

Probability and Statistics

Are you an average teenager?
How could you find out how your answers to these questions compare with those of the average Canadian teenager?



How many hours a week do you spend playing sports?
How are you most likely to communicate with your friends?

What You'll Learn

- Understand the role of probability in society.
- Identify and address problems related to data collection.
- Use either a population or a sample to answer a question.
- Develop and implement a plan to collect, display, and analyze data.

Why It's Important

People make decisions based on data. People can make informed decisions if they understand what the data really mean and where they come from, and are confident the data are accurate.

A collage of images. In the background, three cheerleaders in blue and yellow uniforms with lightning bolt logos and the word 'THUNDER' are smiling. In the foreground, a young woman with braided hair and large beaded earrings is wearing a white polo shirt with a rainbow stripe and is looking at a computer monitor. An orange speech bubble with a torn edge is positioned at the top left.

How do your likes,
dislikes, opinions, and
lifestyle compare
with those of your friends?

Key Words

- population
- census
- sample
- valid conclusions
- rubric

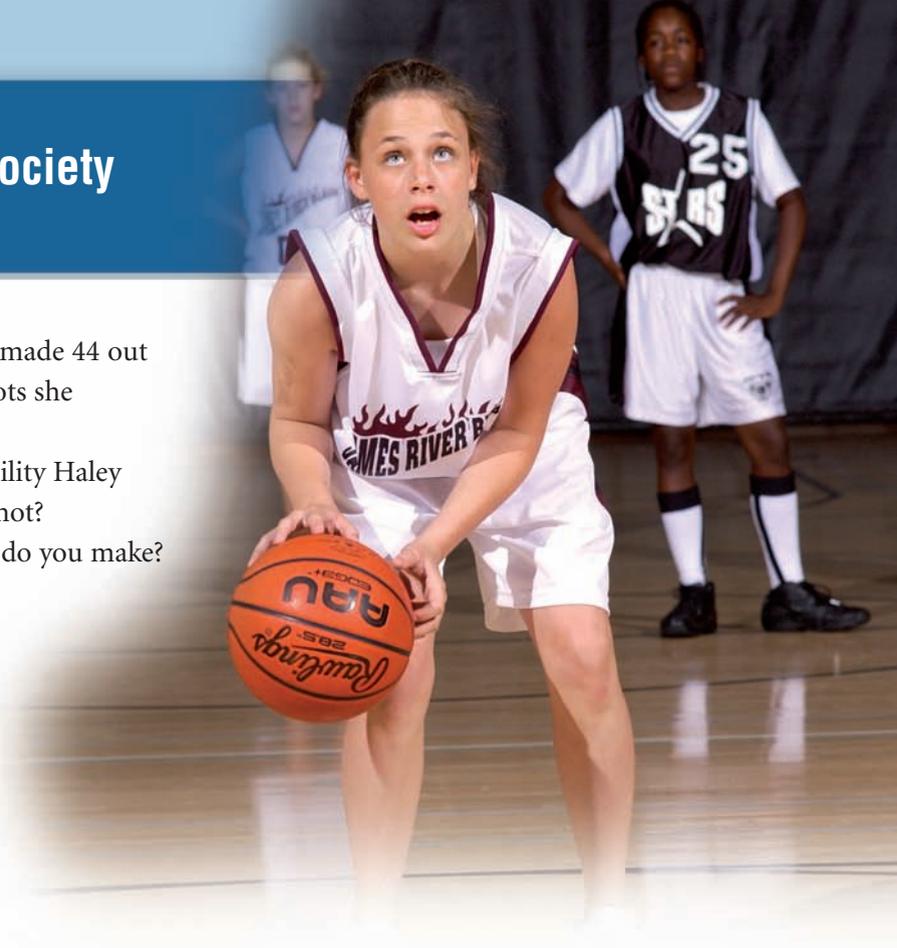
FOCUS

- Explain how probability is used outside the classroom.

This season, Haley made 44 out of 50 basketball shots she attempted.

What is the probability Haley will sink the next shot?

What assumptions do you make?

**Investigate**

From the statements below, identify the different probabilities that Jean-Guy considers in a day. List an assumption associated with each statement.

Explain how the situation would change if that assumption were not true.

- Jean-Guy noticed that, in the last month, 70% of the time the bus was 3 minutes late. So, he takes his time with breakfast today.
- Lately, Jean-Guy's math teacher checks homework 4 days a week. So, Jean-Guy makes sure he has time to complete his homework today.
- At school, Jean-Guy and his friends agree that their lacrosse team has a 95% chance of making the finals.
- In health class, Jean-Guy's teacher reads a magazine that claims 172 out of 1000 male smokers develop lung cancer, but only 13 out of 1000 males who do not smoke develop lung cancer.

Reflect & Share

Share your assumptions with those of another pair of students.

Discuss which assumptions you think are the most likely and least likely to be true.

Which probability could have been most influenced by personal opinion?

How do you think the other probabilities were determined? Explain.

Connect

Probability refers to the likelihood that an event will occur.

By collecting and analyzing data, predictions can be made about the likelihood that a certain event will occur. For example, meteorologists study past weather data to make predictions about future conditions. A 40% probability of snow means that under similar conditions in the past it snowed 40% of the time, or 4 times out of 10.

A probability of 40% can be expressed as 4 out of 10, $\frac{4}{10}$, or 0.4.



When you flip a coin, there is a 0.5 probability the coin will land heads up. Despite this probability, you may feel strongly that the coin will land tails up. In this case, you have made a *subjective judgment*.

Example 1 Identifying Decisions Based on Probabilities and Judgments

Explain how each decision is based on theoretical probability, experimental probability, subjective judgment, or any combination of these.

- It is Ausma's experience that 4 out of 5 times the prize in the cereal box is found at the bottom of the box. So, Ausma opens the bottom of the cereal box to find her prize.
- Two friends are rolling a die. Out of eight rolls made, a "4" came up 7 times. Amith predicts the next roll will likely not be a "4," since each number has an equal chance of being rolled. Maria decides the die is unfair since 7 out of 8 rolls revealed a "4."

▶ A Solution

- Ausma's decision to open the bottom of the cereal box to find her prize is based on past experience. This is an example of experimental probability.
- Amith's decision that the next roll will likely not be a "4" is based on theoretical probability. Amith knows that the probability of rolling each number is 1 out of 6, so the probability of rolling any number other than a "4" is 5 out of 6. Based on previous rolls, Maria has noticed that the experimental probability of rolling a "4" is 7 out of 8. She knows that each number should have an equal probability of being rolled. So, she makes a subjective judgment that the die must be unfair.

Often, we make predictions about an outcome based on assumptions associated with a given probability.

If these assumptions change, the prediction may not match the outcome.

Example 2 Explaining How Assumptions Affect a Probability

In past baseball games, Alice made 2 hits for every 5 times she went up to bat.

- In the next game, suppose Alice goes up to bat. What is the probability that she will get a hit? What assumptions are you making?
- For each assumption, explain how the predicted outcomes might change if the assumption changes.



► A Solution

- The experimental probability of Alice hitting the ball is 2 out of 5, or 40%. We assume that the next team Alice plays against is at the same level of ability as previous teams she has played.
- If the opposing team is more able, then Alice will probably make fewer hits. The likelihood that Alice has a hit would be less than 2 out of 5. If the opposing team is less able, then Alice will probably have more than 2 hits. In this case, the likelihood that Alice has a hit would be greater than 2 out of 5.

Sometimes a probability can be used to support opposing views.

Example 3 Using a Probability to Support Opposing Views

Jon wants to learn how to snowboard but does not want to take lessons. His mother insists that Jon take lessons. Jon and his mother find an article that claims:

68% of snowboarding injuries occur during beginner lessons

Explain how both Jon and his mother can use this statistic to support their opinions.



A Solution

68% of snowboarding injuries occur during beginner lessons. Jon's mother can argue that this statistic proves lessons are important because beginners are prone to accidents. Jon can argue that this statistic is a good reason not to take lessons because the likelihood of getting injured during the lesson is high.

Discuss the ideas

1. When you toss a coin, what assumptions are you making when you say the probability of it landing heads up is $\frac{1}{2}$?
2. Car insurance for teenagers is more expensive than for adults because the probability of an accident is greater for teenage drivers. What assumptions is an insurance company making when it charges a teenage driver more for insurance?

Practice

Check

3. Indicate whether each decision is based on theoretical probability, experimental probability, or subjective judgment. Explain how you know.
 - a) The last two times Andrei won a prize at a coffee shop, he ordered a medium hot chocolate. Andrei never won when he ordered a large hot chocolate, so today he orders a medium hot chocolate.
 - b) Instead of buying her own lottery ticket, Martha pools her money with the people at work to buy more tickets and increase her chances of winning.
 - c) Anita boards the last car of a train because, in the past, the last car always had available seats.
 - d) Doug will not travel by airplane even though experts say it is safer to fly than drive.

4. What assumptions is each person making?
 - a) Based on past math quizzes, Claudia says she has a 90% chance of getting a perfect score on her next math quiz.
 - b) Six times out of ten, Omar gets stuck in traffic when he leaves work. So, he calculates that his chances for getting stuck in traffic today after work are 60%.

Apply

5. The weather forecast is 70% chance of rain. Winona had planned to go canoeing. Explain how the decision she makes may be based either on probability or on subjective judgment.
6. The student council has a draw for a prize during the school dance. Lei decides not to enter the draw because all of his classmates have entered and he feels unlucky today. Is Lei's decision based on probability, on subjective judgment, or both? Explain.

7. One year, the probability of *not* recovering a stolen vehicle in Montreal was 44%. How could politicians use this fact to argue that:
- more money should be allotted to searching for stolen vehicles
 - more money should not be allotted, and instead should go to different causes
8. Vanessa observes her birdfeeder at the same time each day for a week. She notes that 32 of the 100 birds which visit the feeder are cardinals. She concludes that, in general, there is a 32% probability a bird visiting the feeder will be a cardinal.
- What assumptions did Vanessa make?
 - If each assumption changes, how might the predicted outcome change?



9. Kathryn read this headline:

**Poll reveals 30% support
Bradford, 70% support
Choo in next election**

Kathryn says that if she polled the next 10 people she passed on the street, 7 of them would be voting for Choo.

- What assumption is Kathryn making?
- Explain what the effect might be if the assumption were not true.

10. A DNA match was found between a blood sample and a suspect. A forensic scientist testifies that there is a 1 in 7000 chance the blood sample is from someone other than the suspect. Describe how two lawyers could use this statistic to support different positions.

11. **Assessment Focus** An advertisement for acne treatment boasts:

**4 out of 5 users noticed
improvements in two days!**

- Explain how a teenager's decision on whether to try this acne treatment could be based on probability and subjective judgment.
 - If the teenager does decide to try the acne treatment, what assumptions might he be making? For each assumption, explain how the predicted outcome of the treatment might change if the assumption changes.
12. a) Provide 2 examples of how statistics are used in the media to sell a product.
b) Why do advertisers use numbers in these ads? Do you think using statistical data makes the ads more effective?
c) For each example, list some assumptions associated with the statistic.
13. Look at newspapers, magazines, or on the internet. Give 2 examples of how politicians or environmentalists use probability.

Take It Further

14. Shaquille O'Neal's free throw percentage during one season was 62%. A teacher points out that this means each time Shaquille attempted a free throw during that season, his probability of making the shot was 62%. A student then says:
"Shaquille either makes the shot or he doesn't. So, isn't the probability 50%?"
Explain the flaw in the student's thinking.
15. Research 2 occupations that use probability. Explain the role of probability in each occupation.
16. The annual Farmer's Almanac makes predictions about long range weather patterns. Investigate to find out how these predictions are made. What assumptions is the almanac making?
17. According to Transport Canada, in 2004, there were 34 fatalities due to air travel and 2730 fatalities due to road travel.
- What impression does this information give? How might this information be misleading?
 - What additional information would you need to determine whether travelling by plane or by car is safer?

Reflect

Think of 2 decisions that could be influenced by probabilities.
What assumptions would you be making about each probability?
How might the probabilities be different if the assumptions were not true?

Math Link

Your World

Probabilities are used in risk assessment. To compare the safety of certain sport utility vehicles (SUVs) and minivans, researchers subjected both to crash tests while the vehicles moved at 56 km/h. Here are the results:

Probability of:	SUV	Minivan
life threatening head injury	16%	2%
life threatening chest injury	20%	4%
life threatening leg injury	35%	1%



How might insurance companies use this information?
How might car manufacturers use this information?



Cube Master

How to Play

1. Choose a “dealer”. The dealer selects any 30 cubes. (For example, the dealer could choose 5 red cubes, 12 green cubes, and 13 blue cubes.)

No other player should know how many cubes of each colour were selected.

The dealer places the 30 cubes in a container.

2. Each player records a guess of how many cubes of each colour are in the container.

Players should not share these guesses.

3. The players take turns selecting one cube from the container, then returning the cube.

(The dealer makes sure the players cannot see what is in the container.)

Players note which colour was selected each time.

Stop after 10 cubes have been selected and returned.

4. Players now adjust their initial guesses by considering the colours of the cubes selected.

5. Repeat Steps 3 and 4 two more times.

6. Players compare their final estimates with the actual numbers of cubes to calculate their points.

The player with the fewest points wins.

You will need

- more than 30 cubes (blue, green, and red)
- a container for the cubes

Number of Players

- 4

Goal of the Game

- Use experimental probability and subjective judgment to estimate the numbers of coloured cubes in a container.

For example:

	Actual Number of Cubes	Player's Final Estimate	Number of Points (Difference between actual number and estimate)
Red	5	4	1
Green	12	11	1
Blue	13	15	2
Total Number of Points:			4

7. Repeat the game until everyone has had the opportunity to be the dealer.

Share your strategies with the other players.

Whose strategy worked best? Why?

9.2

Potential Problems with Collecting Data

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- Describe how the collection of data may be adversely affected.

Suppose your friend asks you, “Who do you think will win the Western Hockey League (WHL) playoffs?”

What might affect your answer to this question?



Investigate



Choose one person in the group to be the leader. The leader will read the questions below, while the others write down their answers. The leader should ask the questions exactly as they are written, without explanation.

1. How large is this textbook? (Point to this textbook when asking the question.)
2. Do you think students are working too much because of the large amount of homework assigned?
3. What is your favourite genre of music? Choose one from: Rock, Pop, Country

Share all the answers with the group. Did you interpret the questions the same way as your group? Why? Describe any problems with each question. Rewrite each question to avoid these problems.

Reflect & Share

Share your rewritten questions with another group. Discuss how the rewritten questions avoid potential problems. How might a poorly worded question affect data collection? What sort of wording should someone collecting data use? What sort of wording should that person avoid?

Connect

There are several factors that might lead to problems with data collection.

Potential Problem	What It Means	Example
Bias	The question influences responses in favour of, or against the topic of the data collection.	Suppose a person asks: <i>Don't you think the price of a movie ticket is too high?</i> This person has a bias against the current ticket price, and the bias influences how the survey question is written.
Use of Language	The use of language in a question could lead people to give a particular answer.	If you ask: <i>Don't you think the price of a movie ticket is too high?</i> , the question may lead people to answer yes. A better question would be: <i>Do you think the price of a movie ticket is too high, too low, or fair?</i>
Timing	<i>When</i> the data are collected could lead to particular results.	A survey is conducted to find opinions on the need for a vehicle to have winter tires. The results may be different if the survey is conducted in August instead of February.
Privacy	If the topic of the data collection is personal, a person may not want to participate or may give an untrue answer on purpose. Anonymous surveys may help.	People may not want to participate in a study on weight if it means stepping on a scale in front of other people.
Cultural Sensitivity	Cultural sensitivity means that you are aware of other cultures. You must avoid being offensive and asking questions that do not apply to that culture.	Suppose you wanted to know the favourite method of cooking ham, and you asked: <i>Please circle your favourite method:</i> <i>BBQ Bake Fry</i> This question does not apply to everyone because many people do not eat ham. A better question would be: <i>If you eat ham, name your favourite method of cooking it.</i>
Ethics	Ethics dictate that collected data must not be used for purposes other than those told to the participants. Otherwise, your actions are considered unethical.	Suppose you tell your classmates that you want to know their favourite snacks to help you plan your birthday party. If you then use the information to try to sell your classmates their favourite snacks between classes, your actions would be unethical.
Cost	The cost of collecting data must be taken into account.	If you need to pay for printing the questionnaires, or to pay people to collect the data, the cost may be more than you can afford.
Time	The time needed for collecting the data must be considered.	A survey that takes an hour to complete may be too long for most people. This would limit the number of people willing to participate.

Example 1 Identifying and Eliminating Potential Problems

For each survey question, explain why a problem may occur and the effect it would have on the results. Suggest how each problem could be avoided.

- a) A survey is conducted to find out if citizens think the local government should provide more money for youth activities. The question asked was: “Would you support an increase in taxes to create more skate parks?”
- b) A survey is conducted to find out the level of school spirit. Students are polled about their level of school spirit after the soccer team wins the championship.

▶ A Solution

- a) The use of language in the survey question could be problematic. The question emphasizes what citizens would lose; that is, their taxes would increase. The question also downplays what citizens would gain by only mentioning skate parks, instead of a variety of activities. Most people would probably respond by saying they would not support an increase in taxes to build more skate parks. A better question would be: “Do you think the local government should supply more funds for youth recreational activities?”
- b) The timing of the survey question could be problematic. Since the school’s soccer team just won the championship, the level of school spirit would be higher than usual. The results of the survey may show a higher level of school spirit than if the survey was conducted at another time. Asking students the same question a month later, when no school event is occurring, should produce more accurate results.

Example 2 Analyzing Data Collection for Problems

Kublu and Irniq plan to open a shop in Saskatoon that would sell traditional Inuit crafts. To ensure Saskatoon is the best place for their business, they want to survey residents to find out how popular Inuit crafts are. Kublu knows that they would get the most accurate results if each household in Saskatoon is surveyed, but Irniq points out that this is problematic. Explain why.



▶ **A Solution**

The number of households in Saskatoon is great. Kublu and Irniq may have problems related to cost and time.

The cost of printing and mailing enough surveys for each household would be very high. Also, Kublu and Irniq should provide an envelope and stamp for each household to return the survey. This would be an additional cost.

The time it would take to print, mail, and collect the surveys for all the households would be too long.

Example 3 Overcoming Potential Problems of Data Collection

Antonia wants to find out if there is a relationship between household income and how much people spent on Christmas presents.

Identify potential problems Antonia may encounter, and explain how she could deal with the problems.

▶ **A Solution**

Christmas is not celebrated by all cultures, and so the survey question does not apply to everyone. An appropriate opening question for the survey might be: “Do you celebrate Christmas?” If a person responds “No”, then he or she will not need to answer the other question in your survey.

Information about income and spending habits is personal, so people may be uncomfortable revealing it. An anonymous survey would be appropriate.

The use of language may influence responses.

Examples of inappropriate or intrusive questions would be:

“How much do you make?” and “How much do you spend?”

A better question might be:

“Is the amount you spend on Christmas presents:

- greater than your weekly income?
- less than your weekly income?
- equal to your weekly income?”

Discuss the ideas

1. How could the use of language affect the data collected?
Give an example.
2. Two factors that may influence data collection are *time* and *timing*.
What is the difference between these?

Practice

Check

3. Name a problem with each data collection.
 - a) After the first week of school, your principal asks you and your friends how you are enjoying school.
 - b) An online magazine asks readers either to agree or disagree with the statement: "If you find a \$20-bill, you turn it in."
 - c) Brenda asks her classmates if they think girls should not be allowed to cover their heads in school.
 - d) To discover the most popular kind of movie at his school, Carlos plans to ask each student what her or his favourite kind of movie is.

Apply

4. For each scenario in question 3:
 - a) Describe the effect each problem would have on the data collection.
 - b) How could each problem be overcome?
5. Parinder wanted to find out how often the computers in her school were being used. She asked students the question: "How much time do you spend on the computer each week?"
 - a) How do you think her schoolmates will interpret this question?
 - b) How could the question be rewritten so it would more accurately reflect what Parinder wants to know?
 - c) Who might be interested in her findings? Why?
6. Andrew went to each class in his school and asked for a show of hands to find out how many students had ever been bullied at school. Only 2 students raised their hands.

Andrew concluded that bullying was not a major problem at his school.

- a) Is this a reasonable conclusion? Explain.
 - b) Describe a better method for conducting Andrew's survey.
7. Trinity wants to find out how football fans feel about building a new indoor football stadium for a Canadian Football League team. She goes to the stadium to survey fans after a winning game on a warm August evening.
 - a) Describe how the timing of her question may influence the responses.
 - b) In what setting might the responses be different than those Trinity received?



8. a) Describe how each question reveals a bias of the questioner.
 - i) Do you think it is a good idea to use DNA tests to convict a violent criminal?
 - ii) Do you think gas guzzling SUVs should be banned?
 - iii) Do you think students should be allowed to use spell check because it automatically improves spelling?
- b) Rewrite each question to eliminate the bias. Explain how your question is an improvement.

9. Rebecca was looking for a cell phone service provider. She surveyed her friends and asked who their service providers were. Based on these data, she chose the provider that her friends used more than any other.
- Do you think Rebecca's question reflected what she wanted to know? Explain.
 - What questions might have helped Rebecca to make a more informed decision?



10. A fashion website is conducting a survey. Sasha answered questions about his favourite brands of clothing, then provided an email address as a login to the site in the future. Shortly after this, his inbox was full of emails advertising a new brand of clothing.
- Which important factor did the survey designers overlook? How is this problematic?
 - How can the survey designers avoid this problem?
11. Provide an example of data collection where the cost and time needed to complete the collection may lead to problems.

Reflect

Why is it important to identify and overcome sources of potential problems in data collection?

- Write 3 questions people would prefer to answer anonymously.
 - For each question, describe what the results might be if the participants were not anonymous.
13. **Assessment Focus** Bridget wants to find out how much the average grade 9 student spends on clothes each month.
- Identify potential problems she may encounter related to 3 of these factors: use of language, ethics, cost, time, timing, privacy, cultural sensitivity
 - For each potential problem in part a, explain how Bridget could avoid the problem.
14. a) Describe 2 possible data collections that might be problematic because of the time of year they are conducted.
- b) Suggest a better time that each should be conducted.

Take It Further

15. Common methods of surveying are by personal interviews, over the phone, or by email. Identify potential problems associated with each method of surveying.
16. a) Why might questions about Hanukkah be culturally sensitive?
- b) Think of 3 more topics that might be culturally sensitive. Explain why.
- c) Design a culturally sensitive survey question about one of the topics in part a or b. Explain how you would collect the data to address the cultural sensitivity.

9.3

Using Samples and Populations to Collect Data

FOCUS

- Select and defend the choice of using a population or a sample.



To estimate the number of salmon in a river, biologists use a strategy called *mark and recapture*. At one place in the river, biologists capture some fish. Each fish is marked with a tag, then released into the river. At a different place in the river, biologists recapture fish. They track the numbers of marked and unmarked fish caught. They can then estimate the salmon population.

Investigate



Each pair of students will need 50 small pieces of paper.

- Create a population of 50 fish by labelling each piece of paper with either “F” for female or “M” for male.
- Record the percents of female and male fish in your population.
- Fold the pieces of paper and place them in a box.

Trade populations with another pair of students.

- Choose a sample of 10 fish from the other pair’s population. Record the numbers of male and female fish in your sample. Use this to estimate the percents of male and female fish in the population.
- Repeat the preceding step by choosing samples of 20 fish, and then 40 fish.
- Did your estimates of the percents of male and female fish change as the sample size changed? Explain.

Reflect & Share

Compare your estimates with the actual percents recorded by the other pair of students. How did your estimates compare with the actual percents? In general, how did the estimates change as the size of the sample increased?

Connect

When collecting data, the **population** is the group about which you are getting information.

A **census** is conducted when data are collected from each member of the population. For example, suppose you test game consoles made in a factory for defects, then *all* the game consoles made in the factory are the population. If you test each game console, then you have conducted a census.

A census can be costly, time consuming, and difficult or impossible to complete. So, a census is only used when an issue is important or when the population is small.



If a census is not feasible or necessary then data are collected from a small portion, or **sample**, of the population. When the sample chosen is representative of the population, the data collection provides **valid conclusions**. For example, testing 100 game consoles out of 1000 made each day is a sample. If those consoles tested represent the typical quality of consoles made in the factory, the conclusions of the data collection will be valid.

Care must be taken when determining the appropriate size of the sample. If the sample is large, the data collection could be costly or time consuming. If the sample is small, then it may not be representative of the population.

Example 1 Explaining Why Data Are Collected from Populations

In each case, explain why a population was surveyed instead of a sample.

- To determine the average number of siblings of his classmates, Carlos surveyed each person in the class.
- Every 5 years, Statistics Canada conducts a census. One question in the survey is used to determine the ages of the people in each household.

▶ A Solution

- Carlos knows that surveying the entire population will produce exact results, rather than estimates. So, he chose to survey the entire population, the whole class, because it would not take long or cost him anything.
- A census was completed because of the importance of the question. The government requires data about the ages of Canadians so that it can budget for services such as day-care centres, schools, and senior citizens' homes.

Example 2 Reasoning Why and When Samples Should Be Used

The student leadership team is planning a school dance. To attract grade 9 students to the dance, the team decided to collect data about the preferred music of the grade 9 students. The team set up in the hallway to collect the data. By the end of the day it had surveyed 73% of the grade 9 students.

- Why do you think the data were collected from a sample instead of the entire population?
- Will the opinions of the sample likely reflect those of the population? Explain.

A Solution

- There was probably not enough time or people available to ask all grade 9 students. It would also require a lot of effort to find each grade 9 student, especially with absences.
- Since the majority of students, 73%, were asked, it is likely that their opinions will reflect those of the entire population.

Example 3 Identifying and Critiquing the Use of Samples

In each case, identify if data were collected from a sample or a population. Wherever a sample was used, explain if you think the conclusion would be valid.

- A province considers banning cell phones in all of its schools. To determine the opinions of students on this issue, you poll each student in your school.
- To determine which politician is expected to win the municipal election, every person over 18 and who is eligible to vote in the election is polled.
- To determine the average lifetime of a type of light bulb, 150 light bulbs were selected randomly from the production line and tested.



A Solution

- Sample:** The population is all students of all schools in the province. By asking only the students in your school, your results are based on a sample. If the students in your school do not represent typical students in the province, the conclusion will not be valid. For example, if all students in your school own cell phones, your conclusion would probably be not to ban cell phones. However, not every student in the province owns a cell phone. So, your results would not be representative of the population.
- Population:** All possible voters are polled.

- c) Sample: Since not all light bulbs were tested, the results are based on a sample. It would not make sense for the whole population to be tested, since all light bulbs would be destroyed in the process. There would be no light bulbs left to sell. Since a fairly large number of light bulbs were tested, the results will likely give a good estimate of the lifetime of a light bulb. So, the conclusion about the lifetime of a light bulb is likely valid.

Discuss the ideas

1. What factors do you need to consider when you collect data from either a population or a sample?
2. What does “valid conclusion” mean? Provide an example where the conclusion based on a sample is not valid.

Practice

Check

3. In each case, describe the population.
 - a) The management team of a shopping mall in Comox wants to know how to attract more people between the ages of 13 and 25 to the mall.
 - b) A juice company wants to determine the average volume of juice in a 1-L carton.
 - c) A board of education wants to find out which schools need renovations.
 - d) The government wants to determine the average age of First Nations people in Nunavut.
4. In each case, are the data collected from a census or a sample?
 - a) To determine the favourite TV show of grade 9 students in a school, all grade 9 students in the school are surveyed.
 - b) To find out if customers of a chain of coffee shops are happy with the service, some customers in every shop were surveyed.

Apply

5. Identify the population you would sample to find out opinions on:
 - a) bus fares
 - b) the GST
 - c) cost of day care
 - d) emergency room wait times
6. Courtney surveys her friends and finds that 68% of them have an MP3 player. She reports that 68% of the grade 9 students have an MP3 player. James surveys the entire grade 9 population and discovers that 51% have an MP3 player.
 - a) Whose conclusion is more likely to be valid? Explain.
 - b) Why might the other student’s conclusion not be valid?



7. For each situation, explain why data are collected from a sample and not a census.
- to determine the number of hours an AAA battery will last in a calculator
 - to determine the number of First Nations children in Canada who speak Cree



8. Should a census or sample be used to collect data about each topic? Explain your choice.
- the effectiveness of a new suntan lotion
 - the popularity of a fruit-flavoured yogurt
 - the number of grade 9 students in your school with braces
 - the number of your friends who like to play computer games
9. In each case, do you think the conclusion is valid? Justify your answers.
- Irina surveyed 20 students to find out if they eat breakfast. All the students said yes. Irina concluded that everyone in the school eats breakfast.
 - To test for pesticide pollution, a scientist collects and tests one vial of water from a river. From the results, a local newspaper reporter concludes that there are dangerous levels of pesticide in the river.

10. **Assessment Focus** Suppose you are the manager of a high school cafeteria. You want to create a new breakfast and lunch menu for the students.
- What population are you interested in surveying?
 - Would you survey a sample or population? Explain.
 - If you had to use a sample, what would you do to make sure your conclusions are valid?
11. In each case, provide an example and justify your choice.
- Collecting data from a population, rather than a sample, is more appropriate.
 - Collecting data from a sample, rather than the entire population, is more appropriate.

Take It Further

12. a) Describe a situation where a sample:
- represents a population
 - does not represent a population
- b) What changes would you make to the sample in part ii so that the conclusions would be valid?
13. Every 5 years, the *Census of Agriculture* is sent to every farm household across Canada. This census collects data on topics such as crop area, livestock, farm labour, machinery, and expenses. Choose one of these topics. Explain why you think it is important enough for the government to conduct a census.

Reflect

Describe when to use a census and when to use a sample.

Using *Census at School*



FOCUS

- Search a Canadian database for information, then make comparisons.

Statistics Canada is a government agency that collects data on Canadian citizens. *Census at School* is an international online project that engages students from grades 4 to 12 in statistical enquiry. Data on students from 8 to 18 years old can be found at the *Census at School* website.

You can use *Census at School* to find data about Canadian youth under headings such as:

- What is your favourite subject?
- How much pressure do you feel because of schoolwork?
- What is your favourite physical activity?

There is a link to data from other participating countries such as South Africa and New Zealand.

To use *Census at School*, follow these steps:

1. Open the website. Your teacher will give you the address. Select the appropriate language.
2. You will see the *Census at School* homepage. Click on *Data and results* located in the table on the left of the screen.

The screenshot shows the homepage of the *Census at School* website. At the top, there are logos for Statistics Canada and Statistique Canada, along with the Canadian flag and the word 'Canada'. Below this is a navigation bar with links for 'Français', 'Home', 'Contact Us', 'Help', 'Search', and 'canada.gc.ca'. The main content area is titled 'Welcome to *Census at School* - Canada!' and includes a brief description of the project, a 'What teachers are saying...' section with a 'Click here' link, and information about the 2007-2008 survey results and the start date of the 2008-2009 survey. On the left side, there is a 'Census at School' menu with links for 'What's new', 'Teachers', 'Students', 'Parents', 'Survey questions', 'Data and results', 'Learning activities', 'StatCan Learning Resources', 'Census of Canada', 'Privacy', and 'International project'. On the right side, there is an 'Additional information' box with links for 'Frequently Asked Questions', 'About us', 'Related sites', 'StatCan Learning Resources', and 'Resources'. At the bottom of the page, there is a footer with the date 'Date Modified: 2008-09-04', a 'Top of Page' link, and an 'Important Notices' link.

