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2 Working with Real Numbers

2-1 Basic Assumptions

Objective: To use number properties to simplify expressions.

Vocabulary

Unique One and only one

Terms When a and b are added, a and b are called terms.

Factors When a and b are multiplied, a and b are called factors.

Properties of Real Numbers	Addition	Multiplication
Closure Properties The sum and product of any two real numbers are also real numbers and they are unique.	$2 + 3 = 5$ and only 5	$2 \cdot 3 = 6$ and only 6
Commutative Properties The order in which you add or multiply any two real numbers does not affect the result.	$3 + 5 = 5 + 3$	$3 \cdot 5 = 5 \cdot 3$
Associative Properties When you add or multiply any three real numbers, the grouping (or association) of the numbers does not affect the result.	$(3 + 4) + 6 = 3 + (4 + 6)$	$(3 \cdot 4)5 = 3(4 \cdot 5)$

Example 1 Simplify: **a.** $75 + 13 + 25 + 47$ **b.** $4 \cdot 7 \cdot 25 \cdot 3$

Solution Regrouping makes mental math easier.

a. $75 + 13 + 25 + 47 = (75 + 25) + (13 + 47)$ Regroup the terms.
$= 100 + 60$ Simplify within the
$= 160$ parentheses. Add.

b. $4 \cdot 7 \cdot 25 \cdot 3 = (4 \cdot 25)(7 \cdot 3)$ Regroup the factors.
$= 100 \cdot 21$ Simplify within the parentheses.
$= 2100$ Multiply.

Example 2 Simplify $1\frac{1}{3} + 16\frac{4}{5} + 2\frac{2}{3} + 3\frac{1}{5}$.

Solution Regroup the fractions. Simplify within the parentheses. Add.

$1\frac{1}{3} + 16\frac{4}{5} + 2\frac{2}{3} + 3\frac{1}{5} = \left(1\frac{1}{3} + 2\frac{2}{3}\right) + \left(16\frac{4}{5} + 3\frac{1}{5}\right)$
$= 4 + 20$
$= 24$

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2-1 Basic Assumptions (continued)

Example 3 Simplify $0.8 + 3.7 + 0.2 + 5.3$.

Solution Regroup the decimals. Simplify within the parentheses. Add.
$0.8 + 3.7 + 0.2 + 5.3 = (0.8 + 0.2) + (3.7 + 5.3)$
$= 1 + 9$
$= 10$

Simplify.

1. $125 + 42 + 75 + 28$ **270**
2. $507 + 36 + 43 + 14$ **600**
3. $2 \cdot 18 \cdot 5 \cdot 4$ **720**
4. $40 \cdot 3 \cdot 4 \cdot 20$ **9600**
5. $50 \cdot 27 \cdot 4 \cdot 2$ **10,800**
6. $4 \cdot 15 \cdot 25 \cdot 3$ **4500**
7. $3\frac{1}{2} + 5\frac{2}{3} + 2\frac{1}{2} + \frac{1}{3}$ **12**
8. $7\frac{2}{3} + 4\frac{3}{5} + 2\frac{1}{3} + \frac{12}{5}$ **17**
9. $0.2 + 3.9 + 2.8 + 0.1$ **7**
10. $0.6 + 5.2 + 0.4 + 3.8$ **10**
11. $2.85 + 3.75 + 1.15 + 9.25$ **17**
12. $3.25 + 1.95 + 8.75 + 11.05$ **25**

Example 4 Simplify: **a.** $6 + 8m + 4 + 7n$ **b.** $(3w)(2x)(4y)(5z)$

Solution **a.** $6 + 8m + 4 + 7n = 8m + 7n + (6 + 4)$ Regroup the terms.
$= 8m + 7n + 10$ Simplify.

b. $(3w)(2x)(4y)(5z) = (3 \cdot 2 \cdot 4 \cdot 5)(wxyz)$ Regroup the factors.
$= 120wxyz$ Simplify.

Simplify.

13. $2 + 5y + 8$ **5y + 10**
14. $9 + 5z + 11$ **5z + 20**
15. $4 + 3x + 5$ **3x + 9**
16. $3 + 2w + 4$ **2w + 7**
17. $3(20a)$ **60a**
18. $4(5n)$ **20n**
19. $(5x)(6y)$ **30xy**
20. $(8m)(5n)$ **40mn**
21. $(6x)(y)(4z)$ **24xyz**
22. $(2p)(3q)(5r)$ **30pqr**
23. $(3a)(7b)(c)$ **21abc**
24. $(e)(6f)(2g)$ **12efg**
25. $a + 2 + b + 5$
26. $9 + x + y + 3$
27. $3p + 4 + 2q + 6$
28. $7m + 1 + 5n + 4$
29. $4 + 6x + 2 + 3y$ **6x + 3y + 6**
30. $6p + 3 + 2q + 37$ **6p + 2q + 40**
31. $(5a)(4b)(25c)(8d)$ **4000abcd**
32. $(4w)(2x)(5y)(5z)$ **200wxyz**

25. **a + b + 7**
26. **x + y + 12**
27. **3p + 2q + 10**
28. **7m + 5n + 5**

Mixed Review Exercises

Evaluate if $a = 2$, $x = 4$, $y = 6$, and $z = 3$.

1. $\dfrac{3x - a}{a + z}$ **2**
2. $4z(y - a)$ **48**
3. $\dfrac{2a + x}{3z - (y + 2)}$ **8**

Simplify.

4. $|-3| + |-5|$ **8**
5. $\left|-\frac{1}{6}\right| + 0$ **$\frac{1}{6}$**
6. $|-3.2| + |3.2|$ **6.4**
7. $|8| - |-8|$ **0**
8. $|-4| - |-2|$ **2**
9. $\left|-\frac{5}{7}\right| - \left|\frac{3}{7}\right|$ **$\frac{2}{7}$**
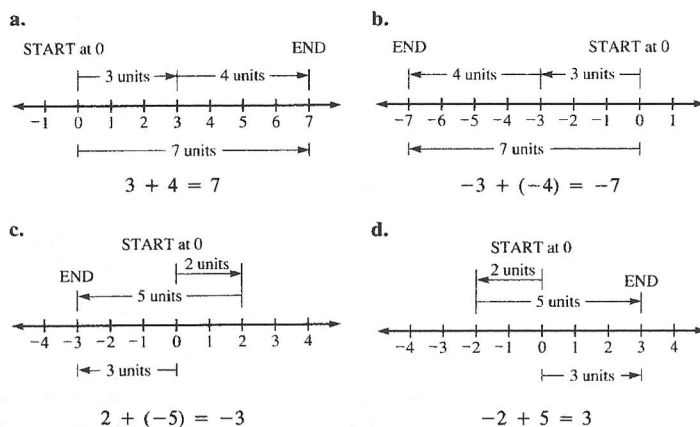
2-2. Addition On A Number Line

Objective: To add real numbers using a number line or properties about opposites.

