 200 turns to 20 turns: **12 V** — *step-down*

Components

Part	What it does
capacitor	stores charge; blocks DC once charged, passes AC
inductor (coil)	opposes changes in current
diode	current one way only; rectifies AC to DC
LED	diode that lights; needs a series resistor
transistor	small base current switches or amplifies a large one
fuse, breaker	opens when current is too high

Color code, AC and safety

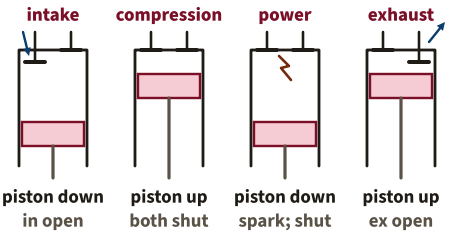
- Bands: black 0, brown 1, red 2, orange 3, yellow 4, green 5, blue 6, violet 7, gray 8, white 9. Two digits, then the zeros: yellow-violet-red = **4,700 Ω**.
- US outlets: about **120 V AC, 60 Hz**. Batteries give DC; cells in series add volts.
- Shut off the breaker and test before touching. Never put in a bigger fuse. The round prong is the ground.

15 AUTO INFORMATION

engine, systems, diagnosis

Systems

System	Key parts and facts
Fuel	pump, filter, injectors (or carburetor); rich = too much fuel, lean = too little
Ignition	coil steps 12 V up to thousands of volts; spark plug
Cooling	water pump, radiator, thermostat (opens when warm), fan
Lubrication	oil pump, filter; 5W-30: the W number is the cold rating
Starting, charging	battery (12.6 V at rest), solenoid, starter; alternator recharges
Drivetrain	clutch or torque converter → transmission → driveshaft → differential → axles
Brakes	master cylinder pushes fluid to calipers (pads on rotors) or wheel cylinders (shoes in drums)
Steering, suspension	rack and pinion, tie rods; springs, shocks or struts



The four strokes: two crankshaft turns (720°) per cycle, so the camshaft turns at half crank speed.

Engine facts

- Piston → connecting rod → crankshaft → flywheel → transmission.
- **Compression ratio** = volume at bottom ÷ volume at top: 500 cc ÷ 50 cc = **10 : 1**.
- **Diesel**: no spark plugs; squeezed air gets hot enough to light the fuel (glow plugs help cold starts).
- **Two-stroke** engines fire every turn; oil is mixed into the fuel.

Lights and codes

- **Red** = stop soon (oil pressure, temperature, charging, brakes). **Amber** = check soon.
- A **flashing** check-engine light means a misfire: ease off.
- **OBD-II** port on cars since the 1996 model year; codes start P, B, C or U.

Diagnosis

Symptom	Likely cause
click, no crank	weak battery or corroded cables
cranks, won't start	no fuel, no spark or no compression
overheating	low coolant, stuck thermostat, bad pump or fan
blue smoke	burning oil
black smoke	too rich
sweet white smoke	burning coolant
squeal when braking	worn pads
keeps bouncing	worn shocks

16 SHOP INFORMATION

tools, fasteners, measuring

Tools by job

Job	Tools
Striking	claw hammer (nails), ball-peen (metal, punches), mallet (no marks)
Turning	box-end grips 6 corners; open-end; socket and ratchet; **torque wrench** for exact tightness
Gripping	slip-joint, needle-nose and locking pliers
Cutting wood	**crosscut** saw across the grain, **rip** saw along it, coping saw for curves, chisel
Cutting metal	**hacksaw** (teeth point forward; cuts on the push), tin snips, file
Shaping	plane smooths wood; rasp rough-shapes wood; file shapes metal
Checking	level, square, tape, caliper, micrometer (0.001 in)

