

# Absolute Value Equations and Inequalities

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 24

## Quick Review

The **absolute value**  $|x|$  measures how far  $x$  sits from 0 on the number line, so it is never negative. To solve  $|x| = c$  when  $c \geq 0$ , split it into **two cases**:  $x = c$  or  $x = -c$ . For  $|x| < c$ , the answer is the band *between* the boundaries,  $-c < x < c$  (an “and” statement). For  $|x| > c$ , the answer is everything *outside* the boundaries,  $x < -c$  or  $x > c$ . And if  $c$  is negative,  $|x| = c$  has **no solution** — a distance can never be negative.

◊ **Example:** Solve  $|2x - 1| = 9$ .

⇒ Here is the key idea: the expression  $2x - 1$  sits 9 units from zero, and that can happen in *two* ways — it could be 9 or it could be  $-9$ . So we make two little equations and solve each one. **First way:**  $2x - 1 = 9$ , so  $2x = 10$  and  $x = 5$ . **Second way:**  $2x - 1 = -9$ , so  $2x = -8$  and  $x = -4$ . Both answers check out — with absolute value, always keep both!

**Answer:**  $x = 5$  or  $x = -4$

## PRACTICE

Solve each equation or inequality. Write the complete solution set.

- |                    |       |                       |       |
|--------------------|-------|-----------------------|-------|
| 1. $ x  = 8$       | _____ | 11. $ 5x - 10  = 25$  | _____ |
| 2. $ x  = 15$      | _____ | 12. $ 4x + 4  = 12$   | _____ |
| 3. $ x - 6  = 10$  | _____ | 13. $ x  < 6$         | _____ |
| 4. $ x + 3  = 7$   | _____ | 14. $ x  \leq 9$      | _____ |
| 5. $ 2x  = 14$     | _____ | 15. $ x - 2  < 5$     | _____ |
| 6. $ 3x  = 21$     | _____ | 16. $ x + 4  \leq 10$ | _____ |
| 7. $ x + 9  = 0$   | _____ | 17. $ x  > 3$         | _____ |
| 8. $ 2x - 5  = 11$ | _____ | 18. $ x  \geq 8$      | _____ |
| 9. $ 3x + 6  = 18$ | _____ | 19. $ x - 5  > 2$     | _____ |
| 10. $ x - 7  = -2$ | _____ | 20. $ 2x + 2  \leq 8$ | _____ |

## Word Problems

21. A thermostat keeps a greenhouse within  $3^\circ\text{F}$  of  $68^\circ\text{F}$ . Write and solve an absolute value inequality for the acceptable temperature  $T$ . \_\_\_\_\_
22. A snack bag should weigh 9 oz, with an allowed error of 0.4 oz. Write and solve an absolute value inequality for the acceptable weight  $w$ . \_\_\_\_\_
23. A machine cuts bolts to a diameter of 12 mm and must stay within 0.05 mm of that target. Write and solve an absolute value inequality for the acceptable diameter  $d$ . \_\_\_\_\_
24. A delivery drone is told to stay within 50 ft of its planned altitude of 400 ft. Write and solve an absolute value inequality for the acceptable altitude  $a$ . \_\_\_\_\_



## Answer Keys

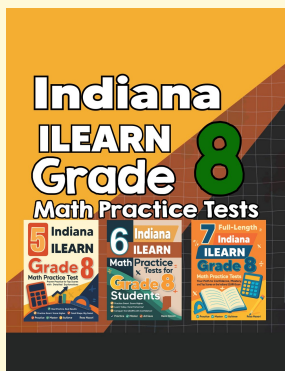
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| <p>1. <math>x = \pm 8</math></p> <p>2. <math>x = \pm 15</math></p> <p>3. <math>x = 16</math> or <math>x = -4</math></p> <p>4. <math>x = 4</math> or <math>x = -10</math></p> <p>5. <math>x = \pm 7</math></p> <p>6. <math>x = \pm 7</math></p> <p>7. <math>x = -9</math></p> <p>8. <math>x = 8</math> or <math>x = -3</math></p> <p>9. <math>x = 4</math> or <math>x = -8</math></p> <p>10. no solution</p> <p>11. <math>x = 7</math> or <math>x = -3</math></p> <p>12. <math>x = 2</math> or <math>x = -4</math></p> | <p>13. <math>-6 &lt; x &lt; 6</math></p> <p>14. <math>-9 \leq x \leq 9</math></p> <p>15. <math>-3 &lt; x &lt; 7</math></p> <p>16. <math>-14 \leq x \leq 6</math></p> <p>17. <math>x &lt; -3</math> or <math>x &gt; 3</math></p> <p>18. <math>x \leq -8</math> or <math>x \geq 8</math></p> <p>19. <math>x &lt; 3</math> or <math>x &gt; 7</math></p> <p>20. <math>-5 \leq x \leq 3</math></p> <p>21. <math> T - 68  \leq 3</math>; <math>65 \leq T \leq 71</math></p> <p>22. <math> w - 9  \leq 0.4</math>; <math>8.6 \leq w \leq 9.4</math></p> <p>23. <math> d - 12  \leq 0.05</math>; <math>11.95 \leq d \leq 12.05</math></p> <p>24. <math> a - 400  \leq 50</math>; <math>350 \leq a \leq 450</math></p> |
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### Step-by-Step Explanations

