

Parallel and Perpendicular Lines: practice solutions, Grade 10 – download the PDF

Written solutions to the chapter problems. Check each step, then correct yourself.

1 Naming angle pairs



- (a) Same corner at each crossing: **corresponding** angles.
- (b) Between the lines, on opposite sides of t : **alternate interior** angles.
- (c) Between the lines, on the same side of t : **same-side interior** angles.
- (d) Outside the lines, on opposite sides of t : **alternate exterior** angles.

2 Finding angles from one measure



$\angle 6$ and $\angle 3$ are alternate interior angles, so $m\angle 6 = 65^\circ$.

$\angle 7$ and $\angle 3$ are corresponding angles, so $m\angle 7 = 65^\circ$.

$\angle 2$ and $\angle 3$ are vertical angles, so $m\angle 2 = 65^\circ$.

$\angle 5$ and $\angle 3$ are same-side interior angles, so $m\angle 5 = 180^\circ - 65^\circ = 115^\circ$.

3 Crossing lines



The vertical angle also measures 38° . Each of the two other angles forms a linear pair with the 38° angle, so it measures $180^\circ - 38^\circ = 142^\circ$.

The four angles are 38° , 142° , 38° , 142° and they add up to 360° .

4 True or false?



False. Corresponding angles are congruent only when the two lines are parallel. For example, if two lines meet at a point and a transversal crosses them, the corresponding angles are different because the lines are tilted relative to each other. Conversely, if the corresponding angles are congruent, the lines are parallel.

5 Slope from two points



$$m = \frac{9 - 1}{4 - 0} = \frac{8}{4} = 2.$$

(a) A parallel line has the same slope, **2**.

(b) A perpendicular line has the opposite reciprocal slope, $-\frac{1}{2}$. Check: $2 \cdot \left(-\frac{1}{2}\right) = -1$.

6 Parallel in disguise



Solve the second equation for y : $-2y = -8x + 7$, so $y = 4x - 3.5$.

Both slopes equal **4**, but the y -intercepts are -5 and -3.5 , so the lines are different. They are **parallel**.

7 Opposite reciprocals



(a) Flip and change the sign: $\frac{3}{5}$.

(b) $4 = \frac{4}{1}$, so the perpendicular slope is $-\frac{1}{4}$.

(c) -2 .

Each product with the original slope equals -1 .

8 Alternate interior angles and algebra



Alternate interior angles are congruent: $4x + 7 = 6x - 21$, so $28 = 2x$ and $x = 14$.

Each angle measures $4(14) + 7 = 63^\circ$. Check: $6(14) - 21 = 63$.

9 Same-side interior angles and algebra



Same-side interior angles are supplementary: $(2x + 15) + (3x + 25) = 180$, so $5x + 40 = 180$ and $x = 28$.

The angles are $2(28) + 15 = 71^\circ$ and $3(28) + 25 = 109^\circ$, and $71 + 109 = 180$.

10 For which x are the lines parallel?



The lines are parallel exactly when the corresponding angles are congruent:

$5x + 8 = 7x - 12$, so $20 = 2x$ and $x = 10$.

Both angles measure $5(10) + 8 = 58^\circ$. For any other value of x the corresponding angles differ and the lines are not parallel.

11 Parallel, perpendicular, or neither?



Slope of A : $\frac{5-2}{5-1} = \frac{3}{4}$. Slope of B : $\frac{-4-0}{3-0} = -\frac{4}{3}$. Slope of C : $\frac{4-1}{2+2} = \frac{3}{4}$.

A and B : $\frac{3}{4} \cdot \left(-\frac{4}{3}\right) = -1$, so they are **perpendicular**.

A and C : equal slopes. Is C the same line as A ? The line A is $y = \frac{3}{4}x + \frac{5}{4}$; at $x = -2$ it gives $-\frac{1}{4}$, not 1 . So they are different lines: **parallel**.

12 A parallel line in standard form



Solve for y : $5y = -2x + 10$, so $y = -\frac{2}{5}x + 2$ and the slope is $-\frac{2}{5}$.

Point-slope form: $y + 3 = -\frac{2}{5}(x - 4)$, so $y = -\frac{2}{5}x + \frac{8}{5} - 3 = -\frac{2}{5}x - \frac{7}{5}$.

Multiplying by 5: $2x + 5y = -7$. Check: $2(4) + 5(-3) = 8 - 15 = -7$.

13 A perpendicular line through a point



The given slope is -3 , so the perpendicular slope is $\frac{1}{3}$.

$y - 1 = \frac{1}{3}(x - 6)$, so $y = \frac{1}{3}x - 2 + 1 = \frac{1}{3}x - 1$.