3. Under *Canadian summary results*, you can access data collected over the past several years. Select the latest summary results.

Canadian summary results

Student responses from across the country are collected throughout the school year and analysed during the summer. Then summary data tables are published in the fall.

- [Summary results 2007/2008](#) (including provinces and territories)
- [Summary results 2006/2007](#) (including provinces and territories)
- [Summary results for 2005/2006](#) (including provinces and territories)
 - [Highlights: What kids said in the last survey](#)
- [Summary results for 2004/2005](#) (including provinces and territories)
- [Summary results for 2003/2004](#)

Note: These results can be viewed by provinces and territories by selecting the *Provinces and territories* link at the top of the page.

Canadian summary results for 2007/2008

- [Canada](#)
- [Provinces and territories](#)

4. Use the site to answer these questions.
- a) What is the most popular mode of transportation to school for Canadian youth? Is this the most popular mode of transportation for each province or territory? Explain.
 - b) What are the two most popular methods of communication for Canadian students?
 - c) Which type of charity would most students support if they had \$1000 to donate?
 - d) What percent of students have been bullied 10 times or more in the last month in Manitoba?
5. To find data from other countries, click on the *International project* link on the left of the screen. Next, click on the *CensusAtSchool* link. Then on the next screen click on the link provided.

6. Select the United Kingdom (UK). Click on the link to *Results and Data*. Then, select the *Phase 7 Results* link. What do 14-year-olds feel is the most important issue facing the UK today?



Results and Data

- See the data presented in a variety of formats, eg tables, spreadsheets, graphs.
- Get a **RANDOM SAMPLE** of the raw census data.
- Access all the different **Questionnaires** including language versions.

Check

Return to the data for Canadian youth.

1. Select a topic that interests you, and report on your findings.
2. How many elementary and secondary students have participated in Canada's *Census at School*? Do you think this sample would produce valid conclusions? Explain.

Mid-Unit Review

- 9.1** 1. Before a security company hires someone, that person must pass a lie-detector test. Suppose that a lie detector has a 0.9 probability of identifying a lie. A person being tested thinks that if he lies 10 times, 9 of those lies will be detected.
- Name one assumption the person is making.
 - Explain how the predicted outcome might change if the assumption changes.



2. Due to global warming, the West Antarctic Ice Sheet (WAIS) could melt and raise sea levels. Some scientists think there is a 1 in 20 chance that WAIS will collapse in the next 200 years. Explain how this statistic could be used to support opposing positions about the effects of global warming.

- 9.2** 3. Ca Bol surveys a group of people to find out how they feel about students listening to music while studying.
- Write a question Ca Bol could use to influence:
 - the responses in favour of students listening to music while studying
 - the responses to oppose students listening to music while studying
 - Write a question that does not show a bias. Explain how this question is more suitable than the questions in part a.

- Suppose your teacher conducts a survey in class about student smoking.
 - What problems might arise?
 - How would these problems affect the data collected?
- Ahmed wanted to find out if a person's years of post-secondary education is related to how much the person earns.
 - Describe problems Ahmed might have to overcome related to:
 - privacy
 - cultural sensitivity
 - use of language
 - cost and time
 - Describe the effect each problem may have on Ahmed's results.
- Describe a situation where the timing of a question may influence the responses.
- Which students in your school would you survey for their opinions on each topic?
 - the quality of cafeteria service
 - the cost of a gym uniform
 - the number of student parking spaces
 - the school spirit at football games
- For each situation, explain why data were not collected by a census.
 - the number of Canadian families with internet access
 - the average cost of DVD players
 - the average mass of a Northern pike in Misaw Lake, Saskatchewan
- For each topic, would you collect data using a census or a sample? Justify your choice.
 - to determine the average height of a grade 9 student in your class
 - to determine the reaction to new traffic laws in your province or territory

9.4

Selecting a Sample

FOCUS

- Understand and choose an appropriate sample.

When we cannot survey an entire population, we choose a sample from the population.

When a political party wants to determine if its candidate is likely to win the next territorial election, it may conduct a telephone survey of a sample of voters. How could the party ensure that the sample is representative of the population?



Investigate



Suppose a school considers making the cafeteria food more healthy. The school would like you to determine the reactions of the school population.

List 3 ways you could select the sample of people to be questioned.

Discuss and record the advantages and disadvantages of each way.

Choose the most appropriate way of selecting your sample.

Reflect & Share

Share your 3 ways of selecting a sample with another pair of students.

Did you come up with any of the same ways?

Which ways had similar advantages and disadvantages?

Discuss and select the best way from all the possibilities.

Justify your choice.

Connect

Here are some common sampling methods:

Simple random sampling

Each member of the population has an equal chance of being selected.

For example, to select a random sample of 5 students from your math class, each student is assigned a number and 5 numbers are drawn from a hat.

Systematic or interval sampling

Every n th member of the population is selected.

This method is often used in manufacturing; for example, every 20th product in an assembly line is tested for quality. If the item is destroyed or unusable after being sampled, then the sample is a *destructive sample*.



Cluster sampling

Every member of each randomly chosen group of the population is selected.

For example, each grade represents a group of the school population. One grade in your school is chosen randomly, and all students in that grade are selected.

Self-selected sampling

Only members who are interested and volunteer will participate.

For example, if a radio station conducts a telephone survey, only people who are interested will call.



Convenience sampling

Only members of the population who are convenient to include are selected.

For example, for a survey about grocery shopping habits, people in a grocery store are approached and questioned.

Stratified random sampling

Some members from each group of the population are randomly selected.

For example, 5 randomly chosen students from each grade in a school could be selected, even if each grade has a different number of students.

Example 1 Identifying Appropriate Samples

The student leadership team wants to find out if students would like the cafeteria to have longer hours. Several sampling methods were suggested. Explain whether each sample is appropriate.

- Every student's name is put into a box, and 100 names are selected randomly to be surveyed.
- Every 5th person entering the school is selected.
- Each person on the leadership team asks her or his friends.
- An announcement is made asking anyone who wishes to participate to fill in a ballot.

A Solution

Sampling Method	Is the Sample Appropriate?
a) Simple random sampling	The sample is appropriate because every student has an equal chance of being selected.
b) Systematic sampling	The sample may or may not be appropriate depending on when you ask students. If you ask students who arrive early in the morning, then these students may appreciate the cafeteria having longer hours. The opinions of these students would likely not be representative of the entire student population.
c) Convenience sampling	The sample is likely not appropriate because friends often have similar views on issues.
d) Self-selected sampling	The sample is likely not appropriate because only students who have strong opinions about this topic may respond.

Example 2 Choosing Appropriate Samples

A company packages boxes of granola bars. The quality-control manager inspects the first 5 boxes each morning to ensure that each has the same number and types of granola bars.

- Is this a good way of ensuring quality control? Explain.
- Suggest 2 other methods of sampling that would be appropriate. Explain why each is appropriate.

A Solution

- This may not be a good way of ensuring quality control because the people working on the assembly line may be more alert in the morning. So, the boxes filled in the mornings may pass inspection. However, the boxes made later in the day, which may not meet the manager's standards, are never inspected.
- Systematic sampling would allow the manager to inspect several boxes throughout the day. For example, each 50th box could be inspected. Simple random sampling throughout the day would also be appropriate because it ensures each box has an equal chance of being selected.

Discuss the ideas

1. Which sampling methods are least likely to produce valid conclusions? Explain.
2. Which sampling methods are most likely to produce valid conclusions? Explain.

Practice

Check

3. Identify a potential problem with each sampling method.
 - a) Suppose you want to know whether most people enjoy shopping. You survey the shoppers at a local mall.
 - b) The cook in the school cafeteria surveys the teachers to find out which items to sell.
 - c) To determine public opinion on the effectiveness of the local police force, residents in the area with the greatest crime rate are surveyed.
 - d) To find out about the exercise habits of Canadian teenagers, a fitness magazine asks its readers to email information about their exercise habits.

Apply

4. Explain whether each sample is appropriate. Justify your answer.
 - a) A TV show asks viewers to text their opinions about the decreased speed limit in town.
 - b) To determine if customers are pleased with the service in a restaurant, every 8th customer is polled on a given day.
 - c) Fifty student ID numbers were randomly selected by a computer. The students with these ID numbers were surveyed about a new school policy.
 - d) Ten students were randomly selected from each grade to estimate how many students in the school cycle to school.

- e) To determine if all physical education students would prefer to go skiing or skating on a field trip, one gym class was randomly selected from a list and each student in the class was polled.
5. a) In each case, will the selected sample represent the population? Explain.
 - i) To find out if the arena should offer more public skating times, a survey is posted on a bulletin board in the arena and left for patrons to complete.
 - ii) To find out the favourite breakfast food of grade 9 students, a survey of 300 randomly-selected grade 9 students was conducted.
 - iii) To find out if the soccer league should buy new uniforms for the players, 20 parents of the students in the soccer league were surveyed.
 - b) If the sample does not represent the population, suggest another sample that would. Describe how you would select that sample.
6. Describe an appropriate sampling method for each situation. Justify your answers.
 - a) The Prime Minister wants to know citizens' opinions about the new budget.
 - b) The school newspaper wants to poll students to predict who will be elected student president.

7. To determine citizens' view of new parking fines, the mayor invites listeners to call in during a radio show. Do you think the results will accurately reflect the opinions of all citizens? Explain.

8. **Assessment Focus** Suppose you want to find out how people feel about lowering the age at which teens can drive.

- Describe a sampling method that would not lead to valid conclusions. Justify your choice.
- Describe a sampling method you might use, and justify your choice.



9. For each topic, identify a sample of people whose opinions would bias the survey results. Explain your choice.

- whether fur from animals should be used for coats
- whether households should be fined for not recycling

10. A survey reports: Fifty Canadians say that the most important issue Canadians face is global warming.

- Do you think this sample is representative of the population? Explain.
- How might this sample have been selected?

c) Suppose you were to repeat the survey. How would you select a sample? Explain how your choice of sample would represent the population.



Take It Further

11. Some sampling methods produce invalid conclusions more often than they produce valid conclusions. Which sampling methods do you think fit this description? Why do you think these sampling methods are still used?

12. a) Explain how you might obtain each sample.

- a simple random sample from the school population
- a systematic sample of cell phones from a factory
- a cluster sample of teenagers from your town
- a stratified random sample of apple trees in an orchard

b) Suggest a topic of data collection for each sample in part a.

Reflect

When you select a sample to represent a population, what factors must you consider?



Using Spreadsheets and Graphs to Display Data

You can use a graph to display your data in a way that is clear and easy to understand.

Spreadsheet software can be used to record and graph data.

FOCUS

- Display data on graphs using spreadsheets.

These data come from the *Census at School* website:

Which method do you use most often to communicate with friends?

Method of communication	Girls	Boys	All students
	%		
Internet chat or MSN	36.11	35.26	35.7
In person	30.02	35.51	32.65
Telephone (land line)	15.61	13.5	14.6
Cell phone	8.91	7.66	8.31
Text messaging	6.59	3.77	5.23
E-mail	1.73	2.20	1.96
Other	1.03	2.11	1.55

Notes: Secondary students only.

Methods of communication appear in order of frequency for all students.

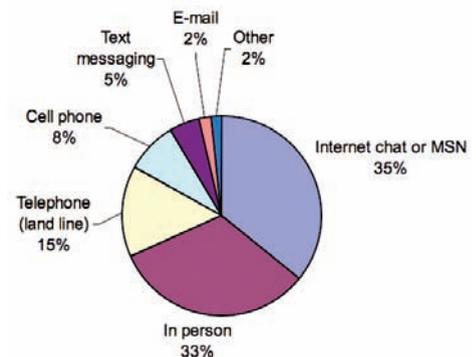
Source: Statistics Canada, Census at School, 2006/2007.

1. Enter the *Method of communication* and the percent of *All students* into columns and rows.
2. Highlight the data including the column heads. Click the graph/chart icon. Select the circle graph, which is sometimes called a pie chart. Label the graph and all sectors of the circle.

Your graph might look like this:

Method of communication	All students
Internet chat or MSN	35.7
In person	32.65
Telephone (land line)	14.6
Cell phone	8.31
Text messaging	5.23
E-mail	1.96
Other	1.55

Method of communication - All students



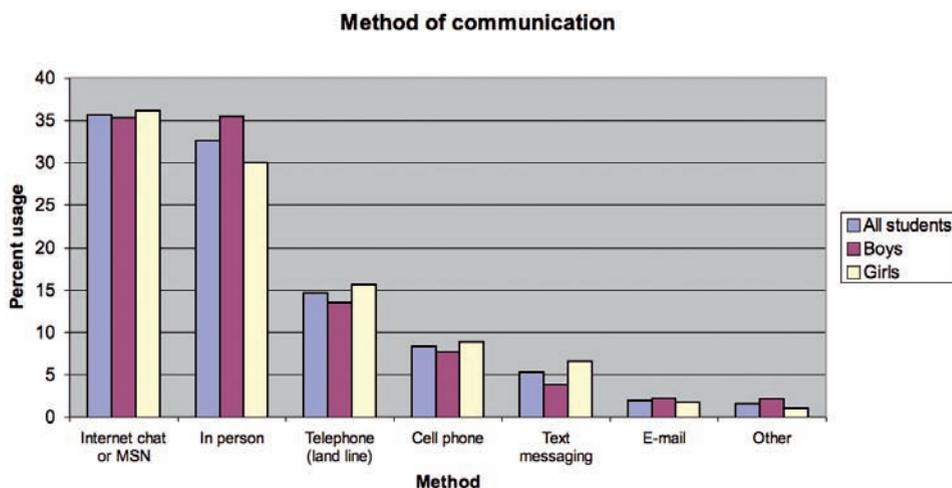
3. You can also display the data using a bar graph. Create a *Vertical bar graph*, sometimes called a *Column graph* for the data. Label the graph and axes. Experiment with the scale of each axis to most clearly display the data.

4. To display the data for *Boys*, *Girls*, and *All students*, you can make a multiple bar graph.

Enter the data for *Boys* and *Girls* into the next two columns of the spreadsheet. Now highlight all the data and create a bar graph.

Your finished graph might look like this:

Method of communication	All students	Boys	Girls
Internet chat or MSN	35.7	35.26	36.11
In person	32.65	35.51	30.02
Telephone (land line)	14.6	13.5	15.61
Cell phone	8.31	7.66	8.91
Text messaging	5.23	3.77	6.59
E-mail	1.96	2.2	1.73
Other	1.55	2.11	1.03



Check

1. List one advantage and one disadvantage of displaying data using each type of graph above.
2. These data are from *Census at School*:

How long does it usually take you to travel to school?

Minutes	Elementary	Secondary
	%	
Less than 10	38.36	18.96
10 to 19	31.83	31.92
20 to 29	12.55	17.96
30 to 44	10.65	16.83
45 to 59	4.16	7.71
60 or more	2.44	6.61

Source: Statistics Canada, Census at School, 2006/2007.

Use an appropriate graph to display the results for all students. Justify your choice of graph.



How Can I Assess My Work?

I can design a **rubric**. A rubric helps me to see how well I understood the task and how good I am at communicating what I know. It lists the content and quality needed for a task; these are called the *criteria* of the task.

My first step to create a rubric is to determine the criteria of the task. Suppose I have to write an article for my school newspaper.

The criteria I would look for in the article are:

- Accurate information
- Well organized
- An eye-catching title
- Correct spelling and grammar

I then assess each criterion using one of 4 *levels of achievement*:

- Not yet adequate
- Adequate
- Proficient
- Excellent



I create a grid:

	Not yet adequate	Adequate	Proficient	Excellent
Accurate information				
Correct spelling and grammar				
Well organized				
Eye-catching title				



I then include what I think needs to be done to achieve each level.

	Not yet adequate	Adequate	Proficient	Excellent
Accurate information	uses few facts that are not enough to explain the topic (1-2 facts)	uses some facts to explain the topic (3-4 facts)	uses most of the available facts to explain the topic (5-7 facts)	uses all the available facts to explain the topic (8 facts)
Correct spelling and grammar		has some spelling and grammatical errors (4-6 errors)	has few spelling and grammatical errors (1-3 errors)	has no spelling or grammatical errors (0 errors)
Well organized	ideas are not in an order that makes sense	ideas are partly in an order that makes sense		all ideas are in an order that makes sense
Eye-catching title	attempts to write a title, but it is not clear and will not attract readers	writes a title that is clear, but may not attract many readers	writes a title that is clear and effective at attracting many readers	writes a title that is very clear and is outstanding at attracting all readers

Check

1. What descriptions might go in the grey areas?

Apply

2. a) Create a rubric to evaluate your day at school. Use the criteria below.

	Not yet adequate	Adequate	Proficient	Excellent
Homework was done				
On time for classes				
Paid attention				
Helped others				

- b) Trade rubrics with a classmate. Suggest how to improve your classmate's rubric.

FOCUS

- Develop a project plan for data collection.

Have you been stopped in the shopping mall by a person with a clipboard and been asked to answer questions for a survey? Have you ever answered the telephone at home in the evening and been asked if you would take part in a survey? Or, have you completed an online survey? If so, what types of questions were you asked?

**Investigate**

Suppose your school board would like to know if there is a relation between the number of hours a student works at a part-time job and her or his academic success. Design a plan that the school board could follow to collect the data.

Reflect & Share

Share your plan with that of another group. How are your plans similar? How are your plans different? Do your plans avoid potential problems? Explain. If not, make adjustments to your plan.

Connect

Here are 5 possible steps to consider when you design a plan for data collection:

- 1. Prepare a question.** The wording should avoid biases, and be culturally sensitive. If the survey question is personal, the participants should be anonymous.
- 2. Identify the population, and possibly choose a sample.** If you select a sample, ensure it represents the population. Consider the time and cost involved in collecting data from your population or sample.
- 3. Collect the data.** Consider the timing of your data collection: does it avoid potential problems?
- 4. Analyze and display the data.** Choose an appropriate display for the data, such as a table, circle graph, bar graph, or line graph.
- 5. Design a rubric.** This should help you evaluate the important components of your project.

Example

Designing a Project Plan

Suppose a frozen yogurt company considers adding a new flavour to its menu. Decide how to conduct a survey to determine whether the new flavour should be added to the menu.

▶ A Solution

Follow the steps:

1. The survey question might be:

Rate the taste of this new flavour of frozen yogurt on a scale of 1 to 5.

1 2 3 4 5
Strongly Dislike Dislike No Opinion Like Strongly Like

2. The population is all people who eat frozen yogurt and may purchase it from this company. A sample of the population might be every 10th customer who comes into a store one day from when it opens to when it closes.
3. To collect the data, the company must have a server who offers every 10th customer a free sample, poses the survey question, and records the responses.
4. To analyze the data, determine the number of people who chose each rating. This can be displayed on a circle graph. Then calculate the mean rating.
5. Evaluate the process you followed to determine if the data are valid and that you have accounted for all possible biases.

Discuss

the ideas

1. Why is it important to plan before you collect data?
2. How can a rubric help you reflect on your plan?

Practice

In this lesson, you will prepare a project plan for your data collection. In the Unit Problem, you will carry out the data collection, analyze and display your results, then draw conclusions.

Developing a Project Plan

3. a) Choose a topic that interests you.
Prepare a question you want to answer about that topic.
 - b) Explain how the wording of your question avoids bias.
 - c) Is your topic a sensitive one for different cultures? If so, how will you deal with this?
 - d) Test your question on a classmate. Make any necessary changes.

4. a) Describe the population for your data collection.
 - b) Will you collect data from the population or a sample? If you work with a sample, how will you select the sample to ensure it represents the population?
 - c) Explain how your choice of population or sample takes into account the time and cost of the project.
5. Explain how you will collect the data. As part of your answer, discuss:
- how the timing of your data collection will not cause a problem
 - any privacy considerations
6. How might you display your data? Justify your choice.

Creating a Rubric for Your Project

7. Create a rubric for your project. In the Unit Problem, you will collect the data and present your findings. Your rubric must assess the following criteria:
- the survey question
 - the choice of sample or population

- how the data were collected
 - the display of your data
 - the conclusions you made
 - your presentation
- Your rubric should have 4 levels of achievement.

Assessing Your Plan

8. a) Trade project plans with a classmate. Look for potential problems in your classmate's plan. Suggest ways of improving the plan.
- b) Incorporate your classmate's comments into your plan.

Reflecting on Your Plan

9. People often make predictions about the results of their data collection. Sometimes these predictions are based on data from the past or personal experience. Make a prediction about your results. Explain why you think it might be true.
10. Why is this topic of interest to you? Who else might be interested in the results?

Reflect

Which step in developing your plan did you find most challenging? Explain.

Math Link

Your World

Every five years, Statistics Canada completes a census by collecting data from every household in Canada. Statistics Canada also requires one in five households to provide more detailed information about themselves. These data are used to help us better understand our country, including its natural resources, educational needs, and the economic situations of people living in various regions. Since the same or similar questions are asked every 5 years, the data can show what changes have taken place in our population over time.

Study Guide

Probability

- ▶ Probability is the likelihood an event will occur. For example, a weather forecast says that the probability of rain is 60%. This assumes that the predicted weather conditions do not change. If they do change, then the likelihood of rain may also change.
- ▶ Decisions based on probabilities may be a combination of theoretical probability, experimental probability, and subjective judgment. People may make different decisions based on one probability. For example, one person may consider a 60% probability of rain as being too high, and cancel a planned outdoor event. Another person may say that a 40% probability it will not rain is good enough to proceed with the event.



Collecting data

- ▶ Problems may arise if a person does not consider:
 - bias
 - use of language
 - ethics
 - cost and time
 - timing
 - privacy
 - cultural sensitivity
- ▶ The population is the group from which you are getting information.
- ▶ When a census is conducted, data are collected from the entire population.
- ▶ When data are collected from only part of the population, a *sample* is used. This sample must be representative of the population.
- ▶ Valid conclusions are obtained when the sample results represent those of the population.

Review

- 9.1** 1. Two weeks before a municipal election, a survey produced these data about voters' preferences for a new mayor.

Preference for Mayor	Number of Votes
Vivian Rogers	19
Fred Yao	11
Mustafa Abaz	34
Undecided	6

- a) Based on these data, predict which candidate will win.
- b) What assumptions are you making? For each assumption, explain what would happen if the assumption changes.
2. A volleyball team has won all 5 games it played this season. Darrell thinks that the team will lose its next game because he believes their winning streak cannot last. The players on the team believe that the team has a 100% chance of winning the next game. Explain how probability and subjective judgment may be influencing these opinions.
3. A local hospital is raising money by selling lottery tickets. The chances of winning are advertised as 1 in 3. Explain how someone can use this probability to support:
- purchasing a ticket
 - not purchasing a ticket
4. Find an example where statistics are used in an advertisement to try to convince consumers that one product is better than another. Suppose the statistic is true. What assumptions are you making about how the data were collected?

- 9.2** 5. a) In each case, identify any problems.
- To determine people's reactions to a possible increase in minimum wage, a student asked: "Don't you agree that minimum wage should increase?"
 - For a class project, a student needed to determine if college students were maintaining healthy weights. After the student completed the project, she gave a weight loss company the addresses of any overweight participants.
 - To test the safety of its deluxe car model, a company subjects many cars to different crash tests.
 - To determine if residents would support the construction of a community outdoor pool, you survey residents by going door-to-door in November.
- b) Describe the effect each problem might have on the results of the data collection.
6. Adila wants to know which digital camera is the best buy.
- What do you think "best buy" means? Design a question that will give Adila the information she wants.
 - Explain how your question avoids bias.
7. For a school project, Raheem wants to find out if there is an increase in teen pregnancy in Canada. Describe the effect of problems Raheem might encounter related to:
- privacy
 - cultural sensitivity
 - use of language
8. a) Provide an example of a question that could lead to problems because participants are only allowed to choose from 3 possible answers.
- b) Reword the question to avoid the potential problems.

9. Provide an example of data you might want to collect, but where the cost and time involved might be problematic.

- 9.3** 10. As an operator of a skydiving school, would you suggest a census or a sample when inspecting parachutes for excess wear? Explain.



11. Leah wants to test the lifespan of different brands of batteries.
- List reasons why Leah would use a sample for her data collection.
 - Suggest how she might choose her sample to ensure it represents the population.
12. a) Explain why a sample might be used in each survey.
- You wish to find out the most popular sport for teens your age.
 - You wish to find out the most popular Internet provider in your area.
- b) Provide an example when a census would be more appropriate for collecting data than a sample.

- 9.4** 13. A TV show surveys viewers to determine the popularity of its singers. At the end of each show, viewers cast votes for their favourite singers by calling in at \$0.75 per call. Do you think the opinions of the sample will reflect those of the population? Explain.

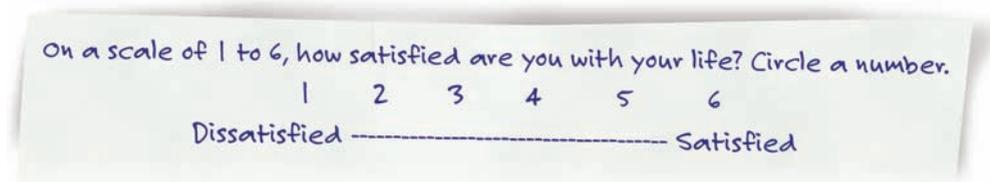
14. Discuss whether each sampling method should lead to valid conclusions.
- A car company subjects every 200th vehicle it manufactures to crash tests.
 - Six students from each grade are selected randomly to complete a survey about which extracurricular activities the school should offer.
 - A juice company sets up a booth in a local mall and allows anyone who wishes to participate in a taste test.
15. Describe an appropriate sampling method for each case. Justify your choice.
- to predict which political party will win the next election
 - to determine which brand of tennis racket is preferred



- 9.5** 16. Adam wants to find out what brand of chewing gum is recommended by most dentists.
- Write an appropriate survey question Adam could use.
 - Choose an appropriate sample. Explain your choice.
 - Explain how Adam could collect the data and display the results.
 - Explain how Adam could express his results as a probability.

Practice Test

1. A coin is tossed 5 times and each time it lands heads up. The coin is to be tossed again. Shawnie says the coin will land heads up. Owen says the coin will land tails up. Jovana says the coin is equally likely to land heads up as tails up. How might these students have made their predictions?
2. Hannah's hockey team won its last 7 out of 8 games. Hannah calculates that the team's probability of winning the next game is $\frac{7}{8} = 0.875$.
 - a) What assumptions is Hannah making?
 - b) For each assumption, explain how the predicted outcome might be affected if the assumption changes.
3. Manroop wants to survey Canadians to determine how happy or depressed they are.
 - a) Describe how the timing of Manroop's survey may influence her results.
 - b) Explain how privacy may be a factor in this survey.
What should Manroop do to ensure the privacy of the participants?
 - c) Manroop designs the following question:



What problems might Manroop encounter with this question?
What effects would those problems have on her data?

4. Provide an example of a situation where:
 - a) collecting data from a sample is more appropriate than a census
 - b) a sample may not result in the same conclusions as a censusJustify each example.
5. For each case, explain how you would select a sample.
 - a) to test the water quality in your school
 - b) to determine the most popular brand of toothpaste used by students at your school
 - c) to measure the average mass of backpacks of students at your school
6. Emile starts a petition to ask the municipal government to allow all stores to open at 9 A.M. on Sunday morning. What problems might he encounter as he solicits signatures? Describe the effect each problem would have on his results.

Unit Problem

What Can You Discover about the World around You?

You will collect data for the project plan you designed in Lesson 9.5. You will then present your findings and assess your work.

Part 1 Collect and Analyze the Data

- Collect the data from your chosen population or sample.
- Organize the data. Consider using a spreadsheet.
- Make an appropriate graph to display your data.
- Analyze your results. What conclusions can you make?

Part 2 Assess Your Data

Use the rubric you made to assess your data collection and make any necessary changes.

Part 3 Present Your Findings

In your presentation, make sure you answer these questions:

- Why did you choose your topic?
- What considerations did you make when writing your question?
- What considerations did you make when selecting the population or sample?
If you chose a sample, how did you try to ensure the conclusions would be valid?
- Why did you choose to display the data in the way you did?
- What conclusions can be made from the data?
- Are you surprised by the results? Explain.
- Who might be interested in your data and why?
- If you were to repeat the project, what steps would you take to improve it? Explain.

Part 4 Assess Your Presentation

Use the rubric to assess your presentation.

Your work should include:

- a project plan from Lesson 9.5
- answers to the presentation questions
- the display of your data and your conclusions
- a rubric used for self-assessment



Reflect

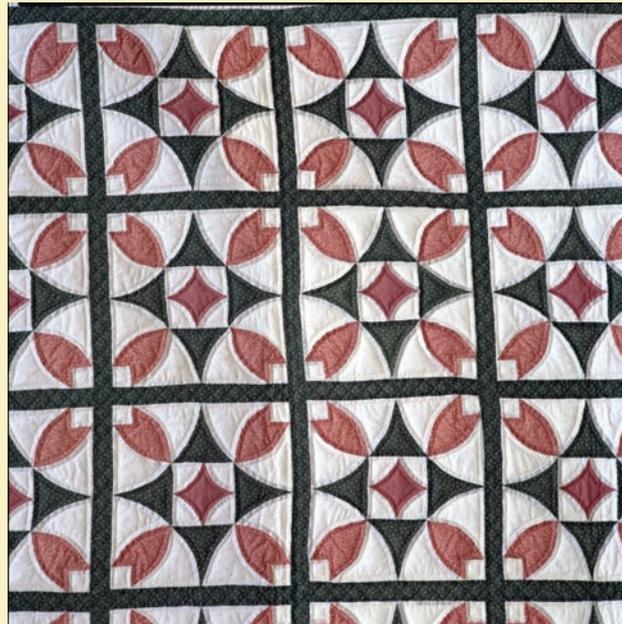
on Your Learning

What are the most important considerations when collecting data? Why? What are the most important questions to ask about probabilities published in the media? Explain.

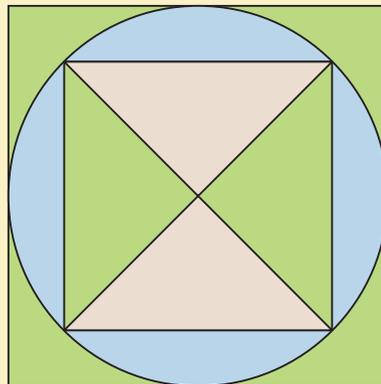
Materials

- ruler
- compass
- pencil crayons or markers
- construction paper
- tape
- dynamic geometry software (optional)

A quilt consists of small blocks that tessellate.



Part 1



The larger shape in this quilt block is a square with side length 15 cm.

