

## 1.4 Absolute Value Equations DAY ONE with work

# Algebra 1: 1.4 Absolute Value Equations Part 1

### WARM-UP:

Review from previous course:

$$|5| = \underline{5}$$

$$|-5| = \underline{5}$$

$$|-72| = \underline{72}$$

$$|72| = \underline{72}$$

Complete the statement with  $<$ ,  $>$ , or  $=$ .

1.  $|-82| \underline{>} |59|$

$$82 \underline{>} 59$$

2.  $|-61| \underline{=} |61|$

$$61 = 61$$

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### Learning Outcomes:

I can solve absolute value equations.

I can solve equations involving two absolute values.

I can identify special solutions of absolute value equations.

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## 1.4 Absolute Value Equations DAY ONE with work

What about this?

If  $|x| = 12$ , what does  $x$  equal?  $-12, 12$

$|x| = 8 \dots x = \underline{-8, 8}$

$|x| = -10 \dots x = \underline{\text{no sol.}}$

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### Core Concept

#### Properties of Absolute Value

Let  $a$  and  $b$  be real numbers. Then the following properties are true.

- $|a| \geq 0$  + positive
- $|-a| = |a|$   $|-5| = |5|$   
 $5 = 5$
- $|ab| = |a||b|$  \*  $|-3 \cdot 2| = 6$   
 $|-3||2| = 6$
- $\left|\frac{a}{b}\right| = \frac{|a|}{|b|}, b \neq 0$

#### Solving Absolute Value Equations

To solve  $|ax + b| = c$  when  $c \geq 0$ , solve the related linear equations

$$ax + b = c \quad \text{or} \quad ax + b = -c.$$

When  $c < 0$ , the absolute value equation  $|ax + b| = c$  has no solution because absolute value always indicates a number that is not negative.

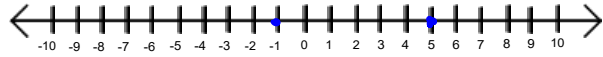
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# 1.4 Absolute Value Equations DAY ONE with work

Example 1:  $|x - 2| = 3$

Graph the solutions.

$$\begin{array}{r} x - 2 = 3 \\ +2 \quad +2 \\ \hline x = 5 \end{array} \qquad \begin{array}{r} x - 2 = -3 \\ +2 \quad +2 \\ \hline x = -1 \end{array}$$



Example 2:  $|3x + 1| = 5$

Graph the solutions.

$$\begin{array}{r} 3x + 1 = 5 \\ -1 \quad -1 \\ \hline 3x = 4 \\ x = \frac{4}{3} \end{array} \qquad \begin{array}{r} 3x + 1 = -5 \\ -1 \quad -1 \\ \hline 3x = -6 \\ x = -2 \end{array}$$



What about this?  $|3x + 1| = -5$

$$3x + 1 = -5$$

no sol.



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Solve the equation. Graph the solutions, if possible.

1.  $|x| = 10$

$$x = 10 \quad x = -10$$

2.  $|x - 1| = 4$

$$\begin{array}{r} x - 1 = 4 \\ +1 \quad +1 \\ \hline x = 5 \end{array} \qquad \begin{array}{r} x - 1 = -4 \\ +1 \quad +1 \\ \hline x = -3 \end{array}$$

3.  $|3 + x| = -3$

$$\text{no sol.}$$

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# 1.4 Absolute Value Equations DAY ONE with work

$| \quad | = \# \quad | \quad | \neq -\#$

You may have to isolate the absolute value first ....

Solve  $|3x + 9| - 10 = -4$ .

then  $\begin{matrix} \nearrow + \\ \searrow - \end{matrix}$

$$\begin{array}{l} \frac{3x + 9 = 6}{-9 \quad -9} \qquad \frac{3x + 9 = -6}{-9 \quad -9} \\ \hline \frac{3x = -3}{3 \quad 3} \qquad \frac{3x = -15}{3 \quad 3} \\ \hline \boxed{x = -1} \qquad \boxed{x = -5} \end{array}$$

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Solve the equation. Check your solutions.

4.  $|x - 2| + 5 = 9$

$$\begin{array}{l} \frac{|x - 2| = 4}{x - 2 = 4} \qquad \frac{|x - 2| = 4}{x - 2 = -4} \\ \hline \frac{x = 6}{x = 6} \qquad \frac{x = -2}{x = -2} \end{array}$$

5.  $4|2x + 7| = 16$

$$\begin{array}{l} \frac{|2x + 7| = 4}{2x + 7 = 4} \qquad \frac{|2x + 7| = 4}{2x + 7 = -4} \\ \hline \frac{2x = -3}{2 \quad 2} \qquad \frac{2x = -11}{2 \quad 2} \\ \hline \boxed{x = -\frac{3}{2}} \qquad \boxed{x = -\frac{11}{2}} \end{array}$$

6.  $-2|5x - 1| - 3 = -11$

$$\begin{array}{l} \frac{-2|5x - 1| = -8}{|5x - 1| = 4} \\ \frac{5x - 1 = 4}{5x = 5} \qquad \frac{5x - 1 = -4}{5x = -3} \\ \hline \boxed{x = 1} \qquad \boxed{x = -\frac{3}{5}} \end{array}$$

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# Core Concept

## Solving Equations with Two Absolute Values

To solve  $|ax + b| = |cx + d|$ , solve the related linear equations

$$ax + b = cx + d \quad \text{or} \quad ax + b = -(cx + d).$$

↑  
opp.

