



Slope, Graphs, and Linear Equations

Four focused lessons, worked examples, a mistake clinic, and 60 practice problems with full explanations.

In this booster

07.1 The Coordinate Plane and Graphing Points

07.2 Slope as Rate of Change

07.3 Slope-Intercept Form

07.4 Standard Form, Point-Slope Form, and Parallel/Perpendicular Lines

Every section teaches the idea, walks through the most common problem types, flags the traps students fall into, and ends with fifteen practice problems. Full answers and explanations are at the back.

07.1 The Coordinate Plane and Graphing Points

Learn to name, plot, and read points on the coordinate plane, find the quadrants, and build a table of values to graph a rule.

Why This Matters

Every graph you will ever read, from a phone battery chart to a map grid, uses the same idea: two number lines that cross, so each spot has an address. Students usually get stuck in three places: mixing up which number comes first, going the wrong way on a negative number, and forgetting that the origin is $(0, 0)$.

The coordinate plane is the base for slope, lines, functions, geometry, and data analysis. Video games use it to place characters, engineers use it to design parts, and scientists use it to show how one quantity changes with another. Get comfortable here and the rest of this booster gets much easier.

Core Ideas

The **coordinate plane** is made from two number lines. The horizontal one is the **x-axis**. The vertical one is the **y-axis**. They cross at the **origin**, which is the point $(0, 0)$. Every point has an **ordered pair** (x, y) . The order matters: $(3, 5)$ and $(5, 3)$ are different points.

Reading an ordered pair

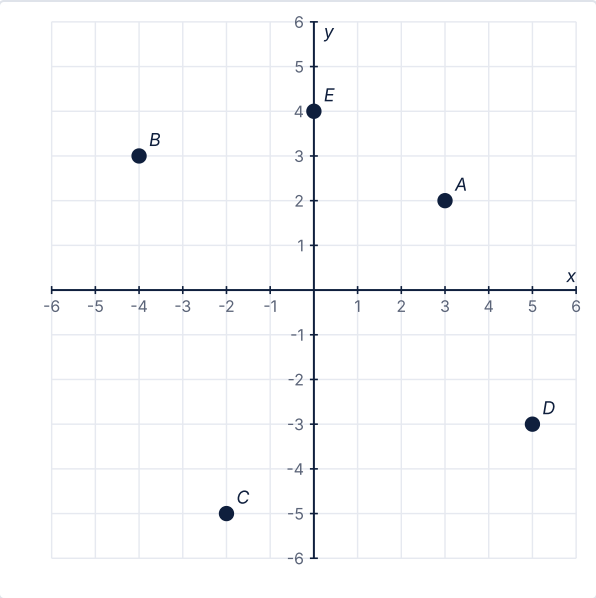
The pair (x, y) means: start at the origin, move **x** units sideways first (right if positive, left if negative), then move **y** units up or down (up if positive, down if negative).

Memory trick: you walk through the hall before you ride the elevator. Sideways first, then up or down.

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Points A(3, 2), B(-4, 3), C(-2, -5), D(5, -3), and E(0, 4). E sits on the y-axis.

The two axes cut the plane into four regions called **quadrants**. They are numbered counterclockwise, starting at the upper right.

Quadrant	Position	Signs of (x, y)	Example
I	upper right	(+, +)	(3, 2)
II	upper left	(-, +)	(-4, 3)
III	lower left	(-, -)	(-2, -5)
IV	lower right	(+, -)	(5, -3)

Points on the axes

A point on the **x-axis** has $y = 0$, like (6, 0). A point on the **y-axis** has $x = 0$, like (0, -2). Points on an axis are not in any quadrant.

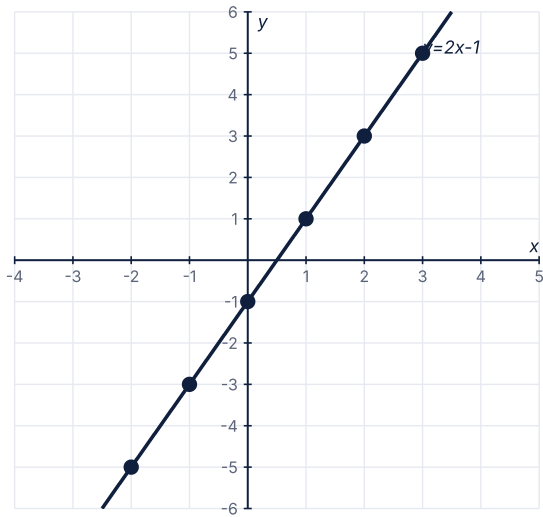
A **rule** such as $y = 2x - 1$ tells you how to get y from x . To graph it, make a **table of values**: pick several x values, put each one into the rule, and record y . Each row is a point. If the rule is a straight-line rule, the points line up.

x	-2	-1	0	1	2	3
$y = 2x - 1$	-5	-3	-1	1	3	5

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The six points from the table lie on one straight line.

A point is on a graph when it fits the rule

A point (a, b) is on the graph of a rule exactly when putting $x = a$ into the rule gives $y = b$.

Worked Examples

EXAMPLE 1: NAMING QUADRANTS

In which quadrant or on which axis does each point lie? (a) $(-7, 2)$ (b) $(4, -9)$ (c) $(0, -3)$ (d) $(-1, -1)$

SOLUTION

Check the sign of each number.

(a) x negative, y positive: **Quadrant II.**

(b) x positive, y negative: **Quadrant IV.**

(c) x is 0, so the point is on the **y-axis**. It is in no quadrant.

(d) both negative: **Quadrant III.**

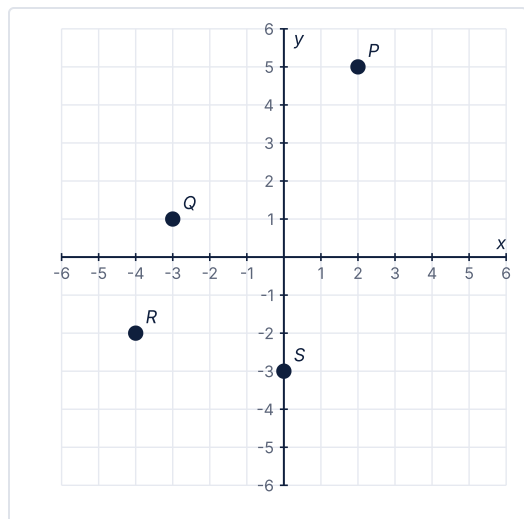
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EXAMPLE 2: READING POINTS FROM A GRAPH

Give the coordinates of points P, Q, R, and S.

**SOLUTION**

P: right 2, up 5, so $(2, 5)$.

Q: left 3, up 1, so $(-3, 1)$.

R: left 4, down 2, so $(-4, -2)$.

S: no sideways move, down 3, so $(0, -3)$ on the y-axis.

EXAMPLE 3: BUILDING A TABLE AND GRAPHING

Make a table of values for $y = -x + 4$ using $x = -1, 0, 1, 2, 3$. Then say whether $(5, 1)$ is on the graph.

SOLUTION

Substitute each x : $-(-1) + 4 = 5$, $0 + 4 = 4$, $-1 + 4 = 3$, $-2 + 4 = 2$, $-3 + 4 = 1$.

Points: $(-1, 5)$, $(0, 4)$, $(1, 3)$, $(2, 2)$, $(3, 1)$. Plot them and they line up going down to the right.

Test $(5, 1)$: $y = -5 + 4 = -1$, not 1. So $(5, 1)$ is **not** on the graph.

