



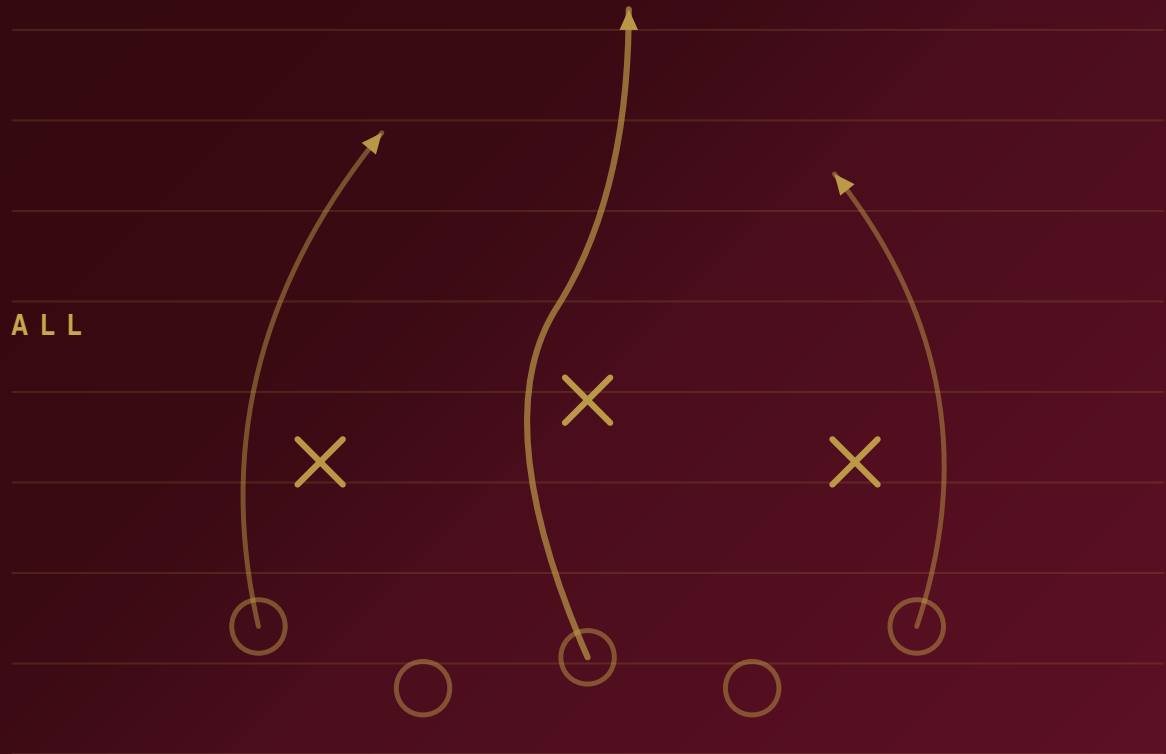
JOSEF AIDEN DURAND · VERITAS HALL

The ACT Playbook

The Gladiator System for 34+. Every skill, 890 original drills, a full practice test, and the free official practice that goes with them.

FIRST EDITION · 2026

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The ACT Playbook

First edition, 2026.

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About the practice material. Every drill, example and practice-test question in this book is original. Named historical figures and well-known facts are real; the other people, studies, data and stories in practice passages were written for

practice and are not real reports. The practice test follows the published structure of the ACT, but it is not an official test, and its scoring guide gives estimates only. For official practice, use the free resources described in “Where to Practice,” including ACT’s free full-length practice tests.

Test facts in this book reflect ACT’s published format as of 2026: English, Math and Reading make up the Composite; Science and Writing are optional. Tests change: check act.org for the current format, dates and policies, including the calculator policy.

No guarantees. This book describes a method that has worked for many students. Scores depend on each student’s preparation, and no book can promise a particular result.

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Same game, different arena.



JOSEF AIDEN DURAND
HARVARD COLLEGE '14
FOUNDER, VERITAS HALL

I've taught standardized tests for more than a decade, from Beijing to California. The most important thing I've learned holds for the ACT just as it does for the SAT: the test doesn't measure how smart you are. It measures how well you play a game whose rules almost nobody explains.

The ACT is a different arena. It moves faster, its passages are longer, its math reaches further, and it gives you no formula sheet. But the opponent is the same: a test-maker who writes three wrong answers for every right one. So we keep the weapons and change the tactics. Hunt the wrong answers. Predict before you look. Choose NO CHANGE when nothing is wrong. Know your formulas cold. Run a clock in your head.

This book gives you all of it: ninety-seven one-page lessons covering English, Reading, Math, Science and the essay; eight hundred ninety original drills; a full-length practice test; and a map to the free official practice from ACT, so you never run out of real questions.

A 34 opens the same doors as a 1500 on the SAT. Every score this system produces is earned. Now step into the arena.

Dominate on three. One, two, three... Dominate!

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Every lesson page is followed by its drill page. Lesson codes run in order within each Part: GL; GM and ENG; RD; MS, AL, AM, DA, GT and AX; SC and WR.

BEFORE YOU START

How to Use This Book

Fourteen weeks, one game week at a time, one page at a time.

THE PLAN IN ONE PARAGRAPH

Take a full official ACT practice test (free at act.org). Find your rung on the Score Ladder (Part I). Learn the Gladiator System (Part II) first. Then study the lessons your misses point to, one page at a time, and do each lesson's drill. Practice the same skill with free official questions. Evaluate every miss. Take the practice test in Part VIII when you're ready, and then every remaining official test, one a week, before your test date.

EVERY LESSON IS TWO PAGES

The lesson: the rule, the patterns, worked examples, the traps, a drill habit and a short Try It. **The drill:** eight to ten original questions with answers, plus exactly where to practice that skill for free.

THE WEEK

The game week: Monday film (30 minutes redoing old misses), install days on Tuesday and Thursday (45 minutes: one lesson, then drills and official practice), a timed test (English, Math, Reading or Science) on Saturday, and Sunday film (30 minutes reviewing every miss). Run the same week for fourteen weeks.

ACT OR SAT?

If you haven't chosen, take one official practice test of each and compare scores (ACT 34 $\approx$ SAT 1500). Play ACT-6 explains how to decide.

Where to Practice, Free

This book teaches the method. Official practice builds the volume.

RESOURCE	WHAT IT IS	HOW TO USE IT WITH THIS BOOK
Free ACT practice tests act.org · Test Prep · Free ACT Practice Tests	Official full-length practice tests from ACT, with answer keys and scoring	Your diagnostic (ACT-1) and your weekly scrimmages in the final month (ACT-27). Save some tests for the end.
ACT QuizMe quizme.act.org/english · /math · /reading · /science	Free official practice questions by subject	Every drill page names the subject and focus. Untimed at first, then timed.
Khan Academy khanacademy.org/math	Free math courses: Algebra 1, Algebra 2, Geometry, Trigonometry, Precalculus, Statistics and probability	Content review for math lessons; every math drill page names the course.
SAT Question Bank satsuitequestionbank.collegeboard.org	Free official SAT questions, filterable by skill	Extra grammar reps: its Standard English Conventions questions test the same rules as ACT English.
This book	97 lessons, 890 original drills, one original practice test	The method and the first reps. Official practice builds the volume.

KEEP OFFICIAL TESTS FRESH

Official ACT tests are limited. Use QuizMe and this book for skill practice, and save full tests for diagnostics and scrimmages.

ALL OF IT IS FREE

ACT’s practice tests, QuizMe, Khan Academy and the SAT Question Bank cost nothing.

ALWAYS EVALUATE

Every miss, from any source, goes on the Film Sheet (REF-3). That’s where scores move.

Welcome to the Colosseum



JOSEF AIDEN DURAND
FROM THE AUTHOR

Picture Russell Crowe in *Gladiator*: the sand, the gates, the roar. Now picture yourself on test morning. Different arena, same stakes. Every wrong answer on the ACT is an opponent built to take points from you, and points are what decide where you go to college, what you study, and, statistically, what you earn for the rest of your life. That isn't drama. That's the math.

Here's the good news. Your opponents are predictable. The test-maker writes three wrong answers for every right one, and most of them are built the same few ways: the opposite of the truth, half the truth, the truth exaggerated, a true statement that answers a different question, something the passage never said, or the passage's own words twisted out of shape. Six tricks, on every multiple-choice question on the test. You're about to get six weapons, one for each.

And here's the shift that changes everything: stop looking for the right answer. When you search for the right answer, your brain starts justifying every choice, and every trap starts to look reasonable. When you hunt the wrong answers instead, you see them for what they are. The right answer is simply what's left standing when the fighting stops.

So step into the arena switched on. Not panicked: alert. Your heart may beat a little faster. Good. Use it. Ask one question of every answer choice you meet, from the first question to the last: **How can I attack this answer?**

Gladiators, I salute you. Let's go to work.

PART I

The Game

What the ACT really measures, the Score Ladder, and the rules everything else is built on.

The ACT Is Not a Test of Intelligence



JOSEF AIDEN DURAND
FROM THE AUTHOR

I've watched brilliant students score a 23 and average students score a 34. The difference was never intelligence. It was preparation for a very specific game.

The ACT measures whether you can do certain things, under time pressure, the way the test-maker expects: read long passages for evidence, apply a fixed set of grammar rules, solve a known menu of math problems, read a graph, and avoid a predictable set of traps. Every one of those can be learned. None of them is a measure of your worth, your potential, or your future.

If you believe the ACT measures intelligence, every low score feels like a verdict, and verdicts make people quit. If you believe it measures a learnable system, a low score is just a map: here's what to learn next. Students with the second belief keep climbing. Students with the first stop at their first plateau.

So meet your real opponent. It isn't the test; it's the test-maker, a person at a desk with a deadline, writing four answers for every question and making three of them wrong in the quickest ways available. Human nature is predictable. So are their traps. That's why this book teaches you their playbook before it teaches you anything else.

"I'm not a reader" is a trait. "I miss inference questions" is a plan. Choose the plan.

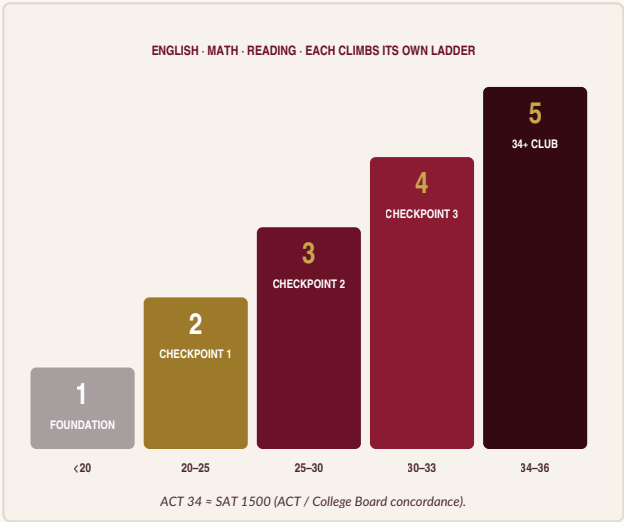
Rules of the Game

Eight rules the whole system is built on.

- 01 Hunt the wrong answers.**
Stop searching for the right answer. Attack all four choices; the right one is what you can't kill (the Golden Mindset Shift).
- 02 Shield before sword.**
Predict the answer before you look at the choices. On English, name the rule; on math, estimate.
- 03 The text is the only witness.**
Only the evidence in the passage counts, and on long passages, go back to the lines every time.
- 04 NO CHANGE is a real answer.**
If nothing is wrong, choose it. If every choice is correct, the shortest one usually wins.
- 05 Every miss gets a film session.**
Evaluate it, log it, redo it. A miss you don't study is a miss you'll repeat.
- 06 Formulas live in your head.**
The ACT gives no formula sheet. Write every formula from memory before test day.
- 07 Train on the clock.**
The ACT is a speed test as much as a knowledge test. Every practice section is timed.
- 08 Every score is earned.**
No shortcuts, no leaked questions, no one else's help on test day, ever. The only score worth having is your own.

The Score Ladder

Five rungs from below 20 to 34+, climbed one test at a time.



HOW THE LADDER WORKS

English, Math and Reading are each scored 1–36, and the composite is their average. Each test climbs its own ladder: a student can be on Rung 4 in Math and Rung 3 in Reading. The diagnostic places each test (ACT-1); the next goal is the next rung (ACT-2).

HOW YOU MOVE UP

A rung is cleared when the student scores in its range on two official practice tests. Accuracy targets below are a guide; each official test has its own raw-to-scaled table, so always score a practice test with its own key.

WHAT 34+ MEANS

By the ACT and College Board concordance, a 34 corresponds to an SAT 1500, a 30 to about 1370, and a 25 to about 1210. At 34+, misses are rare and come from hard traps and time, not content.

RUNG	SCORE	≈ SAT	THE STUDENT...	ACCURACY (GUIDE)	FOCUS
1 · Foundation	below 20	below 1040	Is learning the format and core rules; runs out of time or leaves blanks.	about 50–55%	GL-1 to GL-3 · test overviews · core content
2 · Checkpoint 1	20–25	1040–1210	Gets most early questions; loses points to traps, timing and missing content.	about 60–70%	The weapons · grammar rules · algebra
3 · Checkpoint 2	25–30	1210–1370	Solid on the basics; misses come from harder questions and the clock.	about 70–85%	Passage Attack · advanced math · formulas
4 · Checkpoint 3	30–33	1370–1460	Rarely misses medium questions; loses points to hard traps and careless errors.	about 85–93%	Best of the last two · ACT math extras · pacing
5 · The 34+ Club	34–36	1500–1590	A handful of misses per test, each evaluated within a day.	about 94%+	Hard reps · full scrimmages · mental game

Foundation: Below 20

Learn the format, the method and the core rules.

STRAND	WHAT TO STUDY	EXIT CAN-DO
English: grammar	Don't trust your ear (GM-1); joining sentences (GM-2); subject-verb agreement (GM-8); possessives (GM-11).	Names the rule on every grammar question.
English: rhetoric	The English test (ENG-1); NO CHANGE and the shortest answer (ENG-2); transitions (ENG-3).	Chooses NO CHANGE with confidence when nothing is wrong.
Reading	The Reading test (RD-1); the Passage Attack (RD-2); detail questions (RD-3); literary narrative (RD-9).	Goes back to the lines for every question.
Math: algebra	The Math test (MS-1); linear equations (AL-1); slope (AL-2); two-variable equations (AL-3).	Solves linear equations in under 40 seconds.
Math: geometry + data	Area and volume (GT-1); ratios (DA-1); percentages (DA-2); formulas (MS-7).	Writes the core formulas from memory.
Science (optional)	The Science test (SC-1); reading graphs and tables (SC-2).	Finds values on figures accurately.
Strategy + mind	The Golden Mindset Shift (GL-1); the Four-Step Attack (GL-2); not a test of intelligence (ACT-24).	No blanks; finishes every test.

WHO

Students scoring below 20 on a test, often newer to the test or still building English.

LENGTH

One season; often the biggest point gains come here.

THE WEEK

The game week: film, two install days, a Saturday scrimmage (one timed test), film.

MATERIALS

Free official ACT practice tests (act.org); the Official ACT Prep Guide; this Lesson Book.

EXIT CHECK

Two official practice tests at 20+ on the test.

MINDSET

The ACT is a game with rules. You're learning the rules (ACT-24).

Checkpoint 1: 20 to 25

Stop falling for traps. Fill the content gaps. Learn the clock.

STRAND	WHAT TO STUDY	EXIT CAN-DO
English: grammar	Semicolons, colons, extra information (GM-3 to GM-5); pronouns and tense (GM-9, GM-10).	Uses the finger test on every boundary question.
English: rhetoric	Add, delete or revise (ENG-4); word choice and idioms (ENG-7).	Answers yes/no first, then the reason.
Reading	The six weapons (GL-4 to GL-9); inferences (RD-5); words in context (RD-6); science passages (RD-10).	Writes a trap code next to every eliminated choice.
Math: algebra	Systems (AL-4); inequalities (AL-5); exponents (AM-1); factoring (AM-2).	Translates word problems before solving.
Math: geometry + data	Angles and triangles (GT-2, GT-3); data and probability (DA-3, DA-5); counting (AX-5).	Picks the right denominator in two-way tables.
Science (optional)	Trends (SC-3); experiments (SC-4); outside knowledge (SC-6).	Labels IV, DV and controls in every experiment.
Strategy + mind	Toolbox (MS-2 to MS-5); film review (ACT-7); timing plans (ACT-13, ACT-16, ACT-22).	Finishes every test on time.

WHO

Tests scoring 20–25: the basics are there, points leak to traps, time and gaps.

LENGTH

One season.

THE WEEK

The game week; the error log reviewed on film days (ACT-8).

MATERIALS

Official ACT practice tests; the Official ACT Prep Guide; this Lesson Book.

EXIT CHECK

Two official practice tests at 25+.

MINDSET

Mistakes are data, not verdicts (ACT-25).

Checkpoint 2: 25 to 30

Win the medium questions. Master the formulas and the pacing.

STRAND	WHAT TO STUDY	EXIT CAN-DO
English: grammar	Commas that never go (GM-6); modifiers (GM-7); parallel structure (GM-12); concision (GM-13).	About 30 seconds per grammar question.
English: rhetoric	Goal questions (ENG-5); order (ENG-6); introductions and conclusions (ENG-8).	Writes each essay's purpose before the last questions.
Reading	Main idea (RD-4); author's technique (RD-7); paired passages (RD-8); passage order (RD-11).	About 10 minutes per passage set.
Math: algebra	Quadratics and parabolas (AM-3, AM-4); exponentials (AM-5); functions (AM-8); sequences (AX-4).	Uses the discriminant and vertex form.
Math: geometry + data	Trig (GT-4); circles (GT-5); coordinate geometry (AX-7); samples and studies (DA-6, DA-7).	Every formula in REF-1 from memory.
Science (optional)	Conflicting viewpoints (SC-5); pacing (SC-7).	About one minute per question.
Strategy + mind	Calculator (MS-6); math pacing (MS-8); best of the last two (GL-12).	Clock checks on every test.

WHO

Tests scoring 25–30: solid on the basics, inconsistent on harder questions and the clock.

LENGTH

One season.

THE WEEK

The game week, with one install day spent on a hard-question set.

MATERIALS

Official practice tests; the later, harder questions of each math test.

EXIT CHECK

Two official practice tests at 30+.

MINDSET

Recovery: one question at a time (ACT-25).

Checkpoint 3: 30 to 33

Close the gap: hard traps, ACT-only math, careless errors.

STRAND	WHAT TO STUDY	EXIT CAN-DO
English: grammar	Conventions review (GM-14) at speed.	Zero grammar misses on practice tests.
English: rhetoric	Hard goal and relevance questions.	One miss or fewer per English test.
Reading	Hard inference and technique questions; best of the last two (GL-12).	Names the one word that separates the last two.
Math: algebra	Rational and radical equations (AM-6, AM-7); nonlinear systems (AM-9); logs (AX-3); complex numbers (AX-1).	Checks for extraneous solutions.
Math: geometry + data	Trig beyond right triangles (AX-6); matrices and vectors (AX-2); functions (AX-8); polynomial zeros (AM-10).	Hard questions 36–45 attempted with time to spare.
Science (optional)	Hard multi-figure questions.	Two misses or fewer per Science test.
Strategy + mind	Careless-error protocol (ACT-21); focus and stamina (ACT-26).	Careless misses down to one or fewer per test.

WHO

Tests scoring 30–33: the content is there; the last points are traps, hard math and errors.

LENGTH

One season, often overlapping with test dates.

THE WEEK

The game week; every other scrimmage is a full practice test.

MATERIALS

Every remaining official practice test.

EXIT CHECK

Two official practice tests at 34+.

MINDSET

Every choice is guilty until proven innocent (GL-10).

The 34+ Club: 34 to 36

Repeat it on test day.

STRAND	WHAT TO STUDY	EXIT CAN-DO
English: grammar	Perfect execution.	Zero misses.
English: rhetoric	Perfect execution.	Zero misses.
Reading	Speed and accuracy on your weakest passage type.	Zero or one miss per test.
Math: algebra	Speed on questions 1–30 to bank time.	Zero misses on questions 1–30.
Math: geometry + data	Questions 36–45: a fresh angle, working backward, the calculator.	One miss or fewer on 36–45.
Science (optional)	Pacing and conflicting viewpoints.	Zero or one miss.
Strategy + mind	Full scrimmages (ACT-27); the final month (ACT-28); the Colosseum (ACT-30).	Finishes each test with time to check marked questions.

WHO

Tests at 34+, aiming for a 34–36 composite.

LENGTH

The final weeks before the official test.

THE WEEK

A full practice test every week; two hard-question sets; one review session.

MATERIALS

All official practice tests, retaken if needed.

EXIT CHECK

The official score.

MINDSET

The Colosseum: calm, alert, attacking every answer (ACT-23).

PART II

The Gladiator System

Six weapons, one Shield, and a four-step attack for every question on the test.

The Golden Mindset Shift

Hunt the wrong answers, not the right one.

GL-1

LESSON

THE RULE

Stop looking for the right answer. Every question has one right answer and three wrong ones, and the wrong ones are written to look right to a student who is searching. **Attack the wrong answers instead;** the right answer is the one left standing.

SEARCHING FOR THE RIGHT ANSWER

Your brain goes into justification mode: every choice “sort of” works

One target, hidden among four

Stuck between two, choosing by feel

Slow and anxious

Playing the test-maker’s game

HUNTING THE WRONG ANSWERS

Your brain attacks: every choice must survive

Three targets, out in the open

Each choice dies for a reason you can name

Faster, with time left to check

Using the test to take the test

REMEMBER The one question to ask of every single choice: “**How can I attack this answer?**” If you can’t attack it, leave it standing and move on to the next choice. Don’t select it yet.

WORKED EXAMPLES

- Read choice A. Ask: what’s wrong with it? Find the flaw and cross it out.
- Read choice B. No flaw? Leave it standing, but don’t select it yet.
- Attack C and D the same way.
- One choice left standing: that’s your answer. Two left: use GL-12.

TRAPS

- ✗ “A looks good. I’ll pick it.” ✓ **“What’s wrong with A?”**
- ✗ ~~Reading the choices before you know the question~~ ✓ **Stem first, then text, then choices (GL-2)**
- ✗ ~~Picking the choice that feels most right~~ ✓ **Picking the choice you couldn’t kill**

DRILL HABIT

On your next 10 practice questions, write a reason next to every choice you eliminate, using the six weapon codes from GL-4 to GL-9 (OPP, HALF, EXT, RAWQ, OOS, REC). No reason, no elimination.

TRY IT

- 1 True or false: a random choice is three times more likely to be wrong than right.
- 2 What question do you ask about every choice?
- 3 You can’t find a flaw in B. Do you select it right away?
- 4 What do you do before you look at any choices?

ANSWERS 1 True · 2 How can I attack this answer? · 3 No: attack the rest first · 4 Predict the answer (the Shield, GL-3)

The Golden Mindset Shift: Drill

8 original questions. Answer all of them before checking.

- 1 Text: “The 2018 survey found that most residents supported the new park, though many worried about parking.” Which choice is **wrong**, and why? (A) Most residents backed the park. (B) Residents unanimously backed the park.
- 2 Same text. Name the weapon that kills: “Residents opposed the park because of parking.”
- 3 Same text. Name the weapon that kills: “The park reduced parking problems in the town.”
- 4 Text: “Bats use echolocation to hunt, and some species also use vision at dusk.” Which survives?
(A) All bats hunt only by vision. (B) Bats cannot see. (C) Echolocation was discovered at dusk. (D) Some bats use both echolocation and vision.
- 5 True or false: if you can’t find a flaw in a choice, you should select it immediately.
- 6 Text: “The novelist wrote mostly at night, a habit she later said made her prose quieter.” Which survives?
(A) Night writing improves all prose. (B) She believed writing at night affected her style. (C) She wrote only at night. (D) Her prose was loud.
- 7 How many of the four choices on a typical question are wrong?
- 8 Text: “Early results suggest the vaccine lowers infection rates in adults.” Which survives?
(A) The vaccine may reduce infections among adults. (B) The vaccine prevents all infections. (C) The vaccine works best in children. (D) The vaccine raises infection rates.

WHERE TO PRACTICE • FREE

ACT QuizMe • quizme.act.org/reading • any Reading or English practice

Official practice tests • act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

- 1 B • Trident: “unanimously” claims 100%; the text says most.
- 2 Gladius (and Pugio) • Most supported it; parking was a worry, not opposition.
- 3 Mace • Nothing in the text says what the park did to parking.
- 4 D • A: Trident + Gladius • B: Gladius • C: Axe (recycles “dusk”).
- 5 False • Leave it standing and attack the other choices first (GL-1).
- 6 B • C: Trident (“only” vs. “mostly”) • A: Mace + Trident • D: Gladius.
- 7 Three • Three targets, out in the open: hunt them.
- 8 A • B: Trident • D: Gladius • C: Mace.

The Four-Step Attack

One process for every question on the test.

GL-2

LESSON

THE RULE

Run the same four steps on every question: **1** read the question stem, then the passage. **2** Predict the answer (your Shield). **3** Eliminate with the six weapons. **4** Select from what's left.

STEP	WHAT YOU DO	WHY
1 • Stem, then text	Read exactly what's asked, then read the text to answer it	You read with a purpose, and the Fist (GL-7) can't land
2 • Predict	Answer it in your own words before you look at the choices	A Shield stops every choice from looking right
3 • Eliminate	Attack each choice with the six weapons	Three wrong answers are easier to find than one right one
4 • Select	Choose what survives; if two survive, the one that answers the stem better	"Best" and "most" in a stem warn you it may come down to two

REMEMBER On math, step 2 is your setup or estimate, and step 3 is checking the choices against it or plugging them in (MS-4). Every ACT question is multiple choice, so the weapons work on all of them, including Math, where there are now four choices, not five.

WORKED EXAMPLES

- Stem: "Which choice best states the main purpose of the text?"
→ read for purpose, not details.
- Prediction in five words: "shows the old theory fails."
- Kill: a choice describing one detail the text mentions (a Fist).
- Keep: the choice that means "shows a theory fails."

TRAPS

- ~~X Reading the passage first, slowly, twice~~ ✓ **Stem first: know what to read for**
- ~~X Looking at the choices before predicting~~ ✓ **Predict, then look**
- ~~X Skipping step 3 when a choice "jumps out"~~ ✓ **Attack it first: it's often the trap**

DRILL HABIT

Say the four steps out loud before every question for one full practice test, until you do them without thinking.

TRY IT

- 1 What do you read first?
- 2 When do you make your prediction?
- 3 Two choices survive. What decides?
- 4 Which stem words hint it may come down to two?

ANSWERS 1 The question stem • 2 Before looking at the choices • 3 Which one answers the stem better • 4 "best" and "most"

The Four-Step Attack: Drill

8 original questions. Answer all of them before checking.

- 1 Put the four steps in order: Select • Predict • Stem, then text • Eliminate.
- 2 Stem: “Which choice best describes the function of the underlined sentence?” What are you reading the text for?
- 3 Stem: “Which finding, if true, would most directly weaken the researcher’s claim?” What must you underline first?
- 4 A choice “jumps out” as right before you finish reading the others. What do you do?
- 5 Stem contains “most logically completes the text.” What step 2 action fits?
- 6 Two choices survive. The stem asks for the main purpose. One describes the whole text; one describes paragraph 2. Which?
- 7 On a math question with number choices, what are steps 2 and 3?
- 8 Which word in a stem warns that it may come down to two choices?

WHERE TO PRACTICE • FREE

ACT QuizMe • quizme.act.org/reading • any Reading or English practice

Official practice tests • act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 Stem, then text → Predict → Eliminate → Select • The Four-Step Attack (GL-2).

2 The sentence’s job • Function = what it does, not what it says.

3 The claim, and “weaken” • Know exactly what is asked before reading the choices.

4 Attack it, then attack the rest • The choice that jumps out is often the trap.

5 Write your own ending first • Your ending is the Shield for an inference question.

6 The whole text • Main purpose covers the whole text (GL-12).

7 Estimate or set up; then check or plug in the choices • The attack works on math too (MS-4).

8 “best” or “most” • The better of the last two is the best of the four.

The Shield: Predict First

Know what you're looking for before the choices tell you.

GL-3

LESSON

THE RULE

Before you look at any choice, answer the question yourself in a few plain words. That prediction is your **Shield**: it protects you from choices built to sound right.

QUESTION TYPE	HOW TO PREDICT
Words in context	Cover the blank and fill it with your own simple word. Your gut is good here.
Main purpose or idea	Finish "The author wrote this to..." in under ten words
Function of a sentence	Name its job: introduces, illustrates, contrasts, concludes
Inference (completes the text)	Write the ending yourself, using only the text's logic
Support or weaken a claim	Describe the finding that would prove, or hurt, the claim
Transitions	Name the relationship: adds, contrasts, causes, example, sequence
Math	Estimate: about how big? Positive or negative?

REMEMBER Grammar is the exception: **don't trust your gut on grammar**. Predict the rule being tested (boundary, agreement, tense) instead of what sounds right (GM-1).

WORKED EXAMPLES

- "Though the results seemed ____, they in fact confirmed the theory." Shield: "wrong." (A) unprecedented (B) contradictory (C) ambiguous (D) rigorous → B
- "A shirt costs \$40 after a 20% discount." Shield: the original is a bit more than \$40. \$50 fits; \$32 can't.
- Function of a sentence starting "For example,..." → Shield: "gives an example of the claim before it."
- Main idea of a text with a "however" turn → Shield: the point after the turn.

TRAPS

- ~~X No prediction: all four choices look plausible~~ ✓ **A ten-second prediction, then attack**
- ~~X A prediction from outside knowledge~~ ✓ **A prediction from the text only (GL-10)**
- ~~X Predicting grammar by ear~~ ✓ **Predicting the rule being tested**

DRILL HABIT

For one full timed test, write a 1–5 word prediction for every question before you look at the choices. Count how often your prediction matched the right answer.

TRY IT

- 1 Predict a word: "The critic's review was so ____ that the director framed it and hung it in her office."
- 2 Predict the relationship: "The bridge was old. ____, it carried more traffic than ever."
- 3 Estimate: 19% of 412 is about...?

ANSWERS 1 positive / glowing (e.g., laudatory) • 2 contrast (Nevertheless, Even so) • 3 about 80 (exactly 78.28)

The Shield: Predict First: Drill

8 original questions. Answer all of them before checking.

GL-3

DRILL

- 1 Predict a word: "The mayor's plan was so ___ that even her rivals praised it."
- 2 Predict: "Although the fossil was tiny, its discovery had ___ consequences for the field."
- 3 Predict the relationship: "The ferry was cheap. ___, it took three hours."
- 4 Predict the purpose: a text describes a widely held belief, then two studies that contradict it.
- 5 Estimate: 31% of 598 is about...?
- 6 Predict a word: "The scientist was ___ about the result, insisting it be repeated three times before announcing it."
- 7 Grammar question: choices differ only in "its / it's / their / they're." What do you predict?
- 8 Estimate: a \$79 coat is 25% off. About what's the sale price?

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ANSWERS

- 1 excellent / sensible • Even rivals praised it → strongly positive.
- 2 large / major • "Although tiny" sets up a contrast.
- 3 Contrast (However) • Cheap is good; three hours is bad.
- 4 To challenge a common belief • Setup → contrary evidence.
- 5 About 180 • $0.3 \times 600 = 180$ (exactly 185.38).
- 6 cautious • Repeating three times → careful.
- 7 The rule: pronoun or contraction • On grammar, predict the rule, not the sound.
- 8 About \$60 • $0.75 \times 80 = 60$ (exactly \$59.25).

The Gladius: Opposite

Weapon 1: the answer that says the reverse.

GL-4

LESSON

THE RULE

The fastest way to write a wrong answer is to flip the right one: add a *not*, swap *increase* for *decrease*, *supports* for *undermines*. Nearly every question has an Opposite. Kill it first. Code: **OPP**.

SIGNAL	THE TEXT SAYS	THE OPPOSITE TRAP SAYS
Direction	rainfall rose	rainfall fell
Attitude	the author admires the plan	the author doubts the plan
Relationship	supports the hypothesis	weakens the hypothesis
Negation	was effective	was not effective / was ineffective
Cause	heat caused the change	the change caused the heat
Comparison	more than the control group	less than the control group

REMEMBER Opposites hide in small words and prefixes: **not**, **un-**, **in-**, **dis-**, **except**, **least**, **never**. Read every choice word by word, and re-read the stem for “least” or “except.”

WORKED EXAMPLES

- Text: “Contrary to earlier claims, the 2019 survey found that bee populations in the region had stabilized.”
- Question: What did the survey find?
- ✓ Bee populations stopped declining.
- ✗ Gladius: Bee populations continued to decline. (the earlier claim, which the text rejects)

TRAPS

- ✗ ~~“The data undermine the claim” when they support it~~ ✓ **Check direction: support or undermine?**
- ✗ ~~Missing the “not” in a long choice~~ ✓ **Underline negatives in every choice**
- ✗ ~~Reading “least” as “most” in the stem~~ ✓ **Re-read the stem before choosing**

DRILL HABIT

Take five questions you got right. For each, write the Opposite trap yourself. Writing traps teaches you to see them.

TRY IT

- 1 Text: “The new alloy proved lighter but less durable than steel.” Which is the Opposite trap? (A) The alloy is less durable than steel. (B) The alloy is more durable than steel. (C) The alloy is lighter than steel.
- 2 Text: “Few critics expected the novel to succeed.” Complete the Opposite trap: “Most critics predicted the novel would ____.”
- 3 Which small words should you underline?

ANSWERS 1 B · 2 succeed · 3 not, un-, in-, dis-, except, least, never

The Gladius: Opposite: Drill

8 original questions. Answer all of them before checking.

- 1 Text: "Sales of the paper edition rose after the digital edition launched." Gladius trap?
(A) The digital edition launched. (B) Sales of the paper edition fell. (C) Sales of the paper edition rose. (D) Both editions existed.
- 2 Text: "The critic admired the film's music but disliked its plot." Gladius trap?
(A) The critic praised the music. (B) The critic reviewed the film. (C) The critic disliked the plot. (D) The critic disliked the music.
- 3 Text: "Warmer water increased coral bleaching." Gladius trap?
(A) Warmer water reduced bleaching. (B) Water temperature mattered. (C) Bleaching rose with warmer water. (D) Coral was studied.
- 4 Stem: "Which finding would **weaken** the claim that bees prefer blue flowers?" Which choice is a Gladius for this stem?
(A) Bees avoided blue flowers. (B) Bees visited blue flowers most. (C) Bees visited yellow flowers most. (D) Bees visited all colors equally.
- 5 Text: "The plan was not without critics." Meaning?
(A) The critics wrote the plan. (B) The plan had no critics. (C) Everyone opposed the plan. (D) The plan had some critics.
- 6 Which small words most often hide an Opposite?
- 7 Text: "Unlike the first trial, the second showed a clear effect." Gladius trap?
(A) The trials differed. (B) The second trial showed an effect. (C) The first trial showed a clear effect. (D) There were two trials.
- 8 Stem: "All of the following are supported EXCEPT..." What must you find?

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ANSWERS

- 1 B · Reverses "rose."
- 2 D · Reverses the attitude toward the music.
- 3 A · Reverses the direction.
- 4 B · It supports the claim: the opposite of what's asked.
- 5 D · "Not without" = with. "No critics" is the Gladius.
- 6 not, un-, in-, dis-, except, least, never · Underline them in every choice.
- 7 C · Swaps which trial showed the effect.
- 8 The one unsupported choice · Re-read "EXCEPT": the target flips.

The Pugio: Half-Right

Weapon 2: *half true is all false.*

GL-5

LESSON

THE RULE

A Half-Right choice starts with something true from the text, then adds a part that's wrong, missing or made up. **One wrong word kills the whole choice.** Code: **HALF**.

HOW IT'S BUILT	EXAMPLE (TEXT: "Mice given the drug slept longer but ate less.")
True + false	Mice slept longer and ate more.
True + outside the text	Mice slept longer, which improved their memory.
True + too strong	Mice slept longer and stopped eating.
True + invented cause	Mice slept longer because they ate less.
Both halves true (survivor)	Mice slept longer and ate less.

REMEMBER Read every choice to the last word. The bad half usually comes after *and*, *but*, *because*, *which* or a comma, and it usually carries a second weapon: Opposite, Extreme or Out of Scope.

WORKED EXAMPLES

- Split long choices in two at *and*, *because* or *which*.
- Check each half against the text separately.
- Both halves must be supported. One unsupported half: eliminate.
- Correct ACT answers are usually modest and fully supported.

TRAPS

- ~~X~~ Choosing a choice because its first half matches ✓ **Checking the second half too**
- ~~X~~ "Partly right, so maybe" ✓ **Partly right = wrong**
- ~~X~~ Reading until you recognize words ✓ **Reading to the period**

DRILL HABIT

On ten Reading questions, draw a slash in each long choice where the halves meet, and mark each half ✓ or X.

TRY IT

- 1 Text: "The festival drew record crowds, though vendors reported lower sales." Half-Right or supported? "The festival drew record crowds and vendors made record sales."
- 2 Same text: "Attendance was high, yet vendors sold less than usual."
- 3 Where does the bad half usually hide?

ANSWERS 1 Half-Right (sales were lower) · 2 Supported · 3 After *and*, *but*, *because*, *which* or a comma

The Pugio: Half-Right: Drill

8 original questions. Answer all of them before checking.

- 1 Text: "The town grew quickly after the railroad arrived, but its river port declined." Half-Right?
(A) The railroad arrived. (B) The port declined. (C) The town grew and its port thrived. (D) The town grew after the railroad came.
- 2 Text: "Owls hunt at night and rest during the day." Half-Right?
(A) Owls are nocturnal hunters. (B) Owls hunt at night. (C) Owls rest by day. (D) Owls hunt at night, which helps them avoid hawks.
- 3 Where does the bad half usually hide?
- 4 Text: "The drug reduced pain in 60% of patients but caused nausea in some." Half-Right?
(A) The drug reduced pain in most patients. (B) Some patients had nausea. (C) The drug helped a majority. (D) The drug reduced pain and had no side effects.
- 5 Text: "Her first album sold poorly; her second made her famous." Half-Right?
(A) Her albums had different results. (B) Her first album sold poorly and made her famous. (C) She released at least two albums. (D) Her second album brought her fame.
- 6 A choice is 90% supported, with one unsupported word. Keep or kill?
- 7 Text: "The bridge was built in 1932 and repaired in 1990." Half-Right?
(A) The bridge was built in 1932 because of a flood. (B) The bridge was built in 1932. (C) The bridge was repaired in 1990. (D) The bridge was repaired after it was built.
- 8 Text: "Most of the volunteers were students; a few were retirees." Half-Right?
(A) Most volunteers were students, and none were retirees. (B) Most volunteers were students. (C) Volunteers included students and retirees. (D) Some volunteers were retirees.

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ANSWERS

- 1 C • First half true; "port thrived" is false.
- 2 D • Second half is invented (Pugio + Mace).
- 3 After and, but, because, which, or a comma • Split long choices there.
- 4 D • "No side effects" contradicts the text.
- 5 B • Joins true + false.
- 6 Kill • One wrong word kills the whole choice.
- 7 A • Cause is invented.
- 8 A • "None were retirees" is false.

The Trident: Extreme Language

Weapon 3: *always, never, all, none, proves.*

GL-6

LESSON

THE RULE

Extreme words claim 100% or 0%: *always, never, all, none, every, only, completely, proves.* One exception makes them false. Correct answers are usually qualified: *may, some, often, suggests, partly.* Code: **EXT.**

EXTREME (USUALLY WRONG)	QUALIFIED (USUALLY SAFER)
always / never	often / rarely
all / none / every	many / few / some
proves / disproves	suggests / supports / challenges
completely / entirely	partly / largely
only / solely	mainly / among other things
must / certainly	may / likely
the first / the best	an early / one of the best

REMEMBER Extreme isn't automatically wrong: if the text itself says *all* or *never*, the answer can too. The real rule: **a choice can never be stronger than its evidence.**

WORKED EXAMPLES

- Text: "The results suggest the vaccine reduces infection."
- **X** "The results prove the vaccine prevents all infection." (proves, all)
- **✓** "The results indicate the vaccine may lower infection rates."
- Text: "Every sample tested positive." → "All the samples tested positive" is fine: the text is extreme too.

TRAPS

- X** ~~"The study proves..." after one experiment~~ **✓** "The study supports..."
- X** ~~Eliminating "all" when the text says "all"~~ **✓** **Match the strength of the text**
- X** ~~"The author completely rejects" when she has doubts~~ **✓** "The author questions..."

DRILL HABIT

Circle every extreme word in the choices of your next 20 questions. For each one, ask: does the text go that far?

TRY IT

- 1 Text: "Some historians now doubt the letter is authentic." Extreme trap or fine? "Historians agree the letter is fake."
- 2 Same text: "The letter's authenticity has been questioned."
- 3 Name three qualifiers common in correct answers.

ANSWERS 1 Extreme trap (some ≠ all; doubt ≠ fake) • 2 Fine • 3 may, suggests, some, often, partly, likely

The Trident: Extreme Language: Drill

8 original questions. Answer all of them before checking.

- 1 Text: "Many historians now question the letter's authenticity." Trident trap?
(A) All historians agree the letter is fake. (B) Historians have questions about the letter. (C) The letter's authenticity is debated. (D) Some scholars doubt the letter.
- 2 Text: "The results suggest that sleep may aid memory." Best answer style?
(A) Sleep may support memory. (B) Sleep always improves memory. (C) Sleep proves memory improves. (D) Memory requires sleep.
- 3 Text: "Every sample tested positive for the mineral." Is "All samples contained the mineral" a trap?
- 4 Name three qualifiers that often appear in right answers.
- 5 Text: "The study found a link between exercise and mood in teenagers." Trident trap?
(A) Mood and exercise were related. (B) The study involved teenagers. (C) Exercise was linked to mood. (D) Exercise completely determines mood.
- 6 Text: "Rarely did the composer revise her scores." Trident trap?
(A) She never revised her scores. (B) She seldom revised. (C) Revisions were uncommon. (D) She revised infrequently.
- 7 Text: "The new method is one of the fastest available." Trident trap?
(A) The method is the fastest ever invented. (B) Few methods are faster. (C) The method is very fast. (D) The method is among the quickest.
- 8 Text: "Some critics found the ending confusing." Trident trap?
(A) Critics universally rejected the ending. (B) The ending drew mixed reactions. (C) The ending puzzled some critics. (D) Not every critic understood the ending.

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ANSWERS

- 1 A · "All" and "fake" go far beyond "many question."
- 2 A · Matches the text's qualified strength.
- 3 No · The text itself says every: match its strength.
- 4 may, some, suggests (also: often, partly, likely) · Right answers rarely go further than the evidence.
- 5 D · "Completely determines" overstates a link.
- 6 A · "Never" ≠ "rarely."
- 7 A · "The fastest ever" overstates "one of."
- 8 A · "Universally rejected" overstates.

The Fist: Right Answer, Wrong Question

Weapon 4: true, but not what was asked.

GL-7

LESSON

THE RULE

This choice is accurate: it really is in the text. But it answers a different question from the one in the stem. Reading the stem first, and checking every survivor against it, is the only defense. Code: **RAWQ**.

THE STEM ASKS FOR...	THE FIST GIVES YOU...
The main purpose	a true detail from one sentence
What the researcher concluded	what the researcher assumed at the start
Why the author mentions X	what X is
Evidence for this claim	true evidence for a different claim
How Text 2 responds to Text 1	what Text 2 says on its own
What the table shows	a fact from the passage the table doesn't show

REMEMBER Before you select, ask your survivor: “Does this answer **THIS** stem?” True isn’t enough. The standard is true *and* responsive.

WORKED EXAMPLES

- Stem: “Which choice best states the main purpose of the text?”
- **X** “To describe how sea otters use rocks as tools.” (a detail: true, not the purpose)
- **✓** “To argue that tool use is more widespread among animals than once believed.”
- A choice that summarizes Text 2 alone, when asked how Text 2 responds to Text 1, is a Fist.

TRAPS

- X** ~~Picking a choice because you remember reading it~~ **✓ Checking it against the stem**
- X** ~~Answering “what” when the stem asks “why”~~ **✓ Underline the question word**
- X** ~~Choosing true data for the wrong claim~~ **✓ Re-read the claim in the stem**

DRILL HABIT

Before choosing, say the stem as a question out loud (“Why does the author mention X?”), then say your answer as a reply to it.

TRY IT

- 1 Stem: “Which choice best describes the function of the underlined sentence?” Fist or not? “It states that coral reefs cover less than 1% of the ocean floor.” (The sentence says this.)
- 2 Stem: “Why does the author mention the 1906 earthquake?” Which word decides?
- 3 What two tests must a survivor pass?

ANSWERS 1 Fist: it restates the content, not the function · 2 Why · 3 True to the text, and answers this stem

The Fist: Right Answer, Wrong Question: Drill

GL-7

8 original questions. Answer all of them before checking.

DRILL

- 1 Stem: "Why does the author mention the 1906 earthquake?" Fist trap?
(A) The earthquake destroyed much of the city. (B) To give background for the reforms that followed. (C) To explain why the city rebuilt its water system. (D) To show how the city's planning changed.
- 2 Stem: "Which choice best states the main purpose?" The text is about a scientist's method; one choice repeats a statistic from sentence 3. Weapon?
- 3 Stem: "Which finding would support the claim that crows recognize faces?" Fist trap?
(A) Crows are among the most intelligent birds. (B) Crows avoided only the people who had harmed them.
(C) Crows scolded people who had captured them earlier. (D) Crows ignored unfamiliar people.
- 4 Two-text question: "How would the author of Text 2 respond to Text 1?" A choice summarizes Text 2 alone. Weapon?
- 5 What question do you ask every survivor before selecting it?
- 6 Stem: "What did the researchers conclude?" A choice states what they assumed at the start. Weapon?
- 7 Stem: "Which choice best describes the table's data?" A choice states a fact found only in the passage. Weapon?
- 8 Stem: "Which choice best describes the function of the third sentence?" Fist trap?
(A) It qualifies the claim in sentence 2. (B) It introduces a counterargument. (C) It states that otters use rocks as tools. (D) It gives an example of the claim in sentence 2.

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ANSWERS

- 1 A • A true fact, but it says what, not why.
- 2 Fist • True detail, wrong question.
- 3 A • Possibly true, but not evidence for face recognition.
- 4 Fist • It doesn't relate Text 2 to Text 1.
- 5 "Does this answer THIS stem?" • True isn't enough; it must answer what was asked.
- 6 Fist • Assumption ≠ conclusion.
- 7 Fist (and Mace for the table) • The stem asks about the table.
- 8 C • It restates content, not function.

The Mace: Out of Scope

Weapon 5: beyond the text.

GL-8

LESSON

THE RULE

If the text doesn't say it or clearly support it, it can't be the answer, even if it's true in real life. The passage is finite; everything outside it is out of scope. Code: **OOS**.

OUT-OF-SCOPE TYPE	EXAMPLE (TEXT ABOUT ONE BEE SPECIES IN CHILE)
Too broad	All pollinators worldwide are declining.
New topic	Pesticides should be banned.
Outside knowledge	Einstein warned about bee loss.
Future prediction	The species will be extinct by 2040.
Unstated cause	The decline is caused by climate change.
Recommendation never made	Farmers should plant more wildflowers.

REMEMBER True in the world, wrong on the ACT: if you know it from school or the news but not from this text, eliminate it. Check every noun in a choice: is it in the passage?

WORKED EXAMPLES

- Text: "The Andean condor population in the study area grew 12% after a ban on lead ammunition."
- **X** Mace: "Lead ammunition should be banned worldwide." (a recommendation, and worldwide)
- **X** Mace: "Condors are the largest flying birds." (not in the text)
- **✓** "The condor population increased after a change in hunting rules."

TRAPS

X ~~Choosing what you learned in biology class~~ **✓** **Choosing what this text says**

X ~~A claim broader than the text's sample~~ **✓** **Same place, group and time**

X ~~A cause the text never names~~ **✓** **Only causes the text states or clearly implies**

DRILL HABIT

For each choice you eliminate as Out of Scope, point to the exact word that isn't in the passage. If you can't point to one, look again.

TRY IT

- 1 The text studies 40 students at one school. Out of Scope? "Students nationwide learn better with music."
- 2 Text: "The bridge was completed in 1932." Out of Scope? "The bridge was finished in the early 1930s."
- 3 What should you check for every noun in a choice?

ANSWERS 1 Yes (too broad) · 2 No: same fact in new words · 3 That the text states or clearly supports it

The Mace: Out of Scope: Drill

8 original questions. Answer all of them before checking.

GL-8

DRILL

- 1 Text studies 50 farms in Kenya. Mace trap?
(A) The method was tested in Kenya. (B) The farms in the study benefited. (C) Farmers worldwide should adopt the method. (D) Some farms improved yields.
- 2 Text: "The comet was first recorded in 1682." Mace trap?
(A) The comet was seen before 1700. (B) Halley predicted the comet's return. (C) The comet was observed in the 1600s. (D) A record exists from 1682.
- 3 Text describes a drought's effect on wheat. Mace trap?
(A) Yields dropped in dry years. (B) Wheat yields fell during the drought. (C) The drought was caused by climate change. (D) The drought affected wheat.
- 4 Text: "The violinist practiced six hours a day as a teenager." Mace trap?
(A) Her teenage practice was long. (B) She practiced intensively in her teens. (C) She practiced daily. (D) She will win the next competition.
- 5 What should you check for every noun in a choice?
- 6 Text about a museum's new wing. Mace trap?
(A) The new wing opened. (B) Museums should charge lower fees. (C) The wing added gallery space. (D) The museum expanded.
- 7 True or false: an answer that is true in real life can still be wrong on the ACT.
- 8 Text: "The tortoise lived 150 years, the longest recorded for its species." Mace trap?
(A) It lived 150 years. (B) The tortoise was unusually long-lived for its species. (C) Tortoises live longer than all other animals. (D) It set a record for its species.

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ANSWERS

- 1 C • Too broad + a recommendation the text never makes.
- 2 B • Outside knowledge, even if true.
- 3 C • Unstated cause.
- 4 D • Future prediction.
- 5 That it appears in, or is clearly supported by, the text • Point to it or kill it.
- 6 B • New topic.
- 7 True • Only the text counts (GL-10).
- 8 C • Too broad: all animals.

The Axe: Recycled Language

Weapon 6: same words, wrong meaning.

GL-9

LESSON

THE RULE

A Recycled choice copies exact words from the passage but changes their meaning, order or connection. Matching words is not matching meaning. Correct answers usually **paraphrase**; traps often **copy**. Code: **REC**.

TEXT	RECYCLED TRAP	CORRECT PARAPHRASE
"Light pollution disrupts the migration of birds."	"Birds cause light pollution during migration."	"Artificial light interferes with how birds migrate."
"The poet's early work was ignored; her later work, celebrated."	"The poet's early work was celebrated."	"Recognition came late in the poet's career."
"Prices fell as supply rose."	"Supply fell as prices rose."	"Greater supply lowered prices."

REMEMBER Be suspicious of a choice that looks just like the passage. Read for meaning: who did what to whom, in what order, with what result.

WORKED EXAMPLES

- Underline the words a choice shares with the passage.
- Ask: in the passage, do these words connect the same way?
- Same words, different connection: Axe it.
- Different words, same meaning: a likely survivor.

TRAPS

- ~~X The choice with the most passage words~~ ✓ **The choice with the same meaning**
- ~~X Rejecting a paraphrase because it's "not in the text"~~ ✓ **Paraphrase is how the ACT writes right answers**
- ~~X Matching a rare word from the passage~~ ✓ **Rare-word matches are bait**

DRILL HABIT

Rewrite each sentence of a passage in your own words without reusing any key word. Then compare with the right answers you got: they look like your rewrites.

TRY IT

- 1 Text: "The committee rejected the proposal because it lacked funding." Trap or paraphrase? "The proposal lacked a committee."
- 2 Same text: "The plan was turned down for financial reasons."
- 3 Do correct answers more often copy or paraphrase?

ANSWERS 1 Recycled trap • 2 Paraphrase (likely correct) • 3 Paraphrase

The Axe: Recycled Language: Drill

8 original questions. Answer all of them before checking.

- 1 Text: "Noise from ships disrupts how whales communicate." Axe trap?
(A) Ships are noisy. (B) Ship noise interferes with whale communication. (C) Whales communicate with ships using noise. (D) Whales are affected by sound.
- 2 Text: "The poet's early work was ignored; her later work was celebrated." Axe trap?
(A) Her later poems were praised. (B) Her early work was celebrated. (C) Her early poems went unnoticed. (D) Recognition came late in her career.
- 3 Do correct answers more often copy or paraphrase the text?
- 4 Text: "Prices fell as supply rose." Axe trap?
(A) Supply increased. (B) Prices dropped. (C) Supply fell as prices rose. (D) More supply meant lower prices.
- 5 Text: "The committee rejected the proposal because it lacked funding." Axe trap?
(A) The proposal lacked a committee. (B) The proposal was turned down for financial reasons. (C) The committee said no. (D) Funding was an issue.
- 6 Text: "Volcanic ash blocked sunlight, cooling the planet." Axe trap?
(A) Ash in the air lowered global temperatures. (B) The planet cooled. (C) Sunlight blocked volcanic ash. (D) Ash reduced sunlight.
- 7 What do you underline to spot an Axe?
- 8 Text: "Children who read for pleasure scored higher on vocabulary tests." Axe trap?
(A) Pleasure reading was associated with higher vocabulary scores. (B) Scores differed among children. (C) Vocabulary tests made children read for pleasure. (D) Some children read for pleasure.

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ANSWERS

- 1 C • Same words, new meaning.
- 2 B • Recycles "early" and "celebrated" in the wrong order.
- 3 Paraphrase • Copying is bait.
- 4 C • Same words, reversed connection.
- 5 A • Recycled words, nonsense meaning.
- 6 C • Who did what to whom is reversed.
- 7 The words a choice shares with the passage • Then check they connect the same way.
- 8 C • Reverses the relationship.

The Lawyer in the Courtroom

Only the evidence in front of you counts.

GL-10

LESSON

THE RULE

Treat each question as its own court case. The only admissible evidence is the passage, the note above it and the stem. Read everything literally, and choose the answer you could defend by **pointing to words in the text**.

A LAWYER...	ON THE ACT, YOU...
Uses only evidence admitted in court	Use only this question's passage and data
Takes testimony literally	Read literally: "some" means some
Rejects hearsay	Reject outside knowledge, even if it's true
Can point to the exhibit	Can point to the line that proves the answer
Tries each case separately	Treat every question as a separate case

REMEMBER A standardized test must have exactly one defensible answer, or it couldn't be scored fairly. That's why the right answer is always supported by the text, and why your job is to find the support, not to interpret creatively.

WORKED EXAMPLES

- Before choosing, point to the words that prove your answer.
- Can't point to anything? You're about to choose an Out-of-Scope answer.
- Inference questions too: the answer must *follow* from the text, not just be possible.
- The note above a passage (author, date, context) is evidence too.

TRAPS

- ~~X "Logically, the author probably also believes..."~~ ✓ **"The text says..."**
~~X Using what you studied in history class~~ ✓ **Using only this passage**
~~X Choosing what could be true~~ ✓ **Choosing what must be true, given the text**

DRILL HABIT

For your next 15 Reading and Writing questions, write the quote that proves each answer. If you can't find one, mark the question as a guess and review it.

TRY IT

- 1 Text: "Many residents opposed the dam." Can you conclude most residents opposed it?
- 2 Text: "The painting was sold in 1910 to a private collector." Can you conclude it's in a private collection today?
- 3 Is the note above a passage admissible evidence?

ANSWERS 1 No: many ≠ most • 2 No: only that it was sold to one in 1910 • 3 Yes

The Lawyer in the Courtroom: Drill

8 original questions. Answer all of them before checking.

GL-10

DRILL

- 1 Text: "Several residents opposed the dam." Can you conclude most residents opposed it?
- 2 Text: "The painting was sold in 1910." Can you conclude who owns it today?
- 3 Is the note above a passage (author, date, context) admissible evidence?
- 4 Text: "The team's new design used 30% less steel." Lawyer's answer?
(A) The design used less steel than before. (B) The design was cheaper. (C) The design was safer. (D) Steel is expensive.
- 5 Text: "Most of the letters were written in French." Can you conclude some were not?
- 6 What should you be able to do before choosing any Reading and Writing answer?
- 7 Text: "The study observed 20 students at one school." Can you conclude the finding applies to all teenagers?
- 8 Text: "The explorer reached the river in May and the coast in July." Must-be-true?
(A) The river led to the coast. (B) She traveled by boat. (C) She reached the coast after the river. (D) She arrived in summer both times.

