

Prealgebra Textbook

Second Edition

Chapter 7

Department of Mathematics
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Contents

7	Percent	501
7.1	Percent, Decimals, Fractions	502
	Changing a Percent to a Fraction	502
	Changing a Percent to a Decimal	504
	Changing a Decimal to a Percent	505
	Changing a Fraction to a Percent	506
	Exercises	508
	Answers	510
7.2	Solving Basic Percent Problems	512
	Find a Given Percent of a Given Number	512
	Find a Percent Given Two Numbers	514
	Find a Number that is a Given Percent of Another Number	516
	Exercises	518
	Answers	519
7.3	General Applications of Percent	521
	Exercises	525
	Answers	528
7.4	Percent Increase or Decrease	529
	Percent Increase	529
	Percent Decrease	531
	Discount	534
	Exercises	538
	Answers	541
7.5	Interest	542
	Extending the Simple Interest Formula	545
	Exercises	548
	Answers	550
7.6	Pie Charts	552
	Pie Charts	553
	Exercises	560
	Answers	566

Chapter 7

Percent

When one hears the word “percent,” other words come immediately to mind, words such as “century,” “cents,” or “centimeters.” A *century* equals 100 years. There are one hundred *cents* in a dollar and there are 100 *centimeters* in a meter. Thus, it should come as no surprise that *percent* means “parts per hundred.”

In the world we live in we are constantly bombarded with phrases that contain the word “percent.” The sales tax in California is 8.25%. An employee is asking his boss for a 5% raise. A union has seen a 6.25% increase in union dues. The population of a town is increasing at a rate of 2.25% per year.

In this chapter we introduce the concept of percent, first addressing how to facilitate writing percents in fraction or decimal form and also performing the reverse operations, changing fractions and decimals to percents. Next we use our expertise in solving equations to solve the more common forms that involve percents, then we apply this ability to solving common applications from the real world that use percents. We’ll tackle applications of commission and sales tax, discount and marked price, percent increase or decrease, and simple interest.

Let’s begin the journey.

7.1 Percent, Decimals, Fractions

In the square shown in [Figure 7.1](#), a large square has been partitioned into ten rows of ten little squares in each row. In [Figure 7.1](#), we've shaded 20 of 100 possible little squares, or 20% of the total number of little squares.

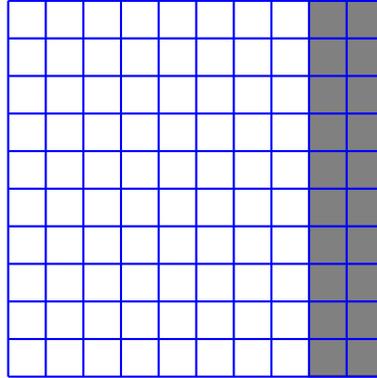


Figure 7.1: Shading 20 of 100 little squares, or 20% of the total number of little squares.

The Meaning of Percent. Percent means “parts per hundred.”

In [Figure 7.1](#), 80 out of a possible 100 squares are left unshaded. Thus, 80% of the little squares are unshaded. If instead we shaded 35 out of the 100 squares, then 35% of the little squares would be shaded. If we shaded all of the little squares, then 100% of the little squares would be shaded (100 out of 100).

So, when you hear the word “percent,” think “parts per hundred.”

Changing a Percent to a Fraction

Based on the discussion above, it is fairly straightforward to change a percent to a fraction.

Percent to Fraction. To change a percent to a fraction, drop the percent sign and put the number over 100.

You Try It!**EXAMPLE 1.** Change 24% to a fraction.

Change 36% to a fraction reduced to lowest terms.

Solution. Drop the percent symbol and put 24 over 100.

$$\begin{aligned} 24\% &= \frac{24}{100} && \text{Percent: Parts per hundred.} \\ &= \frac{6}{25} && \text{Reduce.} \end{aligned}$$

Hence, $24\% = 6/25$.

Answer: 9/25

You Try It!**EXAMPLE 2.** Change $14\frac{2}{7}\%$ to a fraction.Change $11\frac{1}{9}\%$ to a fraction reduced to lowest terms.**Solution.** Drop the percent symbol and put $14\frac{2}{7}$ over 100.

$$\begin{aligned} 14\frac{2}{7}\% &= \frac{14\frac{2}{7}}{100} && \text{Percent: Parts per hundred.} \\ &= \frac{\frac{100}{7}}{100} && \text{Mixed to improper fraction.} \\ &= \frac{100}{7} \cdot \frac{1}{100} && \text{Invert and multiply.} \\ &= \frac{\cancel{100}}{7} \cdot \frac{1}{\cancel{100}} && \text{Cancel.} \\ &= \frac{1}{7} \end{aligned}$$

Hence, $14\frac{2}{7}\% = 1/7$.

Answer: 1/9

You Try It!**EXAMPLE 3.** Change 28.4% to a fraction.

Change 87.5% to a fraction reduced to lowest terms.

Solution. Drop the percent symbol and put 28.4 over 100.

$$\begin{aligned}
 28.4\% &= \frac{28.4}{100} && \text{Percent: Parts per hundred.} \\
 &= \frac{28.4 \cdot 10}{100 \cdot 10} && \text{Multiply numerator and denominator by 10.} \\
 &= \frac{284}{1000} && \text{Multiplying by 10 moves decimal point one place right.} \\
 &= \frac{71 \cdot 4}{250 \cdot 4} && \text{Factor.} \\
 &= \frac{71}{250} && \text{Cancel common factor.}
 \end{aligned}$$

Answer: $7/8$

Changing a Percent to a Decimal

To change a percent to a decimal, we need only remember that percent means “parts per hundred.”

You Try It!

Change 2.4% to a decimal.

EXAMPLE 4. Change 23.25% to a decimal.

Solution. Drop the percent symbol and put 23.25 over 100.

$$\begin{aligned}
 23.25\% &= \frac{23.25}{100} && \text{Percent: Parts per hundred.} \\
 &= 0.2325 && \text{Dividing by 100 moves decimal point 2 places left.}
 \end{aligned}$$

Answer: 0.024

Therefore, $23.25\% = 0.2325$.

This last example motivates the following simple rule.

Changing a Percent to a Decimal. To change a percent to a decimal, drop the percent symbol and move the decimal point two places to the left.

You Try It!

Change $6\frac{3}{4}\%$ to a decimal.

EXAMPLE 5. Change $5\frac{1}{2}\%$ to a decimal.

Solution. Note that $1/2 = 0.5$, then move the decimal 2 places to the left.

$$\begin{aligned} 5\frac{1}{2}\% &= 5.5\% & 1/2 &= 0.5. \\ &= 0.055 & & \text{Drop \% symbol.} \\ & \quad \uparrow & & \text{Move decimal point 2 places left.} \\ &= 0.055 \end{aligned}$$

Thus, $5\frac{1}{2}\% = 0.055$.

Answer: 0.0675

Changing a Decimal to a Percent

Changing a decimal to a percent is the exact opposite of changing a percent to a decimal. In the latter case, we drop the percent symbol and move the decimal point 2 places to the left. The following rule does just the opposite.

Changing a Decimal to a Percent. To change a decimal to a percent, move the decimal point two places to the right and add a percent symbol.

You Try It!

EXAMPLE 6. Change 0.0725 to a percent.

Change to 0.0375 to a percent.

Solution. Move the decimal point two places to the right and add a percent symbol.

$$\begin{aligned} 0.0725 &= 0.0725\% \\ & \quad \uparrow \\ &= 7.25\% \end{aligned}$$

Answer: 3.75%

You Try It!

EXAMPLE 7. Change 1.025 to a percent.

Change 0.525 to a percent.

Solution. Move the decimal point two places to the right and add a percent symbol.

$$\begin{aligned} 1.025 &= 1.025\% \\ & \quad \uparrow \\ &= 102.5\% \end{aligned}$$

Answer: 52.5%

Changing a Fraction to a Percent

One way to proceed is to first change the fraction to a decimal, then change the resulting decimal to a percent.

Fractions to Percents: Technique #1. To change a fraction to a percent, follow these steps:

1. Divide numerator by the denominator to change the fraction to a decimal.
2. Move the decimal point in the result two places to the right and append a percent symbol.

You Try It!

Change $5/16$ to a percent.

EXAMPLE 8. Use Technique #1 to change $5/8$ to a percent.

Solution. Change $5/8$ to a decimal, then change the decimal to a percent.

To change $5/8$ to a decimal, divide 5 by 8. Since the denominator is a product of twos, the decimal should terminate.

To change 0.625 to a percent, move the decimal point 2 places to the right and append a percent symbol.

$$\begin{array}{r} 0.625 \\ 8 \overline{)5.000} \\ \underline{48} \\ 20 \\ \underline{16} \\ 40 \\ \underline{40} \\ 0 \end{array}$$

$$0.625 = 0 \underline{62.5}\% = 62.5\%$$

Answer: 31.35%

□

A second technique is to create an equivalent fraction with a denominator of 100.

Fractions to Percents: Technique #2. To change a fraction to a percent, create an equivalent fraction with a denominator of 100.

You Try It!

Change $4/9$ to a percent.

EXAMPLE 9. Use Technique #2 to change $5/8$ to a percent.

Solution. Create an equivalent fraction for $5/8$ with a denominator of 100.

$$\frac{5}{8} = \frac{x}{100}$$

Solve this proportion for x .

$$\begin{array}{ll} 8x = 500 & \text{Cross multiply.} \\ \frac{8x}{8} = \frac{500}{8} & \text{Divide both sides by 8.} \\ x = \frac{125}{2} & \text{Reduce: Divide numerator and denominator by 4.} \\ x = 62.5 & \text{Divide.} \end{array}$$

Thus,

$$\frac{5}{8} = \frac{62.5}{100} = 62.5\%.$$

Alternate Ending. We could also change $125/2$ to a mixed fraction; i.e., $125/2 = 62\frac{1}{2}$. Then,

$$\frac{5}{8} = \frac{62\frac{1}{2}}{100} = 62\frac{1}{2}\%.$$

Same answer.

Answer: $44\frac{4}{9}\%$

Sometimes we will be content with an approximation.

You Try It!

EXAMPLE 10. Change $4/13$ to a percent. Round your answer to the nearest tenth of a percent.

Change $4/17$ to a percent. Round your answer to the nearest tenth of a percent.

Solution. We will use Technique #1.

To change $4/13$ to a decimal, divide 4 by 13. Since the denominator has factors other than 2's and 5's, the decimal will repeat. However, we intend to round to the nearest tenth of a percent, so we will carry the division to four decimal places only. (Four places are necessary because we will be moving the decimal point two places to the right.)

To change the decimal to a percent, move the decimal point two places to the right.

$$0.3076 \approx 0.3076\% \approx 30.76\%$$

To round to the nearest tenth of a percent, identify the rounding and test digits.

$$30.\overset{\text{Rounding digit}}{\boxed{7}}\overset{\text{Test digit}}{\boxed{6}}\%$$

Because the test digit is greater than or equal to 5, add 1 to the rounding digit and truncate. Thus,

$$0.03076 \approx 30.8\%.$$

Answer: 23.5%

 Exercises 

In Exercises 1-18, convert the given percent to a fraction, and simplify the result.

- | | |
|----------------------|----------------------|
| 1. $4\frac{7}{10}\%$ | 10. $8\frac{5}{8}\%$ |
| 2. $7\frac{1}{4}\%$ | 11. 192% |
| 3. $7\frac{2}{9}\%$ | 12. 5% |
| 4. $4\frac{9}{10}\%$ | 13. 86% |
| 5. 11.76% | 14. 177% |
| 6. 15.2% | 15. 130% |
| 7. 13.99% | 16. 80% |
| 8. 18.66% | 17. 4.07% |
| 9. $4\frac{1}{2}\%$ | 18. 6.5% |
-

In Exercises 19-34, convert the given percent to a decimal.

- | | |
|-------------|------------|
| 19. 124% | 27. 8% |
| 20. 4% | 28. 3% |
| 21. 0.6379% | 29. 59.84% |
| 22. 0.21% | 30. 0.17% |
| 23. 28% | 31. 155% |
| 24. 5.4% | 32. 7% |
| 25. 0.83% | 33. 36.5% |
| 26. 0.3344% | 34. 39.7% |
-

In Exercises 35-50, convert the given decimal to a percent.

- | | |
|-----------|-----------|
| 35. 8.888 | 40. 3.372 |
| 36. 5.1 | 41. 0.14 |
| 37. 0.85 | 42. 4.89 |
| 38. 0.08 | 43. 8.7 |
| 39. 1.681 | 44. 8.78 |

45. 0.38

48. 0.07

46. 1.67

49. 0.044

47. 0.02

50. 0.29

In Exercises 51-68, convert the given fraction to a percent.

51. $\frac{1}{2}$

60. $\frac{18}{25}$

52. $\frac{29}{8}$

61. $\frac{9}{4}$

53. $\frac{5}{2}$

62. $\frac{7}{8}$

54. $\frac{4}{5}$

63. $\frac{7}{5}$

55. $\frac{8}{5}$

64. $\frac{4}{25}$

56. $\frac{7}{20}$

65. $\frac{6}{5}$

57. $\frac{14}{5}$

66. $\frac{23}{8}$

58. $\frac{3}{2}$

67. $\frac{12}{5}$

59. $\frac{9}{2}$

68. $\frac{13}{2}$

69. Convert $\frac{24}{29}$ to a percent, and round your answer to the nearest hundredth of a percent.

74. Convert $\frac{5}{6}$ to a percent, and round your answer to the nearest hundredth of a percent.

70. Convert $\frac{5}{3}$ to a percent, and round your answer to the nearest hundredth of a percent.

75. Convert $\frac{8}{3}$ to a percent, and round your answer to the nearest tenth of a percent.

71. Convert $\frac{15}{7}$ to a percent, and round your answer to the nearest tenth of a percent.

76. Convert $\frac{22}{21}$ to a percent, and round your answer to the nearest tenth of a percent.

72. Convert $\frac{10}{7}$ to a percent, and round your answer to the nearest tenth of a percent.

77. Convert $\frac{9}{23}$ to a percent, and round your answer to the nearest tenth of a percent.

73. Convert $\frac{7}{24}$ to a percent, and round your answer to the nearest hundredth of a percent.

78. Convert $\frac{11}{9}$ to a percent, and round your answer to the nearest tenth of a percent.

- 79.** Convert $17/27$ to a percent, and round your answer to the nearest hundredth of a percent.
- 80.** Convert $22/27$ to a percent, and round your answer to the nearest hundredth of a percent.

