Solving Percent Problems Using Diagrams

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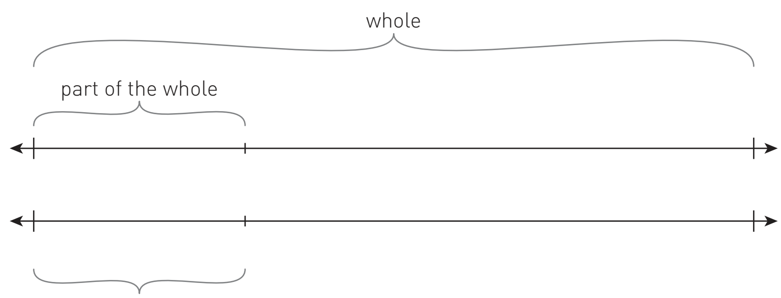
Overview

A variety of percent problems involve the relationship between "the percent," "the part," and "the whole." When this is represented using a double number line, solutions may be determined using logical reasoning or equivalent fractions (proportions). This might look like the diagram shown.

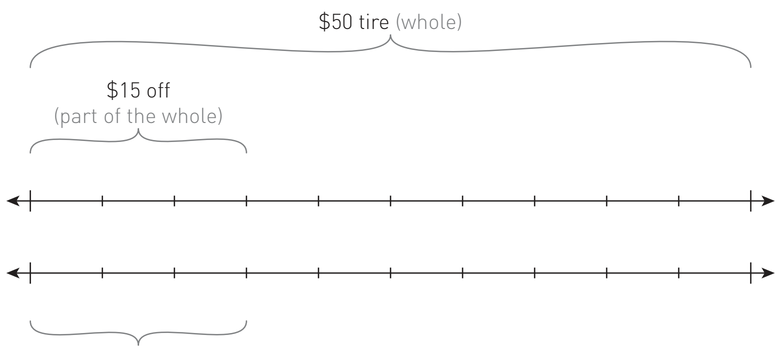


For additional information, see the Methods & Meanings box in Lesson 5.1.2 of the *Core Connections Course 2* text.

Examples

1. Sam's Discount Tires advertises that a tire originally costing \$50 is on sale for \$35. What is the percent discount?

A possible diagram for this situation is shown.

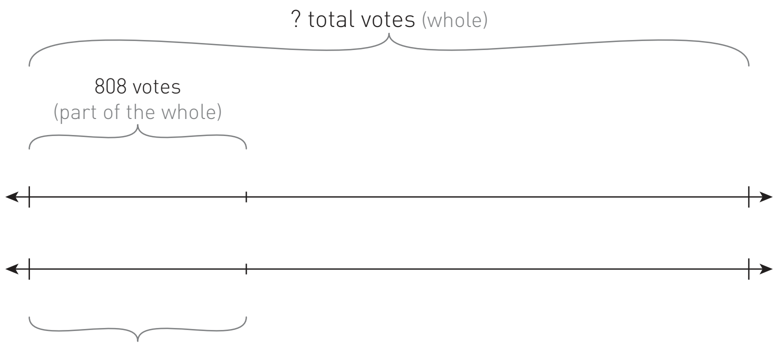


Both number lines are divided into ten parts. Since the cost of the tire (\$50) divided by 10 is \$5, the discount of \$15 is represented by 3 out of the 10 intervals. The percent number line is also divided into 10 intervals, so 3 intervals would represent a discount of 30%. This problem can also be solved by reasoning that since the percent number total (100%) is twice the cost number total (\$50), the percent number saved is twice the cost number saved and it is, therefore, a 30% discount.

The problem could also be represented using a proportion: $\frac{15}{50} = \frac{x}{100}$.

2. Martin received 808 votes for mayor of Smallville. If this was 32% of the total votes cast, how many people voted for the mayor of Smallville?

A possible diagram for this situation is shown.



In this case, the double number line is useful as a visual representation to reason about the problem, but the solution is not easily determined directly from this model. One strategy is to write a pair of equivalent fractions as a proportion: $\frac{808\text{ votes}}{32\%} = \frac{x\text{ votes}}{100\%}$. If using the Giant One, the multiplier is

$\frac{100}{32} = 3.125$, $\frac{808\text{ votes}}{32\%} \cdot \boxed{\frac{3.125}{3.125}} = \frac{2{,}525\text{ votes}}{100\%}$.

