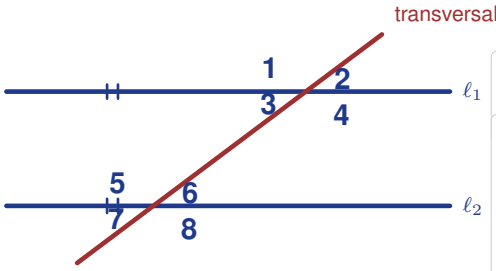
Angle Relationships with Parallel Lines and Transversals

Name: _____	Date: _____	Score: _____ / 17

When a line (called a *transversal*) cuts through two parallel lines, it creates a system of angle relationships. Some pairs, such as **corresponding angles** and **alternate interior angles**, are equal. Others, such as **same-side interior angles**, add to $180°$. Once you can name the angle pairs, many geometry problems become much easier to solve.



Corresponding angles are equal
$\angle 1 = \angle 5,\ \angle 2 = \angle 6$

Other angle pairs
Alternate interior: $\angle 3 = \angle 6,\ \angle 4 = \angle 5$
Alternate exterior: $\angle 1 = \angle 7,\ \angle 2 = \angle 8$
Same-side interior: $\angle 3 + \angle 5 = 180°$

Key Concepts & Quick Review

Equal pairs (parallel lines): Corresponding • Alternate Interior • Alternate Exterior.
Supplementary pair: Same-side interior angles add to $180°$.
Tip: if the lines are *not* parallel, none of these relationships hold.

Examples

① Lines $\ell_1 \parallel \ell_2$. The transversal creates angle $\angle 1 = 70°$ (corresponding to $\angle 5$). Find $\angle 2$, $\angle 3$, $\angle 5$, $\angle 6$, $\angle 7$.

Think It Through: Because the lines are parallel, several angle pairs are related. Start with $\angle 5 = 70°$ because corresponding angles are equal. Then use the linear pair with $\angle 1$ to find $\angle 2 = 180° - 70° = 110°$. Vertical angles are equal, so $\angle 3 = 110°$. Corresponding angles give $\angle 6 = 110°$ and $\angle 7 = 110°$. Once one angle is known, the rest follow from these relationships.

Answer: $110°, 110°, 70°, 110°, 110°$

② $\ell_1 \parallel \ell_2$. An alternate interior angle $= (4x + 10)°$ and its pair $= (6x - 20)°$. Find x and the angle.

Think It Through: Alternate interior angles are equal when the lines are parallel, so set the two expressions equal: $4x + 10 = 6x - 20$. Solve by moving the x terms to one side and the constants to the other: $30 = 2x$, so $x = 15$. Substituting back gives $4(15) + 10 = 70°$. That means both alternate interior angles are $70°$.

Answer: $x = 15$; *angle* $= 70°$

Practice Problems

Lines $\ell_1 \parallel \ell_2$ cut by a transversal. Find each missing angle or value of x.

1. Two corresponding angles are formed by parallel lines and a transversal. One angle is $55°$. Find the other angle. _____
2. Two alternate interior angles are formed by parallel lines and a transversal. One angle is $83°$. Find the other angle. _____
3. Two same-side interior angles are formed by parallel lines and a transversal. One angle is $65°$. Find the other angle. _____
4. Two alternate exterior angles are formed by parallel lines and a transversal. One angle is $130°$. Find the other angle. _____
5. Two corresponding angles measure $(3x)°$ and $57°$. Find x. _____
6. Two alternate interior angles measure $(5x - 10)°$ and $(3x + 18)°$. Find x. _____
7. Two same-side interior angles measure $(6x + 4)°$ and $(4x + 16)°$. Find x. _____
8. Two alternate exterior angles measure $(7x - 5)°$ and $(4x + 25)°$. Find x. _____
9. Two corresponding angles measure $(2x + 30)°$ and $(5x - 15)°$. Find x and the angle measure. _____
10. Two same-side interior angles measure $(4x)°$ and $(8x)°$. Find x and both angle measures. _____
11. In the standard two-parallel-lines diagram, $\angle 1 = 112°$. Find all eight angle measures. _____
12. Two alternate interior angles measure $(3x + 9)°$ and $(5x - 11)°$. Find each angle measure. _____
13. Two corresponding angles measure $2(x + 5)°$ and $(3x - 10)°$. Find x. _____
14. Two same-side interior angles measure $(9x)°$ and $(x + 20)°$. Find x. _____
15. Two alternate exterior angles measure $(4x - 8)°$ and $(2x + 16)°$. Find each angle measure. _____