81. Crime rates. Preliminary crime rates for the first six months of 2009 compared to the same period in 2008 are shown below. *Associated Press-Times-Standard 12/22/09 Despite recession, the national crime rates keep falling.*

Murder	−10.0%
Forcible rape	−3.3%
Robbery	−6.5%
Aggravated assault	−3.2%
Burglary	−2.5%
Larceny-theft	−5.3%
Motor vehicle theft	−18.75%
Arson	−8.2%

Source: Federal Bureau of Investigation

- i) What do the negative signs indicate?
- ii) Which type of crime decreased the most?
- iii) Which type of crime decreased the least?
- 82. Major Hurricanes.** 5 of the 8 hurricanes in 2008 were categorized as major. Write the fractional number of major hurricanes in 2008 as a percent. *NOAA Associated Press 5/22/09*
- 83. Chance of flood.** These excerpts are from the story *Corps: Dam work lessens Seattle-area flood chance* published in the *Times-Standard* on Nov. 6, 2009. Write all four of the odds of flooding as a percent chance. Round to the nearest tenth of a percent if necessary.
- i) Col. Anthony Wright, from the U.S. Army Corps of Engineers, speaking of the repairs to the Green River Dam, reported there was now a 1-in-25 chance that a storm would force the corps to release enough water from the dam's reservoir to cause a flood downstream in the Green River Valley.
- ii) The odds of widespread flooding in the valley improve to 1-in-32 when all the sandbagging and flood-protection efforts are factored in.
- iii) Previously, the Corps of Engineers said the chance of widespread flooding was 1-in-4.
- iv) When the dam operates at capacity, there is a 1-in-140 chance of flooding.



Answers



1. $\frac{47}{1000}$

3. $\frac{13}{180}$

- | | |
|-------------------------|---|
| 5. $\frac{147}{1250}$ | 49. 4.4% |
| 7. $\frac{1399}{10000}$ | 51. 50% |
| 9. $\frac{9}{200}$ | 53. 250% |
| 11. $\frac{48}{25}$ | 55. 160% |
| 13. $\frac{43}{50}$ | 57. 280% |
| 15. $\frac{13}{10}$ | 59. 450% |
| 17. $\frac{407}{10000}$ | 61. 225% |
| 19. 1.24 | 63. 140% |
| 21. 0.006379 | 65. 120% |
| 23. 0.28 | 67. 240% |
| 25. 0.0083 | 69. 82.76% |
| 27. 0.08 | 71. 214.3% |
| 29. 0.5984 | 73. 29.17% |
| 31. 1.55 | 75. 266.7% |
| 33. 0.365 | 77. 39.1% |
| 35. 888.8% | 79. 62.96% |
| 37. 85% | 81. i) The negative signs indicate the crime rate has decreased from previous measures. |
| 39. 168.1% | ii) Motor vehicle theft decreased the most with an 18.75% decrease. |
| 41. 14% | iii) Burglary decreased the least with a 2.5% decrease. |
| 43. 870% | 83. i) 4% chance of flood |
| 45. 38% | ii) 3.1% chance of flood |
| 47. 2% | iii) 25% chance of flood |
| | iv) 0.7% chance of flood |

7.2 Solving Basic Percent Problems

There are three basic types of percent problems:

1. *Find a given percent of a given number.* For example, find 25% of 640.
2. *Find a percent given two numbers.* For example, 15 is what percent of 50?
3. *Find a number that is a given percent of another number.* For example, 10% of what number is 12?

Let's begin with the first of these types.

Find a Given Percent of a Given Number

Let's begin with our first example.

You Try It!

What number is 36% of 120?

EXAMPLE 1. What number is 25% of 640?

Solution. Let x represent the unknown number. Translate the words into an equation.

$$\begin{array}{ccccccc} \text{What number} & \text{is} & 25\% & \text{of} & 640 \\ x & = & 25\% & \cdot & 640 \end{array}$$

Now, solve the equation for x .

$$\begin{array}{ll} x = 25\% \cdot 640 & \text{Original equation.} \\ x = 0.25 \cdot 640 & \text{Change 25\% to a decimal: } 25\% = 0.25. \\ x = 160 & \text{Multiply: } 0.25 \cdot 640 = 160. \end{array}$$

Thus, 25% of 640 is 160.

Alternate Solution. We could also change 25% to a fraction.

$$\begin{array}{ll} x = 25\% \cdot 640 & \text{Original equation.} \\ x = \frac{1}{4} \cdot 640 & \text{Change 25\% to a fraction: } 25\% = 25/100 = 1/4. \\ x = \frac{640}{4} & \text{Multiply numerators and denominators.} \\ x = 160 & \text{Divide: } 640/4 = 160. \end{array}$$

Answer: 43.2

Same answer.

□

You Try It!

EXAMPLE 2. What number is $8\frac{1}{3}\%$ of 120?

Solution. Let x represent the unknown number. Translate the words into an equation.

What number is $4\frac{1}{6}\%$ of 1,200?

What number	is	$8\frac{1}{3}\%$	of	120
x	=	$8\frac{1}{3}\%$	·	120

Now, solve the equation for x . Because

$$8\frac{1}{3}\% = 8.\overline{3}\% = 0.08\overline{3},$$

working with decimals requires that we work with a repeating decimal. To do so, we would have to truncate the decimal representation of the percent at some place and satisfy ourselves with an approximate answer. Instead, let's change the percent to a fraction and seek an exact answer.

$8\frac{1}{3}\% = \frac{8\frac{1}{3}}{100}$	Percent: Parts per hundred.
$= \frac{\frac{25}{3}}{100}$	Mixed to improper fraction.
$= \frac{25}{3} \cdot \frac{1}{100}$	Invert and multiply.
$= \frac{25}{300}$	Multiply numerators and denominators.
$= \frac{1}{12}$	Reduce: Divide numerator and denominator by 25.

Now we can solve our equation for x .

$x = 8\frac{1}{3}\% \cdot 120$	Original equation.
$x = \frac{1}{12} \cdot 120$	$8\frac{1}{3}\% = 1/12$.
$x = \frac{120}{12}$	Multiply numerators and denominators.
$x = 10$	Divide: $120/12=10$.

Thus, $8\frac{1}{3}\%$ of 120 is 10.

Answer: 50

□

You Try It!

EXAMPLE 3. What number is $105\frac{3}{4}\%$ of 18.2?

What number is $105\frac{3}{4}\%$ of 222?

Solution. Let x represent the unknown number. Translate the words into an equation.

$$\begin{array}{ccccccc} \text{What number} & \text{is} & 105\frac{1}{4}\% & \text{of} & 18.2 \\ x & = & 105\frac{1}{4}\% & \cdot & 18.2 \end{array}$$

In this case, the fraction terminates as $1/4 = 0.25$, so

$$105\frac{1}{4}\% = 105.25\% = 1.0525.$$

Now we can solve our equation for x .

$$\begin{array}{ll} x = 105\frac{1}{4}\% \cdot 18.2 & \text{Original equation.} \\ x = 1.0525 \cdot 18.2 & 5\frac{1}{4}\% = 1.0525. \\ x = 19.1555 & \text{Multiply.} \end{array}$$

Answer: 234.765

Thus, $105\frac{1}{4}\%$ of 18.2 is 19.1555. □

Find a Percent Given Two Numbers

Now we'll address our second item on the list at the beginning of the section.

You Try It!

14 is what percent of 25?

EXAMPLE 4. 15 is what percent of 50?

Solution. Let x represent the unknown percent. Translate the words into an equation.

$$\begin{array}{ccccccc} 15 & \text{is} & \text{what percent} & \text{of} & 50 \\ 15 & = & x & \cdot & 50 \end{array}$$

The commutative property of multiplication allows us to change the order of multiplication on the right-hand side of this equation.

$$15 = 50x.$$

Now we can solve our equation for x .

$$\begin{array}{ll} 15 = 50x & \text{Original equation.} \\ \frac{15}{50} = \frac{50x}{50} & \text{Divide both sides by 50.} \\ \frac{15}{50} = x & \text{Simplify right-hand side.} \\ x = 0.30 & \text{Divide: } 15/50 = 0.30. \end{array}$$

But we must express our answer as a percent. To do this, move the decimal two places to the right and append a percent symbol.

$$0.30 = 0 \overset{\text{30.}\%}{\underset{\uparrow}{30}} = 30\%$$

Thus, 15 is 30% of 50.

Alternative Conversion. At the third step of the equation solution, we had

$$x = \frac{15}{50}.$$

We can convert this to an equivalent fraction with a denominator of 100.

$$x = \frac{15 \cdot 2}{50 \cdot 2} = \frac{30}{100}$$

Thus, $15/50 = 30/100 = 30\%$.

Answer: 56%

You Try It!

EXAMPLE 5. 10 is what percent of 80?

10 is what percent of 200?

Solution. Let x represent the unknown percent. Translate the words into an equation.

$$\begin{array}{ccccccc} 10 & \text{is} & \text{what percent} & \text{of} & 80 \\ 10 & = & x & \cdot & 80 \end{array}$$

The commutative property of multiplication allows us to write the right-hand side as

$$10 = 80x.$$

Now we can solve our equation for x .

$$\begin{array}{ll} 10 = 80x & \text{Original equation.} \\ \frac{10}{80} = \frac{80x}{80} & \text{Divide both sides by 80.} \\ \frac{1}{8} = x & \text{Reduce: } 10/80 = 1/8. \\ 0.125 = x & \text{Divide: } 1/8 = 0.125. \end{array}$$

But we must express our answer as a percent. To do this, move the decimal two places to the right and append a percent symbol.

$$0.125 = 0 \overset{\text{12.5}\%}{\underset{\uparrow}{125}} = 12.5\%$$

Thus, 10 is 12.5% of 80.

Alternative Conversion. At the third step of the equation solution, we had

$$x = \frac{1}{8}.$$

We can convert this to an equivalent fraction with a denominator of 100 by setting up the proportion

$$\frac{1}{8} = \frac{n}{100}$$

Cross multiply and solve for n .

$$\begin{aligned} 8n &= 100 && \text{Cross multiply.} \\ \frac{8n}{8} &= \frac{100}{8} && \text{Divide both sides by 8.} \\ n &= \frac{25}{2} && \text{Reduce: Divide numerator and denominator by 4.} \\ n &= 12\frac{1}{2} && \text{Change } 25/2 \text{ to mixed fraction.} \end{aligned}$$

Hence,

$$\frac{1}{8} = \frac{12\frac{1}{2}}{100} = 12\frac{1}{2}\%.$$

Answer: 5%

Same answer.

□

Find a Number that is a Given Percent of Another Number

Let's address the third item on the list at the beginning of the section.

You Try It!

20% of what number is 45?

EXAMPLE 6. 10% of what number is 12?

Solution. Let x represent the unknown number. Translate the words into an equation.

$$\begin{array}{ccccccc} 10\% & \text{of} & \text{what number} & \text{is} & 12 \\ 10\% & \cdot & x & = & 12 \end{array}$$

Change 10% to a fraction: $10\% = 10/100 = 1/10$.

$$\frac{1}{10}x = 12$$

Now we can solve our equation for x .

$$\begin{aligned} 10 \left(\frac{1}{10}x \right) &= 10(12) && \text{Multiply both sides by 10.} \\ x &= 120 && \text{Simplify.} \end{aligned}$$

Thus, 10% of 120 is 12.

Alternative Solution. We can also change 10% to a decimal: $10\% = 0.10$. Then our equation becomes

$$0.10x = 12$$

Now we can divide both sides of the equation by 0.10.

$$\frac{0.10x}{0.10} = \frac{12}{0.10} \quad \text{Divide both sides by 0.10.}$$

$$x = 120 \quad \text{Divide: } 12/0.10 = 120.$$

Same answer.

Answer: 225

You Try It!

EXAMPLE 7. $11\frac{1}{9}\%$ of what number is 20?

$12\frac{2}{3}\%$ of what number is 760?

Solution. Let x represent the unknown number. Translate the words into an equation.

$$\begin{array}{ccccccc} 11\frac{1}{9}\% & \text{of} & \text{what number} & \text{is} & 20 \\ 11\frac{1}{9}\% & \cdot & x & = & 20 \end{array}$$

Change $11\frac{1}{9}\%$ to a fraction.

$$\begin{array}{ll} 11\frac{1}{9}\% = \frac{11\frac{1}{9}}{100} & \text{Percent: Parts per hundred.} \\ = \frac{\frac{100}{9}}{100} & \text{Mixed to improper: } 11\frac{1}{9} = 100/9. \\ = \frac{100}{9} \cdot \frac{1}{100} & \text{Invert and multiply.} \\ = \frac{\cancel{100}}{9} \cdot \frac{1}{\cancel{100}} & \text{Cancel.} \\ = \frac{1}{9} & \text{Simplify.} \end{array}$$

Replace $11\frac{1}{9}\%$ with $1/9$ in the equation and solve for x .

$$\begin{array}{ll} \frac{1}{9}x = 20 & 11\frac{1}{9}\% = 1/9. \\ 9\left(\frac{1}{9}x\right) = 9(20) & \text{Multiply both sides by 9.} \\ x = 180 & \end{array}$$

Thus, $11\frac{1}{9}\%$ of 180 is 20.

Answer: 6,000



Exercises



1. What number is 22.4% of 125?
2. What number is 159.2% of 125?
3. 60% of what number is 90?
4. 25% of what number is 40?
5. 200% of what number is 132?
6. 200% of what number is 208?
7. 162.5% of what number is 195?
8. 187.5% of what number is 90?
9. 126.4% of what number is 158?
10. 132.5% of what number is 159?
11. 27 is what percent of 45?
12. 9 is what percent of 50?
13. 37.5% of what number is 57?
14. 162.5% of what number is 286?
15. What number is 85% of 100?
16. What number is 10% of 70?
17. What number is 200% of 15?
18. What number is 50% of 84?
19. 50% of what number is 58?
20. 132% of what number is 198?
21. 5.6 is what percent of 40?
22. 7.7 is what percent of 35?
23. What number is 18.4% of 125?
24. What number is 11.2% of 125?
25. 30.8 is what percent of 40?
26. 6.3 is what percent of 15?
27. 7.2 is what percent of 16?
28. 55.8 is what percent of 60?
29. What number is 89.6% of 125?
30. What number is 86.4% of 125?
31. 60 is what percent of 80?
32. 16 is what percent of 8?
33. What number is 200% of 11?
34. What number is 150% of 66?
35. 27 is what percent of 18?
36. 9 is what percent of 15?
37. $133\frac{1}{3}\%$ of what number is 80?
38. $121\frac{2}{3}\%$ of what number is 73?
39. What number is $54\frac{1}{3}\%$ of 6?
40. What number is $82\frac{2}{5}\%$ of 5?
41. What number is $62\frac{1}{2}\%$ of 32?
42. What number is $118\frac{3}{4}\%$ of 32?
43. $77\frac{1}{7}\%$ of what number is 27?
44. $82\frac{2}{3}\%$ of what number is 62?
45. What number is $142\frac{6}{7}\%$ of 77?
46. What number is $116\frac{2}{3}\%$ of 84?
47. $143\frac{1}{2}\%$ of what number is 5.74?
48. $77\frac{1}{2}\%$ of what number is 6.2?
49. $141\frac{2}{3}\%$ of what number is 68?
50. $108\frac{1}{3}\%$ of what number is 78?
51. What number is $66\frac{2}{3}\%$ of 96?
52. What number is $79\frac{1}{6}\%$ of 48?
53. $59\frac{1}{2}\%$ of what number is 2.38?
54. $140\frac{1}{5}\%$ of what number is 35.05?
55. $78\frac{1}{2}\%$ of what number is 7.85?
56. $73\frac{1}{2}\%$ of what number is 4.41?
57. What number is $56\frac{2}{3}\%$ of 51?
58. What number is $64\frac{1}{2}\%$ of 4?
59. What number is $87\frac{1}{2}\%$ of 70?
60. What number is $146\frac{1}{4}\%$ of 4?