Therefore, a total of 2,525 people voted for mayor of Smallville.

Practice

Solve each of the following problems using a diagram.

1. Sarah's English test had 90 questions, and she got 18 questions incorrect. What percent of the questions did she get correct?

2. Cargo pants that regularly sell for $36 are now on sale for 30% off. How much is the discount?

3. The bill for a stay in a hotel was $188 including $15 tax. What percent of the bill was the tax?

4. Alicia got 60 questions correct on her science test. If she received a score of 75%, how many questions were on the test?

5. Basketball shoes are on sale for 22% off. What is the regular price if the sale price is $42?

6. Sergio got 80% on his math test. If he answered 24 questions correctly, how many questions were on the test?

7. Ellen bought soccer shorts on sale for $6 off the regular price of $40. What percent did she save?

8. According to school rules, Carol has to convince at least 60% of her classmates to vote for her in order to be elected class president. There are 32 students in her class. How many students must she convince?

9. A sweater that regularly sold for $52 is now on sale at 30% off. What is the sale price?

10. Jody found an $88 pair of sandals marked 20% off. What is the dollar value of the discount?

11. Ly scored 90% on a test. If he answered 135 questions correctly, how many questions were on the test?

12. George has 245 cards in his baseball card collection. Of these, 85 of the cards are pitchers. What percent of the cards are pitchers?

13. Julio bought soccer shoes at a 35% off sale and saved $42. What was the regular price of the shoes?

Answers

1.	80%	**2.**	$10.80	**3.**	about 8%	**4.**	80 questions
5.	≈ $53.85	**6.**	30 questions	**7.**	15%	**8.**	20 students
9.	$36.40	**10.**	$17.60	**11.**	150 questions	**12.**	about 35%
13.	$120						

Ratios

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Overview

A ratio is a comparison of two quantities by division. It can be written in several ways:

$\frac{\text{65 miles}}{\text{1 hour}}$ 65 miles:1 hour 65 miles to 1 hour

For additional information, see the Methods & Meanings box in Lesson 5.1.1 of the *Core Connections Course 2* text.

Examples

A bag contains the following marbles: 7 clear, 8 red, and 5 blue. Determine the following ratios.

1. Ratio of blue to total number of marbles.

Since there are 20 marbles in the bag, the ratio can be written $\frac{\text{5 blue marbles}}{\text{20 total marbles}} = \frac{\text{1 blue marbles}}{\text{4 total marbles}}$, 1:4, or 1 to 4.

2. Ratio of red to clear marbles.

Since there are 8 red and 7 clear marbles, the ratio can be written $\frac{\text{8 red marbles}}{\text{7 clear marbles}}$, 8:7, or 8 to 7.

3. Ratio of red to blue marbles.

Since there are 8 red and 5 blue marbles, the ratio can be written $\frac{\text{8 red marbles}}{\text{5 blue marbles}}$, 8:5, or 8 to 5.

4. Ratio of blue to red marbles.

Since there are 5 blue and 8 red marbles, the ratio can be written $\frac{\text{5 blue marbles}}{\text{8 red marbles}}$, 5:8, or 5 to 8.

Practice

1. Molly's favorite juice drink is made by mixing 3 cups of apple juice, 5 cups of cranberry juice, and 2 cups of ginger ale. State the following ratios:

a. Ratio of cranberry juice to apple juice.

b. Ratio of ginger ale to apple juice.

c. Ratio of ginger ale to total juice drink (the mixture).

2. A 40-passenger bus is carrying twenty 6th grade students, sixteen 7th grade students, and 2 teachers on a field trip to the state capital. State the following ratios:

a. Ratio of 6th graders to 7th graders.

b. Ratio of 7th graders to 6th graders.

c. Ratio of teachers to students.

d. Ratio of teachers to passengers.

3. Molly wants to keep the ratios the same when she mixes larger or smaller amounts of the drink in problem 1. Otherwise, the drink does not taste right. If she needs a total of 30 cups of juice drink, how many cups of each ingredient should she use?

4. If Molly needs 25 cups of juice drink (from problem 1), how many cups of each liquid should be used? Remember that the ratios must stay the same.

