

Adjacent, Vertical, and Linear Pair Angles

Name: _____

Date: _____

Score: _____ / 17

When two lines cross, they create four angles—and those angles are not random! **Adjacent angles** share a side, **vertical angles** sit across from each other and are always equal, and **linear pairs** form a straight line and add to 180° . Once you spot these patterns, you can find missing angles without ever picking up a protractor. This topic trains your eye to see structure instead of just shapes!



Key Concepts & Quick Review

Vertical angles: $a = c$ and $b = d$. They are always *congruent*.

Linear pair: $a + b = 180^\circ$ (angles on a straight line).

Adjacent angles: share a vertex and a common ray; no overlap.

Examples

① Two lines intersect. One angle measures 63° . Find the other three angles.

Think It Through: When two lines cross, the opposite angles are called vertical angles, and they are always equal. So the angle across from 63° is also 63° . The two angles beside 63° form linear pairs with it, so each must add with 63° to make 180° . That gives $180^\circ - 63^\circ = 117^\circ$. So the four angles are 63° , 117° , 63° , and 117° .

Answer: 63° , 117° , 63° , 117°

② A road crosses a rail track. The acute angle between them is $(3x + 9)^\circ$ and its vertical angle is $(5x - 7)^\circ$. Find x and all four angles.

Think It Through: Because the labeled angles are vertical angles, they must be equal. Set up the equation $3x + 9 = 5x - 7$. Solving gives $16 = 2x$, so $x = 8$. Substitute back into either expression to find the acute angle: $3(8) + 9 = 33^\circ$. The angles next to it are linear pairs, so each is $180^\circ - 33^\circ = 147^\circ$. The four angles around the intersection are 33° , 147° , 33° , 147° .

Answer: $x = 8$; angles: 33° , 147° , 33° , 147°



 **Practice Problems**

Find the missing angle(s) using vertical angle and linear pair relationships.

1. Two angles form a linear pair. One angle is 45° . Find the other angle. _____
2. Two angles are vertical angles. One angle is 72° . Find the other angle. _____
3. Two angles form a linear pair. One angle is 118° . Find the other angle. _____
4. Two angles are vertical angles. One angle is 155° . Find the other angle. _____
5. Two lines intersect. One angle is 90° . Find all four angle measures. _____
6. Two angles form a linear pair: $(2x + 10)^\circ$ and 70° . Find x . _____
7. Two vertical angles measure $(4x)^\circ$ and $(3x + 15)^\circ$. Find x . _____
8. Two angles form a linear pair: $(5x - 5)^\circ$ and $(3x + 11)^\circ$. Find x and both angle measures. _____
9. Two lines intersect. One angle is 38° . Find all four angle measures. _____
10. Two vertical angles measure $(7x - 3)^\circ$ and $(5x + 13)^\circ$. Find each angle measure. _____
11. Two equal angles form a linear pair. Find the measure of each angle. _____
12. Two vertical angles measure $(x + 40)^\circ$ and $(3x)^\circ$. Find x . _____
13. Two lines intersect. One angle is 127° . Find all four angle measures. _____
14. Two angles form a linear pair: $2(x + 10)^\circ$ and $(x + 20)^\circ$. Find x . _____
15. Two vertical angles measure $(8 - 2x)^\circ$ and $(2 + 4x)^\circ$. Find each angle measure. _____

Study Tips

-  **Vertical = equal.** Set the two expressions equal and solve for the variable.
-  **Linear pair = sum to 180° .** Add the expressions and set equal to 180.
-  Always sketch the intersecting lines and label the four regions — it takes 10 s and prevents all confusion.

 **Word Problems**

16. Two straight hiking trails intersect at a clearing. Rangers mark one of the four angles as $(4x + 12)^\circ$ and its vertical angle as $(6x - 8)^\circ$. Find x , the measure of all four angles, and identify which angles are linear pairs with each other. _____
17. A carpenter's two pieces of trim cross to form an X-shape on a wall. One angle of the X is $(2y - 5)^\circ$ and the next adjacent angle is $(y + 20)^\circ$. Since they form a linear pair, find y and all four angles. If the carpenter wants the X to be symmetric (all four angles equal), what must each angle be, and is that possible with straight trim pieces? _____



Answer Keys

- | | |
|--|--|
| <p>1) 135°</p> <p>2) 72°</p> <p>3) 62°</p> <p>4) 155°</p> <p>5) 90° each</p> <p>6) 50</p> <p>7) 15</p> <p>8) $x = \frac{87}{4}$; angles $103.75^\circ, 76.25^\circ$</p> <p>9) $38^\circ, 142^\circ, 38^\circ, 142^\circ$</p> <p>10) 53°</p> | <p>11) 90° each</p> <p>12) 20</p> <p>13) $127^\circ, 53^\circ, 127^\circ, 53^\circ$</p> <p>14) $\frac{140}{3}$</p> <p>15) 6°</p> <p>16) $x = 10$; angles $52^\circ, 128^\circ, 52^\circ, 128^\circ$; linear pairs ($52^\circ, 128^\circ$)</p> <p>17) $y = 55$; angles $105^\circ, 75^\circ, 105^\circ, 75^\circ$; symmetric X only at 90°</p> |
|--|--|

Step-by-Step Explanations

Strategy: For Writing and Evaluating Algebraic Expressions, read the expression by its parts, combining like terms, distributing only when needed, and substituting values after simplifying. A quick expression check is to substitute only after the expression has been simplified.

Practice 1: Evaluate $3x + 5$ when $x = 4$. **Answer:** 17

At the beginning of the practice, substitute the value and follow the order of operations before simplifying.

Practice 15: Evaluate $7m - 4$ when $m = \frac{1}{2}$. **Answer:** $-\frac{1}{2}$

For the second model problem, write the expression first, then evaluate it for the given input.

Word-problem notes:

16. Answer: $C = 3.50t + 1.25$; 8 tacos: \$29.25; $18.75 = 3.50t + 1.25 \Rightarrow t = 5$ tacos.

The total cost has two parts: the taco cost and the one-time guacamole fee. That is why the expression is $C = 3.50t + 1.25$. For 8 tacos, substitute $t = 8$: $C = 3.50(8) + 1.25 = 28 + 1.25 = 29.25$. For the second group, solve $3.50t + 1.25 = 18.75$. Subtract 1.25 first to get $3.50t = 17.50$, then divide by 3.50. That gives $t = 5$, so they ordered 5 tacos.

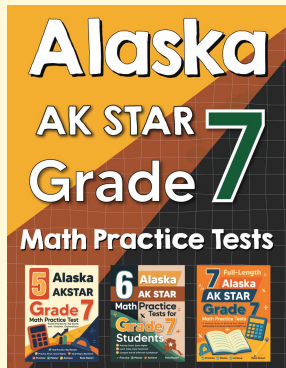
17. Answer: After 3 s: 84 m; after 5 s: 20 m; drops below 30 m between $t = 4$ and $t = 5$.

Use the formula by substituting the time values. At $t = 3$, $h = 120 - 4(3)^2 = 120 - 4(9) = 120 - 36 = 84$ m. At $t = 5$, $h = 120 - 4(5)^2 = 120 - 4(25) = 120 - 100 = 20$ m. To figure out when it first drops below 30 m, test the nearby whole-number times. At $t = 4$, the height is $120 - 4(16) = 56$ m, which is still above 30. At $t = 5$, it is already below, so the drop below 30 happens between 4 and 5 s.



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