EXAMPLE 4: REFLECTIONS

The point $T(-3, 4)$ is reflected across the x-axis, then the result is reflected across the y-axis. Where does it end up?

SOLUTION

Reflecting across the x-axis flips up and down, so the y-coordinate changes sign: $(-3, 4) \rightarrow (-3, -4)$.

Reflecting across the y-axis flips left and right, so the x-coordinate changes sign: $(-3, -4) \rightarrow (3, -4)$.

The final point is $(3, -4)$, in Quadrant IV.

EXAMPLE 5: A RULE FROM REAL LIFE

A climbing gym charges a 10 dollar sign-up fee plus 4 dollars per visit. The cost in dollars after v visits is $C = 4v + 10$. Make a table for $v = 0, 2, 4, 6$, then find how many visits cost 34 dollars.

SOLUTION

Costs: $v = 0$: 10. $v = 2$: 18. $v = 4$: 26. $v = 6$: 34.

Points $(0, 10)$, $(2, 18)$, $(4, 26)$, $(6, 34)$. Visits go on the x-axis, cost on the y-axis.

The point with cost 34 is $(6, 34)$, so **6 visits**.

Check by rule: $4(6) + 10 = 34$.

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EXAMPLE 6: FINDING THE MISSING VERTEX

Three corners of a rectangle are $(-3, 2)$, $(4, 2)$, and $(4, -1)$. Find the fourth corner, the perimeter, and the area.

SOLUTION

The top side runs from $(-3, 2)$ to $(4, 2)$, so the top edge is at $y = 2$. The right side is at $x = 4$ going down to $y = -1$.

The fourth corner shares the x-value of the left top corner and the y-value of the bottom right corner: $(-3, -1)$.

Width: $4 - (-3) = 7$. Height: $2 - (-1) = 3$.

Perimeter: $2(7 + 3) = 20$ units. Area: $7 \times 3 = 21$ square units.

Coach's Playbook

- 1 Sideways, then up.** Say it out loud: x first, y second. Put your pencil on the origin and move.
- 2 Check the scale.** Look at what one grid line is worth before you read a point. Some graphs count by 2 or 5.
- 3 Use a full table.** Pick at least three x values, including a negative number and zero. Three points on one line confirm you did not slip.
- 4 Test a point by substitution.** To decide if a point is on a graph, plug its x into the rule and compare to its y.

Common traps

1. Writing (y, x) instead of (x, y) . 2. Moving right for a negative x-value. Negative x means left. 3. Calling a point on an axis part of a quadrant. 4. Sign slips in a table: forgetting that $-(-1)$ is $+1$ when you substitute a negative x.

Mistake Clinic**Spot the error**

A student plots $(4, -3)$ at the spot left 3 and up 4, which is $(-3, 4)$. **Where it went wrong:** the student swapped x and y. The first number is the sideways move. **Right way:** start at the origin, go right 4, then down 3. The point is in Quadrant IV.

Spot the error

A student makes a table for $y = -2x + 1$ and writes, for $x = -3$: $y = -6 + 1 = -5$. **Where it went wrong:** $-2 \cdot (-3)$ is positive 6, not negative 6. **Right way:** $y = 6 + 1 = 7$, so the point is $(-3, 7)$.

Spot the error

A student says the point $(0, -4)$ is in Quadrant III because the y-value is negative. **Where it went wrong:** the x-value is 0, so the point is on the y-axis, and points on an axis are in no quadrant. **Right way:** say it lies on the y-axis, 4 units below the origin.

Real-World Connection

A map app places your location with two numbers, latitude and longitude. That is an ordered pair on a very large coordinate plane.

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Challenge Corner

The point $A(2, 3)$ is reflected across the y -axis to get B , and A is reflected across the x -axis to get C . Find the area of triangle ABC . **Solution:** $B = (-2, 3)$ and $C = (2, -3)$. Side AB is horizontal with length $2 - (-2) = 4$. Side AC is vertical with length $3 - (-3) = 6$. The two sides meet at a right angle at A , so the area is $\frac{1}{2} \cdot 4 \cdot 6 = 12$ square units.

Practice**PRACTICE The Coordinate Plane and Graphing Points**

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- In which quadrant is the point $(-5, 2)$?
 (A) Quadrant I (B) Quadrant II (C) Quadrant III
 (D) Quadrant IV
- Which point lies on the x -axis?
 (A) $(0, 4)$ (B) $(4, 4)$ (C) $(-3, 0)$ (D) $(2, -2)$
- For the rule $y = 3x - 2$, what is y when $x = 4$?
 (A) 6 (B) 14 (C) 12 (D) 10
- The point $(-4, 3)$ is reflected across the x -axis. What is the new point?
 (A) $(4, 3)$ (B) $(-4, -3)$ (C) $(4, -3)$ (D) $(3, -4)$
- Which point is on the graph of $y = x + 5$?
 (A) $(-2, 3)$ (B) $(-2, -3)$ (C) $(3, 2)$ (D) $(5, 0)$
- A rectangle has vertices $(1, 2)$, $(7, 2)$, $(7, -3)$, and $(1, -3)$. What is its area?
 (A) 22 (B) 30 (C) 11 (D) 15
- Which point is in Quadrant IV?
 (A) $(-4, 2)$ (B) $(-1, -6)$ (C) $(0, -5)$ (D) $(3, -7)$
- Which ordered pair is on the graph of $y = 3 - 2x$?
 (A) $(4, -5)$ (B) $(1, 3)$ (C) $(-4, -5)$ (D) $(3, -1)$
- Three corners of a rectangle are $(-3, 2)$, $(4, 2)$, and $(4, -1)$. What is the fourth corner?
 (A) $(-3, 1)$ (B) $(4, -3)$ (C) $(-3, -1)$ (D) $(3, -1)$
- For the rule $y = -2x + 3$, find y when $x = -3$.
- Find the distance between $(-6, 4)$ and $(5, 4)$.
- A pool already has 40 gallons of water and a hose adds 15 gallons each minute, so $G = 15m + 40$. After how many minutes does the pool hold 250 gallons?
- The point $(-5, 3)$ is reflected across the x -axis, and then the result is reflected across the y -axis. Give the final point.
- A point is 4 units to the left of the y -axis and 6 units below the x -axis. Give its coordinates and quadrant.
- A triangle has vertices $(-2, -1)$, $(6, -1)$, and $(6, 3)$. Find its area.

07.2 Slope as Rate of Change

Find how steep a line is using rise over run, calculate slope from two points, recognize the four kinds of slope, and explain slope as a rate in real situations.

Why This Matters

Slope is the number that tells you how fast something changes. It is the speed on a distance graph, the price per pound at a store, the steepness of a ramp, and the growth rate of a plant. Students most often get stuck by subtracting the coordinates in different orders, by flipping rise and run, and by losing a negative sign.

Slope is the heart of algebra and the first big idea of calculus. It also shows up in science labs, construction, and finance every time someone says "per": miles per hour, dollars per month, degrees per minute.