Answers

1. a. $\frac{5}{3}$ b. $\frac{2}{3}$ c. $\frac{2}{10} = \frac{1}{5}$

2. a. $\frac{20}{16} = \frac{5}{4}$ b. $\frac{16}{20} = \frac{4}{5}$ c. $\frac{2}{36} = \frac{1}{18}$ d. $\frac{2}{38} = \frac{1}{19}$

3. 9 cups apple juice, 15 cups cranberry juice, 6 cups ginger ale

4. $7\frac{1}{2}$ cups apple, $12\frac{1}{2}$ cups cranberry juice, 5 cups ginger ale

Independent and Dependent Events

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Overview

An event is an outcome or group of outcomes from an experiment. Two events are **independent** if the outcome of one event does not affect the outcome of the other event. For example, if you draw a card from a standard deck of playing cards but replace it before you draw again, the outcomes of the two draws are independent.

Two events are **dependent** if the outcome of one event affects the outcome of the other event. For example, if you draw a card from a standard deck of playing cards and do not replace it before the next draw, the outcomes of the two draws are dependent.

For additional information, see the Methods & Meanings box in Lesson 5.2.3 of the *Core Connections Course 2* text.

Examples

1. Juan pulled a red card from a deck of regular playing cards. This probability is $\frac{26}{52}$ or $\frac{1}{2}$. He puts the card back into the deck. Will his chance of pulling a red card next time be the same?

> Yes, his chance of pulling a red card next time will be the same, because he replaced the card. There are still 26 red cards out of 52. This is an example of an independent event; pulling out and replacing a red card does not affect any subsequent selections from the deck.

2. Brett has a bag of 30 colored candies. 15 are red, 6 are blue, 5 are green, 2 are yellow, and 2 are brown. If he pulls out a yellow candy and eats it, does this change his probability of pulling another yellow candy from the bag?

> Yes, this changes the probability because he now has only 29 candies in the bag and only 1 yellow candy. Originally, his probability of yellow was $\frac{2}{30}$ or $\frac{1}{15}$; it is now $\frac{1}{29}$. Similarly, red was $\frac{15}{30}$ or $\frac{1}{2}$ and now is $\frac{15}{29}$, more than $\frac{1}{2}$. This is an example of a dependent event.

Practice

Determine whether these events are independent or dependent events.

1. Flipping a coin, and then flipping it again.

2. Taking a black 7 out of a deck of cards and not returning it, then taking out another card.

3. Taking a red licorice from a bag and eating it, then taking out another piece of licorice.

4. Ama lost her pencil, then later in the day it started raining.

5. Raul comes into class and takes a seat. Henry comes into the same classroom later and takes a seat.

6. A box has both peanut butter and chocolate chip cookies. Geo takes a chocolate chip cookie and eats it first, then Ellie takes a cookie.

7. A spinner with three different colors is spun twice.

8. A six-sided dice is rolled twice.

Answers

1.	independent	**2.**	dependent	**3.**	dependent	**4.**	independent
5.	dependent	**6.**	dependent	**7.**	independent	**8.**	independent

Compound Events

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Overview

There are times when calculating a probability that you are interested in either of two outcomes taking place, but not both. For example, you may be interested in drawing a King or a Queen from a deck of cards. At other times, you might be interested in one event followed by another event. For example, you might want to roll a 1 on a dice and then roll a 6. The probabilities of combinations of simple events are called compound events.

Compound probability refers to the likelihood of two or more desired outcomes happening. Just as with simple probability, compound probability is the fraction of desired outcomes in the sample space for which the compound event occurs. That is, compound probability = $\frac{\text{number of successful outcomes (compound events)}}{\text{total number of possible outcomes}}$.

To calculate the probability of *either* one event *or* another event when the two events are independent, calculate the probability of each event separately and add their probabilities.

Using the example of drawing a King or a Queen from a deck of cards: $P(\text{King}) = \frac{4}{52}$ and $P(\text{Queen}) = \frac{4}{52}$, so $P(\text{King or Queen}) = \frac{4}{52} + \frac{4}{52} = \frac{8}{52} = \frac{2}{13}$.

To calculate the probability of *both* one *and* the other event occurring, calculate the probability of each event separately and then multiply their probabilities.

