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Lesson 9: Problem Solving When the Percent Changes

Student Outcomes

* Students solve percent problems where quantities and percents change.
* Students use a variety of methods to solve problems where quantities and percents change, including double number lines, visual models, and equations.

Lesson Notes

In this lesson, students solve multi-step word problems related to percents that change. They identify the quantities that represent the *part* and the *whole* and recognize when the whole changes based on the context of a word problem. They will build on their understanding of the relationship between the part, whole, and percent. All of the problems can be solved with a visual model. Students may solve some of the problems with an equation, but often the equation will require eighth grade methods for a variable on both sides of the equation. If students generalize and solve such equations, they should be given full credit.

Classwork

Example 1 (5 minutes)

*Scaffolding:*

* Students that had difficulty solving equations in earlier modules may need additional practice working with these one-step equations. Students should continue to use calculators where appropriate throughout the lesson.
* Where appropriate, provide visual models with equations to show an alternative problem-solving strategy for visual learners.

Begin class by displaying Example 1. Have the students work in groups or pairs to try to start the problem on their own.

MP.1

* Based on the words in the example, which person’s money should represent the whole?
  + *The first whole is Sally’s beginning money. The second whole is Sally’s ending money.*

Example 1

The amount of money Tom has is of Sally’s amount of money. After Sally spent and Tom saved all his money, Tom’s amount of money is more than Sally’s. How much money did each have at the beginning? Use a visual model and a percent line to solve the problem.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Before: |  |  |  |  |
| Tom’s Money |  |  |  |  |
| Sally’s Money |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| After: |  |  |  |  |
| Tom’s Money |  |  |  |  |
| Sally’s Money |  |  |  |  |

Each bar is . Tom started with, and Sally started with .

**Example 2 (10 minutes)**

Following the discussion of Example 1, have students try to start Example 2 without modeling. Students will solve the example using a visual model and an equation to show the change in percent. Pose possible discussion questions to the class as you solve the problem.

* Which person’s candy represents the whole?
  + *Erin’s candy represents the whole.*

Example 2

Erin and Sasha went to a candy shop. Sasha bought more candies than Erin. After Erin bought more candies, Sasha had more. How many candies did Erin and Sasha have at first?

* 1. Model the situation using a visual model.

|  |  |  |  |
| --- | --- | --- | --- |
| Before: |  |  |  |
| Erin’s Candies |  |  |  |
| Sasha’s Candies |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| After: |  | |  | |  | |
| Erin’s Candies |  |  |  |  | candies |  |
| Sasha’s Candies |  |  |  |  |  |  |

* 1. How many candies did Erin have at first? Explain.

Each bar in the “after” tape diagram is candies. Sasha has candies. Each bar in the “before” tape diagram is candies. Erin started with candies.

Example 3 (7 minutes)

The previous example presented a visual model approach. In this example, allow students to choose their preferred method to solve the problem. It is important for students to first write an algebraic expression that represents each person’s money before they can form an equation.

*Scaffolding:*

* Consider having some groups solve the problem using a visual model and other groups using an equation.
* Have students explain their models to other groups and look for comparisons for problem solving.
* For the exercises, the teacher could select specific individuals to solve problems using an assigned method to allow students to get comfortable with choosing and utilizing problem-solving methods of choice and efficiency.

MP.4

Point out that since Kimberly and Mike have an equal amount of money in the beginning, the same variable can be used to represent the amount.

Example 3

Kimberly and Mike have an equal amount of money. After Kimberly spent and Mike spent , Mike’s money is more than Kimberly’s. How much did Kimberly and Mike have at first?

* 1. **Use an equation to solve the problem**.

Equation Method:

Let be the amount of Kimberly’s money, in dollars, after she spent . After Mike spent , his money is more than Kimberly’s. Mike’s money is also more than Kimberly’s.

Kimberly started with because . Mike has because .

They each started with .

Lead the class through constructing a visual model for part (b). Since we are subtracting money, first create the *after* picture*,* then, add the money to get the *before* picture.

* 1. **Use a visual model to solve the problem**.

|  |  |  |  |
| --- | --- | --- | --- |
| *AFTER* |  |  |  |
| *Kimberly’s Money* |  |  |  |
| *Mike’s Money* |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *BEFORE* |  |  |  |  |
| *Kimberly’s Money* |  |  |  |  |
| *Mike’s Money* |  |  |  |  |

Each bar is . They both started with .

