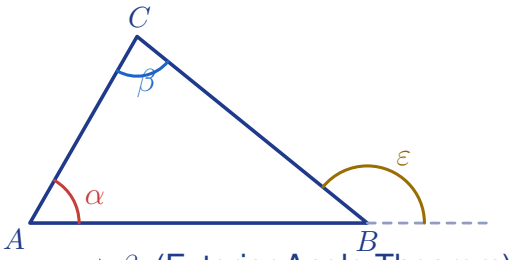
Exterior Angle Theorem

Name: _____	Date: _____	Score: _____ / 17

Extend one side of a triangle and you create an **exterior angle**—and here is the cool shortcut: that exterior angle equals the sum of the two **remote interior angles** (the two inside angles that do not touch it). No need to find the third interior angle first; just add the two remote ones and you are done! This theorem connects right back to the triangle angle sum you already know, giving you a faster path to the answer.



$\varepsilon = \alpha + \beta$ (Exterior Angle Theorem)

Remote interior angles: α and β

Key Concepts & Quick Review

Exterior Angle Theorem: Exterior angle = sum of the two remote interior angles.
$\varepsilon = \alpha + \beta$ (where α and β are the angles *not* adjacent to the exterior angle).

Also useful: the exterior angle and its adjacent interior angle are a **linear pair**: they sum to $180°$.

Examples

① A triangle has remote interior angles $48°$ and $67°$. Find the exterior angle at the third vertex.

Think It Through: Use the Exterior Angle Theorem: an exterior angle equals the sum of the two remote interior angles. So the exterior angle is $48° + 67° = 115°$. A good check is to find the interior angle next to it: $180° - 115° = 65°$. Then verify that the three interior angles of the triangle add to $180°$.

Answer: *Exterior angle* $= 115°$

② The exterior angle at vertex C of a triangle is $(8x - 4)°$. The two remote interior angles are $(3x + 10)°$ and $(2x + 14)°$. Find x and all three interior angles.

Think It Through: Set the exterior angle equal to the sum of the two remote interior angles: $8x - 4 = (3x + 10) + (2x + 14)$. Simplify the right side to get $8x - 4 = 5x + 24$, so $3x = 28$ and $x = \frac{28}{3}$. Now substitute back. The exterior angle is about $70.7°$, so the adjacent interior angle at C is $180° - 70.7° \approx 109.3°$. The other two interior angles are $(3x + 10)° \approx 38.0°$ and $(2x + 14)° \approx 32.7°$. Together they add to the exterior angle, which is exactly what the theorem predicts.

Answer: $x = \frac{28}{3} \approx 9.3$; *exterior* $\approx 70.7°$

Practice Problems

Apply the Exterior Angle Theorem to find the missing angle or value of x.

1. A triangle has remote interior angles $40°$ and $65°$. Find the exterior angle. _____
2. A triangle has remote interior angles $72°$ and $54°$. Find the exterior angle. _____
3. A triangle has remote interior angles $33°$ and $88°$. Find the exterior angle. _____
4. An exterior angle is $110°$, and one remote interior angle is $48°$. Find the other remote interior angle. _____
5. An exterior angle is $95°$, and one remote interior angle is $50°$. Find the other remote interior angle. _____
6. A triangle has remote interior angles $(3x)°$ and $40°$, and the exterior angle is $82°$. Find x. _____
7. A triangle has remote interior angles $x°$ and $2x°$, and the exterior angle is $102°$. Find x. _____
8. An exterior angle is $(5x + 3)°$, and the remote interior angles are $(2x + 9)°$ and $36°$. Find x. _____
9. An exterior angle is $(4x-2)°$, and the remote interior angles are $(x+15)°$ and $(x+5)°$. Find x. _____
10. A triangle has remote interior angles $(2x + 5)°$ and $(3x - 1)°$, and the exterior angle is $(6x + 2)°$. Find x. _____
11. An exterior angle is $135°$. One remote interior angle is twice the other. Find both remote interior angles. _____
12. The remote interior angles are $28°$ and $47°$. Find the exterior angle and the adjacent interior angle. _____
13. An exterior angle is $(7x - 3)°$, and the sum of the remote interior angles is $(4x + 15)°$. Find x. _____
14. A triangle has remote interior angles $(x + 8)°$ and $(2x - 3)°$, and the exterior angle is $(4x)°$. Find x and each angle. _____
15. An exterior angle is $100°$, and the two remote interior angles are equal. Find each remote interior angle. _____