Using the example of rolling a 1 followed by a 6 on a dice: $P(1) = \frac{1}{6}$ and $P(6) = \frac{1}{6}$, so $P(1 \text{ then } 6) = \frac{1}{6} \cdot \frac{1}{6} = \frac{1}{36}$. Note that you would carry out the same computation if you wanted to know the probability of rolling a 1 on a green dice and a 6 on a red dice, if you rolled both of them at the same time.

Sample spaces for compound events can be represented using systematic lists, tables, and tree diagrams. For additional information, see the Methods & Meanings box in Lesson 5.2.5 of the *Core Connections Course 2* text.

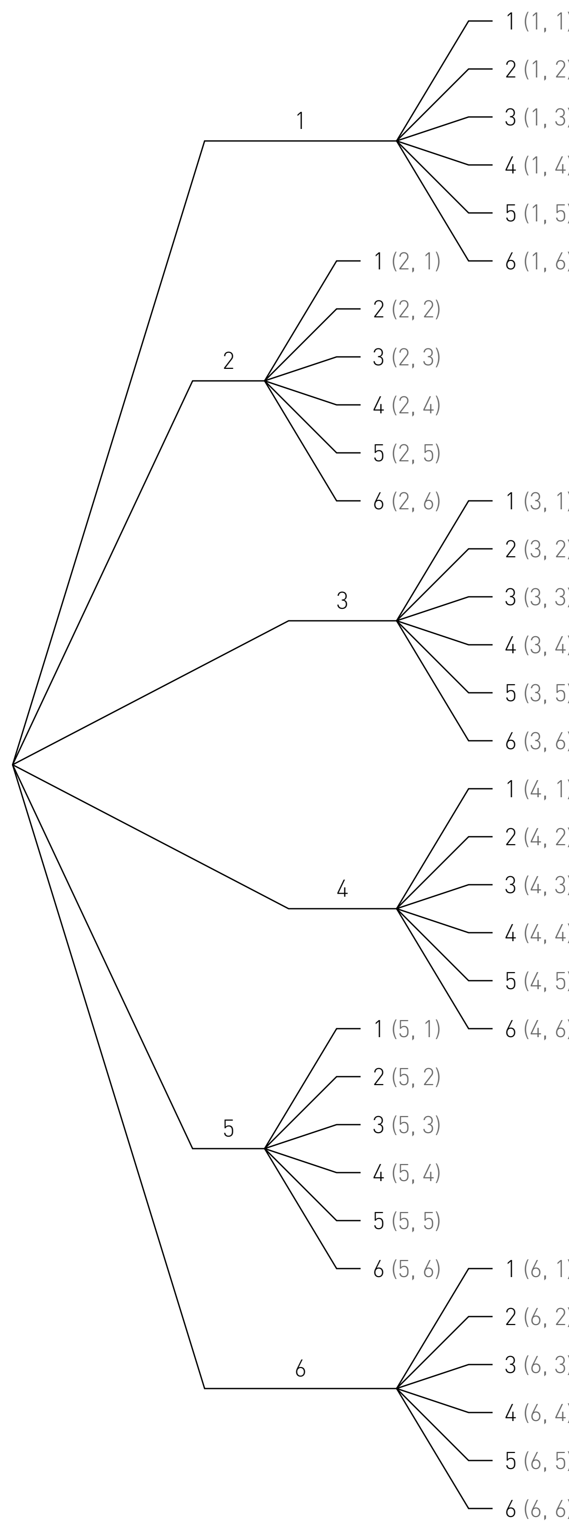
Examples

1. Ajay rolls two dice. What is the probability that Ajay rolls two 6s?

There are 36 possible outcomes of rolling two dice. This sample space can be represented in multiple ways.

(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5), (2, 6), (3, 1), (3, 2), (3, 3), (3, 4), (3, 5), (3, 6), (4, 1), (4, 2), (4, 3), (4, 4), (4, 5), (4, 6), (5, 1), (5, 2), (5, 3), (5, 4), (5, 5), (5, 6), (6, 1), (6, 2), (6, 3), (6, 4), (6, 5), (6, 6)

		Dice 2					
		1	2	3	4	5	6
Dice 1	1	1, 1	1, 2	1, 3	1, 4	1, 5	1, 6
	2	2, 1	2, 2	2, 3	2, 4	2, 5	2, 6
	3	3, 1	3, 2	3, 3	3, 4	3, 5	3, 6
	4	4, 1	4, 2	4, 3	4, 4	4, 5	4, 6
	5	5, 1	5, 2	5, 3	5, 4	5, 5	5, 6
	6	6, 1	6, 2	6, 3	6, 4	6, 5	6, 6



Rolling two 6s is one of the 36 possible outcomes, as shown in each representation, and all outcomes are equally likely. Therefore, $P(6, 6) = \frac{1}{36}$.

