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11 Solving More Problems with Proportional Relationships

Objective

To use proportions to solve multistep real-world percent problems, including percent increase and decrease and percent error

1 Introduction

Students should realize that many problems involving percents require more than one step to solve. Emphasize the need for closely reading the word problem to be certain of understanding what they are being asked to find. Work through the first example to find an amount of interest and then the total amount in the account. Then discuss percent increase or decrease; students should readily recognize this as a percent of change from the original amount.

Think About It

Students should recognize that they need to find 6% of 20 and add that amount to the price.

Common Core Learning Standard
7.RP.3 Use proportional relationships to solve multistep ratio and percent problems.

Vocabulary

percent error: the percent that represents the difference between the measured and actual amounts

percent increase/decrease: the percent that represents the amount of change from the original value

LESSON 11 Solving More Problems with Proportional Relationships CCLS: 7.RP.3

1 Introduction

Sometimes using percents and proportions involves more than one step. Read a problem carefully to determine what information is given and what you are to find.

Joyce puts \$200 into a savings account. The money invested is called the *principal*. The account pays 3% simple interest each year on the principal. What will be the total amount of money in the account after one year?

First, use a proportion to find the amount of interest on the principal.

$$\frac{n}{200} = \frac{3}{100} \cdot 100n = 3 \times 200 = 600 \cdot \frac{100n}{100} = \frac{600}{100}, \text{ so } n = 6$$

The interest on \$200 is \$6.

The total amount of money in the account is the principal plus the interest. Joyce has \$200 principal and \$6 interest, so she has \$206 in the account.

Percents and proportions are also helpful when you shop.

A bracelet that originally cost \$150 is on sale for 25% off. What is the sale price?

Use a proportion to find the amount of the discount. Then subtract the discount from the original price to find the sale price.

$$\frac{n}{150} = \frac{25}{100} \cdot 100n = 150 \times 25 = 5,250, \text{ so } n = 52.5$$

The sale price is \$150 - \$52.50 = \$97.50.

To find a **percent increase** or **decrease** between two amounts, find the difference between the two amounts. Write a ratio of the difference to the original amount. Set up a proportion and solve.

The price of a dozen eggs increases from \$1.40 to \$1.65. What is the percent increase?

$$\frac{(1.65 - 1.40)}{1.40} = \frac{0.25}{1.40} = \frac{n}{100}$$

$$1.40n = 0.25 \times 100, \text{ so } n = 17.8\%$$

The percent increase is 17.8%.

Interest is a fee paid for the use of money. You earn interest on investments. You pay interest on loans.

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Think About It

Explain how you might find your total cost if you buy a shirt for \$20 and there is 6% sales tax on your purchase.

2 Focused Instruction

Use proportions to solve percent problems with multiple steps.

► Faia went out to eat with a friend. Her food and beverage cost a total of \$12.00. She paid 6% tax on her food and beverage cost and also left an 18% tip. Find the total amount she paid.

What proportion will you use to find the amount of tax Faia paid?

$$\frac{n}{12} = \frac{6}{100}$$

What equation is the result of cross multiplying the proportion?

$$100n = 72$$

Solve for the variable representing the tax she paid. $\frac{100n}{100} = \frac{72}{100} = 0.72$

In dollars, what is the amount of tax? **\$0.72**

What proportion will you use to find the amount of the tip?

$$\frac{n}{12} = \frac{18}{100}$$

What equation is the result of cross multiplying the proportion?

$$100n = 216$$

Solve for the variable representing the tip. $\frac{100n}{100} = \frac{216}{100} = 2.16$

In dollars, what is the amount of the tip? **\$2.16**

What operation will you use to find the total amount Faia paid?

addition

Show how you find the total amount she paid. $12 + 0.72 + 2.16$

What is the total she paid? **\$14.88**

Tax and tip are both paid on the amount of food and beverage only.

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2 Focused Instruction

Lesson 11

Percent error expresses the difference between a measured value and an exact value as a percentage. It is calculated like percent increase or decrease.

- Marcus sets his oven for 400°. The oven is not accurate and the actual temperature is 375°. What is the percent error of the oven's temperature?