Core Ideas

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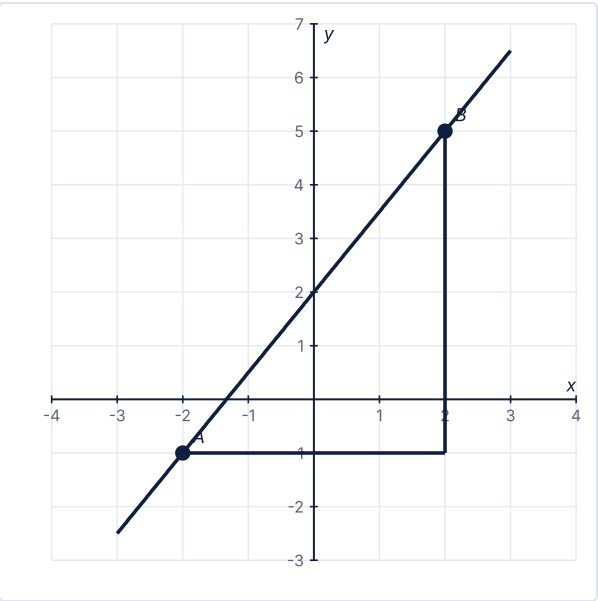
Slope measures steepness. Walk from one point on a line to another. The vertical change is the **rise**. The horizontal change is the **run**. Moving up is a positive rise and moving down is a negative rise. Moving right is a positive run.

Slope formula

Slope = $\frac{\text{rise}}{\text{run}}$. For points (x_1, y_1) and (x_2, y_2) on a line,

$$m = \frac{y_2 - y_1}{x_2 - x_1}.$$

Subtract in the same order on top and bottom. Either point can be called point 1, but you must not mix them.



From A to B the run is 4 and the rise is 6. Slope = $6/4 = 3/2$.

A line can lean four different ways. The sign and size of the slope tell you which.

Slope	What the line does	Example
Positive	rises as you move right	$m = 2$
Negative	falls as you move right	$m = -\frac{1}{3}$
Zero	flat, horizontal	$m = 0$
Undefined	straight up and down, vertical	no slope number

Zero versus undefined

A horizontal line has rise 0, so $m = \frac{0}{\text{run}} = 0$. A vertical line has run 0, and dividing by zero is not possible, so its slope is **undefined**. Remember: horizontal = zero, vertical = undefined.
A bigger absolute value of slope means a steeper line.

In real life, slope is a **rate of change**: how much the output changes for each 1 unit of the input. The units of the slope are (units of y) per (unit of x), like dollars per ticket.

Worked Examples

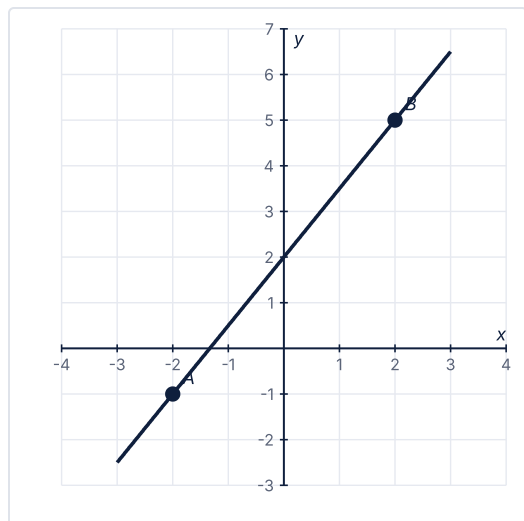
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EXAMPLE 1: SLOPE FROM A GRAPH

Find the slope of the line through points A and B on the graph.

**SOLUTION**

Count from A $(-2, -1)$ to B $(2, 5)$: run 4 to the right, rise 6 up.

$$m = \frac{6}{4} = \frac{3}{2}.$$

A positive slope matches a line rising to the right.

EXAMPLE 2: SLOPE FROM TWO POINTS

Find the slope of the line through $(3, 7)$ and $(8, -3)$.

SOLUTION

Point 1 is $(3, 7)$, point 2 is $(8, -3)$.

$$m = \frac{-3-7}{8-3} = \frac{-10}{5} = -2.$$

Negative slope: the line falls 2 units for each 1 unit right.

EXAMPLE 3: HORIZONTAL AND VERTICAL LINES

Find the slope of the line through (a) $(-4, 5)$ and $(6, 5)$, and (b) $(2, -3)$ and $(2, 8)$.

SOLUTION

$$(a) m = \frac{5-5}{6-(-4)} = \frac{0}{10} = 0. \text{ Horizontal line, slope } 0.$$

$$(b) m = \frac{8-(-3)}{2-2} = \frac{11}{0}. \text{ Division by zero, so the slope is } \mathbf{undefined}. \text{ The line is vertical.}$$

EXAMPLE 4: SLOPE AS A RATE

A hiker is at an elevation of 1200 feet after 2 hours and 1800 feet after 5 hours. Find the slope and say what it means.

SOLUTION

Points are (time, elevation): $(2, 1200)$ and $(5, 1800)$.

$$m = \frac{1800-1200}{5-2} = \frac{600}{3} = 200.$$

The hiker climbs **200 feet per hour**. The units of slope are feet per hour.

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EXAMPLE 5: FIND A MISSING COORDINATE

The line through $(2, 3)$ and $(10, k)$ has slope $-\frac{1}{2}$. Find k .

SOLUTION

Set up: $\frac{k-3}{10-2} = -\frac{1}{2}$.

$\frac{k-3}{8} = -\frac{1}{2}$, so $k-3 = -4$.

$k = -1$. Check: $\frac{-1-3}{8} = \frac{-4}{8} = -\frac{1}{2}$.

EXAMPLE 6: SLOPE FROM A TABLE

Apples cost 7.50 dollars for 3 pounds, 12.50 dollars for 5 pounds, and 22.50 dollars for 9 pounds. Show that the cost has a constant rate of change and find it.

SOLUTION

Use the first two pairs: $\frac{12.50-7.50}{5-3} = \frac{5}{2} = 2.5$.

Use the second and third pairs: $\frac{22.50-12.50}{9-5} = \frac{10}{4} = 2.5$.

Both give the same rate, so the rate is constant: **2.50 dollars per pound**. The graph of cost against pounds is a straight line.

Coach's Playbook

- 1 Label first.** Write (x_1, y_1) and (x_2, y_2) above your two points before you subtract.
- 2 Same order top and bottom.** If y uses point 2 minus point 1, x must also use point 2 minus point 1.
- 3 Sketch a quick picture.** Does the line go up or down as you move right? That tells you the sign of your answer before you calculate.
- 4 Simplify and add units.** Reduce the fraction. For a word problem, say "per" in your sentence.

Common traps

1. Putting run over rise instead of rise over run. 2. Subtracting in different orders, like $y_2 - y_1$ on top but $x_1 - x_2$ on the bottom, which flips the sign. 3. Saying a vertical line has slope 0. It is undefined. 4. Dropping a negative sign when subtracting a negative number, such as $5 - (-3)$.

Mistake Clinic**Spot the error**

Find the slope through $(2, 5)$ and $(6, 3)$. A student writes $\frac{6-2}{3-5} = \frac{4}{-2} = -2$. **Where it went wrong:** the student put run over rise. **Right way:** $m = \frac{3-5}{6-2} = \frac{-2}{4} = -\frac{1}{2}$.

Spot the error

Find the slope through $(1, 4)$ and $(5, -2)$. A student writes $\frac{-2-4}{1-5}$... then simplifies $\frac{-6}{-4} = \frac{3}{2}$. **Where it went wrong:** the order on top was point 2 minus point 1, but on the bottom it was point 1 minus point 2. **Right way:** $\frac{-2-4}{5-1} = \frac{-6}{4} = -\frac{3}{2}$. Check: the line falls, so the slope must be negative.

Spot the error

A student says the vertical line $x = 3$ has slope 0. **Where it went wrong:** a vertical line has run 0, which makes the fraction undefined. Slope 0 belongs to horizontal lines. **Right way:** the slope of $x = 3$ is undefined.