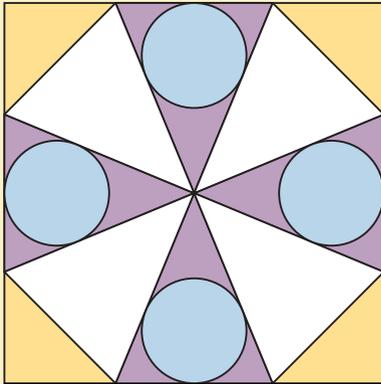
Within the square there is a circle and within this circle there is a smaller square.

- What is the side length of the smaller square?
- Describe the triangles in the block.

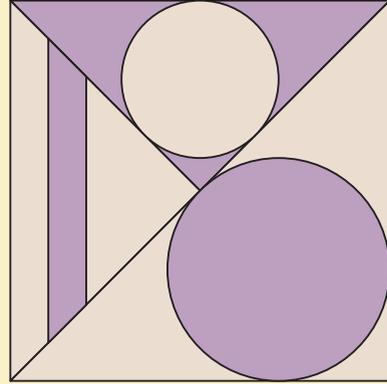
Part 2

Look at these quilt blocks. What shapes do you see?

Block A



Block B



Part 3

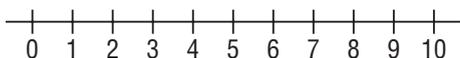
Design a square block with side length 15 cm that will be repeated 3 times to form a square with side length 30 cm. Use circles as part of your design. With your four 15-cm blocks, create as many different 30-cm blocks as you can. Describe the symmetries in each 30-cm block.

Take It Further

Choose a shape other than a square.
Create a block that will tessellate to form a quilt.



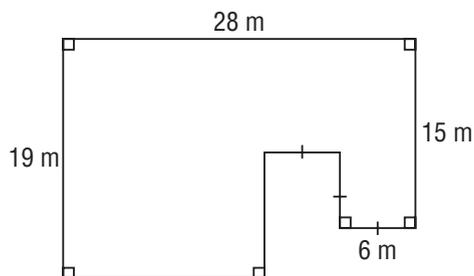
- 1** 1. Sketch this number line.



Do *not* use a calculator. Determine or estimate each square root. Where necessary, write the square root to the nearest tenth. Place each square root on the number line.

- a) $\sqrt{0.64}$ b) $\sqrt{\frac{36}{25}}$ c) $\sqrt{79.7}$ d) $\sqrt{4.41}$
 e) $\sqrt{\frac{100}{9}}$ f) $\sqrt{\frac{89}{90}}$ g) $\sqrt{30.25}$ h) $\sqrt{\frac{17}{4}}$

- 2.** Here is a floor plan for a building that is 5 m tall. It has a flat roof. What is the surface area of the building, including its roof, but excluding its floor?



- 2** 3. A student answered the following skill-testing question to try to win a prize:

$$(-4)^3 - (-2)^4 \div 2^2 + 5^2 \times 7^0$$

The student's answer was 5. Did the student win the prize? Show your work.

- 4.** Express as a single power, then evaluate.

$$\left(\frac{6^7 \times 6^3}{6^5 \times 6^2}\right)^2$$

- 3** 5. During the month of July, Bruce earned \$225 cutting lawns and \$89.25 weeding flower beds. He spent \$223.94 on an MP3 player and purchased 3 DVDs at \$22.39 each.

- a) Write each amount as a rational number. Justify your choice of sign for each number.
 b) Write an addition statement for Bruce's balance at the end of July.
 c) What is Bruce's balance?

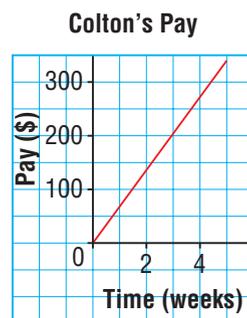
- 6.** Use a calculator. Evaluate to the nearest hundredth.

$$\frac{-17.8 - (-9.6) \div 1.2 + 31.4}{7.6 \times (-4.1) - 2.9}$$

- 4** 7. Marcie is rowing at an average speed of 3 m/s. She travels a distance d metres in t seconds.

- a) Create a table of values for this relation.
 b) Graph the data. Will you join the points on the graph? Explain.
 c) Is the relation linear? How do you know?
 d) Write an equation that relates d to t .
 e) How far does Marcie row in 15 s?
 f) How long does it take Marcie to travel 1 km?

- 8.** Colton works for 8 h each week at a sporting goods store. This graph shows how his pay in dollars relates to the number of weeks he works.



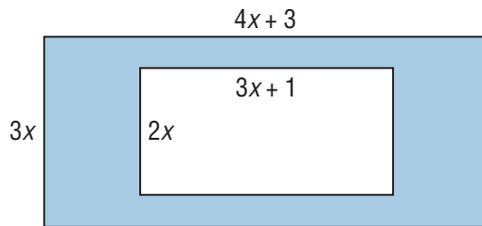
- a) Estimate how much Colton earns after 2 weeks.

- b) Estimate how long it will take Colton to earn \$1000. What assumptions do you make?
- c) What conditions could change that would make this graph no longer valid?

5 **9.** The difference of two polynomials is $4n^2 - 2n + 5$. One polynomial is $-6n^2 - 7n + 8$.

- a) What is the other polynomial? Show your work.
- b) Why are there two possible answers to part a)?

10. This diagram shows one rectangle inside another.



- a) Determine the area of the shaded region. Justify your answer.
- b) Determine the area of the shaded region when $x = 1.5$ cm.

6 **11.** Mountain bikes can be rented from two stores near the entrance to Stanley Park. Store A charges \$6.00 per hour, plus \$3.50 for a helmet and lock. Store B charges \$6.70 per hour and provides a helmet and lock free. Determine the time in hours for which the rental charges in both stores are equal.

- a) Write an equation to solve this problem.
- b) Solve the equation.
- c) Verify the solution.

12. Jerry hires a pedicab to tour a city. He is charged \$2.75 plus \$0.60 per minute of travel. He has \$12.00. How long can he ride in the pedicab?

- a) Choose a variable and write an inequality to solve this problem.
- b) Solve the inequality. Explain the solution in words.
- c) Verify the solution.
- d) Graph the solution.

7 **13.** This photo is to be enlarged. Determine the dimensions of an enlargement with each scale factor.

- a) 2
- b) $\frac{7}{4}$
- c) 3.5

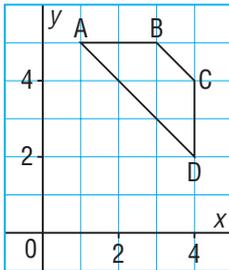


14. A hockey rink measures 60 m by 26 m. A model of a hockey rink measures 1.5 m by 0.65 m.

- a) What is the scale factor for this reduction?
- b) A hockey goal is 1.8 m high and 1.2 m high. What are the dimensions of a goal on the model hockey rink?

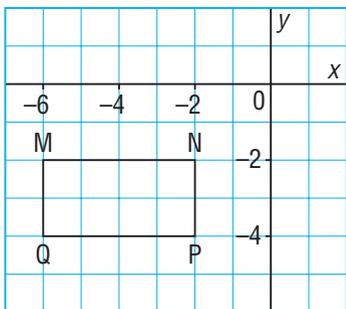
15. Bobbi wants to determine the height of a building. When Bobbi's shadow is 2.5 m long, the shadow of the building is 12 m long. Bobbi is 1.7 m tall. What is the height of the building, to the nearest tenth of a metre? Show your work.

16. Trapezoid ABCD is part of a larger shape.



After each reflection below:

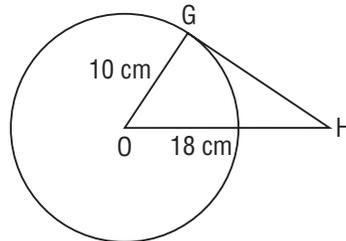
- Draw the image of ABCD.
 - Describe any symmetry in the shape and its image.
- a) a reflection in the horizontal line through 5 on the y -axis
- b) a reflection in the vertical line through 4 on the x -axis
- c) a reflection in the oblique line through (0, 6) and (6, 0)
17. a) Does rectangle MNPQ below have rotational symmetry about its centre? If it does, state the order and the angle of rotation symmetry.



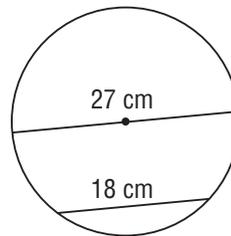
- b) Rectangle MNPQ is part of a larger shape. It is to be completed in three different ways, by each rotation below:
- 90° clockwise about the point $(-2, -3)$
 - 180° about vertex Q
 - 270° clockwise about the point $(-4, -4)$

- i) Draw each rotation image.
- ii) List the coordinates of the larger shape formed by the rectangle and its image each time. Describe any rotational symmetry in this shape.

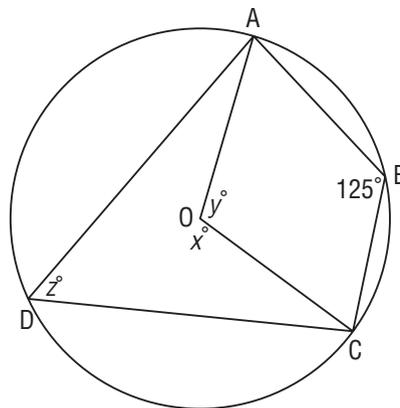
- 8 18. Point G is a point of tangency and O is the centre of the circle. Determine the length of GH to the nearest tenth of a centimetre.



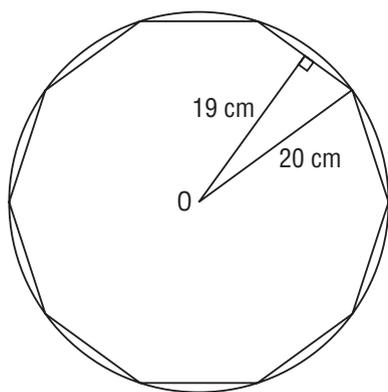
19. A circle has diameter 27 cm. How far from the centre of this circle is a chord 18 cm long? Give your answer to the nearest tenth of a centimetre.



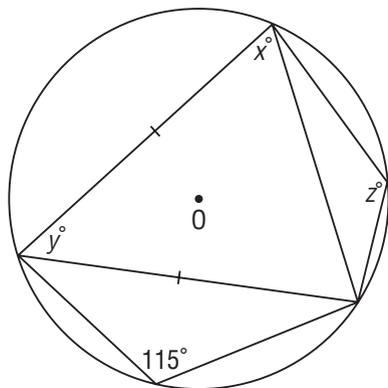
20. Point O is the centre of a circle. Determine the values of x° , y° , and z° .



- 21.** A rectangle is inscribed in a circle with radius 14 cm. The length of the rectangle is 21 cm. Determine the width of the rectangle to the nearest tenth of a centimetre.
- 22.** A regular decagon is inscribed in a circle with radius 20 cm and centre O. The distance from O to each side of the decagon is about 19 cm. What is the perimeter of the decagon to the nearest centimetre?



- 23.** Point O is the centre of a circle. Determine the values of x° , y° , and z° .



- 9 24.** A baseball team won 58 of its first 100 games of the season. Bao concludes that there is a 58% probability of the team winning its next game.
- a) What assumptions is Bao making?
- b) For each assumption, explain how the probability might change if the assumption is not true.

- 25.** Zahara is planning a telephone survey to discover how much weekly allowance parents give their children.
- a) Identify potential problems she may encounter related to 3 of these factors: bias, timing, privacy, cultural sensitivity, ethics, time
- b) For each potential problem in part a, explain how Zahara could avoid the problem.
- 26.** An on-line fashion magazine for teens concludes that high school students spend on average \$200 per month on clothes.
- a) How do you think the magazine may have conducted the survey?
- b) Do you think the conclusion is valid? Explain.
- 27.** For each situation, explain why data are collected from a sample and not a census.
- a) to determine the mean cost of hockey equipment for teenagers in Canada
- b) to determine the number of Canadian families with at least one cell phone
- 28.** Should a census or sample be used to collect data about each topic? Explain your choice.
- a) to determine the popularity of a new television show
- b) to determine the condition of an airplane's seatbelts
- 29.** Discuss whether each sampling method would lead to valid conclusions.
- a) To determine if the prices of items in a grocery store are appropriate, you survey every 12th customer leaving the store on a given day.
- b) To determine the favourite video game of students in a school, you survey 20 randomly selected students from each grade in the school.

Unit 1 Square Roots and Surface Area, page 4

1.1 Square Roots of Perfect Squares, page 11

3. a) 0.5 b) $\frac{3}{4}$ or 0.75
 c) $\frac{4}{5}$ or 0.8
4. a) 1, 4, 9, 16, 25, 36, 49, 64, 81, 100
 b) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
5. a) 0.6 b) 0.7
 c) 0.9 d) 0.4
 e) $\frac{1}{6}$ f) $\frac{5}{3}$
 g) $\frac{8}{10} = \frac{4}{5}$ h) $\frac{6}{4} = \frac{3}{2}$
6. a) 121, 144, 169, 196, 225, 256, 289, 324, 361, 400
 b) 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
7. a) $\frac{13}{4}$ b) $\frac{20}{14} = \frac{10}{7}$
 c) $\frac{16}{19}$ d) $\frac{15}{17}$
 e) 12 f) 0.15
 g) 0.11 h) 1.8
 i) 0.18 j) 0.13
8. a) $0.12 = \frac{12}{100}$ is not a perfect square because 12 is not a perfect square.
 b) $\sqrt{0.81} = 0.9$, so 0.81 is a perfect square.
 c) $\sqrt{0.25} = 0.5$, so 0.25 is a perfect square.
 d) $\sqrt{1.69} = 1.3$, so 1.69 is a perfect square.
 e) $\frac{9}{12}$ is not a perfect square because 12 is not a perfect square.
 f) $\frac{36}{81}$ is a perfect square because both 36 and 81 are perfect squares.
 g) $\frac{81}{49}$ is a perfect square because both 81 and 49 are perfect squares.
 h) $\frac{75}{27} = \frac{25}{9}$ is a perfect square, because both 25 and 9 are perfect squares.
 i) $0.081 = \frac{81}{1000}$ is not a perfect square because 1000 is not a perfect square.
- j) $\frac{25}{10}$ is not a perfect square because 10 is not a perfect square.
 k) $2.5 = \frac{25}{10}$ so it is not a perfect square.
 l) $\frac{8}{50} = \frac{4}{25}$ is a perfect square because both 4 and 25 are perfect squares.
9. a) 0.09 b) 0.0144
 c) 3.61 d) 9.61
 e) $\frac{4}{9}$ f) $\frac{25}{36}$
 g) $\frac{1}{49}$ h) $\frac{4}{25}$
10. a) 3.5 b) 5.5
 c) 4.5 d) 7.5
11. a) i) $36.0 = \frac{36}{1}$ is a perfect square.
 ii) $3.6 = \frac{36}{10} = \frac{18}{5}$ is not a perfect square.
 iii) $0.36 = \frac{36}{100} = \frac{9}{25}$ is a perfect square.
 iv) $0.036 = \frac{36}{1000} = \frac{9}{250}$ is not a perfect square.
 v) $0.0036 = \frac{36}{10\,000} = \frac{9}{2500}$ is a perfect square.
 vi) $0.000\,36 = \frac{36}{100\,000} = \frac{9}{25000}$ is not a perfect square.
 b) i) $\sqrt{36.0} = 6$
 ii) $\sqrt{3.6} \approx 1.9$
 iii) $\sqrt{0.36} = 0.6$
 iv) $\sqrt{0.036} \approx 0.19$
 v) $\sqrt{0.0036} = 0.06$
 vi) $\sqrt{0.000\,36} \approx 0.019$
12. a) i) 300 ii) 30
 iii) 0.3 iv) 0.03
 b) i) 0.05 ii) 0.5
 iii) 50 iv) 500
13. a) i) C ii) A
 iii) E iv) B
 v) F vi) D
14. a) 2.4 cm b) 9.6 cm
15. a) 2.5 km b) 3.2 km
 c) 7.84 km^2
16. No. $\sqrt{0.04} = 0.2$
17. b) For example: (3, 4, 5), (9, 12, 15), (12, 16, 20), (5, 12, 13), (8, 15, 17)
18. Yes, the squares of all numbers between 0.8 and 0.9 are between 0.64 and 0.81.

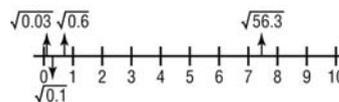
19. a) 3.6 cm b) 1 cut

1.2 Square Roots of Non-Perfect Squares, page 18

4. a) 1 and 4; $\sqrt{1} = 1$ and $\sqrt{4} = 2$
 b) 9 and 16; $\sqrt{9} = 3$ and $\sqrt{16} = 4$
 c) 49 and 64; $\sqrt{49} = 7$ and $\sqrt{64} = 8$
 d) 64 and 81; $\sqrt{64} = 8$ and $\sqrt{81} = 9$
 e) 81 and 100; $\sqrt{81} = 9$ and $\sqrt{100} = 10$
 f) 100 and 121; $\sqrt{100} = 10$ and $\sqrt{121} = 11$
5. a) $\frac{49}{100}$ and $\frac{64}{100}$; $\sqrt{0.49} = 0.7$ and $\sqrt{0.64} = 0.8$
 b) 4 and 9; $\sqrt{4} = 2$ and $\sqrt{9} = 3$
 c) 9 and 16; $\sqrt{9} = 3$ and $\sqrt{16} = 4$
 d) 49 and 64; $\sqrt{49} = 7$ and $\sqrt{64} = 8$
 e) 64 and 81; $\sqrt{64} = 8$ and $\sqrt{81} = 9$
 f) 100 and 121; $\sqrt{100} = 10$ and $\sqrt{121} = 11$
6. Estimates will vary, for example:
 a) $\sqrt{\frac{8}{10}} \doteq 0.9$ b) $\sqrt{\frac{17}{5}} \doteq \frac{9}{5}$
 c) $\sqrt{\frac{7}{13}} \doteq 0.7$ d) $\sqrt{\frac{29}{6}} \doteq 2.2$
7. Approximations will vary, for example:
 a) $\sqrt{4.5} \doteq 2.1$ b) $\sqrt{14.5} \doteq 3.8$
 c) $\sqrt{84.5} \doteq 9.2$ d) $\sqrt{145.5} \doteq 12.1$
 e) $\sqrt{284.5} \doteq 16.9$ f) $\sqrt{304.5} \doteq 17.4$
8. a) $\sqrt{29.5} \doteq 5.4$ b) $\sqrt{\frac{5}{2}} \doteq 1.6$
9. a) The estimate is incorrect. $\sqrt{4.4} \doteq 2.1$
 b) The estimate is incorrect. $\sqrt{0.6} \doteq 0.8$
 c) The estimate is correct to the nearest tenth.
 d) The estimate is incorrect. $\sqrt{0.4} \doteq 0.6$
10. a) Any number between 9 and 16; for example 10.24 and 12.25
 b) Any number between 49 and 64; for example 50.41 and 59.29
 c) Any number between 144 and 169; for example 158.36 and 166.41
 d) Any number between 2.25 and 6.25; for example 3.0 and 3.5
 e) Any number between 20.25 and 30.25; for example 22.09 and 29.16
11. a) About 2.1 b) About 2.9
 c) About 0.4 d) About 0.5
 e) About 0.8 f) About 0.4
 g) About 0.2 h) About 2.2
12. a) 0.6 b) 0.6
 c) 1.8 d) 2.9

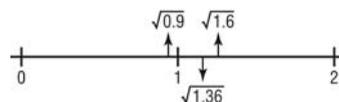
13. a) 1.3 cm b) About 2.7 cm
 c) About 4.85 cm d) 0.7 cm
14. There is no limit to the number of decimals and fractions; for example 0.3025 and $\frac{61}{200}$

15.



16. a) $\sqrt{0.25}$, $\sqrt{0.5}$, $\sqrt{1.44}$, and $\sqrt{3.6}$ are correctly placed.

b)



17. a) $\sqrt{52.9} \doteq 7.2732$ b) $\sqrt{5.29} = 2.3$
 c) $\sqrt{2.25} = 1.5$ d) $\sqrt{22.5} \doteq 4.7434$
18. a) The numbers are greater than 1.
 b) The number must be 0 or 1.
 c) The numbers are less than 1.
19. For example:
 a) 0.64 b) 3
 c) $\frac{2}{5}$ d) 15
20. a) 1.82 km b) 2.36 km
21. a) i) About 0.0707 ii) About 0.7071
 iii) About 7.0711 iv) About 70.7107
 v) About 707.1068
 b) $\sqrt{0.00005} \doteq 0.007071$
 $\sqrt{0.000005} \doteq 0.0007071$
 $\sqrt{50000000} \doteq 7071.0678$
 $\sqrt{5000000000} \doteq 70710.678$
22. Yes. All numbers between 0.775 and 0.781 have squares between 0.6 and 0.61.
23. For example: (1.1, 0.2), (0.6, 0.2) and (0.6, 0.7)
24. a) About 7.8 cm
 b) Doubling the side length would increase the area by a factor of 4.

Unit 1: Mid-Unit Review, page 21

1. a) $\sqrt{\frac{25}{36}} = \frac{5}{6}$ b) $\sqrt{0.36} = 0.6$
2. a) 1.96 b) $\frac{9}{64}$
 c) $\frac{49}{16}$ d) 0.25
3. a) 0.2 b) $\frac{1}{4}$

- c) 1.4 d) $\frac{2}{9}$
- e) 1.3 f) $\frac{11}{7}$
- g) 0.3 h) $\frac{17}{10}$
4. a) 1.8 b) 9.5
- c) 1.6
5. a) 12.2 cm b) 48.8 cm
6. No, the student is incorrect. $\sqrt{0.16} = 0.4$
7. a) $\frac{9}{64}$ is a perfect square, since both 9 and 64 are perfect squares.
- b) $3.6 = \frac{36}{10}$ is not a perfect square, since 10 is not a perfect square.
- c) $\frac{6}{9}$ is not a perfect square, since 6 is not a perfect square.
- d) $5.76 = \frac{576}{100}$ is a perfect square, since both 576 and 100 are perfect squares.
8. Estimates will vary, for example:
- a) About 2.4 b) About 0.95
- c) About 6.5 d) About 5.97
- e) About 0.24 f) 0.3
9. a) About 3.0 cm
- b) 4 cm
10. a) Correct b) About 1.3
- c) Correct d) Correct
11. For example:
- a) 20.25, 33.64 b) 0.5625, 0.64
- c) 1.69, 1.7 d) 0.09, 0.1024
- e) 22.09, 28.09 f) 0.0036, 0.0049

Unit 1: Start Where You Are, page 22

1. About 1385 cm²
2. About 1546 cm²

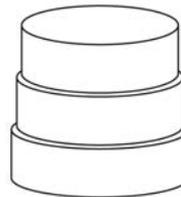
1.3 Surface Areas of Objects Made from Right Rectangular Prisms, page 30

4. a) 14 square units b) 18 square units
- c) 22 square units d) 20 square units
- e) 22 square units f) 26 square units
5. a) i) 18 cm² ii) 18 cm²
- iii) 18 cm²
6. a) i) 20 cm² ii) 20 cm²
- iii) 22 cm²

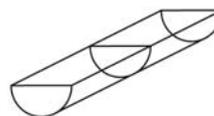
8. a) 68 cm² b) 144 cm²
- c) 255.5 cm²
10. a) 165.03 m² b) \$1609.20
11. 1346 m²
12. a) 54 square units
- b) 9 ways
- c) i) 6 cubes ii) 12 cubes
- iii) 8 cubes iv) 1 cube
- v) 0 cubes
14. c) 22 cm², 24 cm², 26 cm²
16. 110 m²
17. a) The piece made from 3 cubes has surface area 14 cm²; pieces made from 4 cubes have surface area 18 cm².
- c) 68 faces will not be painted.

1.4 Surface Areas of Other Composite Objects, page 40

3. a) 121 cm² b) 117 cm²
- c) 283 cm² d) 360 cm²
- e) 256 cm²
4. a) 58.1 cm² b) 62.1 m²
5. a) About 21.9 m² b) About 58.3 cm²
6. Including the bottom of base: About 707 cm²
7. a) 35 m²
8. a) 5.42 m²
- b) 2 cans of 1-L wood stain
9. a)



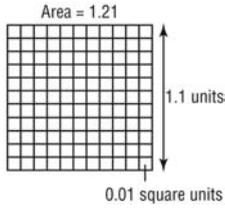
- b) About 2081.3 cm²
10. a) 2832.3 cm² b) 3652.1 cm²
11. 1155 cm²
12. a) 61.1 m²
13. a) 3456 cm² b) 4509 cm²
14. About 10 700 cm²
15. a) About 3336 cm²
- b) i)



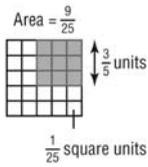
- ii) About 4882 cm²

Unit 1: Review, page 45

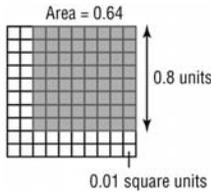
1. a) 1.1



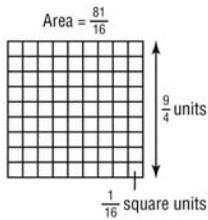
b) $\frac{3}{5}$



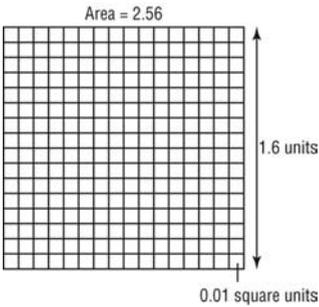
c) 0.8



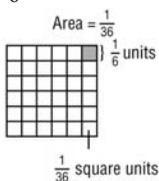
d) $\frac{9}{4}$



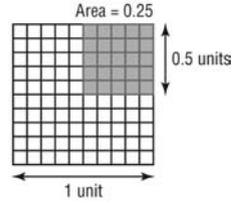
e) 1.6



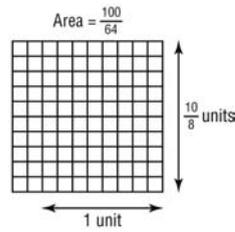
f) $\frac{1}{6}$



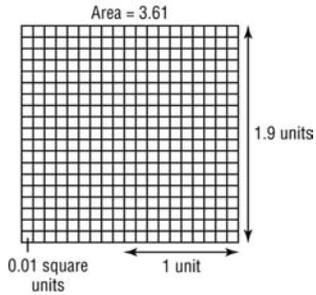
g) 0.5



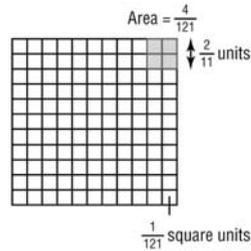
h) $\frac{10}{8} = \frac{5}{4}$



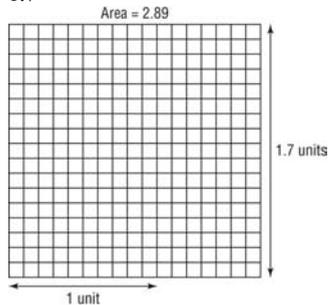
i) 1.9



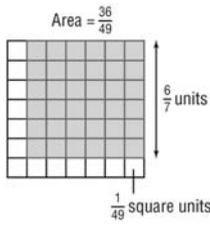
j) $\frac{2}{11}$



k) 1.7



l) $\frac{6}{7}$



2. a) $\frac{12}{5}$ b) $\frac{15}{8}$
 c) $\frac{14}{9}$ d) $\frac{18}{11}$
 e) 0.14 f) 0.17
 g) 1.3 h) 2.1
3. a) $\frac{48}{120}$ is not a perfect square since neither 48 nor 120 are perfect squares.
 b) 1.6 is not a perfect square since $1.6 = \frac{16}{10}$ and 10 is not a perfect square.
 c) $\frac{49}{100} = \left(\frac{7}{10}\right)^2$ is a perfect square.
 d) $0.04 = 0.2^2$ is a perfect square.
 e) $\frac{144}{24} = 6$ is not a perfect square.
 f) $2.5 = \frac{25}{10}$ is not a perfect square since 10 is not.
 g) $\frac{50}{225}$ is not a perfect square since 50 is not.
 h) $1.96 = 1.4^2$ is a perfect square.
 i) $\frac{63}{28}$ simplifies to $\frac{9}{4}$, which is a perfect square.
4. a) $\frac{9}{25}$ b) 2.56
 c) $\frac{81}{49}$ d) 0.64
5. a) 0.9 m b) 0.1 m
 c) 2.2 cm d) 2.5 cm
 e) 0.4 km f) 1.2 km
6. Estimates will vary, for example:
 a) $\sqrt{3.8} \doteq 1.9$, using $\sqrt{1} = 1$ and $\sqrt{4} = 2$
 b) $\sqrt{33.8} \doteq 5.8$, using $\sqrt{25} = 5$ and $\sqrt{36} = 6$
 c) $\sqrt{133.8} \doteq 11.6$, using $\sqrt{121} = 11$ and $\sqrt{144} = 12$
 d) $\sqrt{233.8} \doteq 15.3$, using $\sqrt{225} = 15$ and $\sqrt{256} = 16$
7. Estimates will vary, for example:

a) $\sqrt{\frac{77}{10}} \doteq \frac{14}{5}$, using $\sqrt{\frac{784}{100}} = \frac{14}{5}$

b) $\sqrt{\frac{18}{11}} \doteq \frac{14}{11}$, using $\sqrt{\frac{196}{121}} = \frac{14}{11}$

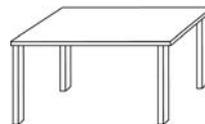
c) $\sqrt{\frac{15}{39}} \doteq \frac{15}{24}$, using $\sqrt{\frac{225}{576}} = \frac{15}{24}$

d) $\sqrt{\frac{83}{19}} \doteq \frac{9}{5}$, using $\sqrt{\frac{81}{25}} = \frac{9}{5}$

e) $\sqrt{\frac{28}{103}} \doteq \frac{5}{10}$, using $\sqrt{\frac{25}{100}} = \frac{5}{10}$

f) $\sqrt{\frac{50}{63}} \doteq \frac{7}{8}$, using $\sqrt{\frac{49}{64}} = \frac{7}{8}$

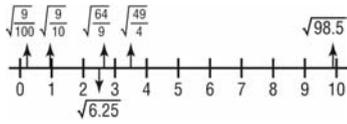
8. Estimates will vary, for example:
 a) About 2.4 b) About 0.6
 c) About 0.8 d) About 0.6
 e) About 4.8 f) About 3
9. a) Correct b) Incorrect; $\sqrt{1.6} \doteq 1.3$
 c) Incorrect; $\sqrt{156.8} \doteq 12.5$
 d) Correct e) Correct
 f) Incorrect; $\sqrt{0.7} \doteq 0.8$
10. $\sqrt{27.4}$, $\sqrt{60.8}$
11. a) $\sqrt{3.2}$, $\sqrt{2.3}$, $\sqrt{2.8}$, $\sqrt{1.2}$
 b) $\sqrt{125.4}$, $\sqrt{134.5}$, $\sqrt{129.9}$
 c) $\sqrt{12.9}$, $\sqrt{15.2}$
 d) $\sqrt{5.7}$, $\sqrt{4.8}$, $\sqrt{3.2}$, $\sqrt{2.3}$, $\sqrt{2.8}$
 e) $\sqrt{21.2}$, $\sqrt{23.1}$, $\sqrt{29.1}$
 f) $\sqrt{237.1}$, $\sqrt{222.1}$, $\sqrt{213.1}$
12. a) About 3.9 cm b) About 3.5 cm
 c) 8.5 cm
13. For example:
 a) $\frac{1}{2}$ b) 0.0625
 c) 1.97 d) $\frac{1}{25}$
14. a) i) About 0.0387 ii) About 0.3873
 iii) About 3.8730 iv) About 38.7298
 v) About 387.2983
15. a) 18 cm^2 b) 22 cm^2
 c) 26 cm^2
16. a) 51.7 cm^2 b) 515.48 m^2
 c) 253.28 m^2
17. a) b) $14\,824 \text{ cm}^2$