Properties	Examples
Identity Property of Addition The sum of a real number and 0 is identical to the number itself. $a + 0 = a$ and $0 + a = a$	$5 + 0 = 5$ and $0 + 5 = 5$
Properties of Opposites Every real number has an opposite. The sum of a real number and its opposite is 0. $a + (-a) = 0$ and $(-a) + a = 0$	$3 + (-3) = 0$ and $(-3) + 3 = 0$
Property of the Opposite of a Sum For all real numbers a and b: $-(a + b) = (-a) + (-b)$	$-(2 + 3) = -5 = (-2) + (-3)$

Example 1   Simplify: **a.** $3 + 4$ **b.** $-3 + (-4)$ **c.** $2 + (-5)$ **d.** $-2 + 5$

Solution   a.

START at 0 ... END
3 units → ← 4 units
$-1\ 0\ 1\ 2\ 3\ 4\ 5\ 6\ 7$
7 units
$3 + 4 = 7$

b.

END ... START at 0
4 units ← 3 units
$-7\ -6\ -5\ -4\ -3\ -2\ -1\ 0\ 1$
7 units
$-3 + (-4) = -7$

c.

START at 0
2 units
END ← 5 units
$-4\ -3\ -2\ -1\ 0\ 1\ 2\ 3\ 4$
3 units
$2 + (-5) = -3$

d.

START at 0
2 units
5 units → END
$-4\ -3\ -2\ -1\ 0\ 1\ 2\ 3\ 4$
3 units
$-2 + 5 = 3$

Simplify each expression. If necessary, draw a number line to help you.

1. $4 + 2$ **6**
2. $-4 + (-2)$ **−6**
3. $6 + (-9)$ **−3**
4. $-6 + 9$ **3**
5. $3 + 5$ **8**
6. $-3 + (-5)$ **−8**
7. $-8 + 4$ **−4**
8. $8 + (-4)$ **4**
9. $(-2 + 5) + 4$ **7**
10. $(-4 + 7) + 1$ **4**
11. $(-3 + 1) + 2$ **0**
12. $(-6 + 5) + 3$ **2**

2-2 Addition On A Number Line (continued)

Simplify each expression. If necessary, draw a number line to help you.

13. $(-6 + 9) + (-2)$ **1**
14. $(-4 + 7) + (-3)$ **0**
15. $(-3 + 5) + 7$ **9**
16. $(-8 + 12) + (-6)$ **−2**
17. $[-6 + (-5)] + 6$ **−5**
18. $[-3 + (-7)] + 3$ **−7**
19. $25 + [7 + (-2)]$ **30**
20. $32 + [8 + (-14)]$ **26**
21. $[19 + (-9)] + [2 + (-2)]$ **10**
22. $(-2 + 2) + [26 + (-6)]$ **20**
23. $[0 + (-6)] + [-5 + (-25)]$ **−36**
24. $(-7 + 7) + [14 + (-4)]$ **10**
25. $-1 + (-2) + (-7)$ **−10**
26. $(-4) + (-6) + (-9)$ **−19**
27. $-3 + (-11) + 8 + (-5)$ **−11**
28. $-10 + 14 + (-3) + (-12)$ **−11**
29. $-5.3 + (-1.5) + 6.8$ **0**
30. $4.2 + (-3.4) + (-6.9)$ **−6.1**
31. $-\frac{3}{4} + 3 + \left(-\frac{9}{4}\right)$ **0**
32. $-\frac{11}{3} + (-4) + \left(-\frac{7}{3}\right)$ **−10**

Example 2   Simplify $3 + (-2) + x + 6$.

Solution   Use the commutative and associative properties to regroup.
$$3 + (-2) + x + 6 = 1 + x + 6$$
$$= x + (1 + 6)$$
$$= x + 7$$

Simplify.

33. $2 + x + (-6)$ **x + (−4)**
34. $y + (-1) + 5$ **y + 4**
35. $3n + 4 + (-1)$ **3n + 3**
36. $5 + 2n + (-4)$ **2n + 1**
37. $12 + 4n + (-20)$ **4n + (−8)**
38. $-8 + (-2z) + 11$ **−2z + 3**

Mixed Review Exercises

Simplify.

1. $6 + 8 \div 2$ **10**
2. $|-5| + |2|$ **7**
3. $9 - [-(-1)]$ **8**
4. $\frac{2 + (3 \cdot 6)}{4}$ **5**
5. $\left|\frac{3}{5}\right| + \left|-\frac{2}{5}\right|$ **1**
6. $\left|-\frac{3}{4}\right| + \left|-\frac{1}{4}\right|$ **1**
7. $52 + 35 + 48 + 15$ **150**
8. $12 \cdot 5 \cdot 30$ **1800**
9. $(2x)(4y)(5z)$ **40xyz**
10. $4\frac{3}{4} + 2\frac{1}{3} + 5\frac{1}{4} + \frac{2}{3}$ **13**
11. $0.3 + 2.6 + 5.7$ **8.6**
12. $4 \cdot 19 \cdot 25$ **1900**

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2–3 Rules for Addition

Objective: To add real numbers using rules for addition.

Vocabulary

Opposite signs A positive and a negative number are said to have opposite signs.

Rules for Addition	Examples
If two numbers have the *same sign*, add their absolute values and put their common sign before the result.	$2 + 5 = 7$ $-2 + (-5) = -7$
If two numbers have *opposite signs*, subtract the lesser absolute value from the greater and put the sign of the number having the greater absolute value before the result.	$6 + (-4) = 6 - 4 = 2$ $(-6) + 4 = -(6 - 4) = -2$
If two numbers are *opposites*, then their sum is zero.	$3 + (-3) = 0$

Example 1 Add $6 + (-8) + 13 + (-9)$.

Solution 1 Add the numbers in order from left to right.

$$\underbrace{6 + (-8)}_{-2} + 13 + (-9)$$
$$\underbrace{-2 + 13}_{11} + (-9)$$
$$\underbrace{11 + (-9)}_{2}$$

Solution 2 1. Add positive numbers. 2. Add negative numbers. 3. Add the results.

6	−8	19
13	−9	−17
19	−17	2

Add.