Fasteners

Fastener	Use
wood screw	tapered, coarse threads
sheet-metal screw	sharp, threaded to the head
machine screw, bolt	fine threads into a nut or tapped hole
lag screw	big hex head for heavy wood
rivet	permanent; pop rivets from one side
finishing nail	small head, set below the surface
lock washer	keeps a nut from loosening

Measuring and materials

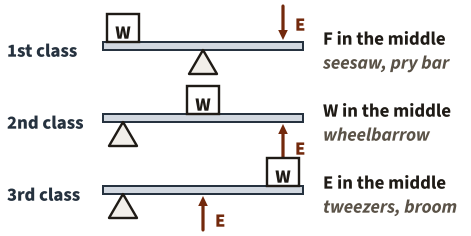
- A tape is marked in sixteenths: 3 in and 11 marks = **$3\frac{11}{16}$ in**.
- A "2 × 4" is about **1½ × 3½ in**.
- Hardwoods (oak, maple) from broadleaf trees; softwoods (pine, fir) from conifers.
- Cast iron is hard but brittle; stainless steel resists rust; brass = copper + zinc; bronze = copper + tin.
- Welding: stick (coated rod), MIG (wire feed), TIG (tungsten), oxy-acetylene.

⚠ Shop safety

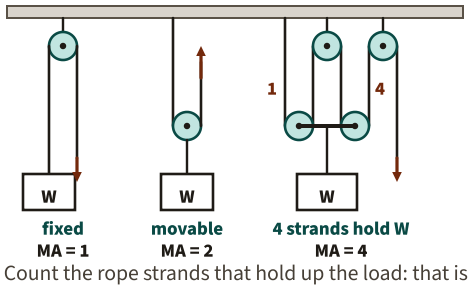
- Eye protection always. Unplug before changing a blade or bit.
- Clamp the work; use a push stick on a table saw.
- No loose sleeves or jewelry near spinning tools.

17 MECHANICAL COMPREHENSION: MACHINES

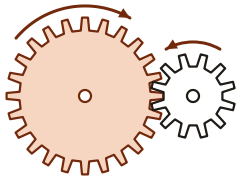
trade force for distance



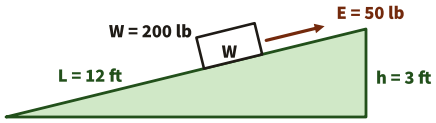
Lever classes: what sits in the middle. W = load, F = fulcrum, E = effort.



Count the rope strands that hold up the load: that is the mechanical advantage.



Meshing gears turn opposite ways; the smaller gear turns faster.



A ramp trades a longer push for a smaller force.

Formulas

Machine	Ideal mechanical advantage
Any	MA = load ÷ effort = effort distance ÷ load distance
Lever	W × its distance = E × its distance (from the fulcrum)
Pulleys	strands holding the load
Gears	teeth × rpm match: $T_1 \times rpm_1 = T_2 \times rpm_2$
Wheel and axle	wheel radius ÷ axle radius
Ramp	length ÷ height
Screw	advance = turns × pitch; pitch = 1 ÷ threads per inch

Work = force × distance (ft·lb). Power = work ÷ time; 1 hp = 550 ft·lb per second. No machine gives out more work than you put in.

Machines WORKED

120 lb, 2 ft from the fulcrum; effort 6 ft away: 120 × 2 ÷ 6 = **40 lb**

lever

4 strands hold 200 lb: **50 lb**; pull 4 ft of rope per foot of lift

pulleys

24-tooth gear at 30 rpm drives a 12-tooth gear: **60 rpm**

gears

200 lb up a 12 ft ramp, 3 ft high: **50 lb** *ramp*

15 in crank, 3 in drum: MA **5** *wheel and axle*

16 threads per inch: ½ in takes **8 turns** *screw*

Crossed belt, 4 in pulley driving an 8 in pulley: **half speed, reversed**

belt

Lift 50 lb 4 ft: **200 ft·lb** of work *W = Fd*

Trains, belts and cams

- In a gear train, neighbors turn opposite ways; gears 1, 3, 5 turn the same way. An idler changes direction, not speed.
- Open belt: same direction. Crossed belt: reversed. The smaller pulley spins faster.
- A cam turns rotation into back-and-forth motion; a crank's stroke is **2 ×** its radius.
- Friction makes real MA smaller; efficiency = work out ÷ work in, always under 100 %.

