PERCENT OF CHANGE  When an increase or decrease is expressed as a percent, the percent is called the **percent of change.** If the new number is greater than the original number, the percent of change is an **percent of increase.** If the new number is less than the original, the percent of change is a **percent of decrease.**

**Example 1  Find Percent of Change**

State whether each percent of change is a percent of increase or a percent of decrease. Then find each percent of change.

a. original: 25  
   new: 28
   
   Find the amount of change. Since the new amount is greater than the original, the percent of change is a percent of increase.
   
   \[ 28 - 25 = 3 \]
   
   Find the percent using the original number, 25, as the base.
   
   \[
   \frac{\text{change}}{\text{original amount}} = \frac{3}{25} = \frac{r}{100}
   \]
   
   \[
   3(100) = 25(r)
   \]
   
   \[
   300 = 25r
   \]

   \[
   300 \div 25 = 25r \div 25
   \]

   \[
   12 = r
   \]

   The percent of increase is 12%.

b. original: 30  
   new: 12
   
   The percent of change is a percent decrease because the new amount is less than the original. Find the change.
   
   \[ 30 - 12 = 18 \]
   
   Find the percent using the original number, 30, as the base.
   
   \[
   \frac{\text{change}}{\text{original amount}} = \frac{18}{30} = \frac{r}{100}
   \]
   
   \[
   18(100) = 30(r)
   \]

   \[
   1800 = 30r
   \]

   \[
   1800 \div 30 = 30r \div 30
   \]

   \[
   60 = r
   \]

   The percent of decrease is 60%.
Example 2 Find the Missing Value

FOOTBALL The field used by the National Football League (NFL) is 120 yards long. The length of the field used by the Canadian Football League (CFL) is 25% longer than the one used by the NFL. What is the length of the field used by the CFL?

Let \( \ell \) = the length of the CFL field. Since 25% is a percent of increase, the length of the NFL field is less than the length of the CFL field. Therefore, \( \ell - 120 \) represents the amount of change.

\[
\text{Percent proportion} \\
\text{original amount} \rightarrow \ell - 120 = \frac{25}{100} \\
(\ell - 120)(100) = 120(25) \\
100\ell - 12,000 = 3000 \\
100\ell - 12,000 + 12,000 = 3000 + 12,000 \\
100\ell = 15,000 \\
\frac{100\ell}{100} = \frac{15,000}{100} \\
\ell = 150
\]

The length of the field used by the CFL is 150 yards.

SOLVE PROBLEMS Two applications of percent of change are sales tax and discounts. Sales tax is a tax that is added to the cost of the item. It is an example of a percent of increase. Discount is the amount by which the regular price of an item is reduced. It is an example of a percent of decrease.

Example 3 Find Amount After Sales Tax

SALES TAX A concert ticket costs $45. If the sales tax is 6.25%, what is the total price of the ticket?
The tax is 6.25% of the price of the ticket.

\[
6.25\% \times 45 = 0.0625 \times 45 \quad 6.25\% = 0.0625 \\
= 2.8125 \quad \text{Use a calculator.}
\]

Round $2.8125 to $2.81.

Add this amount to the original price.

\[
$45.00 + $2.81 = $47.81
\]

The total price of the ticket is $47.81.

Example 4 Find Amount After Discount

DISCOUNT A sweater is on sale for 35% off the original price. If the original price of the sweater is $38, what is the discounted price?
The discount is 35% of the original price.

\[
35\% \times 38 = 0.35 \times 38 \quad 35\% = 0.35 \\
= 13.30 \quad \text{Use a calculator.}
\]

Subtract $13.30 from the original price.

\[
$38.00 - $13.30 = $24.70
\]

The discounted price of the sweater is $24.70.
Check for Understanding

Concept Check
1. Compare and contrast percent of increase and percent of decrease.

2. OPEN ENDED Give a counterexample to the statement The percent of change must always be less than 100%.

3. FIND THE ERROR Laura and Cory are writing proportions to find the percent of change if the original number is 20 and the new number is 30.