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 No · Several ≠ most.

2 No · Only the 1910 sale is in evidence.

3 Yes · It's part of the question.

4 A · Only "used less steel" can be pointed to in the text.

5 Yes · "Most" implies not all.

6 Point to the words that prove it · No pointing, no choosing.

7 No · Only that school's 20 students.

8 C · The others could be true; only the order of arrival must be.

Active Reading: Ask “Why?”

Read for the job of every sentence.

GL-11

LESSON

THE RULE

Active reading means reading while thinking, not just looking at words. For every sentence, ask **why it’s there**: does it introduce, give an example, contrast, explain a cause, or conclude?

SIGNAL WORDS	THE SENTENCE’S JOB
For example, for instance, such as	illustrates a claim
However, but, yet, although, in contrast	turns or contrasts
Because, since, as a result, therefore	gives a cause or an effect
Some argue, it was long believed	sets up a view to challenge
Thus, in short, ultimately	concludes
Moreover, also, in addition	adds support
Recent research, new evidence	introduces a finding

REMEMBER Ask “Why?” two or three times: why this sentence, why here, why this word? ACT passages are long, so a one-word label for every paragraph (RD-2) keeps you oriented when the questions send you back.

WORKED EXAMPLES

- “Scientists long assumed X.” Why? → To set up a view the text will challenge.
- “However, new data show Y.” Why? → The turn: the author’s point.
- “In one trial, Z happened.” Why? → Evidence for Y.
- Now the purpose writes itself: to show X is wrong because of Y.

TRAPS

- ~~X Reading every word with the same weight~~ ✓ **Slowing down at turns: however, but, yet**
- ~~X Treating the first sentence as the main idea~~ ✓ **The point often comes after the turn**
- ~~X Finishing the text with no summary~~ ✓ **Summarize in five words before the choices**

DRILL HABIT

Label each sentence of five passages with one word: SETUP, CLAIM, TURN, EVIDENCE, EXAMPLE or CONCLUSION.

TRY IT

- 1 Job? “Earlier studies, however, relied on very small samples.”
- 2 Job? “For instance, the octopus can open screw-top jars.”
- 3 After “It was long believed that...”, what usually comes next?

ANSWERS 1 Contrasts with, or challenges, earlier studies · 2 Gives an example · 3 A turn that challenges the belief

Active Reading: Ask “Why?”: Drill

8 original questions. Answer all of them before checking.

- 1 Job? “For instance, some octopuses carry coconut shells as shelters.”
- 2 Job? “It was long believed that birds descended from crocodiles.”
- 3 Job? “However, recent fossils point to a different ancestor.”
- 4 Job? “As a result, the lake froze earlier each decade.”
- 5 Job? “Thus, the evidence favors the second explanation.”
- 6 Where does the author’s point usually appear in a text with a “however” turn?
- 7 Job? “Moreover, the method is cheaper.”
- 8 Label each sentence: (1) Scientists assumed X. (2) A 2020 study found not-X. (3) In one trial, Y happened. (4) So X needs revision.

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ANSWERS

- 1 Example · Illustrates a claim.
- 2 Sets up a view to challenge · “Long believed” signals a coming turn.
- 3 Turn / contrast · The author’s point usually follows.
- 4 Effect · “As a result” signals a consequence.
- 5 Conclusion · “Thus” concludes.
- 6 After the turn · Slow down at however, but, yet.
- 7 Adds support · Same direction as the previous point.
- 8 SETUP, TURN, EVIDENCE, CONCLUSION · The purpose writes itself.

Best of the Last Two

When two survive, the stem decides.

GL-12

LESSON

THE RULE

Sometimes only two choices die. Then go back to the stem and the text: the better answer matches the stem more exactly and has no word you can attack. Stems with *best* or *most* tell you this can happen.

COMPARE THE TWO ON...

THE WINNER...

The stem's exact task	does that task (purpose, function, support), not a neighbor of it
Scope	covers the whole text for main idea; one part when asked about one part
Strength	is no stronger than the evidence
Every word	has no word you can point to as unsupported
Your Shield	is closer to the prediction you made before looking

REMEMBER Don't revive a choice you already killed for a reason, and don't flip-flop. Decide with the checklist, mark it, and move on: two minutes on one question costs points elsewhere.

WORKED EXAMPLES

- Last two for main purpose: one covers the whole text, one covers sentence 3 → the whole-text one.
- Last two for support: one shows the effect; the other shows it *only in the treated group*, as the claim requires → the second.
- Last two differ by one word: "suggests" vs. "proves" → the weaker, supported one.
- Still unsure after about 30 seconds? Pick, flag, move on, return if time allows.

TRAPS

- ~~X Choosing by gut between the last two~~ ✓ **Choosing by the checklist**
- ~~X Reviving a choice you eliminated with a reason~~ ✓ **Trusting your earlier elimination**
- ~~X Spending three minutes on one question~~ ✓ **Flag it and come back**

DRILL HABIT

Collect every question where you were stuck between two. For each, write the one word that made the right answer better. Patterns will appear within two weeks.

TRY IT

- 1 Main idea stem. C summarizes the whole text; D describes one example. Which?
- 2 Two choices: "may contribute to" vs. "is the primary cause of." The text says "is one factor in." Which?
- 3 How long should you spend between the last two before picking and flagging?

ANSWERS 1 C · 2 "may contribute to" · 3 About 30 seconds

Best of the Last Two: Drill

8 original questions. Answer all of them before checking.

GL-12

DRILL

- 1 Main idea stem. B summarizes the whole text; D describes its first example. Which?
- 2 Text says the policy “is one factor in” lower crime. Last two: “contributed to” vs. “was the main cause of.” Which?
- 3 Last two differ by one word: “describes” vs. “criticizes.” The text is neutral. Which?
- 4 How long between the last two before you pick, flag and move on?
- 5 You eliminated C for a reason; now it looks good again. What do you do?
- 6 Last two for a function question: one states what the sentence says, one states what it does. Which?
- 7 Last two for “support the claim that only saplings responded.” One shows saplings responded; one shows saplings responded and old ones didn’t. Which?
- 8 Which is closer to the right answer: the survivor that matches your Shield, or the one that sounds more impressive?

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ANSWERS

- 1 B • Main idea covers the whole text.
- 2 “contributed to” • No stronger than the evidence.
- 3 “describes” • Match the tone.
- 4 About 30 seconds • Don’t spend three minutes on one question.
- 5 Trust the earlier elimination • Don’t revive a choice you killed for a reason.
- 6 What it does • The other is a Fist.
- 7 The second • It matches “only.”
- 8 The one that matches your Shield • Impressive isn’t evidence.

PART III

English

Grammar by rule, and every rhetoric question type: NO CHANGE, transitions, add or delete, order, purpose.

The Psychology of Trap Answers



JOSEF AIDEN DURAND
FROM THE AUTHOR

Every trap answer is built on a bet: that you'll be in a hurry, that you'll be looking for the right answer, and that you'll grab the first choice that seems close enough. Close enough is exactly what traps are designed to be.

The test-maker knows you remember the passage's words, so the Axe recycles them. The test-maker knows you like answers that sound confident, so the Trident adds "always" and "proves." The test-maker knows you'll read the first half of a long choice and nod, so the Pugio hides the poison in the second half.

That's why pattern recognition is the elite scorer's real advantage. After a few hundred evaluated questions, you stop seeing four answer choices; you see one survivor and three familiar faces. "That's an Opposite. That's Out of Scope. That one's recycling the passage." The traps don't change. You do.

So don't just do questions. Name every trap you eliminate, and name the trap you fell for every time you miss. Do that for six weeks, and the test starts to feel like a rerun. You've seen this episode before. You know how it ends.

Grammar Rule One: Don't Trust Your Ear

Name the rule, then apply it.

GM-1

LESSON

THE RULE

On ACT English, underlined portions test punctuation and grammar as often as style, and what sounds right is often wrong. **Look at what the choices differ on**, name the rule, then apply it. NO CHANGE is a real option (ENG-2).

IF THE CHOICES DIFFER IN...	THE RULE	LESSON
Periods, commas, semicolons, colons, dashes	Sentence boundaries	GM-2 to GM-6
is / are, has / have	Subject-verb agreement	GM-8
was / had been / is	Tense and form	GM-10
it / they, its / their	Pronoun agreement	GM-9
's / s' / s	Possessives and plurals	GM-11
What comes right after an opening phrase	Modifier placement	GM-7
Entirely different words	Not grammar: transitions, word choice, relevance	ENG-3 to ENG-8

REMEMBER On grammar questions, scan the choices **first**: the differences tell you the rule. Then read the sentence with that rule in mind.

WORKED EXAMPLES

- “trees, they / trees; they / trees they / trees, and, they” → boundaries.
- “has / have / having / to have” → agreement or form.
- “its / it's / their / they're” → pronoun or possessive.
- If two choices are grammatically identical, neither can be the answer.

TRAPS

- ~~✗ Choosing what sounds natural when spoken~~ ✓ **Choosing what follows the rule**
- ~~✗ Reading the whole text before checking what changes~~ ✓ **Scanning the choices first**
- ~~✗ Adding commas where you would pause~~ ✓ **Commas follow rules, not breaths**

DRILL HABIT

For 20 conventions questions, write the rule name in the margin (BOUNDARY, AGREEMENT, TENSE, PRONOUN, POSSESSIVE, MODIFIER) before answering.

TRY IT

- 1 Choices differ: was / were / has been / being. Which rule?
- 2 Choices differ: city, the / city; the / city the / city, and the. Which rule?
- 3 Choices differ: dog's / dogs' / dogs / dogs's. Which rule?

ANSWERS 1 Agreement or tense (GM-8, GM-10) • 2 Boundaries (GM-2) • 3 Possessives (GM-11)

Grammar Rule One: Don't Trust Your Ear: Drill **GM-1**

10 original questions. Answer all of them before checking.

DRILL

- 1 Choices: "was / were / has been / being." Which rule is tested?
- 2 Choices: "river, it / river; it / river it / river, and, it." Which rule?
- 3 Choices: "its / it's / their / they're." Which rule?
- 4 Choices: "Having studied the data, the team... / ...the data was... / ...the team's..." Which rule?
- 5 Choices: "However / Therefore / For example / Similarly." Grammar question?
- 6 Choices: "the poet Rita Dove / the poet, Rita Dove, / the poet, Rita Dove / the poet Rita Dove," Which rule?
- 7 Should you predict a grammar answer by what sounds right?
- 8 Choices: "scientist's / scientists / scientists' / scientist." Which rule?
- 9 Choices: "discovered / discovers / had discovered / discovering." Which rule?
- 10 Two choices are grammatically identical. Can either be the only right answer?

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ANSWERS

- 1 Agreement or tense · GM-8, GM-10.
- 2 Boundaries · GM-2.
- 3 Pronoun / possessive · GM-9, GM-11.
- 4 Modifier placement · GM-7.
- 5 No: a transition question · ENG-3.
- 6 Commas (essential title) · GM-5, GM-6.
- 7 No · Name the rule instead.
- 8 Possessives and plurals · GM-11.
- 9 Tense and form · GM-10.
- 10 No · Eliminate both.

Boundaries: Joining Independent Clauses

The most tested rule on the ACT.

GM-2

LESSON

THE RULE

Two independent clauses (each could be a sentence) can be joined only four ways: **a period, a semicolon, a comma + FANBOYS, or a colon or dash** when the second explains the first. A comma alone is a splice; nothing at all is a run-on.

JOIN	EXAMPLE	OK?
Period	The tide rose. The boats floated.	✓
Semicolon	The tide rose; the boats floated.	✓
Comma + FANBOYS	The tide rose, and the boats floated.	✓
Colon (second explains first)	The tide rose quickly: the moon was full.	✓
Comma alone	The tide rose, the boats floated.	✗ splice
Nothing	The tide rose the boats floated.	✗ run-on
Comma + however	The tide rose, however, the boats floated.	✗ splice

REMEMBER The finger test: put your finger on the punctuation. Can the words before it stand alone? Can the words after? If both are yes, you need one of the four legal joins.

WORKED EXAMPLES

- “The study took a decade, its results changed the field.” ✗ → “decade; its results” or “decade, and its results.”
- “..., however, the results...” between two sentences ✗ → “; however,” or “. However,”
- “Although the study took a decade, its results...” ✓ dependent + independent: a comma.
- “The study took a decade and changed the field.” ✓ one subject, two verbs: no comma.

TRAPS

✗ A comma between two sentences ✓ A semicolon, period, or comma + FANBOYS

✗ A semicolon after a dependent clause (“Although...;”) ✓ A comma

✗ A comma before “and” joining two verbs (“She ran, and won.”) ✓
No comma: one subject

DRILL HABIT

Do 15 boundary questions using the finger test out loud: “Stand alone? Yes. Stand alone? Yes. Legal join needed.”

TRY IT

- 1 “The museum reopened in May ___ visitors lined up for hours.” (A) May, (B) May; (C) May (D) May, however,
- 2 “Because the river flooded ___ the town canceled the fair.” (A) flooded; (B) flooded, (C) flooded. (D) flooded:
- 3 “She studied the data ___ she found an error.” (A) data, she (B) data she (C) data, and she (D) data, however, she

ANSWERS 1 B · 2 B · 3 C

Boundaries: Joining Independent Clauses: Drill GM-2

10 original questions. Answer all of them before checking.

DRILL

- 1 "The storm passed ___ the sky turned pink."
(A) passed; the (B) passed, the (C) passed, however, the (D) passed the
- 2 "Although the storm passed ___ the roads stayed flooded."
(A) passed; the (B) passed, the (C) passed. The (D) passed: the
- 3 "She tested the samples ___ and she recorded the results."
(A) samples: (B) samples, (C) samples (D) samples;
- 4 "The museum reopened ___ visitors returned in record numbers."
(A) reopened, and (B) reopened (C) reopened, (D) reopened, however,
- 5 "He wrote the essay ___ revised it twice."
(A) essay, (B) essay, and (C) essay; and (D) essay and
- 6 "The price rose sharply ___ demand stayed strong."
(A) sharply, demand (B) sharply, nevertheless demand (C) sharply; nevertheless, demand (D) sharply demand
- 7 "The data were clear ___ the hypothesis was wrong."
(A) clear the (B) clear: the (C) clear, the (D) clear, and, the
- 8 "When the bell rang ___ students left."
(A) rang the (B) rang. The (C) rang; the (D) rang, the
- 9 "The bridge is old ___ it is safe."
(A) old, however it (B) old, but it (C) old, it (D) old it
- 10 "Researchers studied the reef for years ___ they found three new species."
(A) years. They (B) years they (C) years, they (D) years, however, they

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ANSWERS

- 1 A · Two independent clauses: semicolon.
- 2 B · Dependent + independent: comma.
- 3 B · Comma + FANBOYS joins two clauses.
- 4 A · Comma alone splices; however can't join.
- 5 D · One subject, two verbs: no comma.
- 6 C · Semicolon before the transition, comma after.
- 7 B · Colon: second clause explains the first.
- 8 D · Introductory dependent clause: comma.
- 9 B · Comma + FANBOYS.
- 10 A · Period is one of the four legal joins.

Semicolons

A semicolon is a period in disguise.

GM-3

LESSON

THE RULE

A semicolon works like a period: **both sides must be independent clauses.**

The one exception: separating list items that already contain commas.

USE	EXAMPLE
Two related independent clauses ✓	Copper conducts heat well; silver conducts it even better.
Before a transition between clauses ✓	The test was hard; nevertheless, most students passed.
List items that contain commas ✓	The tour visits Lima, Peru; Quito, Ecuador; and Bogotá, Colombia.
Before a dependent clause ✗	She smiled; because she won.
Before a list ✗	He packed three things; a map, a tent, and food.
Before a phrase ✗	The fox ran; across the field.

REMEMBER Test: replace the semicolon with a period. If both halves are full sentences, the semicolon is right. Avoid “; and” unless the list exception applies.

WORKED EXAMPLES

- “The forest burned; within a year, new shoots appeared.” ✓
- “The forest burned; leaving only ash.” ✗ the second half is a phrase: use a comma.
- “The vote was close; however, the bill passed.” ✓
- “Members came from Austin, Texas; Reno, Nevada; and Salem, Oregon.” ✓

TRAPS

- ✗ “...; and she left.” ✓ “..., and she left.” or “...; she left.”
- ✗ “Since it rained; we stayed in.” ✓ “Since it rained, we stayed in.”
- ✗ “She had one goal; to win.” ✓ “She had one goal: to win.”

DRILL HABIT

Write five pairs of sentences about your day joined by semicolons. Read each half alone to prove it’s a full sentence.

TRY IT

- 1 “The orchestra tuned ___ the audience fell silent.” (A) tuned; (B) tuned, (C) tuned (D) tuned; and
- 2 “The scientist made a discovery ___ a new species of frog.” (A) discovery; (B) discovery: (C) discovery, and (D) discovery and
- 3 Right or wrong? “Because the bridge was closed; we took the ferry.”

ANSWERS 1 A • 2 B • 3 Wrong: use a comma after a dependent clause

Semicolons: Drill

10 original questions. Answer all of them before checking.

- 1 "The lake froze early ___ skaters arrived by December."
(A) early (B) early, (C) early; (D) early; and
- 2 "The team had one goal ___ to finish first."
(A) goal: (B) goal, (C) goal; and (D) goal;
- 3 "The tour visits Kyoto, Japan ___ Seoul, South Korea ___ and Taipei, Taiwan."
(A) — — (B) , , (C) : : (D) ; ;
- 4 "Because the road was icy ___ the bus was late."
(A) icy: (B) icy (C) icy, (D) icy;
- 5 "The results were mixed ___ however, the method worked."
(A) mixed; (B) mixed: (C) mixed (D) mixed,
- 6 "He packed everything ___ shoes, a tent, and maps."
(A) everything, (B) everything; (C) everything; and (D) everything;
- 7 "The vote passed ___ few expected it."
(A) passed (B) passed; (C) passed; and, (D) passed,
- 8 Right or wrong? "She left early; to catch the train."
- 9 "The ink faded ___ the paper survived."
(A) faded, (B) faded; (C) faded (D) faded; but,
- 10 Test for a semicolon?

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ANSWERS

- 1 C · Two independent clauses.
- 2 A · Colon introduces an explanation; semicolon needs a clause after.
- 3 D · List items with internal commas.
- 4 C · Dependent clause: comma, not semicolon.
- 5 A · Semicolon before a transition joining clauses.
- 6 D · Colon before a list after a full sentence.
- 7 B · Two clauses.
- 8 Wrong · "to catch the train" isn't a clause: no semicolon.
- 9 B · Two clauses.
- 10 Replace it with a period: both halves must be sentences · The period test.

Colons and Dashes

Introduce it, or set it apart.

GM-4

LESSON

THE RULE

A **colon** follows a complete independent clause and introduces what comes next: a list, an explanation or a quotation. **Dashes** set off extra information (a pair, like a pair of commas) or add emphasis at the end (one dash).

MARK	RULE	EXAMPLE
Colon ✓	A complete sentence before it	The recipe needs three spices: cumin, clove, and saffron.
Colon ✓	The second part explains the first	The result was clear: the method worked.
Colon ✗	After a verb or preposition	The spices are: cumin and clove.
Dash pair ✓	Extra information in the middle	The author—a former chemist—wrote it in a year.
Single dash ✓	Emphasis or explanation at the end	She had one fear—failure.
Mixed pair ✗	Opened with a dash, closed with a comma	The author—a former chemist, wrote it...

REMEMBER Be consistent: extra information opened with a dash closes with a dash; opened with a comma, closes with a comma. The ACT loves this mismatch.

WORKED EXAMPLES

- “The study reached one conclusion: sleep improves memory.” ✓
- “The study concluded that: sleep improves memory.” ✗ no colon after “that.”
- “Ada Lovelace—the first programmer—worked with Babbage.” ✓
- “Ada Lovelace—the first programmer, worked...” ✗ mismatch.

TRAPS

- ✗ ~~“such as: apples and pears”~~ ✓ **“such as apples and pears”**
- ✗ ~~A dash, then a comma, around one interruption~~ ✓ **Two dashes or two commas**
- ✗ ~~“The winners were: Ana and Li.”~~ ✓ **“There were two winners: Ana and Li.”**

DRILL HABIT

Set off the extra information in ten sentences three ways: commas, dashes, parentheses. Keep each pair matched.

TRY IT

- 1 “The coach gave one piece of advice ___ never stop running.” (A) advice; (B) advice: (C) advice, (D) advice that:
- 2 “The painting—which hung in the hall for a century ___ was sold.” (A) century, (B) century— (C) century; (D) century
- 3 Right or wrong? “Her favorite cities are: Paris and Hanoi.”

ANSWERS 1 B · 2 B · 3 Wrong: no colon after “are”

Colons and Dashes: Drill

10 original questions. Answer all of them before checking.

GM-4

DRILL

- 1 “The recipe needs one rare spice ___ saffron.”
(A) spice that: (B) spice, (C) spice; (D) spice:
- 2 “The spices include ___ cumin and clove.”
(A) include (B) include— (C) include: (D) include;
- 3 “The architect ___ a former sculptor ___ designed the library.”
(A) , — (B) ; ; (C) — — (D) — ,
- 4 “She had one fear ___ heights.”
(A) fear; (B) fear that (C) fear— (D) fear,
- 5 “The result was clear ___ the method worked.”
(A) clear that: (B) clear (C) clear: (D) clear,
- 6 “The painting ___ which hung in the hall for a century ___ was sold.”
(A) — , (B) — — (C) ; ; (D) , —
- 7 Right or wrong? “The winners are: Ana and Kofi.”
- 8 “The study answered one question ___ does sleep affect memory?”
(A) question: (B) question, (C) question; (D) question
- 9 “The festival—held every June ___ draws thousands.”
(A) June; (B) June (C) June, (D) June—
- 10 “There were three finalists ___ Lee, Okafor, and Ruiz.”
(A) finalists, and (B) finalists: (C) finalists (D) finalists;

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ANSWERS

- 1 D · Colon after a full sentence introduces it.
- 2 A · No colon after a verb.
- 3 C · Matching pair.
- 4 C · Dash for emphasis at the end.
- 5 C · Second clause explains the first.
- 6 B · Opened with a dash, close with a dash.
- 7 Wrong · Words before a colon must be a full sentence.
- 8 A · Colon introduces the question it explains.
- 9 D · Close the dash pair.
- 10 B · Full sentence + list.

Commas Around Extra Information

Nonessential gets commas; essential doesn't.

GM-5

LESSON

THE RULE

Information the sentence could live without (nonessential) is set off by a **pair** of commas, dashes or parentheses. Information needed to identify who or what (essential) gets **no** commas.

TYPE	EXAMPLE
Nonessential clause	My sister, who lives in Hanoi, is a doctor.
Essential clause	The student who won the prize is my cousin.
Nonessential appositive	Toni Morrison, a Nobel laureate, wrote <i>Beloved</i> .
Title or description before a name: no commas	The novelist Toni Morrison wrote <i>Beloved</i> .
Introductory element	In 1969, astronauts landed on the moon.
One comma only ✗	My sister, who lives in Hanoi is a doctor.

REMEMBER The ACT's favorite traps: **no comma between a title or description and the name that follows** ("biologist Rachel Carson"), and **no single comma between a subject and its verb**. Test extra information by deleting it: does the sentence still work and mean the same thing?

WORKED EXAMPLES

- "Physicist Chien-Shiung Wu disproved a law of physics." ✓ title + name: no commas.
- "Chien-Shiung Wu, a physicist, disproved..." ✓ appositive after the name: a pair.
- "The experiment that Wu designed..." ✓ essential: which experiment.
- "Wu's experiment, which took months, ..." ✓ extra information.

TRAPS

- ✗ "Author, Amy Tan, wrote..." ✓ "Author Amy Tan wrote..."
- ✗ Opening a comma without closing it ✓ **Commas in the middle come in pairs**
- ✗ "The book, that I read, ..." ✓ "The book that I read..."

DRILL HABIT

Read each sentence without the part between commas. If it still makes sense, the commas are right; if it breaks, remove them.

TRY IT

- 1 "The architect ___ Zaha Hadid ___ designed the stadium." (A) , , (B) no commas (C) comma before Zaha only (D) comma after Hadid only
- 2 "The Amazon ___ which crosses several countries ___ is home to pink river dolphins." (A) , , (B) no commas (C) — , (D) ; ;
- 3 "The scientist ___ who discovered penicillin was Alexander Fleming." (A) , (B) no comma (C) ; (D) :

ANSWERS 1 B · 2 A · 3 B

Commas Around Extra Information: Drill

GM-5

DRILL

10 original questions. Answer all of them before checking.

- 1 "The novelist ___ Chinua Achebe ___ wrote *Things Fall Apart*."
(A) , , (B) no commas (C) comma after novelist only (D) comma after Achebe only
- 2 "Chinua Achebe ___ a Nigerian novelist ___ wrote *Things Fall Apart*."
(A) no commas (B) ; ; (C) — , (D) , ,
- 3 "The student ___ who won the prize ___ is my cousin."
(A) , , (B) — — (C) no commas (D) ()
- 4 "My father ___ who works nights ___ sleeps until noon."
(A) , (none) (B) , , (C) no commas (D) (none) ,
- 5 "In 1969 ___ astronauts landed on the moon."
(A) 1969, (B) 1969; (C) 1969: (D) 1969
- 6 "The Danube ___ which flows through ten countries ___ is Europe's second-longest river."
(A) — , (B) , ; (C) no commas (D) , ,
- 7 "The painter ___ Frida Kahlo was born in 1907."
(A) painter (B) painter; (C) painter, (D) painter:
- 8 "The book ___ that I borrowed ___ is overdue."
(A) ; ; (B) — — (C) , , (D) no commas
- 9 Test for extra information?
- 10 "Physicist Lise Meitner ___ a pioneer of nuclear fission ___ was born in Vienna."
(A) , (none) (B) no commas (C) — , (D) , ,

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ANSWERS

- 1 B · Title + name: no commas.
- 2 D · Appositive after the name: a pair.
- 3 C · Essential: which student.
- 4 B · Nonessential: I have one father.
- 5 A · Introductory phrase.
- 6 D · Extra information.
- 7 A · Title + name.
- 8 D · "That" clause: essential.
- 9 Delete it; if the sentence still works and means the same, use a pair of commas · The deletion test.
- 10 D · Appositive after the name: a pair.

Commas: Where They Never Go

Many comma questions are won by deleting commas.

GM-6

LESSON

THE RULE

The ACT tests unnecessary commas as often as missing ones. **Never** put a single comma between a subject and its verb, a verb and its object, a preposition and its object, or before “that” starting an essential clause.

NEVER BETWEEN...	X WRONG	✓ RIGHT
Subject and verb	The results of the study, were surprising.	The results of the study were surprising.
Verb and object	She discovered, a new comet.	She discovered a new comet.
Preposition and object	The bridge spans, the river.	The bridge spans the river.
Before “that” (essential)	He argued, that the law was unfair.	He argued that the law was unfair.
Two items joined by “and”	rice, and beans	rice and beans
Title and name	the poet, Langston Hughes, wrote	the poet Langston Hughes wrote

REMEMBER Long subjects tempt you to pause: “The large number of birds that migrate through the valley each spring is...” No comma, however long. When in doubt, the choice with fewer commas is right more often.

WORKED EXAMPLES

- “The scientists who led the project, published a paper.” X → remove the comma.
- “Researchers found, that the virus mutates.” X → “found that”
- “The museum’s collection of ancient coins is rare.” ✓ long subject, no comma.
- “She studied physics, and later became a pilot.” X → no comma (one subject).

TRAPS

- X A comma after a long subject ✓ **No comma before the verb**
- X A comma before “that” ✓ **No comma**
- X Commas around an essential title (“the artist, Kahlo,”) ✓ **No commas (“the artist Kahlo”)**

DRILL HABIT

On 15 comma questions, test the choice with the fewest commas first. Prove it wrong before considering more commas.

TRY IT

- 1 “The paintings in the east wing ___ restored last year.” (A) wing, were (B) wing were (C) wing; were (D) wing: were
- 2 “The study showed ___ the drug worked.” (A) showed, that (B) showed that (C) showed: that (D) showed; that
- 3 “The artist ___ Frida Kahlo painted many self-portraits.” (A) artist, (B) artist (C) artist; (D) artist:

ANSWERS 1 B · 2 B · 3 B

Commas: Where They Never Go: Drill

10 original questions. Answer all of them before checking.

GM-6

DRILL

- 1 “The results of the long study ___ surprised everyone.”
(A) study; (B) study, (C) study (D) study:
- 2 “She argued ___ that the law was unfair.”
(A) argued; (B) argued: (C) argued, (D) argued
- 3 “They bought rice ___ and beans.”
(A) rice (B) rice: (C) rice; (D) rice,
- 4 “The bridge spans ___ the river.”
(A) spans, (B) spans; (C) spans (D) spans:
- 5 “The singer ___ Nina Simone recorded the song.”
(A) singer— (B) singer; (C) singer (D) singer,
- 6 “The large number of birds that migrate through the valley each spring ___ remarkable.”
(A) spring, is (B) spring; is (C) spring: is (D) spring is
- 7 “He studied chemistry ___ and later became a chef.”
(A) chemistry; (B) chemistry (C) chemistry, (D) chemistry:
- 8 “The team found ___ a new species of frog.”
(A) found: (B) found (C) found, (D) found;
- 9 When unsure on a comma question, which choice should you test first?
- 10 “Researchers in Peru ___ discovered the ruins.”
(A) Peru: (B) Peru, (C) Peru (D) Peru;

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ANSWERS

- 1 C · No comma between subject and verb.
- 2 D · No comma before an essential “that.”
- 3 A · Two items: no comma.
- 4 C · No comma between verb and object.
- 5 C · Title + name.
- 6 D · Long subject, still no comma.
- 7 B · One subject, two verbs.
- 8 B · Verb + object.
- 9 The one with the fewest commas · Prove it wrong first.
- 10 C · Subject + verb.

Modifiers: Dangling and Misplaced

Describe the right noun, right away.

GM-7

LESSON

THE RULE

A descriptive phrase at the start of a sentence must be followed **immediately** by the noun it describes. If the phrase is “Born in 1882,” the next words must name the person born in 1882.

OPENING PHRASE	X DANGLING	✓ CORRECT
Born in Ohio,	Born in Ohio, the Wright brothers’ plane flew...	Born in Ohio, the Wright brothers built...
Known for her poetry,	Known for her poetry, Angelou’s memoir...	Known for her poetry, Angelou also wrote...
After testing the samples,	After testing the samples, the results showed...	After testing the samples, the team found...
A former teacher,	A former teacher, the book by Li...	A former teacher, Li wrote the book...

REMEMBER Ask: **who or what** is the opening phrase describing? That must be the first noun after the comma. Watch possessives: “Angelou’s memoir” makes the memoir the subject, not Angelou.

WORKED EXAMPLES

- “Built in 1889, the Eiffel Tower was once the world’s tallest structure.” ✓
- “Built in 1889, Gustave Eiffel designed the tower.” X Eiffel wasn’t built.
- “Hoping to win, the team’s practice ran late.” X the practice isn’t hoping.
- “Hoping to win, the team practiced late.” ✓

TRAPS

- X A possessive after the comma (“Kahlo’s paintings”) ✓ The person (“Kahlo painted...”)
- X The most natural-sounding option ✓ The one whose first noun is described
- X A passive version when a person is described ✓ Check who the phrase describes

DRILL HABIT

Write five sentences starting “Born in...,” “Known for...,” “After finishing...,” and make sure the next word is the right person or thing.

TRY IT

- 1 “Discovered in 1922, ___” (A) Howard Carter found Tutankhamun’s tomb (B) Tutankhamun’s tomb was found by Howard Carter (C) Carter’s discovery of the tomb was famous (D) archaeologists celebrated the tomb
- 2 “A pioneer of jazz, ___” (A) Louis Armstrong’s trumpet changed music (B) Louis Armstrong changed music with his trumpet (C) the trumpet of Louis Armstrong changed music (D) music was changed by Armstrong

ANSWERS 1 B · 2 B

Modifiers: Dangling and Misplaced: Drill

10 original questions. Answer all of them before checking.

GM-7

DRILL

- 1 “Built in 1173, ___”
(A) workers noticed the tower leaning (B) the tower’s lean surprised workers (C) the tower began to lean soon after (D) leaning began immediately
- 2 “A gifted chemist, ___”
(A) Marie Curie’s research won two Nobel Prizes (B) the prizes honored Curie (C) Marie Curie won two Nobel Prizes (D) two Nobel Prizes went to Curie
- 3 “After reviewing the data, ___”
(A) the data’s meaning was clear (B) the conclusion was obvious (C) the scientists reached a conclusion (D) a conclusion emerged
- 4 “Raised in Lagos, ___”
(A) her first novel takes place in Lagos (B) the author’s first novel was set in Nigeria (C) the author set her first novel in Nigeria (D) Nigeria is the novel’s setting
- 5 “Exhausted after the race, ___”
(A) the grass was where the runners collapsed (B) the runners collapsed on the grass (C) the runners’ legs gave out (D) collapse came quickly
- 6 “Known for his murals, ___”
(A) Diego Rivera painted on public walls (B) public walls displayed Rivera’s work (C) Diego Rivera’s paintings filled public walls (D) murals made Rivera famous
- 7 “Hoping to save money, ___”
(A) the family traveled by bus (B) the bus was the family’s choice (C) the family’s trip was by bus (D) buses save money
- 8 “Discovered in 1922, ___”
(A) Howard Carter found the tomb (B) the tomb was found by Howard Carter (C) archaeologists celebrated (D) Carter’s discovery was famous
- 9 What must come right after an opening descriptive phrase?
- 10 “Using a telescope, ___”
(A) Jupiter’s moons were seen by Galileo (B) Galileo observed Jupiter’s moons (C) the moons were discovered (D) Jupiter’s moons became visible

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ANSWERS

- 1 C · The tower was built.
- 2 C · Curie is the chemist.
- 3 C · Scientists reviewed.
- 4 C · The author was raised.
- 5 B · Runners were exhausted.
- 6 A · Rivera is known.
- 7 A · The family hoped.
- 8 B · The tomb was discovered.
- 9 The noun it describes · Not a possessive of it.
- 10 B · Galileo used the telescope.

Subject–Verb Agreement

Strip the sentence to subject + verb.

THE RULE

The verb agrees with its true subject, which the ACT hides behind long phrases, inverted order and tricky words. **Cross out the phrases in between** until subject and verb sit side by side.

THE DISGUISE	STRIPPED	VERB
Prepositional phrase	The collection [of rare maps]...	is
Relative clause	The scientist [who studies whales]...	is
Inverted order	Among the ruins were two statues .	were
Compound subject	The novel and its sequel ...	are
Each, every, one of	Each [of the bridges]...	is
Collective noun	The committee ...	has
Neither... nor	Neither the coach nor the players ...	were (closer subject)

REMEMBER On the ACT, the subject can be 15 words from its verb. Cross out every phrase beginning with *of*, *in*, *with*, *that*, *which*, *who*.

WORKED EXAMPLES

- “The population of honeybees in these valleys **has** declined.” (population)
- “Each of the paintings **was** restored.” (each)
- “There **are** many reasons.” (reasons)
- “Neither the mayor nor the council members **were** available.” (members)

TRAPS

~~X Matching the noun right before the verb~~ ✓ **Matching the true subject**

~~X “Each of them are”~~ ✓ **“Each of them is”**

~~X “There’s many reasons”~~ ✓ **“There are many reasons”**

DRILL HABIT

Bracket the subject and box the verb in 15 sentences from ACT texts. Read just the bracket and the box aloud.

TRY IT

- 1 “The results of the experiment, which took six years, ___ published in May.” (A) was (B) were (C) has been (D) is
- 2 “Hidden beneath the floorboards ___ a set of letters.” (A) was (B) were (C) are (D) have been
- 3 “The team of engineers ___ a new design.” (A) propose (B) proposes (C) are proposing (D) have proposed

ANSWERS 1 B · 2 A · 3 B

Subject-Verb Agreement: Drill

10 original questions. Answer all of them before checking.

GM-8

DRILL

- 1 "The collection of rare coins ___ valuable."
(A) have been (B) were (C) is (D) are
- 2 "Each of the players ___ a jersey."
(A) are having (B) has (C) were having (D) have
- 3 "There ___ several reasons for the delay."
(A) has been (B) was (C) is (D) are
- 4 "The scientist and her assistant ___ the results."
(A) is checking (B) check (C) checks (D) has checked
- 5 "Neither the mayor nor the council members ___ present."
(A) has been (B) is (C) was (D) were
- 6 "Among the ruins ___ a statue of a lion."
(A) were (B) was (C) are (D) have been
- 7 "The team ___ its first game."
(A) win (B) wins (C) are winning (D) have won
- 8 "One of my cousins ___ in Hanoi."
(A) are living (B) have lived (C) live (D) lives
- 9 "The results of the survey, which included 3,000 people, ___ published in May."
(A) has been (B) is (C) was (D) were
- 10 "The information in these files ___ confidential."
(A) have been (B) is (C) are (D) were

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ANSWERS

- 1 C · Collection (singular).
- 2 B · Each = singular.
- 3 D · Reasons (plural).
- 4 B · Compound subject: plural.
- 5 D · Closer subject: members.
- 6 B · Inverted: a statue.
- 7 B · Collective noun: singular.
- 8 D · One.
- 9 D · Results (plural).
- 10 B · Information (uncountable, singular).

Pronouns: Agreement and Case

It or they? Its or their?

GM-9

LESSON

THE RULE

A pronoun must agree in number with the noun it replaces: singular **it / its**, plural **they / their**. Companies, teams, studies and countries are singular: *it*, not *they*.

ANTECEDENT	PRONOUN	EXAMPLE
One company, team, country, study	it / its	The company released its report.
Plural noun	they / their / them	The birds left their nests.
Each, every, either	singular	Each nation sent its delegates.
Subject position	I, he, she, we, they, who	She and I arrived.
Object position	me, him, her, us, them, whom	between you and me
Possessive vs. contraction	its / it's, their / they're, whose / who's	its wings (not it's)

REMEMBER Find the antecedent: ask what the pronoun refers to. It may be several words back. If a pronoun could refer to two nouns, the ACT may prefer repeating the noun.

WORKED EXAMPLES

- “Apple changed its logo.”
- “The team celebrated its win.” (singular in US English)
- “The scientists and their students...”
- “The council and the mayor disagreed, so the council revised its plan.”

TRAPS

- X “~~The study and their results~~” ✓ “The study and its results”
- X “~~it's wings~~” ✓ “its wings”
- X “~~between you and I~~” ✓ “between you and me”

DRILL HABIT

In ten ACT texts, draw an arrow from every pronoun back to its noun. Singular noun, singular pronoun.

TRY IT

- 1 “The museum updated ___ hours.” (A) their (B) its (C) it's (D) they're
- 2 “The researchers published ___ findings.” (A) its (B) their (C) there (D) they're
- 3 “The award went to my brother and ___.” (A) I (B) me (C) myself (D) mine

ANSWERS 1 B · 2 B · 3 B

Pronouns: Agreement and Case: Drill

10 original questions. Answer all of them before checking.

GM-9

DRILL

- 1 “The company released ___ annual report.”
(A) its (B) they’re (C) their (D) it’s
- 2 “The birds returned to ___ nests.”
(A) they’re (B) there (C) their (D) its
- 3 “Each country sent ___ best athletes.”
(A) its (B) theirs (C) their (D) it’s
- 4 “The prize went to Ana and ___.”
(A) mine (B) I (C) myself (D) me
- 5 “___ going to the museum tomorrow?”
(A) Whose (B) Whom’s (C) Who (D) Who’s
- 6 “The study and ___ conclusions were debated.”
(A) their (B) it’s (C) theirs (D) its
- 7 “She and ___ arrived first.”
(A) myself (B) mine (C) me (D) I
- 8 “The museum changed ___ hours.”
(A) its (B) their (C) it’s (D) its’
- 9 “The engineers explained ___ design.”
(A) they’re (B) its (C) their (D) there
- 10 “The jury reached ___ verdict.”
(A) its (B) they’re (C) their (D) it’s

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ANSWERS

- 1 A · Company: singular.
- 2 C · Plural.
- 3 A · Each: singular.
- 4 D · Object of “to.”
- 5 D · Who is.
- 6 D · The study (singular).
- 7 D · Subject position.
- 8 A · Possessive, no apostrophe.
- 9 C · Plural engineers.
- 10 A · Collective: singular in US usage.

Verb Tense and Form

Follow the time clues.

THE RULE

Choose the tense that matches the time frame around it, and the correct form after helpers. Look for clues: dates, “currently,” “by 1900,” and the tense of the other verbs in the text.

CLUE	TENSE	EXAMPLE
Past date, finished event	Past simple	In 1903, the Wrights flew.
Before another past event	Past perfect	By 1910, the company had sold 100 planes.
From the past up to now	Present perfect	Since 2010, scientists have found 30 species.
Facts; describing a text	Present simple	The novel explores loss.
After a modal or “to”	Base form	can fly · to fly
After have / has / had	Past participle	had gone · has written
Main verb missing	Not -ing or “to” alone	X The birds migrating south. ✓ The birds migrate south.

REMEMBER Stay consistent with the text’s tense. And every sentence needs a real main verb: a choice with only “-ing” or “to + verb” can leave the sentence a fragment.

WORKED EXAMPLES

- “Since 1990, the lake **has shrunk** by half.”
- “When the war ended, she **had** already **written** three novels.”
- “In her essay, Didion **describes** California.”
- “The fossil, which **was found** in 2004, is now in a museum.”

TRAPS

- X ~~“has went”~~ ✓ **“has gone”**
- X ~~A sentence whose only verb is “-ing”~~ ✓ **A finite main verb**
- X ~~Switching to present in a past narrative~~ ✓ **Keeping the text’s tense**

DRILL HABIT

For 15 tense questions, underline the time clue that decided the answer before choosing.

TRY IT

- 1 “In 1928, Alexander Fleming ___ penicillin.” (A) discovers (B) discovered (C) has discovered (D) will discover
- 2 “By the time the rescuers arrived, the climbers ___ for two days.” (A) waited (B) have waited (C) had waited (D) wait
- 3 “The poet’s new collection ___ themes of migration.” (A) explore (B) exploring (C) explores (D) to explore

ANSWERS 1 B · 2 C · 3 C

Verb Tense and Form: Drill

10 original questions. Answer all of them before checking.

GM-10

DRILL

- 1 "In 1903, the Wright brothers ___ the first powered flight."
(A) make (B) will make (C) made (D) have made
- 2 "By 1920, the company ___ a million cars."
(A) sold (B) has sold (C) sells (D) had sold
- 3 "Since 2015, scientists ___ ten new species."
(A) have found (B) found (C) had found (D) find
- 4 "In her novel, Morrison ___ memory and trauma."
(A) explored (B) explores (C) exploring (D) to explore
- 5 "The engineers can ___ the bridge in a year."
(A) rebuild (B) to rebuild (C) rebuilt (D) rebuilding
- 6 "She has ___ three books."
(A) writing (B) wrote (C) write (D) written
- 7 "The geese ___ south every October."
(A) migrate (B) to migrate (C) having migrated (D) migrating
- 8 "When the rescuers arrived, the hikers ___ for two days."
(A) waited (B) wait (C) have waited (D) had been waiting
- 9 "The fossil, which ___ in 2004, is now in a museum."
(A) is found (B) was found (C) finds (D) has been found
- 10 "Last year, the town ___ a new library."
(A) built (B) has built (C) builds (D) will build

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ANSWERS

- 1 C · Past tense.
- 2 D · Before another past time.
- 3 A · Past up to now.
- 4 B · Describing a text: present.
- 5 A · After a modal: base form.
- 6 D · Past participle after has.
- 7 A · Needs a main verb.
- 8 D · Ongoing before a past event.
- 9 B · Past event.
- 10 A · "Last year."

Possessives and Plurals

How many? Who owns?

GM-11

LESSON

THE RULE

Plural nouns add -s with no apostrophe. Possession adds 's (singular owner) or ' (plural owner ending in s). Possessive pronouns never use apostrophes.

MEANING	FORM	EXAMPLE
More than one	-s	the scientists
Belongs to one	's	the scientist's notes
Belongs to many	s'	the scientists' notes
Irregular plural owner	's	the children's books
Pronoun possessive	no apostrophe	its, their, whose
Contraction	apostrophe	it's = it is · they're = they are

REMEMBER ACT choices often change plural and possessive at once ("researcher's / researchers / researchers"). Ask two questions: **how many**, and **does it own the next noun**?

WORKED EXAMPLES

- "The orchestra's conductor" (one orchestra)
- "The orchestras' conductors" (many orchestras)
- "The musicians played" (plural, no ownership)
- "The company announced its profits" (no apostrophe)

TRAPS

- X "The artist's painted murals." ✓ "The artists painted murals."
 X "the city's parks" ✓ "the city's parks" or "the cities' parks"
 X "who's book" ✓ "whose book"

DRILL HABIT

Write ten phrases from your life (my friend's phone, my friends' phones, my friends laughed) and say how many and who owns.

TRY IT

- 1 "The two ___ findings were published together." (A) researcher's (B) researchers (C) researchers' (D) researcher
- 2 "The ___ ruins attract thousands of visitors." (one city) (A) cities (B) city's (C) cities' (D) citys
- 3 "The bird returned to ___ nest." (A) it's (B) its (C) its' (D) their

ANSWERS 1 C · 2 B · 3 B

Possessives and Plurals: Drill

10 original questions. Answer all of them before checking.

GM-11

DRILL

- 1 “The two ___ findings were published together.”
(A) researcher (B) researchers’ (C) researcher’s (D) researchers
- 2 “The ___ ruins attract visitors.” (one city)
(A) citys (B) cities’ (C) city’s (D) cities
- 3 “The bird fed ___ chicks.”
(A) its’ (B) their (C) it’s (D) its
- 4 “The ___ toys were scattered.” (many children)
(A) children (B) child’s (C) children’s (D) children’s
- 5 “The ___ played until midnight.”
(A) musician’s (B) musicians (C) musicians’ (D) musician
- 6 “___ jacket is this?”
(A) Whos (B) Who’s (C) Whose’ (D) Whose
- 7 “The ___ decision surprised fans.” (one team)
(A) team’s (B) team (C) teams’ (D) teams
- 8 “The ___ conference drew 500 people.” (many scientists)
(A) scientist’s (B) scientists’ (C) scientist (D) scientists
- 9 “The ___ are ripe.”
(A) apple (B) apples (C) apple’s (D) apples’
- 10 Two questions to ask on possessive items?

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ANSWERS

- 1 B · Plural owners.
- 2 C · One owner.
- 3 D · Possessive pronoun.
- 4 D · Irregular plural owner: ‘s.
- 5 B · Plural, no ownership.
- 6 D · Possession.
- 7 A · One owner.
- 8 B · Plural owners.
- 9 B · Plural, no apostrophe.
- 10 How many? Does it own the next noun? · GM-11.

Parallel Structure

Match the forms. Compare like with like.

GM-12

LESSON

THE RULE

Items in a list, pair or comparison must share the same grammatical form. Paired words (*both... and, either... or, not only... but also, neither... nor*) take matching forms after each half.

PATTERN	X NOT PARALLEL	✓ PARALLEL
List	teaches coding, design, and how to market	teaches coding, design, and marketing
not only... but also	not only fast but also has power	not only fast but also powerful
either... or	either by train or driving	either by train or by car
Comparison	Swimming is harder than to run.	Swimming is harder than running.
Comparing things	Tokyo's population is larger than Paris.	...larger than that of Paris (or Paris's).

REMEMBER Compare like with like: a population with a population, not with a city. "Than that of" and "than those of" are classic ACT answers.

WORKED EXAMPLES

- "to reduce, to reuse, and to recycle" ✓
- "both in Asia and in Africa" ✓
- "The new design is lighter than the old one." ✓
- "Her salary is higher than her manager's." ✓ salary vs. salary

TRAPS

- X "~~than Paris~~" when comparing populations ✓ "than that of Paris"
- X ~~Mixing -ing and to + verb in a list~~ ✓ One form throughout
- X "~~not only... and also~~" ✓ "not only... but also"

DRILL HABIT

For every list in your reading this week, check the first word of each item: same part of speech?

TRY IT

- 1 "The goal is to reduce waste, ___ energy, and lower costs." (A) saving (B) save (C) saves (D) saved
- 2 "Peru's climate is more varied than ___." (A) Chile (B) that of Chile (C) Chile is (D) Chile has
- 3 "She was praised not only for her skill ___ for her kindness." (A) and also (B) but also (C) as well (D) and

ANSWERS 1 B · 2 B · 3 B

Parallel Structure: Drill

10 original questions. Answer all of them before checking.

GM-12

DRILL

- 1 "The program teaches coding, design, and ____."
(A) how to market (B) marketing (C) markets (D) to market
- 2 "She is not only talented but also ____."
(A) she works hard (B) hardworking (C) works hard (D) hard work
- 3 "Walking is better than ____."
(A) drive (B) to drive (C) driving (D) you drive
- 4 "Japan's population is larger than ____."
(A) Italy has (B) Italy (C) Italy is (D) that of Italy
- 5 "The goal is to reduce costs, ____ quality, and grow sales."
(A) improves (B) improve (C) improved (D) improving
- 6 "You can pay either in cash or ____."
(A) by credit card (B) with using credit (C) credit card (D) credit
- 7 "The new phone is lighter than ____."
(A) the old (B) the old one is heavy (C) the old one (D) older
- 8 "He likes hiking, swimming, and ____."
(A) climbs (B) climb (C) to climb (D) climbing
- 9 "The museum's collection is larger than ____."
(A) that of the library (B) libraries (C) the library has (D) the library
- 10 "Neither the heat nor ____ stopped the runners."
(A) raining (B) it was rainy (C) it rained (D) the rain

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ANSWERS

- 1 B · -ing nouns.
- 2 B · Adjective matches adjective.
- 3 C · Matching -ing.
- 4 D · Population vs. population.
- 5 B · to reduce / improve / grow.
- 6 A · in cash / by card.
- 7 C · Phone vs. phone.
- 8 D · -ing list.
- 9 A · Collection vs. collection.
- 10 D · Noun / noun.

Concision and Redundancy

Say it once.

GM-13

LESSON

THE RULE

Redundancy and wordiness are among the most tested ideas on ACT English. When choices say the same thing at different lengths, the **shortest grammatical choice that keeps the meaning** wins, and OMIT is often right (ENG-2).

REDUNDANT	CONCISE
return back	return
past history	history
completely finished	finished
each and every	each
collaborate together	collaborate
Thus, as a result,	Thus,
annually every year	annually

REMEMBER Watch for doubled meanings: “annually each year,” “Therefore, as a result,” “the reason is because,” “past history.” Each one says the same thing twice, and the ACT almost always wants it said once.

WORKED EXAMPLES

- “She returned to Lagos.” not “returned back”
- “Thus, the plan failed.” not “Thus, consequently,”
- “The outcome” not “the final outcome”
- “They collaborated” not “collaborated together”

TRAPS

- ~~X “Thus, therefore,”~~ ✓ **One transition**
- ~~X The longest, most formal choice~~ ✓ **The shortest correct choice**
- ~~X Cutting words that carry meaning~~ ✓ **Cutting only repeats**

DRILL HABIT

Rewrite five sentences from your own essays at 80% of their length without losing meaning.

TRY IT

- 1 “The scientists ___ the experiment.” (A) repeated again (B) repeated (C) did repeat again (D) repeated a second time again
- 2 “___, sales rose.” (A) As a result, therefore (B) Consequently (C) Thus, so (D) So, as a result
- 3 “The festival is held ___.” (A) annually each year (B) annually (C) every year annually (D) yearly every year

ANSWERS 1 B · 2 B · 3 B

Concision and Redundancy: Drill

10 original questions. Answer all of them before checking.

GM-13

DRILL

- 1 "The scientists ___ the test."
(A) repeated a second time again (B) did repeat again (C) repeated again (D) repeated
- 2 "___, the plan failed."
(A) As a result, thus (B) Thus, therefore (C) So, as a result (D) Thus
- 3 "The festival is held ___."
(A) every year annually (B) annually each year (C) yearly each year (D) annually
- 4 "They ___ on the project."
(A) jointly collaborated together (B) collaborated (C) collaborated together (D) worked together jointly
- 5 "The ___ is that the bus was late."
(A) reason (B) cause reason (C) reason is because why (D) reason why is because
- 6 "In my view, ___ the plan is wise."
(A) I personally think (B) I think (C) in my opinion (D) (no words)
- 7 "The outcome ___."
(A) was final and conclusive (B) ended in the end (C) was final (D) was finally final
- 8 Which is usually right when all choices are grammatical and mean the same?
- 9 "She ___ to Hanoi."
(A) returned (B) returned back (C) returned again back (D) went back again
- 10 "The ___ of the town dates to 1600."
(A) historical past (B) old history (C) history (D) past history

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ANSWERS

- 1 D · Again is redundant.
- 2 D · One transition.
- 3 D · Say it once.
- 4 B · Together is implied.
- 5 A · Concise.
- 6 D · Already says "in my view."
- 7 C · Redundant pairs.
- 8 The shortest · Cut repeats, keep meaning.
- 9 A · Return = go back.
- 10 C · History is past.

Conventions Review: The Seven Rules

The whole grammar section on one page.

GM-14

LESSON

THE RULE

ACT English grammar questions reduce to seven rules. Learn the five-second test for each, and you can answer most of them in **under 30 seconds**.

RULE	THE FIVE-SECOND TEST	LESSON
Boundaries	Two full sentences? Period, semicolon, or comma + FANBOYS	GM-2
Semicolons and colons	Semicolon = period test; colon needs a full sentence before it	GM-3, GM-4
Extra information	Delete it: still works? Then a pair of commas or dashes	GM-5
Unneeded commas	Subject-verb, verb-object, title-name: no comma	GM-6
Modifiers	The first noun after the comma is the one described	GM-7
Agreement	Strip to subject + verb; pronoun to its noun	GM-8, GM-9
Tense, form, possessives	Time clue; how many and who owns	GM-10, GM-11

REMEMBER Grammar questions are the fastest points on the English test: aim for 30 seconds each, and bank the time for whole-essay questions (ENG-4 to ENG-6).

WORKED EXAMPLES

- “Explorer Ernest Shackleton led...” → no comma (GM-6).
- “The data, which were collected in 2019, show...” → pair of commas (GM-5).
- “The study was small; however, its results were striking.” (GM-2)
- “The company’s profits doubled.” (GM-11)

TRAPS

- ~~X Guessing by ear under time pressure~~ ✓ **Running the five-second test**
- ~~X Spending a minute on a comma question~~ ✓ **Name the rule, apply it, move**
- ~~X Ignoring what the choices differ on~~ ✓ **Scan the choices first**

DRILL HABIT

Timed: 20 conventions questions in 10 minutes. Then name the rule for every one you missed.

TRY IT

- 1 “The violinist Kim ___ a former child prodigy, performed in Seoul.” (A) Kim, (B) Kim (C) Kim; (D) Kim—
- 2 “Each of the islands ___ its own dialect.” (A) have (B) has (C) are having (D) have had
- 3 “The canal opened in 1914 ___ it shortened the voyage by 8,000 miles.” (A) 1914, (B) 1914 (C) 1914; (D) 1914, it
- 4 “Exhausted after the climb, ___” (A) the summit was reached by the hikers (B) the hikers rested at the summit (C) the hikers’ rest was short (D) rest came quickly

ANSWERS 1 A · 2 B · 3 C · 4 B

Conventions Review: The Seven Rules: Drill GM-14

10 original questions. Answer all of them before checking.

DRILL

- 1 “The violinist ___ Hilary Hahn performed in Tokyo.”
(A) violinist (B) violinist, (C) violinist: (D) violinist;
- 2 “Each of the islands ___ its own language.”
(A) were (B) has (C) are having (D) have
- 3 “The canal opened in 1914 ___ it cut weeks from the voyage.”
(A) 1914, it (B) 1914, (C) 1914 (D) 1914;
- 4 “Tired after the climb, ___”
(A) the summit was reached by the hikers (B) the hikers rested at the summit (C) the hikers’ rest was short (D) rest came quickly
- 5 “The company updated ___ website.”
(A) it’s (B) its (C) their (D) they’re
- 6 “The data, which ___ collected in 2019, show a decline.”
(A) is (B) were (C) has been (D) was
- 7 “The two ___ votes were counted.”
(A) senator’s (B) senators (C) senators’ (D) senator
- 8 “The study had one flaw ___ its sample was small.”
(A) flaw, (B) flaw, and: (C) flaw (D) flaw:
- 9 “The author—a former nurse ___ wrote the memoir in a year.”
(A) nurse; (B) nurse (C) nurse— (D) nurse,
- 10 “The plan aims to cut costs, ___ waste, and boost morale.”
(A) reduced (B) to reducing (C) reducing (D) reduce

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ANSWERS

- 1 A · GM-6: title + name.
- 2 B · GM-8.
- 3 D · GM-2.
- 4 B · GM-7.
- 5 B · GM-9.
- 6 B · GM-8/10: data were (plural, past).
- 7 C · GM-11.
- 8 D · GM-4.
- 9 C · GM-4: matching dashes.
- 10 D · GM-12: cut / reduce / boost.