Check at $x = 6$: $2 - 1 = 1$.

14 The sprinkler pipe



Write the pipe as $5x + 12y - 39 = 0$. Then $d = \frac{|5(0) + 12(0) - 39|}{\sqrt{5^2 + 12^2}} = \frac{39}{13} = 3$.

The shortest distance is **3 meters**, about $3 \times 3.28 \approx 9.8$ feet.

15 Perpendicular bisector equation



Midpoint: $\left(\frac{-2+4}{2}, \frac{3+7}{2}\right) = (1, 5).$

Slope of $\overline{AB}$: $\frac{7-3}{4+2} = \frac{2}{3}$, so the bisector has slope $-\frac{3}{2}$.

$y - 5 = -\frac{3}{2}(x - 1)$, so $y = -\frac{3}{2}x + \frac{13}{2}.$

16 Is the triangle a right triangle?



(a) Slope of $\overline{AB}$: $\frac{3-1}{5-1} = \frac{1}{2}$. Slope of $\overline{BC}$: $\frac{7-3}{3-5} = -2$. Since $\frac{1}{2} \cdot (-2) = -1$, $\overline{AB} \perp \overline{BC}$: the right angle is at B .

(b) $AB = \sqrt{4^2 + 2^2} = \sqrt{20}$ and $BC = \sqrt{(-2)^2 + 4^2} = \sqrt{20}$. The legs are the two perpendicular sides, so the area is $\frac{1}{2} \cdot \sqrt{20} \cdot \sqrt{20} = \frac{20}{2} = 10$ square units.

17 Is PQRS a rectangle?



$\overline{PQ}$: $\frac{2-0}{4-0} = \frac{1}{2}$. $\overline{QR}$: $\frac{6-2}{2-4} = -2$. $\overline{RS}$: $\frac{4-6}{-2-2} = \frac{1}{2}$. $\overline{SP}$: $\frac{0-4}{0+2} = -2$.

Opposite sides have equal slopes, so they are parallel: $PQ \parallel RS$ and $QR \parallel SP$. Adjacent sides have slopes with product -1 , so the angles are right angles. The quadrilateral has four right angles: it is a **rectangle**.

$PQ = \sqrt{20}$ and $QR = \sqrt{4+16} = \sqrt{20}$, so the area is **20** square units (it is actually a square).

18 Distance between parallel lines



The lines have the same slope **2**, so they are parallel. Choose the point **(0, 3)** on the first line.

Write the second line as $2x - y - 7 = 0$. Then

$$d = \frac{|2(0) - 3 - 7|}{\sqrt{2^2 + (-1)^2}} = \frac{10}{\sqrt{5}} = 2\sqrt{5} \approx 4.47.$$

The distance between the lines is $2\sqrt{5} \approx 4.47$ units.

19 Equidistant point on the x-axis



Let $P = (x, 0)$. $PA^2 = (x - 1)^2 + 16$ and $PB^2 = (x - 5)^2 + 4$.

Set them equal: $x^2 - 2x + 17 = x^2 - 10x + 29$, so $8x = 12$ and $x = 1.5$. So $P(1.5, 0)$.

Check: $PA^2 = 0.25 + 16 = 16.25$ and $PB^2 = 12.25 + 4 = 16.25$. By the converse of the perpendicular bisector theorem, P lies on the perpendicular bisector of $\overline{AB}$, which crosses the x -axis at P .

20 Two perpendiculars to a third line



Angle proof. Let c be a transversal of a and b . Since $a \perp c$ and $b \perp c$, the two corresponding angles formed with c both measure 90° . Corresponding angles are congruent, so $a \parallel b$ by the converse of the corresponding angles theorem.

Slope proof. The slope of c is $\frac{2}{5}$, so each line perpendicular to c has slope $-\frac{5}{2}$. Lines a and b have the same slope, so they are parallel (or the same line).

21 Foot of the perpendicular



(a) The perpendicular through P has slope $-\frac{1}{2}$: $y = -\frac{1}{2}x + 6$. Intersect with ℓ :

$2x - 4 = -\frac{1}{2}x + 6$, so $\frac{5}{2}x = 10$ and $x = 4$. Then $y = 2(4) - 4 = 4$. So $H(4, 4)$.

(b) $PH = \sqrt{(4-0)^2 + (4-6)^2} = \sqrt{20} = 2\sqrt{5}$. With the formula, ℓ is $2x - y - 4 = 0$, so $d = \frac{|0 - 6 - 4|}{\sqrt{5}} = \frac{10}{\sqrt{5}} = 2\sqrt{5}$. The two results agree.



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