Laura
Amount of change: 30 - 20 = 10
\[ \frac{10}{20} = \frac{r}{100} \]

Cory
Amount of change: 30 - 20 = 10
\[ \frac{10}{50} = \frac{r}{100} \]

Who is correct? Explain your reasoning.

Guided Practice
State whether each percent of change is a percent of increase or a percent of decrease. Then find each percent of change. Round to the nearest whole percent.

4. original: 72
   new: 36
5. original: 45
   new: 50
6. original: 14
   new: 16
7. original: 150
   new: 120

Find the total price of each item.
8. software: $39.50
   sales tax: 6.5%
9. compact disc: $15.99
   sales tax: 5.75%

Find the discounted price of each item.
10. jeans: $45.00
    discount: 25%
11. book: $19.95
    discount: 33%

Application
EDUCATION For Exercises 12 and 13, use the following information.
According to the Census Bureau, the average income of a person with a bachelor's degree is $40,478, and the average income of a person with a high school diploma is $22,895.

12. Write an equation that could be used to find the percent of increase in average income for a person with a high school diploma to average income for a person with a bachelor's degree.
13. What is the percent of increase?

Practice and Apply
State whether each percent of change is a percent of increase or a percent of decrease. Then find each percent of change. Round to the nearest whole percent.

Homework Help
For Exercises See Examples
| 14-27 | 1 |
| 28-30, 46, 47 | 2 |
| 31-36 | 3 |
| 37-42 | 4 |
| 43-45 | 3, 4 |

Extra Practice
See page 827.

14. original: 50
    new: 70
15. original: 25
    new: 18
16. original: 66
    new: 30
17. original: 58
    new: 152
18. original: 13.7
    new: 40.2
19. original: 15.6
    new: 11.4
20. original: 132
    new: 150
21. original: 85
    new: 90
22. original: 32.5
    new: 30
23. original: 9.8
    new: 12.1
24. original: 40
    new: 32.5
25. original: 25
    new: 21.5

162 Chapter 3 Solving Linear Equations
26. THEME PARKS  In 1990, 253 million people visited theme parks in the United States. In 2000, the number of visitors increased to 317 million people. What was the percent of increase?

27. MILITARY  In 1987, the United States had 2 million active-duty military personnel. By 2000, there were only 1.4 million active-duty military personnel. What was the percent of decrease?

28. The percent of increase is 16%. If the new number is 522, find the original number.

29. FOOD  In order for a food to be marked "reduced fat," it must have at least 25% less fat than the same full-fat food. If one ounce of reduced fat chips has 6 grams of fat, what is the least amount of fat in one ounce of regular chips?


Find the total price of each item.

31. umbrella: $14.00  
tax: 5.5%  
32. backpack: $35.00  
tax: 7%  
33. candle: $7.50  
tax: 5.75%

34. hat: $18.50  
tax: 6.25%  
35. clock radio: $39.99  
tax: 6.75%  
36. sandals: $29.99  
tax: 5.75%

Find the discounted price of each item.

37. shirt: $45.00  
discount: 40%  
38. socks: $6.00  
discount: 20%  
39. watch: $37.55  
discount: 35%

40. gloves: $24.25  
discount: 33%  
41. suit: $175.95  
discount: 45%  
42. coat: $79.99  
discount: 30%

Find the final price of each item.

43. lamp: $120.00  
discount: 20%  
tax: 6%  
44. dress: $70.00  
discount: 30%  
tax: 7%  
45. camera: $58.00  
discount: 25%  
tax: 6.5%

POPULATION  For Exercises 46 and 47, use the following table.

<table>
<thead>
<tr>
<th>Country</th>
<th>1997 Population (billions)</th>
<th>Projected Percent of Increase for 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1.24</td>
<td>22.6%</td>
</tr>
<tr>
<td>India</td>
<td>0.97</td>
<td>57.8%</td>
</tr>
<tr>
<td>United States</td>
<td>0.27</td>
<td>44.4%</td>
</tr>
</tbody>
</table>

Source: USA TODAY

46. What are the projected 2050 populations for each country in the table?
47. Which of these three countries is projected to be the most populous in 2050?