* 1. **Which method do you prefer and why?**

Answers will vary. I prefer the visual method because it is easier for me to draw the problem out instead of using the algebraic properties.

Exercise (13 minutes)

This exercise allows students to choose any method they would like to solve the problem. Then, they must justify their answers by using a different method. After about 10 minutes, ask students to present their solutions to the class. Compare and contrast different methods, and emphasize how the algebraic, numeric, and visual models are related.

Exercise

Todd has more video games than Jaylon. Todd has video games in his collection. He gives Jaylon of his games. How many video games did Todd and Jaylon have in the beginning? How many do they have now?

Answers may vary. Sample answer is provided below.

Visual Model:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | |  |  |  |  |  |
| Jaylon’s Video Games |  |  |  |  |  |  |  |
| Todd’s Video Games |  |  |  |  |  |  |  |

Each bar in the dark box is games.

Equation Method:

Let be the number of video games that Jaylon had at the beginning. Then, Todd started with video games.

In the beginning, Jaylon had , and Todd had . After Todd gave Jaylon of his games, Jaylon had , and Todd had .

Closing (3 minutes)

* What formula can we use to relate the part, whole, and percent?
* Describe at least two strategies for solving a changing percent problem using an equation.
  + *You must identify the first whole and then identify what would represent the second whole.*
  + *You must use algebraic properties such as the distributive property to solve the problem.*

Lesson Summary

* **To solve a changing percent problem, identify the first whole and then the second whole. To relate the part, whole, and percent, use the formula**

**.**

* **Models, such as double number lines, can help visually show the change in quantities and percents.**

Exit Ticket (7 minutes)

Name Date

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Exit Ticket

Terrence and Lee were selling magazines for a charity. In the first week, Terrance sold more than Lee. In the second week, Terrance sold magazines, but Lee did not sell any. If Terrance sold more than Lee by the end of the second week, how many magazines did Lee sell?

Choose any model to solve the problem. Show your work to justify your answer.

Exit Ticket Sample Solutions

Terrence and Lee were selling magazines for a charity. In the first week, Terrence sold more than Lee. In the second week, Terrence sold magazines, but Lee did not sell any. If Terrence sold more than Lee by the end of the second week, how many magazines did Lee sell?

Choose any model to solve the problem. Show your work to justify your answer.

Answers may vary.

Equation Model:

Let be the number of magazines Lee sold.

, so and

Visual Model:

|  |  |  |
| --- | --- | --- |
| First Week: |  |  |
| Lee |  |
| Terrence |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Second Week: |  |  |  |
| Lee |  |
| Terrence |  |  |  |

By subtracting and , I determined that magazines represents of the magazines Lee sold in the first week. Then, I multiplied both the percent and the number of magazines by to find that magazines represents of the magazines Lee sold.

Problem Set Sample Solutions

1. Solve each problem using an equation.
   1. What is of ?
   2. is of what number?
   3. What percent of is ? Round to the nearest hundredth of a percent.
2. The actual length of a machine is . The measured length is . Round the answer to part (b) to the nearest hundredth of a percent.

|  |  |
| --- | --- |
| * 1. Find the absolute error. | * 1. Find the percent error. |

1. A rowing club has members. of them are women. After new members joined the club, the percentage of women was reduced to . How many of the new members are women?

of the new members are women.

1. of the marbles in a bag are yellow. The rest are orange and green. The ratio of the number of orange to the number of green is . If there are green marbles, how many yellow marbles are there? Use a visual model to show your answer.

units marbles

unit marblesmarbles units marblesmarbles

marbles represents of the total. If I divide both and by , I can determine that would be marbles. Then, I can double both of these to find that marbles make up of the total.

There are yellow marbles because of the marbles are yellow.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | | |  | | |  | | |
| Yellow | |  | | |  | | |  | | |
|  |  | O | O | O | O | G | G | G | G | G |

1. Susan has more books than Michael. Michael has books. If Michael buys more books, will Susan have more or less books than Michael? What percent more or less will Susan’s books be? Use any method to solve the problem.

Susan has more.

1. Harry’s amount of money is of Kayla’s amount of money. After Harry earned and Kayla earned more of her money, Harry’s amount of money is of Kayla’s money. How much money did each have at the beginning? Use a visual model to solve the problem.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Before |  |  |  |  |
| Harry |  |  |  |  |
| Kayla |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| After |  |  |  |  |  |
| Harry |  |  |  |  |  |
| Kayla |  |  |  |  |  |

Each bar is . Harry started with , and Kayla started with .