Inside the English Test

50 questions, 35 minutes, about five essays.

ENG-1

LESSON

THE RULE

The English test gives you a set of short essays with underlined portions. For each, choose the best version, or **NO CHANGE**. Other questions ask about the essay as a whole: adding, deleting, ordering, or whether it met a goal. You have about **42 seconds per question**.

CATEGORY	WHAT IT TESTS	LESSONS
Conventions of Standard English	punctuation, sentence boundaries, agreement, tense, pronouns, modifiers	GM-1 to GM-14
Production of Writing	topic development, purpose, relevance, organization, transitions	ENG-3 to ENG-6, ENG-8
Knowledge of Language	precise word choice, concision, consistent style and tone	ENG-7, GM-13

REMEMBER Read the essay as you go and answer each question when you reach it: many depend on the sentences around the underline. The ACT isn't adaptive and there's no penalty for guessing, so answer every question.

WORKED EXAMPLES

- Underline "The museum, which opened in 1902 has...": the choices vary commas → a conventions question (GM-5).
- "Suppose the writer's goal had been to..." → a whole-essay question (ENG-5).
- A bracketed sentence with "Should the writer add...?" → add or delete (ENG-4).
- **NO CHANGE** is a real option, right as often as any other choice.

TRAPS

- ~~X Reading only the underlined words~~ ✓ **Reading the whole sentence, and the one before**
- ~~X Never choosing NO CHANGE~~ ✓ **Choosing it when nothing is wrong**
- ~~X A minute on a comma question~~ ✓ **About 30 seconds; bank time for rhetoric**

DRILL HABIT

Take one English test timed. Note the clock at questions 13, 25 and 38: target about 9, 17 and 26 minutes.

TRY IT

- 1 How many questions and minutes on the English test?
- 2 About how many seconds per question?
- 3 Which three categories does English report?
- 4 Is **NO CHANGE** ever correct?

ANSWERS 1 50 in 35 · 2 About 42 · 3 Production of Writing; Knowledge of Language; Conventions of Standard English · 4 Yes, regularly

Inside the English Test: Drill

8 original questions. Answer all of them before checking.

ENG-1

DRILL

- 1 How many questions and minutes on the English test?
- 2 Name the three English reporting categories.
- 3 Is NO CHANGE ever the right answer?
- 4 Should you read only the underlined words?
- 5 About how long per essay set of 10 questions?
- 6 Is there a penalty for guessing on the ACT?
- 7 Grammar question: target time?
- 8 A question begins “Suppose the writer’s goal had been to...”. Type?

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ANSWERS

1 50 in 35 · About 42 seconds each.

2 Production of Writing; Knowledge of Language; Conventions of Standard English · ENG-1’s table.

3 Yes, regularly · Choose it when nothing is wrong.

4 No: the whole sentence, and the one before · Context decides pronouns, tense and transitions.

5 About 7 minutes · Five sets in 35 minutes.

6 No · Answer every question.

7 About 30 seconds · Bank time for whole-essay questions.

8 Whole-essay (purpose) question · ENG-5.

NO CHANGE and the Shortest Answer

Two rules that win English points fast.

ENG-2

LESSON

THE RULE

First, **NO CHANGE** is a real answer: if the underlined portion has no error, choose it. Second, when choices are all grammatical and keep the meaning, the **shortest** is usually right. OMIT or DELETE choices count: if words add nothing, cut them.

SITUATION	WHAT TO DO
Choices differ only in punctuation	name the rule (GM-1); NO CHANGE if the original follows it
Choices differ in length, same meaning	prefer the shortest grammatical choice
A choice says OMIT or DELETE	does the sentence lose meaning without the words?
The shortest choice breaks grammar or meaning	it's wrong; try the next shortest
All four look fine	re-read the sentences before and after: context decides

REMEMBER Shortest-answer is a tiebreaker, not a law: correctness and meaning come first. But when two answers are both correct, the ACT nearly always prefers fewer words.

WORKED EXAMPLES

- “The team returned back to the lab.” → “returned” (“back” repeats).
- “In my opinion, I think the plan works.” → “I think the plan works.”
- “The bridge, which is a bridge across the river, opened in 1937.” → OMIT the clause: it says nothing new.
- “The results were surprising.” with wordier choices → NO CHANGE.

TRAPS

- ~~X Avoiding NO CHANGE because it feels like a trick~~ ✓ **Choosing it when the original is right**
- ~~X The longest, most formal-sounding choice~~ ✓ **The shortest correct choice**
- ~~X OMIT when it removes needed meaning~~ ✓ **Checking the sentence still says what it must**

DRILL HABIT

On one English test, before reading the choices, ask: is there an error? If not, start with NO CHANGE and try to prove it wrong.

TRY IT

- 1 “The scientists collaborated together on the study.” (A) NO CHANGE (B) collaborated (C) collaborated jointly together (D) did collaborate together
- 2 “The festival, held annually every year, draws crowds.” (A) NO CHANGE (B) held annually, (C) held each year annually, (D) held annually, every single year,
- 3 “Her speech was brief.” Every other choice adds words. Likely answer?

ANSWERS 1 B · 2 B · 3 NO CHANGE

NO CHANGE and the Shortest Answer: Drill **ENG-2**

10 original questions. Answer all of them before checking.

DRILL

- 1 “The two teams cooperated together on the project.”
(A) NO CHANGE (B) did cooperate together (C) cooperated jointly together (D) cooperated
- 2 “She returned back to her hometown in May.”
(A) NO CHANGE (B) went back again (C) returned once more back (D) returned
- 3 “The results were surprising.” (other choices add words)
(A) NO CHANGE (B) The results were surprising and unexpected. (C) Surprisingly, the results surprised. (D) The results, which surprised, were surprising.
- 4 “The festival, which happens every single year annually, draws crowds.”
(A) NO CHANGE (B) which happens each year annually, (C) which annually happens every year, (D) which happens annually,
- 5 “In my opinion, I believe the plan works.”
(A) I believe the plan works. (B) In my opinion, I personally believe the plan works. (C) NO CHANGE (D) I believe, in my opinion, the plan works.
- 6 “The bridge, a bridge that crosses the river, opened in 1937.” Best revision of the underlined clause?
(A) OMIT the clause (and its commas) (B) which is a bridge, (C) a crossing bridge, (D) NO CHANGE
- 7 When all choices are grammatical and mean the same thing, which usually wins?
- 8 The shortest choice breaks the sentence’s grammar. Choose it?
- 9 “The reason is because the bus was late.”
(A) Because the reason is the bus was late. (B) The reason is that the bus was late. (C) The reason why is because the bus was late. (D) NO CHANGE
- 10 Before reading the choices, what do you ask?

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ANSWERS

- 1 D · “Together” repeats “cooperated.”
- 2 D · Return = go back.
- 3 A · Nothing is wrong.
- 4 D · Say it once.
- 5 A · Shortest correct.
- 6 A · It adds nothing.
- 7 The shortest · Correctness first, then fewest words.
- 8 No · Correctness comes first.
- 9 B · “Reason is because” is redundant.
- 10 Is there an error at all? · If not, start with NO CHANGE.

Transitions and Logic

Name the relationship, then choose.

ENG-3

LESSON

THE RULE

Transition questions underline a connecting word or ask which choice best links two sentences or paragraphs. Read the sentence **before** as carefully as the one after, name the relationship, then choose. Sometimes the best choice is no transition at all.

RELATIONSHIP	TRANSITIONS
Adds (same direction)	additionally, furthermore, moreover, similarly, likewise
Contrast	however, nevertheless, by contrast, on the other hand, still
Cause and effect	therefore, thus, consequently, as a result, accordingly
Example	for example, for instance, specifically
Sequence	first, then, subsequently, finally, later
Emphasis or restatement	in fact, indeed, that is, in other words
Concession, then point	admittedly... still · granted... nonetheless

REMEMBER ACT transition questions often include an option that drops the transition entirely: choose it when the second sentence simply continues the first. Two choices with the same meaning are both wrong.

WORKED EXAMPLES

- “The bridge was designed for 5,000 cars a day. ___, it now carries 20,000.” → contrast: Nevertheless.
- “The drug lowered blood pressure. ___, it reduced heart attacks.” → adds: Moreover.
- “Rainfall dropped by half. ___, crop yields fell.” → result: Consequently.
- “She opened the door. She stepped inside.” → often no transition needed.

TRAPS

- ~~X “However” because it sounds smart~~ ✓ **The relationship decides**
- ~~X Reading only the sentence after~~ ✓ **Reading both sides**
- ~~X Forcing a transition where none is needed~~ ✓ **Considering the no-transition choice**

DRILL HABIT

Make one flashcard per relationship. Before every transition question, say the relationship aloud before looking at the choices.

TRY IT

- 1 “Sales rose 40% in March. ___ the company hired 200 workers.” (A) Nevertheless, (B) As a result, (C) For example, (D) In contrast,
- 2 “The method is slow. ___ it is the most accurate one available.” (A) Similarly, (B) Therefore, (C) Still, (D) For instance,
- 3 “Many birds migrate. The arctic tern, ___ travels from pole to pole.” (A) however, (B) for example, (C) consequently, (D) likewise,

ANSWERS 1 B · 2 C · 3 B

Transitions and Logic: Drill

8 original questions. Answer all of them before checking.

- 1 “The museum is free on weekdays. ____, it charges a small fee on weekends.”
(A) Similarly, (B) For example, (C) Therefore, (D) However,
- 2 “The rain fell for three days. ____, the river overflowed.”
(A) Nevertheless, (B) Instead, (C) As a result, (D) For instance,
- 3 “Many animals use camouflage. The octopus, ____, can change both color and texture.”
(A) however, (B) consequently, (C) for example, (D) in contrast,
- 4 “She finished the race. She rested in the shade.”
(A) NO CHANGE (B) However, she (C) Therefore, she (D) For example, she
- 5 “First, the clay is shaped. ____, it is fired.”
(A) Similarly, (B) However, (C) Next, (D) For instance,
- 6 “The plan was expensive. ____, it was the safest option.”
(A) Therefore, (B) Still, (C) For example, (D) Likewise,
- 7 “The drug lowered fevers. ____, it shortened recovery times.”
(A) Nevertheless, (B) Moreover, (C) Instead, (D) In contrast,
- 8 Two choices mean the same thing. Can either be the only right answer?

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ANSWERS

- 1 D · Contrast.
- 2 C · Cause → effect.
- 3 C · Example.
- 4 A · No transition needed: simple sequence.
- 5 C · Sequence.
- 6 B · Concession → contrast.
- 7 B · Adds a benefit.
- 8 No · Look elsewhere.

Add, Delete or Revise

Yes or no, then the reason.

ENG-4

LESSON

THE RULE

Some questions show a proposed sentence and ask whether to add it, or whether to delete one. Decide with one test: **does it serve the paragraph's focus and purpose?** Then choose the reason that is true.

QUESTION	HOW TO DECIDE
"Should the writer add this sentence?"	Yes only if it supports the paragraph's point where it would go
"Should the writer delete the underlined sentence?"	Delete if it's off topic or repeats; keep it if the paragraph needs it
"Which choice best supports the claim...?"	The detail that proves that exact claim (GL-7)
"Which choice is most relevant?"	The detail tied to the paragraph's point, not the most vivid
The reasons in the choices	Must be accurate about the sentence, not just plausible

REMEMBER Answer in two steps: yes or no first (that eliminates two choices), then the reason that correctly describes the sentence. The right yes or no with a wrong reason is still wrong.

WORKED EXAMPLES

- A paragraph on a chef's training; proposed: the history of the restaurant's building → No: off topic.
- A paragraph claims bees can recognize faces; proposed: an experiment showing it → Yes: evidence.
- Delete a sentence that repeats the one before → Yes: redundant.
- Reason trap: "Yes, because it explains why bees are endangered," when it doesn't → wrong reason.

TRAPS

- ~~X Adding a sentence because it's interesting~~ ✓ **Adding only if it serves the paragraph**
- ~~X A reason that isn't true of the sentence~~ ✓ **Checking the reason against the text**
- ~~X Keeping a sentence that repeats a point~~ ✓ **Deleting redundancy**

DRILL HABIT

For every add-or-delete question, say the paragraph's point in five words before deciding.

TRY IT

- 1 A paragraph explains how solar panels convert light into electricity. Proposed: "Solar panels were first used on satellites in 1958." Add it?
- 2 A paragraph argues a town's library is underfunded. Proposed: "Last year the library's budget fell by 30%." Add it?
- 3 What decides yes or no?

ANSWERS 1 No: it's history, not how panels work · 2 Yes: it supports the claim · 3 Whether it serves the paragraph's focus

Add, Delete or Revise: Drill

8 original questions. Answer all of them before checking.

ENG-4

DRILL

- 1 A paragraph explains how bees make honey. Proposed sentence: "Honey was used by ancient Egyptians." Add it?
- 2 A paragraph argues the town needs a new library. Proposed: "The current library has 40 seats for 9,000 residents." Add it?
- 3 A sentence repeats the previous sentence's point in new words. Delete it?
- 4 The right yes/no with a wrong reason: correct or not?
- 5 Which reason fits adding a statistic that supports the paragraph's claim?
(A) It contradicts the paragraph. (B) It provides evidence for the paragraph's main point. (C) It explains the history of the topic. (D) It introduces a new topic.
- 6 A paragraph on a chef's training methods; proposed: the restaurant's parking options. Add it?
- 7 What single test decides add or delete?
- 8 A detail is vivid but unrelated to the paragraph's point. Most relevant?

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ANSWERS

1 No · History, not process: off focus.

2 Yes · Evidence for the claim.

3 Yes · Redundant.

4 Not correct · Both parts must be right.

5 B · Evidence.

6 No · Off topic.

7 Does it serve the paragraph's focus and purpose? · ENG-4.

8 No · Relevance beats vividness.

Purpose and Goal Questions

“Suppose the writer’s goal had been...”

ENG-5

LESSON

THE RULE

Whole-essay questions ask whether the essay achieved a stated goal. Decide yes or no from what the essay **actually does**, then choose the reason that describes the essay accurately.

IF THE GOAL IS...	THE ESSAY ACHIEVES IT IF...
To explain the history of X	it focuses on X’s past, not one person’s experience
To describe a personal experience	it’s told from the writer’s own experience
To argue for a policy	it takes and supports a position
To compare two things	it discusses both and how they differ
To give a broad overview	it covers the field, not one example

REMEMBER Many of these answers are “No”: the stated goal is often broader than, or different from, what the essay does. The reason must match the essay’s real focus.

WORKED EXAMPLES

- Essay: a summer restoring a canoe with her grandfather. Goal: the history of canoe making in North America → No: it’s a personal experience.
- Essay: a profile of one architect. Goal: to describe an architect’s contributions → Yes.
- Reason trap: “No, because it explains canoe history in detail” → wrong (it doesn’t).
- Read the goal word for word: “overview,” “history,” “argue.”

TRAPS

- ~~X Answering from one paragraph~~ ✓ **Answering from the whole essay**
- ~~X Yes because the topics overlap~~ ✓ **Yes only if the essay does exactly that**
- ~~X A reason true of a different essay~~ ✓ **A reason true of this one**

DRILL HABIT

After each English essay, write its purpose in one sentence before answering its last questions.

TRY IT

- 1 Essay: a student’s experience volunteering at a wildlife rescue. Goal: to explain the scientific causes of species decline. Fulfilled?
- 2 Essay: a step-by-step account of how a town built its first library. Goal: to describe how a community created a public resource. Fulfilled?

ANSWERS 1 No: it’s a personal account · 2 Yes

Purpose and Goal Questions: Drill

8 original questions. Answer all of them before checking.

ENG-5

DRILL

- 1 Essay: a student's summer working on her uncle's farm. Goal: to explain the history of farming in the region. Fulfilled?
- 2 Essay: a profile of one scientist's discoveries. Goal: to describe a scientist's contributions. Fulfilled?
- 3 Essay: an argument for later school start times. Goal: to argue for a change in school policy. Fulfilled?
- 4 Essay: a history of one bridge. Goal: to give an overview of bridge engineering worldwide. Fulfilled?
- 5 Are many goal-question answers "No"?
- 6 The reason says the essay "explains the region's farming history in detail," but it doesn't. Weapon?
- 7 Where do you answer goal questions from?
- 8 Essay: how a community built a playground. Goal: to show how neighbors worked together on a project. Fulfilled?

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ANSWERS

- 1 No · Personal experience, not regional history.
- 2 Yes · Matches.
- 3 Yes · It takes and supports a position.
- 4 No · Too narrow for the goal.
- 5 Yes · Stated goals are often broader than the essay.
- 6 Mace (or a false reason) · The reason must be true of the essay.
- 7 The whole essay · Not one paragraph.
- 8 Yes · Matches the focus.

Order: Sentences and Paragraphs

Put it where the links click.

ENG-6

LESSON

THE RULE

Order questions ask where a sentence belongs, or whether a paragraph is in the right place. Look for **links**: a pronoun that needs its noun first, a time word, a reference to “this idea,” or a new term that must be introduced first.

CLUE IN THE SENTENCE	IT GOES...
A pronoun (he, she, it, this, these)	right after the noun it refers to
“Then,” “later,” “after that”	after the earlier event
“This problem,” “such a method”	right after the problem or method is described
Introduces a new person or term	before other sentences use it
A result	after its cause
“For example”	right after the claim it supports

REMEMBER Test the answer: put the sentence there and read the sentences before and after. The links should click. Paragraph order works the same way: a paragraph’s first sentence connects to the end of the one before.

WORKED EXAMPLES

- “She then sold the design to a toy company.” → after she creates the design.
- “This discovery changed the field.” → right after the discovery is described.
- “Mariana Ruiz, the lead engineer, disagreed.” → before any sentence that says just “Ruiz.”
- A paragraph starting “After the war...” → after the paragraph about the war.

TRAPS

- ~~X~~ Placing a sentence by topic alone ✓ **Placing it by its links**
- ~~X~~ Ignoring pronouns ✓ **Matching each pronoun to its noun**
- ~~X~~ Not testing the placement ✓ **Reading before and after**

DRILL HABIT

For each order question, circle the linking word first: a pronoun, a time word, or “this.”

TRY IT

- 1 “These tools made the work twice as fast.” Before or after the sentence describing the tools?
- 2 “Later, she moved to Chicago.” After what kind of sentence?
- 3 Name three placement clues.

ANSWERS 1 After · 2 One describing her earlier life · 3 Pronouns, time words, and references like “this” or “such”

Order: Sentences and Paragraphs: Drill

8 original questions. Answer all of them before checking.

ENG-6

DRILL

- 1 “These changes cut costs by half.” Before or after the sentence describing the changes?
- 2 “Later, he moved to Lisbon.” After what kind of sentence?
- 3 “Dr. Amara Osei, the team’s leader, objected.” Before or after a sentence that says just “Osei”?
- 4 “For example, the city planted 10,000 trees.” Where does it go?
- 5 “This method solved the problem.” Must follow...?
- 6 A paragraph starts “After the flood...”. It follows...?
- 7 How do you test a placement?
- 8 “As a result, enrollment doubled.” Follows...?

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ANSWERS

- 1 After · “These” needs its noun first.
- 2 One about his earlier life · Time word.
- 3 Before · Introduce the name first.
- 4 Right after the claim it supports · Example follows claim.
- 5 A description of the method · “This method.”
- 6 The paragraph about the flood · Paragraph links.
- 7 Read the sentence before and after it in that spot · The links should click.
- 8 Its cause · Result after cause.

Word Choice, Tone and Idioms

The precise word, in the right register.

ENG-7

LESSON

THE RULE

Some questions test the most precise word, the one that fits the essay's tone, or the preposition that goes with a verb. Choose the exact meaning the sentence needs, in the essay's register.

TESTED	EXAMPLE
Precision	"The drought devastated the crops" (if the text shows total loss), not "affected"
Register and tone	formal essay: "numerous," not "a ton of"
Idioms (verb + preposition)	comply with · consist of · capable of · responsible for · interested in
Confused words	affect / effect · than / then · its / it's (GM-11)
Comparisons	fewer (count) / less (amount) · between (two) / among (more)
Consistency	keep the essay's style; no sudden slang

REMEMBER When choices mean roughly the same thing, ask which fits this context exactly and matches the tone. Slang and clichés are wrong in a formal essay.

WORKED EXAMPLES

- "The committee consists **of** nine members."
- "The results were **significant**," not "super big."
- "Between the two teams," but "among the five teams."
- "Fewer cars, less traffic."

TRAPS

- X "~~comply to the rules~~" ✓ "**comply with the rules**"
- X ~~Casual words in a formal essay~~ ✓ **Formal, precise words**
- X "~~less people~~" ✓ "**fewer people**"

DRILL HABIT

List every idiom you miss with its correct preposition; review the list with your word cards.

TRY IT

- 1 "The museum is responsible ___ protecting the paintings." (A) of (B) for (C) to (D) with
- 2 Formal essay: "The experiment was ___." (A) totally awesome (B) a big deal (C) successful (D) super good
- 3 "The prize was divided ___ the five winners." (A) between (B) among

ANSWERS 1 B · 2 C · 3 B

Word Choice, Tone and Idioms: Drill

10 original questions. Answer all of them before checking.

ENG-7

DRILL

- 1 “The team is responsible ___ the budget.”
(A) for (B) with (C) of (D) to
- 2 “The jury consists ___ twelve people.”
(A) from (B) by (C) in (D) of
- 3 “Visitors must comply ___ the rules.”
(A) for (B) at (C) with (D) to
- 4 Formal essay: “The results were ___.”
(A) super cool (B) significant (C) totally wild (D) a big deal
- 5 “There were ___ people at the meeting than expected.”
(A) fewer (B) less (C) lesser (D) littler
- 6 “The prize was shared ___ the three winners.”
(A) across (B) within (C) between (D) among
- 7 “The storm ___ the town, destroying half its homes.”
(A) visited (B) touched (C) devastated (D) affected
- 8 “She is capable ___ leading the team.”
(A) of (B) for (C) to (D) in
- 9 “The new rule will ___ every student.”
(A) effect (B) affect (C) effects (D) affects
- 10 Formal essay: which is best? (A) a ton of evidence (B) substantial evidence

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ANSWERS

- 1 A · Responsible for.
- 2 D · Consists of.
- 3 C · Comply with.
- 4 B · Formal register.
- 5 A · Countable.
- 6 D · More than two.
- 7 C · Precise for the damage shown.
- 8 A · Capable of.
- 9 B · Verb: affect.
- 10 B · Formal and precise.

Introductions, Conclusions and Relevance

Begin, connect and end with purpose.

ENG-8

LESSON

THE RULE

Questions ask which sentence best introduces a paragraph, connects two paragraphs, or concludes the essay. The best choice connects to what comes before and after, or returns to the essay's main point **without starting a new topic**.

TASK	THE BEST CHOICE...
Introduce a paragraph	names the paragraph's main idea
Transition between paragraphs	links the last paragraph's topic to the next one's
Conclude a paragraph	follows from it; no new topic
Conclude the essay	returns to the main point or the opening image
Most relevant detail	supports the paragraph's specific point

REMEMBER Read the whole paragraph before choosing its introduction: the right first sentence previews what the paragraph actually covers. Kill choices that are true but about something else (the Fist and the Mace).

WORKED EXAMPLES

- A paragraph on the cost of a bridge → opening: "The bridge's price soon became the town's biggest debate."
- From drought to new irrigation → "Farmers responded with new ways to water their fields."
- A conclusion that echoes the opening image → strong.
- A conclusion that introduces a new topic → wrong.

TRAPS

- ~~X An opening that's true but off topic~~ ✓ **An opening that previews the paragraph**
- ~~X A conclusion with a new idea~~ ✓ **A conclusion that closes the main idea**
- ~~X Choosing before reading the paragraph~~ ✓ **Reading it first**

DRILL HABIT

After each essay's last paragraph, say its main point in one sentence: that's what a good conclusion returns to.

TRY IT

- 1 A paragraph describes three ways octopuses camouflage themselves. Best opening? (A) Octopuses have three hearts. (B) Octopuses are masters of disguise. (C) Many animals live in the ocean. (D) Soldiers use camouflage.
- 2 An essay about a grandmother's bakery ends. Best conclusion? (A) Bread was invented thousands of years ago. (B) Every time I smell fresh bread, I'm back in her kitchen. (C) Bakeries need ovens. (D) My school has a cafeteria.

ANSWERS 1 B · 2 B

Introductions, Conclusions and Relevance: Drill ENG-8

8 original questions. Answer all of them before checking.

DRILL

- 1 A paragraph describes three ways bats find food. Best opening?
(A) Bats sleep upside down. (B) Bats appear in many legends. (C) Many animals live in caves. (D) Bats have unusual hunting tools.
- 2 An essay about a grandfather's woodshop ends. Best conclusion?
(A) Woodshops can be dangerous. (B) Wood comes from trees. (C) Many people own tools. (D) Whenever I smell sawdust, I'm back at his workbench.
- 3 A conclusion introduces a new topic. Good or bad?
- 4 Best transition between a paragraph on a drought and one on new irrigation?
(A) Rain is important. (B) Irrigation was invented long ago. (C) Farmers responded with new ways to water their crops. (D) Droughts are common worldwide.
- 5 Should you choose an introduction before reading the paragraph?
- 6 A true sentence about a different topic as an opening. Weapon?
(A) Rain is important. (B) Irrigation was invented long ago. (C) Farmers responded with new ways to water their crops. (D) Droughts are common worldwide.
- 7 Which detail is most relevant to a paragraph about a city's bike lanes reducing traffic?
(A) Bikes come in many colors. (B) Car trips downtown fell 15% after the lanes opened. (C) Bikes were invented in the 1800s. (D) The mayor rides a bike.
- 8 A strong essay conclusion often returns to...

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ANSWERS

- 1 D · Previews the paragraph.
- 2 D · Returns to the essay's heart.
- 3 Bad · Close the main idea.
- 4 C · Links both.
- 5 No · Read it first.
- 6 Fist (or Mace) · True but off focus.
- 7 B · Supports the point.
- 8 The main point or the opening image · Closure.

PART IV

Reading

Long passages, every question type, and a clock you control.

Inside the Reading Test

36 questions, 40 minutes, long passages.

RD-1

LESSON

THE RULE

The Reading test has **36 questions in 40 minutes**, built around a few long passages, often including a pair of shorter ones. That's roughly **10 minutes per passage set**. Every answer is supported by the text: this is an evidence test, not an opinion test.

PASSAGE TYPE	WHAT IT'S LIKE	LESSON
Literary narrative	fiction or memoir: characters, feelings, relationships	RD-9
Social science	history, economics, psychology: claims and evidence	RD-10
Humanities	arts, culture, ideas: the author's perspective	RD-4, RD-7
Natural science	studies and explanations	RD-10
Paired passages	two shorter texts on one topic	RD-8

REMEMBER No penalty for guessing: answer every question. You choose the order: many students do best starting with their strongest passage type (RD-11).

WORKED EXAMPLES

- Set 1, literary narrative: 10 minutes.
- Set 2, social science: 10 minutes.
- Clock check at 10, 20 and 30 minutes.
- Last set short on time? Answer the line-reference questions first.

TRAPS

- ~~X Reading at the same slow pace for every passage~~ ✓ **About 10 minutes per set**
- ~~X Answering from opinion~~ ✓ **Answering from the text (GL-10)**
- ~~X Leaving blanks~~ ✓ **Guessing on every question**

DRILL HABIT

Take a timed Reading test with a clock check after each passage set.

TRY IT

- 1 Questions and minutes on Reading?
- 2 About how long per passage set?
- 3 Does Reading count toward the composite?
- 4 Penalty for guessing?

ANSWERS 1 36 in 40 · 2 About 10 minutes · 3 Yes (English, Math, Reading)
· 4 No

Inside the Reading Test: Drill

8 original questions. Answer all of them before checking.

- 1 Questions and minutes on Reading?
- 2 Does Reading count toward the composite?
- 3 Name four passage types.
- 4 Must you do the passages in printed order?
- 5 Are Reading answers matters of opinion?
- 6 About how many minutes per passage set?
- 7 Last set and short on time: which questions first?
- 8 Leave blanks?

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ANSWERS

1 36 in 40 · About 10 minutes per passage set.

2 Yes · English, Math, Reading.

3 Literary narrative, social science, humanities, natural science (plus paired passages) · RD-1's table.

4 No · Your best type first (RD-11).

5 No: every answer is supported by the text · Evidence test.

6 About 10 · 40 minutes total.

7 Line-reference questions · Fastest to answer.

8 Never · No guessing penalty.

The Passage Attack

Preview, read actively, then attack.

THE RULE

Adapt the Four-Step Attack (GL-2) to long passages: **preview the question stems** (not the choices) for about 30 seconds, **read actively** asking “Why?” (GL-11), then for each question re-read the stem, go back to the lines, predict, and eliminate.

STEP	TIME	WHAT YOU DO
1 • Preview stems	~30 sec	note line references and names to watch for
2 • Read actively	~3–4 min	a one-word label per paragraph: SETUP, CLAIM, TURN, EXAMPLE
3 • Stem → lines → Shield	~5–6 min	go back to the text for every question
4 • Eliminate	—	the six weapons; select what's left

REMEMBER Never answer from memory of the passage: go back to the lines every time. Answering from memory is exactly how the Fist and the Axe win.

WORKED EXAMPLES

- Preview: Q3 asks about lines 22–25; Q6 asks about “the narrator’s father.”
- Labels: P1 SETUP (the town), P2 TURN (the factory closes), P3 FEELING (grief).
- Q4: “The narrator’s attitude toward the factory...” → lines 30–36 → Shield: mixed, angry but nostalgic.
- Eliminate “purely hostile” (Trident) and “indifferent” (Gladius).

TRAPS

- ~~✗ Reading the choices during the preview~~ ✓ **Stems only**
- ~~✗ Answering from memory~~ ✓ **Back to the lines every time**
- ~~✗ Re-reading the whole passage for one question~~ ✓ **The lines, plus a little before and after**

DRILL HABIT

For two passages this week, write a one-word label next to every paragraph before answering any questions.

TRY IT

- 1 What do you preview: stems, choices, or both?
- 2 Where do you look to answer a line-reference question?
- 3 Which two weapons punish answering from memory?

ANSWERS 1 Stems only · 2 The cited lines, plus a little before and after · 3 The Fist and the Axe

The Passage Attack: Drill

8 original questions. Answer all of them before checking.

RD-2

DRILL

- 1 During the preview, what do you read: stems, choices, or both?
- 2 What do you write next to every paragraph?
- 3 Answering from memory instead of the lines: which weapons win?
- 4 Order for each question?
- 5 A question cites lines 20–24. Where do you read?
- 6 How long should active reading of a passage take?
- 7 Should you re-read the whole passage for one question?
- 8 Why preview stems?

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ANSWERS

1 Stems only · About 30 seconds.

2 A one-word label (SETUP, CLAIM, TURN, EXAMPLE...) · Keeps you oriented.

3 The Fist and the Axe · Go back every time.

4 Stem → lines → Shield → weapons → select · The Passage Attack.

5 From a sentence before line 20 to a sentence after 24 · Context.

6 About 3–4 minutes · Then the questions.

7 No: the lines plus a little around them · Efficiency.

8 To know which names and lines to watch for · Read with purpose.

Detail Questions and Line References

It says so right there, in other words.

RD-3

LESSON

THE RULE

Detail questions ask what the passage states. The answer is in the text, usually paraphrased. Find the lines, read a little before and after, predict, then match.

STEM	DO THIS
"According to the passage..."	scan for the key word; read that sentence and the next
"In lines 34–38, the author..."	read from a sentence before to a sentence after
"...because..."	find the event; look for because, since, as a result
"...NOT stated" / "EXCEPT"	three choices are in the text; the one you can't find wins
Numbers, dates, names	match them exactly

REMEMBER Line references are a starting point, not a fence: the answer often sits a line before or after. On NOT and EXCEPT questions, circle the word in the stem and flip your thinking.

WORKED EXAMPLES

- Text: "Built in 1883, the bridge was closed in 1990 after engineers found cracks in its cables." Why did it close?
- ✓ "Engineers discovered damage to its cables." (paraphrase)
- X "It was too old." (Out of Scope)
- X "Engineers built it in 1883." (Fist: true, wrong question)

TRAPS

- X ~~Reading only the cited lines~~ ✓ **A sentence before and after**
- X ~~The choice with the text's exact words~~ ✓ **Watching for the Axe**
- X ~~Forgetting NOT or EXCEPT~~ ✓ **Circling it in the stem**

DRILL HABIT

On 10 detail questions, write the line number that proves each answer before you choose.

TRY IT

- 1 Stem: "According to the passage, the bridge closed because..." What do you scan for?
- 2 Stem: "All of the following are mentioned EXCEPT..." How many choices appear in the text?
- 3 The stem cites lines 40–42. Where do you read?

ANSWERS 1 "bridge," "closed," and cause words (because, after, due to) · 2 Three · 3 From a sentence before 40 to a sentence after 42

Detail Questions and Line References: Drill

RD-3

DRILL

8 original questions. Answer all of them before checking.

- 1 Text: "Built in 1885, the lighthouse was replaced in 1960 because erosion had undermined its base." Why was it replaced?
(A) Erosion had weakened its foundation. (B) It was built in 1885. (C) Ships no longer needed it. (D) It was too old.
- 2 Same text. Which choice is a Fact?
(A) Erosion undermined its base. (B) Erosion affected it. (C) It was built in 1885. (D) It was replaced.
- 3 Stem: "All of the following are stated EXCEPT..." How many choices appear in the text?
- 4 Text: "Maria Mitchell discovered a comet in 1847 and later became Vassar's first astronomy professor." What happened first?
- 5 Are line references a fact?
- 6 A choice copies the passage's exact words but changes who did what. Fact?
- 7 Text: "The novel sold poorly at first; sales rose only after the author's death." When did sales rise?
- 8 Numbers and dates in detail answers must...?

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ANSWERS

1 A · Paraphrase of "undermined its base."

2 C · True, but doesn't answer "why."

3 Three · Find the one that doesn't.

4 She discovered a comet · 1847, then the professorship.

5 No: the answer is often a line before or after · Read around them.

6 Fact · Recycled language.

7 After the author died · Stated.

8 Match exactly · Check every one.

Main Idea and Purpose

What it all adds up to.

RD-4

LESSON

THE RULE

Main idea questions ask about the whole passage or one paragraph; purpose questions ask why the author wrote it. Use your paragraph labels (RD-2) to state the main idea in one sentence **before** you look at the choices.

QUESTION	PREDICT FROM...
Main idea of the passage	what the paragraph labels add up to
Main idea of a paragraph	its first and last sentences, plus its label
Purpose of the passage	the author's verb: describe, argue, explain, celebrate, question
Purpose of a paragraph	its job in the passage (RD-7)

REMEMBER Answer whole-passage questions last, after the details. Kill choices that are too narrow (one paragraph) or too broad (beyond the passage).

WORKED EXAMPLES

- Labels: SETUP (an old belief) → TURN (new research) → EXAMPLE (one study) → CONCLUSION (why it matters) → new research is overturning an old belief.
- “To describe how an artist developed her style” vs. “to argue her style is the best” → match the tone.
- Too narrow: “The passage describes one experiment.”
- Too broad: “Science is always changing.”

TRAPS

- ~~X A choice about one paragraph~~ ✓ **A choice about the whole passage**
- ~~X An extreme verb (“prove,” “condemn”)~~ ✓ **The author's actual tone**
- ~~X Answering main idea first~~ ✓ **Answering it last**

DRILL HABIT

After each passage, write a one-sentence main idea and a purpose verb before the big-picture questions.

TRY IT

- 1 Labels: P1 a common belief about sleep; P2 new research challenging it; P3 one study's details; P4 implications for students. Main idea?
- 2 Which verb fits a passage praising a scientist's persistence: criticize, celebrate or question?

ANSWERS 1 New research challenges a common belief about sleep, with implications for students · 2 Celebrate

Main Idea and Purpose: Drill

8 original questions. Answer all of them before checking.

RD-4

DRILL

- 1 Labels: P1 a belief about dolphins; P2 new research; P3 one study; P4 what it means. Main idea?
- 2 A choice describes only paragraph 3. Main idea of the passage?
- 3 Which verb fits a passage praising a musician's influence: criticize, celebrate, question?
- 4 When should you answer whole-passage questions?
- 5 A choice says "Science is always changing" for a passage about one discovery. Weapon?
- 6 Main idea of a paragraph: where to look?
- 7 Passage explains, neutrally, how glaciers carve valleys. Purpose verb?
- 8 Passage argues a city should fund libraries. Purpose verb?

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 New research challenges a common belief about dolphins · The labels add up.

2 No · Too narrow.

3 celebrate · Tone.

4 Last · After the details.

5 Mace (and Trident) · Too broad.

6 Its first and last sentences, plus its label · RD-4.

7 explain · Neutral.

8 argue · Takes a side.

Inferences

One small step, never a leap.

RD-5

LESSON

THE RULE

Inference questions ask what the passage suggests or implies. The answer isn't stated word for word, but it must be **strongly supported** by specific lines: one small logical step.

STEM	THE ANSWER...
"It can reasonably be inferred that..."	follows directly from specific lines
"The passage suggests that..."	is a modest, supported conclusion
"The narrator most likely..."	fits the character's words and actions
"The author would most likely agree..."	matches the author's stated views

REMEMBER If a choice needs outside knowledge or two leaps of logic, it's the Mace. Prefer modest words: may, likely, suggests.

WORKED EXAMPLES

- "Maria checked the clock again and again, then left before her friend arrived." → she was impatient, or gave up waiting.
- ~~X~~ "Maria stayed angry at her friend for years." (too far)
- "Unlike earlier models, the new engine runs on hydrogen." → earlier models didn't.
- ~~X~~ "Hydrogen engines are the future." (Out of Scope)

TRAPS

- ~~X~~ A leap the text doesn't support ✓ **One small step**
- ~~X~~ Using what you know about the topic ✓ **Using only the lines**
- ~~X~~ Strong words ("proves," "always") ✓ **Modest words**

DRILL HABIT

For every inference question, write the line that supports your answer. If you can't, the choice is probably too big a leap.

TRY IT

- 1 "Although the critics dismissed the play, audiences filled the theater every night for a year." Inference? (A) Critics and audiences reacted differently (B) It was the decade's best play (C) The critics later apologized (D) The theater was small
- 2 "He hadn't touched the piano since his teacher retired." Inference? (A) He never learned piano (B) He stopped playing after his teacher retired (C) He hated his teacher (D) He sold the piano

ANSWERS 1 A · 2 B

Inferences: Drill

8 original questions. Answer all of them before checking.

RD-5

DRILL

- 1 “He checked his phone every few seconds and barely touched his food.” Inference?
(A) He was waiting anxiously for news. (B) He was not hungry because he had eaten. (C) He disliked the restaurant. (D) His phone was broken.
- 2 “Unlike earlier engines, the new model runs on electricity.” Inference?
(A) All engines will be electric. (B) Earlier engines did not run on electricity. (C) Electricity is cheaper. (D) The new model is faster.
- 3 A choice needs outside knowledge to be true. Weapon?
- 4 “Critics panned the opera, but it sold out every night for a year.” Inference?
(A) The critics later changed their minds. (B) Critics and audiences reacted differently. (C) The opera was the best ever written. (D) The theater was small.
- 5 Which words fit inference answers: proves / may / suggests?
- 6 “She hadn’t opened the piano since her teacher moved away.” Inference?
(A) She stopped playing after her teacher left. (B) She never learned piano. (C) She disliked her teacher. (D) She sold the piano.
- 7 An inference that requires two leaps of logic. Keep?
- 8 “The town’s population doubled after the railroad arrived.” Inference?
(A) The town was founded by railroad workers. (B) Railroads always double populations. (C) The railroad may have contributed to growth. (D) Population fell later.

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ANSWERS

1 A · Supported by actions.

2 B · One small step.

3 Mace · Inferences come from the lines.

4 B · Supported contrast.

5 may, suggests · Modest.

6 A · Directly supported.

7 No · One small step.

8 C · Modest link.

Words in Context

The meaning in this sentence.

RD-6

LESSON

THE RULE

“As it is used in line 12, the word ‘x’ most nearly means...” The answer is the meaning **in this sentence**, often not the most common one. Cover the word, predict your own replacement, then match.

WORD IN CONTEXT	COMMON MEANING (OFTEN THE TRAP)	MEANING HERE
“She appreciated the danger.”	was grateful for	understood
“a sound argument”	a noise	reliable
“a check on presidential power”	a payment	a limit
“He commanded respect.”	ordered	earned
“a novel approach”	a book	new, original

REMEMBER If the most common meaning is a choice, be suspicious: the ACT likes secondary meanings. Plug your answer back in: it should make sense and keep the tone.

WORKED EXAMPLES

- “The plan’s **chief** drawback was cost.” → main
- “She **cultivated** friendships.” → developed
- “The theory **failed to** account for...” → did not
- Plug in: “She developed friendships” ✓

TRAPS

- ✗ ~~The most common meaning~~ ✓ **The meaning in this sentence**
- ✗ ~~A choice that fits the word but not the tone~~ ✓ **Tone and meaning**
- ✗ ~~Answering without reading the sentence~~ ✓ **The whole sentence first**

DRILL HABIT

Keep a card for every multiple-meaning word you miss, with both meanings and the sentence.

TRY IT

- 1 “The senator’s position was firm.” Most nearly: (A) solid (B) unwavering (C) hard (D) business
- 2 “The scientist entertained the possibility.” (A) amused (B) hosted (C) considered (D) performed
- 3 “The company will observe the holiday.” (A) watch (B) notice (C) celebrate (D) study

ANSWERS 1 B · 2 C · 3 C

Words in Context: Drill

8 original questions. Answer all of them before checking.

RD-6

DRILL

- 1 “The plan’s chief weakness was cost.” Chief most nearly means:
(A) leader (B) boss (C) native (D) main
- 2 “She cultivated relationships with local artists.”
(A) developed (B) planted (C) cut (D) farmed
- 3 “The senator’s stance was firm.”
(A) unwavering (B) company (C) solid (D) hard
- 4 “The museum will observe the holiday.”
(A) watch (B) notice (C) study (D) celebrate
- 5 “He commanded the respect of his peers.”
(A) controlled (B) earned (C) led (D) ordered
- 6 “A sound plan.”
(A) loud (B) audible (C) reliable (D) noisy
- 7 If the most common meaning is a choice, be...?
- 8 Last step on a words-in-context question?

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 D · Main weakness.

2 A · Built up.

3 A · Unchanging position.

4 D · Observe a holiday.

5 B · Earned respect.

6 C · Reliable.

7 Suspicious · The ACT likes secondary meanings.

8 Plug your answer back into the sentence · Meaning and tone.

Author's Technique

Function, structure and point of view.

RD-7

LESSON

THE RULE

Some questions ask how the passage is written: what a detail or paragraph does, how the passage is organized, and whose point of view it's told from. Answer with the **job**, not the content (GL-7).

QUESTION	LOOK FOR
Function of a detail or paragraph	its job: example, contrast, evidence, background, turning point
Overall structure	the sequence of your paragraph labels
Point of view	first person (I) or third (she); a child's view or an adult looking back
Tone	the author's word choices: admiring, critical, nostalgic, neutral
Why a quotation is included	to support, to contrast, or to show someone's view

REMEMBER Narrators often look back on childhood: the passage can show both the child's feelings then and the adult's understanding now. Questions test whether you can tell them apart.

WORKED EXAMPLES

- "The author mentions the 1906 earthquake primarily to..." → give background for the city's rebuilding.
- Structure: an anecdote, then a broader claim, then support.
- "Looking back, I see that my father was afraid." → an adult reflecting on childhood.
- "stubborn genius," "tireless" → admiring tone.

TRAPS

- ~~X What the paragraph says~~ ✓ **What it does**
- ~~X Confusing the narrator then and now~~ ✓ **Watching time words: then, now, looking back**
- ~~X Extreme tone words ("contemptuous")~~ ✓ **Usually milder: critical, skeptical**

DRILL HABIT

For two passages, write the structure as a chain of labels: SETUP → CLAIM → EVIDENCE → CONCLUSION.

TRY IT

- 1 The first paragraph describes a quiet village before the story begins. Its function?
- 2 "As a child, I believed the river was endless." Whose belief?
- 3 Words used: "tireless," "brilliant," "generous." Tone?

ANSWERS 1 It establishes the setting · 2 The narrator's, as a child · 3 Admiring

Author's Technique: Drill

8 original questions. Answer all of them before checking.

RD-7

DRILL

- 1 The first paragraph describes a quiet harbor town before anything happens. Function?
- 2 "As a child, I thought the forest went on forever." Whose belief?
- 3 Words: "reckless," "careless," "short-sighted." Author's tone?
- 4 "The author mentions the 1918 flu primarily to..." Answer with what?
- 5 Structure of: an anecdote, a general claim, then supporting studies?
- 6 "Looking back now, I see my mother was afraid." Perspective?
- 7 A tone choice says "contemptuous" for mild criticism. Weapon?
- 8 Why might an author include a quotation from a critic?

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ANSWERS

1 Establishes the setting · Background.

2 The narrator's, as a child · Time words.

3 Critical · Word choice.

4 The job (e.g., give background, offer a comparison) · Not the content.

5 Anecdote → claim → evidence · Your labels.

6 An adult reflecting on childhood · Then vs. now.

7 Trident · Too extreme.

8 To support, contrast, or show someone's view · Its job.

Paired Passages

Read A, answer A; read B, answer B; then both.

THE RULE

Paired passages give two shorter texts on one topic. Read Passage A and answer its questions, then Passage B and its questions, then the questions about both.

QUESTION	STRATEGY
About Passage A only	answer right after reading A
About Passage B only	answer right after reading B
Agree or disagree	each author's claim in five words first
"How would author B respond to..."	B's view applied to A's specific claim
"Both passages..."	a choice must be true of both

REMEMBER This is the paired-passage skill: most pairs disagree in part, not totally. A "both passages" choice true of only one is a Half-Right (GL-5).

WORKED EXAMPLES

- Read A → A's questions → read B → B's questions → both.
- A: "Homework improves learning." B: "Only some homework does." → B qualifies A.
- "Both authors would agree that..." → the overlap only.
- Trap: a choice giving B's view as if A shared it.

TRAPS

- ~~X Reading both passages before answering anything~~ ✓ **A, then A's questions**
- ~~X "Both" choices true of one passage~~ ✓ **True of both**
- ~~X Assuming total disagreement~~ ✓ **Usually partial**

DRILL HABIT

For each pair, write each author's claim in five words and one word for the relationship: agree, disagree, qualify.

TRY IT

- 1 A praises a city's bike lanes for cutting traffic. B agrees they cut traffic but says they hurt local shops. How do they relate?
- 2 A "both passages" choice is true of A only. Which weapon kills it?

ANSWERS 1 They agree on traffic; B adds a cost A doesn't mention • 2 The Pugio (Half-Right)

Paired Passages: Drill

8 original questions. Answer all of them before checking.

RD-8

DRILL

- 1 Best order for paired passages?
- 2 A: "Homework improves learning." B: "Only well-designed homework does." Relationship?
- 3 A "both passages" choice is true of A only. Weapon?
- 4 A praises a dam for providing power. B agrees but says it harmed fish. Relationship?
- 5 Do most pairs disagree totally?
- 6 "How would the author of B respond to A's claim?" Predict with...?
- 7 What do you write for each pair?
- 8 Both authors would agree that...: the answer comes from?

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ANSWERS

1 Read A → A's questions → read B → B's questions → both · RD-8.

2 B qualifies A · Agrees with a limit.

3 Pugio (Half-Right) · Must be true of both.

4 B accepts the benefit and adds a cost · Partial disagreement.

5 No: usually in part · Watch extreme choices.

6 B's view applied to A's specific claim · Shield.

7 Each author's claim in five words and one relationship word · Agree, disagree, qualify.

8 The overlap only · True of both.

Literary Narrative

Who, what they want, and what changes.

RD-9

LESSON

THE RULE

Literary passages test characters, relationships, feelings and how they change. Track who's who, what each wants, and the emotional turn.

TRACK	ASK
Characters	Who are they, and how are they related?
Feelings	What does each feel, shown by actions and words?
The turn	Where does a feeling or relationship change?
Narrator	Who's telling it, and when?
Details	Why did the author include this image or action?

REMEMBER A character's feelings are shown by what they do and say. If a choice names a feeling the text doesn't show, it's the Mace.

WORKED EXAMPLES

- "She left the letter unopened on the table for three days." → reluctance or fear.
- Sisters argue in paragraph 1, laugh together at the end → the relationship softens.
- An adult remembering summers at a grandparent's farm → nostalgic.
- The broken clock in the hallway → time stopped after a loss.

TRAPS

- ~~X~~ Reading feelings into the text ✓ Pointing to evidence
- ~~X~~ Missing the turn ✓ Noting where the mood changes
- ~~X~~ Confusing characters ✓ Jotting initials and relationships

DRILL HABIT

For each literary passage, write a one-line map: who, what they want, what changes.

TRY IT

- 1 "He laughed too loudly at the joke and kept glancing at the door." Likely feeling?
- 2 Paragraph 1: the narrator resents her new town. Last paragraph: she walks its streets "like they were hers." What changed?

ANSWERS 1 Nervousness or discomfort · 2 She came to accept, or belong in, the town

Literary Narrative: Drill

8 original questions. Answer all of them before checking.

RD-9

DRILL

- 1 “She folded the letter without reading it and put it in a drawer.” Likely feeling?
- 2 Paragraph 1: the brothers argue. Last paragraph: they laugh at an old joke. Change?
- 3 An adult remembers summers at a lake house. Tone?
- 4 A choice names a feeling the text never shows. Weapon?
- 5 “He laughed too loudly and kept glancing at the clock.” Likely feeling?
- 6 What one-line map do you write for a literary passage?
- 7 A stopped clock in a house after a death likely suggests...?
- 8 Narrator resents her new school at first; at the end she defends it. What changed?

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ANSWERS

- 1 Reluctance or avoidance · Actions show feelings.
- 2 The relationship softens · Track the turn.
- 3 Nostalgic · Looking back fondly.
- 4 Mace · Point to evidence.
- 5 Nervousness or discomfort · Signals.
- 6 Who, what they want, what changes · RD-9.
- 7 Time standing still after the loss · Why the detail is there.
- 8 She came to belong · The turn.

Social Science and Natural Science

Claim, evidence, opposing view.

RD-10

LESSON

THE RULE

Informational passages present claims, evidence and explanations. Track the claim, who makes it, the evidence, and any opposing view. You need no background knowledge (GL-10).

PART	MARK IT
The central claim	C
Evidence or a study	E
An opposing or earlier view	X
An example	Ex
A defined term	underline the definition

REMEMBER Science passages often explain a process step by step: number the steps in the margin. Social science passages often weigh two views: mark whose view each paragraph gives.

WORKED EXAMPLES

- “Many economists once assumed...” → X
- “A 2019 study of 4,000 households found...” → E
- “In Kenya, for instance, mobile payments...” → Ex
- “Photosynthesis, the process by which plants make sugar from light,...” → underline

TRAPS

- ~~X Getting stuck on technical terms~~ ✓ **Underlining the definition and moving on**
- ~~X Mixing up whose view is whose~~ ✓ **Marking each paragraph's speaker**
- ~~X Treating an earlier view as the author's~~ ✓ **Marking it X**

DRILL HABIT

For two informational passages, mark C, E, X and Ex in the margin as you read.

TRY IT

- 1 “It was long thought that coral could not recover from bleaching.” Mark?
- 2 “In a study of 30 reefs, researchers found...” Mark?
- 3 Do you need biology knowledge for a natural science passage?

ANSWERS 1 X • 2 E • 3 No: everything you need is in the passage

Social Science and Natural Science: Drill

8 original questions. Answer all of them before checking.

RD-10

DRILL

- 1 “Many historians once assumed...” Mark?
- 2 “A 2020 study of 1,200 farms found...” Mark?
- 3 “In Chile, for instance, ...” Mark?
- 4 “Osmosis, the movement of water across a membrane, ...” What do you do?
- 5 Do you need outside science knowledge for a natural science passage?
- 6 A paragraph presents an earlier view the author rejects. Is it the author’s view?
- 7 A passage explains a process in steps. What do you write in the margin?
- 8 “The author argues that...” follows which mark?

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ANSWERS

1 X (earlier view) · RD-10.

2 E (evidence) · Study.

3 Ex (example) · Example.

4 Underline the definition · Then move on.

5 No · Everything is in the passage.

6 No: mark it X · Track whose view.

7 Step numbers · Order matters.

8 C (central claim) · The author’s claim.

Reading Pacing and Passage Order

Your best passage first.

RD-11

LESSON

THE RULE

Forty minutes, about 10 per passage set. You choose the order: start with the type you do best and keep moving. A finished easy passage is worth more than an unfinished hard one.

PLAN	DETAIL
Before test day	rank the passage types by your accuracy in practice
Order	strongest type first, weakest last
Per set	about 10 minutes; check the clock after each
Stuck on a question	eliminate, guess, mark it, move on
Final minute	no blanks

REMEMBER Many students lose Reading points by spending 14 minutes on the first passage. ACT allows a silent watch on your desk: check it after every set.

WORKED EXAMPLES

- Practice data: natural science 90%, literary 70% → natural science first.
- Clock checks at 10, 20, 30 minutes.
- 9 minutes in with 2 questions left: answer, guess, go.
- Last set short on time: line-reference questions first.

TRAPS

- ~~X Always doing passages in printed order~~ ✓ **Your best order**
- ~~X No clock checks~~ ✓ **A check after every set**
- ~~X Leaving blanks~~ ✓ **Guessing on every question**

DRILL HABIT

Take two timed Reading tests, one in printed order and one in your order. Compare the scores.

TRY IT

- 1 About how many minutes per passage set?
- 2 Which passage should you do first?
- 3 Is a watch allowed on the ACT?

ANSWERS 1 About 10 • 2 Your strongest type • 3 Yes, a silent one, kept on your desk

Reading Pacing and Passage Order: Drill

8 original questions. Answer all of them before checking.

RD-11

DRILL

- 1 Practice accuracy: natural science 90%, literary 65%, humanities 80%. Which first?
- 2 Which last?
- 3 When do you check the clock?
- 4 Is a watch allowed?
- 5 11 minutes into a set with 3 questions left. What now?
- 6 Final minute with blanks?
- 7 Typical mistake on the first passage?
- 8 Does passage order change your score potential?

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ANSWERS

1 Natural science · Best first.

2 Literary · Weakest last.

3 After every passage set · About every 10 minutes.

4 Yes, a silent one on your desk · ACT test-day rules.

5 Answer quickly or guess, and move on · Protect the next set.

6 Fill every blank · No penalty.

7 Spending 14+ minutes on it · Clock checks fix it.

8 Yes: easy points first · Finish the passages you're best at.

PART V

Math

Strategy, your calculator, the formulas, and every skill the ACT tests, including the topics the SAT doesn't.

Why Smart Students Underperform



JOSEF AIDEN DURAND
FROM THE AUTHOR

Smart students often score below their ability for three reasons. They rush, because school rewarded speed. They trust their gut, because their gut is usually right in class. And they skip steps, because writing things down feels beneath them. On the ACT, all three are expensive.

Here's the difference between scorers. A 24 student knows most of the content and loses points to gaps and traps. A 30 student knows the content and loses points to hard traps and careless errors. A 34+ student knows the content, knows the traps, and has a process that removes careless errors: circle what they ask for, write the steps, check the answer against the estimate, plug it back in.

Notice what separates the levels: not raw ability, but process. The top scorers aren't faster thinkers; they're more disciplined ones. They have more ways into a hard question, and they never give away an easy one.

If you're smart and stuck, the fix isn't harder material. It's humbler habits.

Inside the ACT Math Test

45 questions, 50 minutes, four choices, no formula sheet.

MS-1

LESSON

THE RULE

45 questions in 50 minutes (about 67 seconds each), all multiple choice with **four choices**. There is **no formula sheet**, and you bring your own calculator (MS-6). Questions tend to get harder as the test goes on.