Alternatively, since the probability of rolling a 6 on one dice is $\frac{1}{6}$, the probability of rolling two 6s is $\frac{1}{6} \cdot \frac{1}{6} = \frac{1}{36}$. That is, since these are "both–and" compound events, the probabilities can be multiplied: $P(6) = \frac{1}{6}$, so $P(6, 6) = \frac{1}{6} \cdot \frac{1}{6} = \frac{1}{36}$.

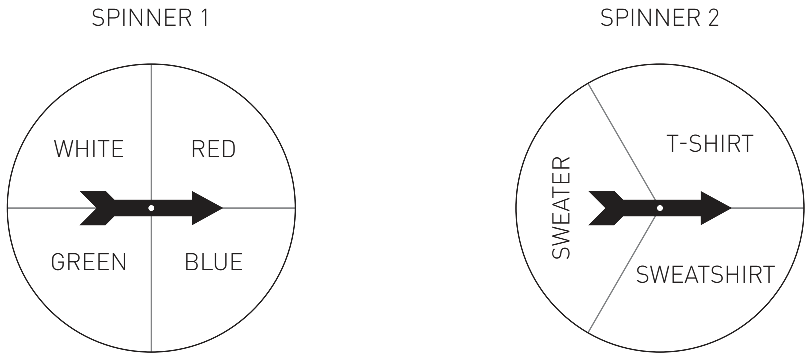
2. A spinner is divided into five equal sections numbered 1 through 5. What is the probability of spinning *either* a 2 *or* a 5?

The sample space is 1, 2, 3, 4, and 5. Each outcome is equally likely, so $P(2) = \frac{1}{5}$ and $P(5) = \frac{1}{5}$.

Since these are "either–or" compound events and there is no overlap between the two events, add the fractions describing each probability: $\frac{1}{5} + \frac{1}{5} = \frac{2}{5}$.

Therefore, the probability of spinning a 2 or a 5 is $\frac{2}{5}$. That is, $P(2 \text{ or } 5) = \frac{2}{5}$.

3. If both spinners shown are divided into evenly sized regions, what is the probability of spinning both spinners and getting a green T-shirt?



A probability area model can be used to show all of the possible combinations of outcomes. Since these are "both–and" compound events, the probabilities can be multiplied.

SPINNER 1 \ SPINNER 2	SWEATER $\frac{1}{3}$	T-SHIRT $\frac{1}{3}$	SWEATSHIRT $\frac{1}{3}$
WHITE $\frac{1}{4}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$
RED $\frac{1}{4}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$
GREEN $\frac{1}{4}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$
BLUE $\frac{1}{4}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$	$\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$

The probability of spinning "green" and "T-shirt" is $\frac{1}{12}$. That is, P(green, T-shirt) = $\frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$.

Practice

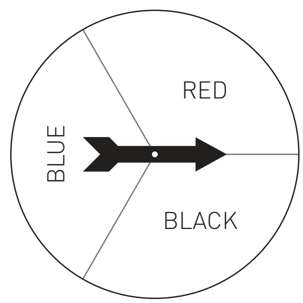
1. A bike shop offers mountain bikes or road bikes. The color options are black, red, yellow, or blue paint, and the bikes come with 3-speed, 5-speed, or 10-speed builds. Represent this sample space using a probability tree.

2. A tax assessor categorizes 25% of the homes in a city as having a large backyard, 65% as having a small backyard, and 10% as having no backyard. 30% of the homes have a tile roof, and the rest have some other kind of roof. Represent this sample space using a list and a probability area model.

Assume in each of the problems that events are independent of each other.