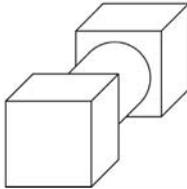
19. a) 940.2 cm^2 b) 1192.8 cm^2
 20. a) 30.2 m^2 b) 2 containers; \$39.90

Unit 1: Practice Test, page 48

1. a)



2. a) i) About 0.65 ii) 7.25
 iii) 4.8 iv) 14.6
 v) About 11.64
 b) ii, iii, and iv are exact, i and v are approximate
3. For example
 a) 0.25 b) 0.04
4. 8.67 km
5. a) 68.2 m^2 b) \$49.84
6. a)

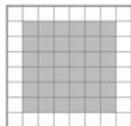


b) 229.7 cm^2

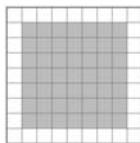
Unit 2 Powers and Exponent Laws, page 50

2.1 What is a Power?, page 55

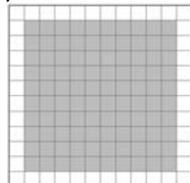
4. a) 2^2 b) 3^2
 c) 5^2
5. a) 3^3 b) 2^3
 c) 5^3
6. a) 4^2 b) 6×6



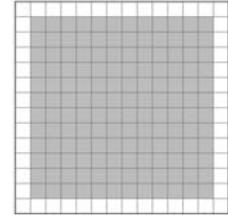
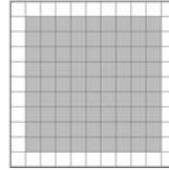
c) 49



d) 10^2



e) 81 f) 12×12



7. a) 2 b) 4
 c) 8 d) -10
 e) -6 f) 8
8. a) 5 b) 4
 c) 1 d) 2
 e) 9 f) 3
9. a) 3×3 b) $10 \times 10 \times 10 \times 10$
 c) $8 \times 8 \times 8 \times 8 \times 8$ d) $(-6)(-6)(-6)(-6)(-6)$
 e) $-6 \times 6 \times 6 \times 6 \times 6$ f) -4×4
10. a) 3^2 can be modelled by 9 unit square tiles arranged in a 3 by 3 square. 2^3 can be modelled by 8 unit cubes arranged in a 2 by 2 by 2 cube.
 b) 3^2 represents the area of a square and 2^3 represents the volume of a cube.
11. $6^4 = 6 \times 6 \times 6 \times 6 = 1296$
 $4^6 = 4 \times 4 \times 4 \times 4 \times 4 \times 4 = 4096$
12. a) 4^4 b) 2^3
 c) 5^6 d) 10^3
 e) $(-79)^2$ f) $-(-2)^8$
13. a) $5^2 = 25$ b) $3^4 = 81$
 c) $10^5 = 100\,000$ d) $-9^3 = -729$
 e) $(-2)^3 = -8$ f) $-(-4)^3 = 64$
 g) $(-5)^4 = 625$ h) $-5^4 = -625$
 i) $-(-5)^4 = -625$
14. a) 8 b) 1 000 000
 c) 3 d) -343
 e) -343 f) 256
 g) -256 h) -1296
 i) 1296 j) -1296
 k) -125 l) -256
15. a) i) $3^2 = 9$ ii) \$13.95
 b) i) $4^2 = 16$ ii) \$8.32
16. a) 531 441 b) -823 543
 c) 48 828 125 d) -1 048 576
 e) 43 046 721 f) 8 388 608
17. a) i) $4 \times 4 \times 4 = 64$ ii) $-4 \times 4 \times 4 = -64$
 iii) $-(-4 \times 4 \times 4) = 64$
 iv) $(-4 \times 4 \times 4) = -64$
 b) i and iii are positive. ii and iv are negative.
 c) i) $4 \times 4 = 16$ ii) $-4 \times 4 = -16$
 iii) $-(-4 \times 4) = 16$ iv) $(-4 \times 4) = -16$
 d) i and iii are positive. ii and iv are negative.

18. a) All three expressions are the same.
For $(-3)^5$, the negative sign is part of the base, -3 .
For $(-3)^5$, the brackets serve no purpose.
b) -4^6 and $(-4)^6$ are the same.
For -4^6 , the negative sign is not part of the base.
For $(-4)^6$, the negative sign is part of the base, -4 .
19. a) When the exponent is an odd number, for example: $(-3)^5, (-6)^3, (-2)^{17}$
b) When the exponent is an even number, for example: $(-3)^6, (-6)^2, (-2)^{10}$
20. a) 2^2 b) 2^4
c) 2^6 d) 2^8
e) 2^5 f) 2^7
21. a) i) $2^4, 4^2, 16^1$ ii) $3^4, 9^2, 81^1$
 iii) $2^8, 4^4, 16^2, 256^1$
22. a) Same: same numbers
 Different: base and exponent interchanged
b) i) 3^2 ii) 2^5
 iii) 3^4 iv) 4^5
23. $3^5, 6^3, 3^4, 5^2$
24. a) $64 = 8^2$ b) $49 = 7^2$
c) $36 = 6^2$ d) $25 = 5^2$
e) $16 = 4^2$ f) $9 = 3^2$
g) $4 = 2^2$ h) $1 = 1^2$

Each number of squares is a square number that decreases as the size of the squares increases.

2.2 Powers of Ten and the Zero Exponent, page 61

4. a) 1 b) 1
c) 1 d) 1
5. a) 1 b) -1
c) -1 d) 1
6. a) 10^3 b) 10^5
c) 10^9 d) 10^4
e) 10^{11}
7. For example: $10^0, 1^4, (-6)^0$
8. a) 10 000 000 b) 100
c) 1 d) 10 000 000 000
e) 10 f) 1 000 000
9. a) 6×10^9 b) 2×10^2
c) $(5 \times 10^4) + (1 \times 10^3) + (4 \times 10^2) + (1 \times 10^1) + (5 \times 10^0)$
d) $(6 \times 10^7) + (7 \times 10^5) + (2 \times 10^3) + (8 \times 10^0)$
e) $(3 \times 10^5) + (2 \times 10^3) + (4 \times 10^2) + (1 \times 10^1) + (1 \times 10^0)$
f) $(2 \times 10^6) + (8 \times 10^0)$
10. a) 70 000 000 b) 39 057
c) 800 500 200 d) 98 000 000 001
e) 1 000 000 000 000 000 f) 904 031

11. $5 \times 10^8; 4 \times 10^4; 3 \times 10^6; (1 \times 10^4) + (7 \times 10^3); (1 \times 10^5) + (3 \times 10^4); 6 \times 10^2$

12. Negative bases may vary.

Exponent	Power	Standard Form
5	$(-3)^5$	-243
4	$(-3)^4$	81
3	$(-3)^3$	-27
2	$(-3)^2$	9
1	$(-3)^1$	-3
0	$(-3)^0$	1

13. a) $4667 > 4327$ b) $24\ 240 > 2432$
c) $70\ 007\ 000 > 777\ 777$
14. a) 1 billion = 10^9 ; 100 000 = 10^5 ; 1000 = 10^3 ;
 $1 = 10^0$; $100 = 10^2$; 10 million = 10^7
b) $10^0, 10^2, 10^3, 10^5, 10^7, 10^9$
c) You only need to order or compare the exponents.
15. One trillion is 10^{12} , one quadrillion is 10^{15} , and one quintillion is 10^{18} .

2.3 Order of Operations with Powers, page 66

3. a) 10 b) 8
c) 16 d) 4
e) 8 f) 0
g) 36 h) 4
i) -14 j) -12
4. a) 40 b) 50
c) 1000 d) 100
e) -200 f) -10
g) -8 h) 1
5. a) 0 b) -1
c) 35 d) 125
e) -8 f) 1
g) -64 h) 8
6. a) i) $4^2 + 4^3 = 80$ ii) $5^3 + 5^6 = 15\ 750$
b) i) $6^3 - 6^2 = 180$ ii) $6^3 - 6^5 = -7560$
7. Correction:
 $= 9 + 4 \times 16 + 36$ $(-6)^2$ should be 36, not -36 .
 $= 9 + 64 + 36$ Calculate 4×16 first, not
 $= 109$ $9 + 4$.
8. a) Multiply: $(7)(4)$; 3 b) Subtract: $(2 - 5)$; 54
c) Evaluate: $(-3)^2$; 37 d) Evaluate: 4^0 ; -8
e) Divide: $[10 \div (-2)]$; 4
f) Divide: $[18 \div (-6)]$; -54
10. a) -392 b) -216
c) -8 d) 9
e) 16 f) 1
11. The order of operations matches the order in which the multiplication and division are written.
 $-4^3 \times 10 - 6 \div 2 = -64 \times 10 - 3 = -640 - 3 = -643$
12. \$1035

13. 5 different answers:
 $2^3 + (3 \times 4)^2 - 6 = 8 + 144 - 6 = 146$;
 $(2^3 + 3) \times 4^2 - 6 = 170$; $2^3 + 3 \times (4^2 - 6) = 38$;
 $(2^3 + 3 \times 4^2) - 6 = 50$; $(2^3 + 3 \times 4)^2 - 6 = 394$;
 $2^3 + (3 \times 4^2 - 6) = 50$
14. a) 43, 43 b) 13, 25
 c) 191, 191 d) 72, 7776
 e) 119, 20
15. The student multiplied 3 by 4 instead of squaring 4 first. This does not affect the answer because any nonzero number with exponent 0 equals 1.
 A more efficient solution:
 $-(24 - 3 \times 4^2)^0 \div (-2)^3 = -1 \div (-8) = \frac{1}{8}$
16. a) -197 568 b) -92 000
 c) -4 d) 40.5
 e) 169 744 f) -1 185 191
17. $(30 + 9 \times 11 \div 3)^0$
18. a) Marcia
 b) Robbie forgot that the square of -4 is positive. Nick forgot that the square of -6 is positive.
19. \$84.81
20. a) $(10 + 2) \times 3^2 - 2 = 106$
 b) $10 + 2 \times (3^2 - 2) = 24$
 c) $(10 + 2) \times (3^2 - 2) = 84$
 d) $(10 + 2 \times 3)^2 - 2 = 254$
21. a) $20 \div (2 + 2) \times 2^2 + 6 = 26$
 b) $20 \div 2 + 2 \times (2^2 + 6) = 30$
 c) $20 \div (2 + 2 \times 2^2) + 6 = 8$
 d) $(20 \div 2 + 2) \times (2^2 + 6) = 120$
22. No, Blake did not win the prize.
 $5 \times 4^2 - (2^3 + 3^3) \div 5$
 $= 5 \times 16 - (8 + 27) \div 5$
 $= 80 - 35 \div 5$
 $= 80 - 7$
 $= 73$
24. a) $1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 = 21^2$
 $1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 + 7^3 = 28^2$
 b) $3^2 - 1^2 = 2^3$; $6^2 - 3^2 = 3^3$; $10^2 - 6^2 = 4^3$;
 $15^2 - 10^2 = 5^3$; $21^2 - 15^2 = 6^3$; $28^2 - 21^2 = 7^3$;
 $36^2 - 28^2 = 8^3$
25. For example, use -2 and 3.
 a) $(-2)^2 + 3^2 = 4 + 9 = 13$ b) $(-2 + 3)^2 = 1^2 = 1$
 c) The answers are different.
 d) I do not agree. The two expressions are not equal because the operations are performed in different orders.
26. Answers may vary. For example:
 $4 \div 4 + 4 - 4 = 1$; $4 \div 4 + 4 \div 4 = 2$;
 $4 - 4 + 4 - 4^0 = 3$; $4^0 + 4^0 + 4^0 + 4^0 = 4$;
 $4 - 4 + 4 + 4^0 = 5$; $4 + 4 - 4^0 - 4^0 = 6$;

$$4 + 4^0 + 4^0 + 4^0 = 7$$
; $(4 + 4) \times 4 \div 4 = 8$;
 $4 \div 4 + 4 + 4 = 9$

27. a) i) $2^4 = 16$ ii) $2^2 = 4$
 iii) $2^5 = 32$ iv) $2^3 = 8$
 b) i) $28 = 2^4 + 2^3 + 2^2$
 ii) $12 = 2^3 + 2^2$ iii) $25 = 2^4 + 2^3 + 2^0$
 iv) $31 = 2^4 + 2^3 + 2^2 + 2^1 + 2^0$
 v) $50 = 2^5 + 2^4 + 2^1$ vi) $75 = 2^6 + 2^3 + 2^1 + 2^0$
 c) For example:
 i) $28 = 3^3 + 3^0$ ii) $12 = 3^2 + 3^1$
 iii) $25 = 3^2 + 3^2 + 3^1 + 3^1 + 3^0$
 iv) $31 = 3^3 + 3^1 + 3^0$
 v) $50 = 3^3 + 3^2 + 3^2 + 3^1 + 3^0 + 3^0$
 vi) $75 = 3^3 + 3^3 + 3^2 + 3^2 + 3^1$

Unit 2: Mid-Unit Review, page 69

1. a) 196 b) 5
 c) -512 d) -256
 e) -216 f) 256

2.

	Power	Base	Exponent	Repeated Multiplication	Standard Form
a)	4^3	4	3	$4 \times 4 \times 4$	64
b)	2^5	2	5	$2 \times 2 \times 2 \times 2 \times 2$	32
c)	8^6	8	6	$8 \times 8 \times 8 \times 8 \times 8 \times 8$	262 144
d)	7^2	7	2	7×7	49
e)	3^4	3	4	$3 \times 3 \times 3 \times 3$	81

3. a)

Power of 7	Standard Form
7^1	7
7^2	49
7^3	343
7^4	2401
7^5	16 807
7^6	117 649
7^7	823 543
7^8	5 764 801

b) The pattern in the ones digits is
 7, 9, 3, 1, 7, 9, 3, 1, ...

c)

Power of 7	Standard Form
7^9	40 353 607
7^{10}	282 475 249
7^{11}	1 977 326 743

- d) i) 1 ii) 9
 iii) 7 iv) 9
4. a) 1 000 000 b) 1
 c) 100 000 000 d) 10 000
5. a) 10^9 b) 10^0
 c) 10^2 d) 10^5
6. a) 1 b) 1

- c) -1 d) 1
7. 10^4 m^2
8. a) Subtract: $(-21 - 6)$; 743
 b) Multiply: (2×3) ; 33
 c) Subtract: $[5 - (-4)]$; 648
 d) Evaluate the power with exponent 0; 1
 e) Subtract: $(3 - 5)$; 8
 f) Subtract: $(7 - 4)$; -57
9. Sophia is correct. Victor might have included the negative sign in the power -2^4 and evaluated it as 16.
10. $(-3)^3 = -27$, not 27; $(-9)^0 = 1$, not -1
 Correction:
 $(-2)^4 - (-3)^3 \div (-9)^0 \times 2^3$
 $= 16 - (-27) \div 1 \times 8$
 $= 16 - (-27) \times 8$
 $= 16 - (-216)$
 $= 232$

Unit 2: Start Where You Are, page 70

1. a) 64.8 b) 162
 c) 15 d) -9
 e) 2
2. a) 1 b) 1.0125
 c) 1

2.4 Exponent Laws I, page 76

4. a) 5^9 b) 10^{13}
 c) $(-3)^6$ d) 21^{10}
 e) $(-4)^4$ f) 6^{15}
 g) 2^4 h) $(-7)^3$
5. a) 4^2 b) 8^3
 c) 15^{10} d) $(-6)^5$
 e) 2^2 f) $(-10)^6$
 g) 6^4 h) $(-1)^1$
6. a) i) 1 ii) 1
 iii) 1 iv) 1
7. a) i) $3^{13} = 1\,594\,323$ ii) $3^{13} = 1\,594\,323$
8. a) 3^2 b) $(-4)^{11}$
 c) 6^1 d) 4^0
 e) $(-3)^4$
9. a) i) $(-6)^1 = -6$ ii) $(-6)^1 = -6$
10. a) $10^4 + 10^4 = 20\,000$ b) $10^6 - 10^3 = 999\,000$
 c) $10^{11} - 10^9 = 99\,000\,000\,000$
 d) $10^1 + 10^7 = 10\,000\,010$
 e) $10^6 = 1\,000\,000$ f) $10^0 = 1$
 g) $10^6 = 1\,000\,000$ h) $10^5 = 100\,000$
 i) $10^5 = 100\,000$ j) $10^2 + 10^2 = 200$
11. a) 32 b) 248
12. a) $10^4 \text{ m} \times 10^3 \text{ m} = 10^7 \text{ m}^2$, or $10\,000\,000 \text{ m}^2$
 b) $2(10^4 \text{ m} + 10^3 \text{ m}) = 22\,000 \text{ m}$

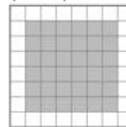
- c) i) $10^7 \text{ m} \times 10^0 \text{ m}$; $10^6 \text{ m} \times 10^1 \text{ m}$; $10^5 \text{ m} \times 10^2 \text{ m}$;
 $10^4 \text{ m} \times 10^3 \text{ m}$
 ii) $2(10^7 \text{ m} + 10^0 \text{ m}) = 20\,000\,002 \text{ m}$
 $2(10^6 \text{ m} + 10^1 \text{ m}) = 2\,000\,020 \text{ m}$
 $2(10^5 \text{ m} + 10^2 \text{ m}) = 200\,200 \text{ m}$
 $2(10^4 \text{ m} + 10^3 \text{ m}) = 22\,000 \text{ m}$
13. a) -32 b) 91
 c) 21 d) -12
 e) 80 f) -272
 g) -10
15. a) The student multiplied the exponents instead of adding them. Correction: $4^3 \times 4^4 = 4^7$
 b) The student divided the exponents instead of subtracting them.
 Correction: $\frac{(-7^6)}{(-7^3)} = \frac{-7^6}{-7^3} = \frac{7^6}{7^3} = 7^3$
 c) The student used the exponent laws but the bases are different. Correction: $3^2 \times 2^3 = 9 \times 8 = 72$
 d) The student multiplied the exponents in the divisor instead of adding them.
 Correction: $\frac{5^8}{5^4 \times 5^2} = \frac{5^8}{5^6} = 25$
 e) The student added all the exponents even though only 2 of them were parts of products of powers.
 Correction: $1^2 + 1^3 \times 1^2 = 1^2 + 1^5 = 1 + 1 = 2$
16. a) $10^2 \times 10^1 = 10^3$ b) 1000 times as large
17. a) i) 150 ii) 3125
 b) Part ii is a product of two powers that can be simplified using an exponent law.
18. a) i) 48 ii) 4
 b) Part ii is a quotient of two powers that can be simplified using an exponent law.
19. Since the base is negative, the power is negative when the exponent is an odd number.
 a) $(-2)^5$ b) $(-2)^5$
 c) $(-2)^2 = 4$ d) $(-2)^0 = 1$
 e) $(-2)^2 = 4$ f) $(-2)^1$
20. For example: $4^2 \times 2^2$
21. a) $1 \text{ km} = 10^3 \text{ m} = 10^3 \times 10^2 \text{ cm} = 10^5 \text{ cm}$
 b) $1 \text{ km} = 10^5 \text{ cm} = 10^5 \times 10^1 \text{ mm} = 10^6 \text{ mm}$
 c) $10^5 \text{ m} = (10^5 \div 10^3) \text{ km} = 10^2 \text{ km}$
 d) $10^9 \text{ mm} = (10^9 \div 10^3) \text{ m} = 10^6 \text{ m}$
22. a) $10^2 \text{ km}^2 = (10^3 \times 10^3) \times 10^2 \text{ m}^2 = 10^8 \text{ m}^2$
 b) $10^6 \text{ cm}^2 = 10^6 \div (10^2 \times 10^2) \text{ m}^2 = 10^2 \text{ m}^2$
 c) $10^6 \text{ cm}^2 = (10^1 \times 10^1) \times 10^6 \text{ mm}^2 = 10^8 \text{ mm}^2$
 d) $1 \text{ km}^2 = (10^3 \times 10^3) \times (10^2 \times 10^2) \text{ cm}^2 = 10^{10} \text{ cm}^2$

2.5 Exponent Laws II, page 84

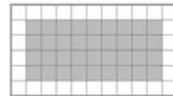
4. a) $6^3 \times 4^3$ b) $2^4 \times 5^4$
 c) $(-2)^5 \times 3^5$ d) $25^2 \times 4^2$

5. e) $11^1 \times 3^1$ f) $(-3)^3 \times (-2)^3$
 a) $8^3 \div 5^3$ b) $21^4 \div 5^4$
 c) $(-12)^5 \div (-7)^5$ d) $\frac{10^3}{3^3}$
 e) $\frac{1^2}{3^2}$ f) $\frac{27^4}{100^4}$
6. a) 3^8 b) 6^9 c) 5^3
 d) 7^0 e) -8^4 f) $(-3)^8$
7. $(2^4)^2 = 2^8$; $(2^2)^4 = 2^8$; The results are the same because each expression is the product of 8 factors of 2.
8. a) $3^3 \times (-5)^3$ b) $-2^5 \times 4^5$
 c) $\frac{2^4}{3^4}$ d) $\frac{(-7)^2}{(-2)^2}$
 e) $-(-10)^3 \times 3^3$ f) $16^2 \div 9^2$
9. Since $-5^2 = -25$, the base is negative. The power $(-5^2)^3$ is negative when the exponent is an odd number.
10. a) I multiplied first because it was easier than using the power of a product law: $(3 \times 2)^3 = 6^3 = 216$
 b) I multiplied first because it was easier than using the power of a product law:
 $[(-2) \times 4]^2 = (-8)^2 = 64$
 c) I divided first because it was easier than using the power of a quotient law: $\left(\frac{9}{-3}\right)^3 = (-3)^3 = -27$
 d) I divided first because it was easier than using the power of a quotient law: $\left(\frac{8}{2}\right)^2 = 4^2 = 16$
 e) I used the zero exponent law: $(12^8)^0 = 1$
 f) I used the power of a power law:
 $[(-4)^2]^2 = (-4)^4 = 256$
11. $[(-2)^3]^4 = (-2)^{12}$; $(-2)^{12}$ is positive because its exponent is even. $[(-2)^3]^5 = (-2)^{15}$; $(-2)^{15}$ is negative because its exponent is odd.
12. $-(4^2)^3 = -4096$; $(-4^2)^3 = -4096$; $[(-4)^2]^3 = 4096$
13. a) i) $(4 \times 3)^3 = 12^3 = 1728$
 $(4 \times 3)^3 = 4^3 \times 3^3 = 64 \times 27 = 1728$
 b) i) $[(-2) \times (-5)]^2 = 10^2 = 100$
 $[(-2) \times (-5)]^2 = (-2)^2 \times (-5)^2 = 4 \times 25 = 100$
 c) i) $\left(\frac{6}{2}\right)^4 = 3^4 = 81$
 $\left(\frac{6}{2}\right)^4 = \frac{6^4}{2^4} = \frac{1296}{16} = 81$
 d) i) $\left(\frac{14}{2}\right)^0 = 7^0 = 1$
 $\left(\frac{14}{2}\right)^0 = \frac{14^0}{2^0} = 1$
 e) i) $[(-5)^2]^2 = 25^2 = 625$
 $[(-5)^2]^2 = (-5)^4 = 625$

- f) i) $(2^5)^3 = 32^3 = 32\,768$
 $(2^5)^3 = 2^{15} = 32\,768$
14. a) 729 b) 256
 c) 64 d) 1 000 000
 e) 1 000 000 000 000 f) 144
 g) 1 h) -512
15. a) The student multiplied the bases and multiplied the powers.
 $(3^2 \times 2^2)^3 = 3^6 \times 2^6 = 729 \times 64 = 46\,656$
 b) The student added the exponents instead of multiplying them. $[(-3)^2]^3 = (-3)^6 = 729$
 c) The student might have thought that 6^1 is 1.
 $\left(\frac{6^2}{6^1}\right)^2 = (6^1)^2 = 6^2 = 36$
 d) The student did not simplify the powers in the brackets correctly.
 $(2^6 \times 2^2 \div 2^4)^3 = (2^{6+2-4})^3 = (2^4)^3 = 2^{12} = 4096$
 e) The student multiplied the powers in the brackets instead of adding them.
 $(10^2 + 10^3)^2 = (100 + 1000)^2 = 1100^2 = 1\,210\,000$
16. a) 1 047 951 b) 28
 c) 4100 d) 46 720
 e) -255 f) 1 006 561
17. a) 1015 b) -59 045
 c) 1033 d) 59 053
 e) -5 f) 60 073
18. a) i) $(2 \times 3)^2 = 6^2$

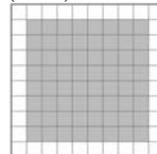


- ii) $(2 \times 3)^2 = 2^2 \times 3^2$
 iii)

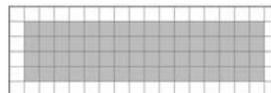


- iv) Both rectangles have an area of 36 but they have different dimensions.

- b) i) $(2 \times 4)^2 = 8^2$

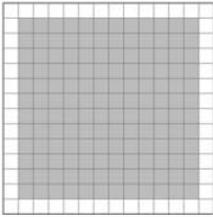


- ii) $(2 \times 4)^2 = 2^2 \times 4^2$
 iii)



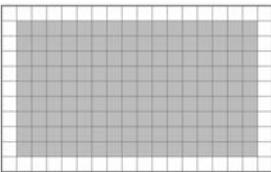
iv) Both rectangles have an area of 64 but they have different dimensions.

c) i) $(3 \times 4)^2 = 12^2$



ii) $(3 \times 4)^2 = 3^2 \times 4^2$

iii)



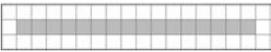
iv) Both rectangles have an area of 144 but they have different dimensions.

d) i) $(1 \times 4)^2 = 4^2$



ii) $(1 \times 4)^2 = 1^2 \times 4^2$

iii)



iv) Both rectangles have an area of 16 but they have different dimensions.

19. a) 255 583 b) 254 819 593
 c) 2 097 152 d) 1631
 e) 6560 f) 54 899
20. a) i) 9^2 ii) $(3 \times 3)^2$ iii) 3^4
 b) i) 8^2 ii) $(2 \times 4)^2$ iii) 2^6
21. a) 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096
 b) i) $2^5 \times 2^6 = 2048$ ii) $2^4 \times 2^3 \times 2^5 = 4096$
 iii) $2^{10} \div 2^7 = 8$ iv) $\frac{2^4 \times 2^8}{2^{10}} = 4$
 v) $(2^3 \times 2^2)^3 = 32\ 768$
 vi) $\left(\frac{2^8}{2^6}\right)^4 = 256$

Unit 2: Review, page 87

1. a) $4 \times 4 \times 4 = 64$ b) $7 \times 7 = 49$
 c) $-(-2)(-2)(-2)(-2)(-2) = 32$
 d) $-3 \times 3 \times 3 \times 3 = -81$
 e) $-1 \times 1 = -1$
 f) $(-1)(-1)(-1)(-1)(-1)(-1)(-1)(-1) = 1$

2. 2^2 can be modelled as the area of a square with side length 2 units. 2^3 can be modelled as the volume of a cube with edge length 2 units.

3. a) $3^6 = 729$ b) $(-8)^3 = -512$
 c) $-2^7 = -128$ d) $12^2 = 144$
 e) $4^5 = 1024$ f) $(-5)^4 = 625$

4. 5^8 means $5 \times 5 = 390\ 625$
 8^5 means $8 \times 8 \times 8 \times 8 \times 8 = 32\ 768$

5. 16 min
 6. a) $-4^2 = -16$; $(-4)^2 = 16$

The values are different. The brackets indicate that the negative sign is included in the base.

b) $-2^3 = -8$; $(-2)^3 = -8$

The values are the same. The brackets indicate that the negative sign is included in the base.

7. a) i) -9 ii) -9
 iii) -9 iv) 9

b) ii) The brackets indicate that the negative sign is not part of the base.

iii) The brackets indicate that the first negative sign is not part of the base and the second negative sign is part of the base.

iv) The brackets indicate that the negative sign is part of the base.