AREA	WHAT'S IN IT	LESSONS
Number and Quantity	exponents, radicals, complex numbers, matrices, vectors	AM-1, AX-1, AX-2
Algebra	linear equations, systems, inequalities, quadratics, polynomials	AL, AM-2, AM-3
Functions	notation, graphs, exponentials, logarithms, sequences, trig functions	AM-5, AM-8, AX-3, AX-4, AX-6
Geometry	shapes, triangles, circles, trigonometry, coordinate geometry	GT, AX-6, AX-7
Statistics and Probability	data, counting, probability	DA, AX-5
Integrating Essential Skills	rates, percents, proportions, area and volume, averages	DA-1, DA-2, GT-1

REMEMBER Pace unevenly: the first 20 questions should take well under a minute each, banking time for the last 15 (MS-8). Memorize the formulas in MS-7 and REF-1: the ACT won't give them to you.

WORKED EXAMPLES

- Q5: a percent question → 30 seconds.
- Q38: a trig identity → the banked time pays off.
- No formula sheet: circle area, the quadratic formula, SOH-CAH-TOA, from memory.
- Four choices: eliminate one and a guess is 1 in 3.

TRAPS

- ~~✗ Equal time on every question~~ ✓ **Fast early, slower late**
- ~~✗ Expecting a formula sheet~~ ✓ **Memorizing REF-1**
- ~~✗ Leaving blanks~~ ✓ **Guessing on every question**

DRILL HABIT

Take a timed math test. Note the clock at questions 20 and 35: target about 15 and 35 minutes.

TRY IT

- 1 Questions and minutes on ACT Math?
- 2 How many answer choices per question?
- 3 Is there a formula sheet?
- 4 Where are the hardest questions, usually?

ANSWERS 1 45 in 50 · 2 Four · 3 No · 4 Near the end

Inside the ACT Math Test: Drill

8 original questions. Answer all of them before checking.

- 1 Questions and minutes on ACT Math?
- 2 How many answer choices per math question?
- 3 Is there a formula sheet?
- 4 Where are the hardest questions, usually?
- 5 Calculator?
- 6 Are there student-produced responses on ACT Math?
- 7 Name two ACT-only topics the SAT doesn't test.
- 8 Target time for questions 1–20?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: any set, timed

Official practice tests · act.org: Free ACT Practice Tests and Prep

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Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 45 in 50 · About 67 seconds each.

2 Four · Since the Enhanced ACT.

3 No · Memorize REF-1.

4 Near the end · Bank time early.

5 Bring your own permitted calculator (no CAS) · ACT calculator policy.

6 No: all multiple choice · POE always available.

7 Matrices, logarithms (also complex numbers, sequences, counting) · AX lessons.

8 About 15 minutes · MS-8.

One Legal Move

Don't look for the whole solution. Look for one move.

MS-2

LESSON

THE RULE

Hard questions freeze students because they look for the whole solution at once. Instead: what exactly do they want, what do I know, and **what is one legal move** with what I know?

ASK	EXAMPLE
1 • What exactly do they want?	"the value of $2x$," not x
2 • What do I know? Write it down.	line through $(2, 5)$; slope 3
3 • What is one legal move?	plug the point in; set equations equal; write a formula
4 • Did the move help?	if not, try a different move
5 • Answer the question asked	compute $2x$, not x

REMEMBER Circle the target in the stem; it's often not x . Many misses at the top level are right math with the wrong last step (finding x when they asked for $3x - 1$).

WORKED EXAMPLES

- "If $3x + 6 = 21$, what is $x + 2$?" One move: $3x + 6 = 3(x + 2) = 21$, so $x + 2 = 7$. No need to find x .
- "A line through $(2, 5)$ has slope 3. y-intercept?" One move: $5 = 3(2) + b \rightarrow b = -1$.
- " $f(x) = x^2 - 4$, $f(a) = 12$, $a > 0$." One move: $a^2 - 4 = 12 \rightarrow a = 4$.
- Stuck? Write any formula that involves what they ask for.

TRAPS

- ~~✗ Solving for x when they asked for $2x$~~ ✓ Circling the target first
- ~~✗ Staring at the problem~~ ✓ Writing down what you know
- ~~✗ Starting with heavy algebra~~ ✓ Looking for a shortcut: factor, substitute

DRILL HABIT

For 10 hard questions, write only the first move of each in 60 seconds. Then solve the ones where your first move was right.

TRY IT

- 1 If $4x - 8 = 20$, what is $x - 2$?
- 2 If $2a + 3b = 12$, what is $4a + 6b$?
- 3 A line through $(1, 4)$ has slope 2. What is its y-intercept?

ANSWERS 1 5 · 2 24 · 3 2

One Legal Move: Drill

10 original questions. Answer all of them before checking.

MS-2

DRILL

- 1 If $5x + 10 = 45$, what is $x + 2$?
- 2 If $3a - 6b = 21$, what is $a - 2b$?
- 3 A line through $(3, 7)$ has slope 2. y-intercept?
- 4 If $2x - 3 = 11$, what is $6x - 9$?
- 5 If $x/4 = 6$, what is $x/2$?
- 6 $f(x) = 3x^2$; $f(a) = 48$, $a > 0$. a ?
- 7 If $x + y = 10$ and $x - y = 2$, what is $x^2 - y^2$?
- 8 If $4n = 7$, what is $12n + 1$?
- 9 What should you circle first in every stem?
- 10 If $(x + 3)^2 = 49$ and $x > 0$, what is x ?

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ANSWERS

1 $9 \cdot 5(x + 2) = 45$.

2 $7 \cdot$ Divide by 3.

3 $1 \cdot 7 = 2(3) + b$.

4 $33 \cdot 3(2x - 3)$.

5 $12 \cdot$ Double it.

6 $4 \cdot a^2 = 16$.

7 $20 \cdot (x + y)(x - y)$.

8 $22 \cdot 3(4n) + 1$.

9 What they ask for · Often not x .

10 $4 \cdot x + 3 = 7$.

Swap in Numbers

Turn variables into numbers you can see.

MS-3

LESSON

THE RULE

When the question and choices are full of variables, replace them with simple numbers of your own. Solve with your numbers to get a **target**, then test each choice with the same numbers. The choice that hits the target wins.

STEP	EXAMPLE: A price p rises 20%, then falls 20%. New price?
1 • Pick easy numbers	$p = 100$
2 • Solve for a target	$100 \rightarrow 120 \rightarrow 96$. Target: 96
3 • Test every choice	(A) $p \rightarrow 100$ (B) $0.96p \rightarrow 96$ (C) $1.04p \rightarrow 104$ (D) $0.8p \rightarrow 80$
4 • Keep the match	B

REMEMBER Pick numbers that are easy but not special: avoid 0 and 1 (they make many expressions equal), and use different numbers for different variables. If two choices hit the target, try a second set.

WORKED EXAMPLES

- Percent questions: start with 100.
- Expressions in x : try $x = 2$ or 3.
- “Must be true” questions: test several numbers, including negatives and fractions.
- Variables in the choices + “equivalent” = make up numbers, or graph both on your graphing calculator.

TRAPS

- ~~X Picking $x = 0$ or 1~~ ✓ **Picking 2, 3 or 5**
- ~~X Different numbers for the target and the choices~~ ✓ **The same numbers throughout**
- ~~X Stopping at the first match~~ ✓ **Checking all four**

DRILL HABIT

Solve 10 “which expression is equivalent” questions twice: once with algebra, once with your own numbers. Time both.

TRY IT

- 1 n is an integer. Which must be even? (A) $n + 1$ (B) $2n + 1$ (C) n^2 (D) $n^2 + n$
- 2 A car travels m miles in h hours. Its speed in miles per minute? (A) $60m/h$ (B) $m/(60h)$ (C) $60h/m$ (D) $mh/60$
- 3 Which is equivalent to $(x + 3)^2 - 9$? (A) x^2 (B) $x^2 + 6x$ (C) $x^2 + 9$ (D) $x^2 - 6x$

ANSWERS 1 D ($n^2 + n = n(n + 1)$) • 2 B • 3 B

Swap in Numbers: Drill

10 original questions. Answer all of them before checking.

MS-3

DRILL

- 1 A price rises 10%, then 10% again. Single equivalent change?
(A) 20% (B) 21% (C) 11% (D) 19%
- 2 n is odd. Which must be even?
(A) $n + 2$ (B) $3n$ (C) $n + 1$ (D) n^2
- 3 Which equals $(x + 2)^2 - 4$?
(A) x^2 (B) $x^2 + 4$ (C) $x^2 - 4x$ (D) $x^2 + 4x$
- 4 A worker earns d dollars per hour. Pay for m minutes?
(A) $60dm$ (B) $60d/m$ (C) dm (D) $dm/60$
- 5 Price p falls 50%, then rises 50%. Result?
(A) $0.75p$ (B) p (C) $0.5p$ (D) $1.25p$
- 6 Which is equivalent to $(a + b)^2 - (a - b)^2$?
(A) $2ab$ (B) $4ab$ (C) 0 (D) $2a^2$
- 7 Why avoid picking $x = 0$ or 1 ?
- 8 If k is a positive integer, which is always divisible by 3?
(A) $3k + 1$ (B) $k + 3$ (C) $k(k + 1)(k + 2)$ (D) k^2
- 9 A tank fills in h hours. Fraction filled per minute?
(A) $60/h$ (B) $h/60$ (C) $60h$ (D) $1/(60h)$
- 10 Which equals $x(x + 5) - 5x$?
(A) x^2 (B) $x^2 - 5$ (C) $x^2 + 10x$ (D) $5x$

WHERE TO PRACTICE · FREE

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ANSWERS

- 1 B · $100 \rightarrow 110 \rightarrow 121$.
- 2 C · Try $n = 3$.
- 3 D · Try $x = 1$: 5.
- 4 D · $d = 60$, $m = 30 \rightarrow 30$.
- 5 A · $100 \rightarrow 50 \rightarrow 75$.
- 6 B · $a = 2$, $b = 1$: $9 - 1 = 8$.
- 7 They make many expressions equal · Use 2, 3 or 5.
- 8 C · Three consecutive integers.
- 9 D · $h = 1 \rightarrow 1/60$.
- 10 A · Expand.

Work Backward

Start from the choices.

MS-4

LESSON

THE RULE

When the question asks for a number and the choices are numbers, test the choices in the problem. Start with a middle value; if it's too big or too small, you'll know which way to go.

USE IT WHEN...

EXAMPLE

The question asks for one value

"What is the value of x ?"

The choices are numbers

(A) 2 (B) 4 (C) 6 (D) 8

Setting up the equation is hard

ages, mixtures, ticket sales

Checking any answer

plug it back into the original

REMEMBER Choices are usually in order, so test B or C first; the result often tells you whether to go higher or lower. Plugging in also catches extraneous solutions automatically (AM-6, AM-7).

WORKED EXAMPLES

- "The sum of three consecutive integers is 84. Smallest?" (A) 26 (B) 27 (C) 28 (D) 29 $\rightarrow 27 + 28 + 29 = 84 \checkmark \rightarrow B$.
- " $\sqrt{x+7} = x - 5$. x ?" (A) 2 (B) 9 (C) 11 (D) 16 $\rightarrow x = 9: \sqrt{16} = 4 = 9 - 5 \checkmark \rightarrow B$.
- If B gives a result that's too small, jump to C or D.
- a graphing calculator alternative: graph both sides and read the intersection.

TRAPS

- ~~X Always testing A first~~ $\checkmark$ **Starting in the middle**
- ~~X Plugging into your rearranged equation~~ $\checkmark$ **Plugging into the original**
- ~~X Using it when choices are expressions~~ $\checkmark$ **Making up numbers instead (MS-3)**

DRILL HABIT

Do 10 word problems by plugging in the answers only. Note which were faster than algebra.

TRY IT

- 1 A number tripled, then decreased by 7, equals 32. Number? (A) 11 (B) 13 (C) 15 (D) 17
- 2 $x^2 - 5x = 24$ and $x > 0$. x ? (A) 3 (B) 6 (C) 8 (D) 12
- 3 Adult tickets cost \$12 and child tickets \$8. Ten tickets cost \$104. How many adult tickets? (A) 4 (B) 5 (C) 6 (D) 7

ANSWERS 1 B · 2 C · 3 C

Work Backward: Drill

10 original questions. Answer all of them before checking.

MS-4

DRILL

- 1 Three consecutive even integers sum to 78. Smallest?
(A) 22 (B) 28 (C) 24 (D) 26
- 2 $\sqrt{x + 11} = x - 1$. x ?
(A) 5 (B) 10 (C) 7 (D) 1
- 3 $2^x + 2^x = 64$. x ?
(A) 5 (B) 6 (C) 32 (D) 4
- 4 A number doubled, plus 9, equals 41. Number?
(A) 20 (B) 16 (C) 14 (D) 18
- 5 $x^2 - 3x = 40$, $x > 0$. x ?
(A) 10 (B) 8 (C) 5 (D) 13
- 6 Pens cost \$3, notebooks \$5; 12 items cost \$44. Notebooks?
(A) 8 (B) 6 (C) 2 (D) 4
- 7 $(x + 4)/(x - 2) = 3$. x ?
(A) 7 (B) 5 (C) 9 (D) 3
- 8 Why start with B or C?
- 9 $3^{x+1} = 81$. x ?
(A) 4 (B) 27 (C) 2 (D) 3
- 10 Ana is 3 times as old as Ben; in 6 years she'll be twice his age. Ben's age now?
(A) 6 (B) 12 (C) 4 (D) 8

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ANSWERS

1 C · $24 + 26 + 28$.

2 A · $\sqrt{16} = 4$.

3 A · $2 \cdot 32 = 64$.

4 B · $2(16) + 9$.

5 B · $64 - 24 = 40$.

6 D · 8 pens \$24 + 4 notebooks \$20.

7 B · $9/3$.

8 Choices are in order; the result tells you to go up or down · Halves the work.

9 D · 3^4 .

10 A · $18 + 6 = 2(6 + 6)$.

Sketch It

If there's no picture, make one.

MS-5

LESSON

THE RULE

If a question describes a shape, a graph, a path or a situation without a picture, draw one. If there is a picture, **add everything you know to it**. Most geometry misses come from working in your head.

SITUATION	DRAW
Geometry with no figure	Sketch it; label every given length and angle
"Not drawn to scale"	Redraw it; don't trust appearances
Points and lines	Quick axes; plot the points
Motion or distance	A line with start, end and distances
Circles	Center, radius, and the triangle two radii make
Ratios and percents	A bar split into parts

REMEMBER You get scratch paper on test day: use it. Labeling a figure with every given and every value you work out turns many "hard" geometry questions into one-step questions.

WORKED EXAMPLES

- "A rectangle's diagonal is 13 and one side is 5. Area?" Draw: 5-12-13 → area 60.
- "Distance from A(1, 2) to B(7, 10)?" Draw the right triangle: legs 6 and 8 → 10.
- "Isosceles triangle, vertex angle 40° ." Draw: base angles $(180 - 40)/2 = 70^\circ$ each.
- "A 10-ft ladder's base is 6 ft from a wall. Height?" Draw: 6-8-10 → 8 ft.

TRAPS

- ~~X Solving geometry in your head~~ ✓ **Drawing and labeling**
- ~~X Trusting a figure marked "not to scale"~~ ✓ **Using only the given facts**
- ~~X Skipping the sketch to save time~~ ✓ **A 10-second sketch saves a minute**

DRILL HABIT

For every geometry question this week, draw before you calculate, even when there's a figure. Label everything.

TRY IT

- 1 A square has diagonal $6\sqrt{2}$. Area?
- 2 Distance between $(-2, 1)$ and $(4, 9)$?
- 3 A triangle's angles are in the ratio 1 : 2 : 3. Largest angle?

ANSWERS 1 36 · 2 10 · 3 90°

Sketch It: Drill

10 original questions. Answer all of them before checking.

MS-5

DRILL

- 1 Rectangle with diagonal 10 and one side 6. Area?
- 2 Distance from (2, 3) to (8, 11)?
- 3 Isosceles triangle, base angles 65° . Vertex angle?
- 4 A 13-ft ladder reaches 12 ft up a wall. Base distance?
- 5 Square with diagonal $8\sqrt{2}$. Area?
- 6 Walk 3 km north, then 4 km east. Straight-line distance from start?
- 7 A triangle's angles are in ratio 2 : 3 : 4. Largest angle?
- 8 Equilateral triangle, side 10. Height?
- 9 A figure says "not drawn to scale." What do you trust?
- 10 Circle with radius 5 centered at the origin. Does (3, 4) lie on it?

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ANSWERS

1 48 · 6-8-10.

2 10 · Legs 6 and 8.

3 50° · $180 - 130$.

4 5 ft · 5-12-13.

5 64 · Side 8.

6 5 km · 3-4-5.

7 80° · $180 \times 4/9$.

8 $5\sqrt{3}$ · 30-60-90.

9 Only the given measurements · Redraw it.

10 Yes · $3^2 + 4^2 = 25$.

Your Calculator

Know it cold, and know the rules.

MS-6

LESSON

THE RULE

On the ACT you bring your own calculator for the math test. Graphing calculators are allowed if they meet ACT's calculator policy: **no computer algebra system (CAS)**, and programs with CAS features and all stored documents must be removed. Then practice until graphing, tables and intersections are automatic.

SKILL	HOW TO PRACTICE
Graph and find intersections	solve equations and systems by graphing
Zeros, maximums, minimums	the calculate menu
Tables	test values fast (MS-3, MS-4)
Fractions and exact values	convert decimals to fractions
Trig mode	degrees vs. radians: check before every trig question
Policy check	read ACT's calculator policy before test day

REMEMBER Use the same calculator on every practice test and change the batteries before test day. The calculator is optional, and many questions are faster by hand.

WORKED EXAMPLES

- Solve $x^2 - 5x + 4 = 0$ by graphing: zeros at 1 and 4.
- Intersection of $y = 2x + 1$ and $y = -x + 7$: (2, 5).
- Degree mode: $\sin 30 = 0.5$; in radian mode the calculator gives about -0.988 .
- A table of $f(x) = 2^x$ for $x = 1$ to 6 shows the doubling pattern.

TRAPS

- ~~X Radian mode on a degree question~~ ✓ **Checking the mode**
- ~~X Bringing a CAS calculator~~ ✓ **A permitted graphing calculator**
- ~~X Using the calculator for 3×4~~ ✓ **Mental math for easy arithmetic**

DRILL HABIT

Do 15 algebra questions using only your calculator's graphing features. List the keystrokes you use most.

TRY IT

- 1 Your trig answer is wildly off. What setting do you check first?
- 2 Are CAS calculators allowed?
- 3 Solve $x^2 - 2x - 8 = 0$ by graphing. Zeros?

ANSWERS 1 Degree vs. radian mode · 2 No, and CAS programs and documents must be removed · 3 $x = -2$ and $x = 4$

Your Calculator: Drill

10 original questions. Answer all of them before checking.

MS-6

DRILL

- 1 Your trig answer is wildly off. First setting to check?
- 2 Are CAS calculators allowed on the ACT?
- 3 Is disabling a CAS program enough?
- 4 Solve $x^2 - 6x + 8 = 0$ by graphing. Zeros?
- 5 Intersection of $y = x + 3$ and $y = -2x + 9$?
- 6 Is the calculator required for every question?
- 7 What should you do with batteries before test day?
- 8 Use a table to test choices on $f(x) = 3^x$: $f(4)$?
- 9 Convert 0.375 to a fraction.
- 10 Should you use the same calculator on every practice test?

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ANSWERS

- 1 Degree vs. radian mode · Mode errors.
- 2 No · Computer algebra systems are prohibited.
- 3 No: it must be removed · ACT policy.
- 4 2 and 4 · Read the x-intercepts.
- 5 (2, 5) · Graph both.
- 6 No: many are faster by hand · Use it for messy work.
- 7 Replace them · No dead calculators.
- 8 81 · Table value.
- 9 $\frac{3}{8}$ · Calculator fraction function.
- 10 Yes · Know it cold.

Formulas to Memorize

The ACT gives you none.

MS-7

LESSON

THE RULE

Unlike the SAT, the ACT provides **no formula sheet**. Memorize these until you can write them all from memory in two minutes (the full list is REF-1).

TOPIC	FORMULAS
Lines	slope $(y_2 - y_1)/(x_2 - x_1)$ · $y = mx + b$ · midpoint · distance
Quadratics	the quadratic formula · discriminant · vertex $x = -b/2a$
Area	rectangle lw · triangle $\frac{1}{2}bh$ · trapezoid $\frac{1}{2}(b_1 + b_2)h$ · circle πr^2
Circles	circumference $2\pi r$ · arcs and sectors · $(x - h)^2 + (y - k)^2 = r^2$
Volume	prism lwh · cylinder $\pi r^2 h$ · sphere $(4/3)\pi r^3$ · cone $(1/3)\pi r^2 h$
Triangles	Pythagorean theorem · 30-60-90 and 45-45-90 · angles sum to 180°
Trig	SOH-CAH-TOA · $\sin^2 \theta + \cos^2 \theta = 1$ · laws of sines and cosines
Counting and data	mean, median · nPr , nCr · probability

REMEMBER Write them from memory every day for two weeks. On test day, once the math test begins, you can jot the ones you worry about on your scratch paper or in the margin of your test booklet.

WORKED EXAMPLES

- Trapezoid with bases 6 and 10, height 4 → 32
- Sphere with $r = 3$ → 36π
- A 90° arc in a circle of radius 4 → 2π
- 5 choose 2 → 10

TRAPS

- ✗ Counting on a formula sheet ✓ Memorizing
- ✗ Mixing up a circle's area and circumference ✓ πr^2 vs. $2\pi r$
- ✗ Forgetting the $\frac{1}{2}$ for triangles and trapezoids ✓ $\frac{1}{2}bh$, $\frac{1}{2}(b_1 + b_2)h$

DRILL HABIT

Blank-page drill: write every formula here from memory in two minutes, check against REF-1, and repeat daily.

TRY IT

- 1 Area of a trapezoid with bases 5 and 9 and height 6?
- 2 Volume of a cone with $r = 3$ and $h = 5$?
- 3 Circumference of a circle with diameter 10?
- 4 Distance between (1, 2) and (4, 6)?

ANSWERS 1 42 · 2 15π · 3 10π · 4 5

Formulas to Memorize: Drill

10 original questions. Answer all of them before checking.

- 1 Area of a trapezoid with bases 4 and 10, height 5?
- 2 Volume of a sphere with radius 6?
- 3 Volume of a cone with $r = 4$, $h = 9$?
- 4 Distance between $(-1, 3)$ and $(5, 11)$?
- 5 Midpoint of $(2, -4)$ and $(8, 6)$?
- 6 Circumference of a circle with radius 7?
- 7 $\sin^2\theta + \cos^2\theta = ?$
- 8 nCr : 6 choose 3?
- 9 Vertex x-coordinate of $y = 2x^2 - 12x + 5$?
- 10 Sum of interior angles of a hexagon?

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ANSWERS

1 $35 \cdot \frac{1}{2}(4 + 10)(5)$.

2 $288\pi \cdot (4/3)\pi \cdot 216$.

3 $48\pi \cdot (1/3)\pi \cdot 16 \cdot 9$.

4 $10 \cdot 6 \cdot 8 \cdot 10$.

5 $(5, 1)$ · Average.

6 $14\pi \cdot 2\pi r$.

7 1 · Pythagorean identity.

8 $20 \cdot 6!/(3!3!)$.

9 $3 \cdot -b/2a$.

10 $720^\circ \cdot (6 - 2)180$.

ACT Math Pacing

Fast early, careful late, no blanks.

MS-8

LESSON

THE RULE

Fifty minutes for 45 questions. Because questions tend to get harder, budget unevenly: about **15 minutes for questions 1–20**, about 20 for 21–35, and about 15 for 36–45. Mark anything taking over two minutes and come back.

QUESTIONS	TARGET TIME	STRATEGY
1–20	~15 min (about 45 sec each)	fast and careful: these are your points
21–35	~20 min	full method; the toolbox (MS-2 to MS-5)
36–45	~15 min	the hardest; skip and return if stuck
Final minute	—	fill every blank

REMEMBER Every correct answer counts the same toward your raw score, hard or easy. Never let one hard question cost you three easy ones.

WORKED EXAMPLES

- Clock check at Q20: about 15 minutes used.
- Q27 takes two minutes with no path: mark it, guess, move on.
- Q40 is a matrix question you know: do it before a hard word problem.
- Last minute: answer every blank.

TRAPS

- ~~X~~ Equal time on every question ✓ **Fast early, slow late**
- ~~X~~ Fighting one question for four minutes ✓ **Marking it at about two**
- ~~X~~ Leaving blanks ✓ **Every question answered**

DRILL HABIT

Take one timed math test with clock checks at questions 20 and 35. Note where you were ahead or behind.

TRY IT

- 1 About how many minutes for questions 1–20?
- 2 Are hard questions worth more on the ACT?
- 3 When do you mark a question and move on?

ANSWERS 1 About 15 · 2 No: each counts the same · 3 After about two minutes without a clear path

ACT Math Pacing: Drill

8 original questions. Answer all of them before checking.

MS-8

DRILL

- 1 Target time for questions 1–20?
- 2 Questions 21–35?
- 3 Questions 36–45?
- 4 When do you mark and move?
- 5 Are hard questions worth more raw points?
- 6 Final minute?
- 7 Clock check points?
- 8 With four choices, how does eliminating one change a guess?

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 About 15 minutes · Fast and careful.

2 About 20 minutes · Full method.

3 About 15 minutes · The hardest.

4 After about two minutes with no clear path · Come back later.

5 No: each counts the same · Don't trade three easy ones for one hard one.

6 Fill every blank · No penalty.

7 After questions 20 and 35 · On track?

8 From 1 in 4 to 1 in 3 · POE pays.

The Myth of Natural Talent, and How to Actually Study



JOSEF AIDEN DURAND
FROM THE AUTHOR

"I'm just not a math person." I've heard it a thousand times, and it has never once been true. Some people started earlier, practiced more, or had better teachers. That's an explanation, not a destiny.

Most students study wrong. They do page after page of questions, check the answers, feel good about the right ones, and move on. The misses, the only questions that could teach them anything, get a glance and a shrug. Then they miss the same kind of question on test day.

Study right instead. Learn one skill at a time. Practice it with questions at the right difficulty. Then spend real time on every miss: prove why the right answer is right, name why yours was wrong, and redo the question three days later, a week later, and three weeks later, from scratch. That last part feels slow. It's the fastest thing you can do.

Talent is what we call the results of practice we didn't see. Go build some.

Linear Equations in One Variable

Isolate x , and know when there's no solution.

THE RULE

Solve by doing the same thing to both sides until x is alone: distribute, combine like terms, move variables to one side, divide. Some equations have **no solution** or **infinitely many**.

CASE	WHAT HAPPENS	EXAMPLE
One solution	$x = \text{a number}$	$3x + 4 = 19 \rightarrow x = 5$
No solution	the variables cancel; a false statement	$2x + 3 = 2x + 7 \rightarrow 3 = 7$
Infinitely many	the variables cancel; a true statement	$2(x + 3) = 2x + 6 \rightarrow 6 = 6$
Fractions	multiply by the common denominator first	$x/3 + x/2 = 10 \rightarrow 2x + 3x = 60 \rightarrow x = 12$
"No solution" questions	same x -coefficient, different constant	$ax + 5 = 3x + 2$ has none when $a = 3$

REMEMBER For "how many solutions" questions, compare coefficients: same x -coefficient and same constant = infinitely many; same x -coefficient, different constant = none; different x -coefficients = exactly one.

WORKED EXAMPLES

- $4(x - 1) = 2x + 10 \rightarrow 4x - 4 = 2x + 10 \rightarrow 2x = 14 \rightarrow x = 7$
- $3x/4 = 9 \rightarrow x = 12$
- $6x + 2 = 2(3x + 1) \rightarrow \text{infinitely many}$
- $ax + 7 = 5x - 1$ has no solution $\rightarrow a = 5$

TRAPS

- ~~$4(x - 1) = 4x - 1$~~ ✓ $4x - 4$ (distribute to every term)
- ~~$-(x - 3) = -x - 3$~~ ✓ $-x + 3$
- ~~$\text{Dividing only one term by 2}$~~ ✓ **Dividing every term**

DRILL HABIT

Twenty linear equations by hand, timed: target under 40 seconds each. Check each by substituting.

TRY IT

- 1 $5(x - 2) = 3x + 6$. x ?
- 2 For what k does $4x + k = 4x - 9$ have infinitely many solutions?
- 3 $7x - 3 = 7x + c$ has no solution. Give one possible c .
- 4 $(2x + 1)/3 = x - 1$. x ?

ANSWERS 1 8 · 2 -9 · 3 Any $c \neq -3$ · 4 4

Linear Equations in One Variable: Drill

10 original questions. Answer all of them before checking.

- 1 $3(x - 4) = x + 6$. x ?
- 2 $x/5 + 2 = 6$. x ?
- 3 $2(x + 3) = 2x + k$ has infinitely many solutions. k ?
- 4 $5x + 1 = 5x + c$ has no solution. Which c works: 1 or 4?
- 5 $(x + 4)/2 = x - 1$. x ?
- 6 $7 - 2x = 3x - 8$. x ?
- 7 $ax + 3 = 4x - 5$ has no solution. a ?
- 8 $0.4x = 12$. x ?
- 9 $x/3 - x/6 = 2$. x ?
- 10 $4(2x - 1) - 3(x + 2) = 5$. x ?

WHERE TO PRACTICE · FREE

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Extra reps · Khan Academy (free) · Algebra 1

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ANSWERS

1 $9 \cdot 3x - 12 = x + 6$.

2 $20 \cdot x/5 = 4$.

3 $6 \cdot$ Same constant.

4 $4 \cdot$ Different constant.

5 $6 \cdot x + 4 = 2x - 2$.

6 $3 \cdot 15 = 5x$.

7 $4 \cdot$ Same coefficient.

8 $30 \cdot 12/0.4$.

9 $12 \cdot x/6 = 2$.

10 $3 \cdot 5x - 10 = 5$.

Linear Functions and Slope

Rate of change and starting value.

THE RULE

A linear function changes by the same amount for every step in x . In $y = mx + b$, m is the slope (rate of change) and b is the y -intercept (starting value).

Slope = rise/run = $(y_2 - y_1)/(x_2 - x_1)$.

IDEA	FORMULA OR MEANING
Slope from two points	$m = (y_2 - y_1)/(x_2 - x_1)$
Slope-intercept form	$y = mx + b$
Point-slope form	$y - y_1 = m(x - x_1)$
Parallel lines	same slope
Perpendicular lines	negative reciprocal slopes (2 and $-1/2$)
In a word problem	m = rate per unit; b = starting amount or fixed fee
Horizontal / vertical	$y = c$ has slope 0; $x = c$ has undefined slope

REMEMBER Word problems test interpretation: in $C = 45h + 60$, 45 is the cost per hour and 60 is the fixed cost (the cost when $h = 0$).

WORKED EXAMPLES

- (1, 5) and (4, 14): $m = 9/3 = 3$
- Parallel to $y = -2x + 7$ through (1, 1): $y = -2x + 3$
- A 500-liter tank drains 20 liters per minute: $V = 500 - 20t$
- Table $x = 0, 1, 2 \rightarrow y = 7, 10, 13$: $y = 3x + 7$

TRAPS

- ~~X~~ Slope = run/rise ☒ rise/run
- ~~X~~ Perpendicular to slope 2 is ~~-2~~ ☒ $-1/2$
- ~~X~~ Reading the intercept as the rate ☒ The rate is the coefficient of x

DRILL HABIT

Write the equation of a line from 10 tables and 10 word problems. Say what m and b mean in words each time.

TRY IT

- 1 Slope through (2, 3) and (6, 11)?
- 2 Slope of a line perpendicular to $y = 4x - 1$?
- 3 $C = 15m + 40$ dollars for m months. What does 40 represent?
- 4 Line through (0, -2) with slope 3?

ANSWERS 1 $2 \cdot 2 - 1/4 \cdot 3$ A one-time starting fee of \$40 $\cdot 4 y = 3x - 2$

Linear Functions and Slope: Drill

10 original questions. Answer all of them before checking.

- 1 Slope through (1, 2) and (5, 14)?
- 2 Slope perpendicular to $y = -3x + 1$?
- 3 Line parallel to $y = 4x - 2$ through (0, 5)?
- 4 $C = 12h + 30$ (cost for h hours). Meaning of 12?
- 5 Same model: meaning of 30?
- 6 Table: $x = 0, 2, 4 \rightarrow y = 5, 11, 17$. Equation?
- 7 A 400-gallon tank drains 25 gallons per minute. When is it empty?
- 8 Line through (2, 9) with slope -2 . y -intercept?
- 9 Slope of a horizontal line?
- 10 $f(x) = 7 - 2x$. f increases or decreases as x increases?

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ANSWERS

- 1 $3 \cdot 12/4$.
- 2 $1/3$ · Negative reciprocal.
- 3 $y = 4x + 5$ · Same slope.
- 4 Cost per hour · The rate.
- 5 Fixed fee (cost at 0 hours) · The intercept.
- 6 $y = 3x + 5$ · Slope $6/2$.
- 7 16 minutes · $400/25$.
- 8 $13 \cdot 9 = -4 + b$.
- 9 0 · No rise.
- 10 Decreases · Negative slope.

Linear Equations in Two Variables

Every solution is a point on the line.

AL-3

LESSON

THE RULE

An equation like $3x + 2y = 12$ describes a line: every (x, y) that makes it true is a point on the line. Know how to switch forms, find intercepts, and **model two-item word problems**.

FORM OR TASK	HOW
Standard form $Ax + By = C$	slope = $-A/B$
x-intercept	set $y = 0$
y-intercept	set $x = 0$
Is a point on the line?	plug it in: true means yes
Two-item word problem	$(\text{price}_1)(\text{count}_1) + (\text{price}_2)(\text{count}_2) = \text{total}$
Which combination works?	test the choices in the equation

REMEMBER Model: pencils at \$2 and pens at \$5 cost \$40 in total $\rightarrow 2x + 5y = 40$. If 10 pencils were bought: $20 + 5y = 40 \rightarrow y = 4$ pens.

WORKED EXAMPLES

- $2x + 3y = 12 \rightarrow$ y-intercept 4, x-intercept 6
- The slope of $6x + 3y = 9$ is -2
- Small boxes hold 4 books, large boxes 10; 58 books fill 7 boxes $\rightarrow 4s + 10l = 58$ and $s + l = 7$
- $y = (2/3)x - 4$ in standard form: $2x - 3y = 12$

TRAPS

- ~~X~~ Slope of $Ax + By = C$ as A/B ✓ $-A/B$
- ~~X~~ Mixing up which variable is which item ✓ Define x and y in words first
- ~~X~~ Setting $x = 0$ for the x-intercept ✓ Set $y = 0$

DRILL HABIT

Translate 10 two-item word problems into equations before solving any of them.

TRY IT

- 1 Slope of $4x - 2y = 10$?
- 2 x-intercept of $3x + 5y = 30$?
- 3 Adult tickets cost \$9, child \$6, total \$72. With 4 adult tickets, how many child tickets?
- 4 Is $(2, -1)$ on $5x + 3y = 7$?

ANSWERS 1 2 · 2 10 · 3 6 · 4 Yes ($10 - 3 = 7$)

Linear Equations in Two Variables: Drill

10 original questions. Answer all of them before checking.

- 1 Slope of $6x + 2y = 10$?
- 2 x-intercept of $4x - 5y = 20$?
- 3 y-intercept of $4x - 5y = 20$?
- 4 Is $(3, 1)$ on $2x + 3y = 9$?
- 5 Apples \$2, pears \$3, total \$24, 6 apples. Pears?
- 6 Write $y = -(1/2)x + 3$ in standard form with integers.
- 7 Small vans hold 8, large hold 12; 10 vans carry 100. Large vans?
- 8 Slope of $3x - y = 7$?
- 9 Which point is on $y = 2x - 3$: $(2, 1)$ or $(1, 2)$?
- 10 Tickets: adult \$10, child \$4. Total \$70 with 5 adults. Children?

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ANSWERS

1 -3 · $-A/B$.

2 5 · $y = 0$.

3 -4 · $x = 0$.

4 Yes · $6 + 3 = 9$.

5 $4 \cdot 12 + 3p = 24$.

6 $x + 2y = 6$ · Multiply by 2.

7 $5 \cdot 8s + 12l = 100$, $s + l = 10$.

8 3 · $y = 3x - 7$.

9 $(2, 1)$ · $4 - 3 = 1$.

10 $5 \cdot 50 + 4c = 70$.

Systems of Linear Equations

Two equations, one point (or none, or infinitely many).

AL-4

LESSON

THE RULE

A system is two equations that must both be true. Solve by **substitution**, **elimination**, or **graphing**. Know how many solutions a system has without solving it.

METHOD OR CASE	HOW OR WHEN
Substitution	one variable is already alone ($y = 2x + 1$)
Elimination	add or subtract equations to cancel a variable
a graphing calculator	graph both; read the intersection
Exactly one solution	different slopes
No solution	same slope, different intercepts (parallel lines)
Infinitely many	the same line (one equation is a multiple of the other)

REMEMBER Shortcut: if they ask for $x + y$ or $6x + 4y$, adding or subtracting the equations may give it directly, without solving for each variable.

WORKED EXAMPLES

- $y = 2x$ and $3x + y = 15 \rightarrow 5x = 15 \rightarrow x = 3, y = 6$
- $x + 2y = 8$ and $x - 2y = 0 \rightarrow$ add: $2x = 8 \rightarrow x = 4$
- $y = 3x + 1$ and $y = 3x - 5 \rightarrow$ parallel $\rightarrow$ no solution
- $2x + y = 5$ and $4x + 2y = 10 \rightarrow$ same line $\rightarrow$ infinitely many

TRAPS

- ~~X Stopping at x when they ask for y~~ ✓ **Answering what they ask**
- ~~X Subtracting only part of an equation~~ ✓ **Subtracting every term**
- ~~X Assuming different intercepts means one solution~~ ✓ **Comparing slopes first**

DRILL HABIT

Solve 10 systems three ways: substitution, elimination, a graphing calculator. Note which is fastest for each type.

TRY IT

- 1 $x + y = 10$ and $x - y = 4$. x ?
- 2 $2x + 3y = 13$ and $x = y + 4$. y ?
- 3 For what k do $3x + ky = 6$ and $6x + 4y = 12$ have infinitely many solutions?
- 4 $4x + y = 9$ and $2x + 3y = 7$. What is $6x + 4y$?

ANSWERS 1 7 · 2 1 · 3 2 · 4 16

Systems of Linear Equations: Drill

10 original questions. Answer all of them before checking.

- 1 $x + y = 12$ and $x - y = 4$. x ?
- 2 $y = 3x$ and $2x + y = 20$. y ?
- 3 $2x + 3y = 12$ and $2x - y = 4$. y ?
- 4 $y = 2x + 5$ and $y = 2x - 1$. Solutions?
- 5 $3x + 2y = 6$ and $6x + 4y = 12$. Solutions?
- 6 For what k do $x + ky = 4$ and $2x + 6y = 8$ have infinitely many solutions?
- 7 $5x + y = 13$ and $3x + 3y = 15$. What is $8x + 4y$?
- 8 $x = 2y$ and $x + y = 15$. x ?
- 9 $4x - y = 7$ and $x + y = 8$. x ?
- 10 When does a system have exactly one solution?

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

- 1 8 · Add: $2x = 16$.
2 12 · $5x = 20$.
3 2 · Subtract: $4y = 8$.
4 None · Parallel.
5 Infinitely many · Same line.
6 3 · Double the first.
7 28 · Add the equations.
8 10 · $3y = 15$.
9 3 · Add: $5x = 15$.
10 Different slopes · Lines cross once.

Linear Inequalities

Like equations, with one twist.

THE RULE

Solve inequalities like equations, with one extra rule: **multiplying or dividing by a negative flips the sign**. On a graph, $<$ and $>$ use a dashed line; $\leq$ and $\geq$ use a solid line, with the solutions shaded.

IDEA	EXAMPLE
Solve	$3x - 5 < 10 \rightarrow x < 5$
Flip when dividing by a negative	$-2x \geq 8 \rightarrow x \leq -4$
Word cues	at least $\geq$ · at most $\leq$ · more than $>$ · fewer than $<$
Model	a van holds at most 12 people: $p \leq 12$
Graph $y > 2x + 1$	dashed line, shade above
System of inequalities	the overlap of the shaded regions
Is a point a solution?	plug it into every inequality

REMEMBER Budget problems are the classic: tickets cost \$15 and parking \$10; she can spend at most \$70 $\rightarrow 15t + 10 \leq 70 \rightarrow t \leq 4$.

WORKED EXAMPLES

- $2x + 7 \leq 15 \rightarrow x \leq 4$
- $-x/3 < 2 \rightarrow x > -6$
- $y \leq -x + 4$: solid line, shade below
- Does (2, 3) satisfy $y > x$ and $y < 5$? $3 > 2$ ✓, $3 < 5$ ✓ $\rightarrow$ yes

TRAPS

- ✗ Not flipping after dividing by -2 ✓ Flipping the sign
- ✗ “at least” as $\leq$ ✓ $\geq$
- ✗ A dashed line for $\leq$ ✓ A solid line

DRILL HABIT

Write inequalities for 10 real limits from your life (budget, time, phone storage), then solve them.

TRY IT

- 1 Solve $-3x + 4 > 19$.
- 2 “At least 40 points” as an inequality in p ?
- 3 Is (1, 5) a solution of $y > 3x + 1$?
- 4 Shirts cost \$12 each plus a \$5 fee; the budget is at most \$65. Maximum shirts?

ANSWERS 1 $x < -5$ · 2 $p \geq 40$ · 3 Yes ($5 > 4$) · 4 5

Linear Inequalities: Drill

10 original questions. Answer all of them before checking.

- 1 Solve $4x - 3 < 13$.
- 2 Solve $-2x + 5 \geq 11$.
- 3 “At most 30 students” in s ?
- 4 Is $(2, 7)$ a solution of $y > 3x$?
- 5 Is $(1, 1)$ a solution of $y \geq 2x + 1$?
- 6 Tickets \$12 each plus \$8 parking; budget \$80. Max tickets?
- 7 Graph of $y < x + 2$: line type?
- 8 Solve $x/3 + 1 \leq 5$.
- 9 “More than 50 points” in p ?
- 10 Solve $3 - x > 1$.

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ANSWERS

- 1 $x < 4$ · $4x < 16$.
- 2 $x \leq -3$ · Flip when dividing by -2 .
- 3 $s \leq 30$ · At most = $\leq$.
- 4 Yes · $7 > 6$.
- 5 No · $1 < 3$.
- 6 $6 \cdot 12t + 8 \leq 80$.
- 7 Dashed · Strict inequality.
- 8 $x \leq 12$ · $x/3 \leq 4$.
- 9 $p > 50$ · Strict.
- 10 $x < 2$ · $-x > -2$.

Exponents and Radicals

Rewrite until it matches.

AM-1

LESSON

THE RULE

Exponent rules let you rewrite expressions to match the choices. Radicals are fractional exponents: $\sqrt{x} = x^{1/2}$, $\sqrt[3]{x} = x^{1/3}$.

RULE	EXAMPLE
$x^a \cdot x^b = x^{a+b}$	$x^3 \cdot x^4 = x^7$
$x^a \div x^b = x^{a-b}$	$x^6 \div x^2 = x^4$
$(x^a)^b = x^{ab}$	$(x^2)^5 = x^{10}$
$x^0 = 1$	$7^0 = 1$
$x^{-a} = 1/x^a$	$2^{-3} = 1/8$
$x^{a/b} = (\text{b-th root of } x)^a$	$8^{2/3} = (\sqrt[3]{8})^2 = 4$
$\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$	$\sqrt{50} = 5\sqrt{2}$

REMEMBER To solve with different bases, rewrite with a common base: $4^x = 2^{2x}$, $27 = 3^3$. Then set the exponents equal.

WORKED EXAMPLES

- $x^5 \cdot x^{-2} = x^3$
- $16^{3/4} = (\text{fourth root of } 16)^3 = 2^3 = 8$
- $2^x = 32 \rightarrow x = 5$
- $(3a^2b)^3 = 27a^6b^3$

TRAPS

- $\times x^3 \cdot x^4 = x^{12}$ $\checkmark x^7$: add exponents
 $\times (2x)^3 = 2x^3$ $\checkmark 8x^3$
 $\times x^{-2} = x^2$ $\checkmark 1/x^2$

DRILL HABIT

Twenty exponent rewrites in 10 minutes. Check the hard ones on your graphing calculator by graphing both forms.

TRY IT

- Simplify $(2x^3)^2 \cdot x$.
- If $9^x = 3^{x+4}$, what is x ?
- Write $\sqrt[3]{x^2}$ as a power of x .
- Simplify $\sqrt{72}$.

ANSWERS 1 $4x^7$ · 2 4 · 3 $x^{2/3}$ · 4 $6\sqrt{2}$

Exponents and Radicals: Drill

10 original questions. Answer all of them before checking.

AM-1

DRILL

- 1 Simplify $x^4 \cdot x^3$.
- 2 Simplify $(3x^2)^3$.
- 3 $8^{2/3} = ?$
- 4 $5^{-2} = ?$
- 5 $4^x = 2^{x+3}$. $x = ?$
- 6 Simplify $\sqrt{48}$.
- 7 Write $\sqrt{(x^3)}$ as a power of x .
- 8 $x^9 \div x^3 = ?$
- 9 $27^x = 9$. $x = ?$
- 10 $(2a^3b)^2 = ?$

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ANSWERS

- 1 x^7 · Add exponents.
- 2 $27x^6$ · Cube both.
- 3 $4 \cdot (\sqrt[3]{8})^2$.
- 4 $1/25$ · Reciprocal.
- 5 $3 \cdot 2^{2x} = 2^{x+3}$.
- 6 $4\sqrt{3} \cdot 16 \cdot 3$.
- 7 $x^{3/2}$ · Root = $\frac{1}{2}$ power.
- 8 x^6 · Subtract.
- 9 $2/3 \cdot 3^{3x} = 3^2$.
- 10 $4a^6b^2$ · Square each factor.

Polynomials: Factoring and Equivalent Forms

Expand, factor, combine.

AM-2

LESSON

THE RULE

Equivalent-expression questions ask you to expand, factor or combine. Know the common patterns on sight; when in doubt, make up a number (MS-3) or graph both (MS-6).

PATTERN	EXAMPLE
Distribute (FOIL)	$(x + 3)(x - 5) = x^2 - 2x - 15$
Greatest common factor	$6x^2 + 9x = 3x(2x + 3)$
Difference of squares	$a^2 - b^2 = (a + b)(a - b)$
Perfect square	$(a + b)^2 = a^2 + 2ab + b^2$
Trinomial	$x^2 + 7x + 12 = (x + 3)(x + 4)$
Leading coefficient $\neq 1$	$2x^2 + 7x + 3 = (2x + 1)(x + 3)$
Combine like terms	$(3x^2 - 2x) - (x^2 - 5x) = 2x^2 + 3x$

REMEMBER When subtracting a polynomial, distribute the minus to **every** term. That single sign error is the most common miss on this skill.

WORKED EXAMPLES

- $x^2 - 9 = (x + 3)(x - 3)$
- $x^2 + 10x + 25 = (x + 5)^2$
- $x^2 - x - 20 = (x - 5)(x + 4)$
- $(x + a)(x + 4) = x^2 + 9x + 20 \rightarrow a = 5$

TRAPS

- $\times (x + 3)^2 = x^2 + 9$ $\checkmark x^2 + 6x + 9$
 $\times -(x^2 - 5x) = -x^2 - 5x$ $\checkmark -x^2 + 5x$
 $\times x^2 + 9 = (x + 3)(x - 3)$ $\checkmark x^2 + 9$ doesn't factor this way

DRILL HABIT

Factor 30 quadratics, timed. Check five of them on your graphing calculator.

TRY IT

- 1 Factor $x^2 - 49$.
- 2 Expand $(2x - 3)^2$.
- 3 Factor $3x^2 - 12x$.
- 4 Simplify $(4x^2 + x) - (2x^2 - 3x)$.

ANSWERS 1 $(x + 7)(x - 7)$ · 2 $4x^2 - 12x + 9$ · 3 $3x(x - 4)$ · 4 $2x^2 + 4x$

Polynomials: Factoring and Equivalent Forms: **Drill-2**

10 original questions. Answer all of them before checking.

DRILL

- 1 Factor $x^2 - 81$.
- 2 Expand $(x - 4)^2$.
- 3 Factor $x^2 + 9x + 20$.
- 4 Factor $5x^2 - 15x$.
- 5 Factor $2x^2 + 5x - 3$.
- 6 $(3x^2 - x) - (x^2 - 4x) = ?$
- 7 $(x + a)(x + 3) = x^2 + 10x + 21$. $a = ?$
- 8 Expand $(2x + 5)(x - 1)$.
- 9 Does $x^2 + 16$ factor over the real numbers?
- 10 Factor $x^2 - 10x + 25$.

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ANSWERS

- 1 $(x + 9)(x - 9)$ · Difference of squares.
- 2 $x^2 - 8x + 16$ · Perfect square.
- 3 $(x + 4)(x + 5)$ · $4 \cdot 5 = 20$, $4 + 5 = 9$.
- 4 $5x(x - 3)$ · GCF.
- 5 $(2x - 1)(x + 3)$ · Check by FOIL.
- 6 $2x^2 + 3x$ · Distribute the minus.
- 7 $7 \cdot a + 3 = 10$.
- 8 $2x^2 + 3x - 5$ · FOIL.
- 9 No · Sum of squares.
- 10 $(x - 5)^2$ · Perfect square.

Quadratic Equations

Factor, formula, or graph, and the discriminant.

THE RULE

Set the equation equal to 0, then factor, use the quadratic formula, complete the square, or graph. The **discriminant** $b^2 - 4ac$ tells you how many real solutions there are.

TOOL	DETAIL
Factor	$x^2 - 5x + 6 = 0 \rightarrow (x - 2)(x - 3) = 0 \rightarrow x = 2 \text{ or } 3$
Quadratic formula	$x = (-b \pm \sqrt{b^2 - 4ac}) / 2a$
Discriminant > 0	two real solutions
Discriminant $= 0$	exactly one real solution
Discriminant < 0	no real solutions
Sum of the solutions	$-b/a$
Product of the solutions	c/a

REMEMBER Sum and product shortcuts save time: for $2x^2 - 8x + 3 = 0$, the sum of the solutions is $8/2 = 4$, with no solving.

WORKED EXAMPLES

- $x^2 = 4x \rightarrow x^2 - 4x = 0 \rightarrow x(x - 4) = 0 \rightarrow x = 0 \text{ or } 4$
- $2x^2 + 3x - 2 = 0 \rightarrow (2x - 1)(x + 2) = 0 \rightarrow x = 1/2 \text{ or } -2$
- $x^2 - 2x - 1 = 0 \rightarrow x = 1 \pm \sqrt{2}$
- $kx^2 + 4x + 1 = 0$ has one solution $\rightarrow 16 - 4k = 0 \rightarrow k = 4$

TRAPS

- ✗ Dividing $x^2 - 4x$ by x (losing $x = 0$) ✓ Moving everything to one side and factoring
- ✗ A sign error in $-b$ ✓ Writing $-b$ carefully
- ✗ Forgetting the $\pm$ ✓ Two roots unless the discriminant is 0

DRILL HABIT

For 15 quadratics, compute the discriminant first and predict the number of solutions before solving.

TRY IT

- 1 Solve $x^2 + 2x - 15 = 0$.
- 2 How many real solutions does $x^2 + 4x + 7 = 0$ have?
- 3 Sum of the solutions of $3x^2 - 12x + 1 = 0$?
- 4 For what c does $x^2 - 6x + c = 0$ have exactly one solution?

ANSWERS 1 $x = 3$ or -5 2 None ($16 - 28 < 0$) 3 4 4 4 9

Quadratic Equations: Drill

10 original questions. Answer all of them before checking.

- 1 Solve $x^2 - x - 12 = 0$.
- 2 How many real solutions: $x^2 + 2x + 5 = 0$?
- 3 Sum of the solutions of $2x^2 - 10x + 3 = 0$?
- 4 Product of the solutions of $3x^2 + 4x - 12 = 0$?
- 5 For what k does $x^2 + kx + 16 = 0$ have exactly one solution ($k > 0$)?
- 6 Solve $x^2 = 5x$.
- 7 Solve $x^2 - 4x - 2 = 0$.
- 8 Solve $4x^2 - 9 = 0$.
- 9 Discriminant of $x^2 - 6x + 9$?
- 10 Solve $2x^2 + 7x + 3 = 0$.

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ANSWERS

1 4 and $-3 \cdot (x - 4)(x + 3)$.

2 None · $4 - 20 < 0$.

3 $5 \cdot -b/a$.

4 $-4 \cdot c/a$.

5 $8 \cdot k^2 = 64$.

6 0 and $5 \cdot x(x - 5) = 0$.

7 $2 \pm \sqrt{6}$ · Quadratic formula.

8 $\pm 3/2 \cdot x^2 = 9/4$.

9 0 · One solution.

10 $-1/2$ and $-3 \cdot (2x + 1)(x + 3)$.

Parabolas: Graphs and Forms

Each form shows something different.

THE RULE

The graph of a quadratic is a parabola. **Standard form** shows the y-intercept, **factored form** shows the x-intercepts, and **vertex form** shows the vertex.

FORM	SHOWS	EXAMPLE
Standard: $y = ax^2 + bx + c$	y-intercept c; opens up if $a > 0$	$y = x^2 - 6x + 8 \rightarrow$ y-intercept 8
Factored: $y = a(x - p)(x - q)$	x-intercepts p and q	$y = (x - 2)(x - 4) \rightarrow$ 2 and 4
Vertex: $y = a(x - h)^2 + k$	vertex (h, k)	$y = (x - 3)^2 - 1 \rightarrow$ (3, -1)
Axis of symmetry	$x = -b/2a$, halfway between the zeros	$x = 3$
Maximum or minimum	the vertex's y-value	minimum -1

REMEMBER All three examples are the same parabola. A common question: "Which form displays the minimum value as a constant or coefficient?" Answer: vertex form.

WORKED EXAMPLES

- $y = x^2 + 4x + 1 \rightarrow$ vertex $x = -4/2 = -2$, $y = -3$
- Zeros 1 and 5 $\rightarrow$ axis $x = 3$
- $y = -(x - 2)^2 + 9 \rightarrow$ maximum 9 at $x = 2$
- $h = -16t^2 + 32t + 5 \rightarrow$ maximum at $t = 1$: $h = 21$

TRAPS

- ~~X~~ Vertex of $(x + 1)^2$ at $x = 1$ ✓ $x = -1$
- ~~X~~ Zeros of $(x - 7)(x + 3)$ are -7 and 3 ✓ 7 and -3
- ~~X~~ $a < 0$ opens up ✓ $a < 0$ opens down

DRILL HABIT

Write one parabola in all three forms and check on your graphing calculator that they overlap.

TRY IT

- 1 Vertex of $y = 2(x + 1)^2 + 5$?
- 2 Zeros of $y = (x - 7)(x + 3)$?
- 3 Axis of symmetry of $y = x^2 - 10x + 4$?
- 4 Does $y = -3x^2 + 2$ open up or down?

ANSWERS 1 (-1, 5) • 2 7 and -3 • 3 $x = 5$ • 4 Down

Parabolas: Graphs and Forms: Drill

10 original questions. Answer all of them before checking.

AM-4

DRILL

- 1 Vertex of $y = (x - 4)^2 + 1$?
- 2 Zeros of $y = (x + 2)(x - 6)$?
- 3 Axis of symmetry of $y = x^2 + 8x - 1$?
- 4 Minimum value of $y = x^2 - 2x + 7$?
- 5 $y = -2(x - 3)^2 + 10$: opens? maximum?
- 6 y-intercept of $y = 3x^2 - 5x + 2$?
- 7 A ball: $h = -16t^2 + 64t$. Maximum height?
- 8 Which form shows the vertex as constants?
- 9 Zeros at 1 and 7. Axis of symmetry?
- 10 Rewrite $y = x^2 + 6x + 5$ in vertex form.

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ANSWERS

- 1 (4, 1) · Vertex form.
- 2 -2 and 6 · Factored form.
- 3 $x = -4 \cdot -b/2a$.
- 4 6 · At $x = 1$.
- 5 Down; $10 \cdot a < 0$.
- 6 $2 \cdot x = 0$.
- 7 $64 \cdot t = 2$.
- 8 Vertex form · $a(x - h)^2 + k$.
- 9 $x = 4$ · Midpoint.
- 10 $y = (x + 3)^2 - 4$ · Complete the square.

Exponential Functions

Same percent every step.