3. One dice, numbered 1, 2, 3, 4, 5, and 6, is rolled. What is the probability of rolling *either* a 1 *or* a 6?

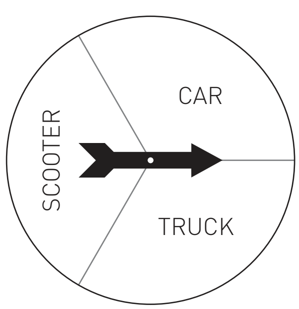
4. Mary is playing a game in which she rolls one dice and spins a spinner. What is the probability she will get *both* a 3 *and* black?

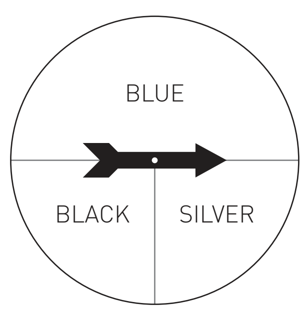


5. A spinner is divided into eight equal sections. The sections are numbered 1, 2, 3, 4, 5, 6, 7, and 8. What is the probability of spinning a 2, 3, or a 4?

6. River has a box of 12 colored pencils. There are 2 blue, 1 black, 1 gray, 3 red, 2 green, 1 orange, 1 purple, and 1 yellow in the box. River closes her eyes and chooses one pencil. She is hoping to choose a green or a red. What is the probability she will get one of her color choices?

7. Use the following spinners to determine the chance of getting a silver truck.



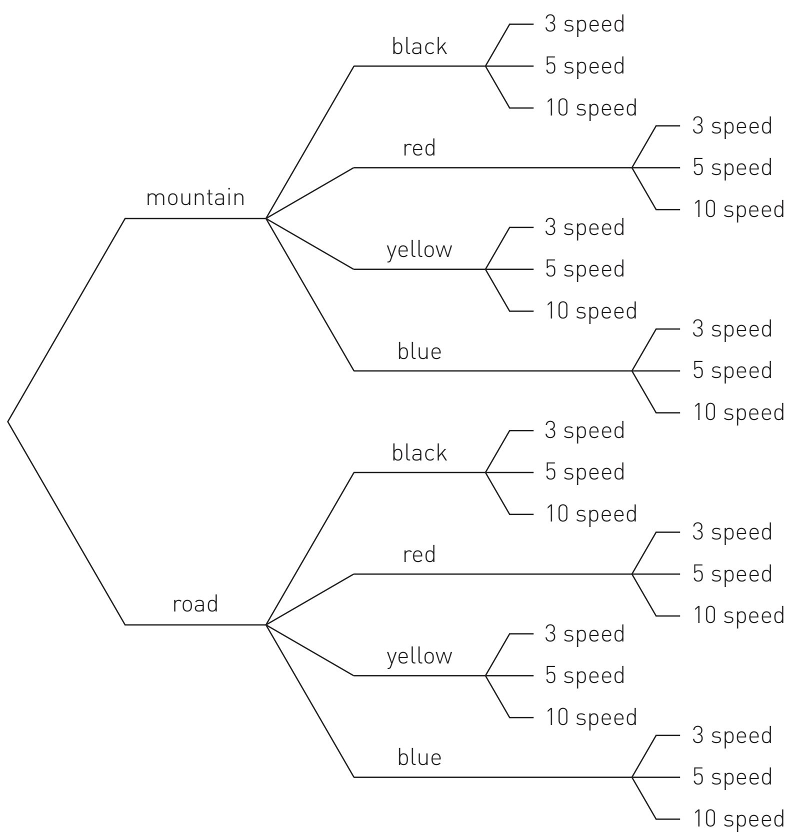


8. On the way to school, the school bus must go through two traffic signals. The first light is green for 25 seconds out of each minute, and the second light is green for 35 seconds out of each minute. What is the probability that both lights will be green on the way to school?

9. A nationwide survey showed that only 4% of children like eating lima beans. What is the probability that any two children will both like lima beans?

Answers

1. There are 24 possible combinations, as shown.



2. There are 6 possibilities.

(large, tile), (large, other), (small, tile), (small, other), (no yard, tile), (no yard, other)

		BACKYARD	
	LARGE 0.25	SMALL 0.65	NO YARD 0.10
ROOF: TILE 0.30	0.075	0.195	0.03
ROOF: OTHER 0.70	0.175	0.455	0.07

3. $\frac{2}{6}$ or $\frac{1}{3}$

4. $\frac{1}{18}$

5. $\frac{3}{8}$

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

7. $\frac{1}{12}$

8. $\frac{25}{60} \cdot \frac{35}{60} = \frac{875}{3{,}600} \approx 0.243$

9. $\frac{1}{625} = 0.0016$

Writing Equations for Word Problems

GUIDED SKILL SUPPORT

Overview

The 5-D Process is an organizational method similar to guess-and-check that supports representation of word problems with algebraic equations.