1.	2.	3.	4.	5.	6.
6	−4	−7	−3	23	−56
2	−7	6	8	64	31
8	**− 11**	**− 1**	**5**	**87**	**− 25**

7.	8.	9.	10.	11.	12.
−37	−35	126	−145	136	−162
−56	120	−35	309	−58	323
− 93	**85**	−37	−47	−47	−47
		−17	−82	−23	−82
		37	**35**	**8**	**32**

Add.

13. $(-8 + 5) + 2$ **−1**   14. $(-12 + 15) + 6$ **9**   15. $(-4 + 8) + (-3)$ **1**

16. $(-2 + 6) + (-4)$ **0**   17. $-5 + (-3) + 5$ **−3**   18. $-4 + (-14) + 4$ **−14**

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2–3 Rules for Addition (continued)

Add.

19. $16 + 5 + (-8)$ **13**   20. $-6 + (-24) + 6$ **−24**

21. $(-3 + 3) + 7 + (-11)$ **−4**   22. $(-3 + 3) + 17 + (-7)$ **10**

23. $-2 + (-4) + (-8)$ **−14**   24. $-7 + (-5) + (-6)$ **−18**

25. $-3 + (-9) + 7 + (-5)$ **−10**   26. $-15 + 10 + (-3) + (-2)$ **−10**

Example 2 Simplify $3 + (-5) + (-x) + 7$.

Solution
$$3 + (-5) + (-x) + 7 = -x + \underbrace{3 + 7} + (-5) \quad \text{Regroup the terms.}$$
$$= -x + \underbrace{10} + (-5) \quad \text{Simplify.}$$
$$= -x + 5$$

Simplify.

27. $-2 + x + (-6) + 3$ **x + (−5)**   28. $3 + (-8) + (-y) + (-11)$ **−y + (−16)**

29. $-5 + 2a + 3 + (-3)$ **2a + (−5)**   30. $-5 + 2a + 8 + 7$ **2a + 10**

31. $17 + 8b + (-15) + (-10)$ **8b + (−8)**   32. $-[6 + (-1)] + (-c) + 2$ **−c + (−3)**

33. $-(-7) + 3y + (-6) + 4$ **3y + 5**   34. $3x + [7 + (-2) + (-3)]$ **3x + 2**

Example 3 Evaluate $x + y + (-2)$ if $x = -2$, and $y = 5$.

Solution
$$x + y + (-2) = \underbrace{(-2) + 5} + (-2) \quad \text{Substitute } -2 \text{ for } x \text{ and } 5 \text{ for } y.$$
$$= \underbrace{3} + (-2) \quad \text{Add from left to right.}$$
$$= 1 \quad \text{Simplify.}$$

Evaluate each expression if $x = -2$, $y = 5$, and $z = -3$.

35. $y + z + (-2)$ **0**   36. $-18 + x + y$ **−15**

37. $-11 + (-x) + (-y)$ **−14**   38. $-z + (-7) + y$ **1**

39. $1 + (-y) + x$ **−6**   40. $-x + (-y) + (-15)$ **−18**

Mixed Review Exercises

Simplify.

1. $3 + 8 \div 2$ **7**   2. $7 \cdot 5 \cdot 3 \cdot 2$ **210**   3. $(9 - 6 \div 3) \cdot 2$ **14**

4. $|-9| - 7$ **2**   5. $|-1.6| + 1.6$ **3.2**   6. $|-11| - |-5|$ **6**

7. $\dfrac{9 \cdot 6 + 9 \cdot 4}{6 + 3}$ **10**   8. $3\frac{1}{5} + 7\frac{1}{2} + 8\frac{4}{5}$ **$19\frac{1}{2}$**   9. $2.7 + 1.0 + 3.3$ **7**

10. $[12 + (-2)] + 5$ **15**   11. $(-7 + 2) + (-3)$ **−8**   12. $-2 + (-8) + 7 + (-1)$ **−4**

2–4 Subtracting Real Numbers

Objective: To subtract real numbers and to simplify expressions involving differences.

Definition of Subtraction

To subtract a real number b, add the opposite of b.
$$a - b = a + (-b)$$
For example, $3 - 9 = 3 + (-9) = -6$.

Example 1 Simplify: **a.** $2 - 7$ **b.** $-6 - 3$ **c.** $-2 - (-8)$

Solution **a.** $2 - 7 = 2 + (-7) = -5$
b. $-6 - 3 = -6 + (-3) = -9$
c. $-2 - (-8) = -2 + 8 = 6$

CAUTION 1 Subtraction is *not* commutative.
$7 - 3 = 4$,
but $3 - 7 = -4$,
so $7 - 3 \neq 3 - 7$

CAUTION 2 Subtraction is *not* associative.
$(7 - 3) - 2 = 4 - 2 = 2$,
but $7 - (3 - 2) = 7 - 1 = 6$,
so $(7 - 3) - 2 \neq 7 - (3 - 2)$

Simplify.

1. $25 - 9$ **16**
2. $17 - 11$ **6**
3. $9 - 13$ **−4**
4. $6 - 16$ **−10**
5. $0 - 5$ **−5**
6. $0 - (-3)$ **3**
7. $-12 - 0$ **−12**
8. $-8 - 1$ **−9**
9. $3 - (-3)$ **6**
10. $7 - (-5)$ **12**
11. $-8 - (-3)$ **−5**
12. $36 - 216$ **−180**
13. $143 - 270$ **−127**
14. $36 - (-34)$ **70**
15. $-25 - (-24)$ **−1**

16. $-15 - (-3)$ **−12**
17. $-3 - (-15)$ **12**
18. $-17 - (-8)$ **−9**
19. $-2.3 - 3.5$ **−5.8**
20. $-4.2 - 5.6$ **−9.8**
21. $2.65 - (-2.35)$ **5**
22. -15 decreased by 5 **−20**
23. -8 decreased by -14 **6**
24. 18 less than -2 **−20**
25. 10 less than -6 **−16**
26. $56 - (45 - 32)$ **43**
27. $125 - (160 - 35)$ **0**
28. $214 - (54 - 66)$ **226**
29. $167 - (20 - 45)$ **192**
30. $(25 - 32) - (44 - 55)$ **4**
31. $(46 - 50) - (65 - 40)$ **−29**
32. $(2 - 7) - (-12 + 15)$ **−8**
33. $(32 - 24) - (-6 + 9)$ **5**

2–4 Subtracting Real Numbers (continued)

Example 2 Simplify $13 - 9 - 8 + 5$.