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Real-World Connection

A road sign that says 8 percent grade means the road rises 8 feet for every 100 feet of horizontal distance. That is a slope of $\frac{8}{100}$.

Challenge Corner

A line passes through $(-2, a)$ and $(4, 2a + 1)$ and has slope $\frac{1}{2}$. Find a and both points. **Solution:** $\frac{(2a+1)-a}{4-(-2)} = \frac{1}{2}$, so $\frac{a+1}{6} = \frac{1}{2}$ and $a + 1 = 3$. Then $a = 2$, and the points are $(-2, 2)$ and $(4, 5)$. Check: $\frac{5-2}{6} = \frac{1}{2}$.

Practice**PRACTICE Slope as Rate of Change**

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- What is the slope of the line through $(1, 2)$ and $(4, 11)$?
(A) $\frac{1}{3}$ (B) -3 (C) 3 (D) 9
- What is the slope of the line through $(-2, 4)$ and $(3, -6)$?
(A) 2 (B) -2 (C) $-\frac{1}{2}$ (D) $\frac{1}{2}$
- What is the slope of a horizontal line?
(A) 0 (B) undefined (C) 1
(D) It equals the y-value
- A tank holds 80 gallons at 2 minutes and 20 gallons at 5 minutes. What is the rate of change?
(A) 20 gallons per minute (B) -60 gallons per minute (C) $-\frac{1}{20}$ gallons per minute
(D) -20 gallons per minute
- Which line is steepest?
(A) slope $\frac{3}{4}$ (B) slope $\frac{1}{2}$ (C) slope $-\frac{5}{4}$ (D) slope 1
- The line through $(a, 4)$ and $(5, 10)$ has slope 2 . What is a ?
(A) 2 (B) 3 (C) 8 (D) 7
- What is the slope of the line through $(0, -3)$ and $(4, 5)$?
(A) -2 (B) 2 (C) 8 (D) $\frac{1}{2}$
- A bus is 90 miles from the start after 2 hours and 240 miles after 5 hours. What is its average speed between those times?
(A) 150 mph (B) 30 mph (C) 48 mph (D) 50 mph
- A line has slope $\frac{3}{4}$ and passes through $(1, 2)$. Which point is also on the line?
(A) $(5, 5)$ (B) $(4, 3)$ (C) $(5, 3)$ (D) $(1, 5)$
- Find the slope of the line through $(-5, -2)$ and $(7, 4)$.
- Find the slope of the line through $(4, -1)$ and $(4, 9)$.
- A wheelchair ramp rises 9 inches over a horizontal distance of 108 inches. What is its slope as a fraction in lowest terms?
- A plant is 12 cm tall at week 2 and 31 cm tall at week 6. Find the growth rate in cm per week, then predict the height at week 10 if the rate stays the same.
- Find the slope of the line through $(-3, 6)$ and $(5, -2)$.
- The line through $(2, 1)$ and $(8, k)$ has slope $\frac{2}{3}$. Find k .

07.3 Slope-Intercept Form

Use $y = mx + b$ to read the slope and y-intercept, graph a line quickly, write an equation from a graph or table, and explain what m and b mean in real situations.

Why This Matters

Slope-intercept form is the most useful way to write a line, because the equation hands you two facts right away: where the line starts and how fast it changes. Students usually get stuck by mixing up m and b , by losing the sign when the equation is not in the order they expect, and by reading the slope backwards when graphing.

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You will use this form in science labs to describe patterns, in business to model a fee plus a rate, and in every later math course, where it becomes the model for linear functions.

Core Ideas

Slope-intercept form

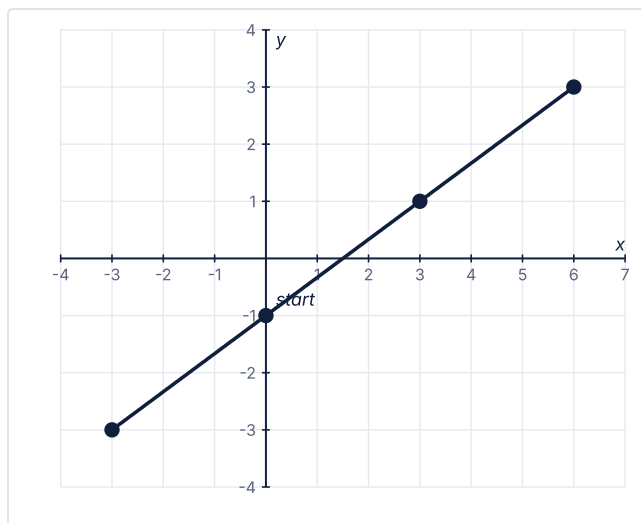
$$y = mx + b$$

Here m is the **slope** (rise over run) and b is the **y-intercept**, the y -value where the line crosses the y -axis. The y -intercept is the point $(0, b)$.

Example: in $y = -3x + 5$, the slope is -3 and the y -intercept is 5 , the point $(0, 5)$.

The b is where you **start** and the m is how you **move**. The equation $y = 2x + 1$ says: start at 1 on the y -axis, then go up 2 each time you go right 1 . The sign belongs to the number in front of it, so in $y = 7 - 2x$ the slope is -2 and $b = 7$. If you want, rewrite it as $y = -2x + 7$.

- 1 Plot the y-intercept.** Put a point at $(0, b)$ on the y -axis.
- 2 Use the slope.** Write m as a fraction. From your point, move up (or down if negative) by the rise, then right by the run, and plot a new point.
- 3 Repeat and draw.** Make two or three more points the same way, then draw a straight line through them with arrows on both ends.



Graph of $y = (2/3)x - 1$. Start at $(0, -1)$, then up 2 and right 3 each step.

Finding m and b from data

From any two points, find $m = \frac{\text{change in } y}{\text{change in } x}$. Then use a point to find b : put the point into $y = mx + b$ and solve for b . If the table or graph shows the point with $x = 0$, then b is its y -value.

Check your equation by testing a second point.

Piece	Meaning in a story	Example: cost = $55h + 40$
m	amount added per 1 unit of x (a rate)	55 dollars per hour
b	starting amount when $x = 0$ (a fee)	40 dollars to show up

Worked Examples

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EXAMPLE 1: READING M AND B

Give the slope and y-intercept of (a) $y = -3x + 5$, (b) $y = \frac{x}{2} - 4$, (c) $y = 7 - 2x$.

SOLUTION

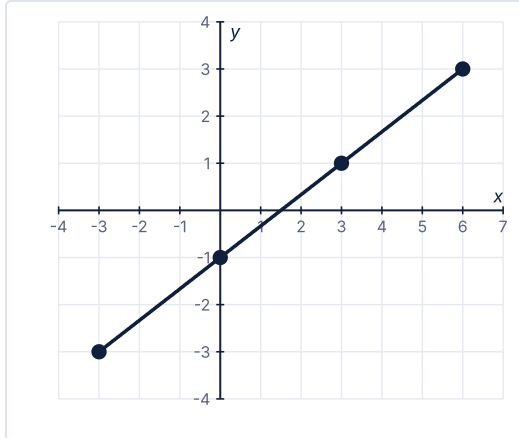
(a) $m = -3$, $b = 5$.

(b) $\frac{x}{2}$ is the same as $\frac{1}{2}x$, so $m = \frac{1}{2}$ and $b = -4$.

(c) Rewrite as $y = -2x + 7$. Then $m = -2$ and $b = 7$.

EXAMPLE 2: GRAPH A LINE

Graph $y = \frac{2}{3}x - 1$.

**SOLUTION**

The y-intercept is -1 , so plot $(0, -1)$.

