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- I. Model Problems.
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### Web Resources

How to Solve Absolute Value Equations

[www.mathwarehouse.com/absolute-value/how-to-solve-absolute-value-equation.php](http://www.mathwarehouse.com/absolute-value/how-to-solve-absolute-value-equation.php)

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## I. Model Problems

The absolute value of a number is its distance from zero on the number line. For example the absolute value of 5, written  $|5|$ , is 5. Likewise, the absolute value of  $-5$ , written  $|-5|$  is also 5, because  $-5$  is also 5 units away from zero on the number line. Absolute value is always positive; if the absolute value of a variable equals a negative number, the solution to the equation is “no solution.”

When solving absolute value equations, remember that there can be two solutions, because the absolute value of a number and its opposite are the same.

**Example 1** Solve  $|x| = 10$ .

$$x = 10 \text{ or } x = -10$$

Definition of absolute value.

**The answer is  $x = 10$  or  $x = -10$ .**

If the absolute value of an expression equals a number, solve by setting up two equations, one with the expression equal to the number and the other with the expression equal to the opposite of the number.

**Example 2** Solve  $|x + 2| = 7$ .

$$x + 2 = 7 \text{ or } x + 2 = -7$$

Definition of absolute value.

$$x = 5 \text{ or } x = -9$$

Subtract.

**The answer is  $x = 5$  or  $x = -9$ .**

Sometimes you need to isolate the absolute value expression before writing separate equations.

**Example 3** Solve  $3|x + 2| + 1 = 13$ .

$$3|x + 2| = 12$$

Subtract.

$$|x + 2| = 4$$

Divide.

$$x + 2 = 4 \text{ or } x + 2 = -4$$

Definition of absolute value.

$$x = 2 \text{ or } x = -6$$

Subtract.

**The answer is  $x = 2$  or  $x = -6$ .**

## II. Practice

Solve. If there is no solution, write “no solution.”

1.  $|x| = 8$

2.  $|x + 6| = 9$

3.  $|x - 3| = 8$

4.  $|x + 9| = 12$

5.  $|x - 1| = -4$

6.  $|4x| = 24$

7.  $\left|\frac{x}{3}\right| = 6$

8.  $|2x + 1| = 25$

9.  $2|x| = 80$

10.  $|3x + 1| = 10$

11.  $|x + 5| + 1 = 11$

12.  $2|x| - 10 = 100$

13.  $0.2|x| - 0.2 = 1.8$

14.  $|x + 9| - 5 = -5$

15.  $|x - 0.5| + 2 = 15$

16.  $\left|\frac{x}{4} + 2\right| = 7$

17.  $|3x + 0.1| = 6$

18.  $|3 - 2x| = 8$

19.  $4|x - 2| = 8$

20.  $|2x - 7| + 8 = 5$

21.  $0.5|x - 0.14| + 0.32 = 0.71$

22.  $-2|0.25x + 2| = 10$

23.  $-2|x| - 9 = -19$

24.  $4|2 - x| = 16$

25.  $\left|2x - \frac{1}{4}\right| = \frac{5}{8}$

26.  $\left|\frac{2}{3}x - 4\right| = 2\frac{1}{5}$

27.  $-3\left|x + \frac{1}{13}\right| = -\frac{12}{13}$

28.  $0.6|1 - 0.2x| = 0.15$

29.  $-3\left|\frac{x}{7} - 6\right| = -30$

30.  $2\left|x + \frac{1}{9}\right| = \frac{2}{9}$

### III. Challenge Problems

31. What is the solution to the equation  $|x + 2| = -x$ ?

32. Does the equation  $|x + 2| = x$  have any solutions? Why or why not?

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### 33. Correct the Error

There is an error in the student work shown below:

Question: Solve  $|x - 1| - 3 = 5$ .

Solution:

$$x - 1 - 3 = 5 \text{ or } x - 1 - 3 = -5$$

$$x - 4 = 5 \text{ or } x - 4 = -5$$

$$x = 9 \text{ or } x = -1$$

What is the error? Explain how to solve the problem.

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#### IV. Answer Key

1. 8 or -8
2. 3 or -15
3. 11 or -5
4. 3 or -21
5. no solution
6. 6 or -6
7. 18 or -18
8. 12 or -13
9. 40 or -40
10. 3 or  $-11/3$
11. 5 or -15
12. 55 or -55
13. 10 or -10
14. -9
15. 13.5 or -12.5
16. 20 or -36
17. 1.97 or -2.03
18. 5.5 or -2.5
19. 4 or 0
20. no solution
21. 0.92 or -0.64
22. no solution
23. 5 or -5
24. -2 or 6
25.  $7/16$  or  $-3/16$
26. 9.3 or 2.7
27.  $3/13$  or  $-5/13$
28. 6.25 or -3.75
29. 112 or -28
30. 0 or  $-2/9$
31.  $x = -1$
32. No. The given equation can be separated into  $x + 2 = x$  and  $x + 2 = -x$ . The first equation  $x + 2 = x$  is equivalent to  $2 = 0$ , which has no solution. The second equation has  $x = -1$  as a solution, but when -1 is plugged back into the original equation, it doesn't work because the

absolute value cannot yield a negative number.

33. The student needed to isolate the absolute value before separating the initial equation into two equations.