AM-5

LESSON

THE RULE

Exponential functions grow or shrink by the same **percent** each step: $f(t) = a(b)^t$, where a is the starting value and b is the growth factor. $b > 1$ is growth; $0 < b < 1$ is decay.

SITUATION	MODEL
Grows 5% per year	$a(1.05)^t$
Decays 20% per year	$a(0.80)^t$
Doubles every 3 years	$a(2)^{t/3}$
Halves every 10 hours	$a(1/2)^{t/10}$
Linear vs. exponential	adds the same amount vs. multiplies by the same factor
Reading b	$1.08 \rightarrow 8\%$ increase · $0.92 \rightarrow 8\%$ decrease

REMEMBER Watch the time units: monthly growth with t in years becomes $(1 + r)^{12t}$. “What does 0.92 represent?” wants the factor or percent decrease, not the starting value.

WORKED EXAMPLES

- \$1,000 at 6% per year: $1000(1.06)^t$
- 80 mg of medicine halving every 6 hours: $80(0.5)^{t/6}$; after 12 hours, 20 mg
- Table 3, 6, 12, 24 $\rightarrow$ exponential ($\times 2$)
- Table 3, 6, 9, 12 $\rightarrow$ linear ($+ 3$)

TRAPS

- ~~X~~ Decay of 20% as $(0.20)^t$ ✓ $(0.80)^t$
- ~~X~~ Doubling every 3 years as 2^{3t} ✓ $2^{t/3}$
- ~~X~~ Calling 1.05 a 105% increase ✓ A 5% increase

DRILL HABIT

Write models for 10 real situations (savings, battery drain, population) and say what a and b mean in each.

TRY IT

- 1 A town of 20,000 grows 3% per year. Model?
- 2 $f(t) = 500(0.85)^t$. Percent decrease per step?
- 3 A culture of 100 doubles every 4 hours. Size after 12 hours?
- 4 Is $y = 3x + 2$ linear or exponential?

ANSWERS 1 $P = 20,000(1.03)^t$ · 2 15% · 3 800 · 4 Linear

Exponential Functions: Drill

10 original questions. Answer all of them before checking.

- 1 A town of 10,000 grows 4% a year. Model?
- 2 $f(t) = 200(0.9)^t$. Percent decrease per step?
- 3 50 bacteria double every 3 hours. Count after 9 hours?
- 4 120 mg halves every 4 hours. Amount after 8 hours?
- 5 Table 2, 6, 18, 54: linear or exponential?
- 6 \$500 at 5% a year for 2 years (compounded yearly)?
- 7 $y = 3(1.2)^x$: initial value and growth rate?
- 8 A car worth \$20,000 loses 15% a year. Value factor per year?
- 9 Doubles every 5 years. Exponent form with t in years?
- 10 Table 4, 7, 10, 13: linear or exponential?

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ANSWERS

1 $P = 10,000(1.04)^t$ · Growth factor 1.04.

2 $10\% \cdot 1 - 0.9$.

3 $400 \cdot 50 \cdot 2^3$.

4 $30 \text{ mg} \cdot 120 \cdot \frac{1}{4}$.

5 Exponential · $\times 3$.

6 $\$551.25 \cdot 500 \cdot 1.05^2$.

7 3; $20\% \cdot a$ and $b - 1$.

8 $0.85 \cdot 1 - 0.15$.

9 $2^{t/5}$ · Divide by the doubling time.

10 Linear · $+ 3$ each step.

Rational Expressions and Equations

Fractions with variables.

AM-6

LESSON

THE RULE

To solve a rational equation, multiply every term by the common denominator, solve, then **check**: values that make a denominator zero are not allowed.

TASK	HOW	EXAMPLE
Simplify	factor, then cancel common factors	$(x^2 - 9)/(x - 3) = x + 3, x \neq 3$
Add or subtract	common denominator	$1/x + 1/2 = (2 + x)/(2x)$
Solve	multiply through by the LCD	$3/x = 6/(x + 2) \rightarrow 3x + 6 = 6x \rightarrow x = 2$
Excluded values	denominator = 0	$x/(x - 4): x \neq 4$
Divide polynomials	long division or rewriting	$(x^2 + 5x + 7)/(x + 2) = x + 3 + 1/(x + 2)$

REMEMBER Multiplying by an expression with x can create an extraneous solution, one that makes a denominator zero. Check every solution in the original equation.

WORKED EXAMPLES

- $(2x + 6)/(x + 3) = 2$
- $1/x = 3/(x + 4) \rightarrow x + 4 = 3x \rightarrow x = 2$
- $(x^2 - 1)/(x + 1) = x - 1$
- Work problems: rate = $1/\text{time}$; combined rate = sum of rates

TRAPS

- ~~✗ Cancelling terms, not factors: $(x + 6)/6 = x$~~ ✓ Only factors cancel
- ~~✗ Keeping a solution that zeroes a denominator~~ ✓ Checking every solution
- ~~✗ Adding fractions by adding denominators~~ ✓ A common denominator

DRILL HABIT

Solve 10 rational equations. For each, write the excluded values first.

TRY IT

- 1 Simplify $(x^2 + 5x + 6)/(x + 2)$.
- 2 Solve $4/(x - 1) = 2$.
- 3 Which value is excluded from $5/(2x - 6)$?
- 4 Solve $x/(x - 2) = 2/(x - 2) + 3$.

ANSWERS $1\ x + 3 \cdot 2\ 3 \cdot 3\ 3 \cdot 4$ No solution ($x = 2$ is excluded)

Rational Expressions and Equations: Drill

10 original questions. Answer all of them before checking.

- 1 Simplify $(x^2 - 16)/(x - 4)$.
- 2 Solve $6/x = 2$.
- 3 Excluded value of $7/(3x - 9)$?
- 4 Solve $2/(x + 1) = 1/(x - 1)$.
- 5 Solve $x/(x - 3) = 3/(x - 3) + 2$.
- 6 Simplify $(x^2 + 7x + 12)/(x + 3)$.
- 7 $1/x + 1/(2x) = 3$. x ?
- 8 Pipe A fills a tank in 3 h, pipe B in 6 h. Together?
- 9 Can you cancel the x 's in $(x + 5)/x$?
- 10 Solve $(x + 2)/(x - 1) = 4$.

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ANSWERS

1 $x + 4$ ($x \neq 4$) · Factor and cancel.

2 $3 \cdot 6 = 2x$.

3 $3 \cdot 3x - 9 = 0$.

4 $3 \cdot 2x - 2 = x + 1$.

5 No solution · $x = 3$ is excluded.

6 $x + 4$ · Factor.

7 $1/2 \cdot 3/(2x) = 3$.

8 2 hours · $1/3 + 1/6 = 1/2$.

9 No · Only factors cancel.

10 $2 \cdot x + 2 = 4x - 4$.

Radical and Absolute Value Equations

Square, solve, check.

AM-7

LESSON

THE RULE

Isolate the radical, square both sides, solve, then check: **squaring can create extraneous solutions**. For absolute value, split into two equations.

TYPE	STEPS	EXAMPLE
$\sqrt{\text{expression}} = \text{number}$	square both sides	$\sqrt{x + 3} = 5 \rightarrow x = 22$
$\sqrt{\text{expression}} = \text{expression}$	square, solve, check both	$\sqrt{x + 6} = x \rightarrow x = 3$ ($x = -2$ fails)
$ \text{expression} = n$	expression = n or $-n$	$ x - 4 = 7 \rightarrow x = 11$ or -3
$ \text{expression} < n$	$-n < \text{expression} < n$	$ x < 3 \rightarrow -3 < x < 3$
$ \text{expression} > n$	expression $> n$ or $< -n$	$ x > 3 \rightarrow x > 3$ or $x < -3$

REMEMBER The $\sqrt{}$ symbol means the non-negative root, so $\sqrt{x + 6} = x$ requires $x \geq 0$. That's why $x = -2$ fails: $\sqrt{4} = 2$, not -2 .

WORKED EXAMPLES

- $\sqrt{x + 4} = 9 \rightarrow \sqrt{x} = 5 \rightarrow x = 25$
- $\sqrt{(3x + 1)} = x - 1 \rightarrow 3x + 1 = x^2 - 2x + 1 \rightarrow x(x - 5) = 0 \rightarrow x = 5$ ($x = 0$ fails)
- $|x + 2| = 0 \rightarrow x = -2$ (one solution)
- $|x| = -4 \rightarrow$ no solution

TRAPS

- ~~✗ Squaring before isolating the radical~~ ✓ Isolating first
- ~~✗ Keeping both roots without checking~~ ✓ Checking both
- ~~✗ $|x| = 6 \rightarrow x = 6$ only~~ ✓ $x = 6$ or -6

DRILL HABIT

Solve 10 radical equations; circle the extraneous roots.

TRY IT

- 1 $\sqrt{(2x - 1)} = 3$. x ?
- 2 $|2x + 1| = 9$. Both solutions?
- 3 $\sqrt{(x + 2)} = x$. Solution(s)?
- 4 $|x - 5| \leq 2$. Range of x ?

ANSWERS 1 5 · 2 4 and -5 · 3 2 ($x = -1$ is extraneous) · 4 $3 \leq x \leq 7$

Radical and Absolute Value Equations: Drill

AM-7

DRILL

10 original questions. Answer all of them before checking.

- 1 Solve $\sqrt{x - 2} = 4$.
- 2 Solve $|x + 1| = 6$.
- 3 Solve $\sqrt{x + 12} = x$.
- 4 Solve $|2x - 3| < 5$.
- 5 Solve $\sqrt{x} + 3 = 10$.
- 6 Solve $|x| = -2$.
- 7 Solve $\sqrt{5x - 1} = 3$.
- 8 Solve $\sqrt{2x + 3} = x$.
- 9 Solve $|x - 4| \geq 3$.
- 10 Why check radical solutions?

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ANSWERS

1 $18 \cdot x - 2 = 16$.

2 5 and -7 · Two cases.

3 $4 \cdot x = -3$ is extraneous.

4 $-1 < x < 4$ · $-5 < 2x - 3 < 5$.

5 $49 \cdot \sqrt{x} = 7$.

6 No solution · Absolute value ≥ 0 .

7 $2 \cdot 5x - 1 = 9$.

8 $3 \cdot x = -1$ fails.

9 $x \leq 1$ or $x \geq 7$ · Two rays.

10 Squaring can create extraneous solutions · Plug back in.

Functions and Transformations

Read function notation as instructions.

THE RULE

$f(x)$ is the output of f for input x . Read every function question as an instruction: **replace x with whatever is in the parentheses.**

IDEA	EXAMPLE
Evaluate	$f(x) = 3x - 2 \rightarrow f(4) = 10$
Solve for the input	$f(x) = 13 \rightarrow 3x - 2 = 13 \rightarrow x = 5$
Composition	$f(g(x))$: put $g(x)$ into f
From a graph	$f(2)$ = the y -value at $x = 2$
Shift up or down	$f(x) + k$ moves up k
Shift left or right	$f(x - h)$ moves right h
Reflect	$-f(x)$ flips over the x -axis

REMEMBER Horizontal shifts feel backward: $f(x - 3)$ moves the graph 3 units **right**. Check with one point: if $f(0) = 1$ and $g(x) = f(x - 3)$, then $g(3) = 1$.

WORKED EXAMPLES

- $f(x) = 2x^2 \rightarrow f(a + 1) = 2(a + 1)^2$
- $h(t) = -5t^2 + 20t \rightarrow h(2) = 20$
- $f(x) = 3x$, $g(x) = x - 4$: $g(2) = -2$, so $f(g(2)) = -6$
- f passes through $(1, 4) \rightarrow f(x) - 3$ passes through $(1, 1)$

TRAPS

- ~~$f(x - 3)$ moves left~~ ✓ **It moves right**
- ~~$f(g(x)) = f(x) - g(x)$~~ ✓ **Put g into f**
- ~~$f(2)$ means f times 2~~ ✓ **The output at $x = 2$**

DRILL HABIT

Make a table of $f(x)$ for $x = -2$ to 2 for five functions, apply three transformations to each, and check on your graphing calculator.

TRY IT

- 1 $f(x) = x^2 + 1$. $f(-3)$?
- 2 $g(x) = 2x + 5$. For what x is $g(x) = 17$?
- 3 $f(x) = x + 1$ and $g(x) = x^2$. $f(g(3))$?
- 4 How does $y = f(x + 4) - 2$ move $y = f(x)$?

ANSWERS 1 10 · 2 6 · 3 10 · 4 4 units left, 2 units down

Functions and Transformations: Drill

10 original questions. Answer all of them before checking.

- 1 $f(x) = 2x^2 - 1$. $f(-2)$?
- 2 $g(x) = 4x - 3$. For what x is $g(x) = 13$?
- 3 $f(x) = x + 2$, $g(x) = 3x$. $f(g(4))$?
- 4 $g(f(4))$ for the same functions?
- 5 How does $y = f(x - 5)$ move $y = f(x)$?
- 6 How does $y = f(x) + 3$ move?
- 7 f passes through $(2, 5)$. $y = -f(x)$ passes through?
- 8 $h(t) = -5t^2 + 30t$. $h(3)$?
- 9 $f(x) = x^2$. $f(a + 1) - f(a)$?
- 10 $f(x) = 10 - x$. Solve $f(x) = 2x + 1$.

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ANSWERS

- 1 $7 \cdot 8 - 1$.
- 2 $4 \cdot 4x = 16$.
- 3 $14 \cdot g(4) = 12$.
- 4 $18 \cdot f(4) = 6$.
- 5 5 units right · Opposite of the sign.
- 6 Up 3 · Vertical shift.
- 7 $(2, -5)$ · Reflect over the x-axis.
- 8 $45 \cdot -45 + 90$.
- 9 $2a + 1$ · Expand.
- 10 $3 \cdot 10 - x = 2x + 1$.

Nonlinear Systems

A line meets a curve: 0, 1 or 2 times.

THE RULE

A system with a line and a parabola (or circle) can have 0, 1 or 2 solutions. Solve by substitution, or **graph on your graphing calculator and read the intersections.**

SYSTEM	METHOD	SOLUTIONS
$y = x^2$ and $y = 4$	$x^2 = 4$	2: (2, 4) and (-2, 4)
$y = x^2 + 1$ and $y = 2x$	$(x - 1)^2 = 0$	1: (1, 2)
$y = x^2 + 5$ and $y = x$	$x^2 - x + 5 = 0$, discriminant < 0	0
Line tangent to a parabola	set equal; discriminant = 0	exactly 1

REMEMBER To count solutions without graphing, set the equations equal, move everything to one side, and check the discriminant (AM-3).

WORKED EXAMPLES

- $y = x^2 - 4x$ and $y = 0 \rightarrow x = 0$ or 4
- $x^2 + y^2 = 25$ and $y = 3 \rightarrow x = \pm 4$
- $y = x^2 - 1$ and $y = x + 1 \rightarrow (2, 3)$ and $(-1, 0)$
- $x^2 + 4 = 4x \rightarrow (x - 2)^2 = 0 \rightarrow$ one point

TRAPS

- ~~X~~ Giving only x-values when asked for points ✓ Finding y too
- ~~X~~ Losing the negative root ✓ $\pm$ after a square root
- ~~X~~ Assuming two solutions ✓ Checking the discriminant

DRILL HABIT

Solve 8 nonlinear systems algebraically, then confirm each on your graphing calculator.

TRY IT

- 1 Solve $y = x^2 - 3$ and $y = 2x$.
- 2 How many solutions do $y = x^2$ and $y = -1$ have?
- 3 For what k does $y = x^2 + k$ touch $y = 0$ exactly once?
- 4 $y = x + 2$ and $y = x^2$. Sum of the solutions' x-values?

ANSWERS 1 (3, 6) and (-1, -2) · 2 None · 3 0 · 4 1

Nonlinear Systems: Drill

10 original questions. Answer all of them before checking.

- 1 Solve $y = x^2 - 1$ and $y = 3$.
- 2 Solve $y = x^2$ and $y = 2x + 3$.
- 3 How many solutions: $y = x^2 + 2$ and $y = 1$?
- 4 $y = x^2 + k$ touches $y = 4$ exactly once. k ?
- 5 $x^2 + y^2 = 25$ and $y = 4$. x -values?
- 6 $y = x^2 - 4x$ and $y = 0$. x -values?
- 7 Is $y = 2x - 1$ tangent to $y = x^2$?
- 8 Sum of x -values where $y = x^2$ meets $y = 5x - 6$?
- 9 Line meets parabola: maximum number of intersections?
- 10 $y = x^2 + 1$ and $y = x$. Solutions?

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ANSWERS

1 (2, 3) and (-2, 3) · $x^2 = 4$.

2 (3, 9) and (-1, 1) · $x^2 - 2x - 3 = 0$.

3 None · $x^2 = -1$.

4 4 · Vertex on the line.

5 ± 3 · $x^2 = 9$.

6 0 and 4 · $x(x - 4)$.

7 Yes · $x^2 - 2x + 1 = (x - 1)^2$.

8 5 · $x^2 - 5x + 6 = 0$.

9 2 · A quadratic has at most 2 roots.

10 None · Discriminant $1 - 4 < 0$.

Polynomial Zeros and Factors

A zero is a factor is an x-intercept.

THE RULE

If $p(a) = 0$, then $(x - a)$ is a factor of $p(x)$, and a is a zero (an x-intercept). The remainder when $p(x)$ is divided by $(x - a)$ equals $p(a)$.

FACT	EXAMPLE
Zero $\leftrightarrow$ factor	$p(3) = 0 \leftrightarrow (x - 3)$ is a factor
Factored form shows zeros	$(x + 1)(x - 2)(x - 5)$: zeros $-1, 2, 5$
Remainder theorem	$p(x) \div (x - 2)$ leaves remainder $p(2)$
Repeated factor	$(x - 1)^2$: the graph touches at 1 without crossing
Degree n	at most n real zeros
End behavior	x^3 rises to the right; $-x^3$ falls

REMEMBER If a table shows $p(4) = 0$, it is telling you $(x - 4)$ is a factor. If $p(4) = 7$, the remainder on dividing by $(x - 4)$ is 7.

WORKED EXAMPLES

- $p(x) = x(x - 3)(x + 3)$: zeros 0, 3, -3
- $p(-1) = 0 \rightarrow (x + 1)$ is a factor
- $x^3 - x = x(x - 1)(x + 1)$
- Crosses at 2, bounces at $-1 \rightarrow (x - 2)(x + 1)^2$

TRAPS

- ~~X~~ A zero at 3 means a factor of ~~$(x + 3)$~~ ✓ $(x - 3)$
- ~~X~~ Ignoring the factor ~~x~~ ✓ $x = 0$ is a zero too
- ~~X~~ Remainder from ~~$x - a$~~ is ~~$p(-a)$~~ ✓ It's $p(a)$

DRILL HABIT

Match 10 graphs to factored forms; check each on your graphing calculator.

TRY IT

- 1 $p(x) = (x - 2)(x + 4)^2$. Zeros?
- 2 $p(5) = 0$. Which must be a factor: $(x + 5)$ or $(x - 5)$?
- 3 $p(x) = x^3 - 2x + 1$. Remainder when divided by $x - 2$?
- 4 Maximum number of real zeros of a degree-4 polynomial?

ANSWERS 1 2 and $-4 \cdot 2(x - 5) \cdot 3 \cdot 5 \cdot 4 \cdot 4$

Polynomial Zeros and Factors: Drill

10 original questions. Answer all of them before checking.

AM-10

DRILL

- 1 Zeros of $p(x) = x(x - 3)(x + 5)$?
- 2 $p(-4) = 0$. Which is a factor: $x + 4$ or $x - 4$?
- 3 Remainder when $x^3 + 2x - 5$ is divided by $x - 1$?
- 4 Factor $x^3 - 9x$.
- 5 $(x - 2)^2(x + 1)$: at $x = 2$ the graph...?
- 6 Most real zeros of a degree-3 polynomial?
- 7 $p(x) = x^2 - 5x + k$ has a zero at 2. k ?
- 8 Remainder when $x^2 + 4$ is divided by $x + 2$?
- 9 Factored form from zeros $-1, 2, 4$ (leading coefficient 1)?
- 10 Table: $p(3) = 0$. What must be true?

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ANSWERS

1 0, 3, -5 · Each factor.

2 $x + 4$ · Zero at -4 .

3 -2 · $p(1)$.

4 $x(x - 3)(x + 3)$ · GCF, then difference of squares.

5 Touches without crossing · Repeated factor.

6 3 · Degree $n \rightarrow$ at most n .

7 $6 \cdot 4 - 10 + k = 0$.

8 $8 \cdot p(-2)$.

9 $(x + 1)(x - 2)(x - 4)$ · Each zero $\rightarrow$ a factor.

10 $(x - 3)$ is a factor · Zero $\leftrightarrow$ factor.

Ratios, Rates and Units

Keep the units attached.

THE RULE

Set ratios up as fractions and keep the units attached. Proportions are two equal ratios: cross-multiply. Unit conversion is **multiplying by 1** in a useful form.

TASK	EXAMPLE
Ratio	boys : girls = 3 : 5 → girls are $\frac{5}{8}$ of the class
Proportion	$\frac{3}{4} = \frac{x}{20} \rightarrow x = 15$
Rate	120 miles in 2 hours = 60 mph
Unit conversion	$90 \text{ km/h} \times (1,000 \text{ m} / 1 \text{ km}) \times (1 \text{ h} / 3,600 \text{ s}) = 25 \text{ m/s}$
Scale	1 cm : 50 km → 3.2 cm = 160 km
Density	mass ÷ volume

REMEMBER Write the units on every number. If they don't cancel to the units the question asks for, the setup is wrong.

WORKED EXAMPLES

- 5 pens cost \$4 → 20 pens cost \$16
- 60 words per minute for 15 minutes = 900 words
- 1 inch = 2.54 cm → 10 in = 25.4 cm
- 50,000 people on 20 km² → 2,500 per km²

TRAPS

- ✗ Ratio 3 : 5 means $\frac{3}{5}$ of the total ✓ $\frac{3}{8}$ of the total
- ✗ Dividing when you should multiply ✓ Tracking units
- ✗ A proportion set up upside-down on one side ✓ Same units in the same positions

DRILL HABIT

Convert 10 everyday quantities (height, commute, phone storage) between units with written unit fractions.

TRY IT

- 1 A recipe uses 3 cups of flour per 2 cups of sugar. Flour for 7 cups of sugar?
- 2 A car uses 8 gallons for 240 miles. Miles per gallon?
- 3 Convert 2.5 hours to minutes.
- 4 Red : blue marbles = 2 : 7; there are 54 marbles. How many are red?

ANSWERS 1 10.5 cups · 2 30 · 3 150 · 4 12

Ratios, Rates and Units: Drill

10 original questions. Answer all of them before checking.

- 1 4 notebooks cost \$10. Cost of 14?
- 2 Ratio of cats to dogs is 3 : 4; 28 animals. Cats?
- 3 Convert 72 km/h to m/s.
- 4 A map: 1 cm = 25 km. 4.4 cm = ?
- 5 A car goes 270 miles on 9 gallons. Miles per gallon?
- 6 $x/8 = 15/24$. x ?
- 7 Density of 60 g in 15 mL?
- 8 Typing 45 words per minute for 20 minutes?
- 9 Convert 3.5 hours to minutes.
- 10 Recipe: 2 cups rice per 3 cups water. Water for 5 cups rice?

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ANSWERS

- 1 \$35 · \$2.50 each.
- 2 12 · 3/7 of 28.
- 3 20 · 72 · 1,000/3,600.
- 4 110 km · 4.4 · 25.
- 5 30 · 270/9.
- 6 5 · Cross-multiply.
- 7 4 g/mL · 60/15.
- 8 900 words · 45 · 20.
- 9 210 · 3.5 · 60.
- 10 7.5 cups · 5 · 3/2.

Percentages

Think in multipliers.

DA-2

LESSON

THE RULE

Percent means per hundred. Use multipliers: an increase of $r\%$ multiplies by $(1 + r/100)$; a decrease, by $(1 - r/100)$. **Percent change** = $(\text{new} - \text{old}) \div \text{old}$.

TASK	METHOD	EXAMPLE
$x\%$ of y	$(x/100) \times y$	15% of 80 = 12
Increase by 20%	$\times 1.20$	50 $\rightarrow$ 60
Decrease by 20%	$\times 0.80$	50 $\rightarrow$ 40
Percent change	$(\text{new} - \text{old}) \div \text{old}$	40 $\rightarrow$ 50: +25%
Original before a change	$\text{new} \div \text{multiplier}$	\$63 after 10% off $\rightarrow 63 \div 0.9 = \70
Successive changes	multiply the multipliers	+10% then +10% = $\times 1.21$ (+21%)
a is what percent of b ?	$a \div b \times 100$	18 of 72 = 25%

REMEMBER Successive changes don't add: up 50% then down 50% leaves you at 75% of the start. And always ask "percent of what?": the base is the original amount.

WORKED EXAMPLES

- 35% of 60 = 21
- 120 is 150% of 80
- p increased by 40% = $1.4p$
- 2,000 $\rightarrow$ 2,600 is a 30% increase

TRAPS

- ~~X Up 20% then down 20% = no change~~ ✓ $\times 1.2 \times 0.8 = 0.96 \rightarrow$ down 4%
- ~~X Percent change using the new value as the base~~ ✓ Use the old value
- ~~X Original = sale price $\times 1.10$ after 10% off~~ ✓ Sale price $\div 0.90$

DRILL HABIT

Solve 10 percent questions using only multipliers.

TRY IT

- 1 A \$250 jacket is 30% off. Sale price?
- 2 A price rose from \$80 to \$92. Percent increase?
- 3 After a 25% raise, a salary is \$50,000. Original salary?
- 4 Up 20%, then down 20%: net percent change?

ANSWERS 1 \$175 · 2 15% · 3 \$40,000 · 4 -4%

Percentages: Drill

10 original questions. Answer all of them before checking.

- 1 25% of 160?
- 2 \$80 jacket, 35% off. Sale price?
- 3 45 → 54: percent increase?
- 4 After a 20% raise, salary is \$48,000. Original?
- 5 Up 25%, then down 20%: net change?
- 6 12 is what percent of 48?
- 7 Price after a 10% increase on \$250?
- 8 200 → 150: percent decrease?
- 9 p increased by 30% as an expression?
- 10 Sale price \$63 after 30% off. Original?

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ANSWERS

1 $40 \cdot \frac{1}{4}$.

2 $\$52 \cdot \times 0.65$.

3 $20\% \cdot 9/45$.

4 $\$40,000 \cdot \div 1.2$.

5 $0\% \cdot 1.25 \times 0.8 = 1$.

6 $25\% \cdot 12/48$.

7 $\$275 \cdot \times 1.1$.

8 $25\% \cdot 50/200$.

9 $1.3p$ · Multiplier.

10 $\$90 \cdot \div 0.7$.

One-Variable Data

Center and spread.

THE RULE

Mean, median and mode measure center. Range and standard deviation measure spread. Know **how each one changes** when the data change.

MEASURE	MEANING OR EFFECT
Mean	sum $\div$ count; pulled by outliers
Median	middle value in order; resistant to outliers
Range	max – min
Standard deviation	typical distance from the mean: more spread, larger SD
Add a high outlier	the mean rises a lot; the median barely moves
Add the same number to every value	mean and median shift; range and SD don't change
Multiply every value by k	mean, median, range and SD all multiply by k

REMEMBER You won't calculate standard deviation; you'll compare it: the set clustered closer to its mean has the smaller SD. For a median from a frequency table with n values, find position $(n + 1)/2$.

WORKED EXAMPLES

- Scores 70, 80, 90: mean 80
- The mean of 4 tests is 85; a fifth test of 95 $\rightarrow$ new mean 87
- Values 1 ($\times 3$), 2 ($\times 5$), 3 ($\times 2$): $n = 10$, median = average of the 5th and 6th = 2
- Add 5 to every value: SD unchanged

TRAPS

- ~~X~~ Finding the median without sorting **✓ Sorting first**
- ~~X~~ Adding 5 to every value changes the SD **✓ It doesn't**
- ~~X~~ Averaging two group means of different sizes **✓ Weighting by group size**

DRILL HABIT

For 10 data questions, predict the effect of a change (bigger, smaller, same) before calculating.

TRY IT

- 1 Data: 3, 5, 7, 7, 18. Mean and median?
- 2 Remove the 18. Which changes more, the mean or the median?
- 3 Set A: 10, 10, 10, 10. Set B: 1, 5, 15, 19. Which has the larger SD?
- 4 The mean of five numbers is 12. What is their sum?

ANSWERS 1 Mean 8, median 7 · 2 The mean ($8 \rightarrow 5.5$; the median $7 \rightarrow 6$) · 3 B · 4 60

One-Variable Data: Drill

10 original questions. Answer all of them before checking.

DA-3

DRILL

- 1 Mean of 4, 8, 9, 11?
- 2 Median of 3, 9, 1, 7, 5?
- 3 Median of 2, 4, 6, 10?
- 4 Mean of 5 tests is 80. Sum?
- 5 Mean of 4 tests is 85; fifth test 95. New mean?
- 6 Range of 12, 7, 20, 15?
- 7 Add 10 to every value. Effect on standard deviation?
- 8 Data: 2, 3, 3, 4, 50. Mean or median better represents center?
- 9 Which set has a larger SD: {5, 5, 5} or {1, 5, 9}?
- 10 Multiply every value by 3. Mean of 7 becomes?

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ANSWERS

1 8 · 32/4.

2 5 · Sort: 1, 3, 5, 7, 9.

3 5 · Average of 4 and 6.

4 400 · 5 · 80.

5 87 · (340 + 95)/5.

6 13 · 20 – 7.

7 None · Shift only.

8 Median · 50 is an outlier.

9 {1, 5, 9} · More spread.

10 21 · Scales.

Two-Variable Data: Scatterplots and Models

DA-4

LESSON

Read the trend, interpret the line.

THE RULE

Scatterplots show how two variables relate. A line of best fit models a linear trend; an exponential curve models percent growth. **Interpret slope and intercept in context** and use the model to predict.

IDEA	WHAT TO SAY OR DO
Positive association	as x increases, y tends to increase
Negative association	as x increases, y tends to decrease
Slope of the best-fit line	predicted change in y for each 1-unit increase in x
y-intercept	predicted y when x = 0 (may not make sense in context)
Prediction	plug x into the model
Residual	actual – predicted
Linear vs. exponential fit	constant change vs. constant percent change

REMEMBER Say “predicted” or “estimated”: a best-fit line describes a trend, not every point. a graphing calculator fits a line from a table in seconds (MS-6).

WORKED EXAMPLES

- $y = -3x + 90$: each extra unit of x predicts 3 fewer units of y
- Points far above the line have positive residuals
- Temperature vs. ice cream sales: positive association
- $y = 100(1.08)^x$: about 8% growth per unit of x

TRAPS

- ✗ ~~The slope as the starting value~~ ✓ **The slope as the rate**
- ✗ ~~“The line proves x causes y”~~ ✓ **Association only (DA-7)**
- ✗ ~~Residual = predicted – actual~~ ✓ **actual – predicted**

DRILL HABIT

Describe 10 scatterplots in one sentence each: direction, form (linear or not), and strength.

TRY IT

- 1 Best fit $y = 2.5x + 10$ (x = hours studied, y = points gained). Meaning of 2.5?
- 2 Predicted y when x = 4?
- 3 An actual point is (4, 23). Residual?
- 4 The data double each year. Linear or exponential model?

ANSWERS 1 Each extra hour predicts 2.5 more points · 2 20 · 3 3 · 4 Exponential

Two-Variable Data: Scatterplots and Models: Drill A-4

10 original questions. Answer all of them before checking.

DRILL

- 1 Best fit $y = 4x + 20$ (x = hours, y = score). Meaning of 4?
- 2 Same model: predicted y at $x = 5$?
- 3 Actual point (5, 46). Residual?
- 4 As temperature rises, heating bills fall. Association?
- 5 Data grow by about 10% per year. Model type?
- 6 Data grow by about 10 units per year. Model type?
- 7 $y = 500(0.9)^x$ models a population. Change per year?
- 8 Does a strong best-fit line prove x causes y ?
- 9 $y = -2x + 60$: predicted y at $x = 12$?
- 10 A point lies below the best-fit line. Residual sign?

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ANSWERS

- 1 Each extra hour predicts 4 more points · Slope = rate.
- 2 $40 \cdot 20 + 20$.
- 3 $6 \cdot 46 - 40$.
- 4 Negative · One up, one down.
- 5 Exponential · Constant percent.
- 6 Linear · Constant amount.
- 7 10% decrease · Factor 0.9.
- 8 No · Association only (DA-7).
- 9 $36 \cdot 60 - 24$.
- 10 Negative · Actual < predicted.

Probability and Two-Way Tables

The word after “given” picks the denominator.

DA-5

LESSON

THE RULE

Probability = favorable outcomes ÷ total outcomes. Conditional probability restricts the total to one group: “given that the student is a senior” means **the denominator is seniors only**.

	SPORT	NO SPORT	TOTAL
Junior	30	20	50
Senior	45	55	100
Total	75	75	150

REMEMBER From the table: $P(\text{sport}) = 75/150 = 1/2$. $P(\text{sport, given senior}) = 45/100$. $P(\text{senior, given sport}) = 45/75 = 3/5$. Same cell, different denominators.

WORKED EXAMPLES

- A fair die: $P(\text{even}) = 3/6 = 1/2$
- “Of the students who play a sport, what fraction are seniors?” → $45/75$
- Expected count: probability $\times$ total = $0.2 \times 500 = 100$
- “Or” in a table: add the cells without counting any twice

TRAPS

- ~~X~~ Using the grand total for a “given” question **✓ The given group’s total**
- ~~X~~ Swapping $P(A \text{ given } B)$ and $P(B \text{ given } A)$ **✓ Reading “given” carefully**
- ~~X~~ Double-counting overlapping groups **✓ Counting each cell once**

DRILL HABIT

For 10 two-way table questions, circle the denominator’s row or column before calculating.

TRY IT

- 1 From the table: $P(\text{junior})$?
- 2 $P(\text{no sport, given junior})$?
- 3 $P(\text{junior, given no sport})$?
- 4 A bag holds 4 red and 6 blue marbles. $P(\text{red})$?

ANSWERS 1 $1/3$ · 2 $2/5$ · 3 $4/15$ · 4 $2/5$

Probability and Two-Way Tables: Drill

10 original questions. Answer all of them before checking.

DA-5

DRILL

- 1 Table — Band: 9th 12, 10th 18 (total 30); Choir: 9th 20, 10th 10 (total 30). $P(\text{band})$?
- 2 Same table: $P(\text{10th grade, given band})$?
- 3 Same table: $P(\text{band, given 10th grade})$?
- 4 Same table: $P(\text{9th grade})$?
- 5 A die: $P(\text{number} > 4)$?
- 6 3 red, 5 blue, 2 green marbles. $P(\text{not blue})$?
- 7 $P(\text{defect}) = 0.04$; 2,500 items. Expected defects?
- 8 What does “given” change?
- 9 Two fair coins: $P(\text{both heads})$?
- 10 Survey: 40 of 160 prefer tea. $P(\text{random respondent prefers tea})$?

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ANSWERS

1 $1/2 \cdot 30/60$.

2 $3/5 \cdot 18/30$.

3 $9/14 \cdot 18/28$.

4 $8/15 \cdot 32/60$.

5 $1/3 \cdot 2/6$.

6 $1/2 \cdot 5/10$.

7 $100 \cdot 0.04 \cdot 2,500$.

8 The denominator: the given group only · DA-5.

9 $1/4 \cdot \frac{1}{2} \cdot \frac{1}{2}$.

10 $1/4 \cdot 40/160$.

Samples, Margin of Error, Inference

What a survey can and can't tell you.

DA-6

LESSON

THE RULE

A random sample lets you generalize to the population it was drawn from. A margin of error gives a range of plausible values. **Larger random samples give smaller margins of error.**

IDEA	WHAT IT MEANS
Random sample	every member of the population had a chance of being chosen
Generalize	only to the population that was sampled
Estimate $\pm$ margin of error	54% $\pm$ 3% $\rightarrow$ plausible range 51% to 57%
Larger sample	smaller margin of error
Biased sample	volunteers, one location, online only: can't generalize
Estimate a total	sample proportion $\times$ population size

REMEMBER A margin of error doesn't guarantee the true value is in the range, and it can't fix a biased sample: surveying gym members about exercise says nothing reliable about the whole city.

WORKED EXAMPLES

- A random sample of 500 voters in a state $\rightarrow$ generalize to that state's voters
- Mean 4.2 hours $\pm$ 0.3 $\rightarrow$ 3.9 to 4.5 hours is plausible
- An online poll of volunteers $\rightarrow$ biased
- The same study with a larger sample $\rightarrow$ a smaller margin of error

TRAPS

- ~~✗ Generalizing beyond the sampled population~~ ✓ **Same population only**
- ~~✗ Treating the estimate as exact~~ ✓ **Using the range**
- ~~✗ A bigger biased sample fixes the bias~~ ✓ **Randomness fixes bias; size doesn't**

DRILL HABIT

For 10 survey descriptions, write the population sampled, whether it was random, and what can be concluded.

TRY IT

- 1 A survey reports 62% $\pm$ 4%. Plausible range?
- 2 How can researchers shrink the margin of error?
- 3 A random sample of 200 of a school's 1,000 students finds 30 who bike to school. Estimate the total who bike.
- 4 A survey of a city's library visitors: can it be generalized to all residents?

ANSWERS 1 58% to 66% • 2 Use a larger random sample • 3 150 • 4 No: only library visitors were sampled

Samples, Margin of Error, Inference: Drill

10 original questions. Answer all of them before checking.

DA-6

DRILL

- 1 Estimate $48\% \pm 3\%$. Plausible range?
- 2 How do you shrink the margin of error?
- 3 Random sample of 300 of 6,000 students; 45 walk to school. Estimate total walkers.
- 4 Survey of gym members about exercise. Generalize to the whole city?
- 5 Random sample of a state's voters. Generalize to?
- 6 Does a larger sample fix a biased sampling method?
- 7 Mean 6.2 hours ± 0.4 . Is 6.9 hours plausible?
- 8 Two surveys: margins 2% and 5%. Which likely had the larger sample?
- 9 Online volunteer poll. Can it estimate the national average?
- 10 Random sample of 200 trees: 30 diseased. Estimate the percent in the forest.

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ANSWERS

- 1 45% to 51% · $\pm$ the margin.
- 2 Use a larger random sample · Size reduces it.
- 3 900 · 15% of 6,000.
- 4 No · Biased sample.
- 5 That state's voters · Same population only.
- 6 No · Randomness fixes bias.
- 7 No · Range is 5.8 to 6.6.
- 8 The 2% survey · Smaller margin.
- 9 No · Self-selected.
- 10 15% · $30/200$.

Study Design: Correlation vs. Causation

Only random assignment shows cause.

DA-7

LESSON

THE RULE

Only a **randomized experiment** (subjects randomly assigned to treatments) supports a cause-and-effect conclusion. Observational studies show association, not causation.

DESIGN	YOU CAN CONCLUDE	EXAMPLE
Random sample + random assignment	cause and effect, for the whole population	random voters randomly shown one of two ads
Random assignment only	cause and effect, for these subjects	volunteers randomly given a drug or a placebo
Random sample only	association, for the population	a random survey on sleep and grades
Neither	association, for this sample only	students choosing whether to join a club

REMEMBER The same rule applies in Reading and Science: when a text says students who sleep more score higher, the correct answer says “associated with,” not “causes,” unless sleep was randomly assigned.

WORKED EXAMPLES

- “Students who eat breakfast earn higher grades” (observational) → association only
- Plants randomly assigned fertilizer or none → the fertilizer caused the difference
- A random sample of farms surveyed → the association generalizes to all such farms
- Self-selected groups → other differences (confounding variables) may explain the result

TRAPS

- ~~X “Causes” from an observational study~~ ✓ **“Is associated with”**
- ~~X Generalizing a volunteer experiment to everyone~~ ✓ **Only to similar subjects**
- ~~X Confusing random sampling with random assignment~~ ✓ **Sampling → generalize; assignment → cause**

DRILL HABIT

Classify 10 study descriptions into the four rows of the table.

TRY IT

- 1 Volunteers were randomly assigned to two diets; diet A's group lost more weight. Conclusion?
- 2 A random survey finds coffee drinkers report more anxiety. Does coffee cause anxiety?
- 3 What two features allow a cause-and-effect conclusion about a whole population?

ANSWERS 1 Diet A caused more weight loss for these volunteers (not necessarily everyone) · 2 Not from this study: association only · 3 Random sampling and random assignment

Study Design: Correlation vs. Causation: Drill

DA-7

10 original questions. Answer all of them before checking.

DRILL

- 1 Volunteers randomly assigned to a drug or placebo; drug group improved more. Conclusion?
- 2 Random survey: coffee drinkers sleep less. Does coffee cause less sleep?
- 3 Which two features allow a causal conclusion about a whole population?
- 4 Students chose whether to join a study club; members had higher grades. Causal?
- 5 Random sample of farms; fertilizer randomly assigned. Conclusion?
- 6 What is a confounding variable?
- 7 Random sampling lets you...?
- 8 Random assignment lets you...?
- 9 Correct wording for an observational finding?
- 10 Plants randomly given more light grew taller. Cause or association?

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ANSWERS

- 1 The drug caused improvement for these volunteers · Random assignment; not random sampling.
- 2 Not shown · Observational.
- 3 Random sampling and random assignment · Both.
- 4 No · Self-selected.
- 5 Fertilizer's effect generalizes to all such farms · Both features.
- 6 A third factor that may explain the result · E.g., motivation.
- 7 Generalize to the population · Not prove cause.
- 8 Conclude cause and effect · For the subjects studied.
- 9 "is associated with" · Not "causes."
- 10 Cause · Random assignment.

Area, Volume and Scale

Know the sheet; know the scale rule.

GT-1

LESSON

THE RULE

The ACT gives **no formula sheet**, so memorize these (MS-7, REF-1). Pick the right formula, plug in carefully, and handle scale: **doubling every length multiplies area by 4 and volume by 8.**

SHAPE	FORMULA
Rectangle · triangle · trapezoid	$A = lw$ · $A = \frac{1}{2}bh$ · $A = \frac{1}{2}(b_1 + b_2)h$
Circle	$A = \pi r^2$ · $C = 2\pi r$
Rectangular prism	$V = lwh$
Cylinder	$V = \pi r^2 h$
Sphere	$V = \frac{4}{3}\pi r^3$
Cone · pyramid	$V = \frac{1}{3}\pi r^2 h$ · $V = \frac{1}{3}lwh$
Scale factor k	lengths $\times k$, areas $\times k^2$, volumes $\times k^3$

REMEMBER Check whether they give the radius or the diameter, and which units they want. Surface area is the sum of the areas of all the faces.

WORKED EXAMPLES

- Triangle with base 10 and height 6: area 30
- Circumference $10\pi \rightarrow r = 5 \rightarrow$ area 25π
- Cone with $r = 3$, $h = 4$: $V = \frac{1}{3}\pi(9)(4) = 12\pi$
- Similar solids with length ratio 1 : 2 $\rightarrow$ volume ratio 1 : 8

TRAPS

- ~~X~~ Using the diameter as the radius ✓ $r = d/2$
- ~~X~~ Doubling lengths doubles area ✓ **Area $\times 4$**
- ~~X~~ Forgetting the $1/3$ for cones ✓ **$\frac{1}{3}\pi r^2 h$**

DRILL HABIT

Write every formula on this page from memory, then check. Repeat until perfect.

TRY IT

- 1 Cylinder with $r = 3$, $h = 10$. Volume?
- 2 A cube's volume is 64. Surface area?
- 3 A rectangle's sides are tripled. Its area is multiplied by?
- 4 A sphere's diameter is 6. Volume?

ANSWERS 1 90π · 2 96 · 3 9 · 4 36π

Area, Volume and Scale: Drill

10 original questions. Answer all of them before checking.

- 1 Triangle: base 12, height 5. Area?
- 2 Circle with diameter 10. Area?
- 3 Cylinder $r = 2$, $h = 9$. Volume?
- 4 Cube with volume 125. Surface area?
- 5 Sphere with radius 3. Volume?
- 6 Cone $r = 6$, $h = 5$. Volume?
- 7 Every length doubles. Volume multiplies by?
- 8 Circumference 14π . Radius?
- 9 Rectangular prism $3 \times 4 \times 10$. Volume?
- 10 Similar triangles, side ratio 2 : 3. Area ratio?

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ANSWERS

1 $30 \cdot \frac{1}{2} \cdot 12 \cdot 5$.

2 $25\pi \cdot r = 5$.

3 $36\pi \cdot \pi \cdot 4 \cdot 9$.

4 $150 \cdot \text{Side } 5; 6 \cdot 25$.

5 $36\pi \cdot (4/3)\pi \cdot 27$.

6 $60\pi \cdot (1/3)\pi \cdot 36 \cdot 5$.

7 $8 \cdot 2^3$.

8 $7 \cdot 2\pi r$.

9 $120 \cdot lwh$.

10 $4 : 9 \cdot \text{Square it}$.

Lines, Angles and Triangles

180, 360, and similar triangles.

GT-2

LESSON

THE RULE

Angles on a line sum to 180° ; around a point, 360° ; in a triangle, 180° .
Parallel lines cut by a transversal make equal alternate and corresponding angles. **Similar triangles have equal angles and proportional sides.**

FACT	USE
Vertical angles are equal	crossing lines
A linear pair sums to 180°	angles on a straight line
Parallel lines: alternate interior angles are equal	the Z shape
Triangle angles sum to 180°	find the missing angle
Exterior angle = sum of the two remote interior angles	a quick shortcut
Isosceles: equal sides $\leftrightarrow$ equal base angles	two equal angles mean two equal sides
Similar triangles (AA)	sides in the same ratio
Polygon interior angles	$(n - 2) \times 180^\circ$

REMEMBER When two triangles share an angle and have parallel sides, look for similarity, then set up a proportion of matching sides (small/large = small/large).

WORKED EXAMPLES

- Parallel lines: one angle is $110^\circ \rightarrow$ its alternate interior angle is 110° , its neighbor 70°
- Isosceles with base angles of $50^\circ \rightarrow$ vertex angle 80°
- A 6-ft person casts a 4-ft shadow; a tree casts a 30-ft shadow $\rightarrow$ the tree is 45 ft
- Pentagon: $(5 - 2) \times 180 = 540^\circ$

TRAPS

- ~~X~~ Mismatching sides in a proportion **✓ Matching sides by angle**
- ~~X~~ Assuming a figure is to scale **✓ Using given facts only**
- ~~X~~ Polygon sum $n \times 180$ **✓ $(n - 2) \times 180$**

DRILL HABIT

Draw and label 10 figures from words only, then solve them.

TRY IT

- 1 Two angles of a triangle are 47° and 68° . The third?
- 2 Sum of the interior angles of a hexagon?
- 3 Similar triangles with ratio 2 : 5; a small side of 6 matches a large side of?
- 4 An exterior angle is 120° ; one remote interior angle is 50° . The other?

ANSWERS 1 65° · 2 720° · 3 15 · 4 70°

Lines, Angles and Triangles: Drill

10 original questions. Answer all of them before checking.

- 1 Two angles of a triangle are 52° and 73° . Third?
- 2 Interior angle sum of an octagon?
- 3 Exterior angle 130° , one remote interior 45° . The other?
- 4 Parallel lines, alternate interior angle 68° . Its partner?
- 5 Linear pair: one angle 115° . Other?
- 6 Isosceles, vertex angle 40° . Each base angle?
- 7 Similar triangles, ratio 3 : 7; small side 9. Matching large side?
- 8 A 5-ft pole casts a 3-ft shadow; a tree casts 18 ft. Tree height?
- 9 Each interior angle of a regular hexagon?
- 10 Vertical angles: one is 38° . The other?

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ANSWERS

1 55° · $180 - 125$.

2 1080° · $6 \cdot 180$.

3 85° · $130 - 45$.

4 68° · Equal.

5 65° · $180 - 115$.

6 70° · $140/2$.

7 $21 \cdot 9 \cdot 7/3$.

8 30 ft · Similar triangles.

9 120° · $720/6$.

10 38° · Equal.

Right Triangles

Pythagoras, triples and the special two.

GT-3

LESSON

THE RULE

The Pythagorean theorem $a^2 + b^2 = c^2$ links the sides of any right triangle. Know the common triples and the two special right triangles (memorize them: the ACT gives no formula sheet).

TOOL	DETAIL
Pythagorean theorem	$a^2 + b^2 = c^2$; c is the hypotenuse
Common triples	3-4-5, 5-12-13, 8-15-17, 7-24-25, and multiples (6-8-10)
45-45-90	sides $x, x, x\sqrt{2}$
30-60-90	sides $x, x\sqrt{3}, 2x$
Distance between points	$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
Converse	if $a^2 + b^2 = c^2$, the triangle is right

REMEMBER An equilateral triangle's height splits it into two 30-60-90 triangles; a square's diagonal splits it into two 45-45-90 triangles. Spot them and skip the algebra.

WORKED EXAMPLES

- Hypotenuse 13, one leg 5 → the other leg is 12
- Square with side 4 → diagonal $4\sqrt{2}$
- Equilateral triangle with side 6 → height $3\sqrt{3}$
- Distance from (1, 1) to (4, 5) = 5

TRAPS

- ✗ Adding the legs instead of their squares ✓ $a^2 + b^2$, then the square root
- ✗ Using a leg as c ✓ c is opposite the right angle
- ✗ $\sqrt{3}$ on the short leg of a 30-60-90 ✓ short x , long $x\sqrt{3}$, hypotenuse $2x$

DRILL HABIT

Memorize the triples and special triangles; solve 15 problems without a calculator.

TRY IT

- 1 Legs 9 and 12. Hypotenuse?
- 2 A 45-45-90 triangle has a leg of 7. Hypotenuse?
- 3 A 30-60-90 triangle has a hypotenuse of 10. Shorter leg? Longer leg?
- 4 Is a triangle with sides 7, 24, 25 a right triangle?

ANSWERS 1 15 · 2 $7\sqrt{2}$ · 3 5 and $5\sqrt{3}$ · 4 Yes ($49 + 576 = 625$)

Right Triangles: Drill

10 original questions. Answer all of them before checking.

- 1 Legs 8 and 15. Hypotenuse?
- 2 Hypotenuse 25, leg 7. Other leg?
- 3 45-45-90 with leg 6. Hypotenuse?
- 4 30-60-90 with hypotenuse 14. Short leg? Long leg?
- 5 Is 9, 12, 15 a right triangle?
- 6 Square with side 7. Diagonal?
- 7 Distance from $(-3, 2)$ to $(3, 10)$?
- 8 Equilateral triangle side 8. Height?
- 9 Legs 5 and 5. Hypotenuse?
- 10 Is 6, 7, 9 a right triangle?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Geometry

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Geometry

Rungs 1–2: untimed sets, then timed; one front at a time

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 17 · 8-15-17.

2 24 · 7-24-25.

3 $6\sqrt{2}$ · $x\sqrt{2}$.

4 7 and $7\sqrt{3}$ · x , $x\sqrt{3}$, $2x$.

5 Yes · $81 + 144 = 225$.

6 $7\sqrt{2}$ · 45-45-90.

7 10 · Legs 6 and 8.

8 $4\sqrt{3}$ · 30-60-90.

9 $5\sqrt{2}$ · 45-45-90.

10 No · $36 + 49 \neq 81$.

Trigonometry

SOH-CAH-TOA, complements and radians.

GT-4

LESSON

THE RULE

In a right triangle: **sin** = opposite/hypotenuse, **cos** = adjacent/hypotenuse, **tan** = opposite/adjacent. Complementary angles: $\sin x^\circ = \cos(90^\circ - x^\circ)$.

Radians: $180^\circ = \pi$.

IDEA	EXAMPLE
SOH-CAH-TOA	3-4-5 triangle, angle A opposite 3: $\sin A = 3/5$, $\cos A = 4/5$, $\tan A = 3/4$
Complementary angles	$\sin 30^\circ = \cos 60^\circ$
Similar triangles share trig ratios	the ratios depend only on the angle
Degrees $\leftrightarrow$ radians	multiply degrees by $\pi/180$
Key values	$\sin 30^\circ = 1/2$, $\cos 60^\circ = 1/2$, $\sin 90^\circ = 1$
Find a side	$\tan 40^\circ = h/50 \rightarrow h = 50 \tan 40^\circ$

REMEMBER If $\sin x^\circ = \cos y^\circ$ for acute angles, then $x + y = 90$. It's one of the most common trigonometry questions on the test.

WORKED EXAMPLES

- 5-12-13 triangle, angle opposite 5: $\tan = 5/12$
- $\cos A = 0.6 \rightarrow \sin(90^\circ - A) = 0.6$
- $60^\circ = \pi/3$ radians
- A 10-ft ladder at 60° to the ground reaches $10 \sin 60^\circ = 5\sqrt{3}$ ft

TRAPS

- ~~X~~ $\tan = \text{adjacent/opposite}$ ✓ **opposite/adjacent**
- ~~X~~ $\sin x = \cos y \rightarrow x + y = 180$ ✓ **$x + y = 90$**
- ~~X~~ $\text{Radians} = \text{degrees} \times 180/\pi$ ✓ **$\text{degrees} \times \pi/180$**

DRILL HABIT

Make flashcards for SOH-CAH-TOA, complements and radian conversions. Review daily for a week.

TRY IT

- 1 Right triangle with opposite side 8 and hypotenuse 17. $\sin?$ $\cos?$
- 2 $\sin(x^\circ) = \cos(25^\circ)$. $x?$
- 3 Convert 135° to radians.
- 4 Convert $3\pi/2$ radians to degrees.

ANSWERS 1 $\sin = 8/17$, $\cos = 15/17$ 2 65° 3 $3\pi/4$ 4 270°

Trigonometry: Drill

10 original questions. Answer all of them before checking.

- 1 Right triangle: opposite 5, hypotenuse 13. $\sin$? $\cos$?
- 2 $\tan$ of that angle?
- 3 $\sin x^\circ = \cos 35^\circ$. x ?
- 4 Convert 150° to radians.
- 5 Convert $\pi/4$ radians to degrees.
- 6 $\cos A = 0.8$ (acute). $\sin(90^\circ - A)$?
- 7 A ramp rises 3 m over a 5 m length (hypotenuse). $\sin$ of the angle?
- 8 $\sin 30^\circ = ?$
- 9 Similar right triangles share which ratios?
- 10 Tree height h , 40 ft away, angle of elevation θ . Expression for h ?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Geometry (trigonometry)

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Trigonometry

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Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 $5/13$ and $12/13$ · Adjacent 12.

2 $5/12$ · Opposite/adjacent.

3 55 · Complements.

4 $5\pi/6$ · $\times \pi/180$.

5 45° · $\times 180/\pi$.

6 0.8 · Complement identity.

7 $3/5$ · Opposite/hypotenuse.

8 $1/2$ · Key value.

9 All trig ratios · Depend only on the angle.

10 $h = 40 \tan \theta$ · $\tan = \text{opposite/adjacent}$.

Circles

Equations, arcs and sectors.

GT-5

LESSON

THE RULE

The equation $(x - h)^2 + (y - k)^2 = r^2$ has center (h, k) and radius r . Arcs and sectors are fractions of the whole circle.

IDEA	FORMULA OR EXAMPLE
Circle equation	$(x - 2)^2 + (y + 3)^2 = 16$: center $(2, -3)$, $r = 4$
Completing the square	$x^2 + 6x + y^2 = 7 \rightarrow (x + 3)^2 + y^2 = 16$
Arc length	$(\text{central angle} \div 360) \times 2\pi r$
Sector area	$(\text{central angle} \div 360) \times \pi r^2$
Radians	arc length = $r\theta$
Tangent line	perpendicular to the radius at the point of tangency
Inscribed angle	half the central angle on the same arc

REMEMBER Completing the square: take half the x-coefficient, square it, and add it to both sides; do the same for y. The radius is the square root of the right side.

WORKED EXAMPLES

- Center $(0, 0)$ through $(3, 4)$: $x^2 + y^2 = 25$
- Central angle 120° , $r = 3$: arc = $(1/3)(6\pi) = 2\pi$
- An inscribed angle on a 100° arc = 50°
- Arc length 4π , radius $8 \rightarrow \theta = \pi/2$ radians

TRAPS

~~$x^2 = 49 \rightarrow r = 49$~~ ✓ $r = 7$

~~Center of $(x + 1)^2$ at $x = 1$~~ ✓ $x = -1$

~~Arc length with πr^2~~ ✓ Arcs use $2\pi r$; sectors use πr^2

DRILL HABIT

Complete the square on 10 circle equations; check each on your graphing calculator.