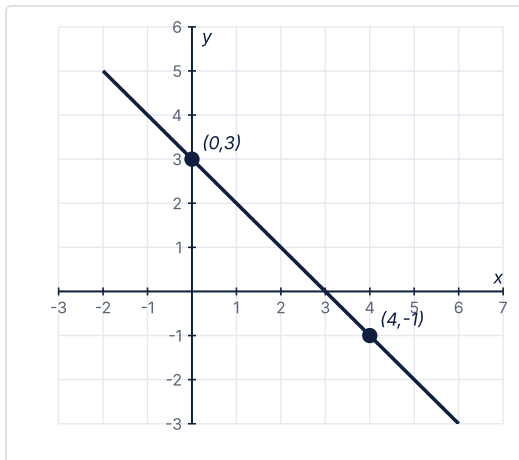
The slope is $\frac{2}{3}$: up 2, right 3. From $(0, -1)$ go to $(3, 1)$, then to $(6, 3)$.

Go the other way from the start to check: down 2, left 3 gives $(-3, -3)$.

Draw the line through these points.

EXAMPLE 3: EQUATION FROM A GRAPH

Write the equation of the line shown.

**SOLUTION**

The line crosses the y-axis at $(0, 3)$, so $b = 3$.

It also passes through $(4, -1)$. From $(0, 3)$ the line goes down 4 while going right 4, so $m = \frac{-4}{4} = -1$.

The equation is $y = -x + 3$. Check $(4, -1)$: $-4 + 3 = -1$. Yes.

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EXAMPLE 4: EQUATION FROM A TABLE

A table shows $x = 1, 2, 3, 4$ and $y = 7, 10, 13, 16$. Find the equation of the line.

SOLUTION

Slope: y goes up 3 each time x goes up 1 (7, 10, 13, 16), so $m = 3$.

The data has no $x = 0$. Use (1, 7) in $y = 3x + b$: $7 = 3(1) + b$, so $b = 4$.

The equation is $y = 3x + 4$. Check $x = 4$: $12 + 4 = 16$. Yes.

EXAMPLE 5: MEANING IN CONTEXT

A plumber charges 40 dollars to come to the house plus 55 dollars for each hour of work. Write the cost equation, then find the cost for 3.5 hours and the hours for a bill of 150 dollars.

SOLUTION

Start amount 40 and rate 55: $C = 55h + 40$.

For $h = 3.5$: $C = 55(3.5) + 40 = 192.5 + 40 = 232.5$ dollars.

For $C = 150$: $55h + 40 = 150$, so $55h = 110$ and $h = 2$ hours.

EXAMPLE 6: EQUATION FROM A SLOPE AND A POINT

A line has slope -2 and passes through (3, 1). Write its equation in slope-intercept form.

SOLUTION

Start with $y = mx + b$ and use $m = -2$: $y = -2x + b$.

Put in the point (3, 1): $1 = -2(3) + b$, so $1 = -6 + b$ and $b = 7$.

The equation is $y = -2x + 7$. Check with $x = 3$: $-6 + 7 = 1$. Yes.

Coach's Playbook

- ◆ Say it as a story: "I start at b and change by m for each step in x ."
- ◆ Always rewrite into $y = mx + b$ order before you read off numbers.
- ◆ Turn an integer slope into a fraction: $3 = \frac{3}{1}$, then rise 3 and run 1.
- ◆ Test one extra point in your final equation. If it fails, find the error before moving on.
- ◆ In a word problem, the fee that happens once is b . The amount that repeats is m .

Common traps

1. Reading the number after the equals sign as the slope when the equation is written like $y = 7 - 2x$. 2. Using the y -value of a point other than (0, b) as the intercept. 3. Graphing a negative slope by going up and right. Negative means down while going right. 4. Writing b in front of x , as in $y = bx + m$.

Mistake Clinic

Spot the error

A student reads the line $y = -2x + 5$ as slope 5 and y -intercept -2 . **Where it went wrong:** the student read the numbers left to right instead of by role. **Right way:** the number multiplying x is the slope, -2 , and the constant is the intercept, 5.

Spot the error

A line passes through (0, 3) and (2, 7). A student writes $y = 4x + 3$ because the rise is 4. **Where it went wrong:** slope is rise divided by run, not just rise. **Right way:** $m = \frac{7-3}{2-0} = 2$, so $y = 2x + 3$. Check (2, 7): $4 + 3 = 7$.

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Spot the error

To graph $y = -\frac{1}{2}x + 2$, a student starts at $(0, 2)$ and goes up 1 and right 2. **Where it went wrong:** that makes the slope positive. A negative slope goes down while moving right. **Right way:** from $(0, 2)$ go down 1 and right 2 to $(2, 1)$, then $(4, 0)$.

Real-World Connection

A streaming plan costs 6 dollars to join and 3 dollars a month. The total after t months is $y = 3t + 6$. The slope is the monthly price and the intercept is the joining fee.

Challenge Corner

Plan A costs $C = 15t + 30$ dollars after t months. Plan B costs $C = 25t$ dollars. When do the two plans cost the same, and what is that cost? **Solution:** set the costs equal: $15t + 30 = 25t$, so $30 = 10t$ and $t = 3$ months. Cost: $25(3) = 75$ dollars. Check with plan A: $15(3) + 30 = 75$. After 3 months Plan A is cheaper because it grows more slowly.

Practice**PRACTICE Slope-Intercept Form**

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- What is the y-intercept of $y = 5x - 7$?
 (A) 5 (B) -7 (C) 7 (D) $-\frac{5}{7}$
- Which equation has slope 3 and passes through $(0, -2)$?
 (A) $y = -2x + 3$ (B) $y = 3x + 2$ (C) $y = 3x$
 (D) $y = 3x - 2$
- A line passes through $(0, 4)$ and $(2, 10)$. What is its equation?
 (A) $y = 3x + 4$ (B) $y = 3x + 10$ (C) $y = 2x + 4$
 (D) $y = 4x + 3$
- The table shows $x = 0, 1, 2, 3$ and $y = 6, 4, 2, 0$. What is the equation?
 (A) $y = 2x + 6$ (B) $y = -2x - 6$ (C) $y = -2x + 6$
 (D) $y = 6x - 2$
- A line crosses the y-axis at -3 and falls 1 unit for every 2 units to the right. What is its equation?
 (A) $y = -2x - 3$ (B) $y = -\frac{1}{2}x - 3$ (C) $y = -\frac{1}{2}x + 3$
 (D) $y = 2x - 3$
- A candle is 20 cm tall and burns down 2.5 cm each hour, so its height is $h = 20 - 2.5t$. What does 2.5 represent?
 (A) The starting height of the candle (B) The time it takes to burn out
 (C) The height after 2.5 hours (D) How many centimeters it burns each hour
- What are the slope and y-intercept of $y = -\frac{x}{4} + 6$?
 (A) $m = 4$, $b = 6$ (B) $m = -4$, $b = 6$ (C) $m = -\frac{1}{4}$, $b = 6$
 (D) $m = 6$, $b = -\frac{1}{4}$
- Which point is on the line $y = 3x - 1$?
 (A) $(2, 5)$ (B) $(1, 3)$ (C) $(-1, 2)$ (D) $(3, -1)$
- A table shows $x = 2, 4, 6$ and $y = 11, 17, 23$. What is the equation?
 (A) $y = 3x + 11$ (B) $y = 3x + 5$ (C) $y = 5x + 3$
 (D) $y = 11x + 3$
- Rewrite $y = 8 - 5x$ in the form $y = mx + b$ and give m and b .
- Write the equation of the line through $(0, -4)$ and $(3, 2)$.