Solution $13 - 9 - 8 + 5 = 13 - 9 - 8 + 5$
$= \underbrace{13 + (-9)}_{} + (-8) + 5$
$= \underbrace{4 \quad + (-8)}_{} + 5$
$= \underbrace{-4 \quad + 5}_{}$
$= 1$

Simplify.

34. $3 - 4 + 7 - 15 + 21$ **12**
35. $14 - 12 + 11 + 3 - 20$ **−4**
36. $-5 - 18 + 6 - 7 + 10$ **−14**
37. $-9 - 21 + 3 - 8 + 30$ **−5**

Example 3 Simplify: **a.** $-(x - 5)$ **b.** $-(3 - y)$ **c.** $-(-2 + a)$

Solution To find the opposite of a sum or a difference, you change the sign of each term of the sum or difference.
a. $-(x - 5) = -x + 5$ **b.** $-(3 - y) = -3 + y$
c. $-(-2 + a) = 2 - a$

Simplify.

38. $-(x + 2)$ **−x − 2**
39. $-(4 - y)$ **−4 + y**
40. $-(-7 + a)$ **7 − a**
41. $-(x - 3)$ **−x + 3**
42. $-(y - 5)$ **−y + 5**
43. $-(8 - x)$ **−8 + x**
44. $-(b - 6)$ **−b + 6**
45. $-(2 + n)$ **−2 − n**

Example 4 Simplify $8 - (x + 3)$.

Solution $8 - (x + 3) = 8 - x - 3$ Change the sign of each term of $x + 3$.
$= (8 - 3) - x$ Regroup the terms.
$= 5 - x$ Simplify.

Simplify.

46. $6 - (y + 4)$ **2 − y**
47. $4 - (q - 6)$ **10 − q**
48. $x - (x + 2)$ **−2**
49. $n - (-3 + n)$ **3**

Mixed Review Exercises

$6x + 5y + 10$

1. $|-6| + |2|$ **8**
2. $17 \cdot 2 \cdot 3 \cdot 5$ **510**
3. $2 + 6x + 5y + 8$
4. $\left|-\frac{3}{4}\right| - \left|-\frac{1}{4}\right|$ **$\frac{1}{2}$**
5. $-\frac{3}{2} + \left(-\frac{5}{2}\right)$ **−4**
6. $1\frac{1}{4} + \left(-3\frac{3}{4}\right)$ **$-2\frac{1}{2}$**
7. $[5 + (-9)] + 7$ **3**
8. $3.4 - 0.5 + (-1.4)$ **1.5**
9. $-4 + [-6 + (-2)]$ **−12**
10. $-2.4 + 8.3 + (-3.6)$ **2.3**
11. $-27 + (-28) + 18 + 47$ **10**
12. $2 + (-3) + (-10) + (-x)$ **−x − 11 or −11 − x**

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2–5 The Distributive Property

Objective: To use the distributive property to simplify expressions.

Vocabulary

Equivalent expressions Expressions that represent the same number.

Simplifying an expression Replacing an expression containing variables by an equivalent expression with as few terms as possible.

Distributive Property
Distributive Property of Multiplication (with respect to addition)   For all real numbers a, b, and c, $a(b + c) = ab + ac$ and $(b + c)a = ba + ca$.   For example, $6(9 + 4) = 6 \cdot 9 + 6 \cdot 4$ and $(9 + 4)6 = 9 \cdot 6 + 4 \cdot 6$
Distributive Property of Multiplication (with respect to subtraction)   For all real numbers a, b, and c, $a(b - c) = ab - ac$ and $(b - c)a = ba - ca$.   For example, $8(12 - 2) = 8 \cdot 12 - 8 \cdot 2$ and $(12 - 2)8 = 12 \cdot 8 - 2 \cdot 8$

CAUTION When using the distributive properties, be sure to multiply *both* of the numbers inside the parentheses by the number outside the parentheses. For example,

$6(13 - 3) = 6 \cdot 13 - 6 \cdot 3$ *not* $6 \cdot 13 - 3$.

Example 1   Simplify: **a.** $5 \cdot 48$ **b.** $8(7.5)$ **c.** $6\left(4\frac{1}{3}\right)$ **d.** $(11 - 5)9$

Solution   Use the distributive property to multiply.

a. $5 \cdot 48 = 5(40 + 8)$
$\quad = (5 \cdot 40) + (5 \cdot 8)$
$\quad = 200 + 40$
$\quad = 240$

b. $8(7.5) = 8(7 + 0.5)$
$\quad = (8 \cdot 7) + (8 \cdot 0.5)$
$\quad = 56 + 4$
$\quad = 60$

c. $6\left(4\frac{1}{3}\right) = 6\left(4 + \frac{1}{3}\right)$
$\quad = (6 \cdot 4) + \left(6 \cdot \frac{1}{3}\right)$
$\quad = 24 + 2$
$\quad = 26$

d. $(11 - 5)9 = (11 - 5)9$
$\quad = (11 \cdot 9) - (5 \cdot 9)$
$\quad = 99 - 45$
$\quad = 54$

Simplify. Use the distributive property.

1. $6 \cdot 35$ **210**   2. $5 \cdot 52$ **260**   3. $4(8.5)$ **34**   4. $8(6.25)$ **50**

5. $12\left(2\frac{1}{3}\right)$ **28**   6. $10\left(2\frac{1}{5}\right)$ **22**   7. $15\left(3\frac{2}{3}\right)$ **55**   8. $12 \cdot 25$ **300**

9. $5(20 - 1)$ **95**   10. $6(60 - 2)$ **348**   11. $9(30 - 1)$ **261**   12. $8(40 - 3)$ **296**

13. $(9 - 4)6$ **30**   14. $(12 - 3)8$ **72**   15. $(20 - 1)5$ **95**   16. $(30 - 7)6$ **138**

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2–5 The Distributive Property (continued)

Example 2 Simplify: **a.** $64 \cdot 19 + 36 \cdot 19$	**b.** $(3.8)(25) - (1.8)(25)$
Solution **a.** $64 \cdot 19 + 36 \cdot 19 = (64 + 36)19$ $\qquad = (100)19$ $\qquad = 1900$	**b.** $(3.8)(25) - (1.8)(25) = (3.8 - 1.8)25$ $\qquad = (2)25$ $\qquad = 50$

Simplify.