61. It was reported that 80% of the retail price of milk was for packaging and distribution. The remaining 20% was paid to the dairy farmer. If a gallon of milk cost \$3.80, how much of the retail price did the farmer receive?

62. At \$1.689 per gallon of gas the cost is distributed as follows:

Crude oil supplies	\$0.95
Oil Companies	\$0.23
State and City taxes	\$0.23
Federal tax	\$0.19
Service Station	\$0.10

Data is from Money, March 2009 p. 22, based on U. S. averages in December 2008. Answer the following questions rounded to the nearest whole percent.

- What % of the cost is paid for crude oil supplies?
- What % of the cost is paid to the service station?

••• **Answers** •••

1. 28	25. 77
3. 150	27. 45
5. 66	29. 112
7. 120	31. 75
9. 125	33. 22
11. 60	35. 150
13. 152	37. 60
15. 85	39. 3.26
17. 30	41. 20
19. 116	43. 35
21. 14	45. 110
23. 23	47. 4
	49. 48

51. 64**57.** 28.9**53.** 4**59.** 61.25**55.** 10**61.** \$0.76

7.3 General Applications of Percent

In this section we will look at an assortment of practical problems involving percent.

You Try It!

EXAMPLE 1. Myrna notes that 20% of her class is absent. If the class has 45 students, how many students are absent?

Aaron notes that 15% of his class is absent. If the class has 80 students, how many students are absent?

Solution. Let n represent the number of students that are absent. Then we can translate the problem statement into words and symbols.

$$\begin{array}{ccccccc} \text{Number absent} & \text{is} & 20\% & \text{of} & \text{total number of} & & \\ & & & & \text{students in the class} & & \\ n & = & 20\% & \cdot & 45 & & \end{array}$$

Because $20\% = 0.20$,

$$\begin{array}{ll} n = 0.20 \cdot 45 & 20\% = 0.20 \\ n = 9 & \text{Multiply: } 0.20 \cdot 45 = 9. \end{array}$$

Therefore, 9 students are absent.

Answer: 12

You Try It!

EXAMPLE 2. Misty answered 90% of the questions on her mathematics examination correctly. If Misty had 27 correct answers, how many questions were on the exam?

Erin answered 85% of the questions on her english examination correctly. If she had 34 correct answers, how many questions were on her exam?

Solution. Let N represent the number of questions on the examination.

$$\begin{array}{ccccccc} \text{Number of} & \text{is} & 90\% & \text{of} & \text{total number of} & & \\ \text{correct answers} & & & & \text{questions} & & \\ 27 & = & 90\% & \cdot & N & & \end{array}$$

Because $90\% = 0.90$, this last equation can be written as

$$27 = 0.90N.$$

Solve for N .

$$\begin{array}{ll} \frac{27}{0.90} = \frac{0.90N}{0.90} & \text{Divide both sides by } 0.90. \\ 30 = N & \text{Divide: } 27/0.90 = 30. \end{array}$$

Hence, there were 30 questions on the examination.

Answer: 40

You Try It!

Alphonso answered 19 of 25 questions on his biology test correctly. What percent of the questions did he mark correctly?

EXAMPLE 3. Misty answered 30 of 40 possible questions on her sociology examination correctly. What percent of the total number of questions did Misty mark correctly?

Solution. Let p represent the percent of the total number of questions marked correctly. Then we can translate the problem statement into words and symbols.

Number of correct answers	is	what percent	of	total number of questions
30	=	p	·	40

Because multiplication is commutative, we can write the last equation in the form

$$30 = 40p.$$

Solve for p .

$$\begin{aligned} \frac{30}{40} &= \frac{40p}{40} && \text{Divide both sides by 40.} \\ \frac{3}{4} &= p && \text{Reduce: } 30/40 = 3/4. \end{aligned}$$

We need to change $p = 3/4$ to a percent. There are two ways to do this:

- We can divide 3 by 4 to get

$$\begin{aligned} p &= \frac{3}{4} \\ &= 0.75 && \text{Divide: } 3/4 = 0.75. \\ &= 75\% && \text{Move decimal point 2 places right.} \end{aligned}$$

- We can create an equivalent fraction with a denominator of 100; i.e.,

$$\begin{aligned} p &= \frac{3}{4} \\ &= \frac{3 \cdot 25}{4 \cdot 25} && \text{Multiply numerator and denominator by 25.} \\ &= \frac{75}{100} && \text{Simplify numerator and denominator.} \\ &= 75\%. && \text{Percent means parts per hundred.} \end{aligned}$$

Either way, Misty got 75% of the questions on her sociology examination correct.

Answer: 76%

□

You Try It!

EXAMPLE 4. 35 millilitres of a 60 millilitre solution is hydrochloric acid. What percent of the solution is hydrochloric acid?

Solution. Let p represent the percent of the percent of the solution that is hydrochloric acid. Then we can translate the problem statement into words and symbols.

25 millilitres of a 40 millilitre solution is sulfuric acid. What percent of the solution is sulfuric acid?

Amount of hydrochloric acid	is	what percent	of	the total amount of solution
35	=	p	·	60

Because multiplication is commutative, we can write the right-hand side of the last equation as follows.

$$35 = 60p$$

Now we can solve for p .

$$\frac{35}{60} = \frac{60p}{60} \quad \text{Divide both sides by 60.}$$

$$\frac{7}{12} = p \quad \text{Reduce: Divide numerator and denominator by 5.}$$

Now we must change p to a percent. We can do this exactly by creating an equivalent fraction with a denominator of 100.

$$\frac{7}{12} = \frac{n}{100}$$

Solve for n .

$$12n = 700 \quad \text{Cross multiply.}$$

$$\frac{12n}{12} = \frac{700}{12} \quad \text{Divide both sides by 12.}$$

$$n = \frac{175}{3} \quad \text{Reduce: Divide numerator and denominator by 4.}$$

$$n = 58\frac{1}{3} \quad \text{Change improper to mixed fraction.}$$

Hence,

$$p = \frac{7}{12} = \frac{58\frac{1}{3}}{100} = 58\frac{1}{3}\%.$$

Thus, $58\frac{1}{3}\%$ of the solution is hydrochloric acid.

Approximate Solution. If all that is needed is an approximate answer, say correct to the nearest tenth of a percent, then we would take a different approach starting with the line from above that has

$$\frac{35}{60} = p.$$

We would divide 35 by 60 to get

$$p \approx 0.5833.$$

Move the decimal two places to the right and append a percent symbol.

$$p \approx 0.5833 \approx 0.5833\% \approx 58.33\%.$$

Round to the nearest tenth of a percent.

$$p \approx 58.\boxed{3}\boxed{3}\%$$

Rounding digit Test digit

Because the test digit is less than 5, leave the rounding digit alone and truncate. Thus, correct to the nearest tenth of a percent,

$$p \approx 58.3\%.$$

Answer: 62.5%

Note that $p \approx 58.3\%$ is approximate, but $p = 58\frac{1}{3}\%$ is exact.

□

 Exercises 

1. 31 millilitres of a 250 millilitre solution is sulphuric acid. What percent of the solution is sulphuric acid? Round your answer to the nearest tenth of a percent.
2. 34 millilitres of a 211 millilitre solution is phosphoric acid. What percent of the solution is phosphoric acid? Round your answer to the nearest tenth of a percent.
3. A family has completed 186 miles of a planned 346 mile trip. Find the percentage of the planned trip already traveled. Round your answer to the nearest percent.
4. A family has completed 153 miles of a planned 431 mile trip. Find the percentage of the planned trip already traveled. Round your answer to the nearest percent.
5. Erin takes roll in her fifth grade class and finds that 19 out of 34 total students on her roster are present. Find the percentage of the class that is present, correct to the nearest percent.
6. Barbara takes roll in her fifth grade class and finds that 15 out of 38 total students on her roster are present. Find the percentage of the class that is present, correct to the nearest percent.
7. Raven answered 135 of 150 possible questions on the meteorology examination correctly. What percent of the total number of questions did Raven mark correctly?
8. Liz answered 30 of 50 possible questions on the algebra examination correctly. What percent of the total number of questions did Liz mark correctly?
9. A family has traveled 114 miles of a planned trip. This is 37% of the total distance they must travel on the trip. Find, correct to the nearest mile, the total distance they will travel on their trip.
10. A family has traveled 102 miles of a planned trip. This is 23% of the total distance they must travel on the trip. Find, correct to the nearest mile, the total distance they will travel on their trip.
11. Trudy takes roll in her class at the university and finds that 65 students are present. If this is 50% of the total class enrollment, how many students are in the class?
12. Sandra takes roll in her class at the university and finds that 104 students are present. If this is 80% of the total class enrollment, how many students are in the class?
13. Bill earns a commission on all sales he makes. He sells a bed for \$591 and earns a commission of \$43. Find the percent commission, rounded to the nearest tenth of a percent.
14. Ira earns a commission on all sales he makes. He sells a sofa for \$408 and earns a commission of \$39. Find the percent commission, rounded to the nearest tenth of a percent.
15. Tami answered 70% of the questions on the physics examination correctly. If Tami had 98 correct answers, how many questions were on the exam?
16. Trinity answered 90% of the questions on the chemistry examination correctly. If Trinity had 99 correct answers, how many questions were on the exam?

17. A state charges 8% sales tax on all sales. If the sales tax on a computer is \$20, find the sales price of the computer, correct to the nearest dollar.
18. A state charges 6.5% sales tax on all sales. If the sales tax on a bed is \$33, find the sales price of the bed, correct to the nearest dollar.
19. Kenon earns 6% commission all his sales. If the sale of a computer earns him a \$37 commission, find the sales price of the computer, correct to the nearest dollar.
20. Donald earns 4.5% commission all his sales. If the sale of a dryer earns him a \$24 commission, find the sales price of the dryer, correct to the nearest dollar.
21. A 23% nitric acid solution contains 59 millilitres of nitric acid. How many total millilitres of solution are present? Round your answer to the nearest millilitre.
22. A 27% sulphuric acid solution contains 67 millilitres of sulphuric acid. How many total millilitres of solution are present? Round your answer to the nearest millilitre.
23. In a state, a television sold for \$428 is assessed a sales tax of \$45. Find the sales tax rate, rounded to the nearest tenth of a percent.
24. In a state, a refrigerator sold for \$503 is assessed a sales tax of \$44. Find the sales tax rate, rounded to the nearest tenth of a percent.
-
25. **Mars gravity.** The force of gravity on Mars is only 38% of the force of gravity on earth. If you weigh 150 pounds on earth, how much will you weigh on Mars?
26. **Wiretaps.** In 2008, there were a total of 1,891 applications to federal and state judges to authorize the interception of wire, oral, or electronic communications. If 94% of all wiretap applications were for a portable device such as a cell phone or pager, how many applications were made to tap mobile devices? Round-off to the nearest application. *Associated Press Times-Standard 4/28/09*
27. **Seniors.** 13% of Humboldt County's population is age 65 and older, about 2% more than the state's average. If the population of Humboldt County is approximately 130,000, how many people in Humboldt County are age 65 and older? *Times-Standard 6/10/2009*
28. **Antibiotics.** "The U.S. used about 35 million pounds of antibiotics last year. 70 percent of the drugs went to pigs, chickens, and cows." How many million pounds of antibiotics went to the pigs, chickens, and cows? *Associated Press-Times-Standard 12/29/09 Pressure rises to stop antibiotics in agriculture.*
29. **Grow faster.** "Approximately 28 million pounds of antibiotics were fed to farm animals in the US during 2008. Thirteen percent of that was fed to healthy animals to make them grow faster." How many pounds of antibiotics were fed to healthy animals? *Associated Press-Times-Standard 12/29/09 Pressure rises to stop antibiotics in agriculture.*
30. **CO2 emissions.** The accord agreed to by the US at the Copenhagen climate talks had greenhouse gas emissions held to 3.5% of 1990 levels. If 1990 levels were 5022 MMT (millions of metric tons), how many millions of metric tons might greenhouse emissions be held to? Round the result to the nearest MMT. *Associated Press-Times-Standard 12/19/09 Elements of new Copenhagen accord.*

- 31. Water supply.** A new water desalination plant, the largest in the Western hemisphere, could come online by 2012 in Carlsbad, California, providing 50 million gallons of drinking water per day, or 10% of the supply for San Diego County. What is the total amount of drinking water supplied to San Diego County daily? *Associated Press-Times-Standard*
- 32. Earthquake damage.** After the recent earthquake in Chile, an estimated 33 million gallons of Chilean wine, or 13% of annual production, was lost. Estimate the total annual production of Chilean wine rounded to the nearest millions of gallons. *Associated Press-Times Standard 03/24/10 Hemorrhaging cabernet: Earthquake hits winemakers in Chile.*
- 33. Snowpack.** At a meadow near Echo Summit in the northern Sierra Nevada, water officials measured the snow at 65.7 inches. The water content was 25.9 inches, which is 92% of the average for this time of year. Determine the average water content for this time of year rounded to the nearest tenth of an inch. *Associated Press-Times Standard 04/02/10 California's Sierra snowpack slightly above normal.*
- 34. Storefronts.** According to the Times-Standard, as of April 2008 the Bayshore Mall had 55 occupied storefronts and 17 vacant storefronts. What percent of total storefronts are vacant? Round your answer to the nearest whole number. *Times-Standard 4/19/09*
- 35. Recovered.** In Humboldt County, California, 427 of the 499 vehicles stolen between August 2008 and August 2009 were recovered. What percent of the stolen vehicles were recovered? Round your result to the nearest tenth of a percent. *Times-Standard CHP offers tips on avoiding vehicle theft.*
- 36. Freshman admissions.** Stanford University sent acceptance letters to 2,300 of 32,022 freshman applicants. What percent of freshman applicants got acceptance letters, rounded to the nearest percent? *Associated Press-Times-Standard 03/30/10 Stanford U. reports record-low admission rate.*
- 37. Reduce.** Each year, Americans throw out an average of about 1,600 pounds of waste per person. Arcata, CA resident Michael Winkler only uses one trash bag every year – totaling at most 40 pounds. Find the percent of average annual waste per person Mr. Winkler throws out to a tenth of a percent. *Times-Standard Allison White 12/26/09 Waste not...*
- 38. Population decrease.** The table below shows the population of Detroit, Michigan. *Associated Press-Times-Standard 03/09/10 Detroit wants to save itself by shrinking.*

Year	Population
1950	1,849,568
1990	1,027,974
2005	890,963

What is the population of Detroit in 2005 as a percent of the population in 1950? Round your result to the nearest percent.

🐼 🐼 🐼 **Answers** 🐼 🐼 🐼

- | | |
|-------------------------|---|
| 1. 12.4 | 21. 257 ml |
| 3. 54 | 23. 10.5 |
| 5. 56 | 25. 57 pounds |
| 7. 90 | 27. 16,900 |
| 9. 308 mi | 29. 3.84 million pounds |
| 11. 130 students | 31. 500 million gallons |
| 13. 7.3 | 33. The average water content is 28.2 inches. |
| 15. 140 | 35. 85.6% of the stolen vehicles were recovered. |
| 17. \$250 | 37. Mr. Winkler throws out 2.5% of the average American's waste. |
| 19. \$617 | |

7.4 Percent Increase or Decrease

A person's salary can increase by a percentage. A town's population can decrease by a percentage. A clothing firm can discount its apparel. These are the types of applications we will investigate in this section.