- Describe/Draw to make sense of the context of the problem and identify important information.
- Define what needs to be determined and set up the columns of the table.
- Do the calculations to determine a result.
- Decide whether the result is correct or not after each trial. Note whether it is too large or too small to inform the value chosen for the next trial.
- Declare the correct answer in a complete sentence that precisely answers the question asked in the problem.

The patterns developed in the 5-D Process can be generalized by using a variable to write an equation. Once you have an equation for the problem, it is sometimes more efficient to solve the equation than to continue using the 5-D Process.

For additional information, see the Methods & Meanings box in Lesson 5.3.3 of the *Core Connections Course 2* text.

Examples

1. A box of fruit has three times as many nectarines as grapefruits. Together, there are 36 pieces of fruit. How many pieces of each type of fruit are there?

DESCRIBE/ DRAW The number of nectarines is three times the number of grapefruits. The number of nectarines plus the number of grapefruits equals 36.

	DEFINE		DO	DECIDE
	Number of Grapefruits	**Number of Nectarines**	**Total Pieces of Fruit**	**36?**
Trial 1	11	33	44	too high
Trial 2	10	30	40	too high

After a few trials to establish a pattern in the problem, you can generalize it by using a variable. Since the number of grapefruits could be any number, use x to represent it. The rule for the number of nectarines is three times the number of grapefruits, or $3x$. The total pieces of fruit is the sum of column one and column two, so the table becomes:

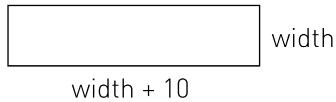
	DEFINE		DO	DECIDE
	Number of Grapefruits	**Number of Nectarines**	**Total Pieces of Fruit**	**36?**
Trial 1	11	33	44	too high
Trial 2	10	30	40	too high
Variable Expression	x	$3x$	$x + 3x$	36

Since the total needs to agree with the check, the equation is $x + 3x = 36$. Rewriting this yields $4x = 36$, so $x = 9$ (grapefruits) and then $3x = 27$ (nectarines).

DECLARE There are 9 grapefruits and 27 nectarines.

2. The perimeter of a rectangle is 120 feet. If the length of the rectangle is 10 feet more than the width, what are the dimensions (length and width) of the rectangle?

DESCRIBE/ DRAW



	DEFINE		DO	DECIDE
	Width	**Length**	**Perimeter = (width + length) · 2**	**120?**
Trial 1	10	20	(10 + 20) · 2 = 60	too low
Trial 2	20	30	(20 + 30) · 2 = 100	too low

Again, since any width is possible, it is appropriate to use a variable such as x. The pattern for the second column is that it is 10 more than the first: $x + 10$. The perimeter is determined by multiplying the sum of the width and length by 2. The table now becomes:

	DEFINE		DO	DECIDE
	Width	**Length**	**Perimeter = (width + length) · 2**	**120?**
Trial 1	10	20	(10 + 20) · 2 = 60	too low
Trial 2	20	30	(20 + 30) · 2 = 100	too low
Variable Expression	x	$x + 10$	$(x + x + 10) \cdot 2$	120

Solving the equation:

$$\begin{aligned}(x + x + 10) \cdot 2 &= 120\\ 2x + 2x + 20 &= 120\\ 4x + 20 &= 120\\ 4x &= 100\\ x &= 25\end{aligned}$$

So $x = 25$ (width) and $x + 10 = 35$ (length).

DECLARE The width is 25 feet and the length is 35 feet.

3. Jorge has some dimes and quarters. He has 10 more dimes than quarters, and the collection of coins is worth \$2.40. How many dimes and quarters does Jorge have?

DESCRIBE/ DRAW The number of quarters plus 10 equals the number of dimes.
The total value of the coins is \$2.40.

