

## CHAPTER 1 INTRODUCTION TO ALGEBRA: INTEGERS

### 1.1 Place Value

#### 1.1 Margin Exercises

- The whole numbers are: 502; 3; 14; 0; 60,005
- The 8 in 45,628,665 is in the thousands place.
  - The 8 in 800,503,622 is in the hundred-millions place.
  - The 8 in 428,000,000,000 is in the billions place.
  - The 8 in 2,385,071 is in the ten-thousands place.
- 23,605 in words: twenty-three thousand, six hundred five.
  - 400,033,007 in words: four hundred *million*, thirty-three *thousand*, seven.
  - 193,080,102,000,000 in words: one hundred ninety-three *trillion*, eighty *billion*, one hundred two *million*.
- Eighteen million, two thousand, three hundred five  
The first group name is *million*, so you need to fill *three groups* of three digits.  
0 1 8, 0 0 2, 3 0 5 = 18,002,305
  - Two hundred billion, fifty million, six hundred sixteen  
The first group name is *billion*, so you need to fill *four groups* of three digits.  
2 0 0, 0 5 0, 0 0 0, 6 1 6 = 200,050,000,616
  - Five trillion, forty-two billion, nine million  
The first group name is *trillion*, so you need to fill *five groups* of three digits.  
0 0 5, 0 4 2, 0 0 9, 0 0 0, 0 0 0 = 5,042,009,000,000
  - Three hundred six million, seven hundred thousand, nine hundred fifty-nine  
The first group name is *million*, so you need to fill *three groups* of three digits.  
3 0 6, 7 0 0, 9 5 9 = 306,700,959

#### 1.1 Section Exercises

- False; we can also use the digit 0.
- True; 16,565, 2, 0, and 400 are whole numbers.
- True; none of the numbers are whole numbers.
- False; the left-most 7 has a value of 7 ten-thousands; the right-most 7 has a value of 7 tens.

- The whole numbers are: 15; 0; 83,001
- The whole numbers are: 457; 0; 6
- The whole numbers are: 7; 362,049
- The whole numbers are: 75,039; 4
- The 2 in 61,284 is in the hundreds place.
- The 2 in 82,110 is in the thousands place.
- The 2 in 284,100 is in the hundred-thousands place.
- The 2 in 823,415 is in the ten-thousands place.
- The 2 in 725,837,166 is in the ten-millions place.
- The 2 in 442,653,199 is in the millions place.
- The 2 in 253,045,701,000 is in the hundred-billions place.
- The 2 in 823,000,419,567 is in the ten-billions place.
- Name the place value for each zero in  
302,016,450,098,570.  
From left to right: ten-trillions, hundred-billions, millions, hundred-thousands, and ones.
- Name the place value for each zero in  
810,704,069,809,035.  
From left to right: trillions, ten-billions, hundred-millions, ten-thousands, and hundreds.
- 8421 in words: eight thousand, four hundred twenty-one.
- 1936 in words: one thousand, nine hundred thirty-six.
- 46,205 in words: forty-six thousand, two hundred five.
- 75,089 in words: seventy-five thousand, eighty-nine.
- 3,064,801 in words: three million, sixty-four thousand, eight hundred one.
- 7,900,408 in words: seven million, nine hundred thousand, four hundred eight.
- 840,111,003 in words: eight hundred forty million, one hundred eleven thousand, three.
- 304,008,401 in words: three hundred four million, eight thousand, four hundred one.
- 51,006,888,321 in words: fifty-one billion, six million, eight hundred eighty-eight thousand, three hundred twenty-one.

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28. 99,046,733,214 in words: ninety-nine billion, forty-six million, seven hundred thirty-three thousand, two hundred fourteen.
29. 3,000,712,000,000 in words: three trillion, seven hundred twelve million.
30. 50,918,000,000,600 in words: fifty trillion, nine hundred eighteen billion, six hundred.
31. Forty-six thousand, eight hundred five  
The first group name is *thousand*, so you need to fill *two groups* of three digits.  
 $\underline{046}, \underline{805} = 46,805$
32. Seventy-nine thousand, forty-six  
The first group name is *thousand*, so you need to fill *two groups* of three digits.  
 $\underline{079}, \underline{046} = 79,046$
33. Five million, six hundred thousand, eighty-two  
The first group name is *million*, so you need to fill *three groups* of three digits.  
 $\underline{005}, \underline{600}, \underline{082} = 5,600,082$
34. One million, thirty thousand, five  
The first group name is *million*, so you need to fill *three groups* of three digits.  
 $\underline{001}, \underline{030}, \underline{005} = 1,030,005$
35. Two hundred seventy-one million, nine hundred thousand  
The first group name is *million*, so you need to fill *three groups* of three digits.  
 $\underline{271}, \underline{900}, \underline{000} = 271,900,000$
36. Three hundred eleven million, four hundred  
The first group name is *million*, so you need to fill *three groups* of three digits.  
 $\underline{311}, \underline{000}, \underline{400} = 311,000,400$
37. Twelve billion, four hundred seventeen million, six hundred twenty-five thousand, three hundred ten  
The first group name is *billion*, so you need to fill *four groups* of three digits.  
 $\underline{012}, \underline{417}, \underline{625}, \underline{310} = 12,417,625,310$
38. Seventy-five billion, eight hundred sixty-nine million, four hundred eighty-eight thousand, five hundred six  
The first group name is *billion*, so you need to fill *four groups* of three digits.  
 $\underline{075}, \underline{869}, \underline{488}, \underline{506} = 75,869,488,506$
39. Six hundred trillion, seventy-one million, four hundred  
The first group name is *trillion*, so you need to fill *five groups* of three digits.  
 $\underline{600}, \underline{000}, \underline{071}, \underline{000}, \underline{400} = 600,000,071,000,400$
40. Four hundred forty trillion, thirty-six thousand, one hundred two  
The first group name is *trillion*, so you need to fill *five groups* of three digits.  
 $\underline{440}, \underline{000}, \underline{000}, \underline{036}, \underline{102} = 440,000,000,036,102$
41. 6041 in words: six thousand, forty-one
42. 9576 in words: nine thousand, five hundred seventy-six
43. Seven hundred sixty million, three hundred nine thousand  
The first group is *millions*, so fill *three groups* of three digits.  
 $\underline{760}, \underline{309}, \underline{000} = 760,309,000$
44. One hundred ten million, three hundred seven thousand, two hundred  
The first group is *millions*, so fill *three groups* of three digits.  
 $\underline{110}, \underline{307}, \underline{200} = 110,307,200$
45. 1,056,720,000 in words: one billion, fifty-six million, seven hundred twenty thousand
46. 13,500,000,000 in words: thirteen billion, five hundred million; 26 in words: twenty-six years old
47. 2000 in words: the year two thousand;  
One hundred forty-one million, seven hundred units: The first group is *millions*, so you need to fill *three groups* of three digits.  
 $\underline{141}, \underline{000}, \underline{700} = 141,000,700$
48. Two million, one hundred thousand is 2,100,000.
49. 6,400,000 in words: six million, four hundred thousand every day. 2,336,000,000 in words: two billion, three hundred thirty-six million in one year.
50. 60,000 in words: sixty thousand every hour.  
525,600,000 in words: five hundred twenty-five million, six hundred thousand per year.
51. Four billion, two hundred million is 4,200,000,000.
52. Two billion, nine hundred million is 2,900,000,000.

**Relating Concepts (Exercises 53–56)**

53. To make the largest possible whole number, arrange the digits from largest to smallest.

97651100  $\rightarrow$  97,651,100

In words: ninety-seven million, six hundred fifty-one thousand, one hundred.

To make the smallest possible whole number, arrange the numbers from smallest to largest with one exception: because we must use all the digits, start with the smallest nonzero digit.

10015679  $\rightarrow$  10,015,679

In words: ten million, fifteen thousand, six hundred seventy-nine.

54. Answers will vary.

55.

sixty-fours	thirty-twos	sixteens	eights	fours	twos	ones
<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>

- (a)  $5 = 4 + 1 =$  binary 101  
 (b)  $10 = 8 + 2 =$  binary 1010  
 (c)  $15 = 8 + 4 + 2 + 1 =$  binary 1111

56. (a) Answers will vary but should mention that the location or place in which a digit is written gives it a different value.

(b)  $8 = 5 + 3 =$  VIII  
 $38 = 30 + 5 + 3 =$  XXXVIII  
 $275 = 200 + 50 + 20 + 5 =$  CCLXXV  
 $3322 = 3000 + 300 + 20 + 2 =$  MMMCCCXXII

(c) The Roman system is *not* a place value system because no matter what place it's in, M = 1000, C = 100, etc. One disadvantage is that it takes much more space to write many large numbers; another is that there is no symbol for zero.

## 1.2 Introduction to Integers

### 1.2 Margin Exercises

- (a) "Below zero" implies a negative number.  
 $-5\frac{1}{2}$  degrees
- (b) "Lost 12 pounds" implies a negative number.  
 $-12$  pounds
- (c) "Deposit" implies a positive number.  
 $+\$210.35$  or  $\$210.35$
- (d) "Overdrawn" implies a negative number.  
 $-\$65$

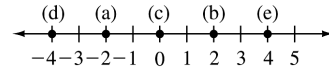
- (e) "Below the surface of the sea" implies a negative number.

$-100$  feet

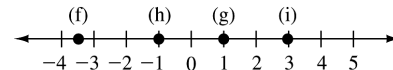
- (f) "Won 50 points" implies a positive number.

$+50$  points or 50 points

2. (a)  $-2$  (b) 2 (c) 0 (d)  $-4$  (e) 4



- (f)  $-3\frac{1}{2}$  (g) 1 (h)  $-1$  (i) 3



3. (a) 5 is to the right of 4 on the number line, so 5 is greater than 4. Write  $5 > 4$ .

(b) 0 is to the left of 2 on the number line, so 0 is less than 2. Write  $0 < 2$ .

(c)  $-3$  is to the left of  $-2$  on the number line, so  $-3$  is less than  $-2$ . Write  $-3 < -2$ .

(d)  $-1$  is to the right of  $-4$  on the number line, so  $-1$  is greater than  $-4$ . Write  $-1 > -4$ .

(e) 2 is to the right of  $-2$  on the number line, so 2 is greater than  $-2$ . Write  $2 > -2$ .

(f)  $-5$  is to the left of 1 on the number line, so  $-5$  is less than 1. Write  $-5 < 1$ .

4. (a)  $|13| = 13$  because the distance from 0 to 13 on the number line is 13 spaces.

(b)  $|-7| = 7$  because the distance from 0 to  $-7$  on the number line is 7 spaces.

(c)  $|0| = 0$  because the distance from 0 to 0 on the number line is 0 spaces.

(d)  $|-350| = 350$  because the distance from 0 to  $-350$  on the number line is 350 spaces.

(e)  $|6000| = 6000$  because the distance from 0 to 6000 on the number line is 6000 spaces.

### 1.2 Section Exercises

- "Above sea level" implies a positive number.  
 $+29,035$  feet or 29,035 feet
- "Below the surface" implies a negative number.  
 $-5314$  feet
- "Below zero" implies a negative number.  
 $-128.6$  degrees
- $+98.6$  degrees or 98.6 degrees

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5. "Lost a total of 18 yards" implies a negative number.

-18 yards

6. "Gained 25 yards" implies a positive number.

+25 yards or 25 yards

7. "Won \$100" implies a positive number.

+\$100 or \$100

8. Overdrawn bank account implies a negative number.

-\$37

9. "Lost  $6\frac{1}{2}$  pounds" implies a negative number.

$-6\frac{1}{2}$  pounds

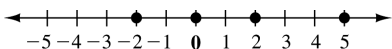
10. "Gained  $2\frac{1}{2}$  ounces" implies a positive number.

$+2\frac{1}{2}$  ounces or  $2\frac{1}{2}$  ounces

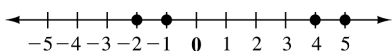
11. Graph -3, 3, 0, -5



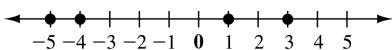
12. Graph -2, 2, 0, 5



13. Graph -1, 4, -2, 5



14. Graph 3, -4, 1, -5



15. (a)  $0 < 5$  in words: zero is less than five, or, zero is less than positive five

(b)  $-10 > -17$  in words: negative ten is greater than negative seventeen

16. (a)  $3 > -7$  in words: three is greater than negative seven, or, positive three is greater than negative seven

(b)  $12 < 22$  in words: twelve is less than twenty-two, or, positive twelve is less than positive twenty-two

17. 10 is to the *right* of 2 on the number line, so 10 is *greater than* 2. Write  $10 > 2$ .

18. 6 is to the *right* of 0 on the number line, so 6 is *greater than* 0. Write  $6 > 0$ .

19. -1 is to the *left* of 0 on the number line, so -1 is *less than* 0. Write  $-1 < 0$ .

20. -3 is to the *left* of -1 on the number line, so -3 is *less than* -1. Write  $-3 < -1$ .

21. -10 is to the *left* of 2 on the number line, so -10 is *less than* 2. Write  $-10 < 2$ .

22. -9 is to the *left* of 7 on the number line, so -9 is *less than* 7. Write  $-9 < 7$ .

23. -3 is to the *right* of -6 on the number line, so -3 is *greater than* -6. Write  $-3 > -6$ .

24. 0 is to the *right* of -1 on the number line, so 0 is *greater than* -1. Write  $0 > -1$ .

25. -10 is to the *left* of -2 on the number line, so -10 is *less than* -2. Write  $-10 < -2$ .

26. -1 is to the *right* of -5 on the number line, so -1 is *greater than* -5. Write  $-1 > -5$ .

27. 0 is to the *right* of -8 on the number line, so 0 is *greater than* -8. Write  $0 > -8$ .

28. 6 is to the *right* of -4 on the number line, so 6 is *greater than* -4. Write  $6 > -4$ .

29. 10 is to the *right* of -2 on the number line, so 10 is *greater than* -2. Write  $10 > -2$ .

30. -2 is to the *left* of 1 on the number line, so -2 is *less than* 1. Write  $-2 < 1$ .

31. -4 is to the *left* of 4 on the number line, so -4 is *less than* 4. Write  $-4 < 4$ .

32. 9 is to the *right* of -9 on the number line, so 9 is *greater than* -9. Write  $9 > -9$ .

33.  $|15| = 15$  because the distance from 0 to 15 on the number line is 15 spaces.

34.  $|10| = 10$  because the distance from 0 to 10 on the number line is 10 spaces.

35.  $|-3| = 3$  because the distance between 0 and -3 on the number line is 3 spaces.

36.  $|-8| = 8$  because the distance from 0 to -8 on the number line is 8 spaces.

37.  $|0| = 0$  because the distance from 0 to 0 on the number line is 0 spaces.

38.  $|100| = 100$  because the distance from 0 to 100 on the number line is 100 spaces.

39.  $|200| = 200$  because the distance between 0 and 200 on the number line is 200 spaces.

40.  $|-99| = 99$  because the distance from 0 to -99 on the number line is 99 spaces.

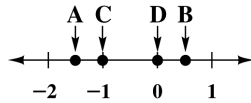
41.  $|-75| = 75$  because the distance between 0 and -75 on the number line is 75 spaces.

42.  $|-6320| = 6320$  because the distance from 0 to -6320 on the number line is 6320 spaces.

43.  $|-8042| = 8042$  because the distance between 0 and  $-8042$  on the number line is 8042 spaces.
44.  $|0| = 0$  because the distance from 0 to 0 on the number line is 0 spaces.

### Relating Concepts (Exercises 45–48)

45. Graph  $-1.5$  as A,  $0.5$  as B,  $-1$  as C, and  $0$  as D.



46. From Exercise 45, in order from lowest to highest:  $-1.5$ ,  $-1$ ,  $0$ ,  $0.5$
47. A:  $-1.5$  is in the Below  $-1$  range. This patient may be at risk.  
B:  $0.5$  is in the Above  $0$  range. This patient is above normal.  
C:  $-1$  is in the  $0$  to  $-1$  range. This patient is normal.  
D:  $0$  is in the  $0$  to  $-1$  range. This patient is normal.
48. (a) A patient who did not understand the importance of the negative sign would think the interpretation of  $-1.5$  was "above normal" (range Above  $0$ ) and wouldn't get treatment.  
(b) For Patient D's score of  $0$ , the sign plays no role. Zero is neither positive nor negative.

## 1.3 Adding Integers

### 1.3 Margin Exercises

1. (a)  $-2 + (-2) = -4$   
(b)  $2 + 2 = 4$   
(c)  $-10 + (-1) = -11$   
(d)  $10 + 1 = 11$   
(e)  $-3 + (-7) = -10$   
(f)  $3 + 7 = 10$
2. (a)  $-6 + (-6)$  Adding *like* signed integers  
**Step 1**  $|-6| = 6$ ;  $|-6| = 6$ ; Add  $6 + 6 = 12$   
**Step 2** Both numbers are negative, so the sum is negative.  
$$-6 + (-6) = -12$$
  
(b)  $9 + 7$  Adding *like* signed integers  
**Step 1**  $|9| = 9$ ;  $|7| = 7$ ; Add  $9 + 7 = 16$   
**Step 2** Both numbers are positive, so the sum is positive.

$$9 + 7 = 16$$

- (c)  $-5 + (-10)$  Adding *like* signed integers  
**Step 1**  $|-5| = 5$ ;  $|-10| = 10$ ; Add  $5 + 10 = 15$   
**Step 2** Both numbers are negative, so the sum is negative.

$$-5 + (-10) = -15$$

- (d)  $-12 + (-4)$  Adding *like* signed integers  
**Step 1**  $|-12| = 12$ ;  $|-4| = 4$ ; Add  $12 + 4 = 16$   
**Step 2** Both numbers are negative, so the sum is negative.

$$-12 + (-4) = -16$$

- (e)  $13 + 2$  Adding *like* signed integers  
**Step 1**  $|13| = 13$ ;  $|2| = 2$ ; Add  $13 + 2 = 15$   
**Step 2** Both numbers are positive, so the sum is positive.

$$13 + 2 = 15$$

3. (a)  $-3 + 7$  Adding *unlike* signed integers  
**Step 1**  $|-3| = 3$ ;  $|7| = 7$ ; Subtract  $7 - 3 = 4$   
**Step 2** 7 has the larger absolute value and is positive, so the sum is positive.

$$-3 + 7 = +4 \text{ or } 4$$

- (b)  $6 + (-12)$  Adding *unlike* signed integers  
**Step 1**  $|6| = 6$ ;  $|-12| = 12$ ; Subtract  
 $12 - 6 = 6$

- Step 2**  $-12$  has the larger absolute value and is negative, so the sum is negative.

$$6 + (-12) = -6$$

- (c)  $12 + (-7)$  Adding *unlike* signed integers  
**Step 1**  $|12| = 12$ ;  $|-7| = 7$ ; Subtract  
 $12 - 7 = 5$

- Step 2** 12 has the larger absolute value and is positive, so the sum is positive.

$$12 + (-7) = +5 \text{ or } 5$$

- (d)  $-10 + 2$  Adding *unlike* signed integers  
**Step 1**  $|-10| = 10$ ;  $|2| = 2$ ; Subtract  
 $10 - 2 = 8$

- Step 2**  $-10$  has the larger absolute value and is negative, so the sum is negative.

$$-10 + 2 = -8$$

- (e)  $5 + (-9)$  Adding *unlike* signed integers  
**Step 1**  $|5| = 5$ ;  $|-9| = 9$ ; Subtract  $9 - 5 = 4$   
**Step 2**  $-9$  has the larger absolute value and is negative, so the sum is negative.

$$5 + (-9) = -4$$

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4. (a) Starting temperature in the morning is  $-15$  degrees. A rise of 21 degrees implies a positive number. A drop of 10 degrees implies a negative number.

$$\begin{aligned} -15 + 21 + (-10) \\ = 6 + (-10) \quad \text{Add left to right.} \\ = -4 \end{aligned}$$

The new temperature is 4 degrees below zero or  $-4$  degrees.

- (b) The beginning balance is \$60. Deposits imply positive numbers and payments imply negative numbers.

$$\begin{aligned} 60 + 85 + (-20) + (-75) \\ = 145 + (-20) + (-75) \quad \text{Add left to right.} \\ = 125 + (-75) \\ = 50 \end{aligned}$$

His account balance is \$50.

5. (a)  $175 + 25 = 25 + 175$

Both sums are 200.

- (b)  $7 + (-37) = -37 + 7$

Both sums are -30.

- (c)  $-16 + 16 = 16 + (-16)$

Both sums are 0.

- (d)  $-9 + (-41) = -41 + (-9)$

Both sums are -50.

6. (a)  $-12 + 12 + (-19) = (-12 + 12) + (-19)$   
 $= 0 + (-19)$   
 $= -19$

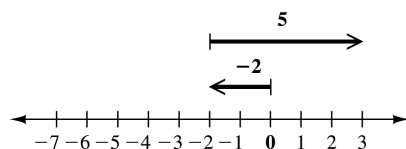
- (b)  $31 + (-75) + 75 = 31 + (-75 + 75)$   
 $= 31 + 0$   
 $= 31$

- (c)  $1 + 9 + (-16) = (1 + 9) + (-16)$   
 $= 10 + (-16)$   
 $= -6$

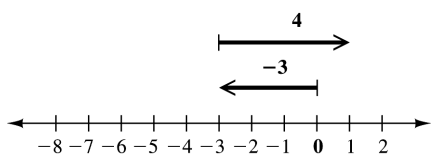
- (d)  $-38 + 5 + 25 = -38 + (5 + 25)$   
 $= -38 + 30$   
 $= -8$

### 1.3 Section Exercises

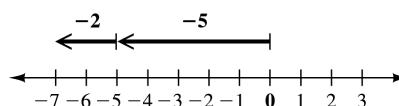
1.  $-2 + 5 = +3$  or 3



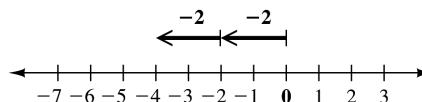
2.  $-3 + 4 = +1$  or 1



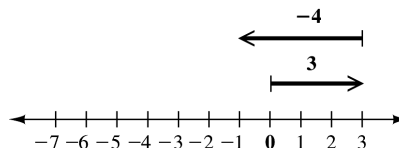
3.  $-5 + (-2) = -7$



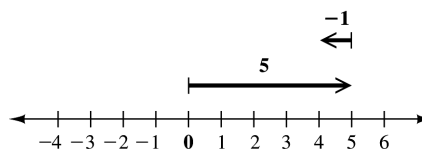
4.  $-2 + (-2) = -4$



5.  $3 + (-4) = -1$



6.  $5 + (-1) = +4$  or 4



7. (a)  $-5 + (-5)$  ■ Adding *like* signed integers

**Step 1** Add the absolute values.

$$|-5| = 5$$

Add  $5 + 5$  to get 10.

