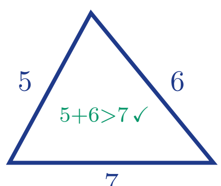
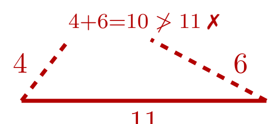
Triangle Inequality Theorem

Name: ______________________	Date: ______________	Score: _____ / 17

Can any three lengths make a triangle? Not always—and the **Triangle Inequality Theorem** tells you exactly when it works! The rule: the sum of any two sides must be *greater than* the third side, so you check $a + b > c$, $a + c > b$, and $b + c > a$. A quick shortcut: just add the two *shortest* sides—if that total beats the longest side, you are good. The theorem also lets you find the range for a missing side: it must be greater than the difference of the other two and less than their sum. Handy for construction, design, and any problem where you need to know if a triangle is even possible!



Valid triangle



Cannot form triangle

Key Concepts & Quick Review

Triangle Inequality Theorem: For any triangle with sides a, b, and c:

$$a + b > c, \qquad a + c > b, \qquad b + c > a$$

All three conditions must be true.
Quick check: Add the two *shortest* sides. If their sum is greater than the longest side, a triangle can be formed.
Finding a range for the third side: Given two sides of lengths a and b (with $a \geq b$), the third side c must satisfy

$$a - b < c < a + b$$

Examples

① Can a triangle have side lengths 4, 6, and 11?

Think It Through: Here is the key test: add the two *shortest* sides and see whether that total is greater than the longest side. The two shortest are 4 and 6, and $4 + 6 = 10$. Is $10 > 11$? Nope—10 falls short! Because the two shorter sticks are not long enough to "reach around" the longest one, these three lengths **cannot** form a triangle.

Answer: *No*

② Two sides of a triangle are 5 and 9. Find the range of possible lengths for the third side.

Think It Through: Think of it this way: the third side has to be short enough that it does not "stretch past" the other two, but long enough that it can actually close the triangle. Subtract the shorter from the longer to get the minimum: $9 - 5 = 4$. Add them for the maximum: $9 + 5 = 14$. So the third side c must satisfy $4 < c < 14$. (Notice: 4 and 14 themselves are *not* included—those would make a flat line, not a triangle!)

Answer: $4 < c < 14$

Practice Problems

*Determine whether the three lengths can form a triangle. Write **Yes** or **No**. For range problems, give the range.*

1. Can side lengths 3, 5, and 7 form a triangle? Write Yes or No. ______
2. Can side lengths 1, 2, and 5 form a triangle? Write Yes or No. ______
3. Can side lengths 6, 8, and 10 form a triangle? Write Yes or No. ______
4. Can side lengths 4, 4, and 9 form a triangle? Write Yes or No. ______
5. Can side lengths 5, 5, and 5 form a triangle? Write Yes or No. ______
6. Can side lengths 2, 3, and 6 form a triangle? Write Yes or No. ______
7. Can side lengths 7, 10, and 12 form a triangle? Write Yes or No. ______
8. Can side lengths 1, 1, and 2 form a triangle? Write Yes or No. ______
9. Can side lengths 9, 12, and 15 form a triangle? Write Yes or No. ______
10. Can side lengths 3, 4, and 8 form a triangle? Write Yes or No. ______
11. Two sides of a triangle are 5 and 8. Find the possible range for the third side c. ______
12. Two sides of a triangle are 3 and 10. Find the possible range for the third side c. ______
13. Two sides of a triangle are 6 and 6. Find the possible range for the third side c. ______
14. Two sides of a triangle are 2 and 7. Find the possible range for the third side c. ______
15. Two sides of a triangle are 4 and 11. Find the possible range for the third side c. ______

Study Tips

- The fastest check: **add the two smallest**. If that sum beats the largest side, a triangle is possible.
- If $a + b = c$ (exactly equal), the three segments form a straight line, **not** a triangle.
- For the range of a missing side, remember the formula $|a - b| < c < a + b$ and note the **strict** inequality (no $\leq$).

Word Problems

16. You have three sticks measuring $8\ cm$, $15\ cm$, and $6\ cm$. Can you use them to build a triangular frame? ______

17. Two sides of a garden bed are 12 feet and 7 feet long. A landscaper is cutting a third piece of edging. What are the shortest and longest whole-number lengths that will form a triangular bed? ______

Answer Keys

1) yes
2) no
3) yes
4) no
5) yes
6) no
7) yes
8) no
9) yes
10) no
11) $3 < c < 13$
12) $7 < c < 13$
13) $0 < c < 12$
14) $5 < c < 9$
15) $7 < c < 15$
16) No; triangle inequality fails
17) The third side can be 6, 7, 8, . . . , $18\,ft$ (whole numbers from 6 to 18 inclusive).

Step-by-Step Explanations

Strategy: For Factoring Expressions, look for a common factor and rewrite the expression as a product that could multiply back. For factoring, look for the common factor before trying anything more complicated.

Practice 1: 4x+8 **Answer:** $4(x+2)$
For the first worked item, isolate the target variable by undoing the operation attached to it.

Practice 15: $7p^2 - 14p$ **Answer:** $7p(p-2)$
Near the end of this topic, collect like terms before solving so the inequality has one variable term.

Word-problem notes:

16. Answer: $12(2n+3)$; at n=5: $12(13) = 156$ tiles; dimensions 12×13.
Factor the expression by pulling out the greatest common factor of $24n$ and 36, which is 12. That gives $24n + 36 = 12(2n+3)$. This shows one possible patio layout is 12 rows by $(2n+3)$ columns. When $n = 5$, the second factor is $2(5) + 3 = 13$, so the patio needs $12 \times 13 = 156$ tiles. The factored form turns the total tile count into a dimensions picture.

17. Answer: $5(p+3)$; reveals a \$5 unit price; p=8: $5(8) + 15 = 55$ and $5(11) = 55$ ✓.
The greatest common factor in $5p + 15$ is 5, so the factored form is $5(p+3)$. This shows that the revenue is built from groups of \$5. When $p = 8$, the original form gives $5(8) + 15 = 40 + 15 = 55$. The factored form gives $5(8+3) = 5(11) = 55$. Since both methods give the same result, the factoring is correct.

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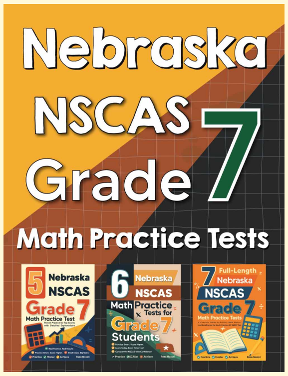

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