Percent Increase

You Try It!

EXAMPLE 1. A salesperson is granted a 5% salary increase. If the salesperson's current salary is \$4,000 per month, what will be his new salary?

Solution. Let x represent the salesperson's salary increase. Then we can translate the problem into words and symbols.

A computer technician is granted a 4% salary increase. If the salesperson's current salary is \$2,800 per month, what will be his new salary?

$$\begin{array}{ccccccc} \text{Salary increase} & \text{is} & 5\% & \text{of} & \text{original salary} \\ x & = & 5\% & \cdot & 4000 \end{array}$$

Solve for x .

$$\begin{array}{ll} x = 0.05 \cdot 4000 & 5\% = 0.05. \\ x = 200 & \text{Multiply: } 0.05 \cdot 4000 = 200. \end{array}$$

Therefore, the salary increase is \$200. To compute the new salary N , we must add this increase to the original salary.

$$\begin{array}{ccccccc} \text{New salary} & \text{is} & \text{original salary} & \text{plus} & \text{increase} \\ N & = & 4000 & + & 200 \end{array}$$

Thus, the new salary is $N = \$4,200$ per month.

Alternative Solution. If the salesperson is to receive a 5% increase in his salary, then his new salary will be 105% of his original salary. Let N represent his new monthly salary. Then,

$$\begin{array}{ccccccc} \text{New salary} & \text{is} & 105\% & \text{of} & \text{original salary} \\ N & = & 105\% & \cdot & 4000 \end{array}$$

Solve for N .

$$\begin{array}{ll} N = 1.05 \cdot 4000 & 105\% = 1.05. \\ N = 4200 & \text{Multiply: } 1.05 \cdot 4000 = 4200. \end{array}$$

Same answer.

Answer: \$2,912

□

You Try It!

A statistician making a salary of \$3,200 per month has his salary increased to \$3,368 per month. What is the percent increase?

EXAMPLE 2. A salesperson making a salary of \$4,500 per month has his salary increased to \$5,000 per month. What is the percent increase?

Solution. To find the increase in salary, first subtract the original salary from the new salary.

$$\begin{aligned}\text{Salary increase} &= \text{new salary} - \text{original salary} \\ &= 5000 - 4500 \\ &= 500\end{aligned}$$

Hence, the salesperson sees an increase in salary of \$500.

Next, let p represent the salesperson's percent salary increase. Then we can translate the problem into words and symbols.

Salary increase	is	what percent	of	original salary
500	=	p	·	4500

The commutative property of multiplication allows us to change the order of multiplication on the right-hand side of this last equation.

$$500 = 4500p$$

Solve for p .

$$\begin{aligned}\frac{500}{4500} &= \frac{4500p}{4500} && \text{Divide both sides by 4500.} \\ \frac{1}{9} &= p && \text{Reduce by dividing numerator and denominator} \\ &&& \text{of } 500/4500 \text{ by 500.}\end{aligned}$$

We need to change $p = 1/9$ to a percent. We can find an exact answer by creating an equivalent fraction with a denominator of 100.

$$\begin{aligned}\frac{1}{9} &= \frac{n}{100} && \text{Make equivalent fraction.} \\ 9n &= 100 && \text{Cross multiply.} \\ \frac{9n}{9} &= \frac{100}{9} && \text{Divide both sides by 9.} \\ n &= 11\frac{1}{9} && \text{Convert } 100/9 \text{ to mixed fraction.}\end{aligned}$$

Hence, the percent increase is

$$p = \frac{1}{9} = \frac{11\frac{1}{9}}{100} = 11\frac{1}{9}\%.$$

Alternative Solution. An alternative approach is to ask what percent of the original salary equals the new salary. In this approach, let p represent the percent of the original salary that equals the new salary.

New salary	is	what percent	of	original salary
5000	=	p	·	4500

Solve for p .

$$5000 = 4500p \quad \text{Change the order of multiplication.}$$

$$\frac{5000}{4500} = \frac{4500p}{4500} \quad \text{Divide both sides by 4500.}$$

$$\frac{10}{9} = p \quad \text{Reduce: Divide numerator and denominator of } 5000/4500 \text{ by 500.}$$

We need to change $10/9$ to a percent. Again, create an equivalent fraction with a denominator of 100.

$$\frac{10}{9} = \frac{n}{100} \quad \text{Make equivalent fraction.}$$

$$9n = 1000 \quad \text{Cross multiply.}$$

$$\frac{9n}{9} = \frac{1000}{9} \quad \text{Divide both sides by 9.}$$

$$n = 111\frac{1}{9} \quad \text{Convert } 1000/9 \text{ to a mixed fraction.}$$

Thus,

$$p = \frac{10}{9} = \frac{111\frac{1}{9}}{100} = 111\frac{1}{9}\%.$$

Hence, the new salary is $111\frac{1}{9}\%$ of the original salary. To find the percent increase, subtract 100% from $111\frac{1}{9}\%$.

$$111\frac{1}{9}\% - 100\% = 11\frac{1}{9}\%$$

This represents an $11\frac{1}{9}\%$ increase in salary, which is the same answer garnered by the first solution technique.

Answer: $5\frac{1}{4}\%$

Percent Decrease

You Try It!

EXAMPLE 3. Due to a mill closure, the population of Silvertown decreases by 8.5%. If the original population was 10,200 hardy souls, what is the new population?

Solution. Let x represent the population decrease. Then we can translate the problem into words and symbols.

Several retail stores close and the population of Athens decreases by 7.2% as a result. If the original population was 12,500, what is the new population?

$$\begin{array}{ccccccc} \text{Population decrease} & \text{is} & 8.5\% & \text{of} & \text{original population} & & \\ x & = & 8.5\% & \cdot & 10200 & & \end{array}$$

Solve for x .

$$\begin{array}{ll} x = 0.085 \cdot 10200 & 8.5\% = 0.085. \\ x = 867 & \text{Multiply: } 0.085 \cdot 10200 = 867. \end{array}$$

Therefore, the population decrease is 867. To compute the new population P , we must subtract this decrease from the original population.

$$\begin{array}{ccccccc} \text{New population} & \text{is} & \text{original population} & \text{minus} & \text{population decrease} & & \\ P & = & 10200 & - & 867 & & \end{array}$$

Thus, the new population is $P = 9,333$ hardy souls.

Alternative Solution. Subtract 8.5% from 100% to obtain

$$100\% - 8.5\% = 91.5\%.$$

Thus, if 8.5% of the population leaves town, then 91.5% of the population stays. Thus, the new population P is calculated from the original as follows:

$$\begin{array}{ccccccc} \text{New population} & \text{is} & 91.5\% & \text{of} & \text{original population} & & \\ P & = & 91.5\% & \cdot & 10200 & & \end{array}$$

Solve for P .

$$\begin{array}{ll} P = 0.915 \cdot 10200 & 91.5\% = 0.915. \\ P = 9333 & \text{Multiply: } 0.915 \cdot 10200 = 9333. \end{array}$$

Answer: 11,600

Same answer.

□

You Try It!

A textile mill closure results in the population of the adjacent town decreasing from 8,956 to 7,800. What is the percent decrease in the population, rounded to the nearest tenth of a percent?

EXAMPLE 4. Millertown falls on hard times and its population decreases from 11,256 to 10,923 in the space of one year. What is the percent decrease, rounded to the nearest hundredth of a percent?

Solution. To find the decrease in population, first subtract the current population from the original population.

$$\begin{aligned} \text{Population decrease} &= \text{original population} - \text{current population} \\ &= 11256 - 10923 \\ &= 333 \end{aligned}$$

Hence, the population has decreased by 333 people.

Next, let p represent the percent population decrease. Then we can translate the problem into words and symbols.

Population decrease	is	what percent	of	original population
333	=	p	·	11256

Solve for p .

$$\frac{333}{11256} = \frac{11256p}{11256} \quad \text{Divide both sides by 11256.}$$

$$0.02958 \approx p \quad \text{Divide: } 333/11256 \approx 0.02958.$$

To change p to a percent, move the decimal point two places to the right and append a percent symbol.

$$p \approx 0.02958 \approx 0.02958\% \approx 2.958\%.$$

We are asked to round to the nearest hundredth of a percent.

$$p \approx 2.9 \boxed{5} \boxed{8} \%$$

Rounding digit Test digit

Because the test digit is greater than or equal to 5, add 1 to the rounding digit and truncate. That is,

$$p \approx 2.96\%.$$

Thus, the population of Millertown decreases approximately 2.96%.

Alternative Solution. An alternative approach is to ask what percent of the original population equals the new population.

New population	is	what percent	of	original population
10923	=	p	·	11256

Solve for p .

$$10923 = 11256p \quad \text{Change the order of multiplication.}$$

$$\frac{10923}{11256} = \frac{11256p}{11256} \quad \text{Divide both sides by 11256.}$$

$$0.97041 \approx p \quad \text{Divide: } 10923/11256 \approx 0.97041.$$

To change p to a percent, move the decimal two places to the right and append a percent symbol.

$$p \approx 0.97041 \approx 0.97041\% \approx 97.041\%.$$

We are asked to round to the nearest hundredth of a percent.

$$p \approx 97.0 \boxed{4} \boxed{1} \%$$

Rounding digit Test digit

Because the test digit is less than 5, leave the rounding digit alone and truncate. That is,

$$p \approx 97.04\%.$$

Thus, 97.04% of the Millertown population remains. To find the percent decrease (the percent who left), subtract 97.04% from 100%.

$$100\% - 97.04\% = 2.96\%$$

Answer: 12.9%

Hence, the population of Millertown decreases by 2.96%. Same answer. □

Discount

Another important application of percent is the discounting of goods.

You Try It!

A pair of hiking boots is marked at \$200. During a sale, the boots are discounted by 8%. What is the new price of the boots?

EXAMPLE 5. A pair of skis is marked at \$310. However, a sign in the shop indicates that skis are being discounted at 15%. What will be the new selling price of the skis?

Solution. Let D represent the discount (in dollars) given for our pair of skis. Then, in words and symbols:

Discount	is	15%	of	original marked price
D	=	15%	·	310

Solve for D .

$$D = 0.15 \cdot 310 \qquad 15\% = 0.15.$$

$$D = 46.50 \qquad \text{Multiply: } 0.15 \cdot 310 = 46.50.$$

Hence, the discount is \$46.50. To find the new selling price, subtract this discount from the original selling price.

$$\begin{aligned}
 \text{New selling price} &= \text{original selling price} - \text{discount} \\
 &= 310 - 46.50 \\
 &= 263.50
 \end{aligned}$$

Hence, the new selling price is \$263.50.

Alternate Solution. Subtract 15% from 100% to obtain

$$100\% - 15\% = 85\%.$$

That is, if an item is discounted 15%, then its new selling price S is 85% of its original marked price.

New selling price	is	85%	of	original marked price
S	=	85%	·	310

Solve for S .

$$S = 0.85 \cdot 310$$

$$85\% = 0.85.$$

$$S = 263.50$$

$$\text{Multiply: } 0.85 \cdot 310 = 263.50.$$

Thus, the new selling price is \$263.50. Same answer.

Answer: \$184

You Try It!

EXAMPLE 6. A pair of ski boots marked at \$210 is sold for \$180. Find the percent discount, correct to the nearest tenth of a percent.

Solution. We can find the discount (in dollars) by subtracting the sale price from the original marked price.

$$\begin{aligned} \text{Discount} &= \text{original marked price} - \text{sale price} \\ &= 210 - 180 \\ &= 30 \end{aligned}$$

Hence, the boots are discounted \$30.

Let p represent the percent discount. Then, in words and symbols:

Discount	is	percent discount	of	original marked price
30	=	p	·	210

Solve for p .

$$30 = 210p$$

Change order of multiplication.

$$\frac{30}{210} = \frac{210p}{210}$$

Divide both sides by 210.

$$\frac{1}{7} = p$$

Reduce: Divide numerator and denominator of $30/210$ by 30.

$$p \approx 0.1428$$

Divide: $1/7 \approx 0.1428$.

A computer marked at \$2,000 is sold at a discount for \$1,850. Find the percent discount, correct to the nearest tenth of a percent.

To change p to a percent, move the decimal point two places to the right and append a percent symbol.

$$p \approx 0.1428 \approx 0 \overset{\text{red bracket}}{14.28}\% \approx 14.28\%.$$

Round to the nearest tenth of a percent.

$$p \approx 14. \boxed{2} \boxed{8} \%$$

Rounding digit Test digit

Because the test digit is greater than or equal to 5, add 1 to the rounding digit and truncate. Thus, correct to the nearest tenth of a percent, the percent discount is

$$p \approx 14.3\%.$$

Alternate Solution. An alternative approach is to ask what percent p of the original marked price equals the selling price.

New selling price	is	what percent	of	original marked price
180	=	p	·	210

Solve for p .

$180 = 210p$	Change the order of multiplication.
$\frac{180}{210} = \frac{210p}{210}$	Divide both sides by 210.
$\frac{6}{7} = p$	Reduce: Divide numerator and denominator of 180/210 by 30.
$p \approx 0.8571$	Divide: $6/7 \approx 0.8571$.

To change p to a percent, move the decimal point two places to the right and append a percent symbol.

$$p \approx 0.8571 \approx 0 \overset{\text{red bracket}}{85.71}\% \approx 85.71\%.$$

Round to the nearest tenth of a percent.

$$p \approx 85. \boxed{7} \boxed{1} \%$$

Rounding digit Test digit

Because the test digit is less than 5, do nothing to the rounding digit and truncate. Thus, correct to the nearest tenth of a percent,

$$p \approx 85.7\%.$$

Thus, the new selling price is 85.7% of the original marked price. Subtract 85.7% from 100%.

$$100\% - 85.7\% = 14.3\%.$$

That is, if the new selling price is 85.7% of the original price, then the percent discount is 14.3%. This is the same answer found with the first method.