**Step 2** Both integers are negative, so the sum is negative.

$$-5 + (-5) = -10$$

- (b)  $5 + 5 = 10$  Adding *like* signed integers

Both addends are positive, so the sum is positive.

8. (a)  $-9 + (-9) = -18$  (Both addends are negative, so the sum is negative.)

(b)  $9 + 9 = 18$

9. (a)  $7 + 5$  ■ Adding *like* signed integers

Both addends are positive, so the sum is positive.

- (b)  $-7 + (-5) = -12$  Adding *like* signed integers

**Step 1** Add the absolute values.

$$|-7| = 7; |-5| = 5$$

Add  $7 + 5$  to get 12.

**Step 2** Both integers are negative, so the sum is negative.

$$-7 + (-5) = -12$$

10. (a)  $3 + 6 = 9$

- (b)  $-3 + (-6) = -9$  (Both addends are negative, so the sum is negative.)

11. (a)  $-25 + (-25)$  ■ Adding *like* signed integers

**Step 1** Add the absolute values.

$$|-25| = 25$$

Add  $25 + 25$  to get 50.

**Step 2** Both integers are negative, so the sum is negative.

$$-25 + (-25) = -50$$

(b)  $25 + 25 = 50$  Adding *like* signed integers  
Both addends are positive, so the sum is positive.

12. (a)  $-30 + (-30) = -60$  (Both addends are negative, so the sum is negative.)

(b)  $30 + 30 = 60$

13. (a)  $48 + 110$  ■ Adding *like* signed integers  
Both addends are positive, so the sum is positive.

(b)  $-48 + (-110) = -158$  Adding *like* signed integers

**Step 1** Add the absolute values.

$$|-48| = 48; |-110| = 110$$

Add  $48 + 110$  to get 158.

**Step 2** Both numbers are negative, so the sum is negative.

$$-48 + (-110) = -158$$

14. (a)  $235 + 21 = 256$

(b)  $-235 + (-21) = -256$  (Both addends are negative, so the sum is negative.)

15. The absolute values are the same in each pair of answers, so the only difference in the sums is the common sign.

16. Add the absolute values and use the common sign as the sign of the sum.

17. (a)  $-6 + 8$  Adding *unlike* signed integers

**Step 1**  $|-6| = 6; |8| = 8$

Subtract  $8 - 6$  to get 2.

**Step 2** 8 has the larger absolute value and is positive, so the sum is positive.

$$-6 + 8 = +2 \text{ or } 2$$

(b)  $6 + (-8)$  Adding *unlike* signed integers

**Step 1**  $|6| = 6; |-8| = 8$

Subtract  $8 - 6$  to get 2.

**Step 2**  $-8$  has the larger absolute value and is negative, so the sum is negative.

$$6 + (-8) = -2$$

18. (a)  $-3 + 7$  Adding *unlike* signed integers

**Step 1**  $|-3| = 3; |7| = 7$

Subtract  $7 - 3$  to get 4.

**Step 2** 7 has the larger absolute value and is positive, so the sum is positive.

$$-3 + 7 = +4 \text{ or } 4$$

(b)  $3 + (-7)$  Adding *unlike* signed integers

**Step 1**  $|3| = 3; |-7| = 7$

Subtract  $7 - 3$  to get 4.

**Step 2**  $-7$  has the larger absolute value and is negative, so the sum is negative.

$$3 + (-7) = -4$$

19. (a)  $-9 + 2$  Adding *unlike* signed integers

**Step 1**  $|-9| = 9; |2| = 2$

Subtract  $9 - 2$  to get 7.

**Step 2**  $-9$  has the larger absolute value and is negative, so the sum is negative.

$$-9 + 2 = -7$$

(b)  $9 + (-2)$  Adding *unlike* signed integers

**Step 1**  $|9| = 9; |-2| = 2$

Subtract  $9 - 2$  to get 7.

**Step 2** 9 has the larger absolute value and is positive, so the sum is positive.

$$9 + (-2) = +7 \text{ or } 7$$

20. (a)  $-8 + 7$  Adding *unlike* signed integers

**Step 1**  $|-8| = 8; |7| = 7$

Subtract  $8 - 7$  to get 1.

**Step 2**  $-8$  has the larger absolute value and is negative, so the sum is negative.

$$-8 + 7 = -1$$

(b)  $8 + (-7)$  Adding *unlike* signed integers

**Step 1**  $|8| = 8; |-7| = 7$

Subtract  $8 - 7$  to get 1.

**Step 2** 8 has the larger absolute value and is positive, so the sum is positive.

$$8 + (-7) = +1 \text{ or } 1$$

21. (a)  $20 + (-25)$  Adding *unlike* signed integers

**Step 1**  $|20| = 20; |-25| = 25$

Subtract  $25 - 20$  to get 5.

**Step 2**  $-25$  has the larger absolute value and is negative, so the sum is negative.

$$20 + (-25) = -5$$

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(b)  $-20 + 25$  Adding *unlike* signed integers

**Step 1**  $|-20| = 20$ ;  $|25| = 25$

Subtract  $25 - 20$  to get 5.

**Step 2** 25 has the larger absolute value and is positive, so the sum is positive.

$$-20 + 25 = +5 \text{ or } 5$$

22. (a)  $30 + (-40)$  Adding *unlike* signed integers

**Step 1**  $|30| = 30$ ;  $|-40| = 40$

Subtract  $40 - 30$  to get 10.

**Step 2**  $-40$  has the larger absolute value and is negative, so the sum is negative.

$$30 + (-40) = -10$$

(b)  $-30 + 40$  Adding *unlike* signed integers

**Step 1**  $|-30| = 30$ ;  $|40| = 40$

Subtract  $40 - 30$  to get 10.

**Step 2** 40 has the larger absolute value and is positive, so the sum is positive.

$$-30 + 40 = +10 \text{ or } 10$$

23. (a)  $200 + (-50)$  Adding *unlike* signed integers

**Step 1**  $|200| = 200$ ;  $|-50| = 50$

Subtract  $200 - 50$  to get 150.

**Step 2** 200 has the larger absolute value and is positive, so the sum is positive.

$$200 + (-50) = +150 \text{ or } 150$$

(b)  $-200 + 50$  Adding *unlike* signed integers

**Step 1**  $|-200| = 200$ ;  $|50| = 50$

Subtract  $200 - 50$  to get 150.

**Step 2**  $-200$  has the larger absolute value and is negative, so the sum is negative.

$$-200 + 50 = -150$$

24. (a)  $150 + (-100)$  Adding *unlike* signed integers

**Step 1**  $|150| = 150$ ;  $|-100| = 100$

Subtract  $150 - 100$  to get 50.

**Step 2** 150 has the larger absolute value and is positive, so the sum is positive.

$$150 + (-100) = +50 \text{ or } 50$$

(b)  $-150 + 100$  Adding *unlike* signed integers

**Step 1**  $|-150| = 150$ ;  $|100| = 100$

Subtract  $150 - 100$  to get 50.

**Step 2**  $-150$  has the larger absolute value and is negative, so the sum is negative.

$$-150 + 100 = -50$$

25. Each pair of answers differs only in the sign of the answer. This occurs because the signs of the addends are reversed.

26. Subtract the lesser absolute value from the greater absolute value. Use the sign of the number with the greater absolute value as the sign of the sum.

27.  $-8 + 5$  Adding *unlike* signed integers

**Step 1**  $|-8| = 8$ ;  $|5| = 5$

Subtract  $8 - 5$  to get 3.

**Step 2**  $-8$  has the larger absolute value and is negative, so the sum is negative.

$$-8 + 5 = -3$$

28.  $-3 + 2 = -1$

29.  $-1 + 8$  Adding *unlike* signed integers

**Step 1**  $|-1| = 1$ ;  $|8| = 8$

Subtract  $8 - 1$  to get 7.

**Step 2** 8 has the larger absolute value and is positive, so the sum is positive.

$$-1 + 8 = +7 \text{ or } 7$$

30.  $-4 + 10 = +6$  or 6

31.  $-2 + (-5)$  Adding *like* signed integers

**Step 1**  $|-2| = 2$ ;  $|-5| = 5$

Add  $2 + 5$  to get 7.

**Step 2** Both integers are negative, so the sum is negative.

$$-2 + (-5) = -7$$

32.  $-7 + (-3) = -10$

33.  $6 + (-5)$  Adding *unlike* signed integers

**Step 1**  $|6| = 6$ ;  $|-5| = 5$

Subtract  $6 - 5$  to get 1.

**Step 2** 6 has the larger absolute value and is positive, so the sum is positive.

$$6 + (-5) = +1 \text{ or } 1$$

34.  $11 + (-3) = +8$  or 8

35.  $4 + (-12)$  Adding *unlike* signed integers

**Step 1**  $|4| = 4$ ;  $|-12| = 12$

Subtract  $12 - 4$  to get 8.

**Step 2**  $-12$  has the larger absolute value and is negative, so the sum is negative.

$$4 + (-12) = -8$$

36.  $9 + (-10) = -1$



37.  $-10 + (-10)$  Adding *like* signed integers

**Step 1**  $|-10| = 10$ ;  $|-10| = 10$

Add  $10 + 10$  to get 20.

**Step 2** Both integers are negative, so the sum is negative.

$$-10 + (-10) = -20$$

38.  $-5 + (-20) = -25$

39.  $-17 + 0 = -17$

Adding zero to any number leaves the number unchanged.

40.  $0 + (-11) = -11$

41.  $1 + (-23)$  Adding *unlike* signed integers

**Step 1**  $|1| = 1$ ;  $|-23| = 23$

Subtract  $23 - 1$  to get 22.

**Step 2**  $-23$  has the larger absolute value and is negative, so the sum is negative.

$$1 + (-23) = -22$$

42.  $13 + (-1) = +12$  or 12

43.  $\underbrace{-2 + (-12)}_{= -14 + (-5)} + (-5)$  Add left to right.  
 $= \underline{-19}$

44.  $\underbrace{-16 + (-1)}_{= -17 + (-3)} + (-3)$  Add left to right.  
 $= \underline{-20}$

45.  $8 + 6 + (-8)$   
 $= 8 + (-8) + 6$  Commute addends.  
 $= 0 + 6$  Add left to right.  
 $= 6$

46.  $-5 + 2 + 5$   
 $= -5 + 5 + 2$  Commute addends.  
 $= 0 + 2$  Add left to right.  
 $= 2$

47.  $-7 + 6 + (-4)$   
 $= -1 + (-4)$  Add left to right.  
 $= -5$

48.  $-9 + 8 + (-2)$   
 $= -1 + (-2)$  Add left to right.  
 $= -3$

49.  $-3 + (-11) + 14$   
 $= -14 + 14$  Add left to right.  
 $= 0$

50.  $15 + (-7) + (-8)$   
 $= 8 + (-8)$  Add left to right.  
 $= 0$

51.  $10 + (-6) + (-3) + 4$   
 $= 4 + (-3) + 4$  Add left to right.  
 $= 1 + 4$   
 $= 5$

52.  $2 + (-1) + (-9) + 12$   
 $= 1 + (-9) + 12$  Add left to right.  
 $= -8 + 12$   
 $= 4$

53.  $-7 + 28 + (-56) + 3$   
 $= 21 + (-56) + 3$  Add left to right.  
 $= -35 + 3$   
 $= -32$

54.  $4 + (-37) + 29 + (-5)$   
 $= -33 + 29 + (-5)$  Add left to right.  
 $= -4 + (-5)$   
 $= -9$

55. "Yards gained" are positive (+13), and "yards lost" are negative (-17).

$$13 + (-17) = -4 \text{ yards}$$

The team lost 4 yards.

56. Temperature on Antarctic islands:  $-15^{\circ}\text{C}$ .

Temperature may "drop" another  $60^{\circ}\text{C}$  implies a negative change in temperature,  $-60^{\circ}\text{C}$ .

$$-15 + (-60) = -75^{\circ}\text{C}$$

The interior temperature is  $-75^{\circ}\text{C}$ .

57. The overdrawn amount is negative ( $-\$62$ ), and the deposit amount is positive ( $+\$50$ ).

$$-\$62 + \$50 = \underline{-\$12}$$

Nick is \$12 overdrawn.

58. Account Balance:  $+\$100$

Check written:  $-\$73$

Overdrawn charge:  $-\$27$

$$\$100 + (-\$73) + (-\$27) = \$27 + (-\$27) = \$0$$

Her account balance is \$0.

59. \$88 stolen implies a loss of money or  $-\$88$ .

Jay received \$35 back implies a gain of money or  $+\$35$ .

$$-\$88 + \$35 = -\$53$$

Jay's net loss was \$53.

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60. Losing weight implies a negative and gaining weight implies a positive.

$$-4 + 2 + 3 = 1$$

Overall, Marion gained 1 pound.

61. Jeff:  $-20 + 75 + (-55)$   
 $= 55 + (-55)$  *Add left to right.*  
 $= 0$  points

Terry:  $42 + (-15) + 20$   
 $= 27 + 20$  *Add left to right.*  
 $= 47$  points

62. Red River:  $8 + (-3) + (-5)$   
 $= 5 + (-5)$  *Add left to right.*  
 $= 0$  feet

Mississippi:  $4 + 7 + (-13)$   
 $= 11 + (-13)$  *Add left to right.*  
 $= -2$  feet

63.  $-2 + 0 + 5 + (-5)$   
 $= -2 + 5 + (-5)$  *Add left to right.*  
 $= 3 + (-5)$   
 $= -2$

Angela lost 2 pounds.

64.  $-1 + 2 + (-6) + 0$   
 $= 1 + (-6) + 0$  *Add left to right.*  
 $= -5 + 0$   
 $= -5$

Syshe lost 5 pounds.

65.  $3 + (-2) + (-2) + 3$   
 $= 1 + (-2) + 3$  *Add left to right.*  
 $= -1 + 3$   
 $= 2$

Brittany gained 2 pounds.

66.  $1 + 1 + (-4) + 2$   
 $= 2 + (-4) + 2$  *Add left to right.*  
 $= -2 + 2$   
 $= 0$

Nicole's weight was the same.

67.  $\underbrace{-18 + (-5)}_{-23} = \underbrace{-5 + (-18)}_{-23}$  *Commutative property*

Both sums are  $-23$ .

68.  $\underbrace{-12 + 20}_{+8} = \underbrace{20 + (-12)}_{+8}$  *Commutative property*

Both sums are  $+8$  or  $8$ .

69.  $\underbrace{-4 + 15}_{+11} = \underbrace{15 + (-4)}_{+11}$  *Commutative property*

Both sums are  $+11$  or  $11$ .

70.  $\underbrace{17 + 1}_{+18} = \underbrace{1 + 17}_{+18}$  *Commutative property*

Both sums are  $+18$  or  $18$ .

71.  $6 + (-14) + 14$

Option 1:  $(6 + (-14)) + 14 = -8 + 14$   
 $= 6$

Option 2:  $6 + (-14 + 14) = 6 + 0$   
 $= 6$

Option 2 is easier.

72.  $-9 + 9 + (-8) = (-9 + 9) + (-8)$   
 $= 0 + (-8)$   
 $= -8$

73.  $14 + 6 + (-7)$

Option 1:  $(14 + 6) + (-7) = 20 + (-7)$   
 $= 13$

Option 2:  $14 + (6 + (-7)) = 14 + (-1)$   
 $= 13$

Option 1 might seem easier.

74.  $-18 + 3 + 7 = -18 + (3 + 7)$   
 $= -18 + 10$   
 $= -8$

75. Answers will vary. Some possibilities are:  
 $-6 + 0 = -6$ ;  $10 + 0 = 10$ ;  $0 + 3 = 3$

76. Answers will vary. Some possibilities are:  
 $(1 + 2) + 3 = 1 + (2 + 3)$  Both sums are  $6$ .  
 $(-5 + 0) + 4 = -5 + (0 + 4)$  Both sums are  $-1$ .  
 $(-15 + 6) + 9 = -15 + (6 + 9)$  Both sums are  $0$ .

77. Be sure to use the *negative* key as opposed to the *subtraction* key.

$$-7081 + 2965 = -4116$$

78.  $-1398 + 3802 = 2404$

79.  $-179 + (-61) + 8926 = 8686$

80.  $36 + (-6215) + 428 = -5751$

81.  $86 + (-99,000) + 0 + 2837 = -96,077$

82.  $-16,719 + 0 + 8878 + (-14) = -7855$

## 1.4 Subtracting Integers

### 1.4 Margin Exercises

- (a) The opposite of  $5$  is  $-5$ .  $5 + (-5) = 0$

(b) The opposite of  $48$  is  $-48$ .  $48 + (-48) = 0$

(c) The opposite of  $0$  is  $0$ .  $0 + 0 = 0$

(d) The opposite of  $-1$  is  $1$ .  $-1 + 1 = 0$

(e) The opposite of  $-24$  is  $24$ .  $-24 + 24 = 0$

2. (a)  $-6 - 5$

$$= -6 + (-5) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change 5 to } -5. \end{array}$$

$$= \underline{-11}$$

(b)  $3 - (-10)$

$$= 3 + (+10) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change } -10 \text{ to } +10. \end{array}$$

$$= \underline{13}$$

(c)  $-8 - (-2)$

$$= -8 + (+2) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change } -2 \text{ to } +2. \end{array}$$

$$= -6$$

(d)  $0 - 10$

$$= 0 + (-10) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change } 10 \text{ to } -10. \end{array}$$

$$= -10$$

(e)  $-4 - (-12)$

$$= -4 + (+12) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change } -12 \text{ to } +12. \end{array}$$

$$= 8$$

(f)  $9 - 7$

$$= 9 + (-7) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change } 7 \text{ to } -7. \end{array}$$

$$= 2$$

3. (a)  $6 - 7 + (-3)$

$$= \underbrace{6 + (-7)}_{-1} + (-3) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change } 7 \text{ to } -7. \\ \text{Add left to right.} \end{array}$$

$$= \underline{-4}$$

(b)  $-2 + (-3) - (-5)$

$$= -2 + (-3) + (+5) \quad \begin{array}{l} \text{Change subtr.} \\ \text{to addition.} \\ \text{Change } -5 \text{ to } +5. \end{array}$$

$$= -5 + 5$$

$$= 0$$

(c)  $7 - 7 - 7$

$$= 7 + (-7) + (-7) \quad \begin{array}{l} \text{Change all subtr.} \\ \text{to additions.} \\ \text{Change } 7 \text{ to } -7. \end{array}$$

$$= 0 + (-7)$$

$$= -7$$

(d)  $-3 - 9 + 4 - (-20)$

$$= -3 + (-9) + 4 + (+20)$$

$$= -12 + 4 + (+20)$$

$$= -8 + (+20)$$

$$= 12$$

## 1.4 Section Exercises

1. The opposite of 6 is  $-6$ .  $6 + (-6) = 0$

2. The opposite of  $-3$  is 3.  $-3 + 3 = 0$

3. The opposite of  $-13$  is 13.  $-13 + 13 = 0$

4. The opposite of 0 is 0.  $0 + 0 = 0$

5. The student forgot to change 6 to its opposite,  $-6$ .

Correct Method:

$$-6 - 6$$

$$= -6 + (-6) \quad \begin{array}{l} \text{Change subtraction to} \\ \text{addition. Change } 6 \text{ to } -6. \end{array}$$

$$= -12 \quad \text{Add.}$$

6. The student changed the sign of the first number, which is the error.

It should be  $-7 + (-5) = -12$ .