When you break it into two parts, you drop the absolute value bars!! | gone!

Solve: (a)  $|3x - 4| = |x|$

$$\begin{array}{l}
 3x - 4 = x \\
 4 = -2x \\
 -2 = -x \\
 \boxed{-2 \neq x} \\
 |3(-2) - 4| = 10 \\
 |-2| = 2
 \end{array}
 \quad
 \begin{array}{l}
 3x - 4 = -x \\
 -4 = -4x \\
 -4 = -4x \\
 \boxed{1 \neq x} \\
 \boxed{\text{NO SOL}}
 \end{array}
 \quad
 \begin{array}{l}
 3(1) - 4 = -1 \\
 |-1| = 1
 \end{array}$$

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(b)  $|x + 8| = |2x + 1|$

$$\begin{array}{l}
 |x + 8| = 2x + 1 \\
 x + 8 = 2x + 1 \\
 8 = x + 1 \\
 \boxed{7 = x} \\
 |7 + 8| = 2(7) + 1 \\
 |15| = 14 + 1
 \end{array}$$

$$\begin{array}{l}
 x + 8 = -(2x + 1) \\
 x + 8 = -2x - 1 \\
 3x + 8 = -1 \\
 3x = -9 \\
 \boxed{x = -3} \\
 -3 + 8 = -(2(-3) + 1) \\
 5 = -(-5) \checkmark
 \end{array}$$

(c)  $|4x - 10| = 2|3x + 1|$

$$\begin{array}{l}
 4x - 10 = 2(3x + 1) \\
 4x - 10 = 6x + 2 \\
 -10 = 2x + 2 \\
 -12 = 2x \\
 \boxed{-6 = x} \\
 4(-6) - 10 = 2(3(-6) + 1) \\
 -24 - 10 = 2(-18 + 1) \\
 -34 = 2(-17) \\
 -34 = -34 \checkmark
 \end{array}$$

$$\begin{array}{l}
 4x - 10 = -2(3x + 1) \\
 4x - 10 = -6x - 2 \\
 10x - 10 = -2 \\
 10x = 8 \\
 x = \frac{8}{10} \\
 \boxed{x = \frac{4}{5}}
 \end{array}$$

$$\begin{array}{l}
 |4(4/5) - 10| \\
 2|3(4/5) + 1|
 \end{array}
 \quad
 \begin{array}{l}
 6.8 \\
 6.8
 \end{array}$$

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1.4 Absolute Value Equations DAY ONE with work

Your turn:

Solve the equations. Check your solutions.

a)

$$3|x - 4| = |2x + 5|$$

$$\begin{aligned} 3(x-4) &= 2x+5 & 3(x-4) &= -2x-5 \\ 3x-12 &= 2x+5 & 3x-12 &= -2x-5 \\ x-12 &= 5 & 5x-12 &= -5 \\ \boxed{x=17} & & 5x &= 7 \end{aligned}$$

$$\begin{aligned} 3|17-4| & \\ 12(17)+5 & \end{aligned}$$

■

39

$$\boxed{x = \frac{7}{5}}$$

39

$$\begin{aligned} 12(\frac{7}{5})+5 & & 7.8 \\ 3|(\frac{7}{5})-4| & & 7.8 \end{aligned}$$

■

b)

$$|2x + 12| = 4x$$

$$\begin{aligned} 2x+12 &= 4x \\ 12 &= 2x \\ \boxed{6=x} & \checkmark \end{aligned}$$

$$12(6)+12|$$

$$4(6)$$

■

24

24

$$\begin{aligned} 2x+12 &= -4x \\ 6x &= -12 \\ \boxed{x=-2} & \times \end{aligned}$$

$$4(-2)$$

$$12(-2)+12|$$

-8  
8

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c)

Solve  $|x + 5| = |x + 11|$ .

$$\begin{aligned} x+5 &= x+11 & x+5 &= -x-11 \\ 5 &= 11 & 2x &= -16 \\ & & \boxed{x=-8} & \end{aligned}$$

$$|-8+5|$$

3

$$|-8+11|$$

3

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HW: 1.4 WS A evens