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. $|x| = 8$ _____

2. $|x| = 15$ _____

3. $|x - 6| = 10$ _____

4. $|x + 3| = 7$ _____

5. $|2x| = 14$ _____

6. $|3x| = 21$ _____

7. $|x + 9| = 0$ _____

8. $|2x - 5| = 11$ _____

9. $|3x + 6| = 18$ _____

10. $|x - 7| = -2$ _____

11. $|5x - 10| = 25$ _____

12. $|4x + 4| = 12$ _____

13. $|x| < 6$ _____

14. $|x| \leq 9$ _____

15. $|x - 2| < 5$ _____

16. $|x + 4| \leq 10$ _____

17. $|x| > 3$ _____

18. $|x| \geq 8$ _____

19. $|x - 5| > 2$ _____

20. $|2x + 2| \leq 8$ _____

♦ Word Problems

21. A thermostat keeps a greenhouse within $3°$F of $68°$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

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

Step-by-Step Explanations

1. Absolute value asks "how far from zero?" Two numbers sit 8 units away — 8 and -8 — so $x = \pm 8$.

2. Same idea: the numbers exactly 15 units from 0 are 15 and -15, giving $x = \pm 15$.

3. Set the inside equal to 10 and to -10: $x - 6 = 10$ gives $x = 16$, and $x - 6 = -10$ gives $x = -4$.

4. Two cases again: $x + 3 = 7 \Rightarrow x = 4$, and $x + 3 = -7 \Rightarrow x = -10$. Always check both!

5. If $|2x| = 14$, then $2x = \pm 14$. Divide by 2 to get $x = \pm 7$.

6. From $|3x| = 21$ we get $3x = \pm 21$. Dividing by 3 gives $x = \pm 7$.

7. Zero is special — an absolute value equals 0 only when the inside is 0. So $x + 9 = 0$ and $x = -9$ (just one answer).

8. $2x - 5 = 11 \Rightarrow 2x = 16 \Rightarrow x = 8$. $2x - 5 = -11 \Rightarrow 2x = -6 \Rightarrow x = -3$.

9. $3x + 6 = 18 \Rightarrow x = 4$. $3x + 6 = -18 \Rightarrow 3x = -24 \Rightarrow x = -8$.

10. Pause before solving — the right side is negative. A distance can never be -2, so there is no solution.

11. $5x - 10 = 25 \Rightarrow 5x = 35 \Rightarrow x = 7$. $5x - 10 = -25 \Rightarrow 5x = -15 \Rightarrow x = -3$.

12. $4x + 4 = 12 \Rightarrow 4x = 8 \Rightarrow x = 2$. $4x + 4 = -12 \Rightarrow 4x = -16 \Rightarrow x = -4$.

13. "Less than" makes a band. Everything closer than 6 units to zero works: $-6 < x < 6$.

14. Same band idea, but $\leq$ includes the endpoints: $-9 \leq x \leq 9$.

15. Unpack to $-5 < x - 2 < 5$, then add 2 to every part: $-3 < x < 7$.

16. Unpack to $-10 \leq x + 4 \leq 10$, then subtract 4 everywhere: $-14 \leq x \leq 6$.

17. "Greater than" splits into two pieces — the values *outside* the band: $x < -3$ or $x > 3$.

18. Outside the band again, and $\geq$ keeps the endpoints: $x \leq -8$ or $x \geq 8$.

19. Split it: $x - 5 > 2 \Rightarrow x > 7$, and $x - 5 < -2 \Rightarrow x < 3$.

20. Unpack to $-8 \leq 2x + 2 \leq 8$, subtract 2 to get $-10 \leq 2x \leq 6$, then divide by 2: $-5 \leq x \leq 3$.

21. "Within $3°$ of $68°$" is exactly what absolute value describes, so write $|T - 68| \leq 3$. Unpacking gives $-3 \leq T - 68 \leq 3$, so $65 \leq T \leq 71$ (degrees F).

22. The weight may differ from 9 oz by at most 0.4 oz: $|w - 9| \leq 0.4$. That unpacks to $-0.4 \leq w - 9 \leq 0.4$, so $8.6 \leq w \leq 9.4$ oz.

23. The diameter is within 0.05 mm of 12 mm, so $|d - 12| \leq 0.05$. Unpack: $-0.05 \leq d - 12 \leq 0.05$, which gives $11.95 \leq d \leq 12.05$ mm.

24. "Within 50 ft of 400 ft" becomes $|a - 400| \leq 50$. Unpacking gives $-50 \leq a - 400 \leq 50$, so the drone may fly between 350 ft and 450 ft.

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