7.  $19 - 5$

$$= 19 + (-5) \quad \begin{array}{l} \text{Change subtraction to} \\ \text{addition. Change } 5 \text{ to } -5. \end{array}$$

$$= \underline{14}$$

8.  $24 - 11$

$$= 24 + (-11) \quad \begin{array}{l} \text{Change subtraction to} \\ \text{addition. Change } 11 \text{ to } -11. \end{array}$$

$$= \underline{13}$$

9.  $10 - 12$

$$= 10 + (-12) \quad \begin{array}{l} \text{Change subtraction to} \\ \text{addition. Change } 12 \text{ to } -12. \end{array}$$

$$= -2$$

10.  $1 - 8$

$$= 1 + (-8) \quad \begin{array}{l} \text{Change subtraction to} \\ \text{addition. Change } 8 \text{ to } -8. \end{array}$$

$$= -7$$

11.  $7 - 19$

$$= 7 + (-19) \quad \begin{array}{l} \text{Change subtraction to} \\ \text{addition. Change } 19 \text{ to } -19. \end{array}$$

$$= -12$$

12.  $2 - 17$

$$= 2 + (-17) \quad \begin{array}{l} \text{Change subtraction to} \\ \text{addition. Change } 17 \text{ to } -17. \end{array}$$

$$= -15$$

13.  $-15 - 10$

$$= -15 + (-10) \quad \begin{array}{l} \text{Change subtraction} \\ \text{to addition.} \\ \text{Change } 10 \text{ to } -10. \end{array}$$

$$= -25$$

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14.  $-10 - 4$   
 $= -10 + (-4)$  *Change subtraction to addition. Change 4 to  $-4$ .*  
 $= -14$
15.  $-9 - 14$   
 $= -9 + (-14)$  *Change subtraction to addition. Change 14 to  $-14$ .*  
 $= -23$
16.  $-3 - 11$   
 $= -3 + (-11)$  *Change subtraction to addition. Change 11 to  $-11$ .*  
 $= -14$
17.  $-3 - (-8)$  *Change subtraction to addition. Change  $-8$  to  $+8$ .*  
 $= -3 + (+8)$   
 $= \underline{5}$
18.  $-1 - (-4)$  *Change subtraction to addition. Change  $-4$  to  $+4$ .*  
 $= -1 + (+4)$   
 $= \underline{3}$
19.  $6 - (-14)$  *Change subtraction to addition. Change  $-14$  to  $+14$ .*  
 $= 6 + (+14)$   
 $= 20$
20.  $8 - (-1)$  *Change subtraction to addition. Change  $-1$  to  $+1$ .*  
 $= 8 + (+1)$   
 $= 9$
21.  $1 - (-10)$  *Change subtraction to addition. Change  $-10$  to  $+10$ .*  
 $= 1 + (+10)$   
 $= 11$
22.  $6 - (-1)$  *Change subtraction to addition. Change  $-1$  to  $+1$ .*  
 $= 6 + (+1)$   
 $= 7$
23.  $-30 - 30$  *Change subtraction to addition. Change 30 to  $-30$ .*  
 $= -30 + (-30)$   
 $= -60$
24.  $-25 - 25$  *Change subtraction to addition. Change 25 to  $-25$ .*  
 $= -25 + (-25)$   
 $= -50$
25.  $-16 - (-16)$  *Change subtraction to addition. Change  $-16$  to  $+16$ .*  
 $= -16 + (+16)$   
 $= 0$
26.  $-20 - (-20)$  *Change subtraction to addition. Change  $-20$  to  $+20$ .*  
 $= -20 + (+20)$   
 $= 0$
27.  $13 - 13$  *Change subtraction to addition. Change 13 to  $-13$ .*  
 $= 13 + (-13)$   
 $= 0$
28.  $19 - 19$  *Change subtraction to addition. Change 19 to  $-19$ .*  
 $= 19 + (-19)$   
 $= 0$
29.  $0 - 6$  *Change subtraction to addition. Change 6 to  $-6$ .*  
 $= 0 + (-6)$   
 $= -6$
30.  $0 - 12$  *Change subtraction to addition. Change 12 to  $-12$ .*  
 $= 0 + (-12)$   
 $= -12$
31. (a)  $3 - (-5)$  *Change subtraction to addition. Change  $-5$  to  $+5$ .*  
 $= 3 + (+5)$   
 $= 8$
- (b)  $3 - 5$  *Change subtraction to addition. Change 5 to  $-5$ .*  
 $= 3 + (-5)$   
 $= -2$
- (c)  $-3 - (-5)$  *Change subtraction to addition. Change  $-5$  to  $+5$ .*  
 $= -3 + (+5)$   
 $= 2$
- (d)  $-3 - 5$  *Change subtraction to addition. Change 5 to  $-5$ .*  
 $= -3 + (-5)$   
 $= -8$

- 32. (a)**  $9 - 6$   
 $= 9 + (-6)$  *Change subtraction to addition. Change 6 to  $-6$ .*  
 $= 3$
- (b)**  $-9 - 6$   
 $= -9 + (-6)$  *Change subtraction to addition. Change 6 to  $-6$ .*  
 $= -15$
- (c)**  $9 - (-6)$   
 $= 9 + (+6)$  *Change subtraction to addition. Change  $-6$  to  $+6$ .*  
 $= 15$
- (d)**  $-9 - (-6)$   
 $= -9 + (+6)$  *Change subtraction to addition. Change  $-6$  to  $+6$ .*  
 $= -3$
- 33. (a)**  $4 - 7$   
 $= 4 + (-7)$  *Change subtraction to addition. Change 7 to  $-7$ .*  
 $= -3$
- (b)**  $4 - (-7)$   
 $= 4 + (+7)$  *Change subtraction to addition. Change  $-7$  to  $+7$ .*  
 $= 11$
- (c)**  $-4 - 7$   
 $= -4 + (-7)$  *Change subtraction to addition. Change 7 to  $-7$ .*  
 $= -11$
- (d)**  $-4 - (-7)$   
 $= -4 + (+7)$  *Change subtraction to addition. Change  $-7$  to  $+7$ .*  
 $= 3$
- 34. (a)**  $8 - (-2)$   
 $= 8 + (+2)$  *Change subtraction to addition. Change  $-2$  to  $+2$ .*  
 $= 10$
- (b)**  $-8 - (-2)$   
 $= -8 + (+2)$  *Change subtraction to addition. Change  $-2$  to  $+2$ .*  
 $= -6$
- (c)**  $8 - 2$   
 $= 8 + (-2)$  *Change subtraction to addition. Change 2 to  $-2$ .*  
 $= 6$
- (d)**  $-8 - 2$   
 $= -8 + (-2)$  *Change subtraction to addition. Change 2 to  $-2$ .*  
 $= -10$
- 35.**  $-2 - 2 - 2$   
 $= \underbrace{-2 + (-2)} + (-2)$  *Change all subtractions to additions. Change 2 to  $-2$  and 2 to  $-2$ .*  
 $= -4 + (-2)$  *Add left to right.*  
 $= -6$
- 36.**  $-8 - 4 - 8$   
 $= \underbrace{-8 + (-4)} + (-8)$  *Change all subtractions to additions. Change 4 to  $-4$  and 8 to  $-8$ .*  
 $= -12 + (-8)$  *Add left to right.*  
 $= -20$
- 37.**  $9 - 6 - 3 - 5$   
 $= 9 + (-6) + (-3) + (-5)$  *Change all subtractions to additions. Change 6 to  $-6$ , 3 to  $-3$ , and 5 to  $-5$ .*  
 $= 3 + (-3) + (-5)$  *Add left to right.*  
 $= 0 + (-5)$   
 $= -5$
- 38.**  $12 - 7 - 5 - 4$   
 $= 12 + (-7) + (-5) + (-4)$  *Change all subtractions to additions. Change 7 to  $-7$ , 5 to  $-5$ , and 4 to  $-4$ .*  
 $= 5 + (-5) + (-4)$  *Add left to right.*  
 $= 0 + (-4)$   
 $= -4$
- 39.**  $3 - (-3) - 10 - (-7)$   
 $= 3 + (+3) + (-10) + (+7)$  *Change all subtractions to additions. Change  $-3$  to  $+3$ , 10 to  $-10$ , and  $-7$  to  $+7$ .*  
 $= 6 + (-10) + (+7)$  *Add left to right.*  
 $= -4 + (+7)$   
 $= 3$

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40.  $1 - 9 - (-2) - (-6)$   
 $= 1 + (-9) + (+2) + (+6)$   
*Change all subtractions to additions.*  
*Change 9 to  $-9$ ,  $-2$  to  $+2$ , and  $-6$  to  $+6$ .*  
 $= -8 + 2 + 6$   
 $= -6 + 6$   
 $= 0$   
*Add left to right.*
41.  $-2 + (-11) - (-3)$   
 $= -2 + (-11) + (+3)$   
*Change subtraction to addition.*  
*Change  $-3$  to  $+3$ .*  
 $= -13 + (+3)$   
 $= -10$   
*Add left to right.*
42.  $-5 - (-2) + (-6)$   
 $= -5 + (+2) + (-6)$   
*Change subtraction to addition.*  
*Change  $-2$  to  $+2$ .*  
 $= -3 + (-6)$   
 $= -9$   
*Add left to right.*
43.  $4 - (-13) + (-5)$   
 $= 4 + (+13) + (-5)$   
*Change subtraction to addition.*  
*Change  $-13$  to  $+13$ .*  
 $= 17 + (-5)$   
 $= 12$   
*Add left to right.*
44.  $6 - (-1) + (-10)$   
 $= 6 + (+1) + (-10)$   
*Change subtraction to addition.*  
*Change  $-1$  to  $+1$ .*  
 $= 7 + (-10)$   
 $= -3$   
*Add left to right.*
45.  $6 + 0 - 12 + 1$   
 $= 6 + 0 + (-12) + 1$   
*Change subtraction to addition.*  
*Change 12 to  $-12$ .*  
 $= 6 + (-12) + 1$   
 $= -6 + 1$   
 $= -5$   
*Add left to right.*
46.  $-10 - 4 + 0 + 18$   
 $= -10 + (-4) + 0 + 18$   
*Change subtraction to addition.*  
*Change 4 to  $-4$ .*  
 $= -14 + 0 + 18$   
 $= -14 + 18$   
 $= 4$   
*Add left to right.*
47. (a) The  $30^{\circ}\text{F}$  column and the 10 mph wind row intersect at  $21^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $30 - 21 = 30 + (-21) = 9$  degrees.
- (b) The  $15^{\circ}\text{F}$  column and the 15 mph wind row intersect at  $0^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $15 - 0 = 15$  degrees.
- (c) The  $5^{\circ}\text{F}$  column and the 25 mph wind row intersect at  $-17^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $5 - (-17) = 5 + (+17) = 22$  degrees.
- (d) The  $-10^{\circ}\text{F}$  column and the 35 mph wind row intersect at  $-41^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $-10 - (-41) = -10 + (+41) = 31$  degrees.
48. (a) The  $40^{\circ}\text{F}$  column and the 20 mph wind row intersect at  $30^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $40 - 30 = 40 + (-30) = 10$  degrees.
- (b) The  $20^{\circ}\text{F}$  column and the 35 mph wind row intersect at  $0^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $20 - 0 = 20$  degrees.
- (c) The  $10^{\circ}\text{F}$  column and the 15 mph wind row intersect at  $-7^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $10 - (-7) = 10 + (+7) = 17$  degrees.
- (d) The  $-5^{\circ}\text{F}$  column and the 30 mph wind row intersect at  $-33^{\circ}\text{F}$ . The difference between the actual temperature and the wind chill temperature is  $-5 - (-33) = -5 + (+33) = 28$  degrees.
49.  $-2 + (-11) + |-2|$   
 $= -2 + (-11) + 2$   
 $= -13 + 2$   
 $= -11$   
 $|-2| = 2$  because the distance from 0 to  $-2$  is 2 units.  
*Add left to right.*
50.  $5 - |-3| + 3$   
 $= 5 - 3 + 3$   
 $= 5 + (-3) + 3$   
 $= 2 + 3$   
 $= 5$   
 $|-3| = 3$  because the distance from 0 to  $-3$  is 3 units.  
*Change subtraction to addition.*  
*Add left to right.*
51.  $0 - |-7 + 2|$   
 $= 0 - |-5|$   
 $= 0 - 5$   
 $= 0 + (-5)$   
 $= -5$   
*Simplify the sum within the absolute value bars first.*  
 $|-5| = 5$  because the distance from 0 to  $-5$  is 5 units.  
*Change subtraction to addition. Change 5 to  $-5$ .*  
*Add.*

52.  $|1 - 8| - |0|$   
 $= |1 + (-8)| - |0|$  *Change subtraction to addition.*  
 $= |-7| - |0|$  *Simplify the sum within the absolute value bars first.*  
 $= 7 - 0$   *$|-7| = 7$  because the distance from 0 to  $-7$  is 7 units.*  
 $= 7$  *Subtract.*

53.  $-3 - (-2 + 4) + (-5)$   
 $= -3 - 2 + (-5)$  *Simplify the sum within the parentheses first.*  
 $= -3 + (-2) + (-5)$  *Change subtraction to addition and change 2 to  $-2$ .*  
 $= -5 + (-5)$  *Add left to right.*  
 $= -10$

54.  $5 - 8 - (6 - 7) + 1$   
 $= 5 - 8 - [6 + (-7)] + 1$  *Change subtraction to addition within the parentheses and change 7 to  $-7$ .*  
 $= 5 - 8 - (-1) + 1$  *Simplify the sum within the brackets.*  
 $= 5 + (-8) + (+1) + 1$  *Change subtraction to addition and change  $-1$  to  $+1$  and 8 to  $-8$ .*  
 $= -3 + 1 + 1$  *Add left to right.*  
 $= -2 + 1$   
 $= -1$

### Relating Concepts (Exercises 55–56)

55.  $-3 - 5 = -3 + (-5) = -8$   
 $5 - (-3) = 5 + (+3) = 5 + 3 = 8$   
 $-4 - (-3) = -4 + (+3) = -4 + 3 = -1$   
 $-3 - (-4) = -3 + 4 = 1$

Subtraction is *not* commutative; the absolute value of the answer is the same, but the sign changes.

56. Subtracting 0 from a number does *not* change the number. For example,  $-5 - 0 = -5$ .  
 But subtracting a number from 0 *does* change the number to its opposite.  
 For example,  $0 - (-5) = 5$ .

## 1.5 Problem Solving: Rounding and Estimating

### 1.5 Margin Exercises

1. (a)  $-746$  (nearest ten)  
 Draw a line under the 4.  $-7\textbf{4}6$   
 $-746$  is closer to  $-7\textbf{5}0$ .

(b)  $2412$  (nearest thousand)  
 Draw a line under the leading 2.  $\textbf{2}412$   
 $2412$  is closer to  $2000$ .

(c)  $-89,512$  (nearest hundred)  
 Draw a line under the 5.  $-89,\textbf{5}12$   
 $-89,512$  is closer to  $-89,\textbf{5}00$ .

(d)  $546,325$  (nearest ten-thousand)  
 Draw a line under the 4.  $5\textbf{4}6,325$   
 $546,325$  is closer to  $5\textbf{5}0,000$ .

2. (a)  $34 \approx 30$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 4 or less, do not change the digit in the underlined place. Change all digits to the right of the underlined place to zeros.  
 Note: The symbol " $\approx$ " means "approximately equal to."

(b)  $-61 \approx -60$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 1 or less, do not change the digit in the underlined place. Change all digits to the right of the underlined place to zeros.

(c)  $-683 \approx -680$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 3 or less, do not change the digit in the underlined place. Change all digits to the right of the underlined place to zeros.

(d)  $1792 \approx 1790$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 2 or less, do not change the digit in the underlined place. Change all digits to the right of the underlined place to zeros.

3. (a)  $1725 \approx 2000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 5 or more, add 1 to the digit in the underlined place. Change all digits to the right of the underlined place to zeros.

(b)  $-6511 \approx -7000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 5 or more, add 1 to the digit in the underlined place. Change all digits to the right of the underlined place to zeros.

(c)  $58,829 \approx 59,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 8 or more, add 1 to the digit in the underlined place. Change all digits to the right of the underlined place to zeros.

- (d)  $-83,904 \approx -84,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Because the next digit to the right of the underlined place is 5 or more, add 1 to the digit in the underlined place. Change all digits to the right of the underlined place to zeros.
4. (a)  $-60\text{36} \approx -6040$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the tens place. Next digit is 5 or more. Tens place changes. Add 1 to 3. Change all digits to the right of the underlined place to zeros.
- (b)  $34,\text{968} \approx 35,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the hundreds place. Next digit is 5 or more. Hundreds place changes. Add 1 to 9. Write 0 and carry 1 into the thousands place. Change all digits to the right of the underlined place to zero.
- (c)  $-73,\text{077} \approx -73,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the thousands place. Next digit is 4 or less. Leave 3 as 3. Change all digits to the right of the underlined place to zeros.
- (d)  $\text{9852} \approx 10,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the thousands place. Next digit is 5 or more. Thousands place changes. Add 1 to 9. Change all digits to the right of the underlined place to zeros.
- (e)  $85,\text{949} \approx 85,900$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the hundreds place. Next digit is 4 or less. Leave 9 as 9. Change all digits to the right of the underlined place to zeros.
- (f)  $40,\text{387} \approx 40,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the thousands place. Next digit is 4 or less. Leave 0 as 0. Change all digits to the right of the underlined place to zeros.
5. (a)  $-14,\text{679} \approx -10,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the ten-thousands place. Next digit is 4 or less. Leave 1 as 1. Change all digits to the right of the underlined place to zeros.
- (b)  $72\text{4,518,715} \approx 725,000,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the millions place. Next digit is 5 or more. Add 1 to 4. Change all digits to the right of the underlined place to zeros.
- (c)  $-49,\text{900,700} \approx -50,000,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the millions place. Next digit is 5 or more. Add 1 to 9. Write 0 and carry 1 to the ten millions place. Change all digits to the right of the underlined place to zeros.
- (d)  $\text{306,779,000} \approx 300,000,000$  ■ Locate the place to which the number is being rounded. Draw a line under that place. Underline the hundred-millions place. Next digit is 4 or less. Leave 3 as 3. Change all digits to the right of the underlined place to zeros.
6. (a)  $-\text{94} \approx -90$   
Underline the first digit. Next digit is 4 or less. Leave 9 as 9. Change 4 to 0.
- (b)  $\text{508} \approx 500$   
Underline the first digit. Next digit is 4 or less. Leave 5 as 5. Change 8 to 0.
- (c)  $-\text{2522} \approx -3000$   
Underline the first digit. Next digit is 5 or more. Add 1 to 2. Change all digits to the right of the underlined place to zeros.
- (d)  $\text{9700} \approx 10,000$   
Underline the first digit. Next digit is 5 or more. Add 1 to 9. Write 0 and carry 1 to the ten thousands place. Change all digits to the right of the underlined place to zeros.
- (e)  $\text{61,888} \approx 60,000$   
Underline the first digit. Next digit is 4 or less. Leave 6 as 6. Change all digits to the right to zeros.
- (f)  $-\text{963,369} \approx -1,000,000$   
Underline the first digit. Next digit is 5 or more. Add 1 to 9. Write 0 and carry 1 to the millions place. Change all digits to the right to zeros.
7. "Overdrawn" implies a negative number,  $-\$3881$   
"Deposit" implies a positive number,  $+\$2090$   
*Estimate:*  $-\$3881 \approx -\$4000$   
 $+\$2090 \approx +\$2000$   
 $\text{Balance} = -\$4000 + \$2000 = \underline{-\$2000}$   
Approximately \$2000 overdrawn.  
*Exact:*  
 $\text{Balance} = -\$3881 + \$2090 = -\$1791$   
Pao Xiong is overdrawn by \$1791.  
The estimate of \$2000 overdrawn is fairly close to the exact amount.

## 1.5 Section Exercises

1. (a) 3702 (nearest ten)  
Draw a line under 0.  $37\text{02}$   
Next digit is 4 or less, so leave 0 as 0 in the tens place.



- (b) 908,546 (nearest thousand)  
Draw a line under 8. 908,546  
Next digit is 5 or more, so change 8 to 9 in the thousands place.
2. (a) 65,081 (nearest hundred)  
Draw a line under 0. 65,081  
Next digit is 5 or more, so change 0 to 1 in the hundreds place.
- (b) 723,900 (nearest ten-thousand)  
Draw a line under 2. 723,900  
Next digit is 4 or less, so leave 2 as 2 in the ten-thousands place.
3.  $6\overline{2}5 \approx 630$  (nearest ten)  
Next digit is 5 or more. Tens place changes. Add 1 to 2. Change 5 to 0.
4.  $2\overline{0}6 \approx 210$  (nearest ten)  
Next digit is 5 or more. Tens place changes. Add 1 to 0. Change 6 to 0.
5.  $-10\overline{8}3 \approx -1080$  (nearest ten)  
Next digit is 4 or less. Tens place remains 8. Change 3 to 0.
6.  $-24\overline{3}9 \approx -2440$  (nearest ten)  
Next digit is 5 or more. Tens place changes. Add 1 to 3. Change 9 to 0.
7.  $7\overline{8}62 \approx 7900$  (nearest hundred)  
Next digit is 5 or more. Hundreds place changes. Add 1 to 8. Change 6 and 2 to 0.
8.  $6\overline{7}46 \approx 6700$  (nearest hundred)  
Next digit is 4 or less. Hundreds place does not change. Change 4 and 6 to 0.
9.  $-86,\overline{8}13 \approx -86,800$  (nearest hundred)  
Next digit is 4 or less. Hundreds place remains 8. Change 1 and 3 to 0.
10.  $-17,\overline{2}11 \approx -17,200$  (nearest hundred)  
Next digit is 4 or less. Hundreds place does not change. All digits to the right of the underlined place change to 0.
11.  $42,\overline{4}95 \approx 42,500$  (nearest hundred)  
Next digit is 5 or more. Hundreds place changes. Add 1 to 4. Change 9 and 5 to 0.
12.  $18,\overline{2}73 \approx 18,300$  (nearest hundred)  
Next digit is 5 or more. Hundreds place changes. Add 1 to 2. Change 7 and 3 to 0.
13.  $-5\overline{9}96 \approx -6000$  (nearest hundred)  
Next digit is 5 or more. Hundreds place changes. Add 1 to 9 and carry 1 to thousands. Change 9 and 6 to 0.
14.  $-8\overline{4}51 \approx -8500$  (nearest hundred)  
Next digit is 5 or more. Hundreds place changes. Add 1 to 4. Change 5 and 1 to 0.
15.  $-7\overline{8},499 \approx -78,000$  (nearest thousand)  
Next digit is 4 or less. Thousands place remains 8. Change 4, 9, and 9 to 0.
16.  $-14,\overline{3}14 \approx -14,000$  (nearest thousand)  
Next digit is 4 or less. Thousands place does not change. All digits to the right of the underlined place change to 0.
17.  $\overline{5}847 \approx 6000$  (nearest thousand)  
Next digit is 5 or more. Thousands place changes. Add 1 to 5. Change 8, 4, and 7 to 0.
18.  $49,\overline{7}06 \approx 50,000$  (nearest thousand)  
Next digit is 5 or more. Thousands place changes. Add 1 to 9. Write 0 and carry 1. All digits to the right of the underlined place change to 0.
19.  $59\overline{5},008 \approx 600,000$  (nearest ten-thousand)  
Next digit is 5 or more. Ten-thousands place changes. Add 1 to 9 and carry 1 to hundred-thousands place. Change 5 and 8 to 0.
20.  $72\overline{5},182 \approx 730,000$  (nearest ten-thousand)  
Next digit is 5 or more. Ten-thousands place changes. Add 1 to 2. All digits to the right of the underlined place change to 0.
21.  $-\overline{8},906,422 \approx -9,000,000$  (nearest million)  
Next digit is 5 or more. Millions place changes. Add 1 to 8. Change other digits to 0.
22.  $-13,\overline{7}13,409 \approx -14,000,000$  (nearest million)  
Next digit is 5 or more. Millions place changes. Add 1 to 3. All digits to the right of the underlined place change to 0.
23.  $139,\overline{6}10,000 \approx 140,000,000$  (nearest million)  
Next digit is 5 or more. Millions place changes. Add 1 to 9. Carry one to ten-millions. Change 6 and 1 to zeros.
24.  $609,\overline{8}45,500 \approx 610,000,000$  (nearest million)  
Next digit is 5 or more. Millions place changes. Add 1 to 9. Write 0 and carry 1 to the ten-millions place. All digits to the right of the underlined place change to 0.
25.  $19,\overline{9}51,880,500 \approx 20,000,000,000$  (nearest hundred-million)  
Next digit is 5 or more. Hundred-millions place changes. Add 1 to 9. Write 0 and carry 1 to the ten-billions place. All digits to the right of the underlined place change to 0.
26.  $5,\overline{9}93,505,000 \approx 6,000,000,000$  (nearest hundred-million)  
Next digit is 5 or more. Hundred-millions place changes. Add 1 to 9. Write 0 and carry 1 to the billions place. All digits to the right of the underlined place change to 0.