Answer: 7.5%



 Exercises 

1. A television set is marked at \$447. However, a sign in the shop indicates that the television set is being discounted at 20.5%. What will be the new selling price of the television set? Round your answer to the nearest penny.
2. A stereo set is marked at \$380. However, a sign in the shop indicates that the stereo set is being discounted at 7.5%. What will be the new selling price of the stereo set? Round your answer to the nearest penny.
3. Due to a ball bearing plant closure, Anselm falls on hard times and its population decreases from 10,794 to 8,925 in the space of one year. What is the percent decrease, rounded to the nearest hundredth of a percent?
4. Due to a logging mill closure, Carlytown falls on hard times and its population decreases from 12,113 to 10,833 in the space of one year. What is the percent decrease, rounded to the nearest hundredth of a percent?
5. A car rack is marked at \$500. However, a sign in the shop indicates that the car rack is being discounted at 3.5%. What will be the new selling price of the car rack? Round your answer to the nearest penny.
6. A car rack is marked at \$405. However, a sign in the shop indicates that the car rack is being discounted at 17.5%. What will be the new selling price of the car rack? Round your answer to the nearest penny.
7. Due to a textile mill closure, the population of Silvertown decreases by 4.1%. If the original population was 14,678 hardy souls, what is the new population, correct to the nearest person?
8. Due to a department store closure, the population of Petroria decreases by 5.3%. If the original population was 14,034 hardy souls, what is the new population, correct to the nearest person?
9. A bartender is granted a 4.6% salary increase. If the bartender's current salary is \$2,500 per month, find the bartender's new monthly salary, rounded to the nearest dollar.
10. A bartender is granted a 5.5% salary increase. If the bartender's current salary is \$2,900 per month, find the bartender's new monthly salary, rounded to the nearest dollar.
11. A car rack marked at \$358 is sold for \$292. Find the percent discount, correct to the nearest tenth of a percent.
12. A bicycle marked at \$328 is sold for \$264. Find the percent discount, correct to the nearest tenth of a percent.
13. Due to a auto manufacturing plant closure, Carlytown falls on hard times and its population decreases from 14,393 to 12,623 in the space of one year. What is the percent decrease, rounded to the nearest hundredth of a percent?
14. Due to a ball bearing plant closure, Mayville falls on hard times and its population decreases from 8,494 to 6,609 in the space of one year. What is the percent decrease, rounded to the nearest hundredth of a percent?
15. Due to a auto manufacturing plant closure, the population of Silvertown decreases by 2.4%. If the original population was 8,780 hardy souls, what is the new population, correct to the nearest person?

16. Due to a textile mill closure, the population of Ghosttown decreases by 6.1%. If the original population was 14,320 hardy souls, what is the new population, correct to the nearest person?
17. A clerk making a salary of \$2,600 per month has her salary increased to \$2,950 per month. Find the percent increase correct to the nearest tenth of a percent.
18. A clerk making a salary of \$3,600 per month has her salary increased to \$4,100 per month. Find the percent increase correct to the nearest tenth of a percent.
19. A bartender making a salary of \$4,200 per month has her salary increased to \$4,300 per month. Find the percent increase correct to the nearest tenth of a percent.
20. A bartender making a salary of \$3,200 per month has her salary increased to \$3,550 per month. Find the percent increase correct to the nearest tenth of a percent.
21. A gardener is granted a 5.1% salary increase. If the gardener's current salary is \$3,200 per month, find the gardener's new monthly salary, rounded to the nearest dollar.
22. A secretary is granted a 2.8% salary increase. If the secretary's current salary is \$3,600 per month, find the secretary's new monthly salary, rounded to the nearest dollar.
23. A television set marked at \$437 is sold for \$347. Find the percent discount, correct to the nearest tenth of a percent.
24. A camera marked at \$390 is sold for \$328. Find the percent discount, correct to the nearest tenth of a percent.

25. Suppose that the price of an 8-ounce can of tomato sauce increased from \$0.20 to \$0.28.
- What was the amount of increase?
 - What was the percent increase?
26. The following table summarizes summertime gasoline prices in San Francisco, CA. The price is the number of dollars required to purchase one gallon of unleaded gasoline. *Data from gasbuddy.com.*

Year	Price per gallon
2003	1.80
2004	2.28
2005	2.57
2006	3.20
2007	3.28
2008	4.61
2009	3.01

What is the percent increase or decrease from 2003 to 2005? Round your answer to the nearest whole percent.

27. Refer to the table of gas prices in Exercise 26. What is the percent increase or decrease from 2005 to 2007? Round your answer to the nearest whole percent.

- 28.** Refer to the table of gas prices in Exercise 26. What is the percent increase or decrease from 2007 to 2009? Round your answer to the nearest whole percent.
- 29. Rate hike.** A family paying \$858 monthly for health coverage is faced with a 39% hike in rates. What will be their new monthly cost after the increase? *Associated Press-Times-Standard 02/09/10 HHS secretary asks Anthem Blue Cross to justify rate hike.*
- 30. Parking fine.** San Francisco's Metropolitan Transportation Agency was expected to consider raising fines for the use of fake, stolen, or borrowed disabled parking tags from \$100 to \$825. What is the percent increase for this fine? *Associated Press-Times-Standard 01/06/10 Fines for fake disabled parking tags may go up in San Francisco.*
- 31. Industrial move.** Regulations in California have caused factory farmers to move out of state. Idaho's industrial dairy went from 180,000 cows in 1990 to 530,000 cows in 2009. What is the percent increase for Idaho industrial dairy cows, rounded to the nearest percent? *Associated Press-Times-Standard 02/09/10 Idaho, others prepare for California egg farm exodus.*
- 32. Whooping crane.** Whooping crane populations made a remarkable comeback from just 15 birds in 1941 to about 400 birds worldwide in 2010. What is the percent increase for the whooping crane population over the past seventy years, rounded to the nearest percent? *Associated Press-Times-Standard 03/17/10 Plucky whooping crane gives wildlife experts hope.*
- 33. Underwater.** The loss of Arctic sea ice will allow for an underwater fiber optic cable that will cut the time it takes to send a message from London to Tokyo from a current 140 milliseconds down to 88 milliseconds. *Associated Press-Times-Standard 01/22/10 Global warming opens up Northwest Passage for underwater fiber optic cable.*
- What is the estimated percent decrease in communication time?
 - At a cost of \$1.2 billion, what is the cost per millisecond of saving (rounded to the nearest dollar)?
- 34. Chinook salmon.** During the 2009 season in the Sacramento river basin, a record low 39,500 chinook salmon were recorded, way down from the more than 750,000 counted in 2002. What is the percent decrease in the salmon count from 2002 to 2009, rounded to the nearest percent? *Associated Press-Times-Standard 02/25/10 Feds predict better year for California salmon.*
- 35. Daylight hours.** In middle latitudes, summer days can have as many as 14 hours of daylight, while winter days can have a few as 10 hours of daylight. What percent more daylight is there in summer than in winter?
- 36. Cyber-experts.** Defense Secretary Robert Gates said the Pentagon will increase the number of cyber-experts it can train each year from 80 to 250 by 2011. What percent increase is this? Round your answer to the nearest percent. *Associated Press Times-Standard 4/19/09*

37. Home prices. Real estate data for Humboldt County, California, is given below. *Associated Press-Times-Standard 01/17/10 How is our local real estate market compared to other regions?*

Year	Number of homes sold	Average home price
2000	1,358	\$152,257
2005	1,432	\$344,500
2009	833	\$285,000

- a) What percent change in average home price occurred between 2000 and 2009?
 b) What percent change in homes sold occurred between 2000 and 2009?

🔍 🔍 🔍 **Answers** 📄 📄 📄

- | | |
|------------------|---|
| 1. \$355.36 | 23. 20.6% |
| 3. 17.32% | 25. a) \$0.08 |
| 5. \$482.50 | b) 40% |
| 7. 14,076 people | 27. 28% increase |
| 9. \$2,615 | 29. \$1,193 |
| 11. 18.4% | 31. 194% increase |
| 13. 12.30% | 33. a) 37% |
| 15. 8,569 | b) About \$23,076,923 per millisecond |
| 17. 13.5% | 35. 40% more daylight |
| 19. 2.4% | 37. a) 87% increase in average home price |
| 21. \$3,363 | b) 39% decrease in home sales |

7.5 Interest

One way of awarding interest is called *simple interest*. Before we provide the formula used in calculating simple interest, let's first define some basic terms.

Balance. The balance is the current amount in an account or the current amount owed on a loan.

Principal. The principal is the initial amount invested or borrowed.

Rate. This is the interest rate, usually given as a percent per year.

Time. This is the time duration of the loan or investment. If the interest rate is per year, then the time must be measured in years.

To calculate the simple interest on an account or loan, use the following formula.

Simple Interest. Simple interest is calculated with the formula

$$I = Prt,$$

where I is the interest, P is the principal, r is the interest rate, and t is the time.

You Try It!

How much simple interest is earned if \$2,500 is invested at 5% per year for 8 years?

EXAMPLE 1. How much simple interest is earned if \$1,200 is invested at 4% per year for 5 years?

Solution. Set up the formula for simple interest.

$$I = Prt$$

The principal is $P = \$1200$, the interest rate is $r = 4\% = 0.04$ per year, and the time or duration of the investment is $t = 5$ years. Substitute each of these numbers into the simple interest formula $I = Prt$.

$$\begin{aligned} I &= (1200)(0.04)(5) && \text{Substitute 1200 for } P, 0.04 \text{ for } r, \text{ and } 5 \text{ for } t. \\ &= 240 && \text{Multiply.} \end{aligned}$$

Answer: \$1,000

Hence, the interest earned in 5 years is \$240.

□

To find the balance, we must add the interest to the principal.

Calculating the Balance. To find the balance, add the interest to the principal. That is,

$$\text{Balance} = \text{Principal} + \text{Interest}.$$

You Try It!

EXAMPLE 2. A contractor borrows \$5,000 at 4.5% per year. The interest accrued is simple interest. The duration of the loan is 6 months. How much will the contractor have to pay back at the end of the 6-month loan period?

Solution. Set up the formula for simple interest.

$$I = Prt$$

The principal is $P = \$5000$, the interest rate is $r = 4.5\% = 0.045$ per year, and the time or duration of the loan is $t = 6$ months. Because the interest rate is per year, the time must be changed to years. That is,

$$\begin{aligned} 6 \text{ months} &= 6 \text{ months} \cdot \frac{1 \text{ yr}}{12 \text{ months}} && \text{Apply conversion factor.} \\ &= 6 \cancel{\text{ months}} \cdot \frac{1 \text{ yr}}{12 \cancel{\text{ months}}} && \text{Cancel common unit.} \\ &= \frac{6}{12} \text{ yr} && \text{Multiply numerators;} \\ & && \text{multiply denominators.} \\ &= \frac{1}{2} \text{ yr} && \text{Reduce.} \end{aligned}$$

Substitute these numbers into the simple interest formula $I = Prt$.

$$\begin{aligned} I &= (5000)(0.045) \left(\frac{1}{2} \right) && \text{Substitute 5000 for } P, 0.045 \text{ for } r, \text{ and } 1/2 \text{ for } t. \\ &= 112.50 && \text{Multiply.} \end{aligned}$$

Hence, the interest accrued in 6 months is \$112.50. Therefore,

$$\begin{aligned} \text{Amount owed} &= \text{Principal} + \text{Interest} \\ &= 5000 + 112.50 \\ &= 5112.50 \end{aligned}$$

That is, the amount owed at the end of the 6-month loan period is \$5,112.50. **Answer:** \$8,110

□

An accountant borrows \$8,000 at 5.5% per year. The interest accrued is simple interest. The duration of the loan is 3 months. How much will the accountant have to pay back at the end of the 3-month loan period?

You Try It!

The owner of Alioto Motors takes out a 8-month loan at 4% per year simple interest. At the end of the 8-month loan period, the interest owed is \$80. What was the principal amount borrowed?

EXAMPLE 3. A business owner takes out a 4-month loan at 5.4% per year simple interest. At the end of the 4-month loan period, the interest owed is \$90. What was the principal amount borrowed?

Solution. Set up the formula for simple interest.

$$I = Prt$$

The interest owed is $I = \$90$, the interest rate is $r = 5.4\% = 0.054$ per year, and the time or duration of the loan is $t = 4$ months. Because the interest rate is per year, the time must be changed to years. That is,

$$\begin{aligned} 4 \text{ months} &= 4 \text{ months} \cdot \frac{1 \text{ yr}}{12 \text{ months}} && \text{Apply conversion factor.} \\ &= 4 \cancel{\text{ months}} \cdot \frac{1 \text{ yr}}{12 \cancel{\text{ months}}} && \text{Cancel common unit.} \\ &= \frac{4}{12} \text{ yr} && \text{Multiply numerators;} \\ & && \text{multiply denominators.} \\ &= \frac{1}{3} \text{ yr} && \text{Reduce.} \end{aligned}$$

Substitute these numbers into the simple interest formula $I = Prt$.

$$90 = P(0.054) \left(\frac{1}{3} \right) \quad \text{Substitute 90 for } I, 0.054 \text{ for } r, \text{ and } 1/3 \text{ for } t.$$

$$90 = \frac{0.054}{3} P \quad \text{Rearrange order of multiplication.}$$

$$90 = 0.018P \quad \text{Divide: } 0.054/3 = 0.018.$$

Solve the equation for P .

$$\frac{90}{0.018} = \frac{0.018P}{0.018} \quad \text{Divide both sides by 0.018.}$$

$$5000 = P \quad \text{Divide: } 90/0.018 = 5000.$$

Answer: \$3,000

Thus, the principal amount borrowed was \$5,000. □

You Try It!

A manufacturer borrows \$10,000 for 4 years. At the end of the 4-year loan period, the interest owed is \$3,200. What was the simple interest rate?

EXAMPLE 4. A pet shop owner borrows \$8,000 for 6 months. At the end of the 6-month loan period, the interest owed is \$200. What was the simple interest rate?

Solution. Set up the formula for simple interest.

$$I = Prt$$

The principal is $P = \$8,000$, the interest owed is $I = \$200$, and the duration of the loan is $t = 6$ months. As we saw in Example 2, 6 months equals $1/2$ year. Substitute these numbers into the simple interest formula $I = Prt$.

$$200 = (8000)(r) \left(\frac{1}{2} \right) \quad \text{Substitute 8000 for } P, 200 \text{ for } I, \text{ and } 1/2 \text{ for } t.$$

$$200 = \frac{8000}{2}r \quad \text{Rearrange order of multiplication.}$$

$$200 = 4000r \quad \text{Divide: } 8000/2 = 4000.$$

Solve this last equation for r .

$$\frac{200}{4000} = \frac{4000r}{4000} \quad \text{Divide both sides by 4000.}$$

$$\frac{1}{20} = r \quad \text{Reduce: Divide numerator and denominator by 200.}$$

We need to change r to a percent. This is easily accomplished by creating an equivalent fraction with a denominator of 100.

$$\begin{aligned} \frac{1}{20} &= \frac{1 \cdot 5}{20 \cdot 5} \\ &= \frac{5}{100} \\ &= 5\% \end{aligned}$$

Thus, the simple interest rate is 5%.

Answer: 8%

Extending the Simple Interest Formula

In Example 2, we had to add the interest to the principal to discover the balance owed at the end of the loan. That is,

$$\text{Balance} = \text{Principal} + \text{Interest},$$

or in symbols,

$$A = P + I,$$

where A is the balance, P is the principal, and I is the simple interest. Because $I = Prt$, we substitute Prt for I in the last equation to get

$$A = P + Prt.$$

Use the distributive property to factor P from each term on the right.

$$A = P \cdot 1 + P \cdot rt$$

$$A = P(1 + rt).$$

Balance Formula Using Simple Interest. If simple interest is applied, then the balance is given by the formula

$$A = P(1 + rt),$$

where A is the balance, P is the principal, r is the simple interest rate, and t is the duration of the loan or investment.

You Try It!

If \$8,000 is invested at 4.25% simple interest, what will be the balance after 4 years?

EXAMPLE 5. If \$4,000 is invested at 6.25% simple interest, what will be the balance after 2 years?