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12. A table shows $x = 2, 4, 6, 8$ and $y = 1, 7, 13, 19$. Write the equation of the line.
13. A taxi charges 3.50 dollars plus 2.25 dollars per mile. Write the cost equation $C = mx + b$, then find how many miles a ride can be for a total of 21.50 dollars.
14. A line has slope -3 and passes through $(2, 4)$. Write its equation in slope-intercept form.
15. Mia has 45 dollars and saves 12 dollars each week. Leo has 90 dollars and saves 3 dollars each week. After how many weeks do they have the same amount, and how much is it?

07.4

Standard Form, Point-Slope Form, and Parallel/Perpendicular Lines

Learn three ways to write a line, convert between them, find intercepts, and use slopes to write equations of parallel and perpendicular lines.

Why This Matters

A line can be written in several ways, and each form is best at a different job. Standard form makes intercepts easy, point-slope form lets you write an equation the moment you have a point and a slope, and slope-intercept form makes graphing quick. Students get stuck when they must switch between forms, when signs flip while moving terms, and when they mix up parallel and perpendicular.

Engineers use parallel and perpendicular lines in building plans, designers use them in layouts, and later courses use these forms to solve systems of equations and describe motion.

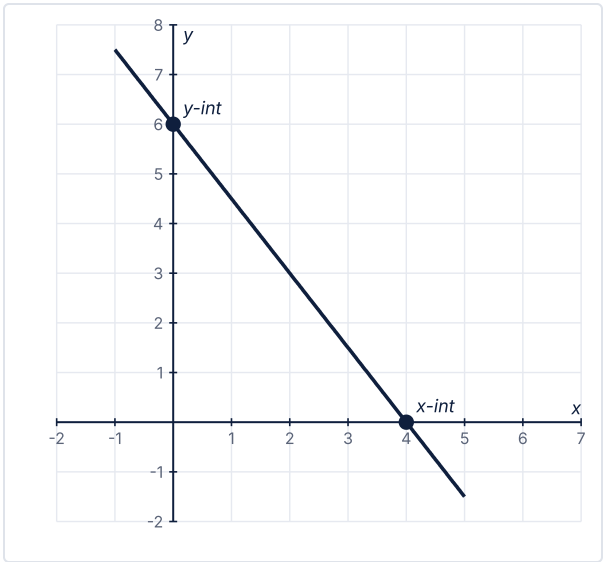
Core Ideas

Form	Pattern	Best for
Slope-intercept	$y = mx + b$	graphing; reading slope and start
Standard	$Ax + By = C$	finding intercepts; whole-number coefficients
Point-slope	$y - y_1 = m(x - x_1)$	writing an equation from a point and slope

Standard form and intercepts

Standard form is $Ax + By = C$ where A, B, C are integers and A is usually positive. To find the **x-intercept**, set $y = 0$ and solve. To find the **y-intercept**, set $x = 0$ and solve.

To convert to slope-intercept form, solve for y : $By = -Ax + C$, so $y = -\frac{A}{B}x + \frac{C}{B}$.



The line $3x + 2y = 12$ crosses the axes at $(4, 0)$ and $(0, 6)$.

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Point-slope form

A line with slope m through the point (x_1, y_1) has equation

$$y - y_1 = m(x - x_1).$$

Watch the signs: the point $(2, -1)$ gives $y + 1 = m(x - 2)$.

Parallel and perpendicular lines

Parallel lines have the **same slope** and different y-intercepts. **Perpendicular** lines have slopes that are **negative reciprocals**: if one slope is $\frac{a}{b}$, the other is $-\frac{b}{a}$. Their product is -1 .

Negative reciprocal means two changes: flip the fraction, and change the sign. The slope 2 becomes $-\frac{1}{2}$. The slope $-\frac{3}{4}$ becomes $\frac{4}{3}$.

Worked Examples

EXAMPLE 1: STANDARD FORM TO SLOPE-INTERCEPT AND INTERCEPTS

For $3x + 2y = 12$, find both intercepts and rewrite it as $y = mx + b$.

SOLUTION

x-intercept: let $y = 0$, so $3x = 12$ and $x = 4$. Point $(4, 0)$.

y-intercept: let $x = 0$, so $2y = 12$ and $y = 6$. Point $(0, 6)$.

Solve for y : $2y = -3x + 12$, so $y = -\frac{3}{2}x + 6$. The slope is $-\frac{3}{2}$ and the y-intercept is 6, matching the graph.

EXAMPLE 2: SLOPE-INTERCEPT TO STANDARD FORM

Write $y = \frac{2}{5}x - 3$ in standard form with integer coefficients.

SOLUTION

Multiply every term by 5 to clear the fraction: $5y = 2x - 15$.

Move the x-term: $-2x + 5y = -15$.

Multiply by -1 so that A is positive: $2x - 5y = 15$.

EXAMPLE 3: POINT-SLOPE FROM A POINT AND SLOPE

Write the equation of the line with slope 3 through $(2, -1)$ in point-slope form, then in slope-intercept form.

SOLUTION

Point-slope: $y - (-1) = 3(x - 2)$, which is $y + 1 = 3(x - 2)$.

Distribute: $y + 1 = 3x - 6$.

Subtract 1: $y = 3x - 7$.

EXAMPLE 4: LINE THROUGH TWO POINTS

Write the equation of the line through $(1, 5)$ and $(4, -1)$.

SOLUTION

Slope: $m = \frac{-1-5}{4-1} = \frac{-6}{3} = -2$.

Use $(1, 5)$: $y - 5 = -2(x - 1)$.

Distribute: $y - 5 = -2x + 2$, so $y = -2x + 7$. Check $(4, -1)$: $-8 + 7 = -1$. Yes.

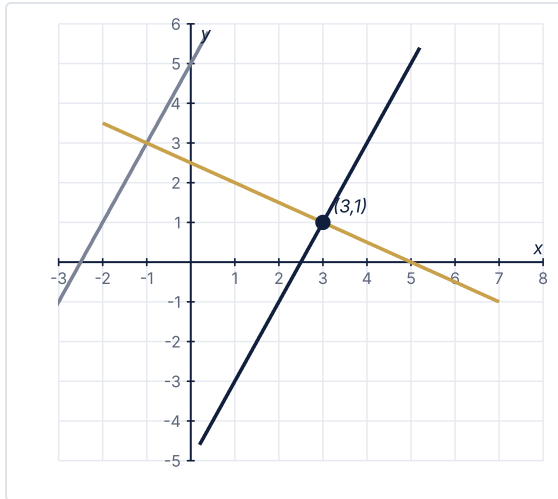
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EXAMPLE 5: PARALLEL AND PERPENDICULAR

Find the equation of the line through $(3, 1)$ that is (a) parallel and (b) perpendicular to $y = 2x + 5$.

**SOLUTION**

(a) Parallel: same slope 2. $y - 1 = 2(x - 3)$ gives $y = 2x - 5$.

(b) Perpendicular: slope $-\frac{1}{2}$. $y - 1 = -\frac{1}{2}(x - 3)$ gives $y = -\frac{1}{2}x + \frac{3}{2} + 1 = -\frac{1}{2}x + \frac{5}{2}$.

Check (b): $-\frac{1}{2}(3) + \frac{5}{2} = 1$. Yes.

EXAMPLE 6: STANDARD FORM FROM TWO POINTS

Write the equation of the line through $(2, 1)$ and $(5, 7)$ in standard form $Ax + By = C$.

SOLUTION

Slope: $m = \frac{7-1}{5-2} = \frac{6}{3} = 2$.