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27.  $\underline{8},608,200,000 \approx 9,000,000,000$  (nearest billion)  
Next digit is 5 or more. Billions place changes.  
Add 1 to 8. All digits to the right of the underlined place change to 0.
28.  $70\underline{3},750,678,005 \approx 704,000,000,000$  (nearest billion)  
Next digit is 5 or more. Billions place changes.  
Add 1 to 3. All digits to the right of the underlined place change to 0.
29. Answers will vary but should mention looking only at the second digit, rounding first digit up when second digit is 5 or more, leaving first digit unchanged when second digit is 4 or less.  
Examples will vary. Some possibilities are  $27 \approx 30$ ,  $641 \approx 600$ .
30. Answers will vary. Some possibilities are: rounded numbers are used when budgeting or talking about driving distances; exact numbers are important for paychecks and medications.
31.  $\underline{31},500 \approx 30,000$  miles  
Next digit is 4 or less. Leave 3 as 3. Change 1 and 5 to 0. 31,500 is closer to 30,000 than 40,000.
32.  $\underline{57},300 \approx 60,000$  miles  
Next digit is 5 or more. Ten-thousands place changes. Add 1 to 5. Change all other digits to 0.
33.  $-\underline{5}6 \approx -60$  degrees  
Next digit is 5 or more. Change 5 to 6 and change 6 to 0.  $-56$  is closer to  $-60$  than  $-50$ .
34.  $-\underline{4}2 \approx -40$  inches  
Next digit is 4 or less. Tens place does not change. Change all other digits to 0.
35.  $\underline{\$}9942 \approx \$10,000$   
Next digit is 5 or more. Add 1 to 9 and carry 1 to the ten-thousands place. Change 9, 4, and 2 to 0.  $\$9942$  is closer to  $\$10,000$  than  $\$9000$ .
36.  $\underline{\$}285 \approx \$300$   
Next digit is 5 or more. Hundreds place changes. Add 1 to 2. Change all other digits to 0.
37.  $\underline{53},500,000,000 \approx 50,000,000,000$  minutes  
Next digit is 4 or less. Leave 5 as 5. Change 3 and 5 to 0. 53,500,000,000 is closer to 50,000,000,000 than 60,000,000,000.
38.  $\underline{104},100,000 \approx 100,000,000$  households  
Next digit is 4 or less. Leave 1 as 1. Change 4 and 1 to 0. 104,100,000 is closer to 100,000,000 than 200,000,000.
39.  $\underline{698},473 \approx 700,000$  people in Alaska  
Next digit is 5 or more. Change 6 to 7. Change all other digits to 0. 698,473 is closer to 700,000 than 600,000.
40.  $\underline{36},961,664 \approx 40,000,000$  people in California  
Next digit is 5 or more. Change 3 to 4. Change all other digits to 0. 36,961,664 is closer to 40,000,000 than 30,000,000.
41.  $\underline{439},010,000 \approx 400,000,000$  people in the United States  
Next digit is 4 or less. Leave 4 as 4. Change all other digits to 0.  
 $\underline{41},135,648 \approx 40,000,000$  people in Canada  
Next digit is 4 or less. Ten-millions place does not change. Change all other digits to 0.
41.  $-42 + 89$   
 $-\underline{4}2$  is closer to  $-40$  than  $-50$ .  
 $\underline{89}$  is closer to 90 than 80.  
*Estimate:*  $-\underline{40} + \underline{90} = \underline{50}$ ;  
*Exact:*  $-42 + 89 = 47$
42.  $-66 + 25$   
 $-\underline{6}6$  is closer to  $-70$  than  $-60$ .  
25 is as close to 30 as it is to 20, so we'll round 25 up to 30 for our estimate.  
*Estimate:*  $-\underline{70} + \underline{30} = \underline{-40}$ ;  
*Exact:*  $-66 + 25 = -41$
43.  $16 + (-97)$   
 $\underline{16}$  is closer to 20 than 10.  
 $-\underline{97}$  is closer to  $-100$  than  $-90$ .  
*Estimate:*  $20 + (-100) = -80$ ;  
*Exact:*  $16 + (-97) = -81$
44.  $58 + (-19)$   
 $\underline{58}$  is closer to 60 than 50.  
 $-\underline{19}$  is closer to  $-20$  than  $-10$ .  
*Estimate:*  $60 + (-20) = 40$ ;  
*Exact:*  $58 + (-19) = 39$
45.  $-273 + (-399)$   
 $-\underline{2}73$  is closer to  $-300$  than  $-200$ .  
 $-\underline{399}$  is closer to  $-400$  than  $-300$ .  
*Estimate:*  $-300 + (-400) = -700$ ;  
*Exact:*  $-273 + (-399) = -672$
46.  $-311 + (-582)$   
 $-\underline{3}11$  is closer to  $-300$  than  $-400$ .  
 $-\underline{582}$  is closer to  $-600$  than  $-500$ .  
*Estimate:*  $-300 + (-600) = -900$ ;  
*Exact:*  $-311 + (-582) = -893$
47.  $3081 + 6826$   
 $\underline{3081}$  is closer to 3000 than 4000.  
 $\underline{6826}$  is closer to 7000 than 6000.  
*Estimate:*  $3000 + 7000 = 10,000$ ;  
*Exact:*  $3081 + 6826 = 9907$

- 48.**  $4904 + 1181$   
 $\underline{4}904$  is closer to 5000 than 4000.  
 $\underline{1}181$  is closer to 1000 than 2000.  
*Estimate:*  $5000 + 1000 = 6000$ ;  
*Exact:*  $4904 + 1181 = 6085$
- 49.**  $23 - 81$   
 $23 + (-81)$  *Change subtraction to addition.*  
*Change 81 to -81.*  
 $\underline{2}3$  is closer to 20 than 30.  
 $-\underline{8}1$  is closer to -80 than -90.  
*Estimate:*  $20 + (-80) = -60$ ;  
*Exact:*  $23 - 81 = 23 + (-81) = -58$
- 50.**  $72 - 84$   
 $72 + (-84)$  *Change subtraction to addition.*  
*Change 84 to -84.*  
 $\underline{7}2$  is closer to 70 than 80.  
 $-\underline{8}4$  is closer to -80 than -90.  
*Estimate:*  $70 + (-80) = -10$ ;  
*Exact:*  $72 - 84 = 72 + (-84) = -12$
- 51.**  $-39 - 39$   
 $-39 + (-39)$  *Change subtraction to addition.*  
*Change 39 to -39.*  
 $-\underline{3}9$  is closer to -40 than -30.  
*Estimate:*  $-40 + (-40) = -80$ ;  
*Exact:*  $-39 - 39 = -39 + (-39) = -78$
- 52.**  $-91 - 91$   
 $-91 + (-91)$  *Change subtraction to addition.*  
*Change 91 to -91.*  
 $-\underline{9}1$  is closer to -90 than -100.  
*Estimate:*  $-90 + (-90) = -180$ ;  
*Exact:*  $-91 - 91 = -91 + (-91) = -182$
- 53.**  $-106 + 34 - (-72)$   
 $-106 + 34 + (+72)$  *Change subtraction to addition of the opposite.*  
 $-\underline{1}06 \approx -100$ ;  $\underline{3}4 \approx 30$ ;  $\underline{7}2 \approx 70$   
*Estimate:*  $-100 + 30 + (+70) = 0$ ;  
*Exact:*  $-106 + 34 - (-72)$   
 $= -106 + 34 + (+72) = 0$
- 54.**  $52 - (-87) - 139$   
 $52 + (+87) + (-139)$  *Change subtraction to addition of the opposite.*  
 $\underline{5}2 \approx 50$ ;  $\underline{8}7 \approx 90$ ;  $-\underline{1}39 \approx -100$   
*Estimate:*  $50 + (+90) + (-100) = 40$ ;  
*Exact:*  $52 - (-87) - 139$   
 $= 52 + (+87) + (-139) = 0$
- 55.** Already raised:  $\$52,882 \approx \$50,000$   
Amount needed:  $\$78,650 \approx \$80,000$   
Amount that still needs to be collected:  
*Estimate:*  $80,000 - 50,000 = \$30,000$ ;  
*Exact:*  $78,650 - 52,882 = \$25,768$
- 56.**  $9250 \approx 9000$  pounds  
 $21,375 \approx 20,000$  pounds  
To find the weight of the firewood subtract the truck's weight from the total weight.  
*Estimate:*  $20,000 - 9000 = 11,000$  pounds  
*Exact:*  $21,375 - 9250 = 12,125$  pounds
- 57.** Estimate Dorene's expenses.  
Rent:  $\$845 \approx \$800$   
Food:  $\$325 \approx \$300$   
Childcare:  $\$365 \approx \$400$   
Transportation:  $\$182 \approx \$200$   
Other:  $\$240 \approx \$200$   
*Estimate:* Dorene's total expenses:  
 $\$800 + \$300 + \$400 + \$200 + \$200 = \$1900$ .  
Estimate Dorene's monthly take home pay.  
 $\$2120 \approx \$2000$   
Subtract Dorene's expenses from her take home pay to estimate her monthly savings.  
 $\$2000 - \$1900 = \$100$ .  
*Exact:*  
Total Expenses =  $\$845 + \$325 + \$365$   
 $+ \$182 + \$240$   
 $= \$1957$   
Monthly savings =  $\$2120 - \$1957 = \$163$ .
- 58.** Using front end rounding:  
 $\$2874 \approx \$3000$   
 $-\$308 \approx -\$300$   
 $-\$580 \approx -\$600$   
 $-\$778 \approx -\$800$   
Amount of money remaining in Jared's account:  
*Estimate:*  $3000 - 300 - 600 - 800 = \$1300$   
*Exact:*  $2874 - 308 - 580 - 778 = \$1208$
- 59.** The final temperature equals the initial temperature plus the two increases.  
 $-102 \approx -100$ ;  $37 \approx 40$ ;  $52 \approx 50$   
*Estimate:*  $-100 + 40 + 50 = -10$  degrees  
*Exact:*  $-102 + 37 + 52 = -13$  degrees
- 60.** Using front end rounding:  
 $-65$  feet  $\approx -70$  feet  
 $24$  feet  $\approx 20$  feet  
 $-49$  feet  $\approx -50$  feet  
The scuba diver's final depth:  
*Estimate:*  $-70 + 20 + (-50) = -100$  feet  
*Exact:*  $-65 + 24 + (-49) = -90$  feet

61.  $412 \approx 400$  doors  
 $147 \approx 100$  windows  
 Total number of doors and windows:  
*Estimate:*  $400 + 100 = 500$  doors and windows  
*Exact:*  $412 + 147 = 559$  doors and windows
62.  $33,000 \approx 30,000$  McDonald's restaurants  
 $12,500 \approx 10,000$  Burger King restaurants  
 Total number of restaurants:  
*Estimate:*  $30,000 + 10,000 = 40,000$  restaurants  
*Exact:*  $33,000 + 12,500 = 45,500$  restaurants

## 1.6 Multiplying Integers

### 1.6 Margin Exercises

1. (a)  $\underbrace{100}_{\text{Factor}} \times \underbrace{6}_{\text{Factor}} = \underbrace{600}_{\text{Product}}$   
 Equivalent forms:  $100(6) = 600$   
 $100 \cdot 6 = 600$   
 $(100)(6) = 600$
- (b)  $\underbrace{7}_{\text{Factor}} \times \underbrace{12}_{\text{Factor}} = \underbrace{84}_{\text{Product}}$   
 Equivalent forms:  $7(12) = 84$   
 $7 \cdot 12 = 84$   
 $(7)(12) = 84$
2. (a)  $7(-2) = -14$   
 The factors have *different* signs, so the product is *negative*.
- (b)  $-5 \cdot (-5) = 25$   
*(same signs, product is positive)*
- (c)  $-1(14) = -14$   
*(different signs, product is negative)*
- (d)  $10 \cdot 6 = 60$   
*(same signs, product is positive)*
- (e)  $(-4)(-9) = 36$   
*(same signs, product is positive)*
3. (a)  $-5 \cdot (10 \cdot 2)$  *Work within parentheses first.*  
 $= -5 \cdot (20)$  *(same signs, product is positive)*  
 $= -100$  *(different signs, product is negative)*
- (b)  $-1 \cdot 8 \cdot (-5)$  *No parentheses.*  
*Multiply from left to right.*  
 $= -8 \cdot (-5)$  *(different signs, product is negative)*  
 $= 40$  *(same signs, product is positive)*
- (c)  $-3(-2)(-4)$  *Multiply from left to right.*  
 $= (6)(-4)$  *(same signs, product is positive)*  
 $= -24$  *(different signs, product is negative)*

- (d)  $-2(7)(-3)$  *Multiply from left to right.*  
 $= (-14)(-3)$  *(different signs, product is negative)*  
 $= 42$  *(same signs, product is positive)*
- (e)  $(-1)(-1)(-1)$  *Multiply from left to right.*  
 $= 1(-1)$  *(same signs, product is positive)*  
 $= -1$  *(different signs, product is negative)*

4. (a)  $819 \cdot 0 = 0$ ; multiplication property of 0  
 (b)  $1(-90) = -90$ ; multiplication property of 1  
 (c)  $25 \cdot 1 = 25$ ; multiplication property of 1  
 (d)  $(0)(-75) = 0$ ; multiplication property of 0
5. (a)  $\underbrace{(3 \cdot 3)}_9 \cdot 2 = 3 \cdot \underbrace{(3 \cdot 2)}_6$   
 $18 = 18$

This illustrates the associative property of multiplication.

- (b)  $11 \cdot 8 = 8 \cdot 11$   
 $88 = 88$   
 Commutative property of multiplication
- (c)  $2 \cdot (-15) = -15 \cdot 2$   
 $-30 = -30$   
 Commutative property of multiplication
- (d)  $-4 \cdot (2 \cdot 5) = (-4 \cdot 2) \cdot 5$   
 $-4 \cdot 10 = -8 \cdot 5$   
 $-40 = -40$   
 Associative property of multiplication
6. (a)  $3(8 + 7) = 3 \cdot 8 + 3 \cdot 7$   
 $3(15) = 24 + 21$   
 $45 = 45$  *Both results are 45.*
- (b)  $10(-6 + 9) = 10(-6) + 10(9)$   
 $10(3) = -60 + 90$   
 $30 = 30$  *Both results are 30.*
- (c)  $-6(4 + 4) = -6 \cdot 4 + (-6) \cdot 4$   
 $-6(8) = -24 + (-24)$   
 $-48 = -48$  *Both results are -48.*
7. 27,095 fans rounds to 30,000 fans and  
 81 games rounds to 80 games.  
 Total attendance for the season:  
*Estimate:*  $30,000(80) = 2,400,000$  fans  
*Exact:*  $27,095(81) = 2,194,695$  fans

## 1.6 Section Exercises

1. (a)  $9 \cdot 7 = 63$  Factors have the **same** sign,  
so the product is **positive**.  
(b)  $-9 \cdot (-7) = 63$  Factors have the **same** sign,  
so the product is **positive**.  
(c)  $-9 \cdot 7 = -63$  Factors have **different** signs,  
so the product is **negative**.  
(d)  $9 \cdot (-7) = -63$  Factors have **different** signs,  
so the product is **negative**.
2. (a)  $-6 \cdot 9 = -54$  Factors have **different** signs,  
so the product is **negative**.  
(b)  $6 \cdot (-9) = -54$  Factors have **different** signs,  
so the product is **negative**.  
(c)  $-6 \cdot (-9) = 54$  Factors have the **same** sign,  
so the product is **positive**.  
(d)  $6 \cdot 9 = 54$  Factors have the **same** sign,  
so the product is **positive**.
3. (a)  $7(-8) = -56$  Factors have **different** signs,  
so the product is **negative**.  
(b)  $-7(8) = -56$  Factors have **different** signs,  
so the product is **negative**.  
(c)  $7(8) = 56$  Factors have the **same** sign,  
so the product is **positive**.  
(d)  $-7(-8) = 56$  Factors have the **same** sign,  
so the product is **positive**.
4. (a)  $8(6) = 48$  Factors have the **same** sign,  
so the product is **positive**.  
(b)  $-8(-6) = 48$  Factors have the **same** sign,  
so the product is **positive**.  
(c)  $-8(6) = -48$  Factors have **different** signs,  
so the product is **negative**.  
(d)  $8(-6) = -48$  Factors have **different** signs,  
so the product is **negative**.
5.  $-5 \cdot 7 = -35$   
(different signs, product is **negative**)
6.  $-10 \cdot 2 = -20$   
(different signs, product is **negative**)
7.  $(-5)(9) = -45$   
(different signs, product is **negative**)
8.  $(-9)(4) = -36$   
(different signs, product is **negative**)
9.  $3(-6) = -18$   
(different signs, product is **negative**)
10.  $8(-9) = -72$   
(different signs, product is **negative**)
11.  $10(-5) = -50$   
(different signs, product is **negative**)
12.  $5(-11) = -55$   
(different signs, product is **negative**)
13.  $(-1)(40) = -40$   
(different signs, product is **negative**)
14.  $(75)(-1) = -75$   
(different signs, product is **negative**)
15.  $-56 \cdot 1 = -56$ ; multiplication property of 1
16.  $1 \cdot (-87) = -87$ ; multiplication property of 1
17.  $-8(-4) = 32$  (same signs, product is **positive**)
18.  $-3(-9) = 27$  (same signs, product is **positive**)
19.  $11 \cdot 7 = 77$  (same signs, product is **positive**)
20.  $4 \cdot 25 = 100$  (same signs, product is **positive**)
21.  $25 \cdot 0 = 0$ ; multiplication property of 0
22.  $0 \cdot 30 = 0$ ; multiplication property of 0
23.  $-19(-7) = 133$  (same signs, product is **positive**)
24.  $-21(-3) = 63$  (same signs, product is **positive**)
25.  $-13(-1) = 13$  (same signs, product is **positive**)
26.  $-1(-31) = 31$  (same signs, product is **positive**)
27.  $(0)(-25) = 0$ ; multiplication property of 0
28.  $(-50)(0) = 0$ ; multiplication property of 0
29.  $-4 \cdot (-6) \cdot 2$   
 $= 24 \cdot 2$  Multiply from left to right.  
 $= \underline{48}$
30.  $-9 \cdot 3 \cdot (-3)$   
 $= -27 \cdot (-3)$  Multiply from left to right.  
 $= \underline{81}$
31.  $(-4)(-2)(-7)$   
 $= 8(-7)$  Multiply from left to right.  
 $= -56$
32.  $(-6)(-2)(-3)$   
 $= 12 \cdot (-3)$  Multiply from left to right.  
 $= -36$
33.  $5(-8)(4)$   
 $= -40(4)$  Multiply from left to right.  
 $= -160$
34.  $5(4)(-6)$   
 $= 20 \cdot (-6)$  Multiply from left to right.  
 $= -120$
35.  $(-3)(\underline{5}) = -15$  (negative product, different signs)

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36.  $6 \cdot (-4) = -24$  (negative product, different signs)

37.  $-3 \cdot 10 = -30$  (negative product, different signs)

38.  $(-4)(-4) = 16$  (positive product, same signs)

39.  $-17 = 17(-1)$  (negative product, different signs)

40.  $29 = -29(-1)$  (positive product, same signs)

41.  $(0)(-350) = 0$  (multiplication property of 0)

42.  $1 \cdot 99 = 99$  (multiplication property of 1)

43.  $5 \cdot (-4) \cdot 5 = -100$   
 $-20 \cdot 5 = -100$  (negative product, different signs)

44.  $6 \cdot 2 \cdot (-2) = -24$   
 $6 \cdot (-4) = -24$  (negative product, different signs)

45.  $(-4)(-5)(-2) = -40$   
 $(-4)(10) = -40$  (negative product, different signs)

46.  $(-3)(-3)(-3) = -27$   
 $9 \cdot (-3) = -27$  (negative product, different signs)

47. Commutative property: changing the *order* of the factors does not change the product.  
 Associative property: changing the *grouping* of the factors does not change the product.  
 Examples will vary. Some possibilities are  
 $-4 \cdot 7 = 7 \cdot (-4) = -28$ ,  
 $(2 \cdot 5) \cdot (-8) = 2 \cdot (5 \cdot (-8)) = -80$ .