Solution. Start with the balance formula for simple interest.

$$A = P(1 + rt)$$

The principal is $P = \$4,000$, the rate is $r = 6.25\% = 0.0625$ per year, and the time is $t = 2$ years. Substitute these numbers in the balance formula $A = P(1 + rt)$.

$$\begin{aligned} A &= 4000(1 + (0.0625)(2)) && \text{Substitute 4000 for } P, 0.0625 \text{ for } r, \\ & && \text{and 2 for } t. \\ A &= 4000(1 + 0.125) && \text{Order of Ops: } 0.0625 \cdot 2 = 0.125. \\ A &= 4000(1.125) && \text{Order of Ops: } 1 + 0.125 = 1.125. \\ A &= 4500 && \text{Multiply: } 4000 \cdot 1.125 = 4500. \end{aligned}$$

\$9,360

Hence, the balance at the end of two years is $A = \$4,500$.

□

You Try It!

The balance due on a 4-year loan is \$6,300. If the simple interest rate is 10%, what was the principal borrowed?

EXAMPLE 6. The balance due on a 2-year loan is \$3,360. If the simple interest rate is 6%, what was the principal borrowed?

Solution. Start with the balance formula for simple interest.

$$A = P(1 + rt)$$

The balance is $A = \$3360$, the rate is $r = 6\% = 0.06$ per year, and the time is $t = 2$ years. Substitute these numbers in the balance formula $A = P(1 + rt)$.

$$\begin{aligned} 3360 &= P(1 + (0.06)(2)) && \text{Substitute 3360 for } A, 0.06 \text{ for } r, \\ & && \text{and 2 for } t. \\ 3360 &= P(1 + 0.12) && \text{Order of Ops: } 0.06 \cdot 2 = 0.12. \\ 3360 &= P(1.12) && \text{Order of Ops: } 1 + 0.12 = 1.12. \\ 3360 &= 1.12P && \text{Change order of multiplication.} \end{aligned}$$

Solve this last equation for P .

$$\frac{3360}{1.12} = \frac{1.12P}{1.12} \quad \text{Divide both sides by 1.12.}$$

$$3000 = P \quad \text{Divide: } 3360/1.12 = 3000.$$

Hence, the principal borrowed was $P = \$3,000$.

Answer: \$4,500

You Try It!

EXAMPLE 7. The balance due on a 2-year loan is \$2,200. If the principal borrowed was \$2,000, what was the rate of simple interest?

The balance due on a 2-year loan is \$4,640. If the principal borrowed was \$4,000, what was the rate of simple interest?

Solution. Start with the balance formula for simple interest.

$$A = P(1 + rt)$$

The balance is $A = \$2,200$, the principal is $P = \$2,000$, and the time is $t = 2$ years. Substitute these numbers in the balance formula $A = P(1 + rt)$.

$$2200 = 2000(1 + (r)(2)) \quad \text{Substitute 2200 for } A, 2000 \text{ for } P, \text{ and } t = 2.$$

$$2200 = 2000(1 + 2r) \quad \text{Change the order of multiplication.}$$

Solve this last equation for r .

$$2200 = 2000 + 4000r \quad \text{Distribute 2000.}$$

$$2200 - 2000 = 2000 + 4000r - 2000 \quad \text{Subtract 2000 from both sides.}$$

$$200 = 4000r \quad \text{Simplify both sides.}$$

$$\frac{200}{4000} = \frac{4000r}{4000} \quad \text{Divide both sides by 4000.}$$

$$\frac{1}{20} = r \quad \text{Reduce: } 200/4000 = 1/20.$$

Of course, r must be changed to a percent. In Example 4, we encountered this same fraction.

$$r = \frac{1}{20} = \frac{5}{100} = 5\%$$

Hence, the rate of simple interest is $r = 5\%$.

Answer: 8%

 Exercises 

1. How much simple interest is earned if \$7,600 is invested at 8% per year for 7 years?
 2. How much simple interest is earned if \$2,500 is invested at 5% per year for 6 years?
 3. How much simple interest is earned if \$5,800 is invested at 3.25% per year for 4 years?
 4. How much simple interest is earned if \$2,000 is invested at 8.5% per year for 6 years?
 5. How much simple interest is earned if \$2,400 is invested at 8.25% per year for 5 years?
 6. How much simple interest is earned if \$4,000 is invested at 6.5% per year for 6 years?
 7. How much simple interest is earned if \$4,000 is invested at 7.25% per year for 6 years?
 8. How much simple interest is earned if \$8,200 is invested at 8% per year for 6 years?
 9. A business owner borrows \$3,600 for 2 months at a 4.5% per year simple interest rate. At the end of the 2-month loan period, how much interest is owed?
 10. A business owner borrows \$3,200 for 4 months at a 9% per year simple interest rate. At the end of the 4-month loan period, how much interest is owed?
 11. A business owner borrows \$2,400 for 6 months at a 2% per year simple interest rate. At the end of the 6-month loan period, how much interest is owed?
 12. A business owner borrows \$2,200 for 4 months at a 3% per year simple interest rate. At the end of the 4-month loan period, how much interest is owed?
 13. A business owner takes out a 6-month loan at a 8% per year simple interest rate. At the end of the 6-month loan period, the interest owed is \$68. What was the principal amount borrowed?
 14. A business owner takes out a 4-month loan at a 6% per year simple interest rate. At the end of the 4-month loan period, the interest owed is \$194. What was the principal amount borrowed?
 15. A business owner borrows \$3,600 for 3 months at a 8% per year simple interest rate. At the end of the 3-month loan period, how much interest is owed?
 16. A business owner borrows \$2,400 for 4 months at a 8.25% per year simple interest rate. At the end of the 4-month loan period, how much interest is owed?
 17. A business owner takes out a 2-month loan at a 8.5% per year simple interest rate. At the end of the 2-month loan period, the interest owed is \$85. What was the principal amount borrowed?
-

18. A business owner takes out a 3-month loan at a 2% per year simple interest rate. At the end of the 3-month loan period, the interest owed is \$45. What was the principal amount borrowed?
19. A business owner borrows \$4,000 for 3 months. At the end of the 3-month loan period, the interest owed is \$35. What was the simple yearly interest rate (as a percent)?
20. A business owner borrows \$4,200 for 4 months. At the end of the 4-month loan period, the interest owed is \$63. What was the simple yearly interest rate (as a percent)?
21. A business owner takes out a 6-month loan at a 7% per year simple interest rate. At the end of the 6-month loan period, the interest owed is \$287. What was the principal amount borrowed?
22. A business owner takes out a 6-month loan at a 2% per year simple interest rate. At the end of the 6-month loan period, the interest owed is \$40. What was the principal amount borrowed?
-
27. Suppose that \$6,700 is invested at 9% simple interest per year. What will the balance be after 4 years?
28. Suppose that \$5,200 is invested at 3.5% simple interest per year. What will the balance be after 2 years?
29. Suppose that \$1,600 is invested at 2% simple interest per year. What will the balance be after 3 years?
30. Suppose that \$8,100 is invested at 8.25% simple interest per year. What will the balance be after 4 years?
23. A business owner borrows \$7,300 for 2 months. At the end of the 2-month loan period, the interest owed is \$73. What was the simple yearly interest rate (as a percent)?
24. A business owner borrows \$5,600 for 6 months. At the end of the 6-month loan period, the interest owed is \$182. What was the simple yearly interest rate (as a percent)?
25. A business owner borrows \$3,200 for 6 months. At the end of the 6-month loan period, the interest owed is \$96. What was the simple yearly interest rate (as a percent)?
26. A business owner borrows \$5,700 for 4 months. At the end of the 4-month loan period, the interest owed is \$133. What was the simple yearly interest rate (as a percent)?
-
31. Suppose that \$8,900 is invested at 2.5% simple interest per year. What will the balance be after 2 years?
32. Suppose that \$9,800 is invested at 2.75% simple interest per year. What will the balance be after 6 years?
33. Suppose that \$5,400 is invested at 4.25% simple interest per year. What will the balance be after 2 years?
34. Suppose that \$8,400 is invested at 4.5% simple interest per year. What will the balance be after 4 years?
-

- 35.** The balance on a 6-year loan is \$10,222. If the principal borrowed was \$7,600, what was the simple interest rate (as a percent)?
- 36.** The balance on a 8-year loan is \$12,264. If the principal borrowed was \$8,400, what was the simple interest rate (as a percent)?
- 37.** The balance on a 5-year loan is \$4,640. If the simple interest rate is 9% per year, what was the principal borrowed?
- 38.** The balance on a 6-year loan is \$6,838. If the simple interest rate is 5.25% per year, what was the principal borrowed?
- 39.** The balance on a 9-year loan is \$9,593. If the simple interest rate is 9% per year, what was the principal borrowed?
- 40.** The balance on a 8-year loan is \$10,032. If the simple interest rate is 4% per year, what was the principal borrowed?
- 41.** The balance on a 3-year loan is \$5,941. If the principal borrowed was \$5,200, what was the simple interest rate (as a percent)?
- 42.** The balance on a 2-year loan is \$9,589. If the principal borrowed was \$8,600, what was the simple interest rate (as a percent)?
- 43.** The balance on a 5-year loan is \$5,400. If the principal borrowed was \$4,000, what was the simple interest rate (as a percent)?
- 44.** The balance on a 6-year loan is \$12,635. If the principal borrowed was \$9,500, what was the simple interest rate (as a percent)?
- 45.** The balance on a 5-year loan is \$11,550. If the simple interest rate is 7.5% per year, what was the principal borrowed?
- 46.** The balance on a 8-year loan is \$3,160. If the simple interest rate is 7.25% per year, what was the principal borrowed?
- 47.** The balance on a 4-year loan is \$5,720. If the principal borrowed was \$4,400, what was the simple interest rate (as a percent)?
- 48.** The balance on a 8-year loan is \$4,422. If the principal borrowed was \$3,300, what was the simple interest rate (as a percent)?
- 49.** The balance on a 8-year loan is \$9,768. If the simple interest rate is 4% per year, what was the principal borrowed?
- 50.** The balance on a 2-year loan is \$8,322. If the simple interest rate is 7% per year, what was the principal borrowed?


Answers


- | | |
|---|--|
| <p>1. \$4,256</p> <p>3. \$754</p> <p>5. \$990</p> <p>7. \$1,740</p> <p>9. \$27</p> | <p>11. \$24</p> <p>13. \$1,700</p> <p>15. \$72</p> <p>17. \$6,000</p> <p>19. 3.5%</p> |
|---|--|

21. \$8,200

23. 6%

25. 6%

27. \$9,112

29. \$1,696

31. \$9,345

33. \$5,859

35. 5.75%

37. \$3,200

39. \$5,300

41. 4.75%

43. 7%

45. \$8,400

47. 7.5%

49. \$7,400

7.6 Pie Charts

In this section we turn our attention to pie charts, but before we do, we need to establish some fundamentals regarding measurement of angles.

If you take a circle and divide it into 360 equal increments, then each increment is called *one degree* (1°). See [Figure 7.2](#).

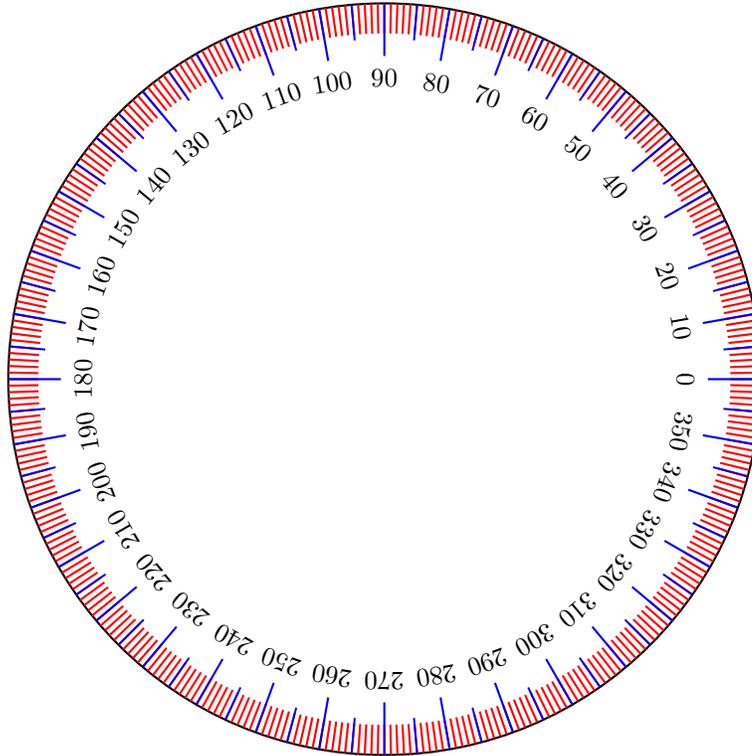


Figure 7.2: There are 360 degrees (360°) in a circle.

A *ray* is a line that starts at a point and then extends indefinitely in one direction. The starting point of the ray is called its *vertex*.



Figure 7.3: A ray with vertex V extends indefinitely in one direction.

If two rays have a common vertex, they form what is called an *angle*. In [Figure 7.4](#) we've labeled the first ray as the "Initial Side" of the angle, and the second as the "Terminal Side" of the angle.

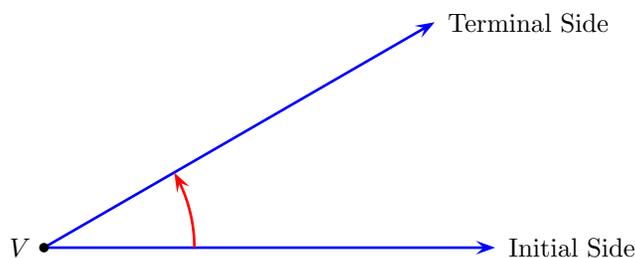


Figure 7.4: Two rays with a common vertex V form an angle.

We can find the degree measure of the angle by using a device called a *protractor*. Align the notch in the center of the base of the protractor with the vertex of the angle, then align the base of the protractor with the initial side of the angle. The terminal side of the angle will intersect the protractor edge where we can read the degree measure of the angle (see [Figure 7.5](#)). In [Figure 7.5](#), note that the terminal side of the angle passes through the tick mark at the number 30, indicating that the degree measure of this angle is 30° .

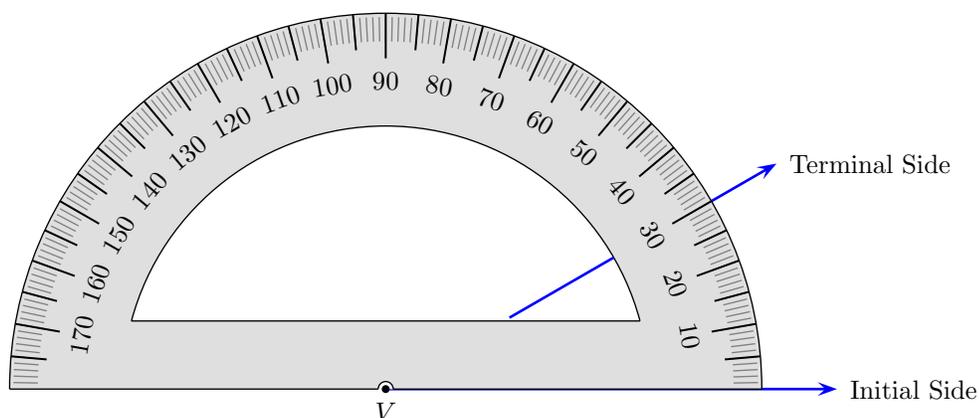


Figure 7.5: The degree measure is 30° .