What is the measured temperature? 400°

What is the actual temperature? 375°

What expression shows the difference between the measured temperature and the actual temperature? 400 - 375

What ratio expresses the difference to the actual amount? $\frac{(400 - 375)}{375}$

What proportion will you use to find the percent error?
 $\frac{25}{375} = \frac{n}{100}$

What equation is the result of cross multiplying the proportion?

(25)100 = 375n

Solve for the variable representing the percent error. Show your work.

2,500 = 375n; 6.7 = n

What is the percent error in the oven's temperature? 6.7%

The proportion for percent error is $\frac{(\text{measured} - \text{actual})}{\text{actual}} = \frac{\text{percent error}}{100}$

Use what you know about percents to answer these questions.

- Nada's electric bill included a charge of \$162 for the electricity used and an additional 5% fee for delivery. What was the total amount of her electric bill?
\$170.10
- Kyle bought a pair of socks for \$6. Last month, his friend bought the same socks for \$5. What is the percent increase in the price of the socks?
20%

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2 Focused Instruction

First, students work through a multistep problem to find the total cost of a meal, setting up proportions and solving them to find 6% tax and 18% tip before adding the three amounts to find the total.

Next, students find the percent error between actual and measured temperatures. Students are guided in writing an expression for the difference, and using this expression as one term in the ratio between the difference and the actual temperature. They set up and solve a proportion to find the percent error.

Conclude the Focused Instruction section by having students answer two questions involving percents.

3 Guided Practice

Lesson 11

Solve the following problems.

- The customer price for books at a bookstore is 40% higher than the price the bookstore owner pays. The bookstore owner pays \$12 for a book. What is the customer price for that book? Show your work.

$\frac{n}{12} = \frac{40}{100}; 100n = 480$
 $n = 4.80$
 $12 + 4.80 = 16.80$

Answer \$ 16.80

A markup is the opposite of a discount. Add instead of subtracting.

- Lorenzo earned \$20 an hour to mow a yard. Now Lorenzo is supposed to trim around the edges of the yard as well, and he makes \$25 an hour. What is the percent increase in the amount Lorenzo earns?

A percent increase is based on the original amount earned.

Answer 25 %

- Mrs. Bell has a rain gauge outside. On a very rainy day, the gauge measured 2.5 inches. The actual amount of rain that fell was 2.3 inches. To the nearest tenth, what is the percent error in Mrs. Bell's measurement? Show your work.

$\frac{(2.5 - 2.3)}{2.3} = \frac{n}{100}$
 $\frac{0.2}{2.3} = \frac{n}{100}; 20 = 2.3n; 8.7 = n$

Answer 8.7 %

If the measured amount is less than the actual amount, the percent error will be negative.

3 Guided Practice

Students should complete the Guided Practice section on their own. Offer assistance as needed, pointing out the reminder and hint boxes along the right side of the page.

Connections to Standards for Mathematical Practice

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Model with mathematics.
- Look for and make use of structure.

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4 Independent Practice
Answer Rationales

1 The proportion used to find the amount of discount is $\frac{n}{35} = \frac{20}{100}$; the value of n is 7, so the sweater is discounted \$7. The cost is $\$35 - \$7 = \$28$; choice C is correct. Choice A is the amount of the discount. Choice B is the discounted price with the discount subtracted again. Choice D is the amount with the discount added instead of subtracted.

2 The proportion used to find the interest is $\frac{n}{600} = \frac{2.5}{100}$; the value of n is 15. The amount of money in the account is $\$600 + \$15 = \$615$. The account will earn \$15 in interest in one year, and the value of the account will be \$615 in one year.

3 The proportion used to find the tax is $\frac{n}{30} = \frac{6}{100}$, and the value of n is 1.8, or \$1.80. The total amount paid is $\$30 + \$1.80 = \$31.80$.

4 **PART A** The proportion used to find the increase in graduates is $\frac{n}{240} = \frac{15}{100}$. The value of n , the number of additional graduates, is 36.