48. No. Work with two factors at a time. The final result is  $-27$ .

$$\underbrace{(-3) \cdot (-3)}_{9 \cdot (-3)} \cdot (-3) = -27$$

49.  $9(-3 + 5)$  rewritten by using the distributive property is  $9 \cdot (-3) + 9 \cdot 5$ .

$$9(-3 + 5) = 9 \cdot (-3) + 9 \cdot 5$$

$$9(2) = -27 + 45$$

$$18 = 18$$

50.  $-6(4 + 5)$  rewritten by using the distributive property is  $-6 \cdot 4 + (-6) \cdot 5$ .

$$-6(4 + 5) = -6 \cdot 4 + (-6) \cdot 5$$

$$-6(9) = -24 + (-30)$$

$$-54 = -54$$

51.  $25 \cdot 8$  rewritten by using the commutative property is  $8 \cdot 25$ .

$$25 \cdot 8 = 8 \cdot 25$$

$$200 = 200$$

52.  $-7 \cdot (-11)$  rewritten by using the commutative property is  $-11 \cdot (-7)$ .

$$-7 \cdot (-11) = -11 \cdot (-7)$$

$$77 = 77$$

53.  $-3 \cdot (2 \cdot 5)$  rewritten using the associative property is  $(-3 \cdot 2) \cdot 5$ .

$$-3 \cdot (2 \cdot 5) = (-3 \cdot 2) \cdot 5$$

$$-3 \cdot 10 = -6 \cdot 5$$

$$-30 = -30$$

54.  $(5 \cdot 5) \cdot 10$  rewritten using the associative property is  $5 \cdot (5 \cdot 10)$ .

$$(5 \cdot 5) \cdot 10 = 5 \cdot (5 \cdot 10)$$

$$25 \cdot 10 = 5 \cdot 50$$

$$250 = 250$$

55. Income:  $\$324 \approx \$300$   
 52 weeks  $\approx 50$

Estimate:  $\$300 \cdot 50 = \$15,000$

Exact:  $\$324 \cdot 52 = \$16,848$

56. 875 students  $\approx 900$

Total increase in enrollment:

Estimate:  $900 \cdot 4 = 3600$  students

Exact:  $875 \cdot 4 = 3500$  students

57. Monthly loss:  $-\$9950 \approx -\$10,000$   
 12 months  $\approx 10$

Estimate:  $-\$10,000 \cdot 10 = -\$100,000$

Exact:  $-\$9950 \cdot 12 = -\$119,400$

58.  $-95$  customers  $\approx -100$  customers per week  
 52 weeks  $\approx 50$  weeks

Customers lost in a year:

Estimate:  $-100 \cdot 50 = -5000$  customers

Exact:  $-95 \cdot 52 = -4940$  customers

59. Tuition:  $\$182$  per credit  $\approx \$200$  per credit  
 13 credits  $\approx 10$  credits

Estimate:  $\$200 \cdot 10 = \$2000$

Exact:  $\$182 \cdot 13 = \$2366$

60. 12 crackers  $\approx 10$  crackers  
 17 calories  $\approx 20$  calories

Calories consumed by Pat:

Estimate:  $20 \cdot 10 = 200$  calories

Exact:  $17 \cdot 12 = 204$  calories

61. Hours:  $24 \approx 20$   
 365 days  $\approx 400$

Estimate:  $20 \cdot 400 = 8000$  hours

Exact:  $24 \cdot 365 = 8760$  hours

62. 5280 feet  $\approx 5000$  feet  
 17 miles  $\approx 20$  miles

Number of feet in 17 miles:

Estimate:  $5000 \cdot 20 = 100,000$  feet

Exact:  $5280 \cdot 17 = 89,760$  feet

63.  $-8 \cdot |-8 \cdot 8|$   
 $= -8 \cdot |-64|$  *Multiply the factors within the absolute value bars (different signs, negative product).*  
 $= -8 \cdot 64$  *-64 is 64 units from 0, so  $|-64| = 64$ .*  
 $= \underline{-512}$  *Multiply. (different signs, negative product)*
64.  $-7 \cdot |7| \cdot |-7| = -7 \cdot 7 \cdot 7$   
 $= -49 \cdot 7$   
 $= \underline{-343}$
65.  $(-37)(-1)(85)(0) = 0$ ;  
multiplication property of 0
66.  $-1(9732)(-1)(-1) = -9732 \cdot (-1) \cdot (-1)$   
 $= 9732 \cdot (-1)$   
 $= -9732$
67.  $|6 - 7| \cdot (-355,299)$   
 $= |6 + (-7)| \cdot (-355,299)$  *Subtract within the abs. value bars first.*  
 $= |-1| \cdot (-355,299)$   
 $= 1 \cdot (-355,299)$  *-1 is 1 unit from 0, so  $|-1| = 1$*   
 $= -355,299$  *Multiplication property of 1*
68.  $987 \cdot (-65,432) \cdot |9 - 9|$   
 $= 987 \cdot (-65,432) \cdot 0$   
 $= 0$  *Any number times 0 is 0.*
69. The charge for each cat's shots will be \$24 + \$29 = \$53.  
The total for all four cats will be four times that, plus the office visit charge.  
 $4 \cdot \$53 + \$35$  *Do the multiplication first.*  
 $= \$212 + \$35$   
 $= \$247$
70. Chantele paid \$20 for the throat culture.  
She paid for a total of 2 meds:  $2(\$12) = \$24$ .  
She paid for 3 office charges:  $3(\$22) = \$66$ .  
Her total was  $\$20 + \$24 + \$66 = \$110$ .
71. The temperature drops 3 degrees ( $-3$  degrees) for every 1000 feet climbed into the air. An altitude of 24,000 feet would require 24 increases of 1000 feet each.  
 $-3 \cdot 24 = -72$  degrees  
The temperature at 24,000 feet is  
 $50 + (-72) = -22$  degrees.
72. The submarine descends to 150 feet below the surface of the ocean or  $-150$  feet. In order to take samples it descends 25 feet ( $-25$  feet) fifteen more times:  $-25(15) = -375$  feet.  
Final depth =  $-150 + (-375) = -525$  feet or 525 feet below the surface.

73. Points possible on tests:  
 $6(100) = 600$  points  
Bonus points possible on tests:  
 $6(4) = 24$  points  
Points possible on quizzes:  
 $8(6) = 48$  points  
Points possible on homework assignments:  
 $20(5) = 100$  points  
Total points possible:  
 $600 + 24 + 48 + 100 = 772$  points
74. Points possible on group projects:  
 $3(25) = 75$  points  
Points possible on tests:  
 $5(100) = 500$  points  
Points possible on the final exam: 150 points  
Points possible on quizzes:  
 $7(12) = 84$  points  
Total points possible:  
 $75 + 500 + 150 + 84 = 809$  points

### Relating Concepts (Exercises 75–76)

75. Examples will vary. Some possibilities are:

(a)  $6 \cdot (-1) = -6$ ;  $2 \cdot (-1) = -2$ ;  
 $15 \cdot (-1) = -15$

(b)  $-6 \cdot (-1) = 6$ ;  $-2 \cdot (-1) = 2$ ;  
 $-15 \cdot (-1) = 15$

The result of multiplying any nonzero number times  $-1$  is the number with the opposite sign.

76.  $-2 \cdot (-2) = \underline{4}$   
 $-2 \cdot (-2) \cdot (-2) = \underline{-8}$   
 $-2 \cdot (-2) \cdot (-2) \cdot (-2) = \underline{16}$   
 $-2 \cdot (-2) \cdot (-2) \cdot (-2) \cdot (-2) = \underline{-32}$

The absolute value doubles each time and the sign changes. The next three products are  
 $-2 \cdot (-32) = 64$ ,  $-2 \cdot 64 = -128$ , and  
 $-2 \cdot (-128) = 256$ .

## 1.7 Dividing Integers

### 1.7 Margin Exercises

1. (a)  $\frac{40}{-8} = -5$  The integers have **different signs**, so the quotient is **negative**.  
(b)  $\frac{49}{7} = 7$  (same signs, quotient is *positive*)  
(c)  $\frac{-32}{4} = -8$  (different signs, quotient is *negative*)  
(d)  $\frac{-10}{-10} = 1$  The integers have the **same sign**, so the quotient is **positive**.

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(e)  $-81 \div 9 = -9$  (*different signs, quotient is negative*)

(f)  $-100 \div (-50) = 2$  (*same signs, quotient is positive*)

2. (a)  $\frac{-12}{0}$  is undefined; division by 0 is undefined.

(b)  $\frac{0}{39} = 0$ ; 0 divided by any nonzero number is 0.

(c)  $\frac{-9}{1} = -9$ ; any number divided by 1 is the number.

(d)  $\frac{21}{21} = 1$ ; any nonzero number divided by itself is 1.

3. (a)  $60 \div (-3)(-5)$   
 $= (-20)(-5)$  *Work from left to right.*  
 $= 100$

(b)  $-6(-16 \div 8) \cdot 2$   
 $= -6(-2) \cdot 2$  *Work inside parentheses first.*  
 $= 12 \cdot 2$  *Now work from left to right.*  
 $= 24$

(c)  $-8(10) \div 4(-3) \div (-6)$   
 $= -80 \div 4(-3) \div (-6)$  *Work left to right.*  
 $= -20(-3) \div (-6)$   
 $= 60 \div (-6)$   
 $= -10$

(d)  $56 \div (-8) \div (-1)$   
 $= -7 \div (-1)$  *Work left to right.*  
 $= 7$

4. A loss of money implies a negative number:  
 $-\$2724$  in stocks rounds to  $-\$3000$ .  
 12 months rounds to 10 months.  
 To find an average, use division.

*Estimate:*  $-\$3000 \div 10 = -\$300$  each month

*Exact:*  $-\$2724 \div 12 = -\$227$  each month

5. (a) 116 cookies are separated into packages of 12 each.

$$\begin{array}{r} 9 \\ 12 \overline{) 116} \\ \underline{108} \\ 8 \end{array}$$

They will have 9 packages of a dozen cookies each, and there will be 8 cookies left over for them to eat.

(b) 249 senior citizens separated into buses with a 44-person limit per bus.

$$\begin{array}{r} 5 \\ 44 \overline{) 249} \\ \underline{220} \\ 29 \end{array}$$

If Coreen dispatches 5 buses, then 29 senior citizens will not have transportation to the game. She will need to dispatch 6 buses.

### 1.7 Section Exercises

1. (a)  $14 \div 2 = 7$  (*same signs, quotient is positive*)

(b)  $-14 \div (-2) = 7$   
*(same signs, quotient is positive)*

(c)  $14 \div (-2) = -7$   
*(different signs, quotient is negative)*

(d)  $-14 \div 2 = -7$   
*(different signs, quotient is negative)*

2. (a)  $-18 \div (-3) = 6$   
*(same signs, quotient is positive)*

(b)  $18 \div 3 = 6$  (*same signs, quotient is positive*)

(c)  $-18 \div 3 = -6$   
*(different signs, quotient is negative)*

(d)  $18 \div (-3) = -6$   
*(different signs, quotient is negative)*

3. (a)  $-42 \div 6 = -7$   
*(different signs, quotient is negative)*

(b)  $-42 \div (-6) = 7$   
*(same signs, quotient is positive)*

(c)  $42 \div (-6) = -7$   
*(different signs, quotient is negative)*

(d)  $42 \div 6 = 7$  (*same signs, quotient is positive*)

4. (a)  $45 \div 5 = 9$  (*same signs, quotient is positive*)

(b)  $45 \div (-5) = -9$   
*(different signs, quotient is negative)*

(c)  $-45 \div (-5) = 9$   
*(same signs, quotient is positive)*

(d)  $-45 \div 5 = -9$   
*(different signs, quotient is negative)*

5. (a)  $\frac{35}{35} = 1$ ; any nonzero number divided by itself is 1.

(b)  $\frac{35}{1} = 35$ ; any number divided by 1 is the number.



- (c)  $\frac{-13}{1} = -13$ ; any number divided by 1 is the number.
- (d)  $\frac{-13}{-13} = 1$ ; any nonzero number divided by itself is 1.
6. (a)  $\frac{-23}{1} = -23$ ; any number divided by 1 is the number.
- (b)  $\frac{-23}{-23} = 1$ ; any nonzero number divided by itself is 1.
- (c)  $\frac{17}{1} = 17$ ; any number divided by 1 is the number.
- (d)  $\frac{17}{17} = 1$ ; any nonzero number divided by itself is 1.
7. (a)  $\frac{0}{50} = 0$ ; zero divided by any nonzero number is 0.
- (b)  $\frac{50}{0}$  is undefined; division by zero is undefined.
- (c)  $\frac{-11}{0}$  is undefined; division by zero is undefined.
- (d)  $\frac{0}{-11} = 0$ ; zero divided by any nonzero number is 0.
8. (a)  $\frac{-85}{0}$  is undefined; division by zero is undefined.
- (b)  $\frac{0}{-85} = 0$ ; zero divided by any nonzero number is 0.
- (c)  $\frac{6}{0}$  is undefined; division by zero is undefined.
- (d)  $\frac{0}{6} = 0$ ; zero divided by any nonzero number is 0.
9.  $\frac{-8}{2} = -4$  (*different signs, quotient is negative*)
10.  $\frac{-14}{7} = -2$  (*different signs, quotient is negative*)
11.  $\frac{21}{-7} = -3$  (*different signs, quotient is negative*)
12.  $\frac{30}{-6} = -5$  (*different signs, quotient is negative*)
13.  $\frac{-54}{-9} = 6$  (*same signs, quotient is positive*)
14.  $\frac{-48}{-6} = 8$  (*same signs, quotient is positive*)
15.  $\frac{55}{-5} = -11$  (*different signs, quotient is negative*)
16.  $\frac{70}{-7} = -10$  (*different signs, quotient is negative*)
17.  $\frac{-28}{0}$  is undefined. Division by zero is undefined.
18.  $\frac{-40}{0}$  is undefined. Division by zero is undefined.
19.  $\frac{14}{-1} = -14$  (*different signs, quotient is negative*)
20.  $\frac{25}{-1} = -25$  (*different signs, quotient is negative*)
21.  $\frac{-20}{-2} = 10$  (*same signs, quotient is positive*)
22.  $\frac{-80}{-4} = 20$  (*same signs, quotient is positive*)
23.  $\frac{-48}{-12} = 4$  (*same signs, quotient is positive*)
24.  $\frac{-30}{-15} = 2$  (*same signs, quotient is positive*)
25.  $\frac{-18}{18} = -1$  (*different signs, quotient is negative*)
26.  $\frac{50}{-50} = -1$  (*different signs, quotient is negative*)
27.  $\frac{0}{-9} = 0$ ; zero divided by any nonzero number is 0.
28.  $\frac{0}{-4} = 0$ ; zero divided by any nonzero number is 0.
29.  $\frac{-573}{-3} = 191$  (*same signs, quotient is positive*)
30.  $\frac{-580}{-5} = 116$  (*same signs, quotient is positive*)
31.  $\frac{163,672}{-328} = -499$   
(*different signs, quotient is negative*)
32.  $\frac{-69,496}{1022} = -68$   
(*different signs, quotient is negative*)
33.  $-60 \div 10 \div (-3)$   
 $= -6 \div (-3)$  *Work left to right.*  
 $= 2$
34.  $36 \div (-4) \div 3$   
 $= -9 \div 3$  *Work left to right.*  
 $= -3$
35.  $-64 \div (-8) \div (-2)$   
 $= 8 \div (-2)$  *Work left to right.*  
 $= -4$

**36.**  $-72 \div (-9) \div (-4)$   
 $= 8 \div (-4)$  *Work left to right.*  
 $= -2$

**37.**  $100 \div (-5)(-2)$   
 $= -20(-2)$  *Work left to right.*  
 $= 40$

**38.**  $-80 \div 4(-5)$   
 $= -20(-5)$  *Work left to right.*  
 $= 100$

**39.**  $48 \div 3 \cdot (-12 \div 4)$   
 $= 48 \div 3 \cdot (-3)$  *Start inside the parentheses.*  
 $= 16 \cdot (-3)$  *Now work from left to right.*  
 $= -48$

40.  $-2 \cdot (-3) \cdot (-7) \div 7$   
 $= 6 \cdot (-7) \div 7$  *Work left to right.*  
 $= -42 \div 7$   
 $= -6$

**41.**  $-5 \div (-5)(-10) \div (-2)$   
 $= 1(-10) \div (-2)$  *Work left to right.*  
 $= -10 \div (-2)$   
 $= 5$

42.  $-9(4) \div (-36)(50)$   
 $= -36 \div (-36)(50)$  *Work left to right.*  
 $= 1(50)$   
 $= 50$

**43.**  $64 \cdot 0 \div (-8)(10)$   
 $= 0 \div (-8)(10)$  *Work left to right.*  
 $= 0(10)$   
 $= 0$

44.  $-88 \div (-8) \div (-11)(0)$   
 $= 11 \div (-11)(0)$  *Work left to right.*  
 $= -1(0)$   
 $= 0$

**45.**  $2 \div 1 = 2$  but  $1 \div 2 = 0.5$ , so division is not commutative.

46.  $\underbrace{(12 \div 6)}_{\underbrace{2 \div 2}_1} \div 2$        $12 \div \underbrace{(6 \div 2)}_{\underbrace{12 \div 3}_4}$   
different  
quotients

Division is not associative.

47. Similar: If the signs match, the result is positive.  
If the signs are different, the result is negative.  
Different: Multiplication is commutative; division is not. You can multiply by 0, but dividing by 0 is undefined.

**48.** Examples will vary. The properties are:

- Any nonzero number divided by itself is 1  
(example:  $4 \div 4 = 1$ ).
- Any number divided by 1 is the number  
(example:  $-7 \div 1 = -7$ ).
- Division by 0 is undefined  
(example:  $-5 \div 0$  is undefined).
- Zero divided by any other number (except 0) is 0  
(example:  $0 \div 9 = 0$ ).

**49.** Examples will vary.

(a)  $\frac{-6}{-1} = 6$ ;  $\frac{-2}{-1} = 2$ ;  $\frac{-15}{-1} = 15$

**(b)**  $\frac{6}{-1} = -6$ ;  $\frac{2}{-1} = -2$ ;  $\frac{15}{-1} = -15$

When dividing by  $-1$ , change the sign of the dividend to its opposite to get the quotient.

50. Division is not commutative.  $\frac{0}{-3} = 0$  because  $0 \cdot (-3) = 0$ . But  $\frac{-3}{0}$  is undefined because when  $\frac{-3}{0} = ?$  is rewritten as  $? \cdot 0 = -3$ , no number can replace  $?$  and make a true statement.

**51.** Depth below sea level implies a negative,  $-35,836$  feet. Use division to find the size of each step.  
 $-35.836 \approx -40.000$ ;  $17 \approx 20$

*Estimate:*  $-40,000 \div \underline{20} = \underline{-2000 \text{ feet}}$

*Exact:*  $-35,836 \div 17 = -2108$  feet

**52.** Using front end rounding:

$-3245 \text{ students} \approx -3000$

11 years  $\approx$  10 years

Average drop in enrollment:

*Estimate:*  $-3000 \div 10 = \underline{-300}$  students

*Exact:*  $-3245 \div 11 = -295$  students

**53.** Overdrawn implies a negative,  $-\$238$ . Transfer of money into the account, implies a positive,  $\$450$ .

$$-238 \approx -200; 450 \approx 500$$

*Estimate:*  $-200 + 500 = \$300$

*Exact:*  $-238 + 450 = \$212$

**54.** Using front end rounding:

Loss of 48 points =  $-48$  points  $\approx -50$  points

Gain of 191 points = +191 points  $\approx$  200 points

Number of points for both rounds:

*Estimate:*  $-50 + 200 = 150$  points

*Exact:*  $-48 + 191 = 143$  points

55. The number of non-foggy days equals the total number of days in a year minus the number of foggy days.  $365 \approx 400$ ;  $106 \approx 100$

*Estimate:*  $400 - 100 = 300$  days

*Exact:*  $365 - 106 = 259$  days

- 56.** Using front end rounding:  
 11 million  $\approx$  10 million  
 327 million  $\approx$  300 million  
 To find the increase in the number of users, use subtraction:  
*Estimate:* 300 million  $-$  10 million = 290 million  
*Exact:* 327 million  $-$  11 million = 316 million
- 57.** Descending implies a negative,  $-730$  feet each minute.  $-730 \approx -700$   
 Because the plane took  $37 \approx 40$  minutes to land, use multiplication to find how far the plane descended.  
*Estimate:*  $-700 \cdot 40 = -28,000$  feet  
*Exact:*  $-730 \cdot 37 = -27,010$  feet
- 58.** Using front end rounding:  
 Lost items:  $-174 \approx -200$   
 Average value:  $\$24 \approx \$20$   
 Total loss due to shoplifting:  
*Estimate:*  $-200 \cdot \$20 = -\$4000$   
*Exact:*  $-174 \cdot \$24 = -\$4176$
- 59.** Use division to find how many miles were covered in each hour.  $315 \approx 300$ ;  $5 \approx 5$   
*Estimate:*  $300 \div 5 = 60$  miles  
*Exact:*  $315 \div 5 = 63$  miles
- 60.** Using front end rounding:  
 48 months  $\approx$  50 months  
 $\$15,072 \approx \$20,000$   
 Rochelle's monthly car payment:  
*Estimate:*  $\$20,000 \div 50 = \$400$   
*Exact:*  $\$15,072 \div 48 = \$314$
- 61.** To find the average, add all the scores and divide by the number of scores.  
 Sum of scores:  $143 + 190 + 162 + 177 = 672$   
 Number of scores: 4 scores given  

$$\text{Average score} = \frac{672}{4} = 168$$
  
 His average score was 168.
- 62.** Amount spent on groceries over 6 weeks:  
 $\$184 + \$111 + \$136 + \$110 + \$98 + \$153 = \$792$   

$$\text{Average weekly cost} = \frac{\$792}{6} = \$132$$
  
 The average weekly cost of her groceries was \$132.
- 63.** Calculate the total weight from the data on the back, then use subtraction to find the difference between that and the figure on the front.  
 Total weight from back:  
 $13 \cdot 40$  grams = 520 grams  
 Difference from front:  $520 - 510 = 10$  grams  
 The back claims 10 more grams than the front.

- 64.** 67 grams of fat at 9 calories per gram:

$$67(9) = 603 \text{ calories in fat.}$$

You can consume  $2000 - 603 = 1397$  calories in other types of food on this diet.

- 65.** The \$302 already in Stephanie's account and her \$347 paycheck are positives. The money she paid for day care, \$116, and rent, \$548, are negatives.

$$\$302 + (-\$116) + (-\$548) + \$347 = -\$15$$

Stephanie's balance is  $-\$15$ . She is overdrawn by \$15.

- 66.** Account balance:

$$\$500 + (-\$18) + (-\$193) + (-\$289) = \$0$$

His account balance is \$0.

- 67.** Use division to convert minutes to hours.

$$\begin{array}{r} 1000 \text{ minutes} \\ 60 \text{ minutes per hour} \end{array} \quad \begin{array}{r} 16 \\ 60 \overline{) 1000} \\ \underline{60} \phantom{0} \\ 400 \\ \underline{360} \phantom{0} \\ 40 \end{array}$$

A new subscriber will receive 1000 minutes, which is 16 hours, with 40 minutes left over.

- 68.** Solve this problem by division and interpretation of the remainder.

$$\begin{array}{r} 100 \text{ guests} \\ 8 \text{ guests per pie} \end{array} \quad \begin{array}{r} 12 \\ 8 \overline{) 100} \\ \underline{8} \phantom{0} \\ 20 \\ \underline{16} \phantom{0} \\ 4 \end{array}$$

If Nikki makes 12 pies, 4 guests will go without pie. She must make 13 pies to serve all the guests with  $8 - 4 = 4$  pieces of pie left over.