Pie Charts

Now that we can measure angles, we can turn our attention to constructing *pie charts*.

Pie Chart. A pie chart is a circular chart that is divided into sectors, each sector representing a particular quantity. The area of each sector is a percentage of the area of the whole circle and is determined by calculating the quantity it represents as a percentage of the whole.

You Try It!

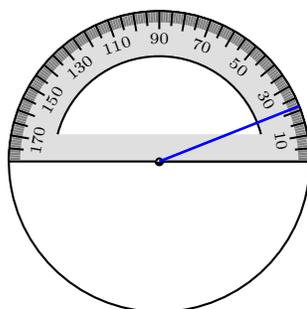
In a recent Gallup poll, 50% of the American public say it is the federal government's responsibility to make sure all Americans have health care, 47% disagree, and 3% were undecided. Create a pie chart that displays these percentages.

EXAMPLE 1. In a recent Gallup poll, 66% of those polled approved of the President's job performance, 28% disapproved, and 6% were undecided. Create a pie chart that displays these percentages.

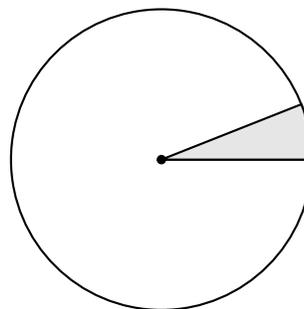
Solution. Let's begin with 6% undecided. We want to create a sector that is 6% of the area of the whole circle. There are 360 degrees in a full circle, so 6% of this number is

$$\begin{aligned} 6\% \cdot 360^\circ &= 0.06 \cdot 360^\circ \\ &= 21.6^\circ. \end{aligned}$$

Start with a circle, set the baseline notch of the protractor on the center of the circle, then mark an angle of 21.6° , as seen in Figure 7.6(a). Shade the resulting region as shown in Figure 7.6(b), called a *sector*, which represents 6% of the total area of the circle.



(a) Mark an angle of 21.6° .



(b) Shaded sector is 6% of total circular area.

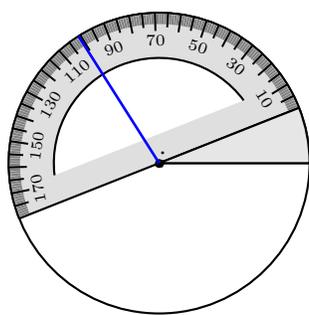
Figure 7.6: Sector with central angle 21.6° represents the 6% of the polling sample that were undecided about the president's performance.

Next, 28% disapproved of the President's job performance. Thus,

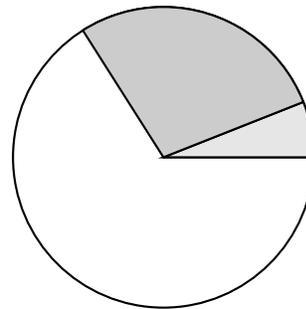
$$\begin{aligned} 28\% \cdot 360^\circ &= 0.28 \cdot 360^\circ \\ &= 100.8^\circ. \end{aligned}$$

Therefore, a sector with a central angle of 100.8° will represent 28% job disapproval.

Place the notch on the baseline of your protractor on the center of the circle, then align the baseline of the protractor with the terminal side of the first angle, as shown in [Figure 7.7\(a\)](#). Mark a central angle of 100.8° , as shown in [Figure 7.7\(a\)](#). Shade the resulting second sector with a darker shade of gray, as shown in [Figure 7.7\(b\)](#). This sector contains 28% of the total area of the circle and represents the portion of the polling sample that disapproved of the president's job performance.



(a) Mark the next angle at 100.8° .

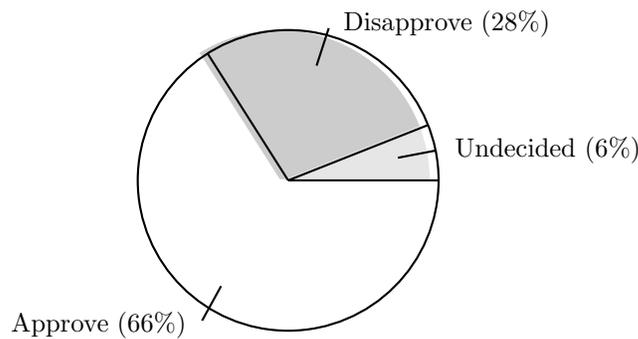


(b) Second shaded sector is 28% of total circular area.

Figure 7.7: Sector with central angle 100.8° represents the 28% of the polling sample that disapproved of the president's performance.

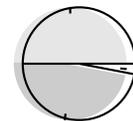
Finally, as we've shaded the sectors representing 6% and 28% of the polling data in [Figure 7.7\(b\)](#), the remaining sector in [Figure 7.7\(b\)](#), shaded in white, represents the 66% of the polling sample who approved of the president's job performance (and 66% of the area of the whole circle).

Once you have computed and plotted the correct central angles for each of the sectors, you will want to label your pie chart. One possible annotation method is shown in [Figure 7.8](#).



Answer:

Agree (50%)



Disagree (47%)

Figure 7.8: Annotating the final pie chart.

You Try It!

Two hundred people were asked whether they vote “Yes” or “No” on Proposition 8. There were 150 “Yes” votes and 50 “No” votes. Create a pie chart showing the distribution of these responses.

EXAMPLE 2. One thousand people were polled with the question “Where does your dog sleep during the night?” The responses are shown in the following table.

Location	Number
Outside	30
Another Room	220
On the Bedroom Floor	330
On the Bed	420
Totals	1000

Create a pie chart showing the distribution of these responses.

Solution. The first step is to express the number in each location as a percentage of the totals. For example,

$$\begin{array}{ccccccc} \text{Outside} & \text{is} & \text{what percent} & \text{of} & \text{total} \\ 30 & = & p & \cdot & 1000 \end{array}$$

Solving for p ,

$$\begin{array}{l} \frac{1000p}{1000} = \frac{30}{1000} \\ p = 0.03 \end{array} \quad \begin{array}{l} \text{Divide both sides by 1000.} \\ \text{Divide: } 30/1000 = 0.03. \end{array}$$

Thus, $p = 3\%$. In similar fashion, divide the number in each location by 1000 to find the following percents.

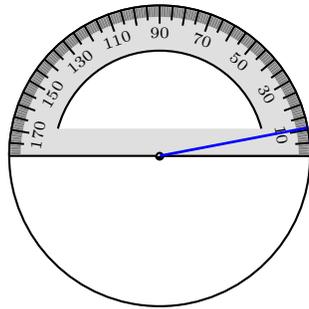
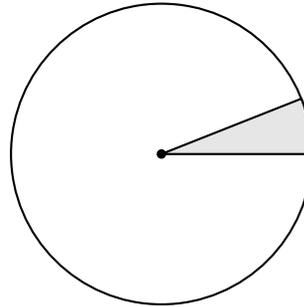
Location	Number	Percent
Outside	30	3%
Another Room	220	22%
On the Bedroom Floor	330	33%
On the Bed	420	42%
Totals	1000	100%

Note that the individual percents must total 100%.

Let's begin with the fact that 3% of the dog owners have their dogs sleep outside. To find the portion of the full circle that represents 3%, we take 3% of 360° .

$$\begin{aligned} 3\% \cdot 360^\circ &= 0.03 \cdot 360^\circ \\ &= 10.8^\circ \end{aligned}$$

Start with a circle, set the baseline notch of the protractor on the center of the circle, then mark an angle of 10.8° , as seen in [Figure 7.9\(a\)](#). Shade the

(a) Mark an angle of 10.8° .

(b) Shaded sector is 3% of total circular area.

Figure 7.9: Sector with central angle 10.8° represents the 3% of the polling sample that have their dogs sleep outside.

resulting sector as shown in [Figure 7.9\(b\)](#), which represents 3% of the total area of the circle.

Next, 22% have their dog sleep in another room.

$$\begin{aligned} 22\% \cdot 360^\circ &= 0.22 \cdot 360^\circ \\ &= 79.2^\circ. \end{aligned}$$

Therefore, a sector with a central angle of 79.2° will represent the fact that 22% of the dog owners have their dog sleep in another room.

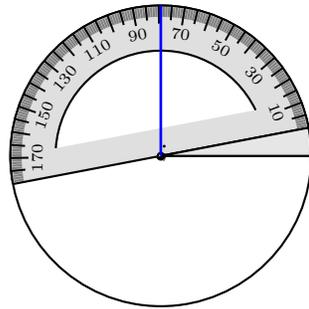
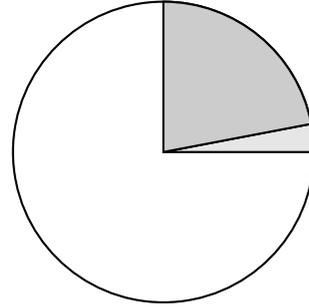
Place the notch on the baseline of your protractor on the center of the circle, then align the baseline of the protractor with the terminal side of the first angle, as shown in [Figure 7.10\(a\)](#). Mark a central angle of 79.2° , as shown in [Figure 7.7\(a\)](#). Shade the resulting second sector with a darker shade of gray, as shown in [Figure 7.10\(b\)](#). This sector contains 22% of the total area of the circle and represents the portion of the polling sample whose dog sleeps in another room.

Next, 33% allow their dog sleep on the bedroom floor.

$$\begin{aligned} 33\% \cdot 360^\circ &= 0.33 \cdot 360^\circ \\ &= 118.8^\circ. \end{aligned}$$

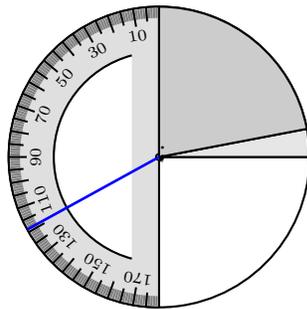
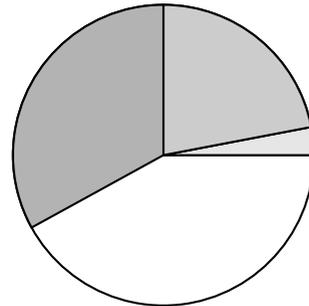
Therefore, a sector with a central angle of 118.8° will represent the fact that 33% of the dog owners allow their dog to sleep on the bedroom floor.

Place the notch on the baseline of your protractor on the center of the circle, then align the baseline of the protractor with the terminal side of the second sector, as shown in [Figure 7.11\(a\)](#). Mark a central angle of 118.8° , as shown in [Figure 7.11\(a\)](#). Shade the resulting second sector with a darker shade of gray, as shown in [Figure 7.11\(b\)](#). This sector contains 33% of the total area of the circle and represents the portion of the polling sample whose dog sleeps on the bedroom floor.

(a) Mark the next angle at 79.2° .

(b) Second shaded sector is 22% of total circular area.

Figure 7.10: Sector with central angle 79.2° represents the 22% of the polling sample whose dogs sleep in another room.

(a) Mark the next angle at 118.8° .

(b) Third shaded sector is 33% of total circular area.

Figure 7.11: Sector with central angle 118.8° represents the 33% of the polling sample whose dogs sleep on the bedroom floor.

Because the first three sectors, shaded in various levels of gray, represent 3%, 22%, and 33% of the total circular area, respectively, the remaining sector (shaded in white) automatically represents

$$100\% - (3\% + 22\% + 33\%) = 42\%$$

of the total circular area. This region represents the percent of dog owners who allow their dogs to sleep on the bed. The final result, with annotations, is shown in [Figure 7.12](#).

Answer:

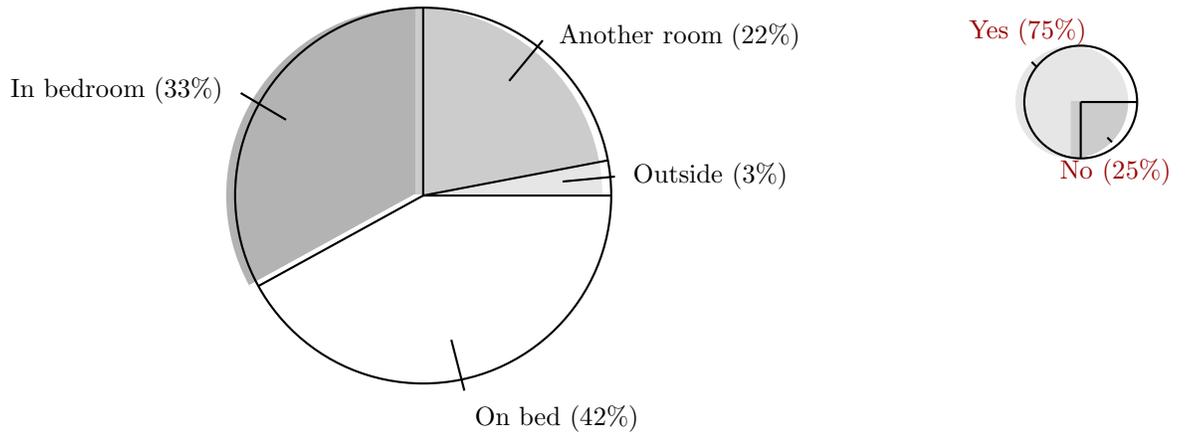


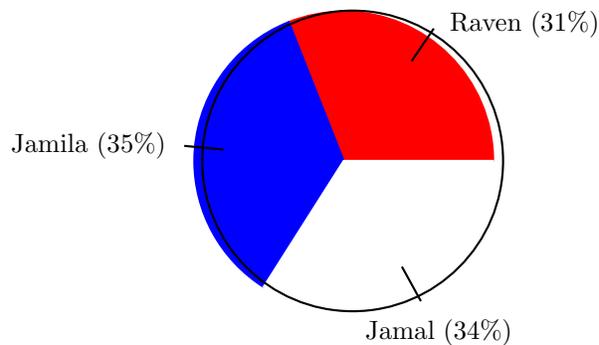
Figure 7.12: Annotating the final pie chart.