Wedges, screws, wheels

- A **wedge** is a moving ramp (axe, chisel, doorstop): longer and thinner gives more MA.
- A **screw** is a ramp wrapped around a post: finer threads give more MA but take more turns.
- A **wheel and axle** (doorknob, steering wheel, screwdriver handle) multiplies the force on the rim at the axle.
- Every machine trades: more force means more distance, and more speed means less force.

18 MECHANICAL COMPREHENSION: FLUIDS & STRUCTURES

pressure, buoyancy, strength

Pressure

- **P = F ÷ A.** 180 lb on 60 in^2 of boot = **3 psi**; on 360 in^2 of snowshoe = **0.5 psi**.
- In a liquid, pressure grows with **depth** and pushes equally in all directions; tank width does not matter.
- Liquids barely compress; gases compress.

Hydraulics (Pascal) WORKED

Pistons of 2 in^2 and 40 in^2: 30 lb in gives **600 lb** out

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

…but the small piston moves **20 in** for each inch of lift

pay in distance

Buoyancy and flow

- The upward push equals the **weight of fluid displaced**. A floating object displaces its own weight.
- A narrower pipe makes faster flow ($A_1v_1 = A_2v_2$); faster flow has lower pressure (a carburetor venturi).

Structures and materials

- A loaded beam: top in **compression**, bottom in **tension**. The nearer support carries more.
- A board on edge is far stiffer: twice as deep is **8 ×** as stiff.
- Triangles hold their shape; concrete needs steel rebar for tension.
- A spring stretches in proportion: 10 lb → 2 in, so 25 lb → **5 in**.

Buoyancy WORKED

A 3 lb block held under water displaces 5 lb of water: net push up **2 lb**

buoyant force − weight

Beam WORKED

12 ft beam, 300 lb load 4 ft from support A: A carries $300 \times \frac{8}{12}$ = **200 lb**, B carries **100 lb**

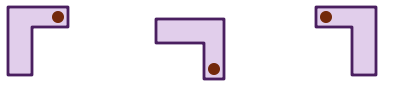
load × far distance ÷ span

Heat, balance and motion

- Metals **expand** when heated: hot water loosens a tight metal lid.
- A **bimetal strip** bends toward the metal that expands less (a thermostat).
- A low center of gravity and a wide base make an object **stable**.
- On a curve, a loose object keeps going straight until something pushes it.
- **Hard** is not **tough**: glass resists scratches but shatters.

19 ASSEMBLING OBJECTS & SPATIAL SKILLS

turns yes, flips no



original | turned 90° same shape ✓ | flipped mirror image ✗

A turned piece is the same piece. A flipped piece is its mirror image.

MEMORY TRICK **Track a landmark**

Follow one feature (a dot, a notch, a corner). "Top left" changes when a piece turns; a landmark does not.

What AO measures

- How parts look put together. Pieces **turn** but never **flip**, and sizes never change. Not in the AFQT.

Fit-the-pieces items

- Count the pieces first; the answer uses the same number.
- Compare the largest and smallest pieces; sizes never change.
- Cross out a choice the moment one piece fails.

Quarter turns

- 90° clockwise: top → right → bottom → left → top.
- 180°: top and bottom swap, and left and right swap.

Joined-at-a-point items

- Name each marked point by a **landmark**: "middle of the short edge by the notch."
- Find the same landmark in each choice.
- Flip check: walk the edge clockwise; a mirror image reverses the landmark order.