8. a) 10^8 b) 10^4
 c) 10^0 d) 10^9
 e) 10^3

9. a) 7×10^8
 b) $(3 \times 10^2) + (4 \times 10^1) + (5 \times 10^0)$
 c) $(8 \times 10^4) + (2 \times 10^1) + (7 \times 10^0)$

10. a)

Power	Repeated Multiplication	Standard Form
3^5	$3 \times 3 \times 3 \times 3 \times 3$	243
3^4	$3 \times 3 \times 3 \times 3$	81
3^3	$3 \times 3 \times 3$	27
3^2	3×3	9
3^1	3	3

b) The exponents are decreasing by 1; the number of factors is decreasing by 1; each number in standard form is divided by 3 to get the number below it.

c) $3^0 = 1$

11. a) $10^4 \div 10^2 = 10^2$, or 100 times as high
 b) $10^{12} \div 10^7 = 10^5$, or 100 000 times as great
12. a) 4729 b) 300 208
13. a) 90 b) -48
 c) 900 d) 600
14. a) 89 b) 175
 c) 0 d) 26

- e) 73 f) 40 000
15. a) i) 1000 ii) 2000
 iii) 4000 iv) 8000
- b) i) $1000 \times 2^4 = 16\,000$ ii) $1000 \times 2^6 = 64\,000$
 iii) $1000 \times 2^9 = 512\,000$
 iv) $1000 \times 2^{12} = 4\,096\,000$
16. 6 different answers:
 $4^3 - (2 \times 3)^4 + 11 = -1221$; $(4^3 - 2) \times 3^4 + 11 = 5033$;
 $(4^3 - 2 \times 3)^4 + 11 = 11\,316\,507$
 $4^3 - (2 \times 3^4 + 11) = -109$; $4^3 - 2 \times (3^4 + 11) = -120$;
 $4^3 - (2 \times 3)^4 + 11 = -87$
17. The student incorrectly applied the exponent law when the bases, (-2) and 2 , are not the same. Also, $-9 \div (-3)$ is 3 , not -3 . Correction:
 $(-2)^2 \times 2^3 - 3^2 \div (-3) + (-4)^2$
 $= 4 \times 8 - 9 \div (-3) + 16$
 $= 32 - (-3) + 16$
 $= 35 + 16$
 $= 51$
18. a) $5^7 = 78\,125$ b) $(-2)^5 = -32$
 c) $3^6 = 729$ d) $-10^4 = -10\,000$
19. $10^{22} = 10\,000\,000\,000\,000\,000\,000\,000$
20. a) $7^2 = 49$ b) $(-10)^6 = 1\,000\,000$
 c) $8^2 = 64$ d) $-6^3 = -216$
21. a) No, the laws of exponents cannot be used because the powers have different bases.
 One can only use the exponent laws to simplify power expressions with the same base.
 b) Yes, even though these powers have different bases, both bases are powers of 3:
 $27^2 \div 9^2 = 3^6 \div 3^4$
22. a) The student divided the exponents instead of subtracting them. $(-3)^6 \div (-3)^2 = (-3)^4 = 81$
 b) The student misread the addition sign as a multiplication sign.
 $(-4)^2 + (-4)^2 = 16 + 16 = 32$
 c) After the first step, the student divided the exponents instead of subtracting them.
 $\frac{(-5)^2 \times (-5)^4}{(-5)^3 \times (-5)^0} = \frac{(-5)^6}{(-5)^3} = (-5)^3 = -125$
23. a) $3^3 \times 5^3 = 3375$ b) $12^5 \div 3^5 = 1024$
 c) $(-4)^4 \times 2^4 = 4096$ d) $63^0 \times 44^0 = 1$
 e) $\frac{3^5}{2^5} = \frac{243}{32}$, or 7.593 75
 f) $\frac{15^2}{2^2} = \frac{225}{4}$, or 56.25
24. a) 3^6 b) 4^0
 c) $(-2)^9$ d) 5^{10}
25. a) i) $(5 \times 3)^3 = 15^3 = 3375$
 ii) $(5 \times 3)^3 = 5^3 \times 3^3 = 3375$

- b) i) $(3 \times 3)^4 = 9^4 = 6561$
 ii) $(3 \times 3)^4 = 3^4 \times 3^4 = 6561$
- c) i) $(8 \div 2)^5 = 4^5 = 1024$
 ii) $(8 \div 2)^5 = 8^5 \div 2^5 = 1024$
- d) i) $\left(\frac{9}{3}\right)^2 = 3^2 = 9$ ii) $\left(\frac{9}{3}\right)^2 = \frac{9^2}{3^2} = 9$

- e) i) $(2^3)^4 = 8^4 = 4096$ ii) $(2^3)^4 = 2^{12} = 4096$
 f) i) $(6^2)^0 = 36^0 = 1$ ii) $(6^2)^0 = 6^0 = 1$

26. a) $6^7 = 279\,936$ b) $(-11)^2 = 121$
 c) $3^6 = 729$ d) $5^0 = 1$
 e) $(-4)^3 = -64$ f) $10^1 = 10$
27. a) 33 b) $\frac{8}{3}$
 c) 186 623 d) 199 065.6

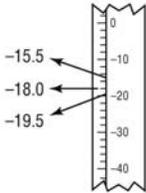
Unit 2: Practice Test, page 90

1. a) $3^3 \times 4^3$ b) $(-5)^4 \times 2^4$
 c) $\frac{1^4}{4^4}$ d) $-\frac{9^3}{3^3}$
2. a) -2^9 b) 6^0
 c) $(-5)^6$ d) $-(-3)^8$
3. a) 1296 b) $\frac{1}{32} = 0.031\,25$
 c) 1 d) 729
4. The value of a power with a negative base is positive when the exponent is an even number, and is negative when the exponent is an odd number.
 For example: $(-3)^2 = (-3) \times (-3) = 9$
 $(-3)^3 = (-3) \times (-3) \times (-3) = -27$
5. The area of the diamond is: $27\text{ m} \times 27\text{ m} = 729\text{ m}^2$, which is less than 1000 m^2 .
6. The brackets are not necessary because the order of operations ensures that the multiplication and division are performed before the subtraction.
 $(-3^5 \times 10) - (9 \div 3) = (-243 \times 10) - (9 \div 3) = -2430 - 3 = -2433$
7. a) $(2^3 + 4)^2$ was calculated as $(2^3 + 4) \times 2$.
 b) The answer -1440 is correct.
 c) $(-10)^3$ was evaluated as 1000 .
 d) The brackets of $(5 + 5)^2$ were ignored, so $(-10)^3$ was divided by 5 and then 5^2 was added.
8. a) 625; The simplified expression $(-5)^{3+2-1} = (-5)^4$ has an even exponent, so the value will be positive.
 b) 1; A power with an exponent of 0 gives a value of 1, so the answer will be positive.
 c) The simplified expression $(-1)^{2+4-3-2} = (-1)^1$ has an odd exponent, so the answer will be negative.

- d) 4352; Each power in the simplified expression $(-4)^6 + (-4)^4$ has an even exponent, so the value will be positive.

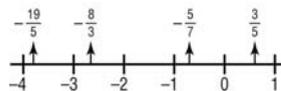
Unit 3 Rational Numbers, page 92

3.1 What Is a Rational Number?, page 101

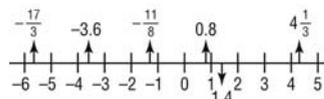
5. $\frac{-3}{2} = -\frac{3}{2} = \frac{3}{-2}$; $\frac{-2}{3} = -\frac{2}{3} = \frac{2}{-3}$
6. a) $-\frac{7}{9}, \frac{-7}{9}$ b) $-\frac{5}{3}, \frac{5}{-3}$
 c) $\frac{-6}{11}, \frac{6}{-11}$
7. a) 1.2 b) -1.2
 c) 2.25 d) $-1.8\bar{3}$
8. a) A: -7.9, B: -7.2 b) C: -4.4, D: -3.2
 c) J: -0.7, K: -0.2
 d) G: -15.37, H: -15.32
9. a) B: -7.2 b) D: -3.2
 c) K: -0.2 d) H: -15.32
10. a) E: $-\frac{45}{4}$, F: $-\frac{43}{4}$ b) L: $-\frac{41}{8}$, M: $-\frac{23}{4}$
 c) N: $-\frac{25}{6}$, P: $-\frac{11}{3}$ d) Q: $-\frac{9}{16}$, R: $-\frac{3}{16}$
11. a) E: $-\frac{45}{4}$ b) M: $-\frac{23}{4}$
 c) N: $-\frac{25}{6}$ d) Q: $-\frac{9}{16}$
12. Answers will vary. For example:
 a) 3.8, 3.9, 4.1 b) -1.2, -1.1, -0.6
 c) -4.4, -4.3, -4.1 d) -5.4, -5.1, -4.8
 e) -3.2, -0.1, 4.7 f) 4.3, 2.1, -2.9
 g) -5.63, -5.66, -5.68
 h) -2.982, -2.987, -2.989
13. a) See diagram below.
- 
- b) No, the temperature in the freezer may be above -18°C .
14. Answers will vary. For example:
 a) $\frac{7}{8}, \frac{9}{8}, \frac{11}{8}$ b) $\frac{11}{10}, \frac{3}{10}, -\frac{13}{10}$
 c) $-\frac{179}{48}, -\frac{89}{24}, -\frac{177}{48}$
 d) $-\frac{3}{8}, -\frac{1}{4}, -\frac{3}{16}$ e) $0.25, \frac{1}{3}, \frac{5}{12}$

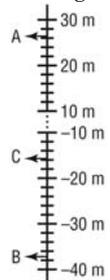
- f) $-0.27, \frac{7}{24}, -0.29$ g) $-\frac{71}{25}, -\frac{72}{25}, -\frac{74}{25}$
 h) $5\frac{16}{25}, 5\frac{17}{25}, 5\frac{19}{25}$

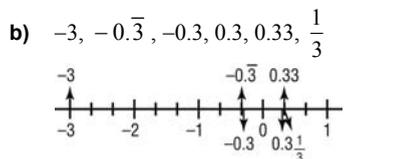
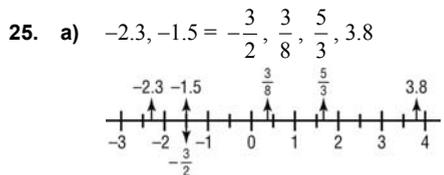
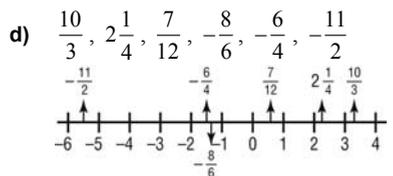
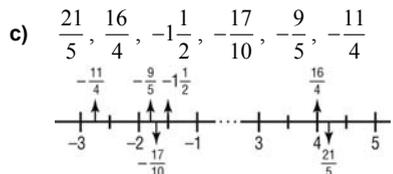
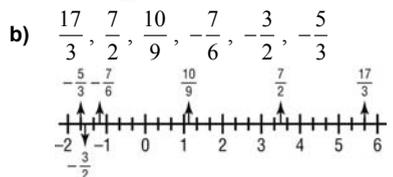
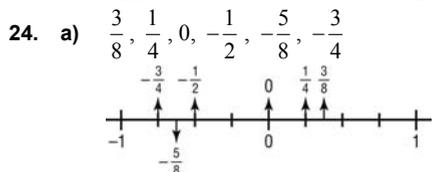
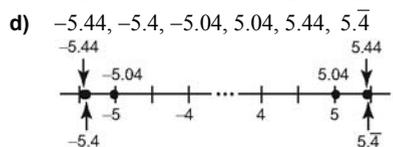
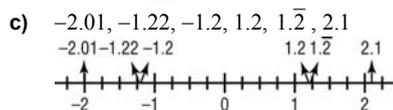
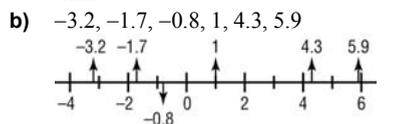
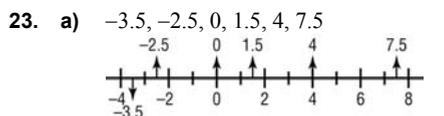
15.



16. a) 2.34 b) -2.3
 c) 1.4 d) 3.96
 e) -5.6 f) $2.8\bar{6}$
17. a) $\frac{3}{5}$ b) $-1\frac{7}{8}$
 c) $-\frac{13}{5}$ d) $-\frac{11}{3}$
18. a) $\frac{6}{7}$ b) $-\frac{3}{4}$
 c) $-\frac{6}{7}$ d) $\frac{5}{9}$
19. The statement is true when both numbers are positive.
20. a)



- b) $-\frac{17}{3}, -3.6, -\frac{11}{8}$ c) $-\frac{11}{8}, 0.8, 1.4, 4\frac{1}{3}$
- d) Answers will vary. For example:
 $-4.5, -2\frac{1}{3}, -0.3, 1.1, 3\frac{5}{8}$
21. a) $-\frac{5}{7} < -\frac{4}{7}$ b) $-\frac{5}{6} < -\frac{5}{7}$
 c) $-2.2 = -\frac{11}{5}$ d) $-4.4\bar{6} < -4.46$
22. a) Hiker A: 26.4 or $\frac{132}{5}$ m
 Hiker B: -37.2 or $-\frac{186}{5}$ m
 Hiker C: -15.7 or $-\frac{157}{10}$ m
- b) See diagram below.
- 
- c) Hiker C d) Hiker B



c) $-0.5 = \frac{-1}{2}$ d) $-7.45 = \frac{-149}{20}$

27. a) Rational number b) Irrational number
c) Rational number d) Rational number

Unit 3: Start Where You Are, page 105

1. a) $3\frac{1}{6}$ b) $2\frac{7}{8}$
c) $1\frac{1}{2}$ d) $5\frac{5}{12}$
e) $2\frac{7}{10}$ f) $\frac{1}{2}$
g) $1\frac{17}{20}$ h) $2\frac{5}{6}$
2. a) 4 b) -4
c) -10 d) 4
e) -1 f) -3
g) 18 h) -18

3.2 Adding Rational Numbers, page 111

3. a) $0.8 + 1.5 = 2.3$ b) $1.5 + (-0.8) = 0.7$
c) $(-0.8) + (-1.5) = -2.3$
d) $(-1.5) + 0.8 = -0.7$
4. a) $\frac{1}{2} + \frac{5}{4} = \frac{7}{4}$ b) $(-\frac{5}{4}) + \frac{1}{2} = -\frac{3}{4}$
c) $\frac{5}{4} + (-\frac{1}{2}) = \frac{3}{4}$ d) $(-\frac{1}{2}) + (-\frac{5}{4}) = -\frac{7}{4}$
5. a) i) 5 ii) 6.2
b) i) -5 ii) -6.2
c) i) -1 ii) -1.4
d) i) 1 ii) 1.4
6. Parts c and d
7. a) i) 12 ii) 6
b) i) -12 ii) -6
c) i) -6 ii) -3
d) i) 6 ii) 3
8. Part c
9. a) -2.4 b) 3.44
c) -32.825 d) -96.05
e) 182.281 f) -17.938
10. Yes, the sum of two negative rational numbers is less than both numbers.
11. a) $-\frac{1}{6}$ b) $\frac{7}{15}$
c) $-3\frac{19}{20}$ d) $7\frac{1}{10}$
e) $-4\frac{1}{12}$ f) $-1\frac{1}{30}$
g) $\frac{7}{8}$ h) $-3\frac{5}{6}$

i) $-5\frac{5}{12}$ j) $\frac{29}{40}$

12. a) The sum is positive. b) The sum is negative.
c) The sum has the same sign as the rational number farther away from 0.

13. a) -36.25 and -25.35
b) i) $-36.25 + (-25.35) = -61.60$
ii) \$61.60
c) i) $-61.60 + (14.75) = -46.85$
ii) \$46.85

14. a) -0.38 b) 0.38
c) $\frac{16}{15}$ d) $\frac{11}{20}$

15. a) -7.7°C b) -17.1°C
c) See diagram below.



16. a) The sum in part ii is greater since the positive number is farther away from 0.

i) -5.77 ii) 5.77

- b) The sum in part ii is greater since the sum in part i is a sum of two negative numbers.

i) $-1\frac{5}{12}$ ii) $\frac{1}{12}$

17. a) $45.50, 22.25, -15.77, -33.10$
b) $45.50 + 22.25 + (-15.77) + (-33.10) = 18.88$
c) \$18.88

18. No, Lucille's business lost \$266.04 in the first 6 months.
 $-545.50 + (-978.44) + 2115.70 + (-888) + 2570.4 + (-2540.2) = -266.04$

19. a) Any number less than or equal to 3.5
b) Any number greater than or equal to -11.6
c) Any number greater than or equal to 14.4
d) Any number less than or equal to 14.4

20. a) $1\frac{5}{8}$ b) $-1\frac{7}{15}$
c) $5\frac{5}{8}$ d) $-3\frac{7}{12}$

21. Any number less than or equal to 3.3

22. The greatest possible sum less than 0 is $-\frac{1}{12}$.

For example: $-\frac{1}{3} + \frac{1}{4} = -\frac{1}{12}$

3.3 Subtracting Rational Numbers, page 119

3. a) i) 2 ii) 1.8
b) i) -8 ii) -8.4
c) i) 2 ii) 1.8
d) i) -2 ii) -1.8

4. Part d

5. a) i) 9 ii) $\frac{9}{5}$
b) i) -13 ii) $-\frac{13}{5}$

- c) i) 13 ii) $\frac{13}{5}$

- d) i) 13 ii) $\frac{13}{5}$

6. Part c

7. a) 7.3 b) -85.77
c) 64.73 d) -31.57
e) -38.03 f) 151.84

8. a) 4.6°C or -4.6°C
b) There are two possible answers depending on which temperature is subtracted from the other temperature.

9. a) $-3\frac{5}{6}$ b) $-4\frac{14}{15}$
c) $-4\frac{11}{12}$ d) $-4\frac{1}{24}$
e) $3\frac{1}{3}$ f) $2\frac{5}{24}$

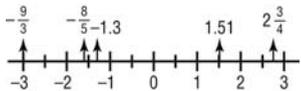
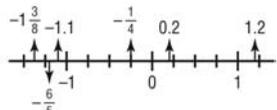
10. Yes, it is possible when you subtract a negative number from a positive number. For example:

$$1.3 - (-3.5) = 5.8; \quad \frac{3}{2} - \left(-\frac{5}{2}\right) = 4$$

11. a) $-417.5, 8844.43$
b) $8844.43 - (-417.5) = 9261.93$
The points are 9261.93 m apart.
12. a) Negative; -44.98 b) Positive; 7.11
c) Positive; $2\frac{1}{4}$ d) Negative; $-6\frac{4}{15}$
13. a) $1\frac{23}{30}$ b) 0.55
c) $4\frac{43}{60}$ d) 7.69
14. a) Any number greater than or equal to -4.9
For example: -4.8
b) Any number less than or equal to -4.6
For example: -5.2
c) Any number greater than or equal to 8.2
For example: 9.3

- d) Any number less than or equal to -3.7
For example: -3.8
15. a) 65.7 b) $\frac{3}{10}$
- c) -2.03 d) $4\frac{1}{6}$
- e) -5 f) $-8\frac{3}{4}$
16. a) Any 2 numbers with a difference of -3.5
For example: -1.1 and 2.4 ; 7.2 and 10.7
- b) Any 2 numbers with a sum of -13.9
For example: -5.7 and -8.2 ; -15.7 and 1.8
- c) Any 2 numbers with a sum of -6.2
For example: -9.3 and 3.1 ; 1.3 and -7.5
17. a) Any number greater than or equal to -17.5
- b) Any number less than or equal to -3.1

Unit 3: Mid-Unit Review, page 121

1. a) 
- b) $-\frac{9}{3}$, and $-\frac{8}{5}$; they are on the left of -1.5 on the number line.
2. $-1\frac{3}{8}$, $-\frac{6}{5}$, -1.1 , $-\frac{1}{4}$, 0.2 , 1.2
- 
3. a) $>$ b) $<$
- c) $<$ d) $>$
4. Answers will vary. For example:
- a) 1.3 b) 0
- c) $\frac{7}{20}$ d) -1
5. a) The sum of two positive numbers is positive.
The sum of two negative numbers is negative.
The sum of a negative number and a positive number has the same sign as the number farther away from 0.
- b) i) Positive; 5.82 ii) Negative; -6.03
- iii) Negative; $-1\frac{19}{24}$ iv) Positive; 1.31
- v) Negative; $-2\frac{43}{45}$ vi) Negative; -0.04
6. a) 8.95 b) -57.82
- c) -124.7 d) $\frac{37}{72}$

- e) $-3\frac{1}{20}$ f) $-4\frac{20}{21}$
7. a) i) 1.4°C ii) An increase
- b) 10.9°C
8. a) -22.85 b) -97.4
- c) $-\frac{1}{2}$ d) $-8\frac{5}{18}$
- e) -6.1 f) $6\frac{3}{8}$
9. $6193.7 - (-86) = 6279.7$
The distance between the two points is 6279.7 m.
10. b) i) Positive; 8.7 ii) Negative; -2.52
- iii) Negative; $-\frac{49}{60}$ iv) Positive; $13\frac{1}{6}$

3.4 Multiplying Rational Numbers, page 127

3. Part d
- a) -15.6 b) -10.4
- c) -6.5 d) 6.39
4. Parts a, c, and d
- a) -2 b) $1\frac{1}{4}$
- c) $-1\frac{3}{5}$ d) $-\frac{7}{16}$
5. a) -0.128 b) 2.855
- c) 3.304 d) 5.95
6. Parts a, b, c, e
7. a) $-\frac{2}{15}$ b) $-\frac{3}{20}$
- c) $\frac{2}{5}$ d) $\frac{5}{9}$
8. a) 12.75
- b) The product is less than 10.
- c) 11
- d) The product is less than 10.
- e) 12.5
- f) The product is less than 10.
9. a) $-\$96$ b) $-\$105$
- c) $\$14.95$
10. $(-10.4)(3.6) = -37.44$
The diver's depth is 37.44 m after 3.6 min.
11. a) -3.444 b) 28.44
- c) 231.04 d) 104.52
12. a) -4 b) $\frac{5}{9}$
- c) $-14\frac{29}{36}$ d) $7\frac{1}{3}$
13. a) 104
- b) i) 1.04 ii) -0.104
- iii) -10.4 iv) 0.104

- c) I only need to determine the sign and estimate the decimal point.
 d) Answers will vary. For example:
 $(260)(0.04) = 10.4$; $(0.026)(4000) = 104$;
 $(-2.6)(-4) = 10.4$
14. a) $(-3457.25)(25) = -86\,431.25$
 b) $-\$40\,863.38$
15. a) Positive; 3.1 b) Negative; $-\frac{5}{7}$
16. a) -4.7 b) $\frac{7}{2}$
 c) -0.4 d) $1\frac{2}{5}$
17. Yes, it is possible when both numbers are between 1 and -1 . For example: $(-0.6)(0.4) = -0.24$
18. b) $-\frac{2759}{7826}$

3.5 Dividing Rational Numbers, page 134

3. a) -0.5 b) -1.4
 c) 2.1 d) -0.2
 e) 2.4 f) -0.9
4. a) $\frac{2}{3}$ b) $-\frac{4}{3}$
 c) $\frac{7}{16}$ d) $\frac{3}{44}$
 e) $-\frac{15}{4}$ f) $\frac{36}{55}$
5. Parts c, d, e, and f
 6. -1.6 m/h
 7. a) 0.8 b) -1.4625
 c) $-0.41\bar{6}$ d) 5.1
 e) $-12.5\bar{3}$ f) 3.5
8. 5 h
 9. a) -11.52 b) $-23.28\bar{3}$
 c) 36.7 d) 4.8
 e) $-10.217\bar{3}$ f) $-0.240\bar{2}$
10. a) 41
 b) The quotient will be less than -10 .
 c) The quotient will be less than -10 .
 d) -1.2
11. a) 48 weeks
12. a) $\frac{15}{14}$ b) $\frac{1}{8}$
 c) $\frac{2}{3}$ d) $-6\frac{2}{15}$
 e) $-1\frac{17}{27}$ f) $\frac{31}{57}$
13. 35 times

14. -2.8°C/h
 15. $-\$0.32$
 16. Part c; $\left(\frac{5}{6}\right) \div \left(-\frac{2}{3}\right) = -\frac{5}{4} = -1\frac{1}{4}$
17. a) -4.5 b) $-\frac{21}{32}$
 c) 2.35 d) $-\frac{17}{3}$
18. a) -2.6 b) -6.9
 c) -6.3 d) -3.586
19. a) Ellice: $1300 \text{ m} \div 7.8 \text{ min} \doteq 166.67 \text{ m/min}$
 Alex: $-630 \text{ m} \div 4.2 \text{ min} = -150 \text{ m/min}$
 1300 m represents distance in the positive direction and -630 m represents distance in the opposite direction.
 b) Ellice runs at the greater average speed.
20. Answers will vary. For example: $-\frac{5}{6} \div \frac{5}{2} = -\frac{1}{3}$
21. Part d

3.6 Order of Operations with Rational Numbers, page 140

3. a) 3.58 b) -16.42
 c) 73 d) -0.192
4. a) $\frac{1}{4}$ b) $-\frac{5}{4}$
 c) $\frac{15}{8}$ d) $\frac{263}{60}$
5. a) -9.1
 6. a) -52.64 b) 98.784
 c) -206.99 d) -561.834
7. a) $-2\frac{7}{12}$ b) $\frac{8}{9}$
 c) $-\frac{8}{27}$ d) -8
8. a) Correction:
 $(-3.7) \times (-2.8 + 1.5) - 4.8 \div (-1.2)$
 $= (-3.7) \times (-1.3) - (-4)$
 $= 4.81 + 4$
 $= 8.81$
 b) Correction:
 $-\frac{3}{8} - \frac{4}{5} \times \frac{3}{10} \div \left(-\frac{4}{5}\right)$
 $= -\frac{3}{8} - \frac{6}{25} \div \left(-\frac{4}{5}\right)$
 $= -\frac{3}{8} - \left(-\frac{3}{10}\right)$
 $= -\frac{3}{40}$
9. $\$192.74$

10. a) 330 cm^2
11. a) i) About -18°C ii) -40°C iii) About -47°C
 b) i) 10°C ii) -25°C iii) 0°C
12. a) Multiplication, addition; $-6\frac{1}{3}$
 b) Multiplication, addition; $6\frac{8}{15}$
 c) Division, multiplication, addition; $3\frac{1}{8}$
 d) Addition, multiplication, subtraction $1\frac{1}{16}$
13. a) 54.6 b) -5.62
 c) About 12.82 d) About -14.24
14. a) $[-8.1 + (-16.7)] \div 2 = -12.4$; -12.4°C
 b) I used brackets to add the two temperatures first before I divided the sum by 2.
15. a) Answers will vary. For example:

$$\frac{-3}{2} + \left(\frac{4}{-5} - \frac{-8}{6} \right) \div \frac{10}{-12} = \frac{-107}{50}$$

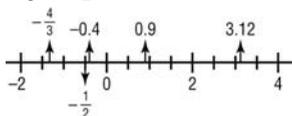
 b) Answers will vary. For example:

$$\left(\frac{6}{-5} - \frac{-12}{10} \right) \left(\frac{2}{-3} - \frac{4}{-8} \right) = 0$$
16. a) Below 0°C b) About -1.01°C
17. Correction:

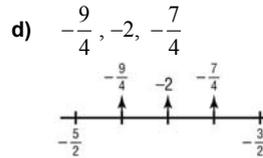
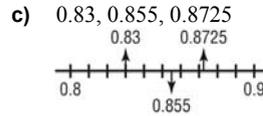
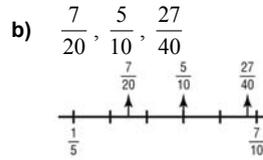
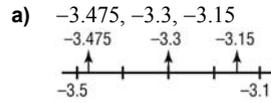
$$\begin{aligned} &(-8.2)^2 \div (-0.3) - 2.9 \times (-5.7) \\ &= 67.24 \div (-0.3) - (-16.53) \\ &= -224.\overline{13} - (-16.53) \\ &= -224.\overline{13} + 16.53 \\ &= -207.60\overline{3} \end{aligned}$$
18. a) 1.63
 b) The student likely calculated $6.8 \div (-3) \times (-6.7) + 3.5$ instead of calculating the numerator and the denominator and then finding the result of the division.
19. $\frac{5}{9}$ is equivalent to $\frac{1}{1.8}$, or dividing by 1.8.
20. -14.1°C
21. $-3.8 + 9.1 \times (-2.5 - 0.5) = -31.1$
 Yes, it is possible to find a positive solution.
 For example: $-(3.8 + 9.1) \times (-2.5) - 0.5 = 31.75$

Unit 3: Review, page 144

1. Parts a and c
2. $-\frac{4}{3}$, $-\frac{1}{2}$, -0.4 , 0.9 , 3.12



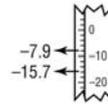
3. Answers will vary. For example:



4. -2.00 ; -0.51 ; -0.09 ; 0.54 ; 0.95

5. a) -1.5 b) 78.44
 c) -28.17 d) 48.053

6. a) -7.9°C
 b) See diagram below.



7. a) $\frac{13}{8}$ b) $1\frac{5}{6}$
 c) $-6\frac{1}{4}$ d) $-\frac{29}{18}$
8. a) 1.4 b) -83.14
 c) -9.64 d) -16.82
9. \$22.35
10. a) $-\frac{1}{2}$ b) $\frac{31}{40}$
 c) $10\frac{43}{70}$ d) $-13\frac{5}{12}$
11. Parts c and d
 a) 1.12 b) -1.28
 c) $-\frac{4}{5}$ d) $\frac{5}{9}$

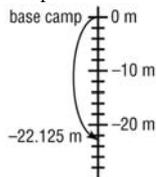
12. -7.1°C

13. Answers will vary. For example:

$$\left(-\frac{7}{9} \right) \left(\frac{4}{5} \right) = \left(-\frac{4}{9} \right) \left(\frac{7}{5} \right)$$

14. a) -1.05 b) -9.43
 c) $\frac{8}{21}$ d) -4

15. The climber will be 22.125 m lower than the base camp.



16. Parts c and d

- a) -5.5 b) About -1.15
 c) $-\frac{3}{5}$ d) $\frac{1}{3}$

17. Answers will vary. For example:

$$\left(-\frac{3}{8}\right) \div \left(\frac{5}{11}\right) = \left(\frac{3}{8}\right) \div \left(-\frac{5}{11}\right)$$

18. a) -3.75 b) -8.3

c) 1.56

19. a) -7 b) $22.\bar{8}$

c) $-\frac{45}{77}$ d) $-\frac{10}{21}$

20. a) i) -4.74 ii) -0.54
 b) The orders of operations are different.

21. a) $-\frac{17}{20}$ b) $\frac{1}{5}$

c) $-\frac{1}{5}$

22. a) 1554.82 cm^2

23. a) -4.9 b) $1\frac{13}{36}$

c) $-1\frac{211}{365}$ d) $2\frac{4}{5}$

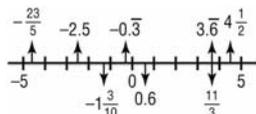
e) $-3\frac{6}{7}$ f) -5.8

g) -13.51

Unit 3: Practice Test, page 146

1. a) Answers will vary. For example: -0.55

2. a)



b) $4\frac{1}{2}, \frac{11}{3} = 3.\bar{6}, 0.6, -0.\bar{3}, -1\frac{3}{10}, -2.5, -\frac{23}{5}$

3. a) -1.3 b) $\frac{1}{2}$

c) 1.6 d) $-\frac{9}{4}$

4. a) It means that she owes \$2.34.
 b) $-\$67.44$ c) 19 withdrawals

5. a) 823.6 b) $7\frac{2}{3}$

c) $2\frac{17}{30}$ d) About -3.75

6. a) $3\frac{1}{2}$

b) The student added $\frac{1}{2} + \left(-\frac{3}{4}\right)$ instead of doing the division first.

7. a) -13.75 b) 3.54

Cumulative Review Units 1-3, page 148

1. a) $\frac{1}{5}$ b) $\frac{15}{13}$

c) $\frac{3}{11}$ d) 1.2

e) 0.4 f) 1.8

2. a) 8 cm b) 1.1 m

c) 8.5 mm

3. a) 0.49 b) 2.56

c) $0.000\ 036$ d) $\frac{144}{289}$

e) $\frac{1}{9}$ f) $\frac{4}{169}$

4. a) $\frac{7}{63} = \frac{1}{9} = \left(\frac{1}{3}\right)^2$, so $\frac{7}{63}$ is a perfect square.

b) $\frac{12}{27} = \frac{4}{9} = \left(\frac{2}{3}\right)^2$, so $\frac{12}{27}$ is a perfect square.

c) $\frac{4}{18} = \frac{2}{9}$, and 2 is not a perfect square, so $\frac{4}{18}$ is not a perfect square.

d) $0.016 = \frac{16}{1000}$, and 1000 is not a perfect square, so 0.016 is not a perfect square.

e) $4.9 = \frac{49}{10}$, and 10 is not a perfect square, so 4.9 is not a perfect square.

f) $0.121 = \frac{121}{1000}$, and 1000 is not a perfect square, so 0.121 is not a perfect square.