 Exercises 

1. In an election for class president, Raven received 21% of the votes, Anita received 27%, Jamal received 24% of the votes, and 28% of the votes were received by other candidates. If a pie chart is created for this data, what will be the degree measure of the central angle of the sector representing Raven's share of the vote? Round your answer to the nearest degree.
 2. In an election for class president, Fernando received 26% of the votes, Luisa received 26%, Ali received 26% of the votes, and 22% of the votes were received by other candidates. If a pie chart is created for this data, what will be the degree measure of the central angle of the sector representing Fernando's share of the vote? Round your answer to the nearest degree.
 3. In an election for class president, Akbar received 23% of the votes, Ali received 27%, Juanita received 30% of the votes, and 20% of the votes were received by other candidates. If a pie chart is created for this data, what will be the degree measure of the central angle of the sector representing Akbar's share of the vote? Round your answer to the nearest degree.
 4. In an election for class president, Kamili received 21% of the votes, Bernardo received 22%, Fernando received 30% of the votes, and 27% of the votes were received by other candidates. If a pie chart is created for this data, what will be the degree measure of the central angle of the sector representing Kamili's share of the vote? Round your answer to the nearest degree.
 5. In an election for class president, Jamal received 30% of the votes, Luisa received 20%, Kamili received 28% of the votes, and 22% of the votes were received by other candidates. If a pie chart is created for this data, what will be the degree measure of the central angle of the sector representing Jamal's share of the vote? Round your answer to the nearest degree.
 6. In an election for class president, Juanita received 30% of the votes, Ali received 24%, Estevan received 24% of the votes, and 22% of the votes were received by other candidates. If a pie chart is created for this data, what will be the degree measure of the central angle of the sector representing Juanita's share of the vote? Round your answer to the nearest degree.
 7. In an election for class president, Chin received 5 votes, Mabel received 13 votes, and Juanita received the remaining 32 votes cast. If a pie chart is created for this voting data, what will be the degree measure of the central angle of the sector representing Chin's share of the vote? Round your answer to the nearest degree.
 8. In an election for class president, Anita received 11 votes, Jose received 9 votes, and Bernardo received the remaining 30 votes cast. If a pie chart is created for this voting data, what will be the degree measure of the central angle of the sector representing Anita's share of the vote? Round your answer to the nearest degree.
-

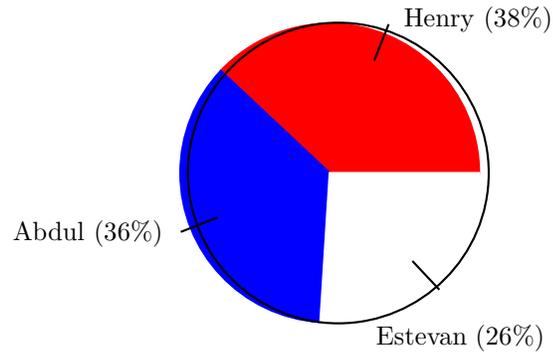
9. In an election for class president, Kamili received 14 votes, Jamal received 9 votes, and Jose received the remaining 27 votes cast. If a pie chart is created for this voting data, what will be the degree measure of the central angle of the sector representing Kamili's share of the vote? Round your answer to the nearest degree.
10. In an election for class president, Jun received 13 votes, Abdul received 15 votes, and Raven received the remaining 22 votes cast. If a pie chart is created for this voting data, what will be the degree measure of the central angle of the sector representing Jun's share of the vote? Round your answer to the nearest degree.
11. In an election for class president, Hue received 13 votes, Ali received 6 votes, and Henry received the remaining 31 votes cast. If a pie chart is created for this voting data, what will be the degree measure of the central angle of the sector representing Hue's share of the vote? Round your answer to the nearest degree.
12. In an election for class president, Mercy received 9 votes, Bernardo received 7 votes, and Hans received the remaining 34 votes cast. If a pie chart is created for this voting data, what will be the degree measure of the central angle of the sector representing Mercy's share of the vote? Round your answer to the nearest degree.

-
13. In an election for class president, the vote distribution among three candidates is shown in the following pie chart.



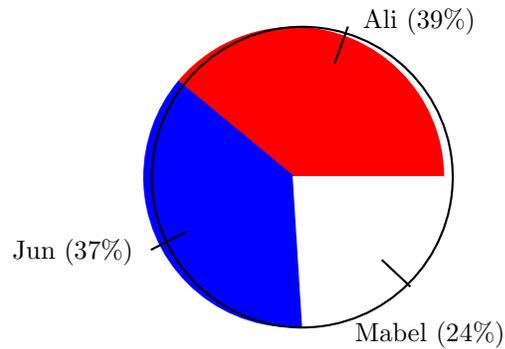
If there were a total of 95 votes cast in the election, find the number of votes that Raven received, correct to the nearest vote.

14. In an election for class president, the vote distribution among three candidates is shown in the following pie chart.



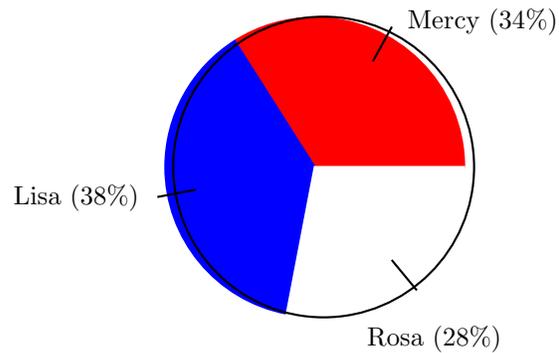
If there were a total of 79 votes cast in the election, find the number of votes that Henry received, correct to the nearest vote.

15. In an election for class president, the vote distribution among three candidates is shown in the following pie chart.



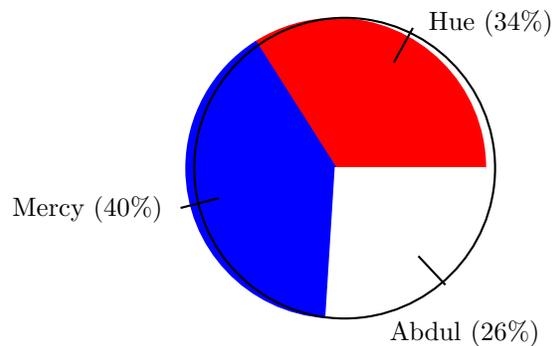
If there were a total of 58 votes cast in the election, find the number of votes that Ali received, correct to the nearest vote.

16. In an election for class president, the vote distribution among three candidates is shown in the following pie chart.



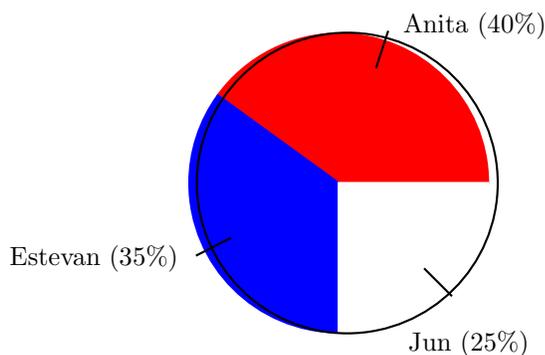
If there were a total of 65 votes cast in the election, find the number of votes that Mercy received, correct to the nearest vote.

17. In an election for class president, the vote distribution among three candidates is shown in the following pie chart.



If there were a total of 95 votes cast in the election, find the number of votes that Hue received, correct to the nearest vote.

18. In an election for class president, the vote distribution among three candidates is shown in the following pie chart.



If there were a total of 75 votes cast in the election, find the number of votes that Anita received, correct to the nearest vote.

19. In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Ali	45
Jamal	34
Jun	52

Use a protractor to help create a pie chart showing the distribution of votes.

20. In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Aisha	39
Akbar	31
Fernando	36

Use a protractor to help create a pie chart showing the distribution of votes.

21. In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Bernardo	44
Rosa	40
Abdul	58

Use a protractor to help create a pie chart showing the distribution of votes.

22. In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Estevan	46
Ali	58
Henry	49

Use a protractor to help create a pie chart showing the distribution of votes.

- 23.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Mercy	56
Hans	53
Lisa	41

Use a protractor to help create a pie chart showing the distribution of votes.

- 24.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Estevan	60
Hue	33
Aisha	31

Use a protractor to help create a pie chart showing the distribution of votes.

- 25.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Raven	43
Mabel	40
Bernardo	52

Use a protractor to help create a pie chart showing the distribution of votes.

- 26.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Hue	48
Lisa	48
Akbar	47

Use a protractor to help create a pie chart showing the distribution of votes.

- 27.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Jun	57
Lisa	30
Aisha	58

Use a protractor to help create a pie chart showing the distribution of votes.

- 28.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Bernardo	54
Mabel	38
Henry	49

Use a protractor to help create a pie chart showing the distribution of votes.

- 29.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Henry	35
Bernardo	32
Estevan	47

Use a protractor to help create a pie chart showing the distribution of votes.

- 30.** In an election for class president, the vote distribution among three candidates is shown in the following table.

Candidate	Votes
Bernardo	38
Fernando	49
Aisha	44

Use a protractor to help create a pie chart showing the distribution of votes.

31. Guard deployment. The table shows the number of guard troop services since Sept. 11, 2001 (as of Dec. 2008; some troops have activated multiple times). *Associated Press-Times-Standard 02/18/10 Guard troops wait for promised pay.*

Mission	Troops
Operation Iraqi Freedom	193,598
Operation Enduring Freedom (Afghanistan)	29,212
Other missions	35,849

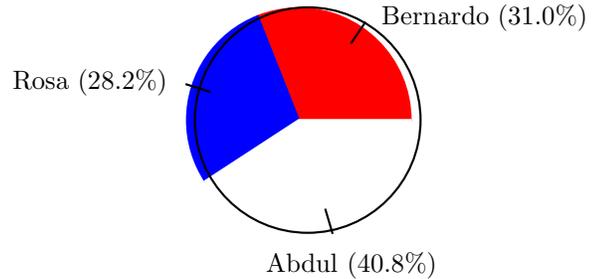
Use a protractor to help create a pie chart showing the distribution of National Guard troops.

🔸 🔸 🔸 **Answers** 🔸 🔸 🔸

- 1. 76°
- 3. 83°
- 5. 108°
- 7. 36°
- 9. 101°
- 11. 94°
- 13. 29 votes
- 15. 23 votes
- 17. 32 votes

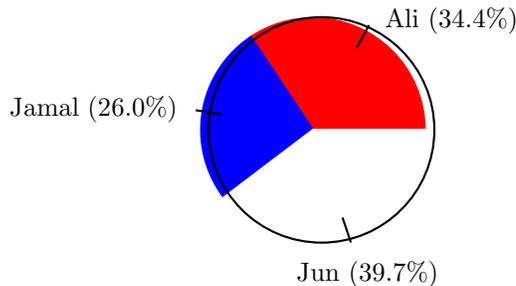
21.

Candidate	Votes	Percent	Degrees
Bernardo	44	31.0%	111.6°
Rosa	40	28.2%	101.52°
Abdul	58	40.8%	146.88°



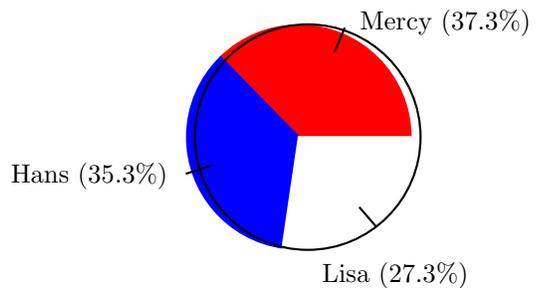
19.

Candidate	Votes	Percent	Degrees
Ali	45	34.4%	123.84°
Jamal	34	26.0%	93.6°
Jun	52	39.7%	142.92°



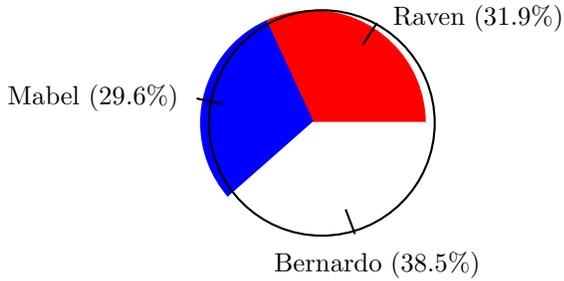
23.

Candidate	Votes	Percent	Degrees
Mercy	56	37.3%	134.28°
Hans	53	35.3%	127.08°
Lisa	41	27.3%	98.28°



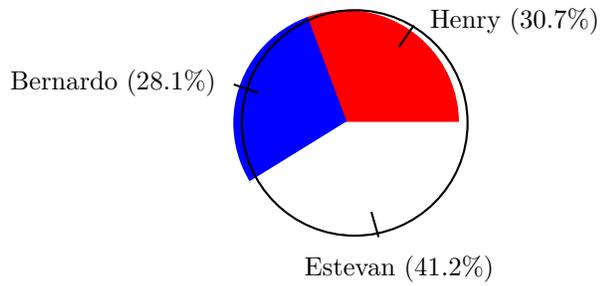
25.

Candidate	Votes	Percent	Degrees
Raven	43	31.9%	114.84°
Mabel	40	29.6%	106.56°
Bernardo	52	38.5%	138.6°



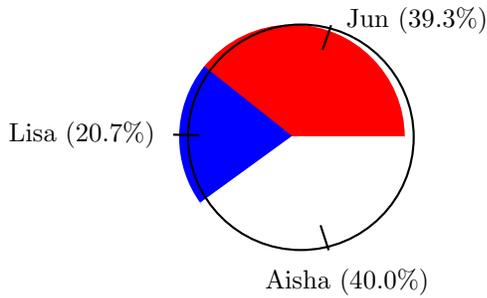
29.

Candidate	Votes	Percent	Degrees
Henry	35	30.7%	110.52°
Bernardo	32	28.1%	101.16°
Estevan	47	41.2%	148.32°



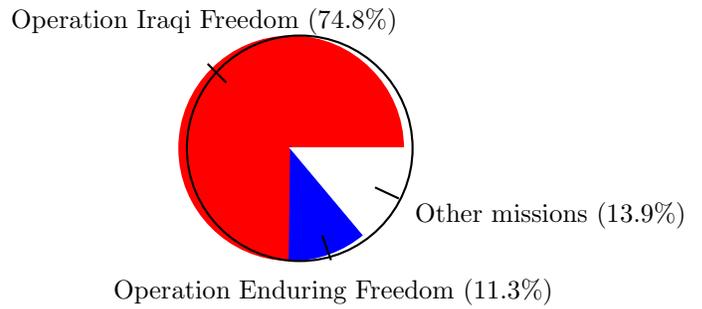
27.

Candidate	Votes	Percent	Degrees
Jun	57	39.3%	141.48°
Lisa	30	20.7%	74.52°
Aisha	58	40.0%	144°



31.

Mission	Troops	Percent	Degrees
Operation Iraqi Freedom	193,598	74.8%	269.28°
Operation Enduring Freedom	29,212	11.3%	40.68°
Other missions	35,849	13.9%	50.04°



Index

- angle, 552
 - degree, 552, 554, 556
 - protractor, 552, 554, 556
- cicle
 - pie chart, 553
- circle
 - degree, 552
- decimal
 - converting from percent, 504
 - converting to percent, 505
- degree
 - angle, 552, 554, 556
 - protractor, 552, 554, 556
- fraction
 - converting from percent, 502
 - converting to percent, 506
 - equivalent fraction, 506
- interest, 542
 - balance, 542, 543, 546
 - principal, 542, 544
 - rate, 542, 544, 547
- percent, 502
 - applications, 521–523, 529–532, 534, 535, 542
 - calculating an unknown percent, 514
 - calculating with a given percent, 512, 516
 - converting from a decimal, 505
 - converting from a fraction, 506
 - converting to a decimal, 504
 - converting to a fraction, 502
 - discount, 534, 535
 - percent decrease, 531, 532, 534, 535
 - percent increase, 529, 530
 - pie chart, 554, 556
 - rounding, 507
 - simple interest, 542
- pie chart, 553
 - percent, 554, 556
- protractor
 - angle, 552, 554, 556
 - degree, 552, 554, 556
- rounding
 - percent, 507