

# Exterior Angle Theorem

Name: \_\_\_\_\_

Date: \_\_\_\_\_

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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.



## Key Concepts & Quick Review

**Exterior Angle Theorem:** Exterior angle = sum of the two remote interior angles.

$\varepsilon = \alpha + \beta$  (where  $\alpha$  and  $\beta$  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  $180^\circ$ .

## Examples

① A triangle has remote interior angles  $48^\circ$  and  $67^\circ$ . 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  $48^\circ + 67^\circ = 115^\circ$ . A good check is to find the interior angle next to it:  $180^\circ - 115^\circ = 65^\circ$ . Then verify that the three interior angles of the triangle add to  $180^\circ$ .

**Answer:** Exterior angle =  $115^\circ$

② The exterior angle at vertex  $C$  of a triangle is  $(8x - 4)^\circ$ . The two remote interior angles are  $(3x + 10)^\circ$  and  $(2x + 14)^\circ$ . 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  $70.7^\circ$ , so the adjacent interior angle at  $C$  is  $180^\circ - 70.7^\circ \approx 109.3^\circ$ . The other two interior angles are  $(3x + 10)^\circ \approx 38.0^\circ$  and  $(2x + 14)^\circ \approx 32.7^\circ$ . Together they add to the exterior angle, which is exactly what the theorem predicts.

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



### Practice Problems

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

1. A triangle has remote interior angles  $40^\circ$  and  $65^\circ$ . Find the exterior angle. \_\_\_\_\_
2. A triangle has remote interior angles  $72^\circ$  and  $54^\circ$ . Find the exterior angle. \_\_\_\_\_
3. A triangle has remote interior angles  $33^\circ$  and  $88^\circ$ . Find the exterior angle. \_\_\_\_\_
4. An exterior angle is  $110^\circ$ , and one remote interior angle is  $48^\circ$ . Find the other remote interior angle. \_\_\_\_\_
5. An exterior angle is  $95^\circ$ , and one remote interior angle is  $50^\circ$ . Find the other remote interior angle. \_\_\_\_\_
6. A triangle has remote interior angles  $(3x)^\circ$  and  $40^\circ$ , and the exterior angle is  $82^\circ$ . Find  $x$ . \_\_\_\_\_
7. A triangle has remote interior angles  $x^\circ$  and  $2x^\circ$ , and the exterior angle is  $102^\circ$ . Find  $x$ . \_\_\_\_\_
8. An exterior angle is  $(5x + 3)^\circ$ , and the remote interior angles are  $(2x + 9)^\circ$  and  $36^\circ$ . Find  $x$ . \_\_\_\_\_
9. An exterior angle is  $(4x - 2)^\circ$ , and the remote interior angles are  $(x + 15)^\circ$  and  $(x + 5)^\circ$ . Find  $x$ . \_\_\_\_\_
10. A triangle has remote interior angles  $(2x + 5)^\circ$  and  $(3x - 1)^\circ$ , and the exterior angle is  $(6x + 2)^\circ$ . Find  $x$ . \_\_\_\_\_
11. An exterior angle is  $135^\circ$ . One remote interior angle is twice the other. Find both remote interior angles. \_\_\_\_\_
12. The remote interior angles are  $28^\circ$  and  $47^\circ$ . Find the exterior angle and the adjacent interior angle. \_\_\_\_\_
13. An exterior angle is  $(7x - 3)^\circ$ , and the sum of the remote interior angles is  $(4x + 15)^\circ$ . Find  $x$ . \_\_\_\_\_
14. A triangle has remote interior angles  $(x + 8)^\circ$  and  $(2x - 3)^\circ$ , and the exterior angle is  $(4x)^\circ$ . Find  $x$  and each angle. \_\_\_\_\_
15. An exterior angle is  $100^\circ$ , 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  $180^\circ$ .



 **Word Problems**

**16.** A surveyor extends one side of a triangular plot of land beyond vertex  $Q$ . The exterior angle at  $Q$  measures  $(6m + 4)^\circ$ . The two remote interior angles at  $P$  and  $R$  are  $(2m + 18)^\circ$  and  $(3m - 6)^\circ$ . 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  $(4t - 10)^\circ$  and the angle at  $C$  (landing zone) is  $(2t + 8)^\circ$ . The exterior angle at  $B$  is  $(7t - 6)^\circ$ . Find  $t$  and the exterior angle. What is the interior angle at  $B$  (zip-line's ground angle)? \_\_\_\_\_



## Answer Keys

- |  |   |
|--|---|
| <p>1) <math>105^\circ</math></p> <p>2) <math>126^\circ</math></p> <p>3) <math>121^\circ</math></p> <p>4) <math>62^\circ</math></p> <p>5) <math>45^\circ</math></p> <p>6) 14</p> <p>7) 34</p> <p>8) 14</p> <p>9) 11</p> | <p>10) 2</p> <p>11) <math>45^\circ, 90^\circ</math></p> <p>12) <math>75^\circ</math>; adjacent <math>105^\circ</math></p> <p>13) 6</p> <p>14) <math>x = 5; 13^\circ, 7^\circ, 20^\circ</math></p> <p>15) <math>50^\circ</math> each</p> <p>16) <math>m = 8</math>; exterior <math>52^\circ</math>; <math>P = 34^\circ</math>, <math>R = 18^\circ</math>,<br/><math>Q = 128^\circ</math>; obtuse</p> <p>17) <math>t = 4</math>; exterior <math>22^\circ</math>; interior at <math>B = 158^\circ</math></p> |
|--|---|

### 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:  $18 \times 12 = 216 \text{ min} = 3.6 \text{ hr}$ .

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:  $18 \times 12 = 216 \text{ min}$ , 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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