5. a) 2.6 m b) 7.8 m

6. $144.5, 168.9$

7. a) About $\frac{1}{6}$ b) About 4

c) About 0.9 d) About $\frac{1}{3}$

8. a) 17.4 cm b) 6.3 m

9. 24 cm^2

10. a) 72 cm^2 b) About 265 cm^2

11. a) $4^3 = 64$ b) $6^4 = 1296$
 c) $(-3)^7 = -2187$ d) $-(-2)^7 = 128$
 e) $-10^5 = -100\,000$ f) $-1^{12} = -1$
12. a) Negative; -81 b) Positive; $15\,625$
 c) Negative; -64 d) Positive; 49
 e) Negative; -1 f) Positive; 1
13. a) 8×10^2 b) $5 \times 10^4 + 2 \times 10^3$
 c) $1 \times 10^3 + 7 \times 10^2 + 6 \times 10^1$
 d) $7 \times 10^6 + 4 \times 10^0$
14. a) 784 b) -5
 c) -10 d) 139
 e) 4 f) 1
15. a) 6^8 b) $(-3)^8$
 c) $(-5)^3$ d) 2^{14}
16. a) -6 b) 12
 c) -3250 d) 512
17. a) $10^4 \text{ m} = 10\,000 \text{ m}$ b) $40\,000 \text{ m}$
18. a) $6^8 = 1\,679\,616$ b) $7^6 + 3^9 = 137\,332$
 c) $(-2)^3 - 1 = -9$ d) $6^8 + 3^{10} = 1\,738\,665$
 e) $(-4)^6 - (-2)^{12} - (-3)^8 = -6561$
 f) $3^6 = 729$
19. a) $-3.\bar{3}$, -3.3 , -2.8 , -1.9 , 1.2 , 4.8
 b) $-\frac{13}{4}$, $-2\frac{1}{2}$, $-\frac{13}{10}$, $-\frac{2}{5}$, $\frac{3}{4}$, $\frac{19}{5}$
 c) $-1.0\bar{1}$, $-\frac{1}{3}$, $-0.1\bar{1}$, 1.1 , $\frac{4}{3}$, $1\frac{3}{8}$
 d) -0.2 , $-\frac{1}{6}$, $-0.\bar{1}$, $\frac{1}{8}$, $\frac{2}{9}$, 0.25
20. a) 1.44 b) -10.307
 c) 9.17 d) -6.43
 e) $-\frac{1}{12}$ f) $-4\frac{17}{24}$
 g) $-7\frac{11}{12}$ h) $6\frac{1}{2}$
21. $\$85.648$
22. a) -36.5 b) 163.84
 c) 3.2 d) -5.6
 e) $11\frac{2}{5}$ f) $-18\frac{2}{3}$
 g) $\frac{1}{20}$ h) $-1\frac{1}{5}$
23. a) $-\frac{11}{24}$ b) -40.55
 c) $-6\frac{1}{20}$ d) $5\frac{1}{8}$

Unit 4 Linear Relations, page 150

Unit 4: Start Where You Are, page 153

1. $3n - 2$
 2. $3n + 1$

4.1 Writing Equations to Describe Patterns, page 159

4. a) 2 b) 3
 c) 4 d) 5
5. a) 7 b) 8
 c) 9 d) 10
6. Parts a and c
7. $f + 5$
8. $n = 4s + 1$ 9. $s = 2f + 3$
10. a) The red number 1 represents the red toothpick that is the same in each picture. The number of black toothpicks added is 4 times the number of houses in the picture.
 b) $1 + 4n$ c) $t = 1 + 4n$
11. a) i) As the term number increases by 1, the term value increases by 11.
 ii) $11t$ iii) $v = 11t$
 b) i) As the term number increases by 1, the term value increases by 3.
 ii) $3t + 2$ iii) $v = 3t + 2$
 c) i) As the term number increases by 1, the term value decreases by 1.
 ii) $8 - t$ iii) $v = 8 - t$
12. a)
- | Figure Number, n | Number of Toothpicks, t |
|--------------------|---------------------------|
| 1 | 3 |
| 2 | 5 |
| 3 | 7 |
| 4 | 9 |
- b) $2n + 1$ c) 91
 d) $t = 2n + 1$ e) Figure 8
13. a)
- | Number of Tables, n | Number of People, p |
|-----------------------|-----------------------|
| 1 | 6 |
| 2 | 10 |
| 3 | 14 |
| 4 | 18 |
- b) As the number of tables increases by 1, the number of people who can be seated increases by 4.
 d) $p = 4n + 2$ e) 10 tables
14. a) $C = 250 + 1.25n$ b) $\$3375$
 c) 300 brochures
15. a)
- | Number of Toppings, n | Cost of Pizza, C (\$) |
|-------------------------|-------------------------|
| 1 | 9.75 |
| 2 | 10.50 |
| 3 | 11.25 |
| 4 | 12.00 |
| 5 | 12.75 |

- b) $C = 9 + 0.75n$ c) 8 toppings
16. a) Variables may differ. $C = 12 + 1.5n$
- b) 11 windows
17. The garden size is 73.
18. b) $t = 5 + 4(n - 1)$
19. a)

Figure Number, n	Perimeter, P	Area, A
1	10	4
2	16	7
3	22	10

- b) Variables may differ. $P = 4 + 6n$
- c) $A = 1 + 3n$
- d) Perimeter: 304 cm; area: 151 cm²
- e) Figure 16 f) Figure 33
20. a) $v = 84 - 4t$
21. a)

Number of Cuts	1	2	3	4	5	6	7	8	9	10
Number of Pieces	2	4	8	16	32	64	128	256	512	1024

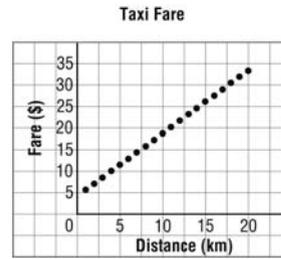
- b) The number of pieces doubled each time. They are powers of 2.
- c) 32 768 pieces d) $P = 2^n$
- e) 16 cuts

Unit 4 Technology: Tables of Values and Graphing, page 163

1. a) $F = 4.20 + 1.46d$
- b)

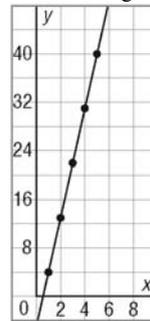
Distance, d (km)	Fare, F (\$)
1	5.66
2	7.12
3	8.58
4	10.04
5	11.50
6	12.96
7	14.42
8	15.88
9	17.34
10	18.80
11	20.26
12	21.72
13	23.18
14	24.64
15	26.10
16	27.56
17	29.02
18	30.48
19	31.94
20	33.40

c)

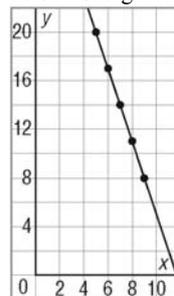


4.2 Linear Relations, page 170

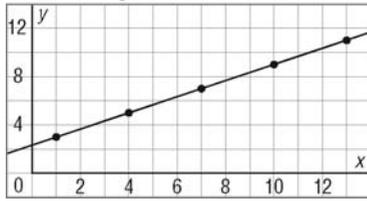
4. Parts a, b, and c
5. a) i) Yes
ii) When x increases by 1, y increases by 9.
- b) i) Yes
ii) When x decreases by 1, y increases by 3.
- c) i) No
iii) When x increases by 1, y does not increase or decrease by a constant value.
- d) i) Yes
ii) When x decreases by 3, y increases by 2.
6. a) The relation is linear since the points on the graph lie on a straight line.



- b) The relation is linear since the points on the graph lie on a straight line.



- d) The relation is linear since the points on the graph lie on a straight line.



7. a) $y = 2x$

x	y
1	2
2	4
3	6
4	8

- b) $y = x + 2$

x	y
1	3
2	4
3	5
4	6

- c) $y = -2x$

x	y
2	-4
4	-8
6	-12
8	-16

- d) $y = x - 2$

x	y
4	2
5	3
6	4
7	5

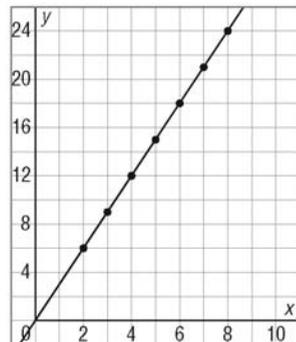
8. a)

x	2	3	4	5	6	7	8
y	6	9	12	15	18	21	24

- b) When x increases by 1, y increases by 3.

- c) $y = 3x$

- d)



- e) $y = -3$

9. a)

x	y
2	11
3	14
4	17
5	20
6	23

- b)

x	y
1	7
3	8
5	9
7	10
9	11

- c)

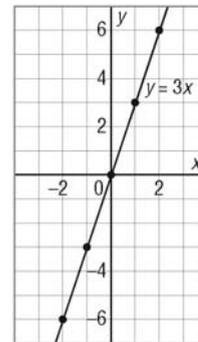
x	y
-4	11
-2	7
0	3
2	-1
4	-5

- d)

x	y
4	-10
6	-7
8	-4
10	-1
12	2

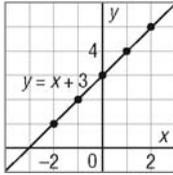
10. a) $y = 3x$

x	y
-2	-6
-1	-3
0	0
1	3
2	6



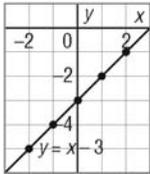
- b) $y = x + 3$

x	y
-2	1
-1	2
0	3
1	4
2	5



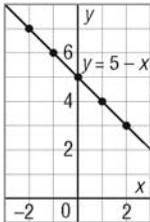
c) $y = x - 3$

x	y
-2	-5
-1	-4
0	-3
1	-2
2	-1



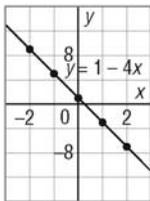
d) $y = 5 - x$

x	y
-2	7
-1	6
0	5
1	4
2	3



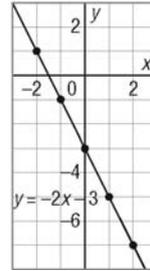
e) $y = 1 - 4x$

x	y
-2	9
-1	5
0	1
1	-3
2	-7



f) $y = -2x - 3$

x	y
-2	1
-1	-1
0	-3
1	-5
2	-7

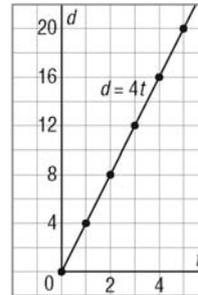


11. a) $d = 4t$

b)

t	d
0	0
1	4
2	8
3	12
4	16
5	20

c) I should join the points since measures of distance and time are not discrete data.



d) The relation is linear.

i) When the time increases by 1, the distance increases by 4.

ii) Points on the graph lie on a straight line.

e) 50.4 km

f) About 1.2 h, or 1 h 11 min

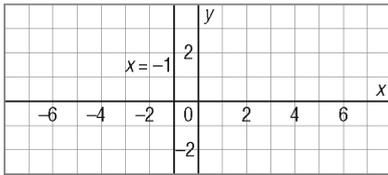
12. a) $T = 0.05p$

b)

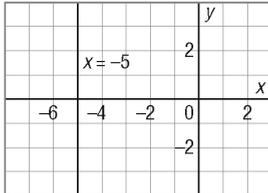
p	T
0	0
10	0.50
20	1.00
30	1.50
40	2.00

c) As the purchase price, p , increases by 10, the tax, T , increases by 0.50.

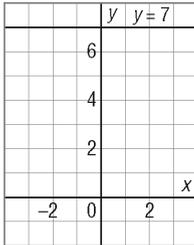
- b) A vertical line that intersects the x-axis at -1



- c) A vertical line that intersects the x-axis at -5



- d) A horizontal line that intersects the y-axis at 7



7. a) $y = 2$ b) $x = 1$

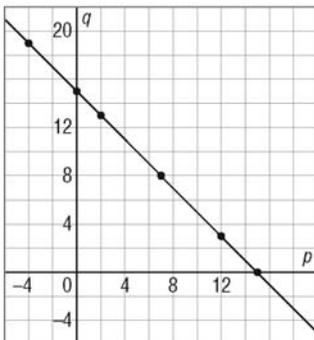
c) $x = -5$

8. $2x + 1 = 0$

9. a)

p	q
-4	19
0	15
2	13
7	8
12	3
15	0

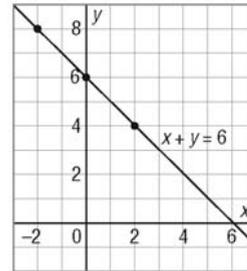
- b)



c) $p + q = 15$

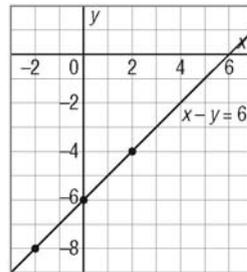
10. a) i) $x + y = 6$

x	y
-2	8
0	6
2	4



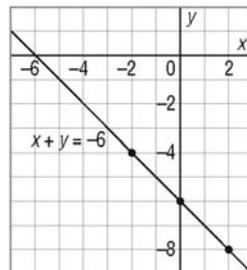
- ii) $x - y = 6$

x	y
-2	-8
0	-6
2	-4



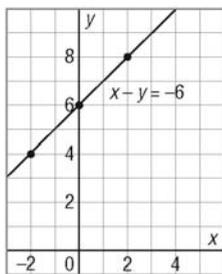
- iii) $x + y = -6$

x	y
-2	-4
0	-6
2	-8

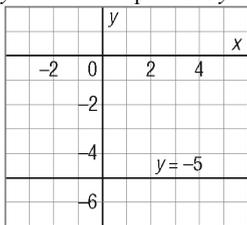


- iv) $x - y = -6$

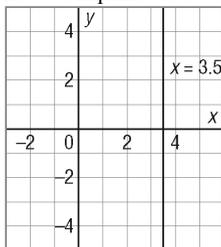
x	y
-2	4
0	6
2	8



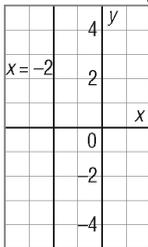
- b) The graphs in part a intersect the x -axis and the y -axis at 6 or -6 .
11. a) $y + 3 = -2$ simplifies to $y = -5$.



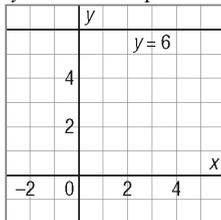
- b) $2x = 7$ simplifies to $x = 3.5$.



- c) $3x + 1 = -5$ simplifies to $x = -2$.

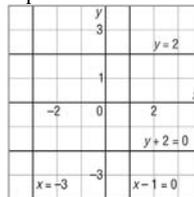


- d) $2y - 2 = 10$ simplifies to $y = 6$.



12. $x = -1, x = 4, y = -4, y = 3$

13. a) Square



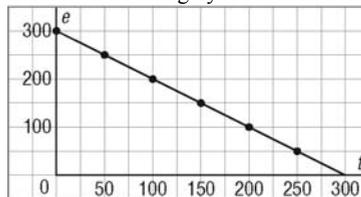
- c) Answers may vary. For example:
 $x = 0, y = 0, x = 4,$ and $y = -4$

14. a)

Distance Travelled, t (km)	Distance to Edmonton, e (km)
0	300
50	250
100	200
150	150
200	100
250	50

- b) 300

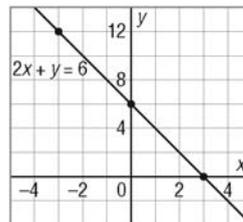
- c) I would join the points because distances between Edmonton and Calgary are not discrete data.



- d) $e + t = 300$

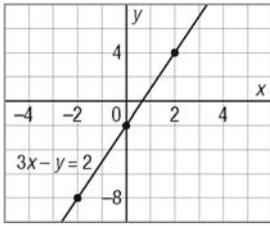
15. a) $2x + y = 6$

x	y
-3	12
0	6
3	0



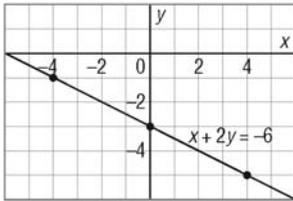
- b) $3x - y = 2$

x	y
-2	-8
0	-2
2	4



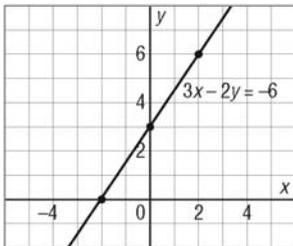
c) $x + 2y = -6$

x	y
-4	-1
0	-3
4	-5

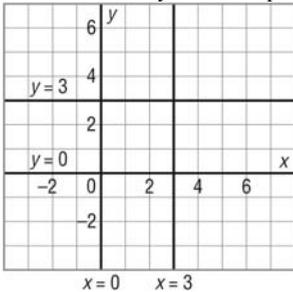


d) $3x - 2y = -6$

x	y
-2	0
0	3
2	6



16. a, b) Answers will vary. For example:



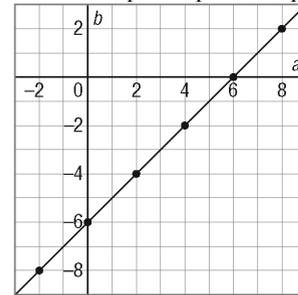
c) The other possible sets of equations are:
 $x = 0, y = 0, x = 3, y = -3$; $x = 0, y = 0, x = -3, y = 3$; $x = 0, y = 0, x = -3, y = -3$

17. a)

a	b
-2	-8
0	-6
2	-4

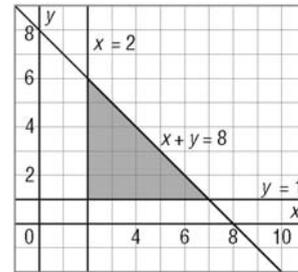
4	-2
6	0
8	2

b) I would join the points because all values between the plotted points are permitted.



c) $a - b = 6$

18. a)

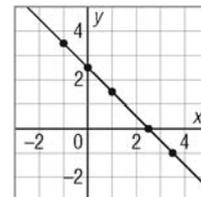


b) Right triangle; the lines $x = 2$ and $y = 1$ are perpendicular.

19. a) Let x and y represent 2 rational numbers with a sum of $2\frac{1}{2}$.

x	y
$3\frac{1}{2}$	-1
$2\frac{1}{2}$	0
$1\frac{1}{2}$	1
0	$2\frac{1}{2}$
-1	$3\frac{1}{2}$

b) The graph is an oblique line that intersects both axes at 2.5.

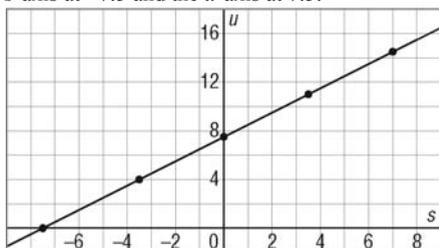


c) $x + y = 2\frac{1}{2}$

20. a) Variables may differ.

s	u
7	14.5
3.5	11
0	7.5
-3.5	4
-7.5	0

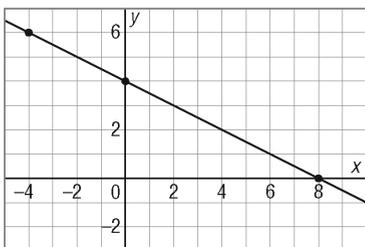
- b) The graph is an oblique line that intersects the s -axis at -7.5 and the u -axis at 7.5 .



- c) $s - u = -7.5$

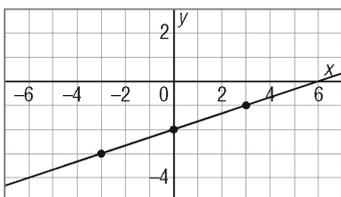
21. a) $\frac{1}{2}x + y = 4$

x	y
-4	6
0	4
8	0



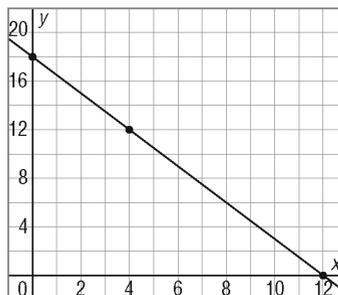
- b) $\frac{1}{3}x - y = 2$

x	y
-3	-3
0	-2
3	-1



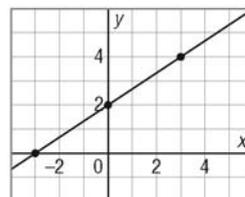
- c) $\frac{1}{2}x + \frac{1}{3}y = 6$

x	y
0	18
4	12
12	0



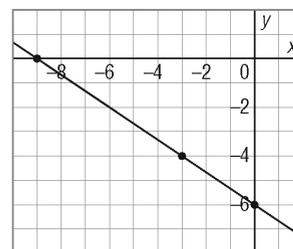
- d) $\frac{1}{3}x - \frac{1}{2}y = -1$

x	y
-3	0
0	2
3	4



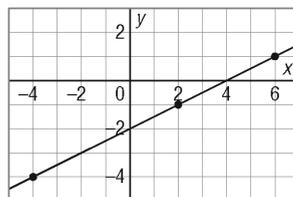
- e) $\frac{1}{3}x + \frac{1}{2}y = -3$

x	y
-9	0
-3	-4
0	-6



- f) $\frac{1}{4}x - \frac{1}{2}y = 1$

x	y
-4	-4
2	-1
6	1



Unit 4: Mid-Unit Review, page 181

1. a)

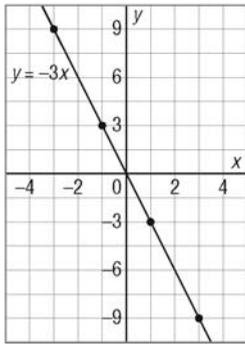
Figure Number, n	Perimeter, P
1	4
2	10
3	16
4	22

- b) $6n - 2$ c) 238 units
 d) $P = 6n - 2$ e) Figure 23

2. a) $C = 10 + 0.25t$ b) \$23.75
 c) 50 min

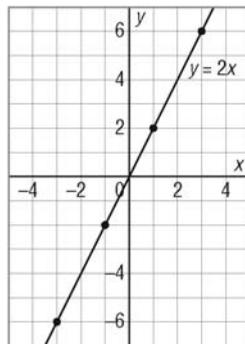
3. a) $y = -3x$

x	y
-3	9
-1	3
1	-3
3	-9



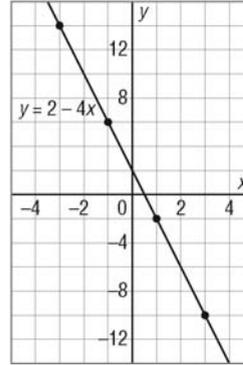
b) $y = 2x$

x	y
-3	-6
-1	-2
1	2
3	6



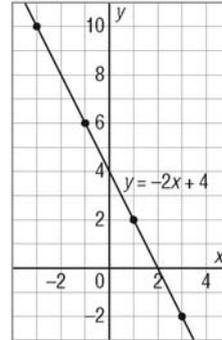
c) $y = 2 - 4x$

x	y
-3	14
-1	6
1	-2
3	-10



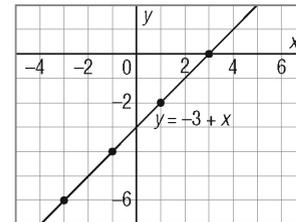
d) $y = -2x + 4$

x	y
-3	10
-1	6
1	2
3	-2



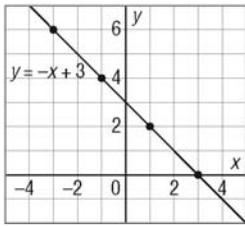
e) $y = -3 + x$

x	y
-3	-6
-1	-4
1	-2
3	0



f) $y = -x + 3$

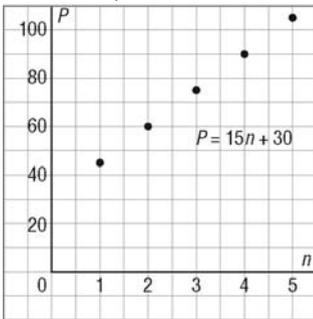
x	y
-3	6
-1	4
1	2
3	0



4. a)

Number of Weeks, n	Total Paid, P (\$)
1	45
2	60
3	75
4	90
5	105

b) I should not join the points because Alicia pays once a week, so the data are discrete.



c) In the table, P increases by \$15 each week. On the graph, to get from one point to the next, move 1 unit right and 15 units up.

5. a)

x	y
1	10
2	14
3	18
4	22
5	26

b)

x	y
1	-6
3	-10
5	-14
7	-18
9	-22

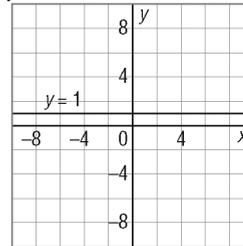
c)

x	y
-2	-15
-1	-9
0	-3
1	3
2	9

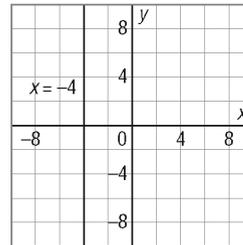
d)

x	y
2	1
4	-2
6	-5
8	-8
10	-11

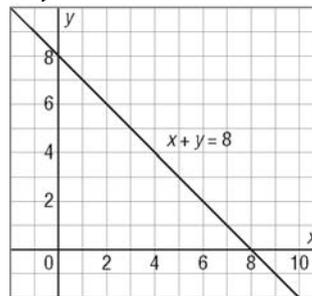
6. a) i) $y = 1$



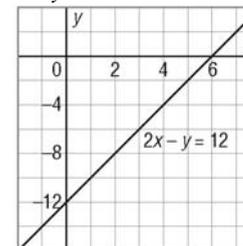
ii) $x = -4$



iii) $x + y = 8$



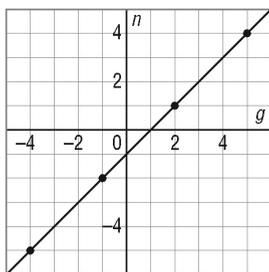
iv) $2x - y = 12$



7. a)

g	n
5	4
2	1
-1	-2
-4	-5

b) I would join the points because all values between the plotted points are permitted.



c) $g - n = 1$

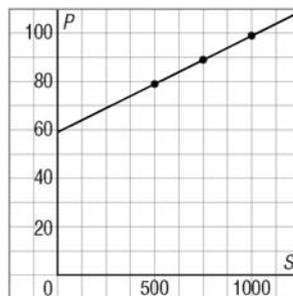
4.4 Matching Equations and Graphs, page 188

3. a) iii b) i
 c) ii
4. a) C b) B
 c) A
5. a) ii b) iii
 c) i
6. a) i b) iii
 c) ii
7. a) B b) A
 c) C
8. Graph B
9. a) $y = -x + 2$ b) $3x - y = -3$
11. c) i) C ii) A
 iii) D iv) B
12. a) $2y - x = 6$ b) $y = 1$
 c) $2x + y = 8$
13. a) $x - 2y = -8$ b) $y = -2x - 8$
 c) $y = -2x + 5$ d) $y = \frac{1}{2}x - \frac{1}{2}$

4.5 Using Graphs to Estimate Values, page 196

4. a) i) 6 ii) 0
 iii) -1
- b) i) -5 ii) 1
 iii) 4
5. a) i) -3 ii) 1
 iii) 7
- b) i) 3 ii) 0
 iii) $-1\frac{1}{2}$
6. a) i) -10 ii) 10
 iii) 18
- b) i) 4 ii) -2
 iii) $-3\frac{1}{2}$
7. a) i) 2.5 ii) -2.5
 iii) -4

- b) i) -9 ii) 7
 iii) 11
8. a) About \$550 b) 10 months
 c) About \$480
9. a) About 300 Calories b) About 24 min
 c) About 100 Calories
10. a) About 0.5 b) About 1.25
 c) About 1.5
11. a) i) About 20 m/s ii) About 30 m/s
 b) i) About 220 km/h ii) About 30 km/h
 c) i) I used interpolation for part a, i and ii and part b, ii.
 ii) I used extrapolation for part b, i.
12. i) About -2.5 ii) About 0.5
 iii) About 3.5
13. a) About \$300
 b) About 11 weeks, assuming her rate of pay stays the same.
 c) If the rate of pay changed, the graph would no longer be valid.
14. a) i) About $-\frac{17}{3}$ ii) About $-\frac{25}{3}$
 iii) About $\frac{35}{3}$
- b) i) About -2.5 ii) About 7.25
 iii) About 8.75
15. a)



- b) About \$1.15 c) About 150 mL

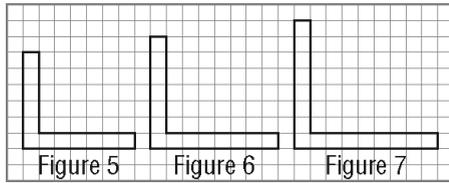
Unit 4 Technology: Interpolating and Extrapolating, page 199

1. a) i) \$8.50 ii) About \$42.50
 b) i) About 76 L ii) About 14 L

Unit 4: Review, page 201

1. a) Figure 1: 10 units Figure 2: 14 units
 Figure 3: 18 units Figure 4: 22 units

b)



c)

Figure Number, n	Perimeter, P
1	10
2	14
3	18
4	22
5	26
6	30
7	34

d) $6 + 4n$ e) $P = 6 + 4n$

f) 126 units g) Figure 21

2. a) As n increases by 1, v increases by 3.

b) $3n - 8$ c) $v = 3n - 8$

e) 55 f) 38

3. a)

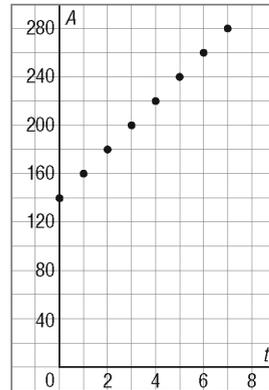
Term Number, n	Term Value, v
1	75
2	71
3	67
4	63
5	59
6	55
7	51

b) $79 - 4n$

4. a)

Time, t (months)	Account Balance, A (\$)
0	140
1	160
2	180
3	200
4	220
5	240
6	260
7	280

b) I will not join the points because Norman deposits money once a month, making the data discrete.



c) The relation is linear because the points lie on a straight line.

d) In the table, as t increases by 1, A increases by \$20. On the graph, to get from one point to the next, move 1 unit right and 20 units up.

e) $A = 140 + 20t$

5.

a) $y = 4x$

x	y
1	4
2	8
3	12

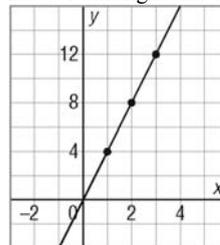
b) $y = 10 - 2x$

x	y
0	10
1	8
2	6

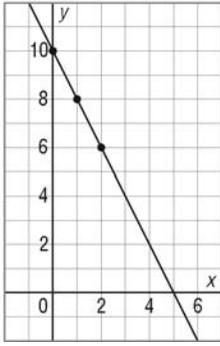
c) $y = 3x + 4$

x	y
-3	-5
-2	-2
-1	1

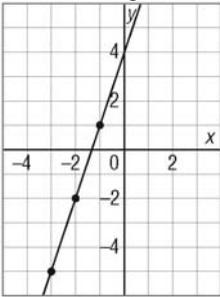
6. a) In the table, as x increases by 1, y increases by 4. On the graph, to get from one point to the next, move 1 unit right and 4 units up.



b) In the table, as x increases by 1, y decreases by 2. On the graph, to get from one point to the next, move 1 unit right and 2 units down.