Point-slope with $(2, 1)$: $y - 1 = 2(x - 2)$, so $y = 2x - 3$.

Move the x-term: $-2x + y = -3$. Multiply by -1 : $2x - y = 3$.

Check $(5, 7)$: $2(5) - 7 = 3$. Yes.

Coach's Playbook

- 1 Pick the form by the job.** Intercepts: use standard form. Point and slope given: use point-slope. Graphing: use slope-intercept.
- 2 Find the slope first.** Almost every line problem needs m . Get it from two points, an equation, or the parallel/perpendicular rule.
- 3 Plug in and simplify.** Use point-slope with any known point, then simplify to $y = mx + b$.
- 4 Check with a point.** Put a known point into your final equation. If it does not work, look for a sign error.

Common traps

1. Writing $y - y_1 = m(x - x_1)$ with the wrong signs, such as $y - 4 = 5(x - 2)$ for the point $(-2, 4)$ instead of $y - 4 = 5(x + 2)$.
2. Using only the reciprocal for a perpendicular slope and forgetting to change the sign.
3. Dividing only one term by B when solving $Ax + By = C$ for y .
4. Setting the wrong variable to zero for an intercept. For the x-intercept, y is 0.

Mistake Clinic

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Spot the error

Find the slope of a line perpendicular to $y = 3x + 2$. A student answers -3 . **Where it went wrong:** only the sign changed. A perpendicular slope is the negative reciprocal. **Right way:** flip $3 = \frac{3}{1}$ to $\frac{1}{3}$ and change the sign: $-\frac{1}{3}$. Check: $3 \cdot (-\frac{1}{3}) = -1$.

Spot the error

Find the x-intercept of $2x + 5y = 10$. A student sets $x = 0$ and gets $5y = 10$, so the intercept is 2. **Where it went wrong:** setting $x = 0$ finds the y-intercept. **Right way:** set $y = 0$: $2x = 10$, so $x = 5$. The x-intercept is $(5, 0)$.

Spot the error

Write a line through $(3, -2)$ with slope 4. A student writes $y - 2 = 4(x - 3)$. **Where it went wrong:** the y-coordinate is -2 , and $y - (-2)$ is $y + 2$. **Right way:** $y + 2 = 4(x - 3)$, which simplifies to $y = 4x - 14$.

Real-World Connection

City streets in a grid are parallel in one direction and perpendicular to the cross streets. A planner uses slopes to make sure a new road is parallel to an existing one.

Challenge Corner

Find the equation, in standard form, of the line through $(-2, 5)$ that is parallel to $3x - 2y = 8$. **Solution:** solve $3x - 2y = 8$ for y : $y = \frac{3}{2}x - 4$, so the slope is $\frac{3}{2}$. A parallel line has the same slope. $y - 5 = \frac{3}{2}(x + 2)$ gives $y = \frac{3}{2}x + 8$. Multiply by 2: $2y = 3x + 16$, so $3x - 2y = -16$. Check $(-2, 5)$: $-6 - 10 = -16$.

Practice**PRACTICE Standard Form, Point-Slope Form, and Parallel/Perpendicular Lines**

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- What is the x-intercept of $4x + 3y = 24$?
(A) 8 (B) 24 (C) 6 (D) 4
- What is the slope of the line $6x - 2y = 10$?
(A) 3 (B) -3 (C) 6 (D) -5
- Which line is parallel to $y = -4x + 1$?
(A) $y = 4x + 1$ (B) $y = -\frac{1}{4}x + 1$ (C) $y = \frac{1}{4}x - 7$
(D) $y = -4x - 7$
- A line is perpendicular to $y = \frac{2}{3}x + 1$. What is its slope?
(A) $\frac{3}{2}$ (B) $-\frac{3}{2}$ (C) $-\frac{2}{3}$ (D) $\frac{2}{3}$
- Which equation has slope 5 and passes through $(-2, 4)$?
(A) $y - 4 = 5(x + 2)$ (B) $y - 4 = 5(x - 2)$ (C) $y + 4 = 5(x + 2)$
(D) $y + 2 = 5(x - 4)$
- Which line passes through $(2, 3)$ and is perpendicular to $y = -2x + 1$?
(A) $y = 2x - 1$ (B) $y = -2x + 7$ (C) $y = \frac{1}{2}x + 2$
(D) $y = \frac{1}{2}x + 3$
- What is the y-intercept of the line $2x - 5y = 20$?
(A) 10 (B) -4 (C) 4 (D) -10

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8. Which is the slope-intercept form of $3x + 4y = 12$?
- (A) $y = \frac{3}{4}x + 3$ (B) $y = -\frac{4}{3}x + 3$ (C) $y = -3x + 12$
 (D) $y = -\frac{3}{4}x + 3$
9. Which pair of lines is perpendicular?
- (A) $y = 2x + 3$ and $y = -\frac{1}{2}x + 5$ (B) $y = 2x + 1$ and $y = 2x - 1$
 (C) $y = 3x$ and $y = -3x$ (D) $y = \frac{1}{2}x$ and $y = 2x$
10. Write $5x - 2y = 20$ in slope-intercept form.
11. Write $y = -\frac{3}{4}x + 2$ in standard form with integer coefficients and a positive A .
12. Write the equation of the line through $(-1, 2)$ and $(3, 10)$ in slope-intercept form.
13. Write the equation, in slope-intercept form, of the line through $(4, -5)$ that is perpendicular to $2x + 3y = 9$.
14. Write the equation, in slope-intercept form, of the line through $(0, -1)$ that is parallel to $y = 4x + 3$.
15. Write the equation of the line through $(-4, 3)$ and $(2, -9)$ in standard form.

Answers**Answers and Explanations**

Complete solutions for every practice problem, numbered to match. Read the explanation even when your answer is right.

07.1 The Coordinate Plane and Graphing Points**PRACTICE · THE COORDINATE PLANE AND GRAPHING POINTS**

- B. Negative x means left and positive y means up, which is the upper left, Quadrant II. Quadrant III would need y negative as well.
- C. A point on the x -axis has $y = 0$. Only $(-3, 0)$ qualifies; $(0, 4)$ is on the y -axis.
- D. Multiply first: $3 \cdot 4 = 12$, then subtract 2 to get 10. Choice C forgets to subtract.
- B. Reflecting across the x -axis changes only the sign of y , so $(-4, 3)$ becomes $(-4, -3)$. Choice C flips both signs, which is a reflection through the origin.
- A. Check each: $-2 + 5 = 3$, so $(-2, 3)$ works. Choice B has the wrong sign for y .
- B. The width is $7 - 1 = 6$ and the height is $2 - (-3) = 5$, so area $= 6 \cdot 5 = 30$. Choice A, 22, is the perimeter.
- D. Quadrant IV needs positive x and negative y , which is $(3, -7)$. Choice B is Quadrant III and choice C is on the y -axis.
- A. For $x = 4$: $3 - 8 = -5$. Choice C has the right y but the wrong x , which gives $3 + 8 = 11$.
- C. The fourth corner has the x -value of the left corner, -3 , and the y -value of the bottom corner, -1 . Choice D has the wrong sign on x .
9. $y = -2(-3) + 3 = 6 + 3 = 9$.
11. Same y , so subtract x -values: $5 - (-6) = 11$.
12. 14 minutes. Solve $15m + 40 = 250$: $15m = 210$, so $m = 14$.
- $(5, -3)$. Across the x -axis: $(-5, 3) \rightarrow (-5, -3)$. Across the y -axis: $(-5, -3) \rightarrow (5, -3)$.
- $(-4, -6)$, Quadrant III. Left means negative x and below means negative y .
- 16 square units. The base along $y = -1$ has length $6 - (-2) = 8$, and the height along $x = 6$ is $3 - (-1) = 4$. Area $= \frac{1}{2} \cdot 8 \cdot 4 = 16$.