TRY IT

- Center and radius of $(x + 1)^2 + (y - 5)^2 = 49$?
- Radius 6, central angle 60° . Arc length?
- Radius 10, central angle 90° . Sector area?
- $x^2 - 4x + y^2 + 2y = 4$. Radius?

ANSWERS 1 $(-1, 5)$, $r = 7$ 2 2π 3 25π 4 3

Circles: Drill

10 original questions. Answer all of them before checking.

- 1 Center and radius of $(x - 3)^2 + (y + 2)^2 = 36$?
- 2 Radius 9, central angle 40° . Arc length?
- 3 Radius 6, central angle 120° . Sector area?
- 4 $x^2 + y^2 + 8x - 6y = 0$. Radius?
- 5 Inscribed angle on a 110° arc?
- 6 Arc length 6π , radius 12. Central angle in radians?
- 7 Circle centered at $(0, 0)$ through $(5, 12)$. Equation?
- 8 Tangent line and radius meet at what angle?
- 9 Center of $(x + 7)^2 + y^2 = 4$?
- 10 Circumference of a circle with area 49π ?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Geometry (circles)

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Geometry

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 $(3, -2)$, $r = 6$ · Read h , k , r .

2 $2\pi \cdot (40/360)(18\pi)$.

3 $12\pi \cdot (1/3)(36\pi)$.

4 $5 \cdot (x + 4)^2 + (y - 3)^2 = 25$.

5 55° · Half the arc.

6 $\pi/2 \cdot s = r\theta$.

7 $x^2 + y^2 = 169$ · $r = 13$.

8 90° · Perpendicular.

9 $(-7, 0)$ · Opposite sign.

10 14π · $r = 7$.

Complex Numbers

i squared is -1.

AX-1

LESSON

THE RULE

$i = \sqrt{-1}$, so $i^2 = -1$. Add and multiply complex numbers like binomials, replacing i^2 with -1 . Powers of i repeat every four: $i, -1, -i, 1$.

IDEA	EXAMPLE
$i^2 = -1$	$\sqrt{-16} = 4i$
Add	$(3 + 2i) + (1 - 5i) = 4 - 3i$
Multiply	$(2 + i)(3 - i) = 6 - 2i + 3i - i^2 = 7 + i$
Powers of i	$i, -1, -i, 1$, then repeat
i^n	divide n by 4 and use the remainder: $i^{23} = i^3 = -i$
Conjugates	$(a + bi)(a - bi) = a^2 + b^2$
Divide	multiply top and bottom by the conjugate

REMEMBER Division example: $5/(2 + i) = 5(2 - i)/((2 + i)(2 - i)) = 5(2 - i)/5 = 2 - i$.

WORKED EXAMPLES

- $\sqrt{-25} = 5i$
- $(4 - 3i) - (1 + 2i) = 3 - 5i$
- $(1 + i)^2 = 1 + 2i + i^2 = 2i$
- $i^{10} = i^2 = -1$

TRAPS

X $i^2 = 1$ **✓** $i^2 = -1$

X $(2 + i)(2 - i) = 3$ **✓** $4 - i^2 = 4 + 1 = 5$

X Adding real and imaginary parts together **✓** Real with real, imaginary with imaginary

DRILL HABIT

Write the cycle $i, -1, -i, 1$ at the top of your scratch paper whenever a question has i in it.

TRY IT

- 1 $(3 + 4i)(3 - 4i) = ?$
- 2 $i^{14} = ?$
- 3 $(2 + 3i) + (5 - 7i) = ?$
- 4 $(1 - i)^2 = ?$

ANSWERS 1 25 2 -1 3 $7 - 4i$ 4 $-2i$

Complex Numbers: Drill

10 original questions. Answer all of them before checking.

AX-1

DRILL

- 1 $i^2 = ?$
- 2 $(2 + 3i)(2 - 3i) = ?$
- 3 $(4 - i) + (-1 + 6i) = ?$
- 4 $i^{17} = ?$
- 5 $\sqrt{-49} = ?$
- 6 $(1 + 2i)^2 = ?$
- 7 $(3 + i)(1 - 2i) = ?$
- 8 $10/(1 + 3i)$ in $a + bi$ form?
- 9 $i^{22} = ?$
- 10 Conjugate of $5 - 4i$?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Number and Quantity

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Algebra 2 (complex numbers)

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ANSWERS

1 -1 · Definition.

2 13 · $4 + 9$.

3 $3 + 5i$ · Combine parts.

4 i · $17 = 4 \cdot 4 + 1$.

5 $7i$ · $\sqrt{49} \cdot i$.

6 $-3 + 4i$ · $1 + 4i + 4i^2$.

7 $5 - 5i$ · $3 - 6i + i - 2i^2$.

8 $1 - 3i$ · Multiply by the conjugate.

9 -1 · Remainder 2.

10 $5 + 4i$ · Flip the sign of the imaginary part.

Matrices and Vectors

Grids of numbers, arrows with length.

THE RULE

A matrix is a grid of numbers described as rows $\times$ columns (written here as $[a \ b; c \ d]$, with rows separated by semicolons). Add same-size matrices entry by entry. **Vectors** have size and direction; add them component by component.

IDEA	EXAMPLE
Dimensions	a 2×3 matrix has 2 rows and 3 columns
Add or subtract	same size only; entry by entry
Multiply by a number	$3 \cdot [1 \ 2; 4 \ 0] = [3 \ 6; 12 \ 0]$
Multiply matrices	$(m \times n)(n \times p)$ gives $m \times p$; each entry = a row times a column
2×2 determinant	$[a \ b; c \ d] \rightarrow ad - bc$
Vector length	$\langle 3, 4 \rangle$ has length $\sqrt{3^2 + 4^2} = 5$
Add vectors	$\langle 1, 2 \rangle + \langle 3, -5 \rangle = \langle 4, -3 \rangle$

REMEMBER Two matrices can be multiplied only if the inside dimensions match: a 2×3 times a 3×4 works (giving 2×4); a 2×3 times a 2×3 doesn't.

WORKED EXAMPLES

- $[1 \ 2; 3 \ 4] + [0 \ 1; 1 \ 0] = [1 \ 3; 4 \ 4]$
- $\det [2 \ 5; 1 \ 3] = 6 - 5 = 1$
- $[1 \ 2]$ times the column $[3; 4] = 1 \cdot 3 + 2 \cdot 4 = 11$
- Length of $\langle 6, 8 \rangle = 10$

TRAPS

- ~~X~~ Adding matrices of different sizes **✓ Same size only**
- ~~X~~ Determinant $ad + bc$ **✓ $ad - bc$**
- ~~X~~ Assuming any two matrices multiply **✓ Inner dimensions must match**

DRILL HABIT

Do five matrix and five vector questions from official practice tests; these are quick points once the rules are automatic.

TRY IT

- 1 Dimensions of the product of a 3×2 and a 2×5 matrix?
- 2 $\det [4 \ 1; 2 \ 3]$?
- 3 $\langle 2, -1 \rangle + \langle -5, 4 \rangle$?
- 4 Length of $\langle 5, 12 \rangle$?

ANSWERS $1 \ 3 \times 5 \cdot 2 \ 10 \cdot 3 \ (-3, 3) \cdot 4 \ 13$

Matrices and Vectors: Drill

10 original questions. Answer all of them before checking.

AX-2

DRILL

- 1 Dimensions of a matrix with 4 rows and 2 columns?
- 2 $[2 \ 1; 0 \ 3] + [1 \ -1; 4 \ 2] = ?$
- 3 $3 \cdot [1 \ -2; 0 \ 4] = ?$
- 4 $\det [5 \ 2; 3 \ 4]$?
- 5 Can a 2×3 matrix multiply a 2×3 matrix?
- 6 Product dimensions of $(3 \times 4)(4 \times 2)$?
- 7 $[1 \ 3]$ times the column $[2; 5] = ?$
- 8 Length of $(8, 15)$?
- 9 $\langle 3, -2 \rangle + \langle -1, 6 \rangle = ?$
- 10 $2\langle 4, -1 \rangle = ?$

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Number and Quantity

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Precalculus (matrices, vectors)

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Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

- 1 4×2 · Rows $\times$ columns.
- 2 $[3 \ 0; 4 \ 5]$ · Entry by entry.
- 3 $[3 \ -6; 0 \ 12]$ · Multiply each entry.
- 4 $14 \cdot 20 - 6$.
- 5 No · Inner dimensions 3 and 2 differ.
- 6 3×2 · Outer dimensions.
- 7 $17 \cdot 2 + 15$.
- 8 $17 \cdot 8 - 15 - 17$.
- 9 $\langle 2, 4 \rangle$ · Add components.
- 10 $\langle 8, -2 \rangle$ · Scale components.

Logarithms

A logarithm is an exponent.

AX-3

LESSON

THE RULE

$\log_b(x) = y$ means $b^y = x$. To solve a log equation, rewrite it in exponential form; to simplify, use the log rules.

RULE	EXAMPLE
Definition	$\log_2(8) = 3$ because $2^3 = 8$
Product	$\log(ab) = \log a + \log b$
Quotient	$\log(a/b) = \log a - \log b$
Power	$\log(a^n) = n \cdot \log a$
Special values	$\log_b(b) = 1 \cdot \log_b(1) = 0$
Common and natural	$\log = \text{base } 10 \cdot \ln = \text{base } e$
Solve $b^x = c$	$x = \log_b(c)$

REMEMBER Rewrite to solve: $\log_3(x) = 4 \rightarrow x = 3^4 = 81$. And $\log(a + b)$ does **not** split into $\log a + \log b$.

WORKED EXAMPLES

- $\log_{10}(1,000) = 3$
- $\log_3(x) = 2 \rightarrow x = 9$
- $\log 2 + \log 5 = \log 10 = 1$
- $2 \log_3(3) = \log_3(9) = 2$

TRAPS

- ✗ $\log(a + b) = \log a + \log b$ ✓ Only $\log(ab)$ splits that way
- ✗ $\log_2(8) = 4$ ✓ 3, because $2^3 = 8$
- ✗ $\log_b(1) = 1$ ✓ 0

DRILL HABIT

Ten log questions: rewrite every one in exponential form first, even when you can see the answer.

TRY IT

- 1 $\log_4(64) = ?$
- 2 $\log_5(x) = 3$. $x = ?$
- 3 $\log_2(32) - \log_2(4) = ?$
- 4 Solve $10^x = 0.01$.

ANSWERS 1 3 · 2 125 · 3 3 · 4 -2

Logarithms: Drill

10 original questions. Answer all of them before checking.

AX-3

DRILL

- 1 $\log_3(81) = ?$
- 2 $\log_2(x) = 5$. $x = ?$
- 3 $\log 4 + \log 25 = ?$
- 4 $\log_5(1) = ?$
- 5 $\log_2(64) - \log_2(8) = ?$
- 6 $3 \log_2(4) = ?$
- 7 Solve $10^x = 1,000$.
- 8 $\log_4(x) = 1/2$. $x = ?$
- 9 Does $\log(a + b) = \log a + \log b$?
- 10 $\ln(e^5) = ?$

WHERE TO PRACTICE · FREE

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Extra reps · Khan Academy (free) · Algebra 2 (logarithms)

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ANSWERS

1 $4 \cdot 3^4 = 81$.

2 $32 \cdot 2^5$.

3 $2 \cdot \log 100$.

4 $0 \cdot 5^0 = 1$.

5 $3 \cdot \log_2(8)$.

6 $6 \cdot \log_2(64)$.

7 $3 \cdot \log 1,000$.

8 $2 \cdot 4^{1/2}$.

9 No · Only $\log(ab)$ splits.

10 5 · Natural log undoes e.

Sequences and Series

Add the same, or multiply the same.

AX-4

LESSON

THE RULE

Arithmetic sequences add the same number each step (the common difference d). **Geometric** sequences multiply by the same number (the common ratio r).

IDEA	FORMULA	EXAMPLE
Arithmetic nth term	$a_n = a_1 + (n - 1)d$	3, 7, 11, ... $\rightarrow a_{10} = 3 + 9 \cdot 4 = 39$
Arithmetic sum	$S_n = n(a_1 + a_n)/2$	$1 + 2 + \dots + 100 = 5,050$
Geometric nth term	$a_n = a_1 \cdot r^{n-1}$	2, 6, 18, ... $\rightarrow a_5 = 2 \cdot 3^4 = 162$
Geometric sum	$S_n = a_1(1 - r^n)/(1 - r)$	$1 + 2 + 4 + 8 + 16 = 31$
Which type?	subtract neighbors (same $\rightarrow$ arithmetic) or divide (same $\rightarrow$ geometric)	2, 5, 10, 17: neither

REMEMBER When in doubt, write out the terms: many ACT sequence questions ask for the 6th or 8th term, which is faster to list than to plug into a formula.

WORKED EXAMPLES

- 5, 8, 11, ...: $d = 3$, $a_{20} = 5 + 19 \cdot 3 = 62$
- 81, 27, 9, ...: $r = 1/3$, next term 3
- The first 10 odd numbers sum to 100
- Rows of 20, 22, 24, ... seats; 15 rows $\rightarrow 15(20 + 48)/2 = 510$

TRAPS

- ~~X~~ $a_n = a_1 + nd$ ✓ $a_1 + (n - 1)d$
- ~~X~~ Adding the ratio in a geometric sequence ✓ Multiplying by it
- ~~X~~ Miscounting terms ✓ Writing a few out

DRILL HABIT

For five sequence questions, solve once with the formula and once by listing terms. Note which was faster.

TRY IT

- 1 Arithmetic: 4, 10, 16, ... 12th term?
- 2 Geometric: 3, 12, 48, ... 6th term?
- 3 Sum: $2 + 4 + 6 + \dots + 40$?
- 4 Is 2, 5, 10, 17, ... arithmetic, geometric or neither?

ANSWERS 1 70 · 2 3,072 · 3 420 · 4 Neither

Sequences and Series: Drill

10 original questions. Answer all of them before checking.

AX-4

DRILL

- 1 Arithmetic: 7, 11, 15, ... 20th term?
- 2 Geometric: 5, 10, 20, ... 7th term?
- 3 Sum $1 + 2 + \dots + 50$?
- 4 Common difference of 30, 24, 18, ...?
- 5 Common ratio of 81, 27, 9, ...?
- 6 Arithmetic: $a_1 = 4$, $a_{10} = 40$. d ?
- 7 Sum of the first 5 terms of 3, 6, 12, ...?
- 8 Is 1, 4, 9, 16, ... arithmetic, geometric or neither?
- 9 Theater rows: 12, 14, 16, ... seats; 10 rows. Total seats?
- 10 Geometric: 2, -6, 18, ... 5th term?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Functions

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Algebra 2 / Precalculus (series)

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ANSWERS

1 $83 \cdot 7 + 19 \cdot 4$.

2 $320 \cdot 5 \cdot 2^6$.

3 $1,275 \cdot 50 \cdot 51/2$.

4 -6 · Subtract neighbors.

5 $1/3$ · Divide neighbors.

6 $4 \cdot 36/9$.

7 $93 \cdot 3 + 6 + 12 + 24 + 48$.

8 Neither · Squares.

9 $210 \cdot 10(12 + 30)/2$.

10 $162 \cdot 2 \cdot (-3)^4$.

Counting: Permutations and Combinations

Does order matter?

AX-5

LESSON

THE RULE

The counting principle: **multiply** the number of choices at each step. If order matters, it's a permutation; if it doesn't, a combination.

IDEA	FORMULA	EXAMPLE
Counting principle	multiply the choices	3 shirts $\times$ 4 pants = 12 outfits
Factorial	$n! = n(n-1)\dots(1)$	$4! = 24$
Permutations (order matters)	$nPr = n!/(n-r)!$	gold, silver, bronze among 8 runners: $8 \cdot 7 \cdot 6 = 336$
Combinations (order doesn't)	$nCr = n!/(r!(n-r)!)$	a team of 3 from 8: 56
Arranging n items	$n!$	5 books on a shelf: 120

REMEMBER Ask one question: if I swap two of the chosen items, is it a different outcome? Yes $\rightarrow$ permutation. No $\rightarrow$ combination. Most calculators have nPr and nCr functions.

WORKED EXAMPLES

- License plate of 3 letters then 2 digits: $26^3 \cdot 10^2 = 1,757,600$
- A committee of 2 from 5: 10
- A president and a vice president from 5: 20
- Arrangements of the letters in CAT: 6

TRAPS

- ~~X~~ Adding choices instead of multiplying **✓ Multiplying**
~~X~~ Permutations for a team **✓ Combinations: order doesn't matter**
~~X~~ $5! = 5 \cdot 4$ **✓ $5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$**

DRILL HABIT

For 10 counting questions, write PERM or COMB before calculating, based on the swap test.

TRY IT

- 1 Ways to choose 2 toppings from 6?
- 2 Ways to award 1st and 2nd place among 6?
- 3 4-digit codes using 0-9 with repeats allowed?
- 4 $6! = ?$

ANSWERS 1 15 · 2 30 · 3 10,000 · 4 720

Counting: Permutations and Combinations: Drill AX-5

10 original questions. Answer all of them before checking.

DRILL

- 1 4 shirts and 3 pants: outfits?
- 2 $5! = ?$
- 3 Committee of 3 from 7?
- 4 President, VP and treasurer from 7?
- 5 Arrangements of the letters in STAR?
- 6 3-digit codes using 0–9, repeats allowed?
- 7 3-digit codes, no repeats?
- 8 Choose 2 pizza toppings from 8?
- 9 Order matters: permutation or combination?
- 10 Ways to seat 6 people in a row?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Statistics and Probability

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Statistics and probability (counting)

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 $12 \cdot 4 \times 3$.

2 $120 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$.

3 $35 \cdot 7C3$.

4 $210 \cdot 7 \cdot 6 \cdot 5$.

5 $24 \cdot 4!$.

6 $1,000 \cdot 10^3$.

7 $720 \cdot 10 \cdot 9 \cdot 8$.

8 $28 \cdot 8C2$.

9 Permutation · Swap test.

10 $720 \cdot 6!$.

Trigonometry Beyond Right Triangles

The unit circle, graphs and the laws.

AX-6

LESSON

THE RULE

The ACT goes past SOH-CAH-TOA (GT-4): the unit circle, trig graphs, identities, and the laws of sines and cosines.

IDEA	FORMULA OR EXAMPLE
Unit circle	$(\cos \theta, \sin \theta)$; $\sin 30^\circ = 1/2$, $\cos 60^\circ = 1/2$, $\sin 45^\circ = \sqrt{2}/2$
Signs by quadrant	all positive (I) · sine (II) · tangent (III) · cosine (IV)
Pythagorean identity	$\sin^2 \theta + \cos^2 \theta = 1$
$\tan \theta$	$\sin \theta / \cos \theta$
Reciprocals	$\csc = 1/\sin$ · $\sec = 1/\cos$ · $\cot = 1/\tan$
$y = a \sin(bx) + d$	amplitude $ a $ · period $2\pi/b$ · midline $y = d$
Law of sines	$a/\sin A = b/\sin B = c/\sin C$
Law of cosines	$c^2 = a^2 + b^2 - 2ab \cos C$

REMEMBER Two angles and a side → law of sines. Two sides and the angle between them → law of cosines. ACT questions often only ask you to set up the expression.

WORKED EXAMPLES

- $\sin 150^\circ = 1/2$ (quadrant II, positive)
- $\sin \theta = 3/5$ in quadrant I → $\cos \theta = 4/5$
- $y = 3 \sin(2x)$: amplitude 3, period π
- Sides 5 and 8 with 60° between: $c^2 = 25 + 64 - 80(1/2) = 49 \rightarrow c = 7$

TRAPS

- ✗ Period of $\sin(2x) = 4\pi$ ✓ $2\pi/2 = \pi$
- ✗ $\csc = 1/\cos$ ✓ $\csc = 1/\sin$
- ✗ $\cos 120^\circ$ is positive ✓ It's negative (quadrant II)

DRILL HABIT

Draw the unit circle from memory (0° , 30° , 45° , 60° , 90° and their quadrant partners) until you can do it in two minutes.

TRY IT

- 1 $\cos \theta = 5/13$ with θ in quadrant I. $\sin \theta$?
- 2 Amplitude and period of $y = 4 \cos(3x)$?
- 3 $\sin^2(40^\circ) + \cos^2(40^\circ) = ?$
- 4 Is $\tan 200^\circ$ positive or negative?

ANSWERS 1 $12/13$ · 2 4 and $2\pi/3$ · 3 1 · 4 Positive (quadrant III)

Trigonometry Beyond Right Triangles: Drill

10 original questions. Answer all of them before checking.

AX-6

DRILL

- 1 $\sin 30^\circ = ?$
- 2 $\cos 60^\circ = ?$
- 3 Is $\cos 135^\circ$ positive or negative?
- 4 $\sin \theta = 8/17$ in quadrant I. $\cos \theta = ?$
- 5 Period of $y = \sin(3x)$?
- 6 Amplitude of $y = -5 \cos x$?
- 7 $\tan 45^\circ = ?$
- 8 Sides 3 and 5 with 60° between them. Third side?
- 9 $\csc \theta$ equals...?
- 10 $\sin^2(25^\circ) + \cos^2(25^\circ) = ?$

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Functions; Geometry

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Trigonometry

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 $1/2$ · Unit circle.

2 $1/2$ · Unit circle.

3 Negative · Quadrant II.

4 $15/17$ · 8-15-17.

5 $2\pi/3$ · $2\pi/b$.

6 $5 \cdot |a|$.

7 $1 \cdot \sin/\cos$.

8 $\sqrt{19} \cdot c^2 = 9 + 25 - 15$.

9 $1/\sin \theta$ · Reciprocal.

10 1 · Identity.

Coordinate Geometry and Conics

Midpoints, distances, circles, ellipses, moves.

AX-7

LESSON

THE RULE

Know distance, midpoint and slope cold, and recognize the equations of circles, parabolas and ellipses, plus how reflections and translations move points.

IDEA	FORMULA OR EXAMPLE
Midpoint	$((x_1 + x_2)/2, (y_1 + y_2)/2)$
Distance	$\sqrt{((x_2 - x_1)^2 + (y_2 - y_1)^2)}$
Circle	$(x - h)^2 + (y - k)^2 = r^2$ (GT-5)
Parabola	$y = a(x - h)^2 + k$, vertex (h, k) (AM-4)
Ellipse	$(x - h)^2/a^2 + (y - k)^2/b^2 = 1$, center (h, k)
Reflections	x-axis: $(x, -y)$ · y-axis: $(-x, y)$ · line $y = x$: (y, x)
Translations	right h , up k : $(x + h, y + k)$

REMEMBER An ellipse with $a^2 = 25$ and $b^2 = 9$ reaches 5 units left and right of its center and 3 up and down. If $a = b$, it's a circle.

WORKED EXAMPLES

- Midpoint of $(2, 6)$ and $(8, -2) = (5, 2)$
- Distance from $(-1, 2)$ to $(5, 10) = 10$
- $(x - 1)^2/16 + (y + 2)^2/4 = 1$: center $(1, -2)$, width 8, height 4
- Reflect $(3, -4)$ over the y-axis $\rightarrow (-3, -4)$

TRAPS

- ✗ Midpoint by subtracting ✓ Averaging the coordinates
- ✗ Center of $(x + 3)^2$ at $x = 3$ ✓ $x = -3$
- ✗ Reflecting over the x-axis changes x ✓ It changes y

DRILL HABIT

Sketch every coordinate question, even when a figure is given (MS-5).

TRY IT

- 1 Midpoint of $(-4, 7)$ and $(6, 1)$?
- 2 Distance from $(0, 0)$ to $(9, 12)$?
- 3 Center of $(x - 2)^2/9 + (y + 5)^2/4 = 1$?
- 4 Reflect $(2, 5)$ over the line $y = x$.

ANSWERS 1 $(1, 4)$ · 2 15 · 3 $(2, -5)$ · 4 $(5, 2)$

Coordinate Geometry and Conics: Drill

10 original questions. Answer all of them before checking.

AX-7

DRILL

- 1 Midpoint of $(-6, 2)$ and $(4, 10)$?
- 2 Distance from $(1, 1)$ to $(7, 9)$?
- 3 Center of $(x + 2)^2 + (y - 7)^2 = 9$?
- 4 Radius of the same circle?
- 5 Ellipse $(x - 1)^2/25 + (y + 3)^2/4 = 1$: center?
- 6 Same ellipse: total width?
- 7 Reflect $(4, -2)$ over the x-axis.
- 8 Reflect $(4, -2)$ over the y-axis.
- 9 Translate $(3, 5)$ right 2 and down 4.
- 10 Reflect $(2, 9)$ over $y = x$.

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Geometry

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Precalculus (conic sections)

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 $(-1, 6)$ · Average.

2 10 · 6-8-10.

3 $(-2, 7)$ · Opposite signs.

4 3 · $\sqrt{9}$.

5 $(1, -3)$ · (h, k) .

6 $10 \cdot 2 \cdot 5$.

7 $(4, 2)$ · Change y.

8 $(-4, -2)$ · Change x.

9 $(5, 1)$ · Add and subtract.

10 $(9, 2)$ · Swap.

Domain, Range, Inverses and Piecewise

What goes in, what comes out, and how to undo it.

AX-8

LESSON

THE RULE

Domain = allowed inputs; **range** = possible outputs. An **inverse** undoes a function. A **piecewise** function uses different rules on different intervals.

IDEA	HOW	EXAMPLE
Domain: fractions	denominator $\neq 0$	$1/(x - 3): x \neq 3$
Domain: square roots	inside ≥ 0	$\sqrt{x - 2}: x \geq 2$
Range	possible outputs; read the graph's height	$y = x^2 + 1: y \geq 1$
Inverse	swap x and y , then solve for y	$f(x) = 2x + 3 \rightarrow f^{-1}(x) = (x - 3)/2$
Piecewise	use the rule for the input's interval	$f(x) = x^2$ if $x < 0$, $2x$ if $x \geq 0 \rightarrow f(-3) = 9$
Even or odd	even: $f(-x) = f(x)$ · odd: $f(-x) = -f(x)$	x^2 is even · x^3 is odd

REMEMBER On a graph, the inverse is the reflection over $y = x$: the point (a, b) on f becomes (b, a) on f^{-1} . And $f^{-1}(x)$ is not $1/f(x)$.

WORKED EXAMPLES

- Domain of $\sqrt{4 - x}$: $x \leq 4$
- Range of $y = -(x - 1)^2 + 5$: $y \leq 5$
- $f(x) = x^3 \rightarrow f^{-1}(x) = \sqrt[3]{x}$
- $(2, 7)$ on $f \rightarrow (7, 2)$ on f^{-1}

TRAPS

- ✗ $f^{-1}(x) = 1/f(x)$ ✓ The inverse undoes f ; it isn't the reciprocal
- ✗ Negative inputs allowed in $\sqrt{x}$ ✓ $x \geq 0$
- ✗ Using the wrong piece ✓ Checking which interval the input is in

DRILL HABIT

For 10 functions, write the domain and range before answering anything else about them.

TRY IT

- 1 Domain of $5/(x + 4)$?
- 2 Inverse of $f(x) = 3x - 6$?
- 3 $f(x) = x + 2$ if $x < 1$; x^2 if $x \geq 1$. $f(1) = ?$
- 4 Is $f(x) = x^2$ even, odd or neither?

ANSWERS 1 $x \neq -4$ · 2 $(x + 6)/3$ · 3 1 · 4 Even

Domain, Range, Inverses and Piecewise: Drill

AX-8

DRILL

10 original questions. Answer all of them before checking.

- 1 Domain of $1/(x - 7)$?
- 2 Domain of $\sqrt{x + 5}$?
- 3 Range of $y = x^2 - 3$?
- 4 Inverse of $f(x) = 5x - 2$?
- 5 $(3, 8)$ is on f . Which point is on f^{-1} ?
- 6 $f(x) = 2x$ if $x < 0$; x^2 if $x \geq 0$. $f(-4)$?
- 7 Same f : $f(3)$?
- 8 Is $f(x) = x^3$ even, odd or neither?
- 9 Is $f^{-1}(x)$ the same as $1/f(x)$?
- 10 Inverse of $f(x) = x^3 + 1$?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/math · Math: Functions

Official practice tests · act.org: Free ACT Practice Tests and Prep

Extra reps · Khan Academy (free) · Algebra 2

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 $x \neq 7$ · Denominator $\neq 0$.

2 $x \geq -5$ · Inside ≥ 0 .

3 $y \geq -3$ · Minimum -3 .

4 $(x + 2)/5$ · Swap and solve.

5 $(8, 3)$ · Swap.

6 -8 · First piece.

7 9 · Second piece.

8 Odd · $f(-x) = -f(x)$.

9 No · Inverse $\neq$ reciprocal.

10 $\sqrt[3]{x - 1}$ · Swap and solve.

PART VI

Science and Writing

The optional tests: figures-first Science and the 40-minute essay.

Science Is a Reading Test with Numbers



JOSEF AIDEN DURAND
FROM THE AUTHOR

Students who skip the optional Science test often do it out of fear: “I’m not a science person.” Here’s the secret: the ACT Science test is barely about science. It’s about reading graphs, tables and experiments quickly and literally, which is exactly what the Gladiator System trains.

Most questions send you to one figure. Find it, read its axes and units, find the value, and match it. Others ask what was changed and what was measured in an experiment. A few ask how two scientists would explain the same result. You need almost no outside knowledge, and what little you need fits on one page (SC-6).

Take Science if any college on your list wants it, if you’re heading toward a STEM field, or if you simply aren’t sure yet. It doesn’t touch your Composite, and it gives you a STEM score you can choose to send. For many students, it turns out to be their best test.

Inside the Science Test

Optional, 40 questions, 40 minutes, reasoning.

SC-1

LESSON

THE RULE

Science is **optional**: 40 questions in 40 minutes, **not part of the composite**. With Math, it produces a STEM score. It tests scientific reasoning (reading figures, understanding experiments, comparing explanations), with little outside knowledge.

PASSAGE TYPE	WHAT IT IS	LESSON
Data representation	graphs and tables to read and interpret	SC-2, SC-3
Research summaries	experiments with variables and results	SC-4
Conflicting viewpoints	two or more explanations of one phenomenon	SC-5

REMEMBER Take Science if any college on your list requires or recommends it, if you're applying in STEM, or if you're not sure yet. It doesn't touch the composite, and it adds a STEM score you can choose to send.

WORKED EXAMPLES

- Data passage: a graph of enzyme activity vs. temperature.
- Research summary: three experiments changing the color of light on plants.
- Conflicting viewpoints: two students explain why ice floats.
- Outside knowledge: a few questions, basics only (SC-6).

TRAPS

- ~~✗ Reading every word of the passage first~~ ✓ **Going to the figures and questions**
- ~~✗ Treating it as a science-knowledge test~~ ✓ **It's a reasoning test**
- ~~✗ Skipping it without checking colleges~~ ✓ **Checking each college's policy**

DRILL HABIT

Take one timed Science test and note which passage type cost you the most time.

TRY IT

- 1 Does Science count toward the composite?
- 2 Science combines with Math to make which score?
- 3 Name the three passage types.

ANSWERS 1 No · 2 STEM · 3 Data representation, research summaries, conflicting viewpoints

Inside the Science Test: Drill

8 original questions. Answer all of them before checking.

- 1 Is Science required?
- 2 Does Science count toward the composite?
- 3 Science + Math produce which score?
- 4 Questions and minutes on Science?
- 5 Name the three passage types.
- 6 Is Science mainly a knowledge test?
- 7 Should you read every word of each passage first?
- 8 Unsure where you'll apply. Take Science?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/science · Science: data, research summaries, conflicting viewpoints

Official practice tests · act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 No: it's optional · Check your colleges.

2 No · Composite = English, Math, Reading.

3 STEM · Reported separately.

4 40 in 40 · About one minute each.

5 Data representation, research summaries, conflicting viewpoints · SC-1.

6 No: a reasoning test · Figures and experiments.

7 No · Questions and figures first.

8 Usually yes · It doesn't affect the composite.

Reading Graphs and Tables

Find the value, with its units.

SC-2

LESSON

THE RULE

Most Science questions are answered by finding a value on a figure. Read the question first, then go straight to the figure it names: title, axes, units and key, then the exact point.

STEP DO THIS

- | STEP | DO THIS |
|------|--|
| 1 | Read the question; note which figure, table or experiment it names |
| 2 | Read that figure's axes, units and key |
| 3 | Find the exact row, column or point |
| 4 | Match the value, with units, to the choices |
| 5 | Watch for questions that combine two figures |

REMEMBER Skip long passage text unless a question needs it: the figures carry the data. Units matter (mg vs. g, °C vs. K).

WORKED EXAMPLES

- “According to Figure 2, at 40°C, enzyme activity was...” → find 40 on the x-axis, read up.
- Key: solid line = Species A, dashed line = Species B.
- Combine: Table 1 gives Lake X's temperature; Figure 3 gives oxygen at that temperature.
- Units trap: the graph is in kPa; one choice is in atm.

TRAPS

- ~~X Reading the passage text first~~ ✓ **Going straight to the named figure**
- ~~X Ignoring units~~ ✓ **Matching units**
- ~~X Mixing up the key's lines~~ ✓ **Reading the key first**

DRILL HABIT

For 10 Science questions, write the figure name and the exact value you read before choosing.

TRY IT

- 1 A graph of plant height (cm) shows 25 cm at day 10. The question asks for the height in mm. Answer?
- 2 Table: Trial 1, 20°C, 4 mL; Trial 2, 30°C, 7 mL; Trial 3, 40°C, 10 mL. Gas produced at 30°C?
- 3 What do you read first on every figure?

ANSWERS 1 250 mm · 2 7 mL · 3 Title, axes, units and key

Reading Graphs and Tables: Drill

8 original questions. Answer all of them before checking.

- 1 A graph shows 30 mg at 20 minutes. The question asks in grams. Answer?
- 2 Table: Trial 1 10°C 3 mL; Trial 2 20°C 5 mL; Trial 3 30°C 8 mL. Gas at 20°C?
- 3 Same table: which trial produced the most gas?
- 4 A key shows dashed line = Species B. What do you read first on a figure?
- 5 Figure 2 gives temperature; Figure 3 gives oxygen at each temperature. A question asks oxygen in Lake X. How?
- 6 The axis is in kPa; a choice is in atm. Trap type?
- 7 Should you skip the intro text when the question names a figure?
- 8 Graph: plant height 12 cm at day 6. Height in mm?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/science · Science: data, research summaries, conflicting viewpoints

Official practice tests · act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 0.03 g · Convert units.

2 5 mL · Read the row.

3 Trial 3 · 8 mL.

4 Title, axes, units, key · Every time.

5 Find Lake X's temperature in Fig. 2, then read Fig. 3 · Combine figures.

6 Units trap · Match units.

7 Usually yes · Go straight to the figure.

8 120 mm · $\times 10$.

Trends, Interpolation, Extrapolation

Say the pattern, then use it.

SC-3

LESSON

THE RULE

Questions ask how one variable changes as another changes (the **trend**), what value falls between data points (**interpolation**), or beyond them (**extrapolation**). Describe the trend in words first.

QUESTION	HOW
Trend	"As X increases, Y increases / decreases / rises then levels off"
Interpolation	between two data points: about halfway between their values
Extrapolation	continue the pattern past the data
Direct or inverse	rise together (direct) or one rises as the other falls (inverse)
Maximum or minimum	the highest or lowest point, and where

REMEMBER Don't extrapolate a pattern the data don't show: if a curve levels off, the next value levels off too.

WORKED EXAMPLES

- Pressure 1, 2, 4 atm → volume 12, 6, 3 L: inverse.
- 20°C gives 5 mL, 30°C gives 9 mL → 25°C about 7 mL.
- Values double each hour (2, 4, 8) → 16 next.
- Enzyme activity rises to 37°C, then falls: maximum at 37°C.

TRAPS

- ~~X Assuming every trend is a straight line~~ ✓ **Reading the shape**
- ~~X Extending a curve that levels off as if it keeps rising~~ ✓ **Following the curve**
- ~~X Reading the wrong axis~~ ✓ **Checking axes first**

DRILL HABIT

Describe every figure's trend in one sentence before answering its questions.

TRY IT

- 1 10 g → 2 cm, 20 g → 4 cm, 30 g → 6 cm. Predict 25 g.
- 2 Same data: predict 50 g.
- 3 As temperature rises, a gas's volume rises. Direct or inverse?
- 4 A curve rises steeply, then flattens at 80. Predict a value far past the data.

ANSWERS 1 5 cm · 2 10 cm · 3 Direct · 4 About 80

Trends, Interpolation, Extrapolation: Drill

8 original questions. Answer all of them before checking.

SC-3

DRILL

- 1 Mass 5, 10, 15 g → stretch 1, 2, 3 cm. Predict 12.5 g.
- 2 Same data: predict 30 g.
- 3 Pressure up, volume down. Direct or inverse?
- 4 Values 3, 6, 12, 24 each hour. Next?
- 5 A curve rises steeply, then flattens at 60. Predict far beyond the data.
- 6 Enzyme activity peaks at 37°C then falls. Maximum where?
- 7 20°C → 4 mL, 40°C → 12 mL. Estimate at 30°C.
- 8 Describe the trend before answering: why?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/science · Science: data, research summaries, conflicting viewpoints

Official practice tests · act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 2.5 cm · Linear.

2 6 cm · Extrapolate.

3 Inverse · Opposite directions.

4 48 · Doubling.

5 About 60 · It levels off.

6 37°C · Highest point.

7 About 8 mL · Halfway.

8 It's your Shield for every question on that figure · Predict first.

Experiments: Variables and Controls

What changed, what was measured, what stayed the same.

SC-4

LESSON

THE RULE

Research summaries describe experiments. Identify the **independent variable** (changed on purpose), the **dependent variable** (measured), and the **controlled variables** (kept the same).

TERM	MEANING	EXAMPLE: PLANTS UNDER COLORED LIGHT
Independent variable	changed on purpose	light color
Dependent variable	measured	plant height
Controlled variables	the same in every trial	water, soil, temperature
Control group	a baseline for comparison	plants under white light
Hypothesis	the predicted relationship	red light increases growth
A second experiment	changes one new variable	Experiment 2 changes the amount of water

REMEMBER Questions often ask why a scientist ran Experiment 2, or what design would test a new hypothesis. The answer changes exactly one variable and keeps everything else the same.

WORKED EXAMPLES

- Experiment 1 changes salt concentration and measures boiling point.
- Controlled: same volume of water, same pot, same altitude.
- Experiment 2 uses sugar instead: does the type of solute matter?
- A design that changes two things at once can't show which one caused the result.

TRAPS

- ~~X~~ Mixing up independent and dependent ✓ **Changed = independent; measured = dependent**
- ~~X~~ A design that changes two things at once ✓ **One variable at a time**
- ~~X~~ Ignoring the control group ✓ **It's the baseline**

DRILL HABIT

For every research summary, write IV, DV and controls in the margin before the questions.

TRY IT

- 1 Researchers test 3 amounts of fertilizer and measure tomato yield. Independent variable?
- 2 Dependent variable?
- 3 Which design tests whether temperature affects yield? (A) change fertilizer and temperature together (B) change only temperature, keeping fertilizer the same

ANSWERS 1 Fertilizer amount · 2 Tomato yield · 3 B

Experiments: Variables and Controls: Drill

8 original questions. Answer all of them before checking.

SC-4

DRILL

- 1 Researchers vary light intensity and measure plant growth. Independent variable?
- 2 Dependent variable?
- 3 Name a likely controlled variable.
- 4 Purpose of plants grown under normal light?
- 5 To test whether temperature affects growth, change...?
- 6 A design changes fertilizer and water together. Problem?
- 7 Experiment 2 uses salt water instead of fresh. What is being tested?
- 8 Hypothesis: "More light increases growth." Which result supports it?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/science · Science: data, research summaries, conflicting viewpoints

Official practice tests · act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

- 1 Light intensity · Changed on purpose.
- 2 Plant growth · Measured.
- 3 Water, soil, temperature, plant species · Kept the same.
- 4 Control group (baseline) · Comparison.
- 5 Only temperature · One variable at a time.
- 6 Can't tell which caused the result · Two variables.
- 7 Whether water type (salinity) matters · The new variable.
- 8 Taller plants under more light, other conditions equal · Matches IV → DV.

Conflicting Viewpoints

What each scientist would say.

SC-5

LESSON

THE RULE

Two or more scientists (or students) explain the same thing differently. Summarize each view in one sentence, note where they agree and where they differ, then answer. It's paired passages (RD-8) for science.

QUESTION	STRATEGY
"Scientist 1 would most likely agree..."	match Scientist 1's summary
"Both scientists agree that..."	only what both say
"Which finding supports Scientist 2?"	evidence matching Scientist 2's claim
"Which finding weakens Scientist 1?"	evidence contradicting Scientist 1
Where they differ	the specific point of disagreement

REMEMBER Don't judge who's right; the questions ask what each would say. It's the most reading-heavy Science passage, so many students save it for last.

WORKED EXAMPLES

- Scientist 1: an asteroid caused the dinosaur extinction. Scientist 2: volcanic eruptions over a long period.
- Both agree: a mass extinction happened about 66 million years ago.
- Supports Scientist 1: a worldwide layer of asteroid material from that time.
- Weakens Scientist 2: no sign of major eruptions in that period.

TRAPS

- ~~X~~ Choosing the view you believe ✓ **What each scientist believes**
- ~~X~~ "Both agree" choices from one view ✓ **True of both**
- ~~X~~ Mixing up the scientists ✓ **A one-line summary each**

DRILL HABIT

For each conflicting-viewpoints passage, write one sentence per scientist and one word for their disagreement.

TRY IT

- 1 Student A: the ice melted from the lamp's heat. Student B: from the salt on it. Both agree that...?
- 2 Evidence: ice with salt but no lamp melted just as fast. Which student does this support?

ANSWERS 1 The ice melted · 2 Student B

Conflicting Viewpoints: Drill

8 original questions. Answer all of them before checking.

SC-5

DRILL

- 1 Scientist 1: birds migrate by the stars. Scientist 2: by Earth's magnetic field. Both agree that...?
- 2 Evidence: birds stay on course under cloudy skies. Supports which scientist?
- 3 Evidence: birds raised without ever seeing the night sky still migrate in the right direction. Weakens which scientist?
- 4 Should you decide which scientist is right?
- 5 A "both scientists agree" choice comes from Scientist 1 only. Weapon?
- 6 Student A: plants bent toward the window because of light. Student B: because of warmth. Evidence: plants bent toward a cold lamp. Supports?
- 7 What do you write for each viewpoint?
- 8 Which passage type do many students save for last?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/science · Science: data, research summaries, conflicting viewpoints

Official practice tests · act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

- 1 Birds navigate during migration · The overlap.
- 2 Scientist 2 · No stars visible.
- 3 Scientist 1 · They navigate without stars.
- 4 No: what each would say · SC-5.
- 5 Pugio · True of both.
- 6 Student A · Light without warmth.
- 7 A one-sentence summary · Then the disagreement word.
- 8 Conflicting viewpoints · Most reading.

Science Knowledge You Need

A small set of facts, once.

SC-6

LESSON

THE RULE

A few Science questions need basic outside knowledge. These facts come up most; learn this page and spend the rest of your time on figures and experiments.

AREA	KNOW THIS
Biology	cells, DNA and genes, photosynthesis (carbon dioxide + water + light → sugar + oxygen), food chains
Chemistry	atoms and molecules; pH below 7 acidic, above 7 basic; states of matter; density = mass ÷ volume
Physics	speed = distance ÷ time; gravity; energy is conserved; heat flows from hot to cold
Earth and space	rock types; the water cycle; the atmosphere's layers; Earth orbits the Sun
Units	kilo = 1,000 · centi = 1/100 · milli = 1/1,000 · K = °C + 273

REMEMBER These questions are a small share of the test. Don't study a textbook for them.

WORKED EXAMPLES

- Water freezes at 0°C (273 K) and boils at 100°C at sea level.
- A solution with pH 3 is acidic.
- 50 g in 25 mL → density 2 g/mL.
- Plants release oxygen during photosynthesis.

TRAPS

- ~~X pH 9 is acidic~~ ✓ pH 9 is basic
~~X K = °C - 273~~ ✓ K = °C + 273
~~X Heat flows from cold to hot~~ ✓ Hot to cold

DRILL HABIT

Read this page aloud twice a week until the test, and quiz yourself on the units row.

TRY IT

- 1 Is pH 11 acidic or basic?
- 2 Convert 25°C to kelvin.
- 3 A 40 g object has a volume of 10 cm³. Density?
- 4 How many milligrams are in 2 grams?

ANSWERS 1 Basic · 2 298 K · 3 4 g/cm³ · 4 2,000

Science Knowledge You Need: Drill

8 original questions. Answer all of them before checking.

SC-6

DRILL

- 1 Is pH 3 acidic or basic?
- 2 Convert 0°C to kelvin.
- 3 Density of 80 g in 20 cm³?
- 4 Milligrams in 3 grams?
- 5 Photosynthesis releases which gas?
- 6 Heat flows from...?
- 7 Speed of a car that goes 150 km in 3 hours?
- 8 Centimeters in 2.5 meters?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/science · Science: data, research summaries, conflicting viewpoints

Official practice tests · act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 Acidic · Below 7.

2 273 K · + 273.

3 4 g/cm³ · m/V.

4 3,000 · × 1,000.

5 Oxygen · SC-6.

6 Hot to cold · Always.

7 50 km/h · d/t.

8 250 · × 100.

Science Pacing

Questions first, figures second, text last.

SC-7

LESSON

THE RULE

Forty minutes, 40 questions: about **one minute each**. Go to the question, then the figure it names; read passage text only when a question needs it. Save conflicting viewpoints for last if it's your slowest type.

PASSAGE TYPE	TARGET TIME	STRATEGY
Data representation	~4–5 min	straight to the figures
Research summary	~6 min	IV, DV and controls, then the questions
Conflicting viewpoints	~7 min	read the views; one-line summaries
Final minute	—	no blanks

REMEMBER The fastest Science scorers barely read the passages: they read questions and figures. Check the clock after every passage.

WORKED EXAMPLES

- Q3 names Figure 1: skip the intro paragraph and read Figure 1.
- A research summary: mark IV, DV and controls in 30 seconds.
- Clock check after every passage.
- Stuck: guess and move; every question counts the same.

TRAPS

- ~~✗ Reading every passage word for word~~ ✓ **Questions and figures first**
- ~~✗ Ten minutes on one passage~~ ✓ **Clock checks**
- ~~✗ Leaving blanks~~ ✓ **Guessing**

DRILL HABIT

Take a timed Science test with a clock check after each passage; note your slowest type.

TRY IT

- 1 About how long per question?
- 2 In a data passage, what do you read first?
- 3 Which passage type do many students save for last?

ANSWERS 1 About one minute · 2 The question, then the figure it names · 3 Conflicting viewpoints

Science Pacing: Drill

8 original questions. Answer all of them before checking.

- 1 About how long per Science question?
- 2 Data passage: read what first?
- 3 Research summary: what do you mark in 30 seconds?
- 4 Target time for a data passage?
- 5 Target time for conflicting viewpoints?
- 6 When to check the clock?
- 7 Stuck on a question?
- 8 What separates fast Science scorers?

WHERE TO PRACTICE · FREE

ACT QuizMe · quizme.act.org/science · Science: data, research summaries, conflicting viewpoints

Official practice tests · act.org: Free ACT Practice Tests and Prep

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

- 1 About one minute · 40 in 40.
- 2 The question, then the figure it names · Not the intro.
- 3 IV, DV and controls · SC-4.
- 4 About 4–5 minutes · Fastest type.
- 5 About 7 minutes · Most reading.
- 6 After every passage · Stay on pace.
- 7 Guess and move · Every question counts the same.
- 8 They read questions and figures, not whole passages · Figures first.

The ACT Essay: The Task

Your argument, in conversation with three perspectives.

WR-1

LESSON

THE RULE

The optional Writing test gives you **40 minutes** for one essay. You read an issue and three perspectives, then write your own argument and relate it to at least one perspective. It's scored separately and doesn't affect the composite.

DOMAIN	WHAT EARNS POINTS
Ideas and Analysis	a clear thesis that engages the perspectives and the issue's complexity
Development and Support	reasons and specific examples that explain why
Organization	introduction, body paragraphs, conclusion; clear transitions
Language Use and Conventions	precise, varied, correct sentences

REMEMBER Check whether your colleges want the essay; many don't. If they do, build it like an argument essay: claim, reasons, evidence, counterargument.

WORKED EXAMPLES

- Issue: should cities ban cars from downtown?
- Thesis: partial bans work best, because...
- Engage Perspective Two: right about pollution, but it ignores deliveries.
- Example: a specific city, from your reading or experience.

TRAPS

- ~~X Summarizing the perspectives without a thesis~~ ✓ **Your position, stated early**
- ~~X Ignoring the perspectives~~ ✓ **Relating your view to at least one**
- ~~X Vague examples~~ ✓ **Specific ones**

DRILL HABIT

If your colleges want the essay, write one timed practice essay a week in the final month.

TRY IT

- 1 How long is the ACT essay?
- 2 Does it count toward the composite?
- 3 How many perspectives are given?
- 4 Name the four scoring domains.

ANSWERS 1 40 minutes · 2 No · 3 Three · 4 Ideas and Analysis; Development and Support; Organization; Language Use and Conventions

The ACT Essay: The Task: Drill

8 original questions. Answer all of them before checking.

- 1 How long is the ACT essay?
- 2 Does it affect the composite?
- 3 How many perspectives are given?
- 4 Name the four scoring domains.
- 5 Is summarizing the perspectives enough?
- 6 What makes examples strong?
- 7 Should you check whether your colleges want the essay?
- 8 Where does your thesis go?

WHERE TO PRACTICE · FREE

ACT Writing · act.org: sample essays and scoring rubric

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 40 minutes · Optional.

2 No · Scored separately.

3 Three · Engage at least one.

4 Ideas and Analysis; Development and Support; Organization; Language Use and Conventions · WR-1.

5 No: you need your own thesis · Argue.

6 Specific, explained ones · Not vague claims.

7 Yes · Many don't.

8 Early, in the introduction · State it clearly.

The ACT Essay: A 40-Minute Plan

Plan 8, write 28, check 4.

WR-2

LESSON

THE RULE

A clear, organized, specific essay beats a long, wandering one. **Plan for 8 minutes, write for 28, proofread for 4.**

MINUTES WHAT YOU DO

0–8	read the issue and perspectives; choose a thesis; outline 2–3 reasons with examples and one counterpoint
8–14	introduction: context, thesis, preview
14–32	2–3 body paragraphs: reason, example, explanation, link to a perspective
32–36	conclusion: the stakes, why your view matters
36–40	proofread: boundaries, agreement, spelling

REMEMBER A strong structure: two body paragraphs support your view, and a third answers the strongest opposing perspective. That alone shows the complexity graders reward.

WORKED EXAMPLES

- Thesis: “Cities should ban cars downtown on weekends, not every day.”
- Body 1: cleaner air, with an example.
- Body 2: more foot traffic for local shops.
- Body 3: answers the perspective that bans hurt commuters.

TRAPS

- ~~X Writing without an outline~~ ✓ **Eight minutes of planning**
- ~~X No counterargument~~ ✓ **One paragraph answering the other side**
- ~~X No time to proofread~~ ✓ **Saving the last four minutes**

DRILL HABIT

Practice the 8-minute outline alone on five different prompts before writing a full essay.

TRY IT

- 1 How many minutes for planning?
- 2 Where does the counterargument usually go?
- 3 What do the last four minutes cover?

ANSWERS 1 About 8 · 2 The last body paragraph · 3 Proofreading

The ACT Essay: A 40-Minute Plan: Drill

8 original questions. Answer all of them before checking.

WR-2

DRILL

- 1 Minutes for planning?
- 2 Minutes for proofreading?
- 3 Where does the counterargument usually go?
- 4 How many body paragraphs?
- 5 What goes in the outline?
- 6 Is a longer essay always better?
- 7 What should the conclusion do?
- 8 Practice the outline alone on how many prompts first?

WHERE TO PRACTICE · FREE

ACT Writing · act.org: sample essays and scoring rubric

Rungs 1–2: untimed sets, then timed; one front at a time

Rung 3: timed sets every session

Rungs 4–5: full timed tests; the hardest questions at the end of each test

ANSWERS

1 About 8 · Outline first.

2 About 4 · The last four.

3 The last body paragraph · Answer the strongest opposing view.

4 Two or three · Plus intro and conclusion.

5 Thesis, 2–3 reasons with examples, one counterpoint · WR-2.

6 No: clear and organized beats long · Quality.

7 State the stakes: why your view matters · Close strong.

8 Five · Then full essays.

PART VII

The Season

Thirty-two plays for planning, practicing, evaluating, and winning test day.

Emotional Discipline and the Art of Recovery



JOSEF AIDEN DURAND
FROM THE AUTHOR

Every student hits a question that rattles them. The difference is what happens next. The undisciplined student spends three minutes fighting it, panics, and rushes the next five. That one question cost six.

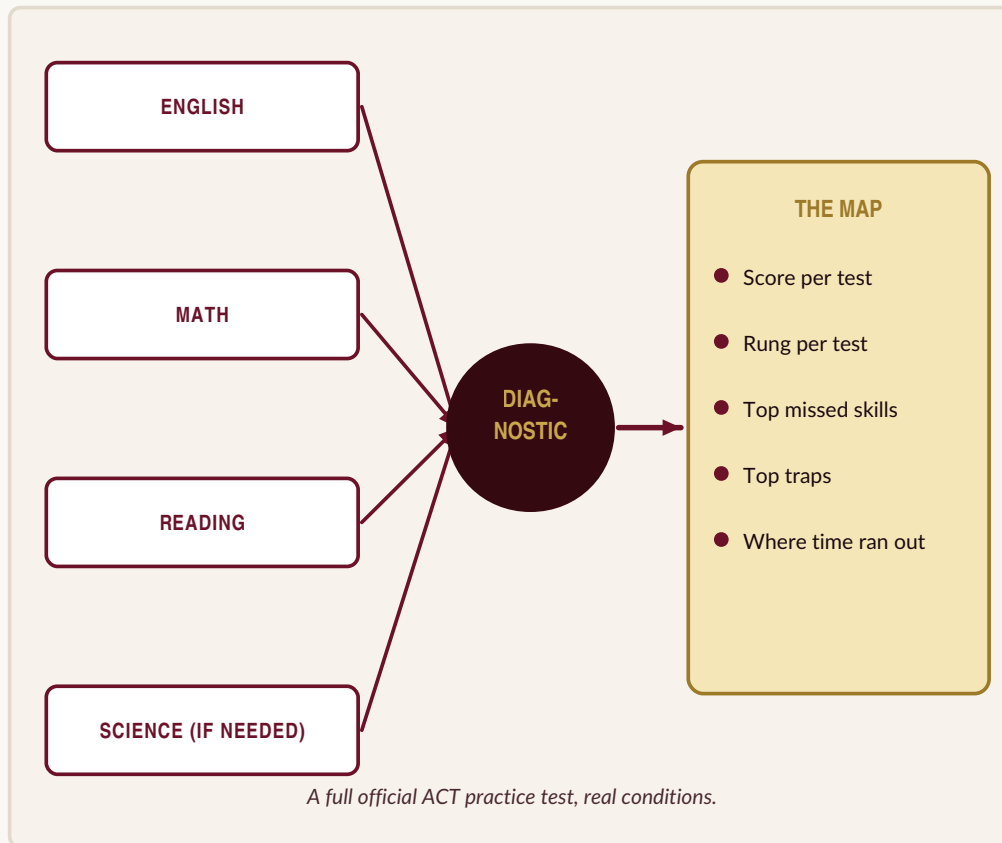
Recovery is a skill. Flag the question, guess, take one slow breath, and play the next question as if it were the first question of a new game. Because it is. The ACT doesn't hold a grudge, and neither should you.

The same goes for bad practice tests. A rough Saturday isn't a verdict; it's film. Football teams don't burn the tape of a loss. They watch it twice, on Monday, with the coaches. Do the same: evaluate every miss within 48 hours and write down what you'll do differently.

Emotional discipline doesn't mean feeling nothing. It means feeling it, and running the play anyway.

The Diagnostic

Start from an official score, not a guess.



SITUATION

Week 0, before any lessons.

THE PLAY

- 1 Take a full official ACT practice test (free on act.org) under real conditions: timed, with breaks, in the format you'll test in (paper or online).
- 2 Include Science if any college might want it; skip the essay unless required.
- 3 Score it with its own key; record each test score and every miss by skill.
- 4 Evaluate every miss and guess within 48 hours (ACT-7).

COACHING POINTS

A diagnostic is a map, not a verdict. The most useful numbers are the skills and traps behind the misses, and where the clock ran out.

FORMATION One full official test, one skill map.

