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1.2 Solving Absolute Value Equations

For use with Exploration 1.2

Essential Question How can you solve an absolute value equation?

1 EXPLORATION: Solving an Absolute Value Equation Algebraically

Work with a partner. Consider the absolute value equation $|x + 2| = 3$.

a. Describe the values of $x + 2$ that make the equation true. Use your description to write two linear equations that represent the solutions of the absolute value equation.

b. Use the linear equations you wrote in part (a) to find the solutions of the absolute value equation.

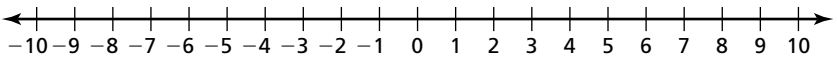
c. How can you use linear equations to solve an absolute value equation?

2 EXPLORATION: Solving an Absolute Value Equation Graphically

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Consider the absolute value equation $|x + 2| = 3$.

a. On a real number line, locate the point for which $x + 2 = 0$.



b. Locate the points that are 3 units from the point you found in part (a). What do you notice about those points?

c. How can you use a number line to solve an absolute value equation?

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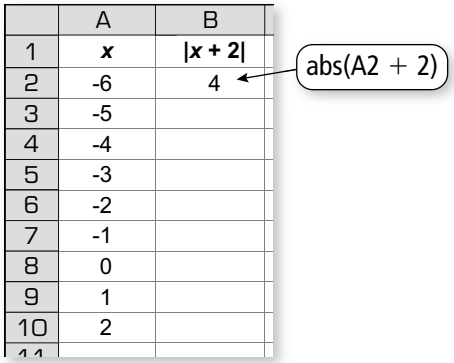
1.2 Solving Absolute Value Equations (continued)

3 EXPLORATION: Solving an Absolute Value Equation Numerically

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Consider the absolute value equation $|x + 2| = 3$.

a. Use a spreadsheet, as shown, to solve the absolute value equation.



b. Compare the solutions you found using the spreadsheet with those you found in Explorations 1 and 2. What do you notice?

c. How can you use a spreadsheet to solve an absolute value equation?

Communicate Your Answer

4. How can you solve an absolute value equation?

5. What do you like or dislike about the algebraic, graphical, and numerical methods for solving an absolute value equation? Give reasons for your answers.

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1.2 Practice

For use after Lesson 1.2

Core Concepts

Properties of Absolute Value

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

1. $|a| \geq 0$

2. $|-a| = |a|$

3. $|ab| = |a||b|$

4. $\left|\frac{a}{b}\right| = \frac{|a|}{|b|}, b \neq 0$

Notes:

Solving Absolute Value Equations

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

$$ax + b = c \quad or \quad ax + b = -c.$$

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

Notes:

Solving Equations with Two Absolute Values

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

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

Notes:

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1.2 Practice (continued)

Worked-Out Examples

Example #1

Simplify the expresssion.

$$\left|-\frac{-12}{4}\right| = |-(-3)| = |3| = 3$$

Example #2

Solve the equation. Graph the solution(s), if possible.

$$-3\left|1 - \frac{2}{3}v\right| = -9$$

$$\frac{-3\left|1 - \frac{2}{3}v\right|}{-3} = \frac{-9}{-3}$$

$$\left|1 - \frac{2}{3}v\right| = 3$$

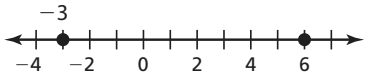
$$1 - \frac{2}{3}v = 3 \quad \textit{or} \quad 1 - \frac{2}{3}v = -3$$

$$\underline{-1} \qquad \underline{-1} \qquad\qquad \underline{-1} \qquad \underline{-1}$$

$$-\frac{2}{3}v = 2 \qquad\qquad -\frac{2}{3}v = -4$$

$$-\frac{3}{2}\left(-\frac{2}{3}v\right) = -\frac{3}{2} \cdot 2 \qquad -\frac{3}{2}\left(-\frac{2}{3}v\right) = -\frac{3}{2}(-4)$$

$$v = -3 \qquad\qquad v = 6$$

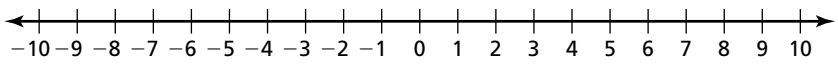


The solutions are $v = -3$ and $v = 6$.

Practice A

In Exercises 1–5, solve the equation. Graph the solution(s), if possible.

1. $|3x + 12| = 0$



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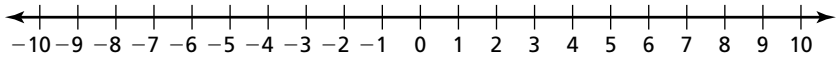
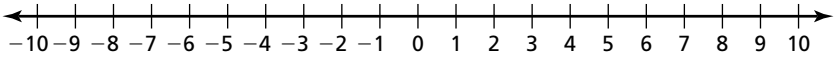
1.2 Practice (continued)

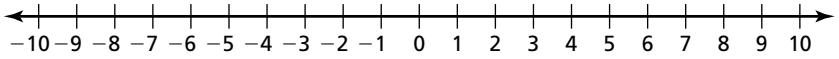
2. $|y + 2| = 8$



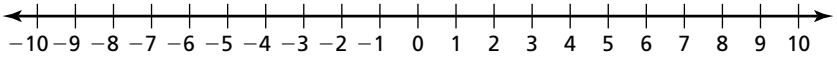
3. $-4|7 - 6k| = 14$



4. $\left|\frac{d}{3}\right| = 3$



5. $3|2x + 5| + 10 = 37$



In Exercises 6–9, solve the equation. Check your solutions.

6. $|20x| = |4x + 16|$

7. $|p + 4| = |p - 2|$

8. $|4q + 9| = |2q - 1|$

9. $|2x - 7| = |2x + 9|$

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Practice B

In Exercises 1–10, solve the equation. Graph the solution(s), if possible.

1. $|p - 3| = 10$

2. $|-2k| = 6$

3. $|6f| = -2$

4. $\left|\frac{q}{5}\right| = 3$

5. $|-a + 2| + 9 = 6$

6. $3|4 - 3m| = 30$

7. $-4|5g - 12| = -12$

8. $|x - 3| + 9 = 30$

9. $3|2d - 6| + 2 = 2$

10. $7|2c - 6| + 4 = 32$

11. A company manufactures penny number 2 nails that are 1 inch in length. The actual length is allowed to vary by up to $\frac{1}{32}$ inch.

a. Write and solve an absolute value equation to find the minimum and maximum acceptable nail length.

b. A penny number 2 nail is 1.05 inches long. Is the nail acceptable? Explain.

In Exercises 12–14, write an absolute value equation that has the given solutions.

12. 3 and 9

13. −5 and 15

14. 4 and 11

In Exercises 15–20, solve the equation. Check your solutions.

15. $|9w - 4| = |2w + 10|$

16. $2|n + 7| = |4n + 8|$

17. $3|3t + 1| = 2|6t + 3|$

18. $|5r + 3| = 2r$

19. $|j - 5| = |j + 9|$

20. $|2k + 4| = |2k + 3|$

21. You conduct a random survey of your small town about having a community garage sale. Of those surveyed, 56% are in favor and 44% are opposed. The actual percent could be 5% more or 5% less than the acquired results.

a. Write and solve an absolute value equation to find the least and greatest percents of your town population that could be opposed to a community garage sale.

b. A friend claims that half the town is actually opposed to a community garage sale. Does this statement conflict with the survey data? Explain.