Study Tips

- **F-shape** → Corresponding (equal). **Z-shape** → Alternate interior (equal). **C- or U-shape** → same-side interior (supplementary).
- If two angles are on the **same side** of the transversal and **between** the parallel lines, they are co-interior and add to $180°$.
- Always check: parallel lines ⇒ all the angle pairs have the special relationships. Without parallel lines, none of them apply!

Word Problems

16. Two parallel railroad tracks are crossed by a road (transversal). The road makes a corresponding angle of $(5x + 12)°$ at the first track and $(8x - 15)°$ at the second. Find x and the angle, and explain why the two

angles must be equal for the tracks to be truly parallel. _____

17. A diagonal brace connects two parallel horizontal beams of a fence. The brace forms a co-interior angle of $(3k + 20)^\circ$ with the top beam and $(5k - 12)^\circ$ with the bottom beam. Find k, both angles, and verify they are supplementary. What does this tell you about the direction the brace leans? _____

Answer Keys

1) $55°$
2) $83°$
3) $115°$
4) $130°$
5) 19
6) 14
7) 16
8) 10
9) $x = 15$; angle $60°$
10) $x = 15$; $60°, 120°$
11) four $112°$ and four $68°$
12) $39°$ each
13) 20
14) 16
15) $40°$ each
16) $x = 9$; angle $57°$
17) $k = 21.5$; angles $84.5°$ and $95.5°$

Step-by-Step Explanations

Strategy: For Adding and Subtracting Linear Expressions, distribute any subtraction sign, combine like terms, and keep variable terms with variable terms. For linear expressions, read aloud whether you are adding an entire expression or subtracting every term.

Practice 1: (2x+5)+(3x-1) **Answer:** $5x + 4$
For the first sample, line up the like terms from both expressions, then add coefficient to coefficient.

Practice 15: (6t-3)-(2t+5) **Answer:** $4t - 8$
Late in the set, subtract the second expression by distributing the negative through every term.

Word-problem notes:

16. Answer: Combined: $13x + 9$; difference: $3x + 15$; at x=10: \$139 and \$45.
To find the combined earnings, add the two expressions: $(8x + 12) + (5x - 3) = 13x + 9$. To find how much more Stand A earned, subtract Stand B from Stand A: $(8x + 12) - (5x - 3)$. Be careful with the subtraction; the minus sign changes the signs in the second expression, so you get $8x + 12 - 5x + 3 = 3x + 15$. When $x = 10$, the combined earnings are $13(10) + 9 = 139$ dollars and the difference is $3(10) + 15 = 45$ dollars.

17. Answer: Original: $7x + 4$; shortcut: $6x + 2$; difference: $x + 2$; at x=6: $8\ mi$ shorter.
The original trail uses all three segments, so add them: $(4x - 1) + (2x + 3) + (x + 2) = 7x + 4$. The shortcut removes the third segment, so only the first two parts remain: $(4x - 1) + (2x + 3) = 6x + 2$. To compare the two routes, subtract the shortcut from the original: $(7x + 4) - (6x + 2) = x + 2$. When $x = 6$, that difference is $6 + 2 = 8$, so the shortcut is $8\ mi$ shorter.

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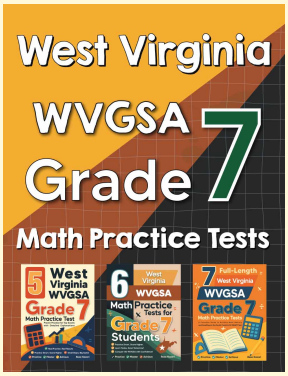

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