- 69.** Use division to find the number of rooms.

$$\begin{array}{r} 163 \text{ people} \\ 5 \text{ people per room} \end{array} \quad \begin{array}{r} 32 \\ 5 \overline{) 163} \\ \underline{15} \phantom{0} \\ 13 \\ \underline{10} \phantom{0} \\ 3 \end{array}$$

32 rooms will be full, and that leaves 3 people. So 33 rooms are needed, with space for 2 people ( $5 - 3 = 2$ ) unused.

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70. Divide \$250,000 into scholarships at \$3500 each.

$$\begin{array}{r} 71 \\ 3500 \overline{) 250,000} \\ \underline{24500} \phantom{0} \\ 5000 \\ \underline{3500} \phantom{0} \\ 1500 \end{array}$$

There will be 71 scholarships of \$3500, with \$1500 left over.

71.  $|-8| \div (-4) \cdot |-5| \cdot |1|$

$$\begin{aligned} &= 8 \div (-4) \cdot 5 \cdot 1 && \text{Simplify the absolute values first.} \\ &= -2 \cdot 5 \cdot 1 && \text{No parentheses, so start from the left.} \\ &= -10 \cdot 1 \\ &= -10 \end{aligned}$$

72.  $-6 \cdot |-3| \div |9| \cdot (-2)$

$$\begin{aligned} &= -6 \cdot 3 \div 9 \cdot (-2) && \text{Simplify the absolute values first.} \\ &= -18 \div 9 \cdot (-2) && \text{No parentheses, so start from the left.} \\ &= -2 \cdot (-2) \\ &= 4 \end{aligned}$$

73.  $-6(-8) \div (-5 + 5)$

$$\begin{aligned} &= -6(-8) \div 0 && \text{Start inside the parentheses.} \\ &= 48 \div 0 && \text{Multiply and divide from left to right.} \\ &\text{Undefined} && \text{Division by zero} \end{aligned}$$

74.  $-9 \div (-9)(-9 \div 9) \div (12 - 13)$

$$\begin{aligned} &= -9 \div (-9)(-1) \div (-1) && \text{Start inside the parentheses.} \\ &= 1(-1) \div (-1) && \text{Multiply and divide from left to right.} \\ &= -1 \div (-1) \\ &= 1 \end{aligned}$$

75. Start by entering 1 000 000 000.

Divide by 60. ( $\approx 16,666,667$  minutes)

Divide by 60. ( $\approx 277,778$  hours)

Divide by 24. ( $\approx 11,574$  days)

Divide by 365. ( $\approx 31.7$  years)

31.70979198 rounds to 32 years to receive one billion dollars.

2.  $(-16)(0) = 0$ ; multiplication property of 0

3.  $-14 - (-7)$   
 $= -14 + 7$  Add the opposite.  
 $= -7$

4.  $\frac{-42}{6} = -7$  (different signs, quotient is negative)

5.  $-9(-7) = 63$  (same signs, product is positive)

6.  $\frac{-12}{12} = -1$  (different signs, quotient is negative)

7.  $(1)(-56) = -56$  Multiplication property of 1

8.  $1 + (-23) = -22$

9.  $5 - (-7)$   
 $= 5 + 7$  Add the opposite.  
 $= 12$

10.  $-88 \div (-11)$   
 $= 8$  (same signs, quotient is positive)

11.  $-18 + 5 = -13$

12.  $\frac{0}{-10} = 0$ ; zero divided by any nonzero number is 0.

13.  $-40 - (-40)$   
 $= -40 + (+40)$  Add the opposite.  
 $= 0$  Addition of opposites is 0.

14.  $-17 + 0 = -17$ ; addition property of 0

15.  $8(-6) = -48$  (different signs, product is negative)

16.  $-1 - 9$   
 $= -1 + (-9)$  Add the opposite.  
 $= -10$

17.  $-5(10) = -50$  (different signs, product is negative)

18.  $\frac{30}{0}$  is undefined. Division by zero is undefined.

19.  $0 - 14$   
 $= 0 + (-14)$  Add the opposite.  
 $= -14$  Addition property of 0.

20.  $\frac{18}{-3} = -6$  (different signs, quotient is negative)

21.  $-13 + 13$   
 $= 0$  Addition of opposites is 0.

22.  $\frac{-16}{-1} = 16$  (same signs, quotient is positive)

23.  $20 - 50$   
 $= 20 + (-50)$  Add the opposite.  
 $= -30$

### Summary Exercises Operations with Integers

1.  $2 - 8$   
 $= 2 + (-8)$  Add the opposite.  
 $= -6$

24.  $\frac{-7}{0}$  is undefined. Division by zero is undefined.
25.  $(-4)(-6)(2)$   
 $= (24)(2)$  *Multiply from left to right.*  
 $= 48$
26.  $-2 + (-12) + (-5)$   
 $= -14 + (-5)$  *Add from left to right.*  
 $= -19$
27.  $-60 \div 10 \div (-3)$   
 $= -6 \div (-3)$  *Divide from left to right.*  
 $= 2$
28.  $-8 - 4 - 8$   
 $= -8 + (-4) + (-8)$  *Add the opposites.*  
 $= -12 + (-8)$  *Add from left to right.*  
 $= -20$
29.  $64(0) \div (-8)$   
 $= 0 \div (-8)$  *Multiply.*  
 $= 0$  *Divide.*
30.  $2 - (-5) + 9$   
 $= 2 + (+5) + 9$  *Add the opposite.*  
 $= 7 + 9$  *Add from left to right.*  
 $= 16$
31.  $-9 + 8 + (-2)$   
 $= -1 + (-2)$  *Add from left to right.*  
 $= -3$
32.  $(-6)(-2)(-3)$   
 $= (12)(-3)$  *Multiply from left to right.*  
 $= -36$
33.  $8 + 6 + (-8)$   
 $= 14 + (-8)$  *Add from left to right.*  
 $= 6$
34.  $9 - 0 - 16$   
 $= 9 - 16$  *Add from left to right.*  
 $= 9 + (-16)$  *Add the opposite.*  
 $= -7$
35.  $-25 \div (-1) \div (-5)$   
 $= 25 \div (-5)$  *Divide from left to right.*  
 $= -5$
36.  $1 - 32 + 0$   
 $= 1 + (-32) + 0$  *Add the opposite.*  
 $= -31 + 0$  *Add from left to right.*  
 $= -31$
37.  $-72 \div (-9) \div (-4)$   
 $= 8 \div (-4)$  *Divide from left to right.*  
 $= -2$
38.  $-7 + 28 + (-56) + 3$   
 $= 21 + (-56) + 3$  *Add from left to right.*  
 $= -35 + 3$   
 $= -32$
39.  $9 - 6 - 3 - 5$   
 $= 9 + (-6) + (-3) + (-5)$  *Add the opposite.*  
 $= 3 + (-3) + (-5)$  *Add from left to right.*  
 $= 0 + (-5)$   
 $= -5$
40.  $-6(-8) \div (-5 - 7)$   
 $= -6(-8) \div [-5 + (-7)]$  *Change to addition.*  
 $= -6(-8) \div (-12)$  *Brackets*  
 $= 48 \div (-12)$  *Multiply.*  
 $= -4$  *Divide.*
41.  $-1(9732)(-1)(-1)$   
 $= (-9732)(-1)(-1)$  *Multiply from left to right.*  
 $= (9732)(-1)$   
 $= -9732$
42.  $-80 \div 4(-5)$   
 $= -20(-5)$  *Divide.*  
 $= 100$  *Multiply.*
43.  $-10 - 4 + 0 + 18$   
 $= -10 + (-4) + 0 + 18$  *Add the opposite.*  
 $= -14 + 0 + 18$  *Add from left to right.*  
 $= -14 + 18$   
 $= 4$
44.  $-7 \cdot |7| \cdot |-7|$   
 $= -7 \cdot 7 \cdot 7$  *Absolute values*  
 $= -49 \cdot 7$  *Multiply from left to right.*  
 $= -343$
45.  $5 - |-3| + 3$   
 $= 5 - 3 + 3$  *Absolute value first*  
 $= 5 + (-3) + 3$  *Add the opposite.*  
 $= 2 + 3$  *Add from left to right.*  
 $= 5$
46.  $-2(-3)(7) \div (-7)$   
 $= 6(7) \div (-7)$  *Multiply.*  
 $= 42 \div (-7)$  *Multiply.*  
 $= -6$  *Divide.*
47.  $-3 - (-2 + 4) - 5$   
 $= -3 - 2 - 5$  *Parentheses first*  
 $= -3 + (-2) + (-5)$  *Add the opposites.*  
 $= -5 + (-5)$  *Add from left to right.*  
 $= -10$

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48.  $0 - |-7 + 2|$   
 $= 0 - |-5|$  *Add within absolute value.*  
 $= 0 - 5$  *Absolute value*  
 $= 0 + (-5)$  *Add the opposite.*  
 $= -5$
49. (a) If zero is divided by a nonzero number, the quotient is 0.  
 (b) If any number is multiplied by 0, the product is 0.  
 (c) If a nonzero number is divided by itself, the quotient is 1.
50. (a)  $\frac{15}{-15} = 0$   
 The quotient is  $-1$ . *Adding*  $15 + (-15)$  would give a *sum* of 0.  
 (b)  $\frac{8}{0} = 8$   
 Dividing by zero cannot be done; the correct answer is "undefined."  
 (c)  $-10 \div (-2) \div (-5) = 1$ .  
 Work with two numbers at a time:  $-10 \div (-2)$  is 5; then  $5 \div (-5)$  is  $-1$ , **not** positive 1.

## 1.8 Exponents and Order of Operations

### 1.8 Margin Exercises

1. (a)  $3 \cdot 3 \cdot 3 \cdot 3 = 3^4$   
 is read "3 to the fourth power."  
 (b)  $6 \cdot 6 = 6^2$   
 is read "6 squared" or "6 to the second power."  
 (c)  $9 = 9^1$   
 is read "9 to the first power."  
 (d)  $(2)(2)(2)(2)(2)(2) = (2)^6 = 2^6$   
 is read "2 to the sixth power."
2. (a)  $(-2)^3 = (-2)(-2)(-2)$   
 $= (\underline{4})(-2)$   
 $= \underline{-8}$   
 (b)  $(-6)^2 = (-6)(-6)$   
 $= 36$   
 (c)  $2^4(-3)^2 = \underbrace{(2)(2)(2)(2)}_{(16)} \cdot \underbrace{(-3)(-3)}_{(9)}$   
 $= 144$   
 (d)  $3^3 \cdot (-4)^2 = \underbrace{(3)(3)(3)}_{(27)} \cdot \underbrace{(-4)(-4)}_{(16)}$   
 $= 432$

3. (a)  $-9 + (-15) - 3$   
 $= -9 + (-15) + (-3)$  *Change subtr. to addition.*  
 $= \underline{-24} + (-3)$  *Change 3 to  $-3$ .*  
 $= \underline{-27}$  *Add left to right.*  
 (b)  $-4 - 2 + (-6)$   
 $= -4 + (-2) + (-6)$  *Change subtr. to addition.*  
 $= -6 + (-6)$  *Change 2 to  $-2$ .*  
 $= -12$  *Add left to right.*  
 (c)  $3(-4) \div (-6)$   
 $= -12 \div (-6)$  *Multiply and divide left to right.*  
 $= 2$   
 (d)  $-18 \div 9(-4)$   
 $= (\underline{-2})(-4)$  *Multiply and divide left to right.*  
 $= 8$
4. (a)  $8 + 6(14 \div 2)$   
 $= 8 + 6(7)$  *Parentheses first*  
 $= 8 + \underline{42}$  *Multiply.*  
 $= \underline{50}$  *Addition last*  
 (b)  $4(1) + 8(9 - 2)$   
 $= 4(1) + 8(7)$  *Parentheses first*  
 $= 4 + 56$  *Multiply.*  
 $= 60$  *Addition last*  
 (c)  $3(5 + 1) + 20 \div 4$   
 $= 3(6) + 20 \div 4$  *Parentheses first*  
 $= 18 + 20 \div 4$  *Multiply and divide left to right.*  
 $= 18 + 5$   
 $= 23$  *Addition last*
5. (a)  $2 + 40 \div (-5 + 3)$   
 $= 2 + 40 \div (-2)$  *Parentheses first*  
 $= 2 + (\underline{-20})$  *Divide.*  
 $= \underline{-18}$  *Addition last*  
 (b)  $-5(5) - (15 + 5)$   
 $= -5(5) - 20$  *Parentheses first*  
 $= -25 - 20$  *Multiply.*  
 $= -25 + (-20)$  *Change subtraction to addition. Change 20 to its opposite.*  
 $= -45$  *Addition last*  
 (c)  $(-24 \div 2) + (15 - 3)$   
 $= -12 + 12$  *Parentheses first*  
 $= 0$  *Addition last*

$$\begin{aligned}
 \text{(d)} \quad & -3(2 - 8) - 5(4 - 3) \\
 & = -3(-6) - 5(1) \quad \text{Parentheses first} \\
 & = 18 - 5(1) \quad \text{Multiply left to right.} \\
 & = 18 - 5 \\
 & = 18 + (-5) \quad \text{Change subtraction to addition. Change 5 to its opposite.} \\
 & = 13 \quad \text{Addition last}
 \end{aligned}$$

$$\begin{aligned}
 \text{(e)} \quad & 3(3) - (10 \cdot 3) \div 5 \\
 & = 3(3) - 30 \div 5 \quad \text{Parentheses first} \\
 & = 9 - 30 \div 5 \quad \text{Multiply and divide left to right.} \\
 & = 9 - 6 \\
 & = 9 + (-6) \quad \text{Change subtraction to addition. Change 6 to its opposite.} \\
 & = 3 \quad \text{Addition last}
 \end{aligned}$$

$$\begin{aligned}
 \text{(f)} \quad & 6 - (2 + 7) \div (-4 + 1) \\
 & = 6 - 9 \div (-3) \quad \text{Parentheses first} \\
 & = 6 - (-3) \quad \text{Divide.} \\
 & = 6 + (+3) \\
 & = 9
 \end{aligned}$$

$$\begin{aligned}
 6. \quad \text{(a)} \quad & 2^3 - 3^2 \\
 & = 8 - 9 \quad \text{Apply exponents.} \\
 & = 8 + (-9) \quad \text{Change subtr. to addition.} \\
 & = -1 \quad \text{Change 9 to -9. Add.} \\
 \text{(b)} \quad & 6^2 \div (-4)(-3) \\
 & = 36 \div (-4)(-3) \quad \text{Apply exponent.} \\
 & = -9(-3) \quad \text{Work left to right.} \\
 & = 27 \\
 \text{(c)} \quad & (-4)^2 - 3^2(5 - 2) \\
 & = (-4)^2 - 3^2(3) \quad \text{Parentheses first} \\
 & = 16 - 9(3) \quad \text{Apply exponents.} \\
 & = 16 - 27 \quad \text{Multiply.} \\
 & = 16 + (-27) \quad \text{Change subtraction to addition.} \\
 & = -11 \quad \text{Change 27 to -27. Add.} \\
 \text{(d)} \quad & (-3)^3 + (3 - 9)^2 \\
 & = (-3)^3 + (-6)^2 \quad \text{Parentheses first} \\
 & = -27 + 36 \quad \text{Apply exponents.} \\
 & = 9 \quad \text{Add.}
 \end{aligned}$$

$$7. \quad \text{(a)} \quad \frac{-3(2^3)}{-10 - 6 + 8}$$

$$\begin{aligned}
 \text{Numerator:} \\
 & = -3(2^3) \\
 & = -3(8) \quad \text{Exponent first} \\
 & = -24 \quad \text{Multiply.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & = -10 - 6 + 8 \\
 & = -10 + (-6) + 8 \quad \text{Change subtraction to addition.} \\
 & = -16 + 8 \quad \text{Change 6 to -6.} \\
 & = -8 \quad \text{Add from left to right.}
 \end{aligned}$$

$$\text{Last step is division: } \frac{-24}{-8} = 3$$

$$\text{(b)} \quad \frac{(-10)(-5)}{-6 \div 3(5)}$$

$$\begin{aligned}
 \text{Numerator:} \\
 & = (-10)(-5) \\
 & = 50
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & = -6 \div 3(5) \\
 & = -2(5) \quad \text{Multiply and divide left to right.} \\
 & = -10
 \end{aligned}$$

$$\text{Last step is division: } \frac{50}{-10} = -5$$

$$\text{(c)} \quad \frac{6 + 18 \div (-2)}{(1 - 10) \div 3}$$

$$\begin{aligned}
 \text{Numerator:} \\
 & = 6 + 18 \div (-2) \\
 & = 6 + (-9) \quad \text{Divide before adding.} \\
 & = -3
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & = (1 - 10) \div 3 \\
 & = -9 \div 3 \quad \text{Parentheses first} \\
 & = -3
 \end{aligned}$$

$$\text{Last step is division: } \frac{-3}{-3} = 1$$

$$\begin{aligned}
 \text{(d)} \quad \text{Numerator:} \\
 & = 6^2 - 3^2(4) \\
 & = 36 - 9(4) \quad \text{Exponents first} \\
 & = 36 - 36 \quad \text{Multiply before subtracting.} \\
 & = 0
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & = 5 + (3 - 7)^2 \\
 & = 5 + (-4)^2 \quad \text{Parentheses first} \\
 & = 5 + 16 \quad \text{Exponent next} \\
 & = 21 \quad \text{Addition last}
 \end{aligned}$$

$$\text{Last step is division: } \frac{0}{21} = 0$$

## 1.8 Section Exercises

- Exponential Form:  $4^3$   
Factored Form:  $4 \cdot 4 \cdot 4$   
Simplified: 64  
Read as: 4 cubed or 4 to the third power

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2. Exponential Form:  $10^2$   
Factored Form:  $10 \cdot 10$   
Simplified: 100  
Read as: 10 squared or 10 to the second power
3. Exponential Form:  $2^7$   
Factored Form:  $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$   
Simplified: 128  
Read as: 2 to the seventh power
4. Exponential Form:  $3^5$   
Factored Form:  $3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$   
Simplified: 243  
Read as: 3 to the fifth power
5. Exponential Form:  $5^4$   
Factored Form:  $5 \cdot 5 \cdot 5 \cdot 5$   
Simplified: 625  
Read as: 5 to the fourth power
6. Exponential Form:  $2^6$   
Factored Form:  $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$   
Simplified: 64  
Read as: 2 to the sixth power
7. Exponential Form:  $7^2$   
Factored Form:  $7 \cdot 7$   
Simplified: 49  
Read as: 7 squared
8. Exponential Form:  $6^3$   
Factored Form:  $6 \cdot 6 \cdot 6$   
Simplified: 216  
Read as: 6 cubed
9. Exponential Form:  $10^1$   
Factored Form: 10  
Simplified: 10  
Read as: 10 to the first power
10. Exponential Form:  $4^4$   
Factored Form:  $4 \cdot 4 \cdot 4 \cdot 4$   
Simplified: 256  
Read as: 4 to the fourth power
11. (a)  $10^1 = 10$   
(b)  $10^2 = 10 \cdot 10 = 100$   
(c)  $10^3 = 10 \cdot 10 \cdot 10$   
 $= 100 \cdot 10$   
 $= 1000$   
(d)  $10^4 = 10 \cdot 10 \cdot 10 \cdot 10$   
 $= 100 \cdot 10 \cdot 10$   
 $= 1000 \cdot 10$   
 $= 10,000$
12. (a)  $5^1 = 5$   
(b)  $5^2 = 5 \cdot 5 = 25$   
(c)  $5^3 = 5 \cdot 5 \cdot 5$   
 $= 25 \cdot 5$   
 $= 125$
- (d)  $5^4 = 5 \cdot 5 \cdot 5 \cdot 5$   
 $= 25 \cdot 5 \cdot 5$   
 $= 125 \cdot 5$   
 $= 625$
13. (a)  $4^1 = 4$   
(b)  $4^2 = 4 \cdot 4 = 16$   
(c)  $4^3 = 4 \cdot 4 \cdot 4$   
 $= 16 \cdot 4$   
 $= 64$   
(d)  $4^4 = 4 \cdot 4 \cdot 4 \cdot 4$   
 $= 16 \cdot 4 \cdot 4$   
 $= 64 \cdot 4$   
 $= 256$
14. (a)  $3^1 = 3$   
(b)  $3^2 = 3 \cdot 3 = 9$   
(c)  $3^3 = 3 \cdot 3 \cdot 3$   
 $= 9 \cdot 3$   
 $= 27$   
(d)  $3^4 = 3 \cdot 3 \cdot 3 \cdot 3$   
 $= 9 \cdot 3 \cdot 3$   
 $= 27 \cdot 3$   
 $= 81$
15.  $5^{10}$  on the calculator is 9,765,625.
16.  $4^9$  on the calculator is 262,144.
17.  $2^{12}$  on the calculator is 4096.
18.  $3^{10}$  on the calculator is 59,049.
19.  $(-2)^2 = (-2)(-2)$   
 $= 4$
20.  $(-4)^2 = (-4)(-4)$   
 $= 16$
21.  $(-5)^2 = (-5)(-5)$   
 $= 25$
22.  $(-10)^2 = (-10)(-10)$   
 $= 100$
23.  $(-4)^3 = (-4)(-4)(-4)$   
 $= 16(-4)$   
 $= -64$
24.  $(-2)^3 = (-2)(-2)(-2)$   
 $= 4(-2)$   
 $= -8$
25.  $(-3)^4 = (-3)(-3)(-3)(-3)$   
 $= 9(-3)(-3)$   
 $= -27(-3)$   
 $= 81$



$$\begin{aligned} 26. \quad (-2)^4 &= (-2)(-2)(-2)(-2) \\ &= 4(-2)(-2) \\ &= -8(-2) \\ &= 16 \end{aligned}$$

$$\begin{aligned} 27. \quad (-10)^3 &= (-10)(-10)(-10) \\ &= 100(-10) \\ &= -1000 \end{aligned}$$

$$\begin{aligned} 28. \quad (-5)^3 &= (-5)(-5)(-5) \\ &= 25(-5) \\ &= -125 \end{aligned}$$

$$29. \quad 1^4 = 1 \text{ because 1 times itself any number of times equals 1.}$$

$$30. \quad 1^5 = 1 \text{ because 1 times itself any number of times equals 1.}$$

$$\begin{aligned} 31. \quad 3^3 \cdot 2^2 &= 27 \cdot 4 \quad \text{Apply exponents.} \\ &= 108 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 32. \quad 4^2 \cdot 5^2 &= 16 \cdot 25 \quad \text{Apply exponents.} \\ &= 400 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 33. \quad 2^3(-5)^2 &= 8(25) \quad \text{Apply exponents.} \\ &= 200 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 34. \quad 3^2(-2)^2 &= 9(4) \quad \text{Apply exponents.} \\ &= 36 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 35. \quad 6^1(-5)^3 &= 6(-125) \quad \text{Apply exponents.} \\ &= -750 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 36. \quad 7^1(-4)^3 &= 7(-64) \quad \text{Apply exponents.} \\ &= -448 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 37. \quad (-2)(-2)^4 &= -2(16) \quad \text{Apply exponent.} \\ &= -32 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 38. \quad -6(-6)^2 &= -6(36) \quad \text{Apply exponent.} \\ &= -216 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 39. \quad (-2)^2 &= \underline{4} & (-2)^6 &= \underline{64} \\ (-2)^3 &= \underline{-8} & (-2)^7 &= \underline{-128} \\ (-2)^4 &= \underline{16} & (-2)^8 &= \underline{256} \\ (-2)^5 &= \underline{-32} & (-2)^9 &= \underline{-512} \end{aligned}$$

(a) When a negative number is raised to an even power, the answer is positive; when raised to an odd power, the answer is negative.