17. $20 \cdot 19 + 80 \cdot 19$ **1900**   18. $13 \cdot 53 + 87 \cdot 53$ **5300**   19. $(17 \cdot 24) - (17 \cdot 24)$ **0**

20. $(63 \cdot 71) + (37 \cdot 71)$ **7100**   21. $(0.65)(28) + (0.35)(28)$ **28**   22. $(4.3)(25) - (2.3)(25)$ **50**

Example 3   Write an equivalent expression without parentheses.

a. $5(n - 2)$ **b.** $(5y + 6)2$

Solution   **a.** $5(n - 2) = 5 \cdot n - 5 \cdot 2$ **b.** $(5y + 6)2 = (5y)2 + (6)2$
$\qquad\qquad = 5n - 10$ $\qquad = 10y + 12$

For each expression write an equivalent expression without parentheses.

23. $2(x + 3)$ **2x + 6**   24. $6(a + 5)$ **6a + 30**   25. $5(n - 1)$ **5n − 5**   26. $7(b - 5)$ **7b − 35**

27. $3(6n + 2)$ **18n + 6** 28. $8(5n - 3)$ 29. $3(x - y)$ **3x − 3y**   30. $2(4x - y)$ **8x − 2y**

31. $(4n - 7)4$ 32. $(3x + 4)5$ 33. $(3x + 4y)8$ 34. $(5m + 7n)2$

28. **40n − 24**   31. **16n − 28**   32. **15x + 20**   33. **24x + 32y**   34. **10m + 14n**

Example 4   Simplify: **a.** $8x + 6x$ **b.** $9y - 2y$ **c.** $5n - 6 + 3n$

Solution   **a.** $8x + 6x = (8 + 6)x = 14x$
$\qquad$ **b.** $9y - 2y = 9y + (-2)y = (9 - 2)y = 7y$
$\qquad$ **c.** $5n - 6 + 3n = 5n + 3n - 6 = 8n - 6$

Simplify.

35. $6a + 4a$ **10a**   36. $5m + 7m$ **12m**   37. $15y - 6y$ **9y**   38. $3x - (-9)x$ **12x**

39. $(-4)n + 9n$ **5n**   40. $(-7)n - 8n$ 41. $2a + 9 + 5a$ 42. $7n + 1 + 3n$

43. $9n - 5 + 2n$ 44. $3x + 8 - 2x$ 45. $9y - 6 + 5y$ 46. $10n - 7 + 6n$

40. **(−15)n** 41. **7a + 9** 42. **10n + 1** 43. **11n − 5** 44. **x + 8** 45. **14y − 6** 46. **16n − 7**

Mixed Review Exercises

Evaluate if $a = -2$, $b = -3$, $c = 4$, $x = 6$, and $y = 8$.

1. $4x + y - c$ **28**   2. $(x \cdot x + c) \div 8$ **5**   3. $3y - (2x \div c)$ **21**   4. $|a| + |b| + (-y)$ **−3**

5. $c + |a| + |-y|$ **14** 6. $2|a| - 3|b|$ **−5**   7. $-(x - b) + c$ **−5**   8. $x + y + (-5)$ **9**

9. $a + b + (-c)$ **−9** 10. $c - (a - b)$ **3**   11. $-a + b - c$ **−5**   12. $|b - a| - c$ **−3**

2–6 Rules for Multiplication

Objective: To multiply real numbers.

Properties	Examples
Identity Property of Multiplication The product of a number and 1 is identical to the number itself. $a \cdot 1 = a$ and $1 \cdot a = a$	$6 \cdot 1 = 6$ and $1 \cdot 6 = 6$
Multiplication Property of Zero When one of the factors of a product is zero, the product itself is zero. $a \cdot 0 = 0$ and $0 \cdot a = 0$	$6 \cdot 0 = 0$ and $0 \cdot 6 = 0$
Multiplication Property of -1 For every real number a: $a(-1) = -a$ and $(-1)a = -a$	$6(-1) = -6$ and $(-1)6 = -6$ $(-5)(-1) = -(-5) = 5$ and $(-1)(-5) = -(-5) = 5$
Property of Opposites in Products For all real numbers a and b: $(-a)(b) = -ab$ $a(-b) = -ab$ $(-a)(-b) = ab$	$(-4)(5) = -20$ $4(-5) = -20$ $(-4)(-5) = 20$

Rules for Multiplication

1. If two numbers have the *same* sign, their product is positive.
   If two numbers have *opposite* signs, their product is negative.

2. The product of an *even* number of negative numbers is positive.
   The product of an *odd* number of negative numbers is negative.

Example 1   Multiply: **a.** $3(6)$ **b.** $(-3)(6)$ **c.** $3(-6)$ **d.** $(-3)(-6)$

Solution
   a. $3(6) = 18$ (Both factors have the same sign.)
   b. $(-3)(6) = -18$ (The two factors have opposite signs.)
   c. $3(-6) = -18$ (The two factors have opposite signs.)
   d. $(-3)(-6) = 18$ (Both factors have the same sign.)

Example 2   **a.** $2(-3)(-4)(-5)$ is negative because it has 3 negative factors.
     b. $(-1)(-4)(-5)(6)(-7)$ is positive because it has 4 negative factors.
     c. $(-6)(7)(0)(-4)$ is zero because it has a zero factor.

2–6 Rules for Multiplication *(continued)*

Multiply.

1. $(-12)(-3)$ **36**   2. $18(-4)$ **−72**   3. $2(17)$ **34**   4. $18(0)$ **0**

5. $(-2)(5)(-8)$ **80**   6. $(4)(-7)(10)$ **−280**   7. $(-2)(-3)(-4)$ **−24**   8. $(-11)(-12)(0)$ **0**

9. $35(-26)(0)$ **0**   10. $5(-2)(-8)(-5)$ **−400**   11. $(-7)(3)(-1)(2)$ **42**   12. $(-8)(-5)(-1)(-3)$ **120**

Example 3   Simplify: **a.** $(-2x)(-6y)$ **b.** $3y + (-7y)$

Solution   **a.** $(-2x)(-6y) = (-2)x(-6)y$ **b.** $3y + (-7y) = [3 + (-7)]y$
                 $= (-2)(-6)xy$ $= (-4)y$
                 $= 12xy$ $= -4y$

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           13. $12ab$ **14.** $30xy$ **15.** $-10pq$ **16.** $-28ef$ **17.** $30ab$
Simplify.   **18.** $-15a$ **19.** $-3x$ **20.** $5x$ **21.** $-8y$ **22.** 0

13. $(-3a)(-4b)$ 14. $(5x)(6y)$ 15. $2p(-5q)$ 16. $(-4e)(7f)$ 17. $(-6a)(-5b)$

18. $-7a + (-8a)$ 19. $2x + (-5x)$ 20. $8x + (-3x)$ 21. $(-11y) + 3y$ 22. $-4n + 4n$

Example 4   Simplify: **a.** $-3(2x - y)$ **b.** $5x - 4(x - 1)$

Solution   **a.** $-3(2x - y) = -3(2x) - (-3)(y)$ **b.** $5x - 4(x - 1) = 5x - (4x - 4 \cdot 1)$
                          $= -6x - (-3y)$ $= 5x - (4x - 4)$
                          $= -6x + 3y$ $= 5x - 4x + 4$
                                                   $= x + 4$

Simplify.