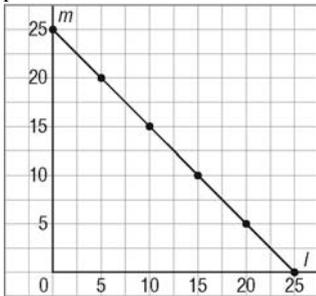
- c) In the table, as x increases by 1, y increases by 3. On the graph, to get from one point to the next, move 1 unit right and 3 units up.



7. a) Let l and m represent the two lengths of string.

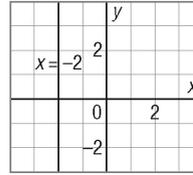
l	m
20	5
15	10
10	15
5	20

- b) i) The relation is linear because the points lie on a straight line.
ii) I should join the points because the string can be cut anywhere, so values between points are permitted.

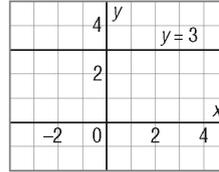


- c) i) Variables may differ: $l + m = 25$
8. I do not need to make a table of values since the graphs are vertical lines and horizontal lines.

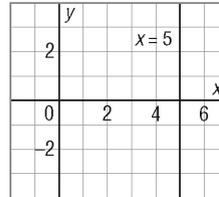
a) $x = -2$



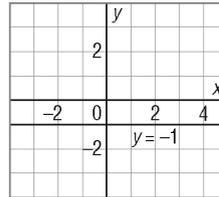
b) $y = 3$



c) $x = 5$

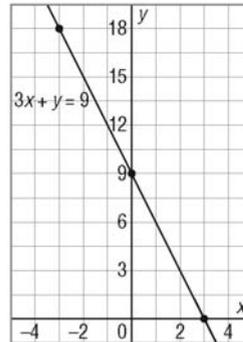


d) $y = -1$



9. a) $3x + y = 9$

x	y
-3	18
0	9
3	0



b) $2x - y = 4$

x	y
-2	-8
0	-4
2	0

- b) Coefficient: 14; variable: a ; degree: 2
 c) Coefficient: 1; variable: m ; degree: 1
 d) No coefficient; no variable; degree: 0
7. a) 2 b) 1
 c) 2 d) 0
8. Parts a and d can be modelled by the same set of algebra tiles. Parts b and f can be modelled by the same set of algebra tiles.
9. a) Coefficients: 5, -6; variable: x ; degree: 2; constant term: 2
 b) Coefficient: 7; variable: b ; degree: 1; constant term: -8
 c) Coefficient: 12; variable: c ; degree: 2; constant term: 2
 d) Coefficient: 12; variable: m ; degree: 1
 e) No coefficients; no variable; degree: 0; constant term: 18
 f) Coefficients: 5, -8; variable: x ; degree: 2; constant term: 3
10. Both students are correct. A monomial is a polynomial with one term.
11. a)  b)  c)  d)  e)  f) 
12. a) B b) D
 c) E d) A
 e) C
13. a) -16; monomial b) $x - 8$; binomial
 c) $4x$; monomial d) $2x^2 - 8x + 3$; trinomial
 e) $-5t + 5$; binomial f) $5x^2$; monomial
 g) $-2x^2 + 2x - 3$; trinomial
 h) $-3x^2 + 8$; binomial
14. Answers will vary. For example:
 a) $3x - 2$ b) 5

- c) $-2x^2$
 d) $x^2 + 3x + 5$
15. Parts a and f; b, d, and h; c and e; g and i are equivalent.
16. Parts b and e are equivalent because they can be represented by the same algebra tiles. Parts c and d are equivalent because they can be represented by the same algebra tiles.
17. Answers will vary. For example: 4^x
18. a) i) Variable: x ; degree: 2; number of terms: 3; coefficients: -3, -2
 ii) Variable: m ; degree: 2; number of terms: 2; coefficients: 1, 1

- b) Answers will vary. For example: $c^2 - 5$
 c) $-5 + c^2$; they can be represented by the same algebra tiles.
19. a) $-8d^2 - 4 - 3d$; $-3d - 8d^2 - 4$; $-3d - 4 - 8d^2$; $-4 - 3d - 8d^2$; $-4 - 8d^2 - 3d$
 b) $-8d^2 - 3d - 4$; for 3 terms, the maximum number of arrangements is 6.
20. a) i) 22.5 m
 ii) 70 m
 iii) 240 m
 b) No, doubling the speed more than doubles the stopping distance.

5.2 Like Terms and Unlike Terms, page 222

4. a) $3d$

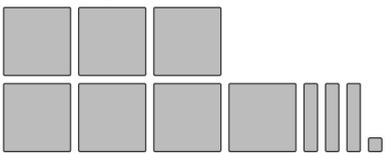
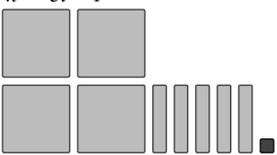
 $-5d$
 b) $3d$ and $-5d$ are like terms because both can be modelled by algebra tiles of the same shape and size. They have the same variable raised to the same exponent.
5. a) $4p$

 $2p^2$


- b) $4p$ and $2p^2$ are unlike terms because they cannot be modelled by algebra tiles of the same shape and size. They have the same variable, but raised to different exponents.
6. $-3x, 3x, 7x$; they have the same variable raised to the same exponent.
7. $-n^2, 2n^2, 5n^2$; they have the same variable raised to the same exponent.
8. a) $x + 4$ b) $x - 2$
 c) $2x^2 + x + 1$ d) $5x^2 - 3x + 1$
 e) $-2x + 4$ f) $-x^2 - 2x - 1$
9. Parts a and e are equivalent; both simplify to $2x^2 + 1$. Parts b and f are equivalent; both simplify to $-x - 3$. Parts c and d are equivalent; both simplify to $-x^2 + 2x$.
10. $2x + 3x = 5x$; $4 + 3x$ cannot be simplified.
11. a) $5c + 4$

 b) $2x^2 - 2x$

 c) $-3f^2 + 1$

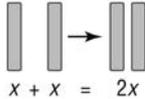
 d) $7b^2 + 3b + 1$

 e) $4t^2 + 5t - 1$

 f) $a^2 + 7a - 4$

12. a) $-m - 4$ b) $x + 2$
 c) $g + 3$ d) $-3h - 4$
 e) $-11n - 11$ f) $-s - 11$
13. a) $x^2 - 4x + 15$ b) $-3m^2 + 10m$
 c) $8x - 7$ d) $4p^2 - 2p + 7$
 e) 0 f) $-9x^2 + 5x + 4$
14. a) $x^2 + 4y - 1$ b) $-p^2 + 3p - 4pq - 1$
 c) $4x^2 - 7x + 7xy - 2y$ d) $4r^2 - 3rs + s$
 e) $-2g^2 + 6g + gh - 4$ f) $-6s^2 + 5s - 11st$

15. Parts a and f are equivalent; both simplify to $5x + 1$. Parts b and e are equivalent; part b simplifies to $2x^2 - 3x + 5$. Parts c and d are equivalent; part c simplifies to $-3x^2 - 5x + 4$.

16. Answers will vary. For example:
 $5a^2 - 7a^2 + 6a - 2a - 8$

17. Answers will vary. For example:
 $x^2 + 3 + 2x - 2x + 7$

18. a) $x + x = 2x$


- b) i) $2r + 1$ ii) $6t^2 - 9t$
 iii) $4c^2 + 6c + 3$ iv) $6x^2 - 2xy - 3y$

- c) Answers will vary. For example: $-8d^2 - 3d - 4$

19. a) $5x + x + 5x + x = 12x$
 b) $2x + 2 + 2x + 2 = 4x + 4$
 c) $3x + 2x + 3x + 2x = 10x$
 d) $4x + 3 + 4x + 3 = 8x + 6$

20. a) 5 rectangles; for example:



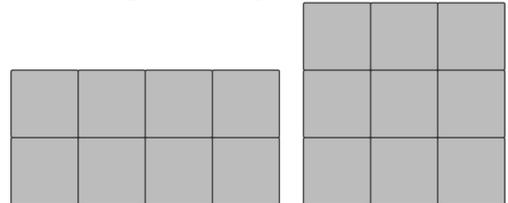
- b) 1 rectangle



- c) 4 rectangles; for example:



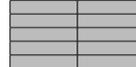
- d) 3 rectangles; for example:



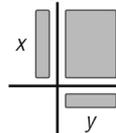
- e) 1 rectangle



- f) 8 rectangles; for example:



21. An xy tile would be a rectangle with dimensions equal to the lengths of the x -tile and the y -tile.

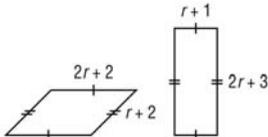


22. $x + y + 2x + 2y + 3x + 3y = 6x + 6y$

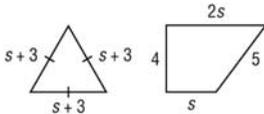
5.3 Adding Polynomials, page 228

3. a) $(3x + 5) + (-2x + 2)$
 b) $(-2x^2 + 4x - 2) + (2x^2 + 4x + 8)$
 c) $(3x^2 - 6x + 4) + (-x^2 - 4x + 2)$
4. $4x^2 + 1$
5. a) $7g + 7$ b) -1
 c) $6p - 5$ d) $-m + 11$
6. a) $5x - 1$ b) $x^2 - 3x$
 c) $-5x^2 + 2x + 12$
8. a) $9x + 7$ b) $7b + 5$
 c) $-5y + 3$ d) $2n + 5$
 e) $-7s + 1$ f) $-14h$
 g) $11m - 5$ h) $-11m + 5$
9. a) $6m^2 + 2m - 4$ b) $-6k + 4$
 c) $p^2 - 7p + 2$ d) $3t^2 + 9$
 e) $5x^2 - 2x + 7$ f) $-3x^2 - x + 13$
 g) $-5x^2 - x + 16$ h) $-2r^2 + r + 6$
10. a) i) $(2n + 1) + (n + 5) + (2n + 5) = 5n + 11$
 ii) $(7r + 2) + (7r + 2) + (7r + 2) + (7r + 2) = 28r + 8$
 iii) $(6t + 5) + (2t + 1) + (6t + 5) + (2t + 1) = 16t + 12$
 iv) $(f + 2) + (3f + 1) + (f + 2) + (3f + 1) = 8f + 6$
11. Answers will vary. For example:

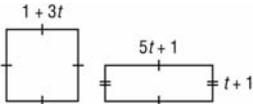
a)



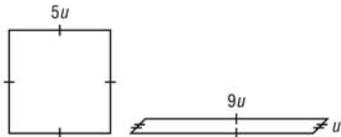
b)



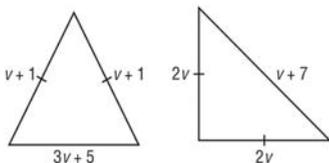
c)



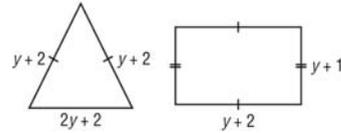
d)



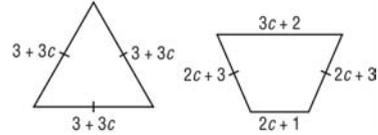
e)



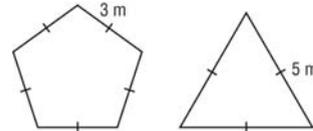
f)



g)



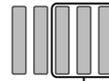
h)



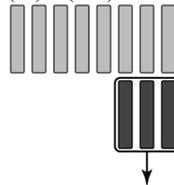
12. No, the student made errors in simplifying.
 $-7x - 5x = -12x$, not $-2x$, and $3 + 9 = 12$, not 1.
 The correct answer is: $3x^2 - 12x + 12$
13. a) Answers will vary. For example:
 $-2x^2 + 2x + 1 = (-x^2 + x + 1) + (-x^2 - x)$
 b) There are many possibilities.
14. $8m^2 + 8m - 4$
15. a) $2x^2 + 3x - 1$ b) $-x^2 - 2x + 6$
 c) $x^2 - 4x - 2$ d) $-4x^2 - 6x - 3$
 e) $-3x^2 - 5x + 1$ f) $-3x^2 - 7x + 2$
16. a) $-5x^2 - 3x + 1$
 b) The coefficients of the like terms are opposites.
17. a) $-4y^2 - xy$ b) $p^2 - 5q^2 + 7p - q + pq$
 c) $m^2 + 4n^2 + 5m - 8n + 3mn + 10$
 d) $-f^2 + 2g^2 - 11f + 9g - 2$
18. a) $3x + 2y + 2$
19. There are many possibilities.
 For example: $(x + y + 1)$, $(x + y + 1)$, $(x + 3y + 5)$

5.4 Subtracting Polynomials, page 234

4. a) $(-2x^2 + 4x - 2) - (-x^2 + 3x - 1) = -x^2 + x - 1$
 b) $(x^2 - 5x - 4) - (x^2 - 4x - 2) = -x - 2$
5. a) $(5r) - (3r) = 2r$



b) $(5r) - (-3r) = 8r$



c) $(-5r) - (3r) = -8r$

d) $(-5r) - (-3r) = -2r$

e) $(3r) - (5r) = -2r$

f) $(-3r) - (5r) = -8r$

g) $(3r) - (-5r) = 8r$

h) $(-3r) - (-5r) = 2r$

6. a) $2x + 1$ b) $2x + 5$
 c) $8x + 1$ d) $8x + 5$
7. a) $s^2 + s + 3$ b) $s^2 - s + 3$
 c) $5s^2 - 3s - 3$ d) $-5s^2 + 3s - 3$
8. a) $5x + 9$ b) $4b^2 - 3b$
 c) $-7x + 2$ d) $2p + 1$
 e) $2x^2 + 4x + 8$ f) $4m^2 - 7m + 10$
 g) $-5x^2 + x + 4$ h) $4r^2 - 7r - 4$
9. a) $(4n + 2500) - (2n + 2100)$
 b) \$6400 more
10. a) Answers may vary. For example:
 Substitute $x = 4$.

$$\begin{aligned} & [2(4)^2 + 5(4) + 10] - [(4)^2 - 3] \\ &= 2(16) + 20 + 10 - (16 - 3) \\ &= 32 + 20 + 10 - 13 \\ &= 49 \\ &(4)^2 + 8(4) + 10 \\ &= (16) + 32 + 10 \\ &= 58 \end{aligned}$$

$49 \neq 58$, so the answer is incorrect.

b) Correction:
 $(2x^2 + 5x + 10) - (x^2 - 3)$
 $= 2x^2 + 5x + 10 - x^2 + 3$
 $= 2x^2 - x^2 + 5x + 10 + 3$
 $= x^2 + 5x + 13$

12. a) The student did not change the signs of $+5y$ and -2 inside the second pair of brackets.

b) Correction:
 $(2y^2 - 3y + 5) - (y^2 + 5y - 2)$
 $= 2y^2 - 3y + 5 - y^2 - 5y + 2$
 $= y^2 - 8y + 7$

13. a) $w + 4$ b) $s + 3$
 c) $4p + 1$

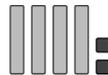
14. c) The sum of the two polynomials is 0.
 The coefficients of the like terms in each polynomial are opposites.

15. a) $3r^2 + 10s^2$ b) $-8m^2 - 3mn - 3n^2$
 c) $12c^2 - 10d^2 - cd$ d) $-e^2 + 15e + 6f + 5f^2$
 e) $-2j^2 - 10j + 5jk - 2k + k^2$
16. a) $-5x^2 + 9x - 11$ or $-11x^2 + x + 3$
 b) $(-5x^2 + 9x - 11) - (-8x^2 + 5x - 4) = 3x^2 + 4x - 7$
 $(-8x^2 + 5x - 4) - (-11x^2 + x + 3) = 3x^2 + 4x - 7$

17. $6x - 8$
18. There are many possibilities.
 For example: $(-4x^2 - 2x) - (-4x + 5) = -4x^2 + 2x - 5$

Unit 5: Mid-Unit Review, page 237

1. a) Variable: m ; number of terms: 2; coefficient: 3; constant term: -5 ; degree: 1
 b) Variable: r ; number of terms: 1; coefficient: 4; constant term: none; degree: 1
 c) Variable: x ; number of terms: 3; coefficients: 1, 4; constant term: 1; degree: 2
2. Answers will vary, for example: $3m^2 - 4m - 5$
3. a) $-x^2 + 12$; binomial
 b) $-2x^2 - 4x + 8$; trinomial c) $-4x$; monomial
4. a)



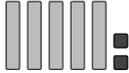


5. a) $2x$ and $-5x$ are like terms because they have the same variable raised to the same exponent.
 b) 3 and $4g$ are unlike terms because one is a constant and the other has a variable.
 c) 10 and 2 are like terms because they are both constants.
 d) $2q^2$ and $-7q^2$ are like terms because they have the same variable raised to the same exponent.
 e) $8x^2$ and $3x$ are unlike terms because they have variables raised to different exponents.
 f) $-5x^2$ and $-5x$ are unlike terms because they have variables raised to different exponents.

6. $-2x^2 - 3x + 1$

7. No, both answers are correct. The polynomials have their terms ordered differently.

8. No, Cooper is incorrect. $5x$ and -2 are unlike terms that cannot be simplified.

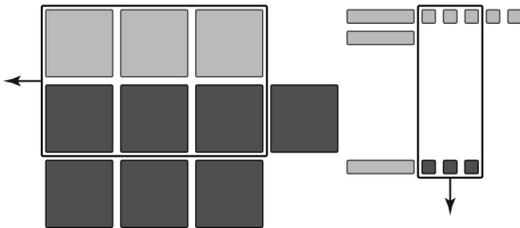


9. Parts a and h, b and e, d and f are equivalent.

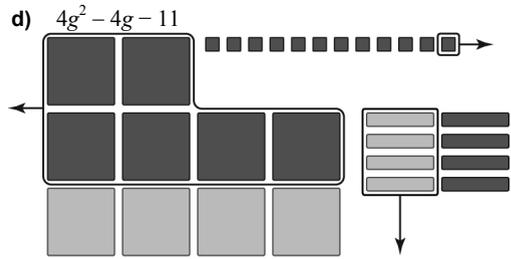
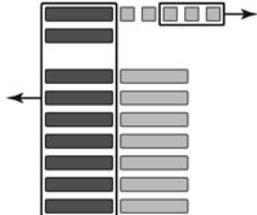
10. a) $2f^2 - 4f$



b) $-4r^2 + 3r + 2$



c) $7v + 2$



11. a) $15w^2 + 14w$ b) $6m^2$
 c) $6h - 6$ d) $-a^2 + 6a + 9$
 e) $y^2 + 13y - 6$ f) $10p^2 + 7p - 24$
 12. a) $2x^2 + 2x + 3$ b) $-2x^2 - 2x - 3$

5.5 Multiplying and Dividing a Polynomial by a Constant, page 246

3. a) $(4)(5) = 20$ b) $(3)(x) = 3x$
 c) $2(x + 2) = 2x + 4$ d) $3(3x + 2) = 9x + 6$
 4. a) $20 \div 4 = 5$ b) $3x \div 3 = x$
 c) $(2x + 4) \div 2 = x + 2$ d) $(9x + 6) \div 3 = 3x + 2$

5. a) ii

6. Part c

7. a) i) $15r$ ii) $-15r$
 iii) $15r$ iv) $-15r$
 v) $15r$ vi) $-15r$

b) The product of two negative numbers or two positive numbers is positive. The product of a negative number and a positive number is negative.

c) i)

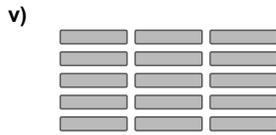


ii)

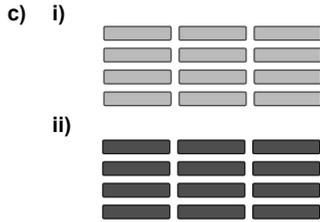


iii)





8. a) i) $3k$ ii) $-3k$
 iii) $-3k$ iv) $3k$
 b) Dividing two numbers with the same sign gives a positive quotient. Dividing two numbers with opposite signs gives a negative quotient.



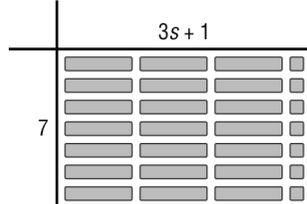
9. a) $(2)(3v^2 + 2v + 4) = 6v^2 + 4v + 8$

b) $5(m^2 + 3) = 5m^2 + 15$

10. a) $\frac{6v^2 + 4v + 8}{2} = 3v^2 + 2v + 4$

b) $\frac{5m^2 + 15}{5} = m^2 + 3$

11. a) $7(3s + 1) = 21s + 7$



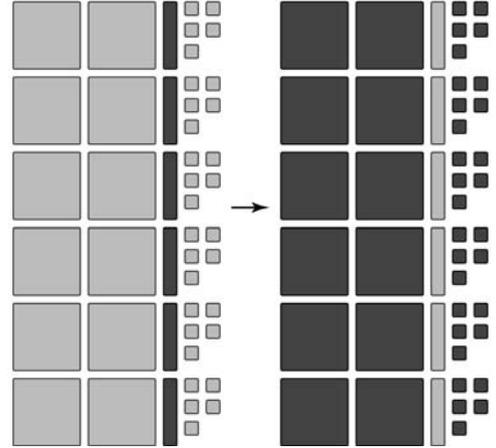
b) $-2(-7h + 4) = 14h - 8$



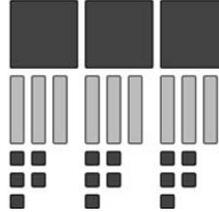
c) $2(-3p^2 - 2p + 1) = -6p^2 - 4p + 2$



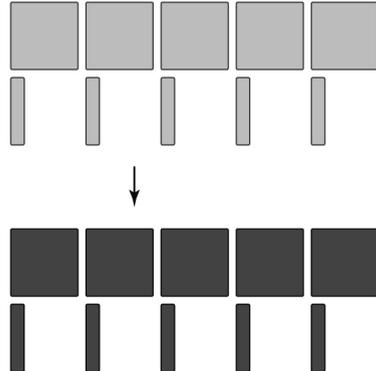
d) $-6(2v^2 - v + 5) = -12v^2 + 6v - 30$



e) $(-w^2 + 3w - 5)(3) = -3w^2 + 9w - 15$



f) $(x^2 + x)(-5) = -5x^2 - 5x$

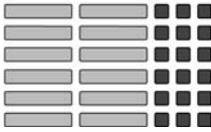


12. The errors are: $-2(-r) = 2r$, not $-2r$, and $-2(7) = -14$, not -16 .

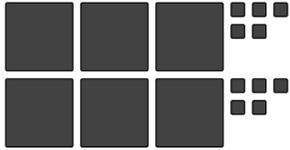
Correction:

$$\begin{aligned} & -2(4r^2 - r + 7) \\ &= (-2)(4r^2) + (-2)(-r) + (-2)(7) \\ &= -8r^2 + 2r - 14 \end{aligned}$$

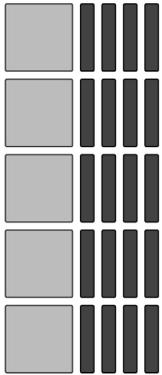
13. a) $\frac{12p-18}{6} = 2p-3$



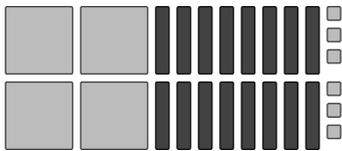
b) $\frac{-6q^2-10}{2} = -3q^2-5$



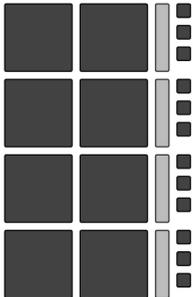
c) $\frac{5h^2-20h}{5} = h^2-4h$



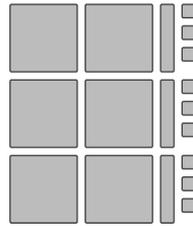
d) $\frac{4r^2-16r+6}{2} = 2r^2-8r+3$



e) $\frac{-8a^2+4a-12}{4} = -2a^2+a-3$



f) $\frac{6x^2+3x+9}{3} = 2x^2+x+3$



14. Errors are: The negative sign should apply to all the denominators. $\frac{-7}{7}$ simplifies to -1 , not 0 .

$2m^2 - 4m$ cannot be simplified to $-2m$.

Correction:

$$(-14m^2 - 28m + 7) \div (-7)$$

$$= \frac{-14m^2}{-7} + \frac{-28m}{-7} + \frac{7}{-7}$$

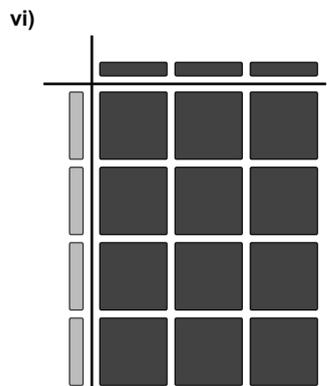
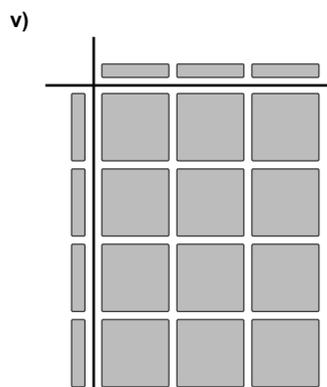
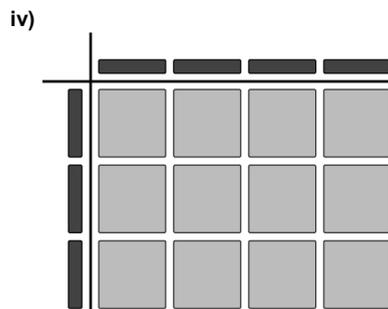
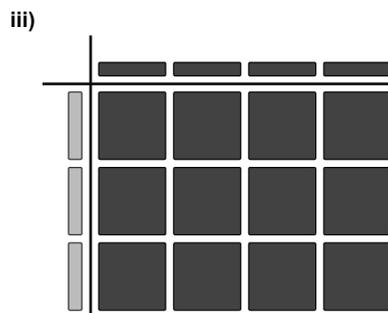
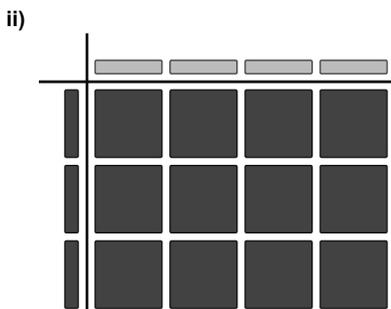
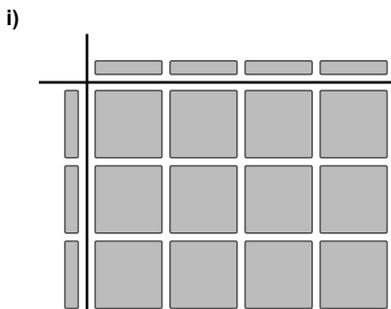
$$= 2m^2 + 4m - 1$$

15. a) $12u^2 - 48u - 24$ b) $24m^2 - 36m$
 c) $-20t^2 - 8t$ d) $30s^2 + 25s + 35$
 e) $-28y^2 + 12y - 36$ f) $80n^2 - 10n - 60$
16. a) $2d^2 - 1$ b) $2x + 1$
 c) $5 - 2m^2$ d) $-5 + n$
 e) $-2k^2 + 4k - 7$ f) $6d^2 - 3d - 5$
 g) $2c^2 - 3c + 1$
17. Parts c and f; the expressions in each pair are equivalent because of the distributive property.
18. a) i) $12p$ ii) $-7x$
 iii) $-12m^2 + 28$ iv) $-f^2 + 7f - 4$
 v) $-y^2 + 6y$ vi) $-24n + 6 - 9n^2$
- b) The products and quotients in parts i, ii, iii, iv, and vi can be modelled with algebra tiles.
19. a) i) $4x + 2$; $6x + 3$; $8x + 4$; $10x + 5$
 ii) $2 - 4x$; $3 - 6x$; $4 - 8x$; $5 - 10x$
- b) i) Each time, the coefficient of the x -term increases by 2 while the constant term increases by 1.
 ii) Each time, the coefficient of the x -term decreases by 2 while the constant term increases by 1.
- c) i) $12x + 6$; $14x + 7$; $16x + 8$
 ii) $6 - 12x$; $7 - 14x$; $8 - 16x$
- d) i) $2x + 1$; 0 ; $-2x - 1$
 ii) $1 - 2x$; 0 ; $-1 + 2x$
20. a) $5a^2 + 7a + 2$ b) 110 cm
21. a) Perimeter of square A: $4(4s + 1) = 16s + 4$
 Perimeter of square B: $3(16s + 4) = 48s + 12$
 b) $32s + 8$
22. a) $4x^2 - 6xy + 14y^2$ b) $-4pq - 12p^2 - 12q^2$
 c) $-6gh + 18h^2 - 9g^2 - 27g$

- d) $-5r^2 + 40rs - 15s^2 - 25s + 20r$
 e) $-8t^2 + 6v^2 - 38tv + 12v + 2t$
 23. a) $n^2 - 4mn + 2m^2$ b) $3rs + 8r + 2s$
 c) $2gh - 6g^2 - 3h$ d) $-2t^2 + 4ut + 8t$
 24. $\pi(3x)^2 - \pi x^2 = 8\pi x^2$

5.6 Multiplying and Dividing a Polynomial by a Monomial, page 255

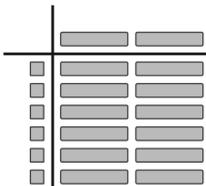
4. a) $(3c)(3c) = 9c^2$ b) $m(m+3) = m^2 + 3m$
 c) $2r(r+2) = 2r^2 + 4r$
 5. a) $\frac{9c^2}{3c} = 3c$
 b) For example: $\frac{m^2 + 3m}{m} = m + 3$
 c) For example: $\frac{2r^2 + 4r}{2r} = r + 2$
 6. Part c
 7. a) $3x(2x + 1) = 6x^2 + 3x$
 b) $4x(2x + 7) = 8x^2 + 28x$
 8. a) For example: $\frac{6x^2 + 3x}{3x} = 2x + 1$
 b) For example: $\frac{8x^2 + 28x}{4x} = 2x + 7$
 9. a) i) $12m^2$ ii) $-12m^2$
 iii) $-12m^2$ iv) $12m^2$
 v) $12m^2$ vi) $-12m^2$
 b) The products have the same two factors, $3m$ and $4m$, that only differ by the sign of the coefficient.
 c) Each of the problems can be modelled by algebra tiles.



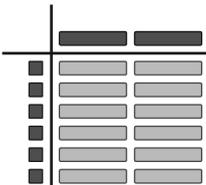
10. a) i) 6 ii) -6
 iii) -6 iv) 6
 v) 6x v) 6
 vii) -6 viii) -6

- b) Some quotients are the same because they have the same numerators and denominators that only differ by the signs of the coefficients.