(b) 15 is odd, so the sign of  $(-2)^{15}$  is negative. 24 is even, so the sign of  $(-2)^{24}$  is positive.

40. We need rules so that everyone will work problems the same way and get the same answers. We probably want to work from left to right because in many languages we read from left to right.

$$\begin{aligned} 41. \quad 12 \div 6(-3) &= \underline{2}(-3) \quad \text{Divide.} \\ &= \underline{-6} \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 42. \quad 10 - 30 \div 2 &= 10 - \underline{15} \quad \text{Divide.} \\ &= 10 + (-15) \quad \text{Add the opposite.} \\ &= \underline{-5} \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 43. \quad -1 + 15 - 7 - 7 &= 14 - 7 - 7 \quad \text{Add left to right.} \\ &= 14 + (-7) + (-7) \quad \text{Add the opposite.} \\ &= 7 + (-7) \quad \text{Add left to right.} \\ &= 0 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 44. \quad 9 + (-5) + 2(-2) &= 9 + (-5) + (-4) \quad \text{Multiply.} \\ &= 4 + (-4) \quad \text{Add from left to right.} \\ &= 0 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 45. \quad 10 - 7^2 &= 10 - 49 \quad \text{Apply exponent.} \\ &= 10 + (-49) \quad \text{Add the opposite.} \\ &= -39 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 46. \quad 5 - 5^2 &= 5 - 25 \quad \text{Apply exponent.} \\ &= 5 + (-25) \quad \text{Add the opposite.} \\ &= -20 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 47. \quad 2 - (-5) + 3^2 &= 2 - (-5) + 9 \quad \text{Apply exponent.} \\ &= 2 + (+5) + 9 \quad \text{Add the opposite.} \\ &= 7 + 9 \quad \text{Add from left to right.} \\ &= 16 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 48. \quad 6 - (-9) + 2^3 &= 6 - (-9) + 8 \quad \text{Apply exponent.} \\ &= 6 + (+9) + 8 \quad \text{Add the opposite.} \\ &= 15 + 8 \quad \text{Add from left to right.} \\ &= 23 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 49. \quad 3 + 5(6 - 2) &= 3 + 5[6 + (-2)] \quad \text{Add the opposite.} \\ &= 3 + 5(4) \quad \text{Brackets} \\ &= 3 + 20 \quad \text{Multiply.} \\ &= 23 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 50. \quad 4 + 3(8 - 3) &= 4 + 3[8 + (-3)] \quad \text{Add the opposite.} \\ &= 4 + 3(5) \quad \text{Brackets} \\ &= 4 + 15 \quad \text{Multiply.} \\ &= 19 \quad \text{Add.} \end{aligned}$$

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$$\begin{aligned}
 51. \quad & -7 + 6(8 - 14) \\
 & = -7 + 6[8 + (-14)] \quad \text{Add the opposite.} \\
 & = -7 + 6(-6) \quad \text{Brackets} \\
 & = -7 + (-36) \quad \text{Multiply.} \\
 & = -43 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 52. \quad & -3 + 5(9 - 12) \\
 & = -3 + 5[9 + (-12)] \quad \text{Add the opposite.} \\
 & = -3 + 5(-3) \quad \text{Brackets} \\
 & = -3 + (-15) \quad \text{Multiply.} \\
 & = -18 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 53. \quad & 2(-3 + 5) - (9 - 12) \\
 & = 2(-3 + 5) - [9 + (-12)] \quad \text{Add the opposite.} \\
 & = 2(2) - (-3) \quad \text{Brackets} \\
 & = 4 - (-3) \quad \text{Multiply.} \\
 & = 4 + (+3) \quad \text{Add the opposite.} \\
 & = 7 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 54. \quad & 3(2 - 7) - (-5 + 1) \\
 & = 3[2 + (-7)] - (-5 + 1) \quad \text{Add the opposite.} \\
 & = 3(-5) - (-4) \quad \text{Brackets} \\
 & = -15 - (-4) \quad \text{Multiply.} \\
 & = -15 + (+4) \quad \text{Add the opposite.} \\
 & = -11 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 55. \quad & -5(7 - 13) \div (-10) \\
 & = -5[7 + (-13)] \div (-10) \quad \text{Add the opposite.} \\
 & = -5(-6) \div (-10) \quad \text{Brackets} \\
 & = 30 \div (-10) \quad \text{Multiply.} \\
 & = -3 \quad \text{Divide.}
 \end{aligned}$$

$$\begin{aligned}
 56. \quad & -4(9 - 17) \div (-8) \\
 & = -4[9 + (-17)] \div (-8) \quad \text{Add the opposite.} \\
 & = -4(-8) \div (-8) \quad \text{Brackets} \\
 & = 32 \div (-8) \quad \text{Multiply.} \\
 & = -4 \quad \text{Divide.}
 \end{aligned}$$

$$\begin{aligned}
 57. \quad & 9 \div (-3)^2 + (-1) \\
 & = 9 \div 9 + (-1) \quad \text{Exponent first} \\
 & = 1 + (-1) \quad \text{Divide.} \\
 & = 0 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 58. \quad & -48 \div (-4)^2 + 3 \\
 & = -48 \div 16 + 3 \quad \text{Exponent first} \\
 & = -3 + 3 \quad \text{Divide.} \\
 & = 0 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 59. \quad & 2 - (-5)(-2)^3 \\
 & = 2 - (-5)(-8) \quad \text{Exponent first} \\
 & = 2 - 40 \quad \text{Multiply.} \\
 & = 2 + (-40) \quad \text{Add the opposite.} \\
 & = -38 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 60. \quad & 1 - (-10)(-3)^3 \\
 & = 1 - (-10)(-27) \quad \text{Exponent first} \\
 & = 1 - 270 \quad \text{Multiply.} \\
 & = 1 + (-270) \quad \text{Add the opposite.} \\
 & = -269 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 61. \quad & -2(-7) + 3(9) \\
 & = 14 + 3(9) \quad \text{Multiply.} \\
 & = 14 + 27 \quad \text{Multiply.} \\
 & = 41 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 62. \quad & 4(-2) + (-3)(-5) \\
 & = -8 + (-3)(-5) \quad \text{Multiply.} \\
 & = -8 + 15 \quad \text{Multiply.} \\
 & = 7 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 63. \quad & 30 \div (-5) - 36 \div (-9) \\
 & = -6 - 36 \div (-9) \quad \text{Divide.} \\
 & = -6 - (-4) \quad \text{Divide.} \\
 & = -6 + (+4) \quad \text{Add the opposite.} \\
 & = -2 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 64. \quad & 8 \div (-4) - 42 \div (-7) \quad \text{Divide.} \\
 & = -2 - 42 \div (-7) \quad \text{Divide.} \\
 & = -2 - (-6) \quad \text{Add the opposite.} \\
 & = -2 + (+6) \quad \text{Add.} \\
 & = 4
 \end{aligned}$$

$$\begin{aligned}
 65. \quad & 2(5) - 3(4) + 5(3) \\
 & = 10 - 3(4) + 5(3) \quad \text{Multiply.} \\
 & = 10 - 12 + 5(3) \quad \text{Multiply.} \\
 & = 10 - 12 + 15 \quad \text{Multiply.} \\
 & = 10 + (-12) + 15 \quad \text{Add the opposite.} \\
 & = -2 + 15 \quad \text{Add.} \\
 & = 13 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 66. \quad & 9(3) - 6(4) + 3(7) \\
 & = 27 - 24 + 21 \quad \text{Multiply.} \\
 & = 27 + (-24) + 21 \quad \text{Add the opposite.} \\
 & = 3 + 21 \quad \text{Add.} \\
 & = 24 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 67. \quad & 4(3^2) + 7(3 + 9) - (-6) \\
 & = 4(3^2) + 7(12) - (-6) \quad \text{Parentheses first} \\
 & = 4(9) + 7(12) - (-6) \quad \text{Exponent next} \\
 & = 36 + 7(12) - (-6) \quad \text{Multiply.} \\
 & = 36 + 84 - (-6) \quad \text{Multiply.} \\
 & = 36 + 84 + (+6) \quad \text{Add the opposite.} \\
 & = 120 + 6 \quad \text{Add.} \\
 & = 126 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 68. \quad & 5(4^2) - 6(1 + 4) - (-3) \\
 & = 5(4^2) - 6(5) - (-3) \quad \text{Parentheses first} \\
 & = 5(16) - 6(5) - (-3) \quad \text{Exponent next} \\
 & = 80 - 30 - (-3) \quad \text{Multiply.} \\
 & = 80 + (-30) + (+3) \quad \text{Add the opposite.} \\
 & = 50 + 3 \quad \text{Add.} \\
 & = 53 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 69. \quad & (-4)^2 \cdot (7 - 9)^2 \div 2^3 \\
 & = (-4)^2 \cdot [7 + (-9)]^2 \div 2^3 \quad \text{Add the opposite.} \\
 & = (-4)^2 \cdot (-2)^2 \div 2^3 \quad \text{Brackets first} \\
 & = 16 \cdot 4 \div 8 \quad \text{Exponents next} \\
 & = 64 \div 8 \quad \text{Multiply.} \\
 & = 8 \quad \text{Divide.}
 \end{aligned}$$

$$\begin{aligned}
 70. \quad & (-5)^2 \cdot (9 - 17)^2 \div (-10)^2 \\
 & = (-5)^2 \cdot [9 + (-17)]^2 \div (-10)^2 \quad \text{Add the opposite.} \\
 & = (-5)^2 \cdot (-8)^2 \div (-10)^2 \quad \text{Brackets} \\
 & = 25 \cdot 64 \div 100 \quad \text{Exponents} \\
 & = 1600 \div 100 \quad \text{Multiply.} \\
 & = 16 \quad \text{Divide.}
 \end{aligned}$$

$$\begin{aligned}
 71. \quad & \frac{-1 + 5^2 - (-3)}{-6 - 9 + 12} \\
 \text{Numerator:} \\
 & -1 + 5^2 - (-3) \\
 & = -1 + 25 - (-3) \quad \text{Exponent first} \\
 & = -1 + 25 + (+3) \quad \text{Add the opposite.} \\
 & = 24 + 3 \quad \text{Add left to right.} \\
 & = 27
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & -6 - 9 + 12 \\
 & = -6 + (-9) + 12 \quad \text{Add the opposite.} \\
 & = -15 + 12 \quad \text{Add left to right.} \\
 & = -3
 \end{aligned}$$

$$\text{Last step is division: } \frac{27}{-3} = -9$$

$$\begin{aligned}
 72. \quad & \frac{-6 + 3^2 - (-7)}{7 - 9 - 3} \\
 \text{Numerator: } & -6 + 3^2 - (-7) = -6 + 9 - (-7) \\
 & = -6 + 9 + (+7) \\
 & = 3 + 7 \\
 & = 10
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator: } & 7 - 9 - 3 = 7 + (-9) + (-3) \\
 & = -2 + (-3) \\
 & = -5
 \end{aligned}$$

$$\text{Last step is division: } \frac{10}{-5} = -2$$

$$\begin{aligned}
 73. \quad & \frac{-2(4^2) - 4(6 - 2)}{-4(8 - 13) \div (-5)} \\
 \text{Numerator:} \\
 & -2(4^2) - 4(6 - 2) \\
 & = -2(4^2) - 4(4) \quad \text{Parentheses first} \\
 & = -2(16) - 4(4) \quad \text{Exponent} \\
 & = -32 - 16 \quad \text{Multiply from left to right.} \\
 & = -32 + (-16) \quad \text{Add the opposite.} \\
 & = -48 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & -4(8 - 13) \div (-5) \\
 & = -4[8 + (-13)] \div (-5) \quad \text{Add the opposite.} \\
 & = -4(-5) \div (-5) \quad \text{Brackets first} \\
 & = 20 \div (-5) \quad \text{Multiply.} \\
 & = -4 \quad \text{Divide.}
 \end{aligned}$$

$$\text{Last step is division: } \frac{-48}{-4} = 12$$

$$\begin{aligned}
 74. \quad & \frac{3(3^2) - 5(9 - 2)}{8(6 - 9) \div (-3)} \\
 \text{Numerator: } & 3(3^2) - 5(9 - 2) = 3(9) - 5(7) \\
 & = 27 - 35 \\
 & = 27 + (-35) \\
 & = -8
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & 8(6 - 9) \div (-3) = 8(6 + (-9)) \div (-3) \\
 & = 8(-3) \div (-3) \\
 & = -24 \div (-3) \\
 & = 8
 \end{aligned}$$

$$\text{Last step is division: } \frac{-8}{8} = -1$$

$$\begin{aligned}
 75. \quad & \frac{2^3 \cdot (-2 - 5) + 4(-1)}{4 + 5(-6 \cdot 2) + (5 \cdot 11)} \\
 \text{Numerator:} \\
 & 2^3 \cdot (-2 - 5) + 4(-1) \\
 & = 2^3 \cdot [-2 + (-5)] + 4(-1) \quad \text{Add the opposite.} \\
 & = 2^3 \cdot (-7) + 4(-1) \quad \text{Brackets} \\
 & = 8 \cdot (-7) + 4(-1) \quad \text{Exponent} \\
 & = -56 + 4(-1) \quad \text{Multiply.} \\
 & = -56 + (-4) \quad \text{Multiply.} \\
 & = -60 \quad \text{Add.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Denominator:} \\
 & 4 + 5(-6 \cdot 2) + (5 \cdot 11) \\
 & = 4 + 5(-12) + (5 \cdot 11) \quad \text{Parentheses} \\
 & = 4 + 5(-12) + 55 \quad \text{Parentheses} \\
 & = 4 + (-60) + 55 \quad \text{Multiply.} \\
 & = -56 + 55 \quad \text{Add left to right.} \\
 & = -1
 \end{aligned}$$

$$\text{Last step is division: } \frac{-60}{-1} = 60$$

$$76. \frac{3^3 + 4(-1 - 2) - 25}{-4 + 4(3 \cdot 5) + (-6 \cdot 9)}$$

$$\begin{aligned}\text{Numerator: } & 3^3 + 4(-1 - 2) - 25 \\ & = 3^3 + 4(-1 + (-2)) - 25 \\ & = 3^3 + 4(-3) - 25 \\ & = 27 + 4(-3) - 25 \\ & = 27 + (-12) - 25 \\ & = 15 - 25 \\ & = 15 + (-25) \\ & = -10\end{aligned}$$

$$\begin{aligned}\text{Denominator: } & -4 + 4(3 \cdot 5) + (-6 \cdot 9) \\ & = -4 + 4(15) + (-54) \\ & = -4 + 60 + (-54) \\ & = 56 + (-54) \\ & = 2\end{aligned}$$

$$\text{Last step is division: } \frac{-10}{2} = -5$$

$$\begin{aligned}77. & 5^2(9 - 11)(-3)(-3)^3 \\ & = 5^2[9 + (-11)](-3)(-3)^3 \quad \text{Add the opposite.} \\ & = 5^2(-2)(-3)(-3)^3 \quad \text{Brackets first} \\ & = 25(-2)(-3)(-27) \quad \text{Exponents} \\ & = -50(-3)(-27) \quad \text{Mult. left to right.} \\ & = 150(-27) \\ & = -4050\end{aligned}$$

$$\begin{aligned}78. & 4^2(13 - 17)(-2)(-2)^3 \\ & = 16(13 + (-17))(-2)(-8) \\ & = 16(-4)(-2)(-8) \\ & = -64(-2)(-8) \\ & = 128(-8) \\ & = -1024\end{aligned}$$

$$\begin{aligned}79. & |-12| \div 4 + 2 \cdot |(-2)^3| \div 4 \\ & = |-12| \div 4 + 2 \cdot |-8| \div 4 \quad \text{Work inside the} \\ & \quad \text{absolute value} \\ & \quad \text{bars signs first.} \\ & = 12 \div 4 + 2 \cdot 8 \div 4 \quad \text{Absolute values} \\ & = 3 + 2 \cdot 8 \div 4 \quad \text{Divide.} \\ & = 3 + 16 \div 4 \quad \text{Multiply.} \\ & = 3 + 4 \quad \text{Divide.} \\ & = 7 \quad \text{Add.}\end{aligned}$$

$$\begin{aligned}80. & 6 - |2 - 3 \cdot 4| + (-5)^2 \div 5^2 \\ & = 6 - |2 - 12| + 25 \div 25 \\ & = 6 - |2 + (-12)| + 25 \div 25 \\ & = 6 - |-10| + 25 \div 25 \\ & = 6 - 10 + 25 \div 25 \\ & = 6 - 10 + 1 \\ & = 6 + (-10) + 1 \\ & = -4 + 1 \\ & = -3\end{aligned}$$

$$81. \frac{-9 + 18 \div (-3)(-6)}{32 - 4(12) \div 3(2)}$$

$$\begin{aligned}\text{Numerator: } & -9 + 18 \div (-3)(-6) \\ & = -9 + (-6)(-6) \quad \text{Divide.} \\ & = -9 + 36 \quad \text{Multiply.} \\ & = 27 \quad \text{Add.}\end{aligned}$$

$$\begin{aligned}\text{Denominator: } & 32 - 4(12) \div 3(2) \\ & = 32 - 48 \div 3(2) \quad \text{Multiply.} \\ & = 32 - 16(2) \quad \text{Divide.} \\ & = 32 - 32 \quad \text{Multiply.} \\ & = 32 + (-32) \quad \text{Add the opposite.} \\ & = 0 \quad \text{Add.}\end{aligned}$$

$$\text{Last step is division: } \frac{27}{0} \text{ is undefined.}$$

$$82. \frac{-20 - 15(-4) - (-40)}{14 + 27 \div 3(-2) - (-4)}$$

$$\begin{aligned}\text{Numerator: } & -20 - 15(-4) - (-40) \\ & = -20 - (-60) - (-40) \\ & = -20 + (+60) + (+40) \\ & = 40 + 40 \\ & = 80\end{aligned}$$

$$\begin{aligned}\text{Denominator: } & 14 + 27 \div 3(-2) - (-4) \\ & = 14 + 9(-2) - (-4) \\ & = 14 + (-18) - (-4) \\ & = 14 + (-18) + (+4) \\ & = -4 + 4 \\ & = 0\end{aligned}$$

$$\text{Last step is division: } \frac{80}{0} \text{ is undefined.}$$

## Chapter 1 Review Exercises

- The whole numbers are: 86; 0; 35,600
- 806 in words: eight hundred six
- 319,012 in words: three hundred nineteen thousand, twelve
- 60,003,200 in words: sixty million, three thousand, two hundred
- 15,749,000,000,006 in words: fifteen trillion, seven hundred forty-nine billion, six
- Five hundred four thousand, one hundred  
The first group name is *thousand*, so you need to fill *two groups* of three digits.

$$\underline{504}, \underline{100} = 504,100$$

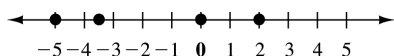
7. Six hundred twenty million, eighty thousand  
The first group name is *million*, so you need to fill *three groups* of three digits.

$$\underline{620}, \underline{080}, \underline{000} = 620,080,000$$

8. Ninety-nine billion, seven million, three hundred fifty-six  
The first group name is *billion*, so you need to fill *four groups* of three digits.

$$\underline{099}, \underline{007}, \underline{000}, \underline{356} = 99,007,000,356$$

9. Graph  $-3, 2, -5, 0$



10. 0 is to the *right* of  $-4$  on the number line, so 0 is *greater than*  $-4$ . Write  $0 > -4$ .
11.  $-3$  is to the *left* of  $-1$  on the number line, so  $-3$  is *less than*  $-1$ . Write  $-3 < -1$ .
12. 2 is to the *right* of  $-2$  on the number line, so 2 is *greater than*  $-2$ . Write  $2 > -2$ .
13.  $-2$  is to the *left* of 1 on the number line, so  $-2$  is *less than* 1. Write  $-2 < 1$ .
14.  $|-5| = 5$  because the distance from 0 to  $-5$  on the number line is 5 spaces.
15.  $|9| = 9$  because the distance from 0 to 9 on the number line is 9 spaces.
16.  $|0| = 0$  because the distance from 0 to 0 on the number line is 0 spaces.
17.  $|-125| = 125$  because the distance from 0 to  $-125$  on the number line is 125 spaces.
18.  $-9 + 8$  ■ Add *unlike* signed integers.

$$|-9| = 9; |8| = 8; \text{ Subtract } 9 - 8 \text{ to get } 1.$$

$-9$  has the larger absolute value and is negative, so the sum is negative.

$$-9 + 8 = -1$$

19.  $-8 + (-5)$  ■ Add *like* signed integers.

$$|-8| = 8; |-5| = 5; \text{ Add } 8 + 5 \text{ to get } 13.$$

Both numbers are negative, so the sum is negative.

$$-8 + (-5) = -13$$

20.  $16 + (-19)$  ■ Add *unlike* signed integers.

$$|16| = 16; |-19| = 19; \text{ Subtract } 19 - 16 \text{ to get } 3.$$

$-19$  has the larger absolute value and is negative, so the sum is negative.

$$16 + (-19) = -3$$

21.  $-4 + 4 = 0$   
Addition of opposites is always zero.