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| <p>1. Absolute value asks "how far from zero?" Two numbers sit 8 units away — 8 and <math>-8</math> — so <math>x = \pm 8</math>.</p> <p>2. Same idea: the numbers exactly 15 units from 0 are 15 and <math>-15</math>, giving <math>x = \pm 15</math>.</p> <p>3. Set the inside equal to 10 and to <math>-10</math>: <math>x - 6 = 10</math> gives <math>x = 16</math>, and <math>x - 6 = -10</math> gives <math>x = -4</math>.</p> <p>4. Two cases again: <math>x + 3 = 7 \Rightarrow x = 4</math>, and <math>x + 3 = -7 \Rightarrow x = -10</math>. Always check both!</p> <p>5. If <math> 2x  = 14</math>, then <math>2x = \pm 14</math>. Divide by 2 to get <math>x = \pm 7</math>.</p> <p>6. From <math> 3x  = 21</math> we get <math>3x = \pm 21</math>. Dividing by 3 gives <math>x = \pm 7</math>.</p> <p>7. Zero is special — an absolute value equals 0 only when the inside is 0. So <math>x + 9 = 0</math> and <math>x = -9</math> (just one answer).</p> <p>8. <math>2x - 5 = 11 \Rightarrow 2x = 16 \Rightarrow x = 8</math>. <math>2x - 5 = -11 \Rightarrow 2x = -6 \Rightarrow x = -3</math>.</p> <p>9. <math>3x + 6 = 18 \Rightarrow x = 4</math>. <math>3x + 6 = -18 \Rightarrow 3x = -24 \Rightarrow x = -8</math>.</p> <p>10. Pause before solving — the right side is negative. A distance can never be <math>-2</math>, so there is no solution.</p> <p>11. <math>5x - 10 = 25 \Rightarrow 5x = 35 \Rightarrow x = 7</math>. <math>5x - 10 = -25 \Rightarrow 5x = -15 \Rightarrow x = -3</math>.</p> <p>12. <math>4x + 4 = 12 \Rightarrow 4x = 8 \Rightarrow x = 2</math>. <math>4x + 4 = -12 \Rightarrow 4x = -16 \Rightarrow x = -4</math>.</p> | <p>13. "Less than" makes a band. Everything closer than 6 units to zero works: <math>-6 &lt; x &lt; 6</math>.</p> <p>14. Same band idea, but <math>\leq</math> includes the endpoints: <math>-9 \leq x \leq 9</math>.</p> <p>15. Unpack to <math>-5 &lt; x - 2 &lt; 5</math>, then add 2 to every part: <math>-3 &lt; x &lt; 7</math>.</p> <p>16. Unpack to <math>-10 \leq x + 4 \leq 10</math>, then subtract 4 everywhere: <math>-14 \leq x \leq 6</math>.</p> <p>17. "Greater than" splits into two pieces — the values <i>outside</i> the band: <math>x &lt; -3</math> or <math>x &gt; 3</math>.</p> <p>18. Outside the band again, and <math>\geq</math> keeps the endpoints: <math>x \leq -8</math> or <math>x \geq 8</math>.</p> <p>19. Split it: <math>x - 5 &gt; 2 \Rightarrow x &gt; 7</math>, and <math>x - 5 &lt; -2 \Rightarrow x &lt; 3</math>.</p> <p>20. Unpack to <math>-8 \leq 2x + 2 \leq 8</math>, subtract 2 to get <math>-10 \leq 2x \leq 6</math>, then divide by 2: <math>-5 \leq x \leq 3</math>.</p> <p>21. "Within <math>3^\circ</math> of <math>68^\circ</math>" is exactly what absolute value describes, so write <math> T - 68  \leq 3</math>. Unpacking gives <math>-3 \leq T - 68 \leq 3</math>, so <math>65 \leq T \leq 71</math> (degrees F).</p> <p>22. The weight may differ from 9 oz by at most 0.4 oz: <math> w - 9  \leq 0.4</math>. That unpacks to <math>-0.4 \leq w - 9 \leq 0.4</math>, so <math>8.6 \leq w \leq 9.4</math> oz.</p> <p>23. The diameter is within 0.05 mm of 12 mm, so <math> d - 12  \leq 0.05</math>. Unpack: <math>-0.05 \leq d - 12 \leq 0.05</math>, which gives <math>11.95 \leq d \leq 12.05</math> mm.</p> <p>24. "Within 50 ft of 400 ft" becomes <math> a - 400  \leq 50</math>. Unpacking gives <math>-50 \leq a - 400 \leq 50</math>, so the drone may fly between 350 ft and 450 ft.</p> |
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