23. $-6(x - 2y)$ **−6x + 12y**   24. $-5(2c + d)$ **−10c − 5d**   25. $-4(3m + 2n)$ **−12m − 8n**

26. $-7(-4y - 5)$ **28y + 35**   27. $(3x - 5)(-6)$ **−18x + 30**   28. $(-3 + 5y)(-2)$ **6 − 10y**

29. $4x - 3(x - 2)$ **x + 6**   30. $6x - 2(x + 3)$ **4x − 6**   31. $3x - 5(x - 1)$ **−2x + 5**

32. $(-1)(a - b + 2)$ 33. $(-1)(2x - y - 3)$ 34. $(-1)(x + y - z)$

35. $4x - 2x + 7 + x$ 36. $2y - 5 - 5y + 3$ 37. $11p - 6c - 7c + 9p$
                     32. $-a + b - 2$ **33.** $-2x + y + 3$ **34.** $-x - y + z$
                     35. $3x + 7$ **36.** $-3y - 2$ **37.** $20p - 13c$

Mixed Review Exercises

Translate each sentence into an equation.

1. Three times a number is 27.   **$3n = 27$**   2. The quotient of n and 4 is 15.   **$\frac{n}{4} = 15$**

3. One half of a number is nine.   **$\frac{1}{2}n = 9$**   4. Six less than twice a number is 14.
                                                                    $2n - 6 = 14$

Simplify.

5. $110 - (12 - 8)$ **106**   6. $161 - (8 - 11)$ **164**   7. $2 + (-5) + (-y) + 9$ **6 − y**

8. $3(20 + 5)$ **75**   9. $2n + (-5n)$ **− 3n**   10. $5(n + 1) + 7$ **5n + 12**

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2–7 Problem Solving: Consecutive Integers

Objective: To write equations to represent relationships among integers.

Vocabulary

Consecutive Integers Numbers obtained by counting by ones from any integer.
For example, $-2, -1, 0, 1$, and 2 are consecutive integers.

Even Integer An integer that is the product of 2 and any integer.
For example, $-10, -4, 2, 6$, and 8 are even integers.

Odd Integer An integer that is not even.
For example, $-3, -1, 7, 9$, and 11 are odd integers.

Consecutive Even Integers Numbers obtained by counting by twos from any even integer.
For example, $-6, -4, -2, 0$, and 2 are consecutive even integers.

Consecutive Odd Integers Numbers obtained by counting by twos from any odd integer.
For example, $-5, -3, -1, 1$, and 3 are consecutive odd integers.

Example 1 An integer is represented by n.
  a. Write the next four consecutive integers after n.
  b. Write an equation to represent this relationship:
    The sum of three consecutive integers starting with n is 93.
  c. Write an equation to represent this relationship:
    The product of two consecutive integers starting with n is 56.

Solution
  a. $n + 1, n + 2, n + 3, n + 4$
  b. $n + (n + 1) + (n + 2) = 93$
  c. $n(n + 1) = 56$

Write an equation to represent the given relationship.

1. $n + (n + 1) + (n + 2) = 39$
2. $n + (n + 1) + (n + 2) = -51$

1. The sum of three consecutive integers is 39.   **2.** The sum of three consecutive integers is -51.

3. The product of two consecutive integers is 42.   **4.** The product of two consecutive integers is 30.
$n(n + 1) = 42$ $n(n + 1) = 30$

Example 2 Write an equation to represent this relationship:
  The sum of three consecutive odd numbers is 33.

Solution Let n = the first integer, $n + 2$ = the second integer,
  and $n + 4$ = the third integer.

  The sum of three consecutive odd integers is 33.
  $n + (n + 2) + (n + 4)$ $= 33$

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5. $n + (n + 2) + (n + 4) = 45$
6. $n + (n + 2) + (n + 4) = 72$

Write an equation to represent the given relationship.

5. The sum of three consecutive odd integers is 45.   **6.** The sum of three consecutive even integers is 72.

7. The sum of four consecutive integers is 90.   **8.** The sum of four consecutive even integers is -44.
$n + (n + 1) + (n + 2) + (n + 3) = 90$ $n + (n + 2) + (n + 4) + (n + 6) = -44$

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2–7 Problem solving: Consecutive Integers (continued)

Example 3 Write an equation to represent this relationship:
  The product of two consecutive integers is 110.

Solution Let n = the first integer and $n + 1$ = the second integer.

  The product of the two consecutive integers is 110.
  $n(n + 1)$ $= 110$

Write an equation to represent the given relationship.

9. The product of two consecutive integers is 72. $n(n + 1) = 72$ **10.** The product of two consecutive even integers is 80. $n(n + 2) = 80$

11. The product of two consecutive integers is 132. $n(n + 1) = 132$ **12.** The product of two consecutive odd integers is 195. $n(n + 2) = 195$

Example 4 Solve over the given domain: The sum of three consecutive odd integers is 32 more than the smallest integer. What are the integers?
  Domain for the smallest integer: {9, 11, 13}

Solution
  Step 1 The unknowns are the three consecutive odd integers.
  Step 2 Let n = the smallest integer, $n + 2$ = the middle integer, and $n + 4$ = the largest integer.
  Step 3
  The sum   is 32 more than the smallest integer.
  $n + (n + 2) + (n + 4) =$ $n + 32$
  Step 4 Replace n in turn by 9, 11, and 13.

n	$n + (n + 2) + (n + 4) = n + 32$				
9	$9 +$	$11 +$	13	$= 9 + 32$	False
11	$11 +$	$13 +$	15	$= 11 + 32$	False
13	$13 +$	$15 +$	17	$= 13 + 32$	True

  Step 5 The check is left to you. The integers are 13, 15, and 17.

Solve over the given domain.