	DEFINE				DO	DECIDE
	Number of Quarters	**Number of Dimes**	**Value of Quarters**	**Value of Dimes**	**Total Value**	**2.40?**
Trial 1	10	20	2.50	2.00	4.50	too high
Trial 2	8	18	2.00	1.80	3.80	too high
Variable Expression	x	$x + 10$	$0.25x$	$0.10(x + 10)$	$0.25x + 0.10(x + 10)$	2.40

Since you need to know both the number of coins and their value, the equation is more complicated. The number of quarters becomes x, but then in the table, the "Value of Quarters" column is $0.25x$. Similarly, the number of dimes is $x + 10$, but the value of dimes is $0.10(x + 10)$. Finally, to determine the numbers, the equation becomes $0.25x + 0.10(x + 10) = 2.40$.

Solving the equation:

$$\begin{aligned} 0.25x + 0.10(x + 10) &= 2.40 \\ 0.25x + 0.10x + 1.00 &= 2.40 \\ 0.35x + 1.00 &= 2.40 \\ 0.35x &= 1.40 \\ x &= 4.00 \end{aligned}$$

DECLARE There are 4 quarters, worth \$1.00 collectively, and 14 dimes, worth \$1.40 collectively, for a total value of \$2.40.

Practice

Use the 5-D Process to help you write and solve an equation to answer each question.

1. A wood board 100 centimeters long is cut into two pieces. One piece is 26 centimeters longer than the other. What are the lengths of the two pieces?

2. Thu is five years older than her brother Tuan. The sum of their ages is 51. What are their ages?

3. Tomás is thinking of a number. If he triples his number and subtracts 13, the result is 305. What number is Tomás thinking of?

4. Two consecutive numbers have a sum of 123. What are the two numbers?

5. Two consecutive even numbers have a sum of 246. What are the numbers?

6. Joe's age is three times Aaron's age, and Aaron is six years older than Christina. If the sum of their ages is 149, what is Christina's age? Joe's age? Aaron's age?

7. Farmer Fran has 38 barnyard animals, consisting of only chickens and goats. If these animals have 116 legs, how many of each type of animal are there?

8. A strip of fabric 156 centimeters long is cut into three parts. The two longer parts are the same length and are 15 centimeters longer than the shortest part. How long are the three parts?

9. Juan has 15 coins, all nickels and dimes. This collection of coins is worth 90¢. How many nickels and dimes are there? (Hint: Create separate column titles for, "Number of Nickels," "Value of Nickels," "Number of Dimes," and "Value of Dimes.")

10. Tickets to the school play are \$5.00 for adults and \$3.50 for students. If the total value of all the tickets sold was \$2,517.50 and 100 more students bought tickets than adults, how many adults and students bought tickets?

11. A pipe 250 centimeters long is cut into five pieces: three short ones of equal length and two that are both 15 centimeters longer than the shorter ones. What are the lengths of the pipes?

12. Conrad has a collection of three types of coins: nickels, dimes, and quarters. There is an equal amount of nickels and quarters but three times as many dimes. If the entire collection is worth \$9.60, how many nickels, dimes, and quarters are there?

Answers

Equations may vary.

1. $x + (x + 26) = 100$
The lengths of the boards are 37 cm and 63 cm.

2. $x + (x + 5) = 51$
Thu is 28 years old and her brother is 23 years old.

3. $3x - 13 = 305$
Tomás is thinking of the number 106.

4. $x + (x + 1) = 123$
The two consecutive numbers are 61 and 62.

5. $x + (x + 2) = 246$
The two consecutive even numbers are 122 and 124.

6. $x + (x + 6) + 3(x + 6) = 149$
Christine is 25, Aaron is 31, and Joe is 93 years old.

7. $2x + 4(38 - x) = 116$
Farmer Fran has 20 goats and 18 chickens.

8. $x + (x + 15) + (x + 15) = 156$
The lengths of the pieces of fabric are 42, 57, and 57 cm.

9. $0.05x + 0.10(15 - x) = 0.90$
Juan has 12 nickels and 3 dimes.

10. $5x + 3.50(x + 100) = 2{,}517.50$
There were 255 adult and 355 student tickets purchased for the play.

11. $3x + 2(x + 15) = 250$
The lengths of the pipes are 44 and 59 cm.

12. $0.05x + 0.25x + 0.10(3x) = 9.60$
Conrad has 16 quarters, 16 nickels, and 48 dimes.