22.  $6 + (-5) = +1$  or 1

23.  $-12 + (-12) = -24$

24.  $0 + (-7) = -7$

25.  $-16 + 19 = +3$  or 3

26.  $9 + (-4) + (-8) + 3$   
 $= 5 + (-8) + 3$  *Add from left to right.*  
 $= -3 + 3$   
 $= 0$

27.  $-11 + (-7) + 5 + (-4)$   
 $= -18 + 5 + (-4)$  *Add from left to right.*  
 $= -13 + (-4)$   
 $= -17$

28. The opposite of  $-5$  is 5.  $-5 + 5 = 0$

29. The opposite of 18 is  $-18$ .  $18 + (-18) = 0$

30.  $5 - 12$   
 $= 5 + (-12)$  *Change subtraction to addition. Change 12 to  $-12$ .*  
 $= -7$

31.  $24 - 7$   
 $= 24 + (-7)$  *Add the opposite.*  
 $= 17$

32.  $-12 - 4$   
 $= -12 + (-4)$  *Add the opposite.*  
 $= -16$

33.  $4 - (-9)$   
 $= 4 + (+9)$  *Add the opposite.*  
 $= 13$

34.  $-12 - (-30)$   
 $= -12 + (+30)$  *Add the opposite.*  
 $= 18$

35.  $-8 - 14$   
 $= -8 + (-14)$  *Add the opposite.*  
 $= -22$

36.  $-6 - (-6)$   
 $= -6 + (+6)$  *Add the opposite.*  
 $= 0$

37.  $-10 - 10$   
 $= -10 + (-10)$  *Add the opposite.*  
 $= -20$

38.  $-8 - (-7)$   
 $= -8 + (+7)$  *Add the opposite.*  
 $= -1$

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39.  $0 - 3$   
 $= 0 + (-3)$  *Add the opposite.*  
 $= -3$
40.  $1 - (-13)$   
 $= 1 + (+13)$  *Add the opposite.*  
 $= 14$
41.  $15 - 0$   
 $= 15 + 0$  *Add the opposite.*  
 $= 15$
42.  $3 - 12 - 7$   
 $= 3 + (-12) + (-7)$  *Add the opposites.*  
 $= -9 + (-7)$  *Add left to right.*  
 $= -16$
43.  $-7 - (-3) + 7$   
 $= -7 + (+3) + 7$  *Add the opposite.*  
 $= -7 + 7 + (+3)$  *Commutative property*  
 $= 0 + (+3)$   
 $= 3$
44.  $4 + (-2) - 0 - 10$   
 $= 4 + (-2) + 0 + (-10)$  *Add the opposites.*  
 $= 2 + 0 + (-10)$  *Add left to right.*  
 $= 2 + (-10)$   
 $= -8$
45.  $-12 - 12 + 20 - (-4)$   
 $= -12 + (-12) + 20 + (+4)$  *Add opposites.*  
 $= -24 + 20 + 4$  *Add left to rt.*  
 $= -4 + 4$   
 $= 0$
46.  $205 \approx 210$   
 Underline the tens place. The next digit is 5 or more. Add 1 to 0. Change 5 to 0.
47.  $59,499 \approx 59,000$   
 Underline the thousands place. The next digit is 4 or less. Leave 9 as 9. Change all digits to the right of the underlined place to zeros.
48.  $85,066,000 \approx 85,000,000$   
 Underline the millions place. The next digit is 4 or less. Leave 5 as 5. Change all digits to the right of the underlined place to zeros.
49.  $-2963 \approx -3000$   
 Underline the hundreds place. The next digit is 5 or more. Add 1 to 9. Write 0 and carry the one to the thousands place. Change all digits to the right of the underlined place to zeros.
50.  $-7,063,885 \approx -7,060,000$   
 Underline the ten-thousands place. The next digit is 4 or less. Leave 6 as 6. Change all digits to the right of the underlined place to zeros.
51.  $399,712 \approx 400,000$   
 Underline the thousands place. The next digit is 5 or more. Add 1 to 9. Write 0 and carry the one to the ten-thousands place:  $9 + 1 = 10$ . Write 0 and carry the one to the hundred-thousands place:  $3 + 1 = 4$ . Change all digits to the right of the underlined place to zeros.
52. Weight loss implies a negative number:  
 $-197$  pounds  $\approx -200$  pounds  
 Underline the first digit. The next digit is 5 or more. Add 1 to 1. Change all digits to the right of the underlined place to zeros.
53. Below sea level implies a negative number:  
 $-1388 \approx -1000$  feet  
 Underline the first digit. The next digit is 4 or less. Leave 1 as 1. Change all digits to the right of the underlined place to zeros.
54.  $2,095,006,000$  Internet users  $\approx$   
 $2,000,000,000$  Internet users  
 Underline the first digit. The next digit is 4 or less. Leave 2 as 2. Change all digits to the right of the underlined place to zeros.
55.  $9,502,000,000$  people  $\approx 10,000,000,000$  people  
 Underline the first digit. The next digit is 5 or more. Add 1 to 9. Change all digits to the right of the underlined place to zeros.
56.  $-6(9) = -54$  (*different signs, product is negative*)
57.  $(-7)(-8) = 56$  (*same signs, product is positive*)
58.  $10(-10) = -100$   
 (*different signs, product is negative*)
59.  $-45 \cdot 0 = 0$ ; multiplication property of 0
60.  $-1(-24) = 24$  (*same signs, product is positive*)
61.  $17 \cdot 1 = 17$ ; multiplication property of 1
62.  $4(-12) = -48$   
 (*different signs, product is negative*)
63.  $(-5)(-25) = 125$  (*same signs, product is positive*)
64.  $-3(-4)(-3)$   
 $= 12 \cdot (-3)$  *Multiply from left to right.*  
 $= -36$

$$\begin{aligned} 65. \quad & -5(2)(-5) \\ & = -10 \cdot (-5) \quad \text{Multiply from left to right.} \\ & = 50 \end{aligned}$$

$$\begin{aligned} 66. \quad & (-8)(-1)(-9) \\ & = 8(-9) \quad \text{Multiply from left to right.} \\ & = -72 \end{aligned}$$

$$67. \quad \frac{-63}{-7} = 9 \quad (\text{same signs, quotient is positive})$$

$$68. \quad \frac{70}{-10} = -7 \quad (\text{different signs, quotient is negative})$$

$$69. \quad \frac{-15}{0} \text{ is undefined. Division by zero is undefined.}$$

$$\begin{aligned} 70. \quad & -100 \div (-20) = 5 \\ & (\text{same signs, quotient is positive}) \end{aligned}$$

$$\begin{aligned} 71. \quad & 18 \div (-1) = -18 \\ & (\text{different signs, quotient is negative}) \end{aligned}$$

$$72. \quad \frac{0}{12} = 0; 0 \text{ divided by any nonzero number is } 0.$$

$$73. \quad \frac{-30}{-2} = 15 \quad (\text{same signs, quotient is positive})$$

$$74. \quad \frac{-35}{35} = -1 \quad (\text{different signs, quotient is negative})$$

$$\begin{aligned} 75. \quad & -40 \div (-4) \div (-2) \\ & = 10 \div (-2) \quad \text{Divide from left to right.} \\ & = -5 \end{aligned}$$

$$\begin{aligned} 76. \quad & -18 \div 3(-3) \\ & = -6(-3) \quad \text{Divide.} \\ & = 18 \quad \text{Multiply.} \end{aligned}$$

$$\begin{aligned} 77. \quad & 0 \div (-10)(5) \div 5 \\ & = 0(5) \div 5 \quad \text{Divide.} \\ & = 0 \div 5 \quad \text{Multiply.} \\ & = 0 \quad \text{Divide.} \end{aligned}$$

$$78. \quad 1250 \text{ hours are separated into 8-hour days.}$$

$$\begin{array}{r} 156 \\ 8 \overline{) 1250} \\ \underline{8} \phantom{0} \\ 45 \\ \underline{40} \phantom{0} \\ 50 \\ \underline{48} \phantom{0} \\ 2 \end{array}$$

It took 156 work days of 8 hours each, plus 2 extra hours.

$$79. \quad 10^4 = 10 \cdot 10 \cdot 10 \cdot 10 = 10,000$$

$$80. \quad 2^5 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$$

$$81. \quad 3^3 = 3 \cdot 3 \cdot 3 = 27$$

$$82. \quad (-4)^2 = (-4)(-4) = 16$$

$$\begin{aligned} 83. \quad & (-5)^3 = (-5)(-5)(-5) \\ & = (25)(-5) \\ & = -125 \end{aligned}$$

$$84. \quad 8^1 = 8$$

$$\begin{aligned} 85. \quad & 6^2 \cdot 3^2 \\ & = 36 \cdot 9 \quad \text{Apply exponents.} \\ & = 324 \end{aligned}$$

$$\begin{aligned} 86. \quad & 5^2(-2)^3 \\ & = 25(-8) \quad \text{Apply exponents.} \\ & = -200 \end{aligned}$$

$$\begin{aligned} 87. \quad & -30 \div 6 - 4(5) \\ & = -5 - 4(5) \quad \text{Divide.} \\ & = -5 - 20 \quad \text{Multiply.} \\ & = -5 + (-20) \quad \text{Add the opposite.} \\ & = -25 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 88. \quad & 6 + 8(2 - 3) \\ & = 6 + 8(-1) \quad \text{Parentheses first} \\ & = 6 + (-8) \quad \text{Multiply.} \\ & = -2 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 89. \quad & 16 \div 4^2 + (-6 + 9)^2 \\ & = 16 \div 4^2 + (3)^2 \quad \text{Parentheses first} \\ & = 16 \div 16 + 9 \quad \text{Apply exponents.} \\ & = 1 + 9 \quad \text{Divide.} \\ & = 10 \quad \text{Add.} \end{aligned}$$

$$\begin{aligned} 90. \quad & -3(4) - 2(5) + 3(-2) \\ & = -12 - 10 + (-6) \quad \text{Multiply left to right.} \\ & = -12 + (-10) + (-6) \quad \text{Add the opposite.} \\ & = -22 + (-6) \quad \text{Add left to right.} \\ & = -28 \end{aligned}$$

$$91. \quad \frac{-10 + 3^2 - (-9)}{3 - 10 - 1}$$

Numerator:

$$\begin{aligned} & -10 + 3^2 - (-9) \\ & = -10 + 9 - (-9) \quad \text{Exponent} \\ & = -10 + 9 + (+9) \quad \text{Add the opposite.} \\ & = -1 + (+9) \quad \text{Add from left to right.} \\ & = 8 \end{aligned}$$

Denominator:

$$\begin{aligned} & 3 - 10 - 1 \\ & = 3 + (-10) + (-1) \quad \text{Add the opposites.} \\ & = -7 + (-1) \quad \text{Add from left to right.} \\ & = -8 \end{aligned}$$

$$\text{Last step is division: } \frac{8}{-8} = -1$$

$$92. \frac{-1(1-3)^3 + 12 \div 4}{-5 + 24 \div 8 \cdot 2(6-6) + 5}$$

Numerator:

$$\begin{aligned} & -1(1-3)^3 + 12 \div 4 \\ & = -1(-2)^3 + 12 \div 4 && \text{Parentheses first} \\ & = -1(-8) + 12 \div 4 && \text{Exponent} \\ & = 8 + 12 \div 4 && \text{Multiply.} \\ & = 8 + 3 && \text{Divide.} \\ & = 11 && \text{Add.} \end{aligned}$$

Denominator:

$$\begin{aligned} & -5 + 24 \div 8 \cdot 2(6-6) + 5 \\ & = -5 + 24 \div 8 \cdot 2(0) + 5 && \text{Parentheses first} \\ & = -5 + 3 \cdot 2(0) + 5 && \text{Divide.} \\ & = -5 + 6(0) + 5 && \text{Multiply.} \\ & = -5 + 0 + 5 && \text{Multiply.} \\ & = -5 + 5 && \text{Add.} \\ & = 0 && \text{Add.} \end{aligned}$$

Last step is division:  $\frac{11}{0}$  is undefined.

$$93. [1.3] -3 + (5 + 1) = (-3 + 5) + 1$$

Associative property of addition

$$94. [1.6] -7(2) = 2(-7)$$

Commutative property of multiplication

$$95. [1.3] 0 + 19 = 19$$

Addition property of 0

$$96. [1.6] -42 \cdot 0 = 0$$

Multiplication property of 0

$$97. [1.6] 2(-6 + 4) = 2 \cdot (-6) + 2 \cdot 4$$

Distributive property

$$98. [1.6] (-6 \cdot 3) \cdot 1 = -6 \cdot (3 \cdot 1)$$

Associative property of multiplication

$$99. [1.6] 192 \text{ rounds to } 200.$$

\$11,900 rounds to \$10,000.

*Estimate:*  $\$10,000 \cdot 200 = \$2,000,000$  total value*Exact:*  $\$11,900 \cdot 192 = \$2,284,800$  total value

$$100. [1.3] \text{ Account balance of } \$185 \text{ rounds to } \$200.$$

The deposit of \$428 rounds to \$400.  
The check for \$706 rounds to \$700.

*Estimate:*  $\$200 + \$400 - \$700 = -\$100$ *Exact:*  $\$185 + \$428 - \$706 = -\$93$ 

$$101. [1.7] 22 \text{ gallons rounds to } 20 \text{ gallons.}$$

880 miles rounds to 900 miles.  
Divide miles by gallons to get miles per gallon.

*Estimate:*  $900 \div 20 = 45$  miles for each gallon*Exact:*  $880 \div 22 = 40$  miles for each gallon

$$102. [1.6] 19 \text{ calculators rounds to } 20.$$

12 modems rounds to 10.  
\$39 rounds to \$40. \$85 rounds to \$90.

*Estimate:*

$$(\$40 \cdot 20) + (\$90 \cdot 10) = \$800 + \$900 = \$1700$$

*Exact:*

$$(\$39 \cdot 19) + (\$85 \cdot 12) = \$741 + \$1020 = \$1761$$

$$103. [1.3] \text{ Expenses imply negative numbers.}$$

$$\text{Jan. } \$2400 + (-\$3100) = -\$700 \text{ (loss)}$$

$$\text{Feb. } \$1900 + (-\$2000) = -\$100 \text{ (loss)}$$

$$\text{Mar. } \$2500 + (-\$1800) = \$700 \text{ (profit)}$$

$$\text{Apr. } \$2300 + (-\$1400) = \$900 \text{ (profit)}$$

$$\text{May } \$1600 + (-\$1600) = \$0 \text{ (neither)}$$

$$\text{June } \$1900 + (-\$1200) = \$700 \text{ (profit)}$$

$$104. [1.3] \text{ January had the greatest loss.}$$

April had the greatest profit.

$$105. [1.7] \text{ To find her average monthly income, add her income from each month and divide by the number of months.}$$

$$\begin{aligned} & \$2400 + \$1900 + \$2500 \\ & \quad + \$2300 + \$1600 + \$1900 \\ & \quad \quad \quad 6 \\ & = \frac{\$12,600}{6} = \$2100 \end{aligned}$$

$$106. [1.7] \text{ To find her average monthly expenses, add her expenses from each month and divide by the number of months.}$$

$$\begin{aligned} & -\$3100 + (-\$2000) + (-\$1800) \\ & \quad + (-\$1400) + (-\$1600) + (-\$1200) \\ & \quad \quad \quad 6 \\ & = \frac{-\$11,100}{6} = -\$1850 \end{aligned}$$

## Chapter 1 Test

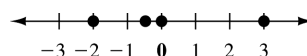
$$1. \quad 20,008,307 \text{ in words: twenty million, eight thousand, three hundred seven}$$

$$2. \quad \text{Thirty billion, seven hundred thousand, five}$$

The first group name is *billion*, so you need to fill *four groups* of three digits.

$$\underline{030}, \underline{000}, \underline{700}, \underline{005} = 30,000,700,005$$

$$3. \quad \text{Graph } 3, -2, 0, -\frac{1}{2}$$



$$4. \quad 0 \text{ is to the right of } -3 \text{ on the number line, so } 0 \text{ is greater than } -3. \text{ Write } 0 > -3.$$

$$-2 \text{ is to the left of } -1 \text{ on the number line, so } -2 \text{ is less than } -1. \text{ Write } -2 < -1.$$



5.  $|10| = 10$  because the distance from 0 to 10 on the number line is 10 spaces.  
 $|-14| = 14$  because the distance from 0 to  $-14$  on the number line is 14 spaces.
6.  $3 - 9$   
 $= 3 + (-9)$  *Add the opposite.*  
 $= -6$
7.  $-12 + 7 = -5$   
 Add *unlike* signed integers.  
 $|-12| = 12$ ;  $|7| = 7$ ; Subtract  $12 - 7$  to get 5.  
 $-12$  has the larger absolute value and is negative, so the sum is negative.
8.  $\frac{-28}{-4} = 7$  (*same* signs, quotient is *positive*)
9.  $-1(40) = -40$  (*different* signs, product is *negative*)
10.  $-5 - (-15)$   
 $= -5 + (+15)$  *Change sub. to addition.*  
 $= 10$  *Add.*
11.  $(-8)(-8) = 64$  (*same* signs, product is *positive*)
12.  $-25 + (-25)$   
 $= -50$  *Add.*
13.  $\frac{17}{0}$  is undefined.
14.  $-30 - 30$   
 $= -30 + (-30)$  *Change subtraction to addition.*  
 $= -60$  *Add.*
15.  $\frac{50}{-10} = -5$  (*different* signs, quotient is *negative*)
16.  $5(-9) = -45$  (*different* signs, product is *negative*)
17.  $0 - (-6)$   
 $= 0 + (+6)$  *Change subtraction to addition.*  
 $= 6$  *Addition property of zero*
18.  $-35 \div 7(-5)$   
 $= -5(-5)$  *Divide.*  
 $= 25$  *Multiply.*
19.  $-15 - (-8) + 7$   
 $= -15 + (+8) + 7$  *Change subtraction to addition.*  
 $= -7 + 7$  *Add from left to right.*  
 $= 0$
20.  $3 - 7(-2) - 8$   
 $= 3 - (-14) - 8$  *Multiply.*  
 $= 3 + (+14) + (-8)$  *Change subtraction to addition.*  
 $= 17 + (-8)$  *Add from left to right.*  
 $= 9$
21.  $(-4)^2 \cdot 2^3$   
 $= 16 \cdot 8$  *Apply exponents.*  
 $= 128$
22.  $\frac{5^2 - 3^2}{(4)(-2)}$   
 Numerator:  
 $5^2 - 3^2$   
 $= 25 - 9$  *Apply exponents.*  
 $= 25 + (-9)$  *Add the opposite.*  
 $= 16$  *Add.*  
 Denominator:  
 $(4)(-2)$   
 $= -8$  *Multiply.*  
 Last step is division:  $\frac{16}{-8} = -2$
23.  $-2(-4 + 10) + 5(4)$   
 $= -2(6) + 5(4)$  *Parentheses*  
 $= -12 + 5(4)$  *Multiply.*  
 $= -12 + 20$  *Multiply.*  
 $= 8$  *Add.*
24.  $-3 + (-7 - 10) + 4(6 - 10)$   
 $= -3 + [-7 + (-10)] + 4[6 + (-10)]$   
 $= -3 + (-17) + 4(-4)$  *Brackets*  
 $= -3 + (-17) + (-16)$  *Multiply.*  
 $= -20 + (-16)$  *Add.*  
 $= -36$  *Add.*
25. An exponent shows how many times to use a factor in repeated multiplication. Examples will vary.  
 Some possibilities are  
 $(2)^4 = 2 \cdot 2 \cdot 2 \cdot 2 = 16$ ;  $(-3)^2 = (-3)(-3) = 9$ .
26. Commutative property: changing the *order* of addends does not change the sum.  
 One possible example:  $2 + 5 = 5 + 2$   
 Associative property: changing the *grouping* of addends does not change the sum.  
 One possible example:  
 $(-1 + 4) + 2 = -1 + (4 + 2)$
27.  $\underline{8}51 \approx 900$   
 Underline the hundreds place. The next digit is 5 or more. Add 1 to 8. Change all digits to the right of the underlined place to zeros.

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28.  $36,420,498,725 \approx 36,420,000,000$

Underline the millions place. The next digit is 4 or less. Leave 0 as 0. Change all digits to the right of the underlined place to zeros.

29.  $349,812 \approx 350,000$

Underline the thousands place. The next digit is 5 or more. Add 1 to 9. Write 0 and carry 1 to the ten-thousands place. Change all digits to the right of the underlined place to zeros.

30. \$184 account balance rounds to \$200.  
The \$293 deposit rounds to \$300.  
The \$506 tuition check rounds to \$500.

Balance in her account:

*Estimate:*  $\$200 + \$300 + (-\$500) = \$0$

*Exact:*  $\$184 + \$293 + (-\$506) = -\$29$

31. Loss of 1144 pounds rounds to 1000 pounds.  
22 people rounds to 20 people.

Average weight loss for each person:

*Estimate:*  $-1000 \div 20 = -50$  pounds

*Exact:*  $-1144 \div 22 = -52$  pounds

32. Cereal 1: 220 calories rounds to 200  
Cereal 2: 110 calories rounds to 100  
31 days rounds to 30

*Estimate* of calories saved by eating Cereal 2:

$200 - 100 = 100$  calories per day

$30 \cdot 100 = 3000$  calories in the month

*Exact* calories saved by eating Cereal 2:

$220 - 110 = 110$  calories per day

$31 \cdot 110 = 3410$  calories in the month

33. The difference between the high and low temperatures on Mars is:

$$-10 - (-100)$$

$$= -10 + (+100) \quad \text{Add the opposite.}$$

$$= 90 \text{ degrees difference}$$

34. 1276 books separated into cartons holding 48 books each.

$$\begin{array}{r} 26 \\ 48 \overline{) 1276} \\ \underline{96} \phantom{00} \\ 316 \\ \underline{288} \\ 28 \end{array}$$

Anthony will need 27 cartons to ship all of the books. He will have 26 full boxes and one box with only 28 books in it.