13. The sum of three consecutive even integers is 50 more than the largest integer. What are the integers? Domain for the smallest integer: {20, 22, 24} **24, 26, and 28**

14. The sum of three consecutive odd integers is 72 more than the smallest integer. What are the integers? Domain for the smallest integer: {29, 31, 33} **33, 35, and 37**

Mixed Review Exercises

1. $(30 - 3) - (43 - 20)$ **4**   **2.** $-4.5 + 2.3 - 1.7$ **-3.9**   **3.** $-2 + 3c + (-4) + 7$ **$3c + 1$**

4. $\frac{7}{4} + \left(-\frac{10}{4}\right)$ **$-\frac{3}{4}$**   **5.** $2\frac{2}{5} + 10 + 3\frac{3}{5}$ **16**   **6.** $5\left(\frac{3}{4}\right) - 4\left(\frac{1}{4}\right) + 3\left(\frac{3}{4}\right)$ **5**

7. $-(10 - x) - (x - 15)$ **5**   **8.** $14a - 4a + 5a$ **$15a$**   **9.** $10 + 4y + 5 + (-3)$ **$12 + 4y$**

2–8 The Reciprocal of a Real Number

Objective: To simplify expressions involving reciprocals.

Vocabulary

Reciprocals Two numbers whose product is 1 are called reciprocals of each other.

For example, 5 and $\frac{1}{5}$ are reciprocals.

Symbols $\frac{1}{a}$ (the reciprocal of a) $-\frac{1}{a}$ (the reciprocal of $-a$)

Properties	Examples
Property of Reciprocals Every *nonzero* real number a has a reciprocal $\frac{1}{a}$, such that $a \cdot \frac{1}{a} = 1$ and $\frac{1}{a} \cdot a = 1.$	$3 \cdot \frac{1}{3} = 1$ and $\frac{1}{3} \cdot 3 = 1$
Property of the Reciprocal of the Opposite of a Number For every *nonzero* number a, $\frac{1}{-a} = -\frac{1}{a}.$	$\frac{1}{-3} = -\frac{1}{3}$
Property of the Reciprocal of a Product For all *nonzero* numbers a and b, $\frac{1}{ab} = \frac{1}{a} \cdot \frac{1}{b}.$	$\frac{1}{2 \cdot 3} = \frac{1}{2} \cdot \frac{1}{3}$

CAUTION   0 has no reciprocal; 1 is its own reciprocal; and −1 is its own reciprocal.

Example 1   Simplify: **a.** $\frac{1}{3} \cdot \frac{1}{-5}$ **b.** $3y \cdot \frac{1}{3}$ **c.** $(-6xy)\left(-\frac{1}{2}\right)$

Solution   **a.** $\frac{1}{3} \cdot \frac{1}{-5} = \frac{1}{3(-5)} = \frac{1}{-15} = -\frac{1}{15}$

b. $3y \cdot \frac{1}{3} = \left(3 \cdot \frac{1}{3}\right)y = 1y = y$

c. $(-6xy)\left(-\frac{1}{2}\right) = (-6)\left(-\frac{1}{2}\right)(xy) = 3xy$

Simplify each expression.

1. $\frac{1}{3}(-12)$ **−4**

2. $-\frac{1}{8}(24)$ **−3**

3. $-50\left(\frac{1}{5}\right)$ **−10**

4. $-30\left(\frac{1}{3}\right)$ **−10**

5. $(-20)\left(-\frac{1}{4}\right)$ **5**

6. $(-42)\left(-\frac{1}{7}\right)$ **6**

7. $-36\left(-\frac{1}{4}\right)\left(\frac{1}{3}\right)$ **3**

8. $60\left(-\frac{1}{5}\right)\left(-\frac{1}{12}\right)$ **1**

9. $72\left(-\frac{1}{8}\right)\left(-\frac{1}{9}\right)$ **1**

10. $-54\left(-\frac{1}{6}\right)\left(-\frac{1}{9}\right)$ **−1**

11. $\frac{1}{-2}(24)\left(\frac{1}{4}\right)$ **−3**

12. $-60\left(\frac{1}{2}\right)\left(\frac{1}{3}\right)$ **−10**

2–8 The Reciprocal of a Real Number (continued)

Simplify each expression.

13. $6r\left(-\frac{1}{6}\right)$ **−r**

14. $32p\left(-\frac{1}{8}\right)$ **−4p**

15. $\frac{1}{x}(8x), x \ne 0$ **8**

16. $9x\left(\frac{1}{x}\right), x \ne 0$ **9**

17. $21xy\left(\frac{1}{7}\right)$ **3xy**

18. $72ab\left(\frac{1}{9}\right)$ **8ab**

19. $18xy\left(\frac{1}{6}\right)$ **3xy**

20. $(-54xy)\left(\frac{1}{-9}\right)$ **6xy**

21. $15xy\left(\frac{1}{-3}\right)$ **−5xy**

22. $6cd\left(\frac{1}{-2}\right)$ **−3cd**

23. $(-8pq)\left(\frac{1}{-2}\right)$ **4pq**

24. $(-42ac)\left(\frac{1}{-7}\right)$ **6ac**

Example 2   Simplify: **a.** $\frac{1}{2}(8m - 4n)$ **b.** $(-21a - 63b)\left(-\frac{1}{7}\right)$

Solution   **a.** $\frac{1}{2}(8m - 4n) = \frac{1}{2}(8m) - \frac{1}{2}(4n)$ Use the distributive property.

$= \left(\frac{1}{2} \cdot 8\right)m - \left(\frac{1}{2} \cdot 4\right)n$ Use the associative property.

$= 4m - 2n$ Simplify.

b. $(-21a - 63b)\left(-\frac{1}{7}\right) = (-21a)\left(-\frac{1}{7}\right) - (63b)\left(-\frac{1}{7}\right)$

$= (-21)\left(-\frac{1}{7}\right)a - (63)\left(-\frac{1}{7}\right)b$

$= (3)a - (-9)b$

$= 3a + 9b$

Simplify each expression.

25. $\frac{1}{2}(-8a + 10)$ **−4a + 5**

26. $\frac{1}{3}(9y - 21)$ **3y − 7**

27. $-\frac{1}{5}(-25c + 10d)$ **5c − 2d**

28. $-\frac{1}{4}(24g - 32h)$ **−6g + 8h**

29. $(-21m - 14n)\left(-\frac{1}{7}\right)$ **3m + 2n**

30. $(-26e - 52f)\left(-\frac{1}{13}\right)$ **2e + 4f**

31. $(40x - 56y)\left(-\frac{1}{8}\right)$ **−5x + 7y**

32. $(-5a + 30b)\left(\frac{1}{-5}\right)$ **a − 6b**

Mixed Review Exercises

Translate each sentence into an equation. **6x + 3 = 21**   **x − 12 = 200**

1. Three more than six times a number is 21.   2. Twelve less than a number is 200.

3. The sum of two consecutive integers is 71.   4. The product of two consecutive integers is 90.

$n + (n + 1) = 71$ $n(n + 1) = 90$

Simplify.