Study Tips

- The exterior angle is always **larger** than either remote interior angle alone. If your answer is smaller, check your setup.
- **Remote** means "not touching" the exterior angle. The adjacent interior angle is *not* remote — it forms a linear pair with the exterior angle.
- Two methods always give the same answer: (1) exterior $=$ sum of remotes, or (2) find all three interior angles first, then subtract from $180°$.

Word Problems

16. A surveyor extends one side of a triangular plot of land beyond vertex Q. The exterior angle at Q measures $(6m + 4)°$. The two remote interior angles at P and R are $(2m + 18)°$ and $(3m - 6)°$. Find m, the exterior angle, and all three interior angles. What type of triangle is this plot (classify by angles)? _____

17. A zip-line cable is anchored at point A on a cliff, stretches to platform B on the ground, and the cable support pole at B is extended upward to a reference point D (making an exterior angle at B). The angle at A (cliff face) is $(4t - 10)°$ and the angle at C (landing zone) is $(2t + 8)°$. The exterior angle at B is $(7t - 6)°$. Find t and the exterior angle. What is the interior angle at B (zip-line's ground angle)? _____

Answer Keys

1) $105°$
2) $126°$
3) $121°$
4) $62°$
5) $45°$
6) 14
7) 34
8) 14
9) 11
10) 2
11) $45°, 90°$
12) $75°$; adjacent $105°$
13) 6
14) $x = 5$; $13°, 7°, 20°$
15) $50°$ each
16) $m = 8$; exterior $52°$; $P = 34°$, $R = 18°$, $Q = 128°$; obtuse
17) $t = 4$; exterior $22°$; interior at $B = 158°$

Step-by-Step Explanations

Strategy: For Solving Two-Step Equations, remove the constant term first, then divide or multiply to isolate the variable. Check the solution in the original equation before accepting it.

Practice 1: 2x+3=11 **Answer:** 4
In the opening example, clear the constant first, then divide by the coefficient of the variable.

Practice 15: -6x-3=-33 **Answer:** 5
For the end-of-set item, reverse the two operations in the order opposite of how they were built.

Word-problem notes:

16. Answer: $15n + 50 = 320 \Rightarrow n = 18$ levels; play time: $18 \times 12 = 216\,min = 3.6\,hr$.
Let n be the number of levels. The total score is the starting 50 points plus 15 points for each level, so write $15n + 50 = 320$. Subtract 50 to get $15n = 270$, then divide by 15 to find $n = 18$. For play time, multiply the number of levels by $12\,min$ each: $18 \times 12 = 216\,min$, which is 3.6 hours, or 3 hours and $36\,min$.

17. Answer: $8.5c - 34 = 93.5 \Rightarrow c = 15$ candles; for \$200 profit: $c = 28$ candles.
Profit means money earned minus costs, so the equation is $8.5c - 34 = 93.5$. Add 34 to both sides to get $8.5c = 127.5$, then divide by 8.5 to find $c = 15$. For a profit of \$200, write $8.5c - 34 = 200$. Add 34 to get $8.5c = 234$, and divide: $c \approx 27.5$. Since Priya cannot sell half a candle and needs to reach at least the goal, she must sell 28 candles.

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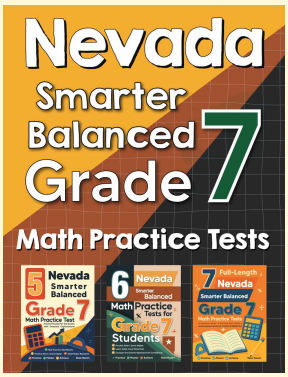

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