07.2 Slope as Rate of Change**PRACTICE · SLOPE AS RATE OF CHANGE**

- C. $\frac{11-2}{4-1} = \frac{9}{3} = 3$. Choice A flips rise and run; choice D gives only the rise.
- B. $\frac{-6-4}{3-(-2)} = \frac{-10}{5} = -2$. Choice A forgets the negative that comes from the falling line.
- A. A horizontal line has rise 0, so $m = 0$. Undefined is the slope of a vertical line.
- D. $\frac{20-80}{5-2} = \frac{-60}{3} = -20$. Choice B is the total change, not the rate per minute.
- C. Steepness uses the size of the slope, ignoring the sign. $|\frac{-5}{4}| = 1.25$ is larger than 1, $\frac{3}{4}$, and $\frac{1}{2}$. Choice D is tempting because 1 looks biggest.
- A. $\frac{10-4}{5-a} = 2$, so $5 - a = 3$ and $a = 2$. Choice B subtracts $5 - 2 = 3$ and stops one step too early.
- B. $\frac{5-(-3)}{4-0} = \frac{8}{4} = 2$. Choice D flips rise and run; choice C is only the rise.
- D. Rate $= \frac{240-90}{5-2} = \frac{150}{3} = 50$. Choice C divides 240 by 5, which uses the start of the trip, not the change between the readings.
- A. Run 4 gives rise 3: $(1 + 4, 2 + 3) = (5, 5)$. Choice C uses run 4 but rise 1.
- $\frac{1}{2}$. $m = \frac{4-(-2)}{7-(-5)} = \frac{6}{12} = \frac{1}{2}$.
- Undefined. The x -values are equal, so the run is 0 and the line is vertical.
- $\frac{1}{12}$. Slope $= \frac{9}{108} = \frac{1}{12}$.
- 4.75 cm per week; 50 cm at week 10. Rate $= \frac{31-12}{6-2} = \frac{19}{4} = 4.75$. Four more weeks adds $4 \times 4.75 = 19$ cm, so $31 + 19 = 50$.
- 1. $\frac{-2-6}{5-(-3)} = \frac{-8}{8} = -1$.
- $k = 5$. $\frac{k-1}{6} = \frac{2}{3}$, so $k - 1 = 4$.

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07.3 Slope-Intercept Form**PRACTICE · SLOPE-INTERCEPT FORM**

1. B. In $y = mx + b$ the y-intercept is b , here -7 . Choice A is the slope.
2. D. The y-intercept is -2 and the slope is 3 , so $y = 3x - 2$. Choice B has the wrong sign on b ; choice A swaps m and b .
3. A. $m = \frac{10-4}{2-0} = 3$ and $b = 4$ because $(0, 4)$ is on the line. Choice B uses the y-value of the second point as b .
4. C. The point $(0, 6)$ gives $b = 6$. y drops 2 as x rises 1, so $m = -2$. Choice A has the right intercept but the wrong sign for the slope.
5. B. Falling 1 for each 2 right gives $m = -\frac{1}{2}$. Choice A flips rise and run.
6. D. The coefficient of t is the change in height for each hour: the candle burns 2.5 cm per hour. The starting height is the 20.
7. C. $-\frac{x}{4}$ means $-\frac{1}{4}x$, so $m = -\frac{1}{4}$ and $b = 6$. Choice D swaps the roles.
8. A. For $x = 2$: $3(2) - 1 = 5$. Choice D swaps x and y .
9. B. The slope is $\frac{17-11}{4-2} = 3$. Then $11 = 3(2) + b$ gives $b = 5$. Choice A uses the first y-value as b .
10. $y = -5x + 8$, so $m = -5$ and $b = 8$. The sign stays with the 5.
11. $y = 2x - 4$. $m = \frac{2-(-4)}{3-0} = 2$ and the y-intercept is -4 .
12. $y = 3x - 5$. $m = \frac{7-1}{4-2} = 3$. Use $(2, 1)$: $1 = 6 + b$, so $b = -5$.
13. $C = 2.25x + 3.5$; 8 miles. Solve $2.25x + 3.5 = 21.5$: $2.25x = 18$, so $x = 8$.
14. $y = -3x + 10$. $4 = -3(2) + b$, so $b = 10$.
15. 5 weeks, 105 dollars. $45 + 12w = 90 + 3w$ gives $9w = 45$, so $w = 5$. Then $45 + 12(5) = 105$.

07.4 Standard Form, Point-Slope Form, and Parallel/Perpendicular Lines**PRACTICE · STANDARD FORM, POINT-SLOPE FORM, AND PARALLEL/PERPENDICULAR LINES**

1. C. Let $y = 0$: $4x = 24$, so $x = 6$. Choice B, 24, is the value of C , not the intercept, and choice A, 8, is the y-intercept (found by setting $x = 0$).
2. A. Solve for y : $-2y = -6x + 10$, so $y = 3x - 5$ and the slope is 3. Choice D mistakes the constant for the slope, and choice B loses the signs when dividing by -2 .
3. D. Parallel lines have the same slope, -4 . Choice A changes the sign and choice B is the perpendicular-style slope.
4. B. Flip $\frac{2}{3}$ to $\frac{3}{2}$ and change the sign: $-\frac{3}{2}$. Choice A only flips; choice C only changes the sign.
5. A. Point-slope is $y - y_1 = m(x - x_1)$. With $(x_1, y_1) = (-2, 4)$: $y - 4 = 5(x - (-2)) = 5(x + 2)$. Choice B forgets that subtracting -2 makes a plus.
6. C. The perpendicular slope is $\frac{1}{2}$. Then $y - 3 = \frac{1}{2}(x - 2)$ gives $y = \frac{1}{2}x + 2$. Choice A has the right point but slope 2, and choice B is the parallel line.
7. B. Set $x = 0$: $-5y = 20$, so $y = -4$. Choice A is not the intercept; it comes from $20 \div 2$.
8. D. $4y = -3x + 12$, so divide every term by 4. Choice C divides only the x-term incorrectly and forgets to divide 12.
9. A. The slopes 2 and $-\frac{1}{2}$ multiply to -1 . Choice B is parallel, and choices C and D have slopes that do not multiply to -1 .
10. $y = \frac{5}{2}x - 10$. $-2y = -5x + 20$, so $y = \frac{5}{2}x - 10$.
11. $3x + 4y = 8$. Multiply by 4: $4y = -3x + 8$, then move $3x$ over.
12. $y = 2x + 4$. $m = \frac{10-2}{3-(-1)} = 2$. Then $y - 2 = 2(x + 1)$, so $y = 2x + 4$.
13. $y = \frac{3}{2}x - 11$. The given line has slope $-\frac{2}{3}$, so the perpendicular slope is $\frac{3}{2}$. Then $y + 5 = \frac{3}{2}(x - 4)$ gives $y = \frac{3}{2}x - 6 - 5 = \frac{3}{2}x - 11$.
14. $y = 4x - 1$. Parallel means slope 4, and the y-intercept is -1 .
15. $2x + y = -5$. Slope = $\frac{-9-3}{2+4} = -2$. Then $y - 3 = -2(x + 4)$ gives $y = -2x - 5$, so $2x + y = -5$. Check $(2, -9)$: $4 - 9 = -5$.

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