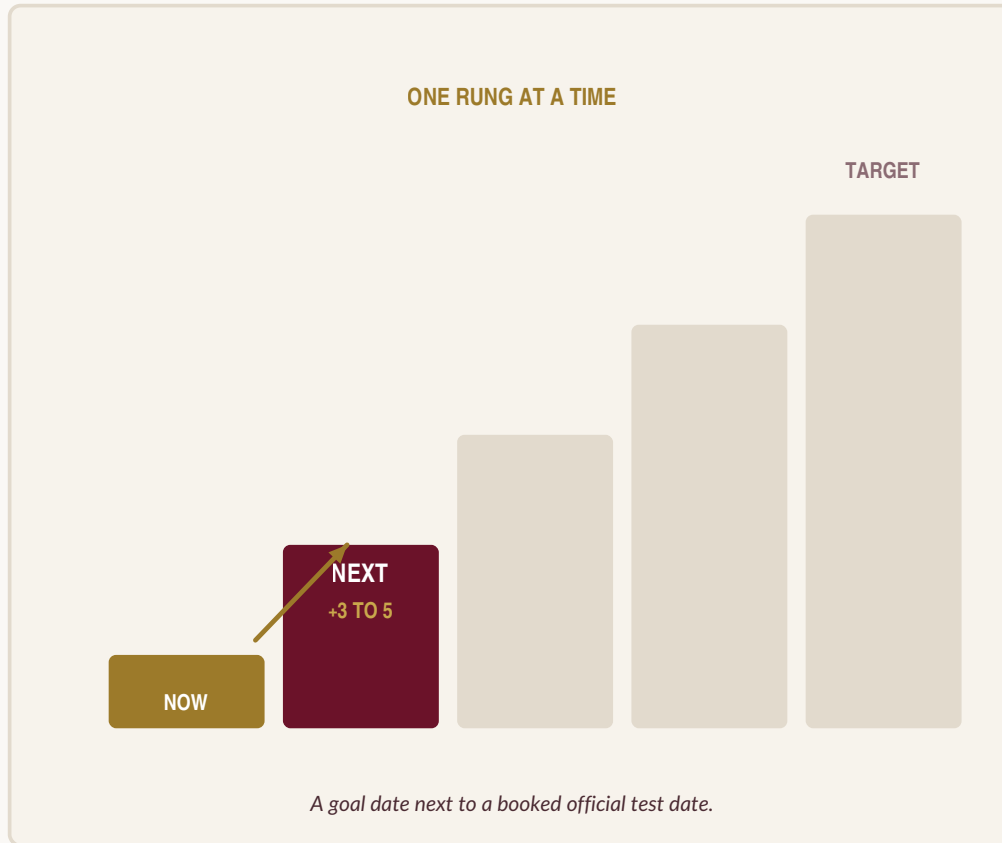
SCOREBOARD

Every student starts with an official practice score and a skill map.

FILM act.org, free ACT practice tests • The ACT Playbook

The Next Rung

The next rung, not the summit.



FORMATION One rung per test, with a date.

SCOREBOARD

A written next goal for each test, with a date.

FILM The ACT Playbook • your college list

SITUATION

After the diagnostic and after every rung exit.

THE PLAY

- 1 Set the goal as the next rung for each test separately: about 3 to 5 points, not 36.
- 2 Set the long-term target from the score ranges of the colleges on your list.
- 3 Put the goal date next to a booked official test date.
- 4 Review progress at every monthly practice test.

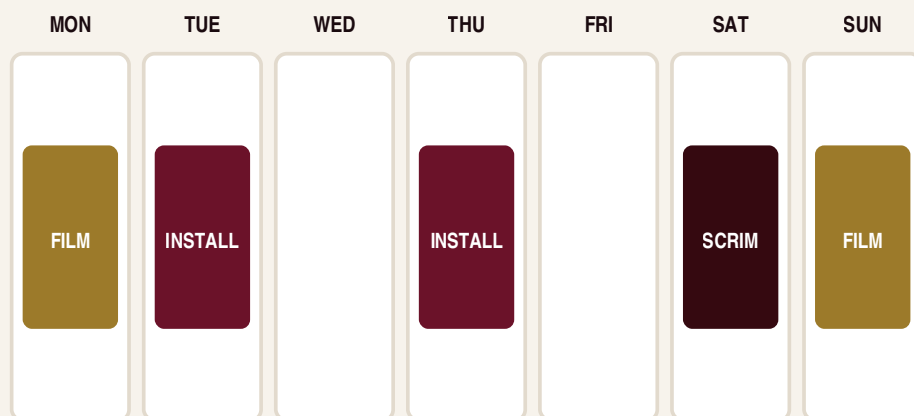
COACHING POINTS

A 12-point jump feels impossible; a 4-point jump feels like next month. Students who see the next rung climb faster.

The Game Week

Film, install, scrimmage, film.

THE GAME WEEK



Film Monday · install Tuesday and Thursday (ACT-5) · scrimmage Saturday · film Sunday

The same week, all season.

FORMATION A football week: Monday film, two install days, a Saturday scrimmage, Sunday film.

SCOREBOARD

Every day of the game week done, every week.

FILM The ACT Playbook

SITUATION

Every week of the season.

THE PLAY

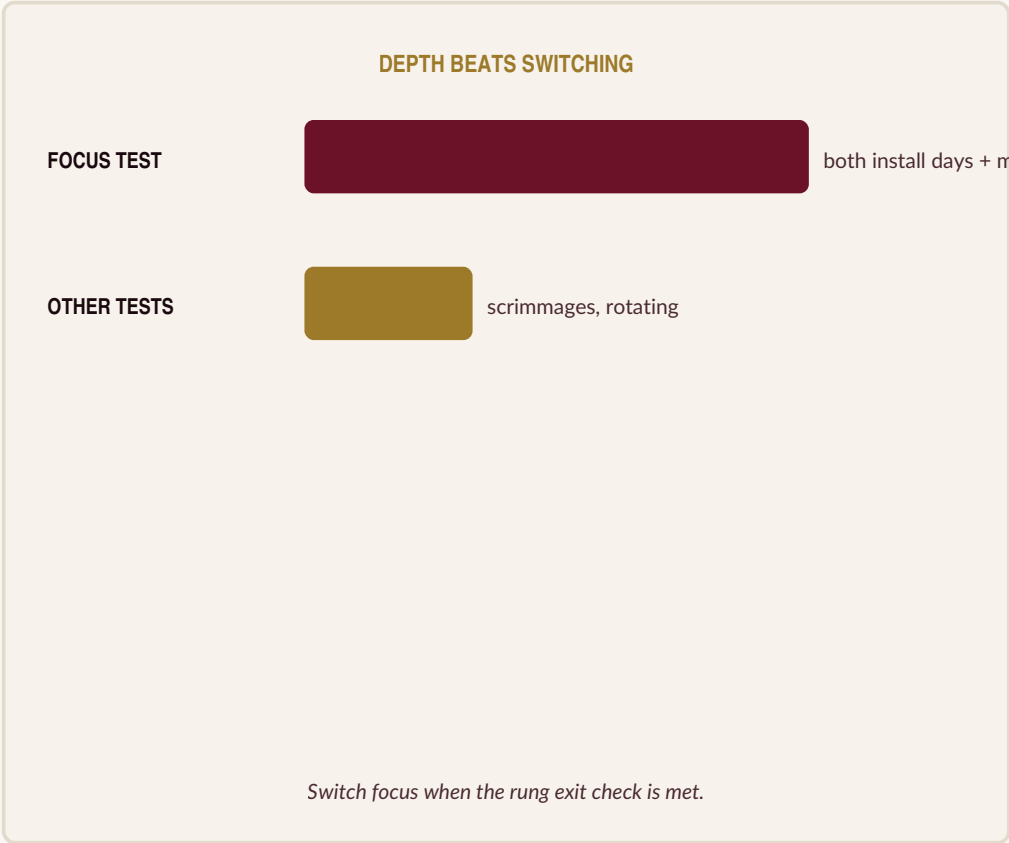
- 1 Monday, 30 minutes: film. Redo the misses due today (ACT-10) and reread last week's Film Sheet.
- 2 Tuesday and Thursday, 45 minutes each: install days (ACT-5).
- 3 Saturday: the scrimmage, one timed test (English, Math, Reading or Science).
- 4 Sunday, 30 minutes: film review of every scrimmage miss (ACT-7), with the tutor if you have one.

COACHING POINTS

Teams win on the same week, run all season. A fixed game week survives busy weeks; "I'll study when I have time" doesn't.

One Front at a Time

Depth beats switching.



SITUATION

Every block of the season.

THE PLAY

- 1 Choose the test with the biggest gap to its goal, or the one closest to its next rung.
- 2 Both install days go to it until the rung is cleared.
- 3 Hold the others with the Saturday scrimmage, rotating through them.
- 4 Switch focus when the rung exit check is met.

COACHING POINTS

Splitting every week across three or four tests makes slow progress on all of them. Focus produces visible jumps.

FORMATION Attack one front; hold the rest.

SCOREBOARD

One focus test at a time, the others maintained.

FILM The ACT Playbook

Install Day

One page in, then the reps.

INSTALL DAY · 45 MINUTES

LEARN

15

one lesson page

REPS

25

10–15 timed questions

LOG

5

for Sunday

The lesson before the reps. Film days do the reviewing.

FORMATION 15 minutes to learn, 25 to rep, 5 to log.

SCOREBOARD

Every install day ends with every miss logged.

FILM The ACT Playbook

SITUATION

Tuesday and Thursday of every game week.

THE PLAY

- 1 15 minutes: one Lesson Book page, chosen from the last scrimmage's film.
- 2 25 minutes: a timed set on that skill from official material (ACT-9).
- 3 5 minutes: log every miss and guess on the Film Sheet for Sunday (REF-3).
- 4 Stop on time. The film days do the reviewing.

COACHING POINTS

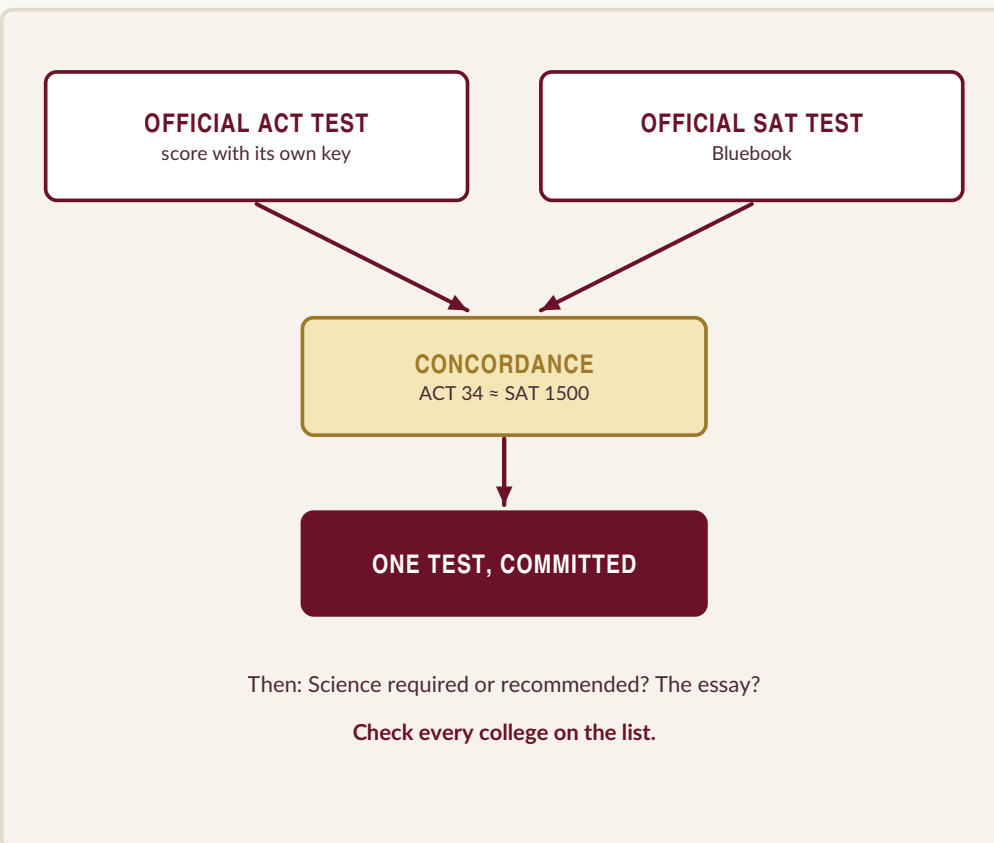
Install days put the lesson before the reps, and the film days make sure nothing missed goes unreviewed.

ACT or SAT? Science? The Essay?

Decide on evidence, then commit.

ACT-6

PLAY CALL



SITUATION

Week 0.

THE PLAY

- 1 If unsure, take one official practice test of each (ACT and SAT) and compare with the concordance (ACT 34 ≈ SAT 1500).
- 2 Choose the test with the higher concordance score, or the one the student prefers; commit to one.
- 3 Check each college on the list: Science required or recommended? Essay required?
- 4 Book two official test dates (paper or online) and plan the second sitting from the start.

COACHING POINTS

Some students are faster readers than deep thinkers, or stronger in advanced math; the ACT rewards speed and reach, the SAT rewards precision. One test, fully prepared, beats two half-prepared.

FORMATION *Diagnose both; choose one; book the dates.*

SCOREBOARD

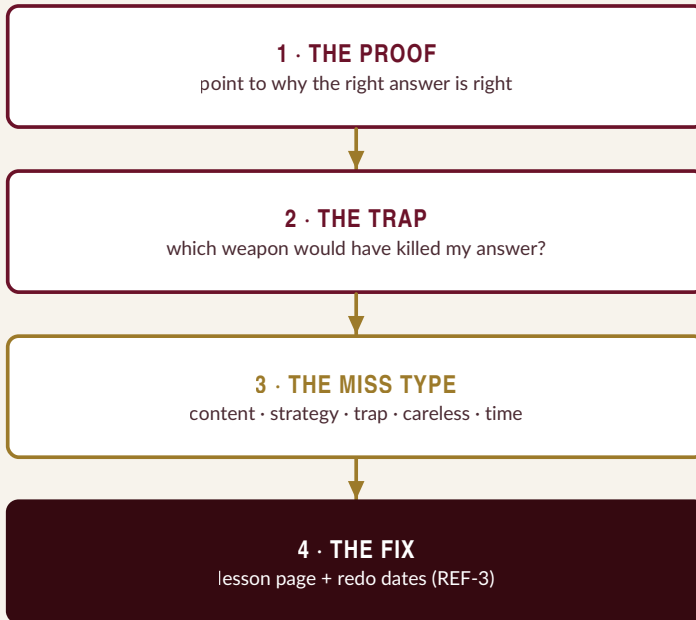
One test chosen and dates booked before training starts.

FILM ACT/College Board concordance (2018) • act.org test options

Film Review

Every miss gets a film session.

EVERY MISS, WITHIN 48 HOURS



Every miss gets a film session.

FORMATION Proof, trap, miss type, fix.

SCOREBOARD

Zero unevaluated misses.

FILM The Gladiator System · REF-3 The Film Sheet

SITUATION

Every missed or guessed question, within 48 hours.

THE PLAY

- 1 Prove the right answer: point to the words, the rule or the math that make it right.
- 2 Name why your answer was wrong: which weapon (GL-4 to GL-9) or which step.
- 3 Classify the miss: content, strategy, trap, careless or time.
- 4 Write the fix: a Lesson Book page and redo dates, on the worksheet (REF-3).

COACHING POINTS

Teams that skip film repeat their mistakes on Saturday. Name the trap once, in writing, and it rarely beats the student again.

The Error Log

Patterns, not problems.

ACT-8

PLAY CALL

THIS WEEK'S PATTERN COUNT

RAN OUT OF TIME



9 · Reading

BOUNDARIES



6 · comma splice

INFERENCE



5 · OOS

TRIG



3 · no formula

PERCENTS



1

On the ACT, count "time" as its own category.

SITUATION

Every week.

THE PLAY

- 1 Keep every evaluation in one log.
- 2 Each week, count misses by skill, by trap code, and by "ran out of time."
- 3 The top three skills set next week's lessons; the top trap sets next week's drill.
- 4 Use the counts to plan next week's sessions.

COACHING POINTS

On the ACT, "time" is often the biggest category. Counting it separately turns a vague feeling into a pacing plan.

FORMATION Every evaluation in one place.

SCOREBOARD

A weekly pattern count, every week.

FILM The ACT Playbook

Targeted Reps

The exact skill, from official material.



Keep some full official tests untouched for scrimmages.

FORMATION Tag, learn, rep.

SCOREBOARD

Every set chosen from the error log's top skills.

SITUATION

Every install day.

THE PLAY

- 1 Tag every question in the official practice tests you've taken by skill (use the Lesson Book codes).
- 2 For a weak skill, pull every past question with that tag, plus the matching Try It items.
- 3 Keep some full official tests untouched for scrimmages (ACT-27).
- 4 Work sets timed, then evaluate.

COACHING POINTS

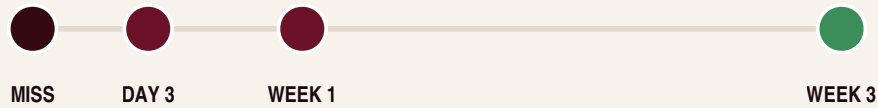
Official questions are the gold standard and they're limited; tagging them by skill makes every one count twice.

FILM act.org practice tests • Official ACT Prep Guide • The ACT Playbook

Redo Until Automatic

Solve it again: in 3 days, a week, 3 weeks.

REDO FROM SCRATCH, NO PEEKING



Mastered = two correct redos with full reasoning.

A redo miss resets the schedule.

SITUATION

Every evaluated miss.

THE PLAY

- 1 Redo every missed question 3 days later, from scratch, without the solution.
- 2 Redo it a week later and three weeks later.
- 3 Mastered: two correct redos with the full reasoning written out.
- 4 A redo miss resets the schedule.

COACHING POINTS

Spaced practice improves long-term memory more than massed practice. Redoing a missed question is the most efficient practice there is.

FORMATION *Three redos on a schedule.*

SCOREBOARD

Every missed question redone on schedule.

FILM Cepeda et al. (2006), distributed practice

Read the Essay, Not Just the Line

Context answers half the questions.



Shortest correct answer wins the tie.

FORMATION Sentence, choices, rule, choose.

SCOREBOARD

Every question answered with the full sentence read.

FILM Lesson Book ENG-1, ENG-2, GM-1

SITUATION

Every English question.

THE PLAY

- 1 Read the essay as you go, answering each question when you reach it.
- 2 Read the whole sentence around the underline, and the one before it.
- 3 Scan the choices: what's different? Grammar rule or rhetoric?
- 4 Choose; NO CHANGE if nothing is wrong; the shortest if all are correct (ENG-2).

COACHING POINTS

Many English questions can't be answered from the underlined words alone: pronouns, tense and transitions all depend on the sentences around them.

Grammar by Rule

Not by ear.

SITUATION

Every grammar question.

THE PLAY

- 1 Scan the choices: what's different?
- 2 Name the rule: boundaries, agreement, tense, pronoun, possessive, modifier, concision.
- 3 Apply the five-second test (GM-14).
- 4 Choose; about 30 seconds per question.

COACHING POINTS

The fastest English points belong to students who stop guessing by sound. Every second saved here buys time for whole-essay questions.



Grammar by rule, never by ear.

FORMATION Choices first, rule second, sentence third.

SCOREBOARD

About 30 seconds per grammar question, with the rule named.

FILM The Gladiator System • Lesson Book GM-1 to GM-14

English Timing

About 42 seconds a question.

50 QUESTIONS, 35 MINUTES

GRAMMAR



~30 sec

TRANSITIONS



~35 sec

WORD CHOICE



~40 sec

ADD / DELETE



~60 sec

ORDER, GOAL



~70 sec

About 7 minutes per essay; about 42 seconds on average.

SITUATION

Every timed English test.

THE PLAY

- 1 Budget about 7 minutes per essay set (50 questions in 35 minutes).
- 2 Move fast on grammar (about 30 seconds); slow down on add/delete, order and goal questions.
- 3 Clock check after every essay.
- 4 No blanks: guess and move when stuck.

COACHING POINTS

English is the fastest test on the ACT. Students who slow down on commas run out of time on the whole-essay questions at the end of each passage.

FORMATION Five essays, about 7 minutes each.

SCOREBOARD

Every English test finished, with clock checks.

FILM act.org (English: 50 questions, 35 minutes) • Lesson Book ENG-1

The Passage Attack

Preview, read actively, go back to the lines.



Never answer from memory: go back to the lines.

FORMATION Stems, labels, lines, Shield, weapons.

SCOREBOARD

Every answer checked against the lines.

SITUATION

Every Reading passage.

THE PLAY

- 1 Preview the question stems for about 30 seconds (not the choices).
- 2 Read actively, writing a one-word label next to every paragraph.
- 3 For each question: stem, then the lines, then your Shield.
- 4 Eliminate with the six weapons; select what's left.

COACHING POINTS

Long passages punish answering from memory. Going back to the lines every time is how the Fist and the Axe lose.

Weapons Check

Name the weapon for every kill.

SITUATION

Every practice question until it's automatic.

THE PLAY

- 1 Write a weapon code next to every eliminated choice.
- 2 No code, no elimination.
- 3 In film review, name the weapon that would have killed the trap you chose.
- 4 Drill your most common trap the next week.

COACHING POINTS

Naming the weapon turns a feeling into a reason. Within a few weeks, students see the traps before they finish reading them.

GLADIUS

OPP

Opposite

PUGIO

HALF

Half-Right

TRIDENT

EXT

Extreme Language

FIST

RAWQ

Right Answer, Wrong Question

MACE

OOS

Out of Scope

AXE

REC

Recycled Language

"How can I attack this answer?"

The Shield first (GL-3). Then the six weapons (GL-4 to GL-9).

FORMATION Six codes: OPP, HALF, EXT, RAWQ, OOS, REC.

SCOREBOARD

Every elimination has a code during training.

FILM The Gladiator System • REF-2 The Arsenal

Reading Timing and Passage Order

About 10 minutes a set, your best first.

36 QUESTIONS, 40 MINUTES

SET 1 · BEST TYPE



~9 min

SET 2



~10 min

SET 3



~10 min

SET 4 · WEAKEST



~10 min

FINAL MINUTE



no blanks

Clock check after every set. A silent watch is allowed.

SITUATION

Every timed Reading test.

THE PLAY

- 1 Rank the passage types by your practice accuracy.
- 2 Do your strongest type first, your weakest last.
- 3 About 10 minutes per set; check your watch after each.
- 4 No blanks: guess on anything left in the final minute.

COACHING POINTS

Reading is where most ACT students run out of time. Order and clock checks recover points without reading any faster.

FORMATION Rank, order, check the clock.

SCOREBOARD

Every Reading test finished, in your order.

FILM Lesson Book RD-11 • act.org (Reading: 36 questions, 40 minutes)

Science: Figures First

Optional, but fast points if you take it.



Science tests reasoning with figures, not memorized facts.

FORMATION Question, figure, axes, value.

SCOREBOARD

About one minute per question, every test finished.

SITUATION

Every Science passage, for students taking Science.

THE PLAY

- 1 Read the question first; go to the figure it names.
- 2 Read the figure's axes, units and key; find the exact value.
- 3 For experiments, mark the independent and dependent variables and controls (SC-4).
- 4 About one minute per question; save conflicting viewpoints for last if it's slow for you.

COACHING POINTS

Science rewards reading figures, not science knowledge. Students who stop reading every word of the passage gain minutes.

FILM Lesson Book SC-1 to SC-7 • act.org (Science: optional, 40 questions, 40 minutes)

Content Before Speed

You can't outrun a gap.

CONTENT FIRST, THEN SPEED

1

ALGEBRA + FUNCTIONS

AL, AM: the core of the test

2

GEOMETRY + TRIG

GT, plus unit-circle trig (AX-6)

3

DATA + PROBABILITY

DA, plus counting (AX-5)

4

NUMBER AND QUANTITY

complex numbers, matrices, vectors (AX-1, AX-2)

5

THE EXTRAS

logs, sequences, conics, inverses (AX-3, AX-4, AX-7, AX-8)

FORMATION *Algebra, functions, geometry, then the extras.*

SCOREBOARD

Every missed content skill has a lesson and 10 reps.

SITUATION

The first weeks of every Math focus block.

THE PLAY

- 1 Map the diagnostic misses to Lesson Book pages (AL, AM, DA, GT, AX).
- 2 Learn the page; do 10 targeted reps.
- 3 Cover the ACT-only topics the SAT skips: complex numbers, matrices, logs, sequences, counting, unit-circle trig (AX-1 to AX-8).
- 4 Only then work on speed.

COACHING POINTS

The ACT reaches further than the SAT. A student who has never seen a matrix loses that point no matter how fast they are.

FILM act.org (Math) • Lesson Book AL, AM, DA, GT, AX

Formulas From Memory

No sheet. No excuses.

THE BLANK PAGE · 5 MINUTES

$$A = \frac{1}{2}bh \quad A = \pi r^2 \quad C = 2\pi r$$

$$V = \pi r^2 h \quad V = \frac{4}{3}\pi r^3$$

$$a^2 + b^2 = c^2 \quad x, x\sqrt{3}, 2x$$

$$m = (y_2 - y_1)/(x_2 - x_1)$$

$$x = (-b \pm \sqrt{b^2 - 4ac})/2a$$

$$\text{SOH-CAH-TOA} \quad \sin^2 + \cos^2 = 1$$

$$a_n = a_1 + (n - 1)d$$

$$nCr = n!/(r!(n - r)!)$$

The ACT gives no formula sheet.

FORMATION *The blank-page drill.*

SCOREBOARD

All of REF-1 from memory by week 4.

FILM Lesson Book MS-7 · REF-1

SITUATION

Daily for the first four weeks; weekly after.

THE PLAY

- 1 Write every formula in REF-1 from memory on a blank page in under five minutes.
- 2 Check against REF-1; circle any you missed.
- 3 Re-write the circled ones three times.
- 4 On test day, jot the shaky ones on your scratch paper as the math test begins.

COACHING POINTS

The SAT hands students a reference sheet; the ACT doesn't. A formula you can't recall is a question you can't start.

The Strategy Toolbox

Four tools for any stuck question.

STUCK? PICK A TOOL

ONE MOVE

MS-2

SWAP IN NUMBERS

MS-3

WORK BACKWARD

MS-4

SKETCH IT

MS-5

Top scorers have more ways in.

FORMATION One move, swap in numbers, work backward, sketch.

SCOREBOARD

Every stuck question tried with at least one tool before guessing.

FILM Lesson Book MS-2 to MS-6

SITUATION

Any question without an obvious path.

THE PLAY

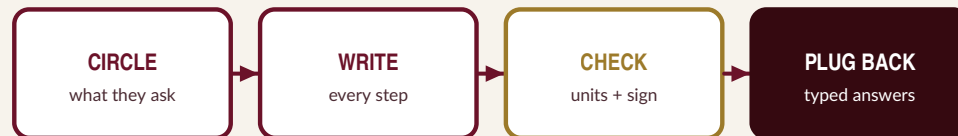
- 1 Find one legal move (MS-2).
- 2 Variables everywhere? Swap in numbers (MS-3).
- 3 Number choices and a hard setup? Work backward from the choices (MS-4).
- 4 Shapes or situations? Sketch it (MS-5), or graph it on your calculator (MS-6).

COACHING POINTS

With four choices on every ACT math question, plugging in and eliminating are always available. Top scorers have more ways in.

The Careless-Error Protocol

Right math, wrong answer, no more.



Careless errors come from skipped steps.

FORMATION Circle, write, check, plug back.

SCOREBOARD

One or fewer careless misses per practice test.

FILM Lesson Book MS-2, MS-6

SITUATION

Every math question at Rungs 4–5, and anyone losing points to careless errors.

THE PLAY

- 1 Circle what they ask for (x, 2x, the sum, the negative root).
- 2 Write every step; no mental algebra with negative signs.
- 3 Check units, the sign, and your calculator's degree/radian mode.
- 4 Plug your answer back into the original.

COACHING POINTS

At 30+, careless errors are often the biggest category of misses. They come from skipped steps, and a protocol removes them.

Math Timing

Fast early, careful late.

45 QUESTIONS, 50 MINUTES

QUESTIONS 1–20



~15 min • fast

QUESTIONS 21–35



~20 min • full method

QUESTIONS 36–45



~15 min • hardest

FINAL MINUTE



no blanks

Mark anything over two minutes and come back.

SITUATION

Every timed math test.

THE PLAY

- 1 Questions 1–20 in about 15 minutes.
- 2 Questions 21–35 in about 20 minutes.
- 3 Questions 36–45 in about 15 minutes; mark anything over two minutes.
- 4 No blanks.

COACHING POINTS

The hardest questions tend to sit at the end. Students who bank time early arrive there with minutes to think.

FORMATION 15, 20, 15.

SCOREBOARD

Every math test finished with marked questions revisited.

FILM Lesson Book MS-8 • act.org (Math: 45 questions, 50 minutes)

Focus, Fatigue, and the War Against Distraction



JOSEF AIDEN DURAND
FROM THE AUTHOR

The ACT takes about two hours, and more than three with Science and the essay. Most teenagers haven't focused on one thing for two hours since they got a phone. That's not a character flaw. It's a training gap, and it can be closed.

Start with your study sessions. Phone in another room, notifications off, door closed. It will feel strange for a week. Then it will feel like a superpower. Every minute of real focus in practice buys you calm on test day.

Fatigue is real, too. Late-test misses are often tiredness, not ignorance. Build stamina the way athletes do: full-length practice tests in the final month, the same time of day as the real thing. And protect your sleep. A rested brain is worth more points than one more night of cramming.

Win the war against distraction in practice, and on test day there won't be a war at all.

The Gladiator Mindset

Switched on, not panicked.

ACT-23

PLAY CALL

SITUATION

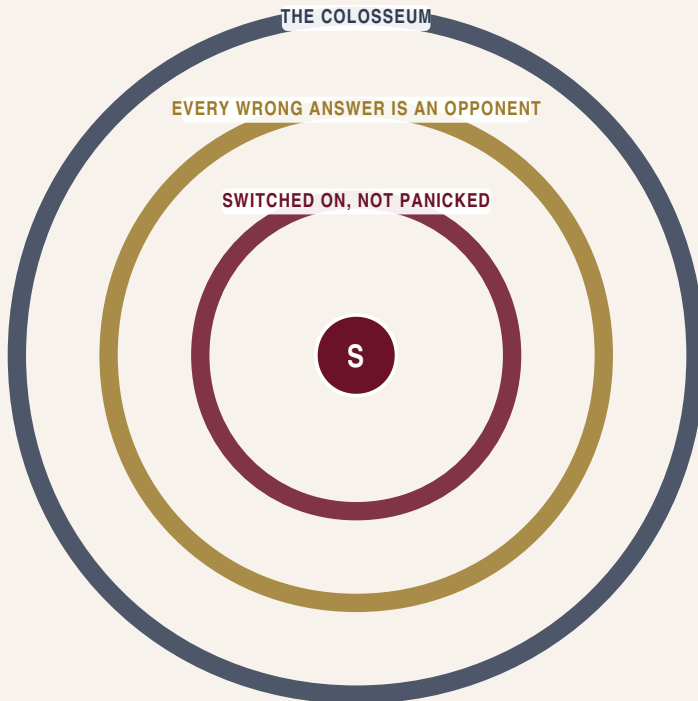
Every timed practice and test day.

THE PLAY

- 1 Treat the test as a contest: every wrong answer is an opponent trying to take points.
- 2 Ask of every choice: "How can I attack this answer?"
- 3 Stay alert and steady; breathe between passages.
- 4 At each break, reset: stand, breathe, drink water.

COACHING POINTS

The right intensity sharpens attention. The gladiator frame turns nerves into focus.



FORMATION Every choice is an opponent.

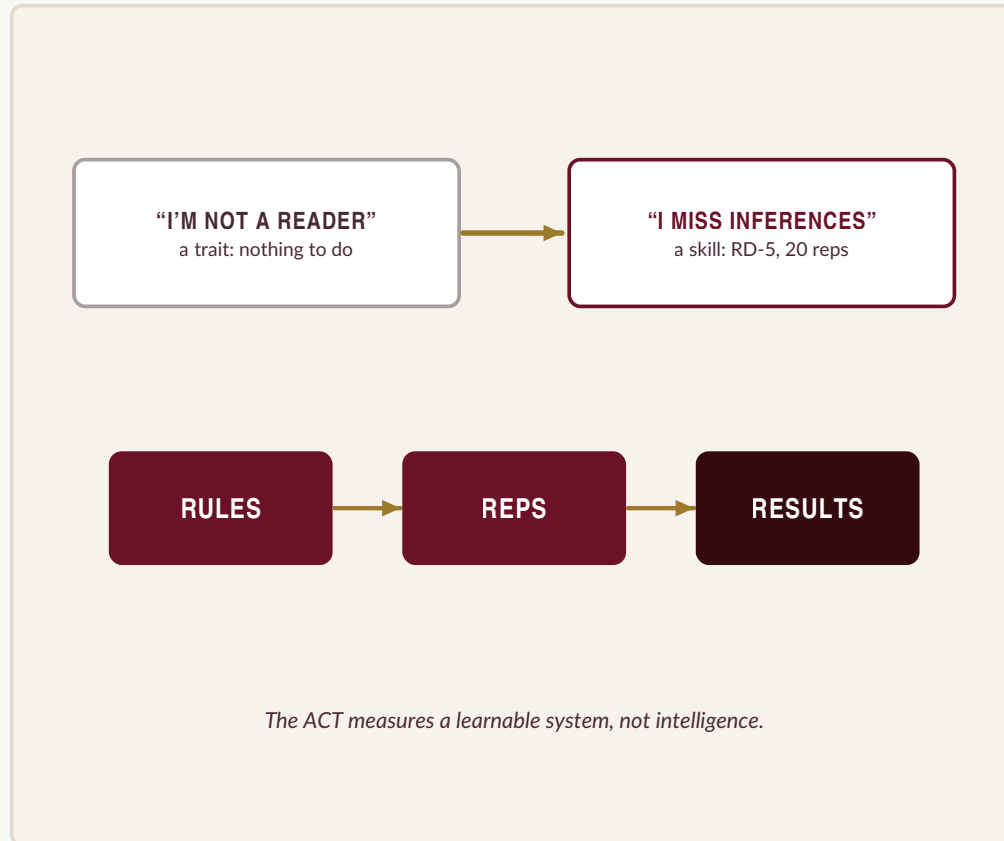
SCOREBOARD

Practice tests taken with full intensity, start to finish.

FILM The ACT Playbook

Not a Test of Intelligence

It's a game with rules. Learn the rules.



FORMATION Rules, reps, results.

SCOREBOARD

Every student can name the skill behind a low score, not a trait.

FILM The ACT Playbook

SITUATION

Week 0, and whenever a student calls a whole subject a weakness.

THE PLAY

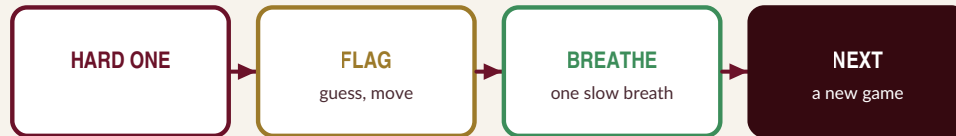
- 1 Explain the opponent: the test-maker, its traps and its clock.
- 2 Name the skill, not the trait: pacing on literary passages, not "reading."
- 3 Show progress with numbers: rung by rung, skill by skill.
- 4 Celebrate the process: sessions done, misses evaluated.

COACHING POINTS

Students who believe the ACT measures intelligence stop at their first plateau. Students who believe it measures a learnable system keep climbing.

Recovery

The next question is a new game.



One hard question costs one point. Panic costs five.

FORMATION *Mark, breathe, next.*

SCOREBOARD

No more than one question over three minutes per test.

FILM The ACT Playbook

SITUATION

Any hard question, and any moment of panic.

THE PLAY

- 1 Hard question? Mark it, guess, move on: it costs one point; panic costs five.
- 2 One slow breath before the next question.
- 3 A bad passage doesn't predict the next one; play the passage in front of you.
- 4 After the test, review it as data, not as a verdict.

COACHING POINTS

On a fast test, recovering in one breath is a scoring skill.

Focus and Stamina

Two hours or more of full attention.

ACT-26

PLAY CALL

FOCUS IS TRAINED LIKE A MUSCLE

1

PHONE IN ANOTHER ROOM

notifications off

2

FULL-LENGTH TESTS

two hours or more, Science included if you take it

3

SAME SLEEP SCHEDULE

all week, especially test week

4

USE THE BREAK

water, snack, short walk, no phone

SITUATION

Every study session; especially the final month.

THE PLAY

- 1 Study with the phone in another room.
- 2 Build stamina with full-length tests, including Science if you're taking it.
- 3 Protect sleep: the same bedtime and wake time all week.
- 4 Use breaks for water, a snack and a short walk; no phone.

COACHING POINTS

Late-test misses are often fatigue, not knowledge, and Reading comes after English and Math. Focus is trained like a muscle.

FORMATION Phone out, full tests, sleep.

SCOREBOARD

Every study session distraction-free.

FILM The ACT Playbook

Full Scrimmages

Practice the whole game.



Several scrimmages, and test day feels like home.

FORMATION *Full test, test conditions, evaluated.*

SCOREBOARD

A full scrimmage every week in the final month, evaluated.

FILM act.org practice tests • The ACT Playbook

SITUATION

Every week in the final 4–5 weeks.

THE PLAY

- 1 Take a full official practice test at the same time of day as the real test, in the same format (paper or online).
- 2 Real conditions: timed, real breaks, your calculator, a silent watch, no phone.
- 3 Evaluate every miss and guess within 48 hours.
- 4 Track each test score on the ladder chart.

COACHING POINTS

Scrimmages test the whole system at once: knowledge, strategy, pacing, stamina and nerves.

The Final Month

Sharpen, don't cram.

SHARPEN, DON'T CRAM

WEEK 4



scrimmage + targeted reps

WEEK 3



scrimmage + targeted reps

WEEK 2



scrimmage + error log

FINAL WEEK



redo the log · rest · sleep

No new content in the final week.

SITUATION

The four weeks before an official test.

THE PLAY

- 1 Weeks 4–2: a scrimmage every week; targeted reps on the error log's top skills.
- 2 Final week: no new content; redo the error log; one light timed test.
- 3 Fix the sleep schedule to the test-day wake time.
- 4 Re-read REF-1 and REF-2.

COACHING POINTS

The last month is for sharpening and arriving rested. New content in the final week adds anxiety, not points.

FORMATION Scrimmage, review, rest.

SCOREBOARD

No new content in the final week.

FILM The ACT Playbook

The Night Before and the Morning Of

Nothing left to chance.

THE NIGHT BEFORE AND THE MORNING OF

- ☒ Admission ticket (photo uploaded)
- ☒ Acceptable photo ID
- ☒ No. 2 pencils with erasers
- ☒ Permitted calculator, fresh batteries
- ☒ Silent watch (no alarm)
- ☒ Water and a snack for the break
- ☒ Online test: charged device + charger
- ☒ Sleep on schedule • leave early

FORMATION *The checklist.*

SCOREBOARD

Every item on the checklist done the night before.

FILM act.org, What to Bring on Test Day • ACT calculator policy

SITUATION

The day before and the morning of every official test.

THE PLAY

- 1 Night before: admission ticket printed (with your photo uploaded), photo ID ready.
- 2 Pack No. 2 pencils with erasers, a permitted calculator with fresh batteries, a silent watch, water and a snack; for online testing, a charged device and charger.
- 3 Light review only: REF-1 and REF-2. Sleep on schedule.
- 4 Morning: a real breakfast, leave early, arrive before check-in.

COACHING POINTS

Test-day mistakes are usually logistics. A checklist turns the morning into a routine.

In the Colosseum

Test day: run the system.



Run each test's time plan. No blanks anywhere.

FORMATION English, Math, break, Reading, Science, Writing.

SCOREBOARD

The system run, start to finish.

FILM The ACT Playbook

SITUATION

Every official test.

THE PLAY

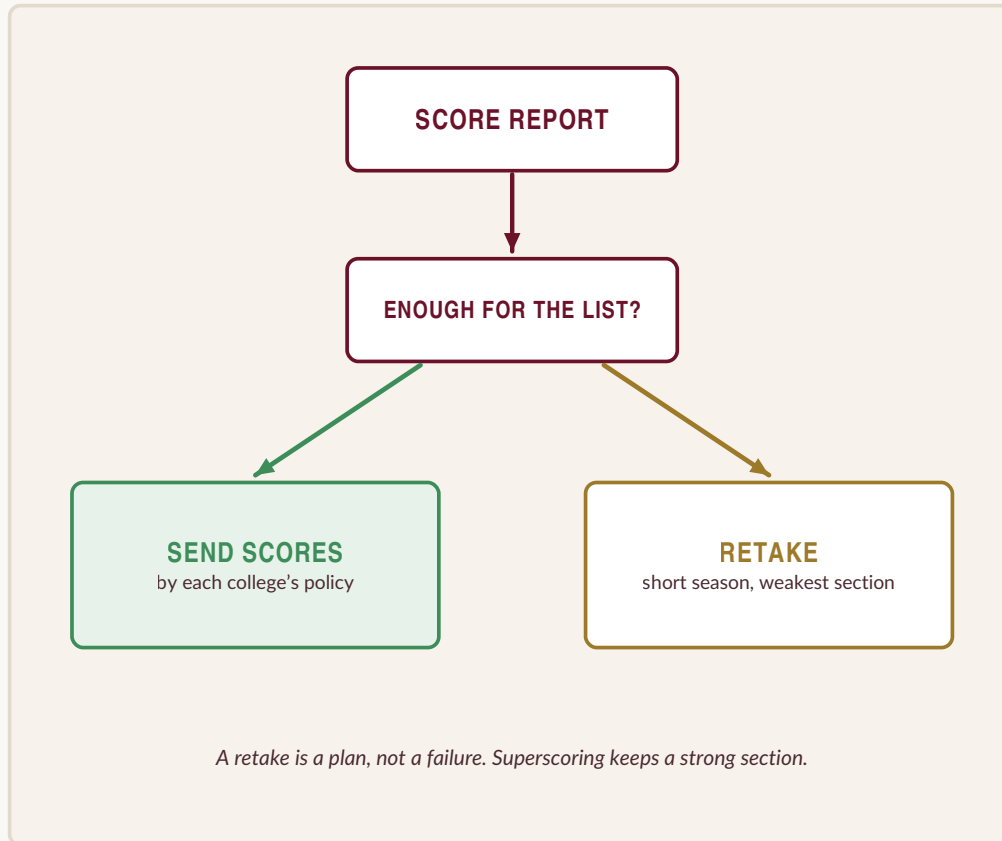
- 1 Run the time plan for each test exactly as practiced; check your watch.
- 2 English and Math first; reset completely at the break.
- 3 Reading in your passage order; Science and the essay if registered.
- 4 No blanks on any test.

COACHING POINTS

Test day isn't the day to try something new. The student who runs the same system as in scrimmages gets the score the scrimmages predicted, or better.

After the Test

Score, decide, plan.



FORMATION Score report, retake decision, next sitting.

SCOREBOARD

A decision and a plan within a week of every score report.

FILM act.org, Sending Your Scores

SITUATION

When official scores arrive.

THE PLAY

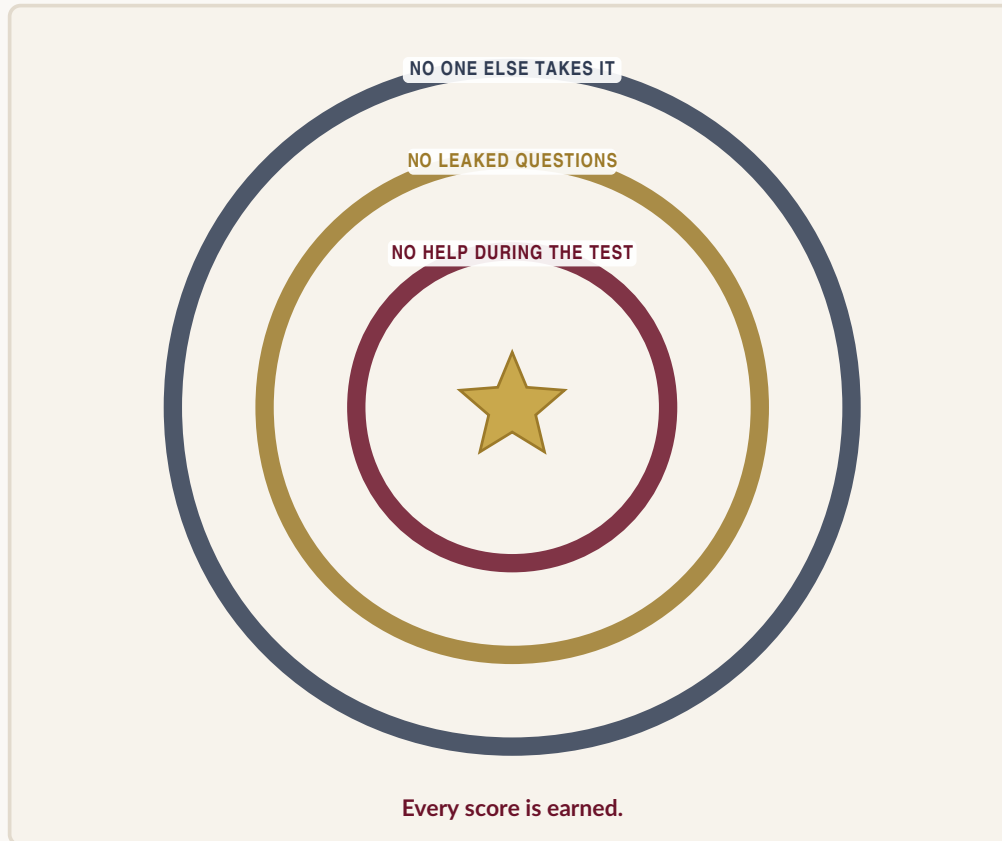
- 1 Compare the scores with the goal and the scrimmages.
- 2 Decide (with a counselor if you have one): is the score enough for your list, or retake?
- 3 If retaking: a short season aimed at the weakest test.
- 4 Send scores by each college's policy; many colleges superscore the ACT.

COACHING POINTS

A retake is a plan, not a failure. Superscoring means a strong test is never wasted.

Every Score Is Earned

The integrity rule.



FORMATION *Your own work, every time.*

SCOREBOARD

Zero tolerance, zero exceptions.

SITUATION

Always.

THE PLAY

- 1 Every score comes from the student's own work on test day.
- 2 No leaked or "real" questions from current tests, ever.
- 3 No help from anyone during the test, and no one else takes it.
- 4 Report anyone offering shortcuts to ACT.

COACHING POINTS

Cheating risks cancelled scores and a student's future, and teaches nothing. An earned 34 builds the student who will do the work in college.

FILM ACT Terms and Conditions • Rules of the Game

PART VIII

The Practice Test

A full-length original ACT practice test, with answers, explanations and a scoring guide.

Test-Day Nerves and Timing Anxiety



JOSEF AIDEN DURAND
FROM THE AUTHOR

Timing anxiety destroys smart students because it turns the clock into a threat. On the ACT, the clock is part of the test, so turn it into a schedule. English: about seven minutes per essay. Math: fifteen minutes for the first twenty questions, twenty for the next fifteen, fifteen for the last ten. Reading: about ten minutes per passage set. Science: about a minute a question. Know your checkpoints, check your watch, and keep moving.

On test day, your nerves will show up. Let them. A little adrenaline sharpens attention. What matters is that your process shows up too: the Shield before every set of choices, the six weapons, NO CHANGE when nothing is wrong, the formulas you wrote from memory, the marks and the returns. You've practiced all of it. Test day isn't the day to invent anything new.

Before you take the practice test that follows, set it up like the real thing. A quiet room. A timer. A silent watch. Your calculator. A short break after Math. No phone. Then run the system, start to finish, and evaluate every miss within two days. That's how this test becomes practice for the one that counts.

Directions

About two hours, plus Science and Writing if you take them.

BEFORE YOU START

Set it up like test day: a quiet room, a timer, a silent watch, pencils, scratch paper and a permitted calculator. Phone in another room.

TIMING

English: 50 questions, 35 minutes.

Math: 45 questions, 50 minutes.

Break: a short break.

Reading: 36 questions, 40 minutes.

Science (optional): 40 questions, 40 minutes.

Writing (optional): one essay, 40 minutes.

ANSWERING

Every question has four choices. As on the ACT, odd-numbered questions use A, B, C, D and even-numbered questions use F, G, H, J. In English, the

first choice of an underlined question is always NO CHANGE. There is no penalty for guessing: answer every question.

ABOUT THIS TEST

Every passage and question is original and follows the structure and question types of the ACT. It is not an official ACT test.

RUN THE SYSTEM

Stem first. Shield before sword. Attack every choice. Check your watch at each checkpoint. No blanks.

AFTERWARD

Score it with the answer keys and the scoring guide. Then evaluate every miss and every guess on the worksheet (REF-3) within 48 hours.

PASSAGE I · THE BREAD MY GRANDMOTHER TAUGHT ME

Every Saturday morning, my grandmother rose before sunrise, to start¹ the bread. By the time I came downstairs, the kitchen smelled of yeast and flour dusted² every surface like early snow.

She never used a recipe. Instead,³ she measured with her hands and her memory: a palmful of salt, a mug of warm water, flour until the dough “felt right.” For years I watched without understanding what “right” meant.

The summer I turned twelve, she finally let me try. My first loaf was so dense, it⁴ could have anchored a boat. My second was better, my third better still. Each time, she pressed the dough with one finger and watched as the dent slowly fill back in⁵.

“Bread is patient,” she told me,⁶ “You have to be patient too.” I didn’t believe her. I wanted to finish fast, to pull the loaf out early, to cut into it while it’s⁷ still steaming.

Each of my mistakes were⁸ a lesson she let me learn for myself.

Now, years later, I bake on Saturday mornings in my own small kitchen. I still don’t use a recipe. When the dough feels right, I think of her hands,⁹

1

- A NO CHANGE
- B rose, before sunrise to start
- C rose before sunrise to start
- D rose before sunrise; to start

2

- F NO CHANGE
- G smelled of yeast and, flour dusted
- H smelled, of yeast and flour dusted
- J smelled of yeast, and flour dusted

3

- A NO CHANGE
- B For example,
- C Similarly,
- D Therefore,

4

- F NO CHANGE
- G was so dense; it
- H was, so dense it
- J was so dense it

5

- A NO CHANGE
- B watching as the dent slowly fills back in
- C watched as the dent slowly filled back in
- D watched as the dent slowly filling back in

6

- F NO CHANGE
- G told me.
- H told me,
- J told me:

7

- A NO CHANGE
- B cut into it while its
- C cutting into it while it's
- D cut into it while it was

8

- F NO CHANGE
- G Each of my mistake's were
- H Each of my mistakes was
- J Each of my mistakes have been

9 The writer wants a final sentence that connects the ending to the essay's opening image. Which choice best does so?

- A NO CHANGE
- B Some people prefer store-bought bread.
- C My kitchen is smaller than hers was.
- D Bread is sold in many stores.

10 Suppose the writer's goal had been to explain the chemistry of how yeast makes bread rise. Would this essay accomplish that goal?

- F Yes, because it describes the dough rising.
- G No, because it argues that recipes are unnecessary.
- H No, because it focuses on a personal relationship and learning patience.
- J Yes, because it explains how to measure ingredients.

PASSAGE II · THE DANCE OF THE HONEYBEE

When a honeybee finds a rich patch of flowers, it returns to the hive and performs a dance, that tells¹¹ other bees where to go. The Austrian scientist Karl von Frisch spent decades decoding this “waggle dance,” work that helped earn him a share of the 1973 Nobel Prize.

The dance is surprisingly precise.¹² The bee runs in a straight line while wagging its body, then circles back and repeats. The angle of the straight run, measured against the vertical comb, tells its¹³ sisters the direction of the food relative to the sun. The length of the waggle run tells them how far to fly. As a result, longer runs mean longer flights.¹⁴

Von Frisch’s conclusions were not accepted immediately, some¹⁵ researchers argued that bees simply followed the scent of flowers. Later experiments, in which researchers used radar to follow bees that had just watched a dance, supports¹⁶ von Frisch’s view. Most of the bees flew almost straight to the spot the dance had indicated.¹⁷

Today, scientists use robotic bees and tiny radio tags to study the dance in even greater detail.¹⁸ What von Frisch first described with a notebook and a stopwatch now continues to reveal how a few thousand insects share information.¹⁹

11

- A NO CHANGE
- B performs, a dance that tells
- C performs a dance that tells
- D performs a dance; that tells

12 Which choice best introduces the details in the rest of the paragraph?

- F NO CHANGE
- G is similar to human dancing.
- H is popular with beekeepers.
- J was filmed for the first time in color.

13

- A NO CHANGE
- B it’s
- C they’re
- D their

14

- F NO CHANGE
- G tells them how far to fly: longer runs mean longer flights.
- H tells them how far to fly, longer runs mean longer flights.
- J tells them how far to fly longer runs mean longer flights.

15

- A NO CHANGE
- B immediately, and, some
- C immediately; some
- D immediately some

16

- F NO CHANGE
- G has supported
- H supporting
- J supported

17 The writer is considering deleting this sentence. Should the sentence be kept or deleted?

- A Kept, because it states the result that makes the experiments support von Frisch.
- B Deleted, because it repeats the previous sentence.
- C Deleted, because it contradicts von Frisch.
- D Kept, because it introduces robotic bees.

18 At this point, the writer wants to add a sentence that gives a specific example of new technology. Which choice best accomplishes this?

- F Bees are important pollinators.
- G Many people are afraid of bees.
- H Science has advanced a great deal.
- J Robotic bees can now perform the dance inside a hive, and real bees follow their directions.

19

- A NO CHANGE
- B Von Frisch first described with a notebook and a stopwatch, and now continues
- C What von Frisch first described with a notebook and a stopwatch, now continues
- D What von Frisch first described, with a notebook and a stopwatch, now continue

20 Suppose the writer’s goal had been to describe how scientists came to understand a form of animal communication. Would this essay accomplish that goal?

- F No, because it argues that bees should be protected.
- G No, because it focuses only on robotic bees.
- H Yes, because it explains how honey is made.
- J Yes, because it traces the study of the waggle dance from von Frisch to today.

PASSAGE III · THE GARDEN ON ELM STREET

For twenty years, the lot on Elm Street has been²¹ empty except for broken glass and weeds. Then, in the spring of 2019, a retired teacher named Ruth Okafor knocked on her neighbors' doors with a simple question: what if we planted something.²²

At first, few people were interested.²³ Ruth persisted, and by June a dozen volunteers had cleared the lot, built raised beds, and plant²⁴ tomatoes, beans, and sunflowers. A local hardware store donated tools; the city meanwhile, agreed²⁵ to provide water.

The garden changed more than the lot. Neighbors who had lived on the same block for years met for the first time. Children, who had never seen a vegetable grow, pulled carrots from the soil.²⁶ Older residents, many of them, from farming families²⁷, taught the children how to save seeds.

This year, the garden will expand to a second lot. Ruth, who is now seventy-eight, still arrives first every Saturday.²⁸ When asked why she started, she shrugs. "Somebody had to knock on the first door," she says, then she goes²⁹ back to her beans.

21

- A NO CHANGE
- B is
- C had been
- D will be

22

- F NO CHANGE
- G planted something?
- H planted something!
- J planted, something.

23 Which choice best introduces the paragraph's contrast between early doubts and later success?

- A NO CHANGE
- B Ruth taught science for thirty years.
- C Elm Street is in the center of town.
- D Tomatoes grow well in raised beds.

24

- F NO CHANGE
- G planted
- H plants
- J planting

25

- A NO CHANGE
- B the city meanwhile agreed
- C the city, meanwhile agreed
- D the city, meanwhile, agreed

26

- F NO CHANGE
- G Children who had never seen a vegetable grow, pulled carrots from the soil.
- H Children who had never seen a vegetable grow pulled carrots from the soil.
- J Children, who had never seen a vegetable grow pulled carrots from the soil.

27

- A NO CHANGE
- B many, of them from farming families,
- C many of them from farming families,
- D many of them from farming families

28 The writer is considering deleting this sentence. Should it be kept or deleted?

- F Kept, because it explains how the second lot was purchased.
- G Kept, because it shows Ruth's continuing commitment, setting up the final quotation.
- H Deleted, because it repeats information from the first paragraph.
- J Deleted, because it shifts the focus to the hardware store.