5. $(-8)(-3)(-5)$ **−120**

6. $-24(25)(-4)$ **2400**

7. $5(-7)(-6)$ **210**

8. $-8(2a - 5b)$ **−16a + 40b** 9. $-2(2 + x) - 2(x - 2)$ **−4x** 10. $10(x - 1) + 4(3 - x)$ **6x + 2**

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2–9 Dividing Real Numbers

Objective: To divide real numbers and to simplify expressions involving quotients.

Definition of Division

To divide by a nonzero real number b, multiply by the reciprocal of b.

$$a \div b \text{ or } \frac{a}{b} = a \cdot \frac{1}{b}. \qquad \text{For example, } 24 \div 3 = 24 \cdot \frac{1}{3}.$$

Rules for Division

If two numbers have the same sign, their quotient is positive.
If two numbers have opposite signs, their quotient is negative.

CAUTION 1 You can't divide by zero since zero has no reciprocal.

CAUTION 2 Division is not commutative. For example, $4 \div 2 = 2$, but $2 \div 4 = \frac{1}{2}$.

CAUTION 3 Division is not associative. For example, $(12 \div 6) \div 2 = 2 \div 2 = 1$, but $12 \div (6 \div 2) = 12 \div 3 = 4$.

Example 1 Simplify: **a.** $\frac{30}{6}$ **b.** $\frac{30}{-6}$ **c.** $\frac{-30}{6}$ **d.** $\frac{-30}{-6}$

Solution **a.** $\frac{30}{6} = 30 \div 6 = 30 \cdot \frac{1}{6} = 5$ **b.** $\frac{30}{-6} = 30 \div (-6) = 30\left(-\frac{1}{6}\right) = -5$

c. $\frac{-30}{6} = -30 \div 6 = -30 \cdot \frac{1}{6} = -5$ **d.** $\frac{-30}{-6} = -30 \div (-6) = -30\left(-\frac{1}{6}\right) = 5$

Simplify.

1. $42 \div 14$ **3** **2.** $-56 \div 7$ **−8** **3.** $-24 \div (-6)$ **4** **4.** $-32 \div (-8)$ **4**

5. $\frac{-144}{12}$ **−12** **6.** $\frac{96}{-16}$ **−6** **7.** $\frac{-100}{-5}$ **20** **8.** $\frac{-75}{-3}$ **25**

Example 2 Simplify: **a.** $8 \div \left(-\frac{4}{5}\right)$ **b.** $\frac{-4}{-\frac{1}{2}}$

Solution **a.** $8 \div \left(-\frac{4}{5}\right) = 8\left(-\frac{5}{4}\right) = -10$ **b.** $\frac{-4}{-\frac{1}{2}} = (-4) \div \left(-\frac{1}{2}\right) = (-4)(-2) = 8$

Simplify.

9. $6 \div \left(-\frac{1}{3}\right)$ **−18** **10.** $12 \div \left(-\frac{1}{4}\right)$ **−48** **11.** $0 \div \frac{5}{6}$ **0** **12.** $-8 \div \left(-\frac{1}{2}\right)$ **16** **13.** $0 \div \left(-\frac{2}{7}\right)$ **0**

14. $\frac{-12}{-\frac{1}{4}}$ **48** **15.** $\frac{8}{-\frac{1}{2}}$ **−16** **16.** $\frac{-20}{\frac{1}{5}}$ **−100** **17.** $\frac{0}{\frac{1}{9}}$ **0** **18.** $\frac{-8}{-\frac{1}{8}}$ **64**

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2–9 Dividing Real Numbers (continued)

Example 3 Simplify: **a.** $\frac{32x}{-8}$ **b.** $\frac{w}{12} \cdot 12$

Solution **a.** $\frac{32x}{-8} = 32x\left(-\frac{1}{8}\right)$ Multiply by the reciprocal of -8.

$= 32\left(-\frac{1}{8}\right)x$ Regroup the factors.

$= -4x$ Simplify.

b. $\frac{w}{12} \cdot 12 = w \cdot \frac{1}{12} \cdot 12$

$= w \cdot 1$

$= w$

Simplify.

19. $\frac{-18x}{3}$ **−6x** **20.** $\frac{-42x}{6}$ **−7x** **21.** $\frac{50x}{-10}$ **−5x** **22.** $\frac{-36x}{-6}$ **6x**

23. $5 \cdot \frac{x}{5}$ **x** **24.** $\frac{-w}{8} \cdot 8$ **−w** **25.** $(-6)\left(\frac{-y}{2}\right)$ **3y** **26.** $(-10)\left(\frac{x}{-2}\right)$ **5x**

27. $\frac{144b}{12}$ **12b** **28.** $\frac{121b}{-11}$ **−11b** **29.** $\frac{-48x}{6}$ **−8x** **30.** $\frac{-108x}{-36}$ **3x**

Example 4 Find the average of $14, -2, -8, -12$.

Solution Find the sum of the numbers and divide by the number of numbers.

$$\frac{14 + (-2) + (-8) + (-12)}{4} = \frac{-8}{4} = -2$$

Find the average of the given numbers.

31. $-12, 5, -10, -7$ **−6** **32.** $15, -21, -8, 6$ **−2** **33.** $13, -5, -16, -4$ **−3**

34. $23, -13, -18, 20$ **3** **35.** $11, -15, -22, 16, 0$ **−2** **36.** $23, -12, -17, 21, 5$ **4**

Mixed Review Exercises

Solve if $x \in \{0, 1, 2, 3, 4, 5, 6\}$.

1. $x + 5 = 7$ **{2}** **2.** $\frac{1}{2}x = 3$ **{6}** **3.** $x - 1 = 4$ **{5}**

4. $3x = 9$ **{3}** **5.** $3x + 1 = 7$ **{2}** **6.** $x \div 3 = 1$ **{3}**

Solve over the domain $\{0, 1, 2, 3, 4, 5\}$.

7. $\frac{1}{3}n = 1$ **{3}** **8.** $3y - 1 = 14$ **{5}** **9.** $x + 2 = 6$ **{4}**

10. $2x = 2$ **{1}** **11.** $x \cdot x = 4$ **{2}** **12.** $3n = n \cdot 3$ **{0, 1, 2, 3, 4, 5}**