20 TEST DAY & STUDY PLAN

pace, review, plan

Strategy by format

	Paper	CAT-ASVAB
Skip and return	yes, within a subtest	no
Change an answer	yes, until time is up	no: answers are final
Blanks	never: guess on all	not allowed; answer each one
Last minute	fill every bubble	keep a steady pace; no rushed guesses

Pace: seconds each = minutes × 60 ÷ questions. At half time, be about half done.

Error log

Miss type	Fix
didn't know it	relearn the fact or formula; add a card
set it up wrong	rework it slowly; write Asked and Given
careless slip	circle words like NOT; check the row
ran short of time	timed sets of 10

Two-week plan

- 30–40 minutes a day on the weakest **AFQT** subtest: review, 10 timed questions, log misses.
- Week 2: add the weakest line-score subtest.
- Take the course's Practice Test A, review, then Practice Test B. One rest day a week.
- **Test morning:** normal sleep, breakfast, water; confirm ID, time and place with your recruiter.

"And whatsoever ye do, do it heartily, as to the Lord, and not unto men" (Colossians 3:23, KJV).

21 PRACTICE SET

original items, answers checked

Thirty-two practice items (original; not from any test)

#	Question	Answer	#	Question	Answer
1	(GS) Which cell part releases energy from food?	**mitochondria**	9	(AR) Mean of 72, 88, 91 and 85?	**84**
2	(GS) Atomic no. 17, mass no. 35: neutrons?	**18**	10	(WK) *Candid* most nearly means	**frank**
3	(GS) What causes Earth's seasons?	**the tilt of its axis**	11	(WK) *Diligent* most nearly means	**hard-working**
4	(GS) Does sound travel faster in air or in steel?	**steel**	12	(WK) Unlike her **lethargic** brother, Ana rose at dawn.	**sluggish**
5	(AR) 84 ft of fence in 3.5 h: feet per hour?	**24**	13	(WK) *Benevolent* (bene = good)	**kind**
6	(AR) A $45 drill is 20 % off. Sale price?	**$36**	14	(PC) "Mulch keeps soil damp." Infer: bare soil …	**dries out faster**
7	(AR) Flour : sugar = 5 : 2. Sugar in 21 cups?	**6 cups**	15	(MK) Solve $3(x - 4) = 2x + 1$	**$x = 13$**
8	(AR) Hoses fill a pool in 4 h and 12 h. Together?	**3 h**	16	(MK) Simplify $(2a^3)^2$	**$4a^6$**

#	Question	Answer	#	Question	Answer
17	(MK) Simplify $\sqrt{50}$	**$5\sqrt{2}$**	25	(AS) Crankshaft at 3,000 rpm: camshaft rpm?	**1,500**
18	(MK) Triangle area, base 14, height 9	**63**	26	(AS) Blue exhaust smoke usually means	**burning oil**
19	(MK) Slope through (−1, 4) and (3, −4)	**−2**	27	(AS) Tape reads 5 in and 7 sixteenth marks	**$5\frac{7}{16}$ in**
20	(MK) Solve $x^2 - 9x + 20 = 0$	**4 or 5**	28	(MC) 90 lb 2 ft from fulcrum; effort at 6 ft	**30 lb**
21	(EI) 24 V across 8 Ω: current?	**3 A**	29	(MC) 3 strands hold 240 lb: effort?	**80 lb**
22	(EI) 6 Ω and 3 Ω in parallel	**2 Ω**	30	(MC) 36 teeth at 20 rpm drive 12 teeth	**60 rpm, reversed**
23	(EI) Which part passes current one way only?	**diode**	31	(MC) Pistons 1 in² and 25 in²; push 40 lb	**1,000 lb**
24	(EI) Brown-black-red resistor	**1,000 Ω**	32	(MC) 150 lb up a 10 ft ramp, 2 ft high	**30 lb**

AO is a picture test: practice with the course's Lessons 10.1–10.2, Practice Tests A and B and the free official samples.