29

- A NO CHANGE
- B says. Then she goes
- C says, then, she goes
- D says then she goes

30 Which choice best describes the essay's main focus?

- F How one person's initiative turned an empty lot into a community garden
- G The best vegetables to grow in a city
- H Why cities should provide free water
- J The history of Elm Street since its founding

PASSAGE IV · HOW OCTOPUSES THINK

An octopus has about 500 million neurons, far³¹ more than most other invertebrates. What makes the animal unusual, however, is not the number of neurons but there location³²: about two-thirds of them are in its eight arms, not its central brain.

This arrangement allows each arm to act with surprising independence. An arm³³ can taste, touch, and even react after being separated from the body. For example,³⁴ scientists debate how much the arms “decide” on their own and how much the brain directs them.

Octopuses are also skilled problem-solvers. In laboratories, they have learned³⁵ to open screw-top jars, to escape from tanks, and navigating simple mazes³⁶. Some aquarium workers report that individual octopuses seem to recognize particular people, squirting water at staff members they dislike.

Yet most octopuses live only one to two years.³⁷ Unlike many intelligent animals, they do not learn from parents or live in groups. Their intelligence appear³⁸ to have evolved for solving problems alone. Studying them, scientists hope, may reveal more than one path to a thinking mind.³⁹

31

- A NO CHANGE
- B neurons. Far
- C neurons; far
- D neurons far

32

- F NO CHANGE
- G but they're location
- H but it's location
- J but their location

33

- A NO CHANGE
- B with surprising independence, an arm
- C with surprising independence an arm
- D with surprising independence and, an arm

34

- F NO CHANGE
- G Still,
- H As a result,
- J Similarly,

35

- A NO CHANGE
- B learning
- C has learned
- D learns

36

- F NO CHANGE
- G navigate simple mazes
- H they navigate simple mazes
- J to navigate simple mazes

37 Which choice provides the most effective transition from the previous paragraph to this one?

- A NO CHANGE
- B Octopuses have blue blood.
- C Octopuses come in many sizes.
- D Some octopuses are venomous.

38

- F NO CHANGE
- G appears
- H are appearing
- J have appeared

39

- A NO CHANGE
- B Studying them scientists hope, may
- C Studying them; scientists hope, may
- D Studying them, scientists hope may

40 Suppose the writer's goal had been to show that octopus intelligence differs from that of many other intelligent animals. Would this essay accomplish that goal?

- F Yes, because it lists the octopus's favorite foods.
- G No, because it focuses on aquarium workers.
- H No, because it argues octopuses are not intelligent.
- J Yes, because it describes the octopus's distributed neurons and solitary, short life.

PASSAGE V · MARY ANNING AND THE SEA DRAGONS

In the early 1800s, the cliffs near Lyme Regis, England, crumbled with every winter storm, exposing fossils that collectors eagerly bought⁴¹. Among the people who searched the beaches was a girl named Mary Anning, who's family⁴² sold fossils to tourists to survive.

Around 1811, when Mary was about twelve, she and her brother uncovered the skeleton of a creature that looked like a cross between a fish and a lizard⁴³. It was later named *Ichthyosaurus*, meaning “fish lizard.” Over the following decades, Anning's found⁴⁴ many more remarkable fossils, including one of the first nearly complete plesiosaurs.

Despite her discoveries, Anning was largely excluded from the scientific societies of her time, which did not admit women, scientists⁴⁵ bought her fossils and described them in their papers, often without naming her. Nonetheless⁴⁶ many of them visited her shop to learn from her knowledge of anatomy.

Today, Anning is recognized as one of the more important⁴⁷ fossil collectors in history. Her work helped convince scientists that species could become extinct, an idea that was still controversial in her lifetime⁴⁸. A statue of her now stands in Lyme Regis, it⁴⁹ shows her holding a hammer, ready to search the beach.

41

- A NO CHANGE
- B eager bought
- C eagerly buyed
- D eagerly have bought

42

- F NO CHANGE
- G whose family
- H who family
- J whose' family

43

- A NO CHANGE
- B that looks like a cross between a fish and a lizard.
- C that looked like a cross between a fish, and a lizard.
- D looking like a cross, between a fish and a lizard.

44

- F NO CHANGE
- G Anning found
- H Anning, found
- J found by Anning were

45

- A NO CHANGE
- B which, did not admit women. Scientists
- C which did not admit women; and scientists
- D which did not admit women. Scientists

46

- F NO CHANGE
- G For example,
- H Therefore,
- J Similarly,

47

- A NO CHANGE
- B most important
- C most importantest
- D importantest

48 The writer is considering deleting this sentence. Should it be kept or deleted?

- F Kept, because it describes the statue.
- G Deleted, because it is unrelated to Anning.
- H Deleted, because it repeats the first paragraph.
- J Kept, because it explains the scientific significance of Anning's work.

49

- A NO CHANGE
- B Lyme Regis; it
- C Lyme Regis it
- D Lyme Regis, and, it

50 Which choice best describes how the essay is organized?

- F As a comparison of two fossil collectors
- G As an argument against scientific societies
- H Chronologically, from Anning's childhood discoveries to her legacy today
- J As a list of fossil types

1 What is the value of $4x - 9$ when $x = 6$?

- A 24
- B -3
- C 33
- D 15

2 A phone plan costs \$30 per month plus \$0.10 per text. What is the cost of a month with 250 texts?

- F \$25
- G \$32.50
- H \$280
- J \$55

3 What is 15% of 80?

- A 65
- B 8
- C 15
- D 12

4 Solve $2(x + 5) = 18$.

- F 9
- G 4
- H 6.5
- J 13

5 What is the slope of the line through $(-2, 3)$ and $(4, 15)$?

- A $\frac{1}{2}$
- B 2
- C 3
- D 6

6 The mean of 6, 9, 10 and x is 9. What is x ?

- F 11
- G 36
- H 9
- J 12

7 Which expression is equivalent to $3x(x - 4) + 2x$?

- A $3x^2 + 2x - 4$
- B $5x^2 - 12x$
- C $3x^2 - 10x$
- D $3x^2 - 14x$

8 A rectangle has a perimeter of 30 and a length of 9. What is its area?

- F 54
- G 81
- H 36
- J 21

9 A bag has 3 red, 5 blue and 4 yellow marbles. What is the probability of drawing a yellow marble?

- A $1/3$
- B $1/4$
- C $4/9$
- D $5/12$

10 What is the value of $|-7 + 3| - |2 - 5|$?

- F 7
- G -1
- H 1
- J 4

11 Which value of x satisfies $3x - 7 > 11$?

- A 4
- B 7
- C 6
- D 5

12 A map scale is 1 inch : 40 miles. Two towns are 3.5 inches apart on the map. How many miles apart are they?

- F 140
- G 160
- H 120
- J 43.5

13 In a right triangle, the legs are 7 and 24. What is the hypotenuse?

- A $\sqrt{527}$
- B 25
- C 31
- D 26

14 What are the solutions of $x^2 + x - 20 = 0$?

- F -2 and 10
- G 2 and -10
- H 4 and -5
- J -4 and 5

15 If $f(x) = 2x^2 - 3$, what is $f(-3)$?

- A -21
- B 9
- C 33
- D 15

16 Two angles of a triangle measure 35° and 85° . What is the third angle?

- F 120°
- G 60°
- H 70°
- J 50°

17 Which is equivalent to $(x^3)^4 \cdot x^2$?

- A x^{14}
- B x^{12}
- C x^9
- D x^{24}

18 $x + 2y = 10$ and $3x - 2y = 6$. What is x ?

- F 2
- G 8
- H 6
- J 4

19 What is the midpoint of the segment with endpoints $(-4, 7)$ and $(10, -1)$?

- A $(3, 4)$
- B $(7, -4)$
- C $(3, 3)$
- D $(6, 6)$

20 A shirt costs \$40 after a 20% discount. What was the original price?

- F \$60
- G \$48
- H \$32
- J \$50

21 $(3 + 2i)(1 - i) = ?$ ($i^2 = -1$)

- A $5 + i$
- B $5 - i$
- C $1 - i$
- D $3 - 2i$

22 What is the 15th term of the arithmetic sequence 4, 9, 14, ...?

- F 74
- G 75
- H 79
- J 69

23 What is $\log_2(32) + \log_3(9)$?

- A 8
- B 7
- C 5
- D 11

24 What is the determinant of the matrix $\begin{bmatrix} 6 & 2 \\ 4 & 3 \end{bmatrix}$?

- F 26
- G 10
- H 18
- J 14

25 How many different 4-person teams can be chosen from 9 people?

- A 3,024
- B 6,561
- C 126
- D 36

26 What is the vertex of $y = (x - 5)^2 - 8$?

- F (-8, 5)
- G (5, -8)
- H (-5, -8)
- J (5, 8)

27 A circle has the equation $(x + 3)^2 + (y - 1)^2 = 16$. What are its center and radius?

- A (3, -1), 4
- B (3, 1), 8
- C (-3, 1), 4
- D (-3, 1), 16

28 In right triangle ABC, the side opposite angle A is 9 and the hypotenuse is 15. What is $\tan A$?

- F $\frac{3}{5}$
- G $\frac{3}{4}$
- H $\frac{4}{3}$
- J $\frac{9}{15}$

29 A population of 2,000 bacteria doubles every 5 hours. How many bacteria are there after 20 hours?

- A 32,000
- B 40,000
- C 8,000
- D 16,000

30 What is the value of x if $\sqrt{3x + 1} = 5$?

- F 8
- G $\frac{26}{3}$
- H $\frac{4}{3}$
- J 24

31 Which of the following is the inverse of $f(x) = (x - 4)/3$?

- A $(x + 4)/3$
- B $3x - 4$
- C $3x + 4$
- D $x/3 + 4$

32 What is the amplitude of $y = 4 \sin(2x) + 1$?

- F 1
- G 5
- H 4
- J 2

33 What is the period of $y = 4 \sin(2x) + 1$?

- A π
- B 4π
- C 2π
- D $\pi/2$

34 A cylinder has radius 3 and volume 72π . What is its height?

- F 6
- G 8
- H 24
- J 12

35 For what value of k does $x^2 - 10x + k = 0$ have exactly one real solution?

- A 25
- B 10
- C 5
- D 20

36 If $\sin \theta = 5/13$ and θ is acute, what is $\cos \theta$?

- F $12/13$
- G $13/12$
- H $8/13$
- J $5/12$

37 What is the sum of the solutions of $2x^2 - 9x + 4 = 0$?

- A 4
- B 2
- C $9/2$
- D $-9/2$

38 How many ways can 5 different books be arranged on a shelf?

- F 3,125
- G 60
- H 25
- J 120

39 What is the sum of the first 6 terms of the geometric sequence 2, 6, 18, ...?

- A 1,458
- B 242
- C 486
- D 728

40 What is the distance between $(-3, -2)$ and $(5, 13)$?

- F 15
- G 19
- H $\sqrt{233}$
- J 17

41 Which value of x is NOT in the domain of $g(x) = 5/(x^2 - 9)$?

- A -9
- B 3
- C 9
- D 0

42 In a triangle, sides of 6 and 10 meet at a 120° angle. What is the length of the third side? ($\cos 120^\circ = -1/2$)

- F $\sqrt{76}$
- G $\sqrt{136}$
- H 14
- J 16

43 $i^{2026} = ?$

- A i
- B $-i$
- C -1
- D 1

44 $p(x) = x^3 - 2x^2 - 5x + 6$. Which of the following is a zero of p ?

- F -1
- G 3
- H -3
- J 2

45 The ellipse $(x - 2)^2/36 + (y + 1)^2/9 = 1$ has what total width (horizontal)?

- A 6
- B 18
- C 12
- D 9

PASSAGE I · LITERARY NARRATIVE

This passage is adapted from an original short story. The narrator, Lena, returns to the town where she grew up.

The bus let me off at the corner where the hardware store used to be. It was a phone shop now, its window full of bright cases nobody in this town had needed when I was a girl. I stood there longer than I meant to, my suitcase at my feet, waiting for the street to look the way I remembered it.

It didn't, of course. The bakery had become a bank. The movie theater, where my brother Teo and I had spent every rainy Saturday, was boarded up, its marquee still announcing a film that had left theaters years before. I had told myself on the bus that I wouldn't be sentimental. I had told myself a great many things.

My mother's house was six blocks away. I walked slowly, partly because of the suitcase and partly because I wasn't sure what I would say. We had not spoken in three years, not since the argument about the restaurant—her restaurant, the one she had built from nothing and wanted me to take over, and the one I had walked away from to study engineering in a city she called “too far to matter.”

The house was smaller than I remembered, the way houses always are. The porch light was on, though it was the middle of the afternoon. That was her habit: leave the light on for anyone who might be coming. When I was little I thought it was for me. Later I understood it was for my father, who never came back, and later still I stopped thinking about it at all.

I knocked. Footsteps, then a pause, long enough that I wondered if she had seen me through the curtain and decided not to answer. Then the door opened, and my mother looked at me with the same expression she used to give a sauce that wasn't quite right—not angry, exactly, but studying it, deciding what it needed.

“You're thin,” she said.

“Hello, Mama.”

She stepped aside to let me in. The kitchen smelled of onions and cumin and something sweet I couldn't name, and for a moment I was nine years old again, sitting on the counter while she worked. She set a bowl in front of me without asking whether I was hungry. I ate. Neither of us mentioned the restaurant, or the three years, or the porch light. But when I finished, she took the bowl, rinsed it, and said, without turning around, “Teo says you build bridges now.”

“I help design them,” I said.

She nodded slowly, still facing the sink. “Good,” she said. “Somebody should build something that lasts.”

1 The passage is told from the point of view of:

- A a narrator describing her own return home.
- B a mother waiting for her daughter.
- C a narrator describing her brother's return.
- D an outside observer of a family.

2 The details about the hardware store, bakery and theater in the first two paragraphs mainly serve to:

- F describe the town's economic success.
- G show how the town has changed since Lena left.
- H introduce Lena's brother.
- J explain why Lena became an engineer.

3 As it is used in paragraph 2, the phrase "I had told myself a great many things" most nearly suggests that Lena:

- A often fails to follow her own resolutions.
- B talks to herself on buses.
- C has an excellent memory.
- D planned every word she would say.

4 According to the passage, Lena and her mother had not spoken because of a disagreement about:

- F the house.
- G Lena's father.
- H Teo's career.
- J the family restaurant.

5 The porch light is described as having different meanings to Lena at different times. Which sequence best reflects those meanings?

- A It was always a signal that her mother was home.
- B She thought it was for her, then understood it was for her father, then stopped thinking about it.
- C She never noticed it until she returned.
- D She thought it was for her father, then for Teo, then for herself.

6 The comparison of the mother's expression to how she looked at "a sauce that wasn't quite right" suggests that the mother:

- F has forgotten who Lena is.
- G is angry and plans to send Lena away.
- H is carefully evaluating Lena.
- J is thinking about cooking dinner.

7 It can most reasonably be inferred that the mother serves Lena food without asking because she:

- A forgot that Lena had already eaten.
- B does not want Lena to stay long.
- C is testing a new recipe.
- D expresses care through actions rather than words.

8 The mother's final line, "Somebody should build something that lasts," most likely suggests that she:

- F dislikes bridges.
- G regrets building the restaurant.
- H has come to accept Lena's choice of career.
- J wants Lena to return to the restaurant.

9 Over the course of the passage, the relationship between Lena and her mother is best described as moving from:

- A close friendship toward open conflict.
- B trust toward suspicion.
- C uncertain distance toward a quiet reconciliation.
- D anger toward indifference.

PASSAGE II · SOCIAL SCIENCE

This passage is adapted from an original article about how cities measure walkability.

For most of the twentieth century, American cities were designed around the automobile. Wide roads, large parking lots and separated zones for homes, shops and offices made sense when nearly every adult drove. By the 2000s, however, a growing number of urban planners had begun to ask a different question: how easy is it to live in a neighborhood without a car?

Answering that question required a way to measure it. Early walkability scores counted how many destinations—grocery stores, schools, parks, pharmacies—lay within a short walk of a given address. A home with twenty destinations within half a mile scored higher than one with five. The method was simple, and it quickly became popular with real estate websites and city governments alike.

Critics soon pointed out its limits. A grocery store half a mile away is not truly walkable, they argued, if reaching it requires crossing a six-lane highway with no crosswalk. Nor does distance alone capture whether sidewalks exist, whether streets are lit at night, or whether the route feels safe. Two neighborhoods with identical scores, critics noted, could feel entirely different to the people who lived in them.

In response, researchers developed more detailed measures. Some added data on intersection density, reasoning that a grid of short blocks offers more route choices than a maze of cul-de-sacs. Others sent trained observers to rate sidewalks, shade and traffic speed street by street. One research team combined both approaches and found that its detailed scores predicted how often residents actually walked far better than distance-based scores did.

Better measurement has had practical consequences. Several cities now use detailed walkability data to decide where to add crosswalks or widen sidewalks, directing limited budgets to the streets where small changes could make the biggest difference. Public health researchers have also used the scores to study whether people in walkable neighborhoods are more physically active—though, as many of them caution, people who already like to walk may simply choose to live in such places.

That caution points to a broader lesson. Measuring a neighborhood is not the same as understanding it. The best walkability scores today are tools, not verdicts: useful for comparing places and guiding investment, but most valuable when paired with the experiences of the people who walk, or try to walk, those streets every day.

10 The main purpose of the passage is to:

- F explain the history of the American highway system.
- G describe how methods for measuring walkability developed and what they can and cannot show.
- H argue that cars should be banned from cities.
- J rank cities by walkability.

11 According to the passage, early walkability scores were based mainly on:

- A sidewalk quality.
- B residents' surveys.
- C the number of nearby destinations.
- D traffic speed.

12 The example of the grocery store across a six-lane highway primarily serves to:

- F illustrate a weakness of distance-based scores.
- G support the early scoring method.
- H argue for building more highways.
- J show that grocery stores are rare.

13 The researchers who added intersection density reasoned that:

- A intersections are dangerous for walkers.
- B short blocks offer more route choices.
- C longer blocks reduce traffic.
- D cul-de-sacs are safer for children.

14 According to the passage, the team that combined both approaches found that its detailed scores:

- F were identical to distance-based scores.
- G showed that residents rarely walk.
- H could not be used by city governments.
- J predicted actual walking better than distance-based scores.

15 The caution described in paragraph 5 suggests that a link between walkable neighborhoods and physical activity:

- A does not exist.
- B applies only to large cities.
- C may not show that walkability causes people to be more active.
- D proves that walkability makes people healthier.

16 As it is used in paragraph 6, the word “verdicts” most nearly means:

- F court cases.
- G opinions of critics.
- H measurements.
- J final judgments.

17 The author would most likely agree that walkability scores are most useful when:

- A combined with the experiences of residents.
- B based only on distance.
- C used to replace local knowledge.
- D kept private from the public.

18 Which choice best describes the structure of the passage?

- F A personal story followed by statistics
- G A ranking of cities by walkability
- H Two opposing arguments with no conclusion
- J A problem, an early solution, its critics, improved methods, and their uses and limits

PASSAGE III · HUMANITIES (PAIRED PASSAGES)

Passage A is adapted from an original essay about museum audio guides. Passage B is adapted from an original essay about silence in museums.

PASSAGE A

When I was a child, museums felt like libraries in which every book was locked. The paintings hung there, enormous and silent, and I had no idea what I was supposed to see. The first time I used an audio guide, at sixteen, the locks came off. A calm voice told me why the woman in the portrait held a lemon, what the dog at her feet symbolized, and how the painter had smuggled his own reflection into a mirror in the corner. I stood in front of that one painting for twenty minutes.

Critics complain that audio guides turn visitors into passive listeners, shuffling from number to number. Some do. But for visitors who arrive, as I did, without the background that art historians take for granted, a good guide is an invitation. It offers a way in. Museums that want new audiences should be making more of them, not fewer.

PASSAGE B

Last spring I visited a museum that asked every visitor to leave phones and audio guides at the door for one hour. At first I felt lost. Without a voice telling me what mattered, I didn't know where to look. Then, slowly, I started to look anyway—at the way light fell across a fold of cloth, at a face in the background that no guide would have mentioned.

I don't object to audio guides; they can teach us things we would never find on our own. But they can also teach us that art is a puzzle with one correct answer, supplied by an expert. An hour of silence taught me something different: that looking is a skill, and that the first answers we find for ourselves are often the ones we remember.

19 In Passage A, the comparison of museums to “libraries in which every book was locked” mainly emphasizes the author’s childhood sense that:

- A books were more interesting than art.
- B art was inaccessible without explanation.
- C museums charged too much.
- D museums were too crowded.

20 According to Passage A, the audio guide explained all of the following EXCEPT:

- F what the dog symbolized.
- G how the painter included his reflection.
- H why the woman held a lemon.
- J how much the painting was worth.

21 The author of Passage A acknowledges which criticism of audio guides?

- A They are too long.
- B Some visitors become passive listeners.
- C They are too expensive.
- D They are always inaccurate.

22 In Passage B, the author’s initial reaction to the museum’s policy was one of:

- F anger.
- G disorientation.
- H boredom.
- J relief.

23 The author of Passage B suggests that audio guides can teach visitors that art:

- A has a single correct interpretation supplied by experts.
- B is best enjoyed with friends.
- C should be viewed quickly.
- D is too difficult to understand.

24 As it is used in Passage B, the word “skill” most nearly means:

- F a natural talent.
- G a trick.
- H a job requirement.
- J an ability that can be developed.

25 Both authors would most likely agree that audio guides:

- A make museums less crowded.
- B can teach visitors things they would not discover alone.
- C are the only way to understand art.
- D should be banned from museums.

26 Compared with the author of Passage A, the author of Passage B places more emphasis on:

- F attracting new audiences.
- G the cost of museum admission.
- H the history of a single painting.
- J the value of looking without guidance.

27 How would the author of Passage B most likely respond to Passage A’s claim that museums should make more audio guides?

- A By insisting all audio guides be removed
- B By claiming audio guides are inaccurate
- C By agreeing they help, but arguing visitors also benefit from time without them
- D By arguing museums need more paintings

PASSAGE IV · NATURAL SCIENCE

This passage is adapted from an original article about how trees in a forest may share resources.

Beneath most forests lies a network few people ever see. The roots of many trees are wrapped in threads of fungi called mycorrhizae, which extend far into the surrounding soil. The partnership is ancient and mutual: the fungi help trees absorb water and minerals such as phosphorus, and in return the trees supply the fungi with sugars made through photosynthesis.

Because a single fungus can connect to the roots of several trees at once, researchers began to ask whether these networks might also move resources between trees. In a series of experiments beginning in the 1990s, scientists exposed one tree to air containing carbon atoms of a slightly heavier, traceable form. Weeks later, they found traces of that carbon in the tissues of neighboring trees connected through the same fungal network.

Some researchers described these findings in striking terms, suggesting that large “mother trees” nourish their seedlings through the network. The image proved popular. Books and documentaries described forests as cooperative communities in which trees warn and feed one another.

Other scientists urged caution. The amount of carbon that moved between trees in most studies was small, they noted, and it was not always clear that it reached the living tissues of the receiving tree rather than remaining in the fungus. Some experiments that cut fungal connections found little effect on seedling growth; others found a large effect. Differences in tree species, soil and climate may explain some of the disagreement.

What most researchers now agree on is more modest, but still remarkable. Fungal networks are real, widespread and important to forest health. Resources can move through them, at least under some conditions. Whether trees use them in anything like a deliberate, cooperative way remains an open question—one that new tools, such as sensors that track nutrients in real time, may help answer.

The debate offers a lesson that reaches beyond forests. An exciting idea can travel faster than the evidence for it. The challenge for scientists, and for the public, is to stay curious about the idea while keeping track of how much the evidence actually shows.

28 The main purpose of the passage is to:

- F explain how photosynthesis works.
- G describe research on fungal networks and the debate over what it shows.
- H argue that forests should be protected from logging.
- J prove that trees cooperate deliberately.

29 According to the passage, in the partnership between trees and mycorrhizae, the trees provide:

- A phosphorus.
- B water.
- C sugars.
- D carbon from the soil.

30 The experiments described in paragraph 2 used traceable carbon in order to:

- F kill harmful fungi.
- G measure rainfall.
- H make the trees grow faster.
- J detect whether carbon moved from one tree to its neighbors.

31 The phrase “The image proved popular” in paragraph 3 mainly serves to:

- A introduce a new experiment.
- B suggest the idea was proven.
- C show how widely the “mother tree” idea spread.
- D criticize documentaries.

32 According to paragraph 4, one reason some scientists urged caution was that:

- F the experiments were never repeated.
- G the amount of carbon moved was often small.
- H no carbon ever moved between trees.
- J fungi do not connect to tree roots.

33 The passage suggests that differences in tree species, soil and climate might explain:

- A why documentaries were popular.
- B why experiments reached different results.
- C why trees make sugar.
- D why fungi exist.

34 As it is used in paragraph 5, “modest” most nearly means:

- F inexpensive.
- G simple to understand.
- H limited in its claims.
- J shy.

35 Which statement would the author most likely agree with?

- A Whether trees cooperate deliberately is still unresolved.
- B Fungal networks are unimportant to forests.
- C Trees definitely warn each other of danger.
- D The “mother tree” idea has been disproven.

36 The final paragraph primarily serves to:

- F introduce a new experiment.
- G criticize the earliest researchers.
- H draw a broader lesson about ideas and evidence.
- J summarize the fungal life cycle.

PASSAGE I

Botanists measured the percent of seeds that germinated (sprouted) within 10 days for three plant species kept at different soil temperatures. Each value is the average of 5 trays of 40 seeds.

Soil temp (°C)	Species X (%)	Species Y (%)	Species Z (%)
10	12	40	5
15	35	62	18
20	70	75	44
25	88	71	80
30	81	52	93

Table 1

- 1** According to Table 1, at 20°C, which species had the highest percent germination?
- A Species Z
B Species Y
C All were equal
D Species X
- 2** For Species Z, as soil temperature increased from 10°C to 30°C, percent germination:
- F increased only.
G increased, then decreased.
H stayed the same.
J decreased only.
- 3** At which temperature did Species X reach its maximum germination?
- A 30°C
B 15°C
C 20°C
D 25°C
- 4** Based on Table 1, the percent germination of Species Y at 22°C would most likely be closest to:
- F 40%
G 90%
H 60%
J 73%
- 5** Each tray contained 40 seeds. At 15°C, about how many seeds of Species X germinated per tray, on average?
- A 14
B 35
C 26
D 4
- 6** A student hypothesizes that Species Y is better adapted to cooler soils than Species Z is. Do the data support this?
- F No; Species Z germinated more at 10°C.
G Yes; Species Y had the highest value at 30°C.
H No; the species germinated equally at all temperatures.
J Yes; at 10°C and 15°C, Species Y germinated far more than Species Z.

PASSAGE II

Students investigated what affects the period of a pendulum (the time for one complete back-and-forth swing).

Experiment 1. A 0.10 kg mass hung from strings of different lengths. Each pendulum was released from a 10° angle, and the time for 10 swings was divided by 10.

Length (m)	Period (s)
0.25	1.00
0.50	1.42
1.00	2.01
2.00	2.84

Experiment 2. The length was fixed at 1.00 m and the release angle at 10°, but the mass was varied.

Mass (kg)	Period (s)
0.05	2.01
0.10	2.01
0.20	2.00
0.40	2.01

7 In Experiment 1, the independent variable was:

- A period.
- B release angle.
- C string length.
- D mass.

8 Which variable was held constant in Experiment 2?

- F Length
- G Period
- H Mass
- J Number of students

9 Based on Experiment 1, as length increased, the period:

- A stayed the same.
- B decreased.
- C increased, then decreased.
- D increased.

10 Based on Experiment 2, the mass of the pendulum:

- F halved the period when doubled.
- G had little or no effect on the period.
- H had a large effect at small masses only.
- J doubled the period when doubled.

11 When the length was quadrupled from 0.25 m to 1.00 m, the period approximately:

- A halved.
- B stayed the same.
- C quadrupled.
- D doubled.

12 Based on Experiment 1, a 4.00 m pendulum would most likely have a period closest to:

- F 4.0 s
- G 8.0 s
- H 3.0 s
- J 5.7 s

13 Why did the students time 10 swings and divide by 10 rather than timing one swing?

- A To reduce the effect of timing errors
- B To change the mass
- C To make the angle larger
- D To increase the period

PASSAGE III

Dissolved oxygen (DO) was measured at several depths in a lake in July and in January.

Depth (m)	July DO (mg/L)	January DO (mg/L)	July temp (°C)	January temp (°C)
0	8.5	12.0	24	1
5	8.0	11.8	22	3
10	4.5	11.5	12	4
15	1.5	11.2	8	4
20	0.5	11.0	6	4

Cold water can hold more dissolved oxygen than warm water. Many fish need at least 5 mg/L of DO.

14 In July, at what depth was DO lowest?

- F 5 m
- G 20 m
- H 0 m
- J 10 m

15 In January, as depth increased, DO:

- A stayed exactly the same.
- B decreased slightly.
- C decreased sharply.
- D increased sharply.

16 In July, between which two measured depths did DO first fall below the 5 mg/L that many fish need?

- F Between 5 m and 10 m
- G Between 0 m and 5 m
- H At no depth
- J Between 15 m and 20 m

17 At 10 m, how much higher was DO in January than in July?

- A 11.5 mg/L
- B 7.0 mg/L
- C 4.5 mg/L
- D 16.0 mg/L

18 At the surface, DO was higher in January than in July. This is consistent with the statement that:

- F deep water is always warmer.
- G oxygen is produced only in winter.
- H fish need 5 mg/L of DO.
- J cold water can hold more dissolved oxygen.

19 Based on the table, in July a fish that needs at least 5 mg/L of DO and prefers the coldest available water would most likely be found at about:

- A 20 m
- B 0 m
- C 5 m
- D 15 m

PASSAGE IV

A plastic bottle was filled halfway with hot water, sealed tightly, and placed in a refrigerator. An hour later, the sides of the bottle had caved inward. Two students explained the observation.

Student 1: When the bottle was sealed, the air inside was hot. As the air cooled in the refrigerator, it contracted, lowering the pressure inside the bottle. The higher air pressure outside then pushed the sides inward. The water itself played only a minor role.

Student 2: When the bottle was sealed, the air inside contained a large amount of water vapor from the hot water. As the bottle cooled, most of this vapor condensed into liquid water, removing gas from the inside of the bottle. This loss of gas, more than the cooling of the air, lowered the pressure inside and caused the bottle to cave in.

20 Both students agree that the bottle caved in because:

- F the plastic melted.
- G the pressure inside became lower than the pressure outside.
- H air leaked into the bottle.
- J the water froze and expanded.

21 According to Student 2, the main reason the inside pressure dropped was:

- A the air contracting as it cooled.
- B water vapor condensing into liquid.
- C the water evaporating.
- D the bottle leaking.

22 Which observation would most strongly support Student 2?

- F A sealed bottle of hot, dry air caved in exactly as much as the bottle with hot water.
- G A sealed bottle of hot, dry air (no water) caved in much less than the bottle with hot water.
- H The bottle caved in faster in a warmer room.
- J The water in the bottle froze.

23 Which observation would most strongly support Student 1?

- A A bottle sealed with cold water did not cave in.
- B Drops of water formed on the inside of the bottle.
- C A sealed bottle of hot, dry air caved in about as much as the bottle with hot water.
- D The bottle was made of plastic.

24 Student 1 would most likely predict that a bottle sealed while filled with cold air and then warmed would:

- F stay exactly the same.
- G fill with water.
- H bulge outward.
- J cave inward.

25 Drops of liquid water appear on the inside walls of the cooled bottle. This observation is more directly consistent with the explanation of:

- A neither student.
- B both students equally, because it shows the bottle cooled.
- C Student 1, because it shows air contracting.
- D Student 2, because it shows vapor condensing.

26 Which statement would both students most likely accept?

- F The temperature of the bottle's contents decreased in the refrigerator.
- G Air does not change volume with temperature.
- H Water vapor played no role at all.
- J The bottle leaked.

PASSAGE V

Students studied how dissolving table salt (NaCl) in water affects its boiling point and freezing point. All trials used 500 g of water at sea-level pressure.

Experiment 1. Different masses of salt were dissolved, and the boiling point was measured.

Salt (g)	Boiling point (°C)
0	100.0
15	100.5
30	101.0
60	102.1

Experiment 2. The same solutions were cooled, and the freezing point was measured.

Salt (g)	Freezing point (°C)
0	0.0
15	-1.9
30	-3.8
60	-7.6

27 In both experiments, the independent variable was:

- A the freezing point.
- B the mass of water.
- C the boiling point.
- D the mass of salt.

28 Which variable was controlled in both experiments?

- F The mass of water
- G The mass of salt
- H The freezing point
- J The boiling point

29 As the mass of salt increased, the freezing point:

- A stayed the same.
- B increased.
- C decreased.
- D increased, then decreased.

30 Based on Experiment 2, a solution with 45 g of salt would most likely freeze at about:

- F -5.7°C
- G -7.6°C
- H -2.9°C
- J -9.5°C

31 Doubling the salt from 30 g to 60 g changed the freezing point by about:

- A -1.9°C
- B 0°C
- C -3.8°C
- D -7.6°C

32 Which change was larger when going from 0 g to 60 g of salt?

- F They were equal
- G The rise in boiling point
- H Neither changed
- J The drop in freezing point

33 Cities spread salt on icy roads in winter. Based on Experiment 2, this works mainly because salt:

- A lowers the temperature at which water freezes.
- B raises the boiling point of water.
- C heats the road.
- D makes ice heavier.

PASSAGE VI

Enzymes speed up chemical reactions in living things. Researchers measured the reaction rate of two digestive enzymes at different pH values. Rates are given as a percent of each enzyme's maximum rate.

pH	Enzyme P rate (%)	Enzyme T rate (%)
1	60	0
2	100	2
4	45	15
6	5	70
8	0	100
10	0	40

The stomach has a pH of about 2. The small intestine has a pH of about 8.

34 At what pH did Enzyme P reach its maximum rate?

- F 2
- G 1
- H 6
- J 8

35 At pH 6, which enzyme was more active?

- A Enzyme T
- B Both were equal
- C Neither was active
- D Enzyme P

36 Based on the table, Enzyme P most likely functions in the:

- F blood.
- G stomach.
- H small intestine.
- J mouth only.

37 As pH increased from 8 to 10, Enzyme T's rate:

- A stayed the same.
- B doubled.
- C increased.
- D decreased.

38 Is a pH of 8 acidic or basic?

- F Neutral
- G Basic
- H It cannot be determined
- J Acidic

39 At which pH were both enzymes active at less than 50% of their maximum rates?

- A pH 8
- B pH 2
- C pH 6
- D pH 4

40 A researcher hypothesizes that each enzyme works best near the pH of the organ where it acts. Do the data support this for both enzymes?

- F No; Enzyme T is most active in the stomach.
- G Yes; P peaks near pH 2 (stomach) and T near pH 8 (small intestine).
- H No; both enzymes peak at the same pH.
- J Yes; both enzymes peak at pH 6.

Public Spaces and Phones

Many public places—museums, concert halls, restaurants, even some parks—have begun asking visitors to put their phones away. Supporters say phone-free spaces help people pay attention and connect with one another. Others argue that phones help people learn, stay safe and share experiences, and that rules banning them go too far. Should public places limit the use of phones?

PERSPECTIVE ONE

Phone-free spaces give people something rare: undivided attention. When everyone puts their phones away, people notice more and connect more.

PERSPECTIVE TWO

Phones are tools for learning, safety and access. A rule that bans them treats every user as a distraction and shuts out people who rely on them.

PERSPECTIVE THREE

The best approach is balance: places can set quiet zones or times without banning phones entirely, letting visitors choose.

ESSAY TASK

Write an essay that takes a clear position on whether public places should limit phone use. Discuss at least one of the perspectives above, explain how your view relates to it, and support your position with reasons and specific examples.

Plan for about 8 minutes, write for about 28, and proofread for the last 4 (WR-2). Scoring: Ideas and Analysis; Development and Support; Organization; Language Use and Conventions (WR-1).

English

#	ANS	LESSON	WHY
1	C	GM-6	No comma before an infinitive of purpose (GM-6).
2	J	GM-2	Two independent clauses joined by “and” need a comma before “and”; otherwise “yeast and flour” reads as one list (GM-2).
3	A	ENG-3	Contrast with using a recipe: Instead.
4	J	GM-6	“so...that” construction needs no comma (GM-6).
5	C	GM-10	Past tense, consistent with “pressed” (GM-10).
6	G	GM-3	Her quoted sentence is complete, and the next quotation starts a new sentence: a period.
7	D	GM-10	Keep the past tense of the narrative (GM-10).
8	H	GM-8	Each = singular (GM-8).
9	A	ENG-8	Returns to her hands and the bread (ENG-8).
10	H	ENG-5	Personal narrative, not chemistry (ENG-5).
11	C	GM-6	Essential “that” clause: no comma (GM-6).
12	F	ENG-8	The paragraph explains the dance’s precision (ENG-8).
13	A	GM-9	Possessive of “the bee” (GM-9).
14	G	GM-4	The second clause explains the first: a colon. “As a result” misstates the relationship (GM-4).
15	C	GM-2	Two independent clauses (GM-2).
16	J	GM-8	Subject “experiments” (plural), past tense (GM-8, GM-10).
17	A	ENG-4	It supplies the key result (ENG-4).
18	J	ENG-4	Specific example (ENG-4).
19	A	GM-6	Subject “What...stopwatch” takes singular “continues”; no comma between subject and verb.
20	J	ENG-5	Matches the essay (ENG-5).
21	C	GM-10	Before another past event (2019): past perfect (GM-10).
22	G	GM-14	A direct question needs a question mark.
23	A	ENG-8	Sets up “Ruth persisted” (ENG-8).
24	G	GM-12	Parallel with “had cleared” and “built” (GM-12).
25	D	GM-5	Interrupting “meanwhile” takes a pair of commas (GM-5).

#	ANS	LESSON	WHY
26	H	GM-5	Essential clause (which children): no commas (GM-5).
27	C	GM-5	Extra information set off by a pair of commas; no comma inside it.
28	G	ENG-4	Supports the ending (ENG-4).
29	B	GM-2	Two independent clauses: a comma alone is a splice (GM-2).
30	F	ENG-5	Main idea (RD-4).
31	A	GM-5	Comma before a descriptive phrase.
32	J	GM-9	Possessive “their” (GM-9).
33	A	GM-2	Two sentences, correctly separated.
34	G	ENG-3	After describing abilities, the debate is a qualification: Still.
35	A	GM-8	Plural “they” with present perfect.
36	J	GM-12	Parallel: to open, to escape, to navigate (GM-12).
37	A	ENG-8	“Yet” sets up the surprising contrast developed here (ENG-8).
38	G	GM-8	Intelligence (singular) (GM-8).
39	A	GM-5	“scientists hope” is an interruption set off by a pair of commas.
40	J	ENG-5	Matches (ENG-5).
41	A	GM-10	Correct past tense with adverb.
42	G	GM-9	Possessive “whose,” not “who’s” = who is (GM-9).
43	A	GM-6	Correct as written.
44	G	GM-6	Subject “Anning” + verb “found”; no apostrophe, no comma (GM-6).
45	D	GM-2	Comma splice fixed with a period (GM-2).
46	F	ENG-3	Contrast: they excluded her, yet learned from her.
47	B	GM-12	“One of the most...”: superlative.
48	J	ENG-4	Explains why she matters (ENG-4).
49	B	GM-2	Two independent clauses: a comma alone is a splice (GM-2).
50	H	ENG-6	Childhood → career → exclusion → legacy (ENG-6).

Math

#	ANS	LESSON	WHY
1	D	AL-1	$24 - 9$.
2	J	AL-2	$30 + 25$.
3	D	DA-2	0.15×80 .
4	G	AL-1	$x + 5 = 9$.
5	B	AL-2	$12/6$.
6	F	DA-3	Sum 36.
7	C	AM-2	$3x^2 - 12x + 2x$.
8	F	GT-1	Width 6.
9	A	DA-5	$4/12$.
10	H	AM-7	$4 - 3$.
11	B	AL-5	$x > 6$.
12	F	DA-1	3.5×40 .
13	B	GT-3	7-24-25.
14	H	AM-3	$(x + 5)(x - 4)$.
15	D	AM-8	$18 - 3$.
16	G	GT-2	$180 - 120$.
17	A	AM-1	$x^{12} \cdot x^2$.
18	J	AL-4	Add: $4x = 16$.
19	C	AX-7	Average.
20	J	DA-2	$40 \div 0.8$.
21	B	AX-1	$3 - 3i + 2i - 2i^2$.
22	F	AX-4	$4 + 14 \cdot 5$.
23	B	AX-3	$5 + 2$.

#	ANS	LESSON	WHY
24	G	AX-2	$18 - 8$.
25	C	AX-5	$9C4$.
26	G	AM-4	Vertex form.
27	C	GT-5	(h, k) and $\sqrt{16}$.
28	G	GT-4	Adjacent 12; $9/12$.
29	A	AM-5	$2,000 \cdot 2^4$.
30	F	AM-7	$3x + 1 = 25$.
31	C	AX-8	Swap and solve.
32	H	AX-6	$ a $.
33	A	AX-6	$2\pi/2$.
34	G	GT-1	$72\pi \div 9\pi$.
35	A	AM-3	$100 - 4k = 0$.
36	F	AX-6	5-12-13.
37	C	AM-3	$-b/a$.
38	J	AX-5	$5!$.
39	D	AX-4	$2(3^6 - 1)/2$.
40	J	AX-7	8-15-17.
41	B	AX-8	$x^2 = 9$.
42	H	AX-6	$36 + 100 + 60 = 196$.
43	C	AX-1	$2026 = 4 \cdot 506 + 2$.
44	G	AM-10	$27 - 18 - 15 + 6 = 0$.
45	C	AX-7	$2 \cdot 6$.

Reading

#	ANS	LESSON	WHY
1	A	RD-7	First person, Lena returning (RD-7).
2	G	RD-7	Function: change over time (RD-7).
3	A	RD-5	She resolved not to be sentimental, but is (RD-5).
4	J	RD-3	Stated in paragraph 3 (RD-3).
5	B	RD-3	Paragraph 4 (RD-3).
6	H	RD-9	"Not angry... studying it" (RD-6, RD-9).
7	D	RD-5	Consistent with her character (RD-5).
8	H	RD-9	A softening (RD-9).
9	C	RD-9	The turn (RD-9).
10	G	RD-4	Whole passage (RD-4).
11	C	RD-3	Paragraph 2 (RD-3).
12	F	RD-7	Function (RD-7).
13	B	RD-3	Paragraph 4 (RD-3).
14	J	RD-3	Paragraph 4 (RD-3).
15	C	RD-5	Self-selection; association, not cause (RD-5).
16	J	RD-6	Tools, not final judgments (RD-6).
17	A	RD-5	Paragraph 6 (RD-5).
18	J	RD-7	Paragraph labels (RD-7).

#	ANS	LESSON	WHY
19	B	RD-7	Function of the image (RD-7).
20	J	RD-3	Not mentioned (RD-3).
21	B	RD-3	"Some do." (RD-3).
22	G	RD-9	"At first I felt lost." (RD-9).
23	A	RD-3	Paragraph 2 of B (RD-3).
24	J	RD-6	Context (RD-6).
25	B	RD-8	The overlap (RD-8).
26	J	RD-8	B's distinct point (RD-8).
27	C	RD-8	Partial agreement (RD-8).
28	G	RD-4	Whole passage (RD-4).
29	C	RD-3	Paragraph 1 (RD-3).
30	J	RD-10	Purpose of the method (RD-10).
31	C	RD-7	Function (RD-7).
32	G	RD-3	Stated (RD-3).
33	B	RD-5	Paragraph 4 (RD-5).
34	H	RD-6	Context (RD-6).
35	A	RD-5	Paragraph 5 (RD-5).
36	H	RD-7	Conclusion (RD-7).

Science

#	ANS	LESSON	WHY
1	B	SC-2	$75 > 70 > 44$ (SC-2).
2	F	SC-3	$5 \rightarrow 93$ (SC-3).
3	D	SC-3	88% at 25°C (SC-3).
4	J	SC-3	Between 75 and 71 (SC-3).
5	A	SC-2	35% of 40 = 14 (SC-2).
6	J	SC-4	40 vs. 5 and 62 vs. 18 (SC-4).
7	C	SC-4	Changed on purpose (SC-4).
8	F	SC-4	Length fixed at 1.00 m (SC-4).
9	D	SC-3	$1.00 \rightarrow 2.84$ (SC-3).
10	G	SC-3	2.00–2.01 s throughout (SC-3).
11	D	SC-3	$1.00 \rightarrow 2.01$ (SC-3).
12	F	SC-3	Quadrupling length doubles the period: $2 \times 2.01 \approx 4.0$ (SC-3).
13	A	SC-4	Better precision (SC-4).
14	G	SC-2	0.5 mg/L (SC-2).
15	B	SC-3	$12.0 \rightarrow 11.0$ (SC-3).
16	F	SC-3	8.0 at 5 m, 4.5 at 10 m (SC-3).
17	B	SC-2	$11.5 - 4.5$ (SC-2).
18	J	SC-6	Surface 1°C vs. 24°C (SC-6).
19	C	SC-3	Coldest depth with DO ≥ 5 is 5 m (22°C, 8.0) (SC-3).
20	G	SC-5	The overlap (SC-5).

#	ANS	LESSON	WHY
21	B	SC-5	Student 2's claim (SC-5).
22	G	SC-5	Removing vapor reduces the effect (SC-5).
23	C	SC-5	Same effect without vapor (SC-5).
24	H	SC-5	Warming air expands (SC-5).
25	D	SC-5	Condensation is Student 2's mechanism (SC-5).
26	F	SC-5	Both rely on cooling (SC-5).
27	D	SC-4	SC-4.
28	F	SC-4	500 g every trial (SC-4).
29	C	SC-3	$0 \rightarrow -7.6$ (SC-3).
30	F	SC-3	Halfway between -3.8 and -7.6 (SC-3).
31	C	SC-2	$-3.8 \rightarrow -7.6$ (SC-2).
32	J	SC-2	7.6 vs. 2.1 (SC-2).
33	A	SC-6	Freezing-point depression (SC-6).
34	F	SC-2	100% at pH 2 (SC-2).
35	A	SC-2	70% vs. 5% (SC-2).
36	G	SC-3	Peak at pH 2 (SC-3).
37	D	SC-3	$100 \rightarrow 40$ (SC-3).
38	G	SC-6	Above 7 (SC-6).
39	D	SC-2	45% and 15% (SC-2).
40	G	SC-4	Matches both organs (SC-4).

Estimate Your Scores

An estimate only: every official ACT form has its own scale.

ENGLISH (OF 50) CORRECT	SCORE
50	36
48	34
46	32
44	30
41	28
38	26
35	24
31	22
27	20
23	18
19	16
15	14
10	11
0	1

MATH (OF 45) CORRECT	SCORE
45	36
43	34
41	32
38	30
35	28
31	26
27	24
23	22
19	20
16	18
13	16
10	14
6	11
0	1

READING (OF 36) CORRECT	SCORE
36	36
35	34
33	32
31	30
29	28
27	26
24	24
21	22
18	20
15	18
12	16
9	14
5	10
0	1

SCIENCE (OF 40) CORRECT	SCORE
40	36
39	34
37	32
35	30
33	28
30	26
27	24
24	22
20	20
17	18
14	16
10	14
6	11
0	1

HOW TO USE IT

Count your correct answers in each test, find the highest row you reached, and read the estimate.

YOUR COMPOSITE

Average your English, Math and Reading scores and round to the nearest whole number. Science is reported separately; Math and Science together make your STEM score.

WHY IT'S AN ESTIMATE

This test hasn't been calibrated on real test-takers. For an official-style score, take a free full-length ACT practice test and score it with its own key.

THEN

Evaluate every miss with REF-3, and study the lesson listed for each one in the answer key.

PART IX

After the Game

The final month, the systems behind the score, and the reference pages.

The Final Month



JOSEF AIDEN DURAND
FROM THE AUTHOR

The last month isn't for learning new things. It's for sharpening what you have and arriving rested.

Weeks four, three and two: one full practice test a week, at the same time of day as your real test, in the same format you'll test in (paper or online), with every miss evaluated within 48 hours. Between tests, targeted practice on the three skills your error log says matter most.

Final week: no new content. Redo your error log. One light, timed test to stay sharp. Move your bedtime and wake time to match test day. Re-read the Arsenal and the formulas. Then rest.

The night before, pack your bag, print your admission ticket and check your calculator's batteries, and go to sleep. You've already done the work. Test day is just where it shows.

The ACT Is Testing Your Life Systems



JOSEF AIDEN DURAND
FROM THE AUTHOR

Here's a secret: the ACT is less a test of what you know than of how you live. Do you keep a schedule? Do you sleep? Do you finish what you start? Do you learn from mistakes, or repeat them? Your score reflects all of it.

Elite scorers don't have more willpower than anyone else. They have systems: four study blocks on the calendar, a worksheet for every miss, a redo schedule, a bedtime. Systems don't depend on motivation. That's the point.

And here's the payoff: the systems you build for the ACT don't expire after test day. The student who learns to plan a season, evaluate honestly and recover from setbacks has learned how to succeed in college, in a career, and in a life. The score is the receipt. The systems are the real prize.

Formulas to Memorize

The ACT gives you no formula sheet. This is the sheet, in your head.

AREA AND VOLUME

Rectangle lw · Triangle $\frac{1}{2}bh$ · Trapezoid $\frac{1}{2}(b_1 + b_2)h$ · Parallelogram bh · Circle πr^2 , circumference $2\pi r$ · Prism lwh · Cylinder $\pi r^2 h$ · Sphere $(4/3)\pi r^3$ · Cone $(1/3)\pi r^2 h$ · Pyramid $(1/3)Bh$ · Surface area: add the faces

TRIANGLES

Angles sum to 180° · $a^2 + b^2 = c^2$ · 30-60-90: $x, x\sqrt{3}, 2x$ · 45-45-90: $x, x, x\sqrt{2}$ · Triples 3-4-5, 5-12-13, 8-15-17, 7-24-25 · Exterior angle = sum of the two remote interior angles · Polygon interior sum $(n - 2)180^\circ$

LINES AND COORDINATES

Slope $(y_2 - y_1)/(x_2 - x_1)$ · $y = mx + b$ · $y - y_1 = m(x - x_1)$ · $Ax + By = C$ has slope $-A/B$ · Parallel: equal slopes · Perpendicular: negative reciprocals ·

Midpoint $((x_1 + x_2)/2, (y_1 + y_2)/2)$ · Distance $\sqrt{(\Delta x)^2 + (\Delta y)^2}$

QUADRATICS AND POLYNOMIALS

$x = (-b \pm \sqrt{b^2 - 4ac})/2a$ · Discriminant: > 0 two, $= 0$ one, < 0 none · Vertex $x = -b/2a$ · Sum of roots $-b/a$ · Product c/a · $(a \pm b)^2 = a^2 \pm 2ab + b^2$ · $a^2 - b^2 = (a + b)(a - b)$

EXPONENTS AND LOGS

$x^a x^b = x^{a+b}$ · $(x^a)^b = x^{ab}$ · $x^{-a} = 1/x^a$ · $\log_b x = y \Leftrightarrow b^y = x$ · $\log(ab) = \log a + \log b$ · $\log(a^n) = n \log a$ · Growth $a(1 + r)^t$

CIRCLES

$(x - h)^2 + (y - k)^2 = r^2$ · Arc $= (\theta/360)2\pi r$ · Sector $= (\theta/360)\pi r^2$ · Arc $= r\theta$ (radians) · Inscribed angle $= \frac{1}{2}$ central angle · $180^\circ = \pi$ radians

TRIGONOMETRY

SOH-CAH-TOA · $\sin^2 \theta + \cos^2 \theta = 1$ · $\tan = \sin / \cos$ · $\sin x^\circ = \cos(90^\circ - x^\circ)$ · $\csc, \sec, \cot = 1/\sin, 1/\cos, 1/\tan$ · Law of sines $a/\sin A = b/\sin B$ · Law of cosines $c^2 = a^2 + b^2 - 2ab \cos C$ · Period of $\sin(bx) = 2\pi/b$

SEQUENCES, COUNTING, DATA

$a_n = a_1 + (n - 1)d$ · $a_n = a_1 r^{n-1}$ · $nPr = n!/(n - r)!$ · $nCr = n!/(r!(n - r)!)$ · Mean, median, mode, range · Probability = favorable $\div$ total · Percent change = $(\text{new} - \text{old})/\text{old}$

COMPLEX NUMBERS AND MATRICES

$i^2 = -1$; powers of i cycle $i, -1, -i, 1$ · $(a + bi)(a - bi) = a^2 + b^2$ · 2×2 determinant $ad - bc$ · $(m \times n)(n \times p) \rightarrow m \times p$

The Arsenal

Six weapons. Every wrong answer dies to at least one.

WEAPON	CODE	THE TRAP	HOW TO SPOT IT	THE KILL QUESTION
Gladius	OPP	Opposite	Reverses the text: increase/decrease, supports/undermines, a hidden “not”	Does this say the reverse of the text?
Pugio	HALF	Half-Right	First half matches; the part after and, but, because or which doesn’t	Is every part of this supported?
Trident	EXT	Extreme Language	always, never, all, none, only, proves, completely	Is this stronger than the evidence?
Fist	RAWQ	Right Answer, Wrong Question	True to the text, but answers a different question	Does this answer THIS stem?
Mace	OOS	Out of Scope / Beyond the Text	Outside knowledge, too broad, new topics, unstated causes	Can I point to it in the text?
Axe	REC	Recycled Language	Copies passage words but changes the meaning or order	Same words, but same meaning?

THE FOUR-STEP ATTACK

1 Stem, then the text. 2 Predict: your Shield. 3 Attack every choice. 4 Select what’s left.

ON ACT ENGLISH

NO CHANGE is a real answer. When choices are all correct, the shortest wins. Name the rule before you read the choices.

THE ONE QUESTION

Ask it of every answer choice on the test: “How can I attack this answer?” The right answer is the one you can’t kill.

The Film Sheet

Fill one row for every question you missed or guessed. Every miss gets a film session.

DATE · Q	SKILL	MINE / RIGHT	WHY THE RIGHT ANSWER IS RIGHT (THE PROOF)	TRAP (CODE)	MISS TYPE	FIX (LESSON)	REDO DATES
10/4 · Eng 23	Boundaries	A / C	Two full sentences joined by a comma alone: a splice. Semicolon fixes it.	—	Content	GM-2	10/7 · 10/11 · 10/25
10/4 · Read 31	Inference	D / B	Lines 62–64 show the narrator forgave her brother; D adds anger the text never shows	OOS	Trap	RD-5, GL-8	10/7 · 10/11 · 10/25

CONTENT: I didn’t know the rule or formula. Fix: the lesson page, then targeted reps.

STRATEGY: I skipped a step (no Shield, no POE, answered from memory). Fix: GL-2, RD-2.

TRAP: I fell for a weapon’s target. Fix: write the trap code and three more examples.

CARELESS OR TIME: I misread, miscalculated or rushed. Fix: ACT-21 or the pacing plays.

What the ACT Is Actually Teaching You



JOSEF AIDEN DURAND
FROM THE AUTHOR

Strip away the scaled scores and the percentiles, and the ACT is teaching you a handful of lessons that will serve you long after you forget the law of cosines.

Read what's actually there, not what you expect to see. Make a prediction before you look at the options. Be suspicious of anything that sounds too absolute. Check whether an answer addresses the question you were actually asked. Separate evidence from opinion. Plan your time. Recover from setbacks quickly. Learn more from your mistakes than from your successes.

Those are the habits of good scientists, good lawyers, good founders and good friends. The ACT just happens to be where many students practice them for the first time.

So earn the score. Then keep the habits. We don't just get students in. We build who they become.

ABOUT THE AUTHOR

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Josef Aiden Durand is the founder and CEO of Veritas Hall and a graduate of Harvard College (A.B. in Psychology). He has more than a decade of experience as an admissions coach and SAT tutor in math and reading, working with students from Beijing to California and with firms including Quad Education, Elite Educational Institute, IvyMax, FLEX College Prep, Bridge Education Foundation and Zenith Prep Academy.

His students have been admitted to Harvard, Yale, Princeton, Stanford, MIT, Columbia, Penn, Brown, Dartmouth and Cornell, and to competitive BS/MD programs. He has been featured in Forbes and The Hill discussing standardized testing and admissions.

Josef played twelve years of football, including at Don Bosco Prep, where he competed for a national championship. The coaches who built those teams taught him that winning comes from a system, a playbook and the discipline to run it. He is also the author of *Art of Admissions: The Official College Application Strategy Guide*.

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We build who they become.*

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