PART B To find the number of graduates in this year's class, add: $240 + 36 = 276$.

5 Percent error is the ratio of the difference between measured and actual values to the actual value. The proportion used to find the percent error is $\frac{(48.6 - 50.2)}{50.2} = \frac{n}{100}$. The difference in measurements is a negative value, -1.6 . So the ratio is $-\frac{1.6}{50.2}$. Cross multiply: $-1.6 \times 100 = 50.2n$, and solve for n : -3.187 , which rounds to -3.2% . The percent error is negative, meaning that the measured amount is below the actual amount.

4 Independent Practice Lesson 11

Solve the following problems.

1 A sweater is discounted by 20%. The original price of the sweater is \$35. What is the discounted price of the sweater? **DOK 2 7.RP.3**

A \$7
B \$21
C \$28
D \$42

2 Judith puts \$600 into an account that pays 2.5% simple interest per year. Choose an option in each set to correctly complete the statement. **DOK 2 7.RP.3**

The account will earn \$15, \$25, \$150 / in interest in one year, and the value of the account will be \$615, \$675, \$750 / in one year.

3 Lance paid 6% sales tax on a \$30 game. What total amount did Lance pay? **DOK 2 7.RP.3**

Answer \$ 31.80

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4 Independent Practice Lesson 11

4 Last year, the police academy had 240 graduates. This year, the class was 15% larger. **DOK 3 7.RP.3**

Part A How many more graduates were in this year's class than last year's?

Answer 36 graduates

Part B How many graduates were in this year's class?

Answer 276 graduates

5 An airline charges an additional fee for all suitcases that weigh 50 pounds or more. Lukja weighed her suitcase at home in order to avoid the fee and found it weighed 48.6 pounds. At the airport's official scale, however, it weighed 50.2 pounds. What was the percent error of Lukja's measurement? **DOK 3 7.RP.3**

Show your work.

$$\frac{(48.6 - 50.2)}{50.2} = \frac{n}{100}$$

$$-\frac{1.6}{50.2} = \frac{n}{100}$$

$$-160 = 50.2n$$

$$-3.187 = n = -3.2\%$$

Answer -3.2 %

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4 Independent Practice

Lesson 11

- 6 Vito raises green beans to sell. Last year, he raised 250 pounds of beans. The weather was better this year, and his crop increased by 12%. How many pounds of beans did he raise this year?

DOK 2
7.RP.3Answer 280 pounds

- 7 Planners for Center City know that people there are moving to the suburbs. They expect an 8% loss in the number of people who live in the city over the next 10 years. They expect 25,000 people to live in the city 10 years from now.

DOK 3
7.RP.3

- Part A** Let n represent the number of people who live in the city now. Write an expression for the difference between the number of people who live there now and the number of people expected to live there in 10 years.

Answer $n - 25,000$

- Part B** What is this expression for a difference equal to?

Answer the number of people who want to move, 8% of n

- Part C** Write a proportion you could use to solve this problem.

Answer $\frac{(n - 25,000)}{n} = \frac{8}{100}$

- Part D** How many people currently live in the city? Round your answer to the nearest whole number.

Answer 27,174 people

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6 The proportion used to find the amount of increase is $\frac{n}{250} = \frac{12}{100}$. The value of n is 30, or 30 pounds. Add to find the total weight of beans this year: $250 + 30 = 280$. Vito raised 280 pounds of beans this year.

7 **PART A** If n equals the number currently living in the city and 25,000 people are expected to leave, then the expression for the difference is $n - 25,000$.

PART B The expression is equal to 8% of n , the number of people who want to move.

PART C The proportion used to find the number of people currently in Center City is $\frac{(n - 25000)}{n} = \frac{8}{100}$.

PART D To the nearest whole number, the value of n is 27,174.

Extension Activity

Direct students to determine the percent increase or decrease for local stocks over several time periods, including the last day, month, and year. Have groups of students select a local stock from a list and research its opening and closing prices per share over the indicated time frames. Then have them find the percent change and indicate if it was an increase or a decrease for the time period. Ask them to draw conclusions about the performance of the stocks from their data.