48. RESEARCH  Use the Internet or other reference to find the tuition for the last several years at a college of your choice. Find the percent of change for the tuition during these years. Predict the tuition for the year you plan to graduate from high school.

49. CRITICAL THINKING  Are the following expressions sometimes, always, or never equal? Explain your reasoning.

\[ x\% \text{ of } y \quad \quad y\% \text{ of } x \]
50. **Writing in Math**  Answer the question that was posed at the beginning of the lesson.

**How can percents describe growth over time?**

Include the following in your answer:
- the percent of increase in the number of area codes from 1996 to 1999, and
- an explanation of why knowing a percent of change can be more informative than knowing how much the quantity changed.

51. The number of students at Franklin High School increased from 840 to 910 over a 5-year period. Which proportion represents the percent of change?

   A) \( \frac{70}{910} = \frac{r}{100} \)
   B) \( \frac{70}{840} = \frac{r}{100} \)
   C) \( \frac{r}{910} = \frac{70}{100} \)
   D) \( \frac{r}{840} = \frac{70}{100} \)

52. The list price of a television is $249.00. If it is on sale for 30% off the list price, what is the sale price of the television?

   A) $74.70  
   B) $149.40  
   C) $174.30  
   D) $219.00

---

**Maintain Your Skills**

**Mixed Review**  
Solve each proportion.  \( \text{(Lesson 3-6)} \)

53. \( \frac{a}{45} = \frac{3}{15} \)
54. \( \frac{2}{3} = \frac{8}{d} \)
55. \( \frac{5.22}{13.92} = \frac{t}{48} \)

Solve each equation. Then check your solution.  \( \text{(Lesson 3-5)} \)

56. \( 6n + 3 = -3 \)
57. \( 7 + 5c = -23 \)
58. \( 18 = 4a - 2 \)

Find each quotient.  \( \text{(Lesson 2-4)} \)

59. \( \frac{2}{5} \div 4 \)
60. \( -\frac{4}{5} \div \frac{2}{3} \)
61. \( -\frac{1}{9} \div \left( -\frac{3}{4} \right) \)

State whether each equation is true or false for the value of the variable given.  \( \text{(Lesson 1-3)} \)

62. \( a^2 + 5 = 17 - a, a = 3 \)
63. \( 2v^2 + v = 65, v = 5 \)
64. \( 8y - y^2 = y + 10, y = 4 \)
65. \( 16p - p = 15p, p = 2.5 \)

**Getting Ready for the Next Lesson**

**PREREQUISITE SKILL**  Solve each equation. Then check your solution.  
(To review solving equations, see Lesson 3-5.)

66. \( -43 - 3t = 2 - 6t \)
67. \( 7y + 7 = 3y - 5 \)
68. \( 7(d - 3) - 2 = 5 \)
69. \( 6(p + 3) = 4(p - 1) \)
70. \( -5 = 4 - 2(a - 5) \)
71. \( 8x - 4 = -10x + 5 \)

**Practice Quiz 2**

Solve each equation. Then check your solution.  \( \text{(Lessons 3-4 and 3-5)} \)

1. \( -3x - 7 = 18 \)
2. \( 5 = \frac{m - 5}{4} \)
3. \( 4k + 5 = 11 \)
4. \( 5d - 6 = 3d + 9 \)
5. \( 7 + 2(w + 1) = 2w + 9 \)
6. \( -8(4 + 9r) = 7(-2 - 11r) \)

Solve each proportion.  \( \text{(Lesson 3-6)} \)

7. \( \frac{2}{a} = \frac{1}{5} \)
8. \( \frac{3}{5} = \frac{24}{x} \)
9. \( \frac{y}{4} = \frac{y + 5}{8} \)

10. **Postage**  In 1975, the cost of a first-class stamp was 10c. In 2001, the cost of a first-class stamp became 34c. What is the percent of increase in the price of a stamp?  \( \text{(Lesson 3-7)} \)