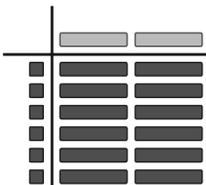
c) i)



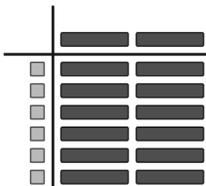
ii)



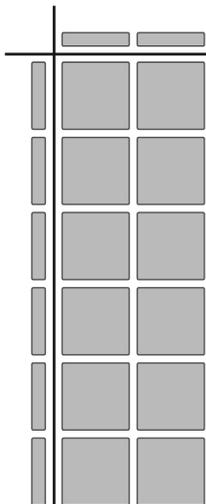
iii)



iv)



v)



11. a) $-12r^2$ b) $2n$
 c) $-35g^2$ d) -4
 e) $27h^2$ f) $4p$

- g) -6 h) 3

12. a) $2x^2 + 12x$ b) $15t^2 + 6t$
 c) $-6w^2 + 10w$ d) $-2x - 8x^2$
 e) $-15g - 3g^2$ f) $8y + 6y^2$
 g) $7sy + y$ h) $-6r + 12r^2$

13. $2x(x+1) = 2x(x) + 2x(1) = 2x^2 + 2x$

14. The student calculated $(-2d)(-3d)$ as $-6d^2$ instead of $6d^2$ and wrote $(-9)(-3d)$ instead of $(9)(-3d)$ in the second line.

Correction:

$$\begin{aligned} &(-2d+9)(-3d) \\ &= (-2d)(-3d) + (9)(-3d) \\ &= 6d^2 - 27d \end{aligned}$$

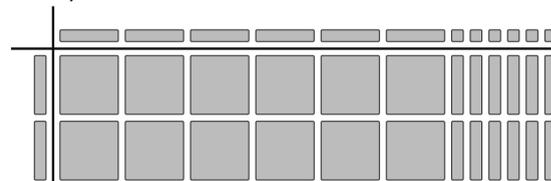
15. Think multiplication: $3r(r-4) = 3r^2 - 12r$

$$\frac{3r^2 - 12r}{3r} = r - 4$$

Or, write the quotient expression as the sum of two fractions:

$$\begin{aligned} &\frac{3r^2 - 12r}{3r} \\ &= \frac{3r^2}{3r} + \frac{-12r}{3r} \\ &= r - 4 \end{aligned}$$

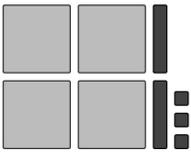
16. a) $5x + 2$ b) $6x + 4$
 c) $2 + y$ d) $5x - 2$
 e) $3 - 2g$ f) $-4 - 8k$
 g) $-6h - 9$ h) $4m - 9$
17. a) i) $3n + 1$ ii) $-12r + 21r^2$
 iii) $8s - 2$ iv) $4t^2 - 36t$
18. a) $6x + 6$

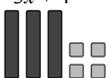
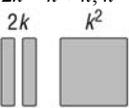


19. a) Larger rectangle: $(2s)(3s+2) = 6s^2 + 4s$
 Smaller rectangle: $(2s)(s+1) = 2s^2 + 2s$
 b) $(6s^2 + 4s) - (2s^2 + 2s) = 4s^2 + 2s$
 c) 30 cm^2
20. a) $6mn + 12m$ b) $10g - 6fg$
 c) $-42mp + 49m^2$ d) $-32hk - 12k^2$
 e) $-8t^2 + 12rt$ f) $-8gh + 5g^2$
21. a) $4x + 2y$ b) $6h + 3$
 c) $-3p + 4q$ d) $-8s + 7$
 e) $-2n - 6p$
22. Divide the shape into two rectangles.
 $(7x)(5x) + (4x)(7x) = 63x^2$
23. a) $\frac{54s^2}{6} = 9s^2$ b) $3s$

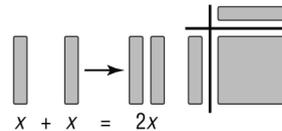
24. a) $2\pi r(r+h) = 2\pi r^2 + 2\pi r'h$
 b) $2\pi(5)(5+3) = 251 \text{ cm}^2$
 $2\pi(5)^2 + 2\pi(5)(3) = 251 \text{ cm}^2$
25. $\frac{13}{2}x - 6 - \frac{9}{4}y + \frac{5}{4x}$

Unit 5: Review, page 259

1. a) 
 b) 
2. a) Variable: w ; coefficient: 4; constant: -3
 b) Variable: v ; coefficient: 5; constant: 3
 c) Variable: y ; coefficients: $-1, 5$; constant: -6
3. a) i) Binomial ii) 1st degree
 b) i) Monomial ii) 2nd degree
 c) i) Trinomial ii) 2nd degree
4. a) $-y^2 - 3y + 4$

 b) $-3x + 4$

5. Parts a and h; b and g; d and e are equivalent.
6. a) $4x + 3$; 1st degree
 b) $2x^2 - 2x + 6$; 2nd degree
 c) $-x^2 - 9$; 2nd degree
7. $2k = k + k$; $k^2 = k \times k$

8. a) $-2h - 1$ b) $2j^2 + 3j - 4$
 c) $p^2 - 5p$
9. a) $5x^2$ and $-2x^2$ are like terms.
 b) $-8x, 5x$, and $-x$; 8, -2 , and 11 are like terms.
10. a) B b) C
 c) E d) A
 e) D
11. Answers will vary. For example:
 $-x^2 + 3x - 2x + 3 + 5$
12. a) $4x - 7$ b) $-7y^2 + y$
 c) $3a + 3$ d) $2a$

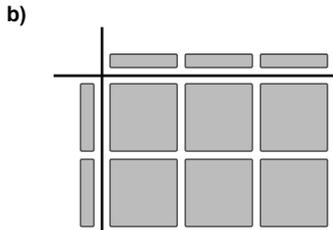
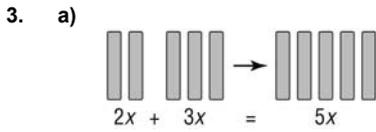
13.



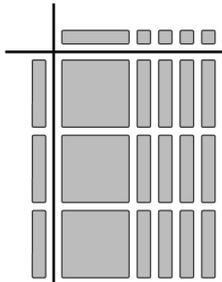
14. a) $(-2x^2 + 3x - 4) + (-4x^2 + x - 3) = -6x^2 + 4x - 7$
 b) $(3x^2 - 6x + 7) - (2x^2 - 2x + 3) = x^2 - 4x + 4$
15. a) $4p^2 + 4p + 6$ b) $q^2 + 2q + 5$
 c) $4r^2 - 7r - 3$ d) $-3s^2 + 8s + 8$
 e) $-2t^2 + 2t + 10$ f) $-6u^2 + 4$
 g) $-4a^2 - 5ab - 4b^2$
 h) $4x^2 + 2x + 9xy - 5y - 3y^2$
16. $12c + 13$
17. A - Q; B - S; C - P; D - R; E - T
18. $-5d^2 - 12d + 5$ or $-11d^2 + 2d - 3$
19. a) $10a + 10$; 40 cm b) $15a + 21$; 66 cm
20. a) $(4)(-x) = -4x$ b) $2(2x + 3) = 4x + 6$
21. a) For example: $\frac{-4x}{4} = -x$
 b) For example: $\frac{4x + 6}{2} = 2x + 3$
22. a) $5k$ b) $-20x^2$
 c) $-6m + 8$ d) $-2n^2$
 e) $-12s + 3$ f) $3 - 4m$
 g) $-35 + 10x$ h) $-2 + 4n - 6n^2$
 i) $2x + 6x^2$ j) $3p^2 + 3p - 2$
 k) $-5 + 7q - 2q^2$ l) $-12 - 30n + 42n^2$
23. a) $2x^2 - 2xy - 2y^2$ b) $-6m^2 + 3n - 4m$
 c) $-6pq + p^2 - 3q$ d) $8r^2 - 12r + 16s - 20s^2$
24. a) $(3x)(2x + 3) = 6x^2 + 9x$
 b) $(5a)(8a + 3) = 40a^2 + 15a$
25. a) For example: $\frac{6x^2 + 9x}{3x} = 2x + 3$
 b) For example: $\frac{40a^2 + 15a}{5a} = 8a + 3$
26. a) $14s^2$ b) $15g^2$
 c) $3m^2 + 2m$ d) $-5t^2 + 15t$
 e) $-28z^2 - 7z$ f) $6f^2 + 10f$
 g) $-15k + 5k^2$ h) $y - y^2$
27. a) Inside rectangle: $8x^2$; outside rectangle: $18x^2$
 b) $18x^2 - 8x^2 = 10x^2$
28. a) -4 b) 8
 c) $4x$ d) $-2a - 3$
 e) $-2 + c$ f) $-2y + 3$
29. a) $(2d + 5)$ metres
 b) The deck is 16 m by 13 m with an area of 208 m².

Unit 5: Practice Test, page 262

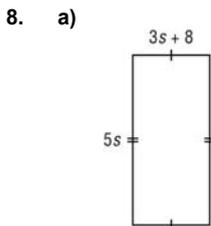
- $2t^2 - 6t + 4$
 - Degree: 2; number of terms: 3
 - Constant: 4; coefficient of t^2 : 2
- $d + 2 + (d + 3) + 6 + (d + d + 3) + 4 = 4d + 18$
 - 38 m



4. The student's answer is incorrect.
 $3r(r + 4) = 3r^2 + 12r$



- $-18d + 18$
 - $3h^2 + 9h - 6$
 - $-5y^2 + 7y - 12$
 - $8y^2 - 2y$
- $75m^2 - 50m$
 - $-15v^2 + 10v + 5$
 - $4x - 2$
 - $2 - g^2 + 5g$
- Answers will vary. For example:
 - $(x^2 + x + 1) + (2x^2 - 5x - 3) = 3x^2 - 4x - 2$
 - $(5x^2 + 2x + 2) - (2x^2 + 6x + 4) = 3x^2 - 4x - 2$

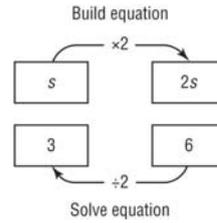


- b) $15s^2 + 40s$ c) $16s + 16$

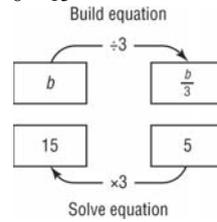
Unit 6 Linear Equations and Inequalities, page 264

6.1 Solving Equations by Using Inverse Operations, page 271

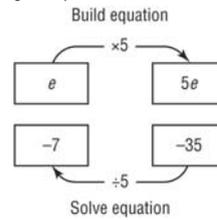
5. a) $s = 3$



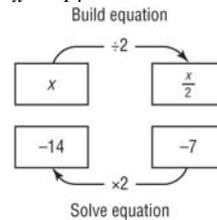
- b) $b = 15$



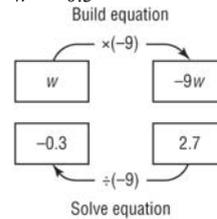
- c) $e = -7$



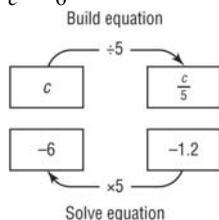
- d) $x = -14$



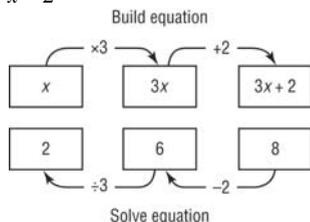
- e) $w = -0.3$



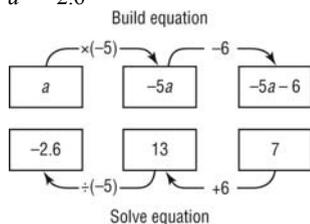
f) $c = -6$



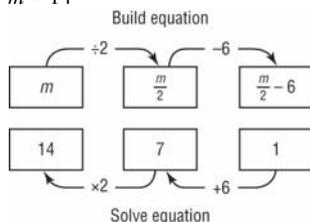
6. a) $x = 2$



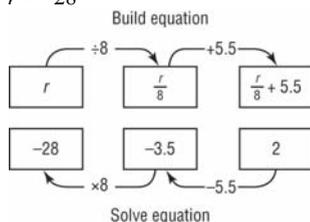
b) $a = -2.6$



c) $m = 14$



d) $r = -28$



7. The student should divide each side by -5 instead of adding 5 to undo multiplying m by -5 .

Correction:

$$-5m = 15$$

$$m = \frac{15}{-5}$$

$$m = -3$$

8. a) $x = 2.4$ b) $b = 7.5$
 c) $x = 40$ d) $x = 4.3$
 e) $n = 120$ f) $c = -4$
9. a) $2x = -10; x = -5$

b) $3x + 6.4 = 13.9; x = 2.5$

c) $4x = -8.8; x = -2.2$ d) $2x + 3.6 = 10; x = 3.2$

10. a) $c = 45$ b) $m = -33$

c) $n = -6$ d) $q = -20$

e) $c = 3$ f) $a = -5.85$

11. a) $\frac{x}{4} = -7; x = -28$ b) $3 + \frac{x}{5} = 6; x = 15$

c) $\frac{x}{2} = 2.5; x = 5$ d) $\frac{x}{3} - 4 = 2; x = 18$

12. No, Jenna's partner should undo the operations in the reverse order: subtract 4 then divide by -2 .

13. a) $\frac{b}{3} - 13.5 = 2.8$ b) $b = 48.9$

14. a) $2(1.2 + l) = 6.6$ b) $l = 2.1$

15. a) $0.12x = 39.48; x = 329$

b) $0.12(329) = 39.48$

16. a) \$3500

17. a) Let s represent Steve's sales, in dollars.
 $1925 + 0.1s = 2725$

b) \$8000

18. a) $x = 4$ b) $m = 1.5$

c) $t = 2.1$ d) $y = 0.8$

e) $a = -3.8$

19. a) Let w represent the volume of 1 bottle of water, in litres. $4w + 6(0.5) = 4.42$

b) 0.355 L

20. a) The student should not multiply 4.2 by 3 in line 2.

Correction:

$$3(x - 2.4) = 4.2$$

$$3x - 3(2.4) = 4.2$$

$$3x - 7.2 = 4.2$$

$$3x = 4.2 + 7.2$$

$$3x = 11.4$$

$$x = \frac{11.4}{3}$$

$$x = 3.8$$

- b) The student forgot the negative sign for $\frac{1}{2}x$ in line 3, and should multiply -2 by -2 instead of dividing it by 2 in line 4.

Correction:

$$5 - \frac{1}{2}x = 3$$

$$5 - \frac{1}{2}x - 5 = 3 - 5$$

$$-\frac{1}{2}x = -2$$

$$x = 4$$

21. a) Let t represent the number of extra toppings.
 $16.50 = 7.50 + 1.50t$

- b) The customer ordered 6 toppings.
22. a) Let c dollars represent the original price.
 $0.09c = 4.95$
 b) The item cost \$55.00.
 $0.09c = 4.95$

$$c = \frac{4.95}{0.09}$$

$$c = 55$$
23. a) $180(n - 2) = 1080$
 b) Kyler's solution:
 $180(n - 2) = 1080$
 $180n - 360 = 1080$
 $180n - 360 + 360 = 1080 + 360$
 $180n = 1440$

$$n = \frac{1440}{180}$$

$$n = 8$$
- c) Esta's solution:
 $180(n - 2) = 1080$

$$n - 2 = \frac{1080}{180}$$

$$n - 2 = 6$$

$$n = 6 + 2$$

$$n = 8$$
- d) Answers may vary. Esta's method of undoing the operations is simpler.
24. a) $x = -6.1$ b) $m = 3.25$
 c) $p = -2\frac{1}{12}$ d) $g = 0.965$

6.2 Solving Equations by Using Balance Strategies, page 280

4. a) $3t + 2 = t + 8; t = 3$ b) $5s + 3 = 2s + 9; s = 2$
5. a) Step 1: Subtract f from each side.
 Step 2: Add 2 to each side.
 Step 3: Divide each side by 2.
- b) Algebraic solution:
 $3f - 2 = f + 4$
 $3f - 2 - f = f + 4 - f$
 $2f - 2 = 4$
 $2f - 2 + 2 = 4 + 2$
 $2f = 6$

$$\frac{2f}{2} = \frac{6}{2}$$

$$f = 3$$
6. a) $g = 1$ b) $k = -2$
 c) $a = -2$ d) $h = 2$
7. a) i) $h = 3$ ii) $h = -3$
 iii) $h = -3$ iv) $h = -3$
 v) $h = 3$ vi) $h = 3$
8. a) $s = 2$ b) $t = -3$
 c) $w = 0.2$
9. $\frac{10}{x} = -3; x = -3\frac{1}{3}$
10. a) $a = 5$ b) $y = -3.2$
 c) $z = 5.4$ d) $u = 6.3$
 e) $b = 4.1$ f) $p = -2.5$
11. a) $n = -1$ b) $q = 9$
 c) $a = 3.6$ d) $v = -2.8$
 e) $x = 2.5$ f) $b = -3.5$
12. a) Let n represent the number of people.
 $50n = 2000 + 40n$
 b) The two halls will cost the same with 200 people.
13. $5 - 3n = 3.5n - 8; n = 2$
14. a) $1500 + 0.04s$ b) $1700 + 0.02s$
 c) $1500 + 0.04s = 1700 + 0.02s$
 d) $s = 10\ 000$; \$10 000 of sales would result in the same total earnings from both plans.
15. a) Student A forgot to write the negative sign for -5 in the last line.
 Correction:
 $2.2x = 7.6x + 27$
 $2.2x - 7.6x = 7.6x - 7.6x + 27$
 $-5.4x = 27$
 $x = -5$
- b) Student B should subtract $2.2x$ instead of adding $2.2x$ on each side in line 2.
 Correction:
 $-2.3x - 2.7 = 2.2x + 11.7$
 $-2.3x - 2.2x - 2.7 = 2.2x - 2.2x + 11.7$
 $-4.5x - 2.7 = 11.7$
 $-4.5x - 2.7 + 2.7 = 11.7 + 2.7$
 $-4.5x = 14.4$

$$x = \frac{14.4}{-4.5}$$

$$x = -3.2$$
16. a) i) $x = 81; x = 9$ ii) $a = 432; a = 3$
 b) An additional step of multiplying each side by the variable is required to solve a variable in the denominator. After this step, solving for the variable is the same as solving for a variable in the numerator.
17. a) $g = 35$ b) $j = -17.5$
 c) $h = 2.54$ d) $s = 10$
18. a) Let k represent the number of kilometres driven.
 $199 + 0.2k = 149 + 0.25k$
 b) Hendrik must drive a distance of 1000 km for the two rental costs to be the same.

19. a) $m = 8$ b) $t = \frac{20}{11}$
 c) $r = -\frac{1}{39}$ d) $x = \frac{67}{90}$

20. a) Dembe's method:

$$\begin{aligned} \frac{x}{3} + \frac{x}{4} &= x - \frac{1}{6} \\ 12\left(\frac{x}{3} + \frac{x}{4}\right) &= 12\left(x - \frac{1}{6}\right) \\ 4x + 3x &= 12x - 2 \\ 7x &= 12x - 2 \\ 7x - 12x &= 12x - 12x - 2 \\ -5x &= -2 \\ \frac{-5x}{-5} &= \frac{-2}{-5} \\ x &= \frac{2}{5} \end{aligned}$$

Bianca's method:

$$\begin{aligned} \frac{x}{3} + \frac{x}{4} &= x - \frac{1}{6} \\ 24\left(\frac{x}{3} + \frac{x}{4}\right) &= 24\left(x - \frac{1}{6}\right) \\ 8x + 6x &= 24x - 4 \\ 14x &= 24x - 4 \\ 14x - 24x &= 24x - 24x - 4 \\ -10x &= -4 \\ \frac{-10x}{-10} &= \frac{-4}{-10} \\ x &= \frac{4}{10} \\ x &= \frac{2}{5} \end{aligned}$$

b) Using the least common denominator saves the step of simplifying the final answer.

21. a) $x = -3\frac{2}{3}$ b) $x = 20$

c) $x = 4$ d) $x = 5$

22. Marlene made 10 assisted blocks.

23. a) Let m represent the number of minutes.

$$28 + 0.45(m - 30) = 40 + 0.25m$$

b) The monthly costs for both plans are the same at 127.5 min.

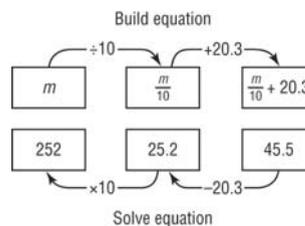
Unit 6: Start Where You Are, page 285

1. The price before the increase was \$1.28/L.

Unit 6 Mid-Unit Review, page 286

1. a) Divide by -3 . b) Add 2.
 c) Divide by 2. d) Subtract 9.

2. a)



b)

$$\begin{aligned} \frac{m}{10} + 20.3 &= 45.5 \\ \frac{m}{10} + 20.3 - 20.3 &= 45.5 - 20.3 \\ \frac{m}{10} &= 25.2 \\ \frac{m}{10} \times 10 &= 25.2 \times 10 \\ m &= 252 \end{aligned}$$

3. a) $2.5 + 1.2k = 27.7$; $k = 21$

Sheila travelled 21 km.

4. a) Let s represent the length of the third side in centimetres: $2(2.7) + s = 7.3$, or $5.4 + s = 7.3$

b) $s = 1.9$

5. a) $k = -4.5$ b) $b = 7\frac{2}{3}$

c) $x = 10.1$ d) $b = 7$

e) $n = 2.4$ f) $h = -23.2$

6. $6k + 1 = 2k + 9$; $k = 2$

7. a) $a = -16$ b) $w = 6.4$

c) $z = 8.4$ d) $x = 6$

e) $r = 7$ f) $y = -3$

g) $m = -1$

8. a) Let t represent the time in hours. $15 + 3t = 12 + 4t$

b) $t = 3$

6.3 Introduction to Linear Inequalities, page 292

3. a) True b) False

c) False d) False

e) True f) True

g) True h) False

4. a) $x < -2$ b) $p \geq 6$

c) $y < 0$ d) $m > 0$

5. a) No, $0 > -2$ b) Yes, $-6.9 < -2$

c) Yes, $-2.001 < -2$ d) Yes, $-3 < -2$

e) No, $-2 = -2$ f) No, $-\frac{1}{2} > -2$

6. Answers will vary. For example:

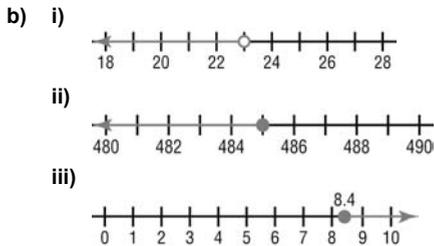
a) 5.01, 8, 10, 35 b) 6.9, 6, 0, -7

c) -1.5, 0, 2, 2.01 d) -20, -15, -13, -12.25

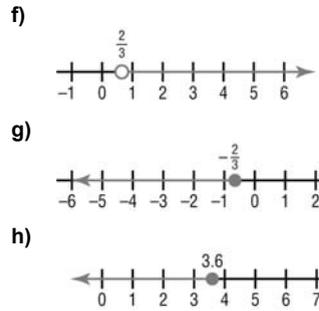
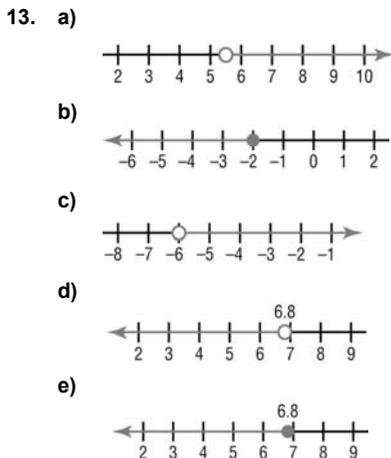
7. a) No b) Yes

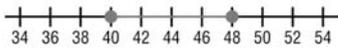
c) No d) Yes

8. a) Let c represent the number of cups of water a coffee maker can hold. $c \leq 12$
 b) Let a years represent the age to obtain a learner's permit to drive in Nunavut. $a \geq 15$
 c) Let m represent the maximum seating capacity of a school bus. $m \leq 48$
 d) Let n represent the number of people participating in the charity bike-a-thon each year. $n > 2500$
 e) Let s represent the size of shoes in a shoe store. $s \leq 13$
9. a) Graph v b) Graph iii
 c) Graph iv d) Graph ii
 e) Graph i f) Graph v
 g) Graph iv h) Graph i
10. Both are correct. They wrote the same inequality using a different variable.
11. a) i) Let k represent the mass in kilograms of a child who must ride in a car seat in Canada. $k < 23$
 ii) Let t represent the temperature in degrees Celsius that a silicone oven mitt can resist. $t \leq 485$
 iii) Let w dollars represent the minimum hourly wage in dollars in Alberta. $w \geq 8.40$



12. a) $x > 1$; neither 1 nor -3 is part of the solution.
 b) $x \leq 2$; both 1 and -3 are part of the solution.
 c) $x < -10$; neither 1 nor -3 is part of the solution.

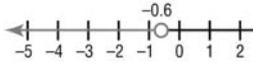


14. Let t represent the possible show time in minutes. $t \leq 48$ and $t \geq 40$
- 
15. a) Over is $>$; under is $<$; maximum is \leq ; minimum is \geq ; at least is \geq ; no more than is \leq .
16. $y \geq 0$

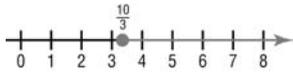
6.4 Solving Inequality by Using Addition and Subtraction, page 298

4. a) Subtract 4. b) Add $\frac{2}{3}$.
 c) Add 4. d) Add 4.5.
 e) Subtract $\frac{3}{10}$.
 f) Subtract 4.9.
5. a) Add 2. b) Subtract 4.2.
 c) Add $\frac{1}{2}$.
6. Answers will vary. For example:
 a) 5, 6.5, $\frac{15}{2}$ b) 10, 9.5, $\frac{3}{2}$
 c) $-5, -7.1, -8\frac{1}{4}$ d) 11, 11.2, $\frac{23}{2}$
7. a) $c > 4$ corresponds to graph iii; 3 is not a solution.
 b) $w \leq 13$ corresponds to graph ii; 3 is a possible solution.
 c) $r < -7$ corresponds to graph i; 3 is not a solution.
 d) $m \leq -9$ corresponds to graph iv; 3 is not a solution.
8. a) $x > -3$ b) $y \leq -6$
 c) $a \leq 4$ d) $x < -5$
 e) $k < -21$ f) $q < 6.4$
9. a) $t < 43$ b) $x < -11$
 c) $x < 11$ d) $a \leq -7$
 e) $p \geq -10.4$ f) $y \geq -37.4$
10. No, -9 is only one of the possible solutions. The solution of $-7 \geq b + 2$ is $-9 \geq b$.
11. a) $p = -10.2$ b) $p \geq -10.2$
 c) The processes are the same.

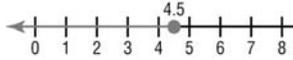
c) $a < -0.6$



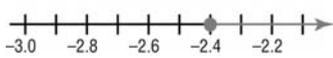
d) $b \geq \frac{10}{3}$



e) $s \leq 4.5$



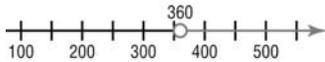
f) $v \geq -2.4$



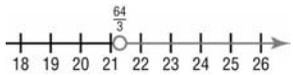
10. a) $7.5s - 1200 > 1500$, where s is the whole number representing the number of tickets sold.

b) $s > 360$; more than 360 tickets need to be sold.

c)



11. a) $x > \frac{64}{3}$



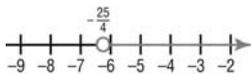
b) $c \geq 16$



c) $d \leq 6$



d) $f > -\frac{25}{4}$



12. a) $a \geq 2\frac{1}{3}$ b) $t \geq 2$

c) $z \geq 2$ d) $b \geq -9$

13. a) Let k represent the number of kilometres driven.
 $2.5 + 1.2k \leq 12$

b) $k \leq 7.91\bar{6}$ or $k \leq 7\frac{11}{12}$

Jake can travel up to $7.91\bar{6}$ km for \$12.

d)



14. a) $w = \frac{2}{5}$ b) $w \leq \frac{2}{5}$

c) The processes are the same, except when multiplying each side by a negative fraction. The equality symbol stays the same but the inequality symbol reverses.

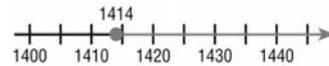
d) Both solutions involve the same fraction. The solution of an inequality is a range of numbers, whereas the solution of the related equation is one number.

15. a) Let h represent the number of hours.

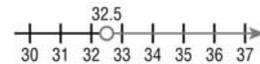
$0.55 + 0.00420h > 5 + 0.00105h$

b), c) $h > 1412.7$; Since the minimum cost of electricity, \$0.01, is for about 2 h use of the regular light bulb or for about 10 h use of the energy saver light bulb, we need to check the time of use near 1413 h for a more accurate solution. For 1413 h, electricity cost of regular light bulb: $\$0.55 + \$0.00420(1413) = \$6.48$
For 1413 h, electricity cost of energy saver light bulb: $\$5.00 + \$0.00105(1413) = \$6.48$
For 1414 h, electricity cost of regular light bulb: $\$0.55 + \$0.00420(1414) = \$6.49$
For 1414 h, electricity cost of energy saver light bulb: $\$5.00 + \$0.00105(1414) = \$6.48$
So, for 1414 h or more, it is cheaper to use an energy saver light bulb.

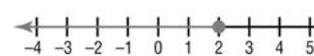
d)



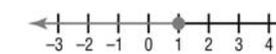
16. a) $h > 32.5$



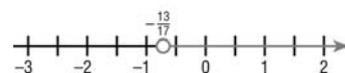
b) $n \leq 2$



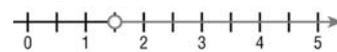
c) $v \leq 1$



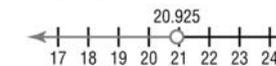
d) $z > -\frac{13}{17}$



17. a) $a > \frac{3}{2}$



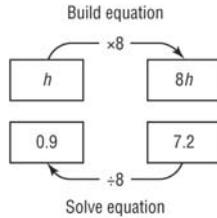
b) $m < 20.925$



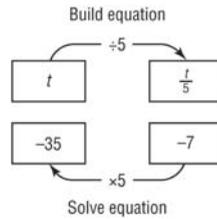
18. a) 5000 brochures b) 0 to 4999 brochures
 c) More than 5000 brochures

Unit 6: Review, page 308

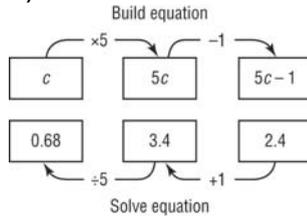
1. a) i) $h = 0.9$



- ii) $t = -35$



- iii) $c = 0.68$



- b) i)

$$8h = 7.2$$

$$\frac{8h}{8} = \frac{7.2}{8}$$

$$h = 0.9$$

- ii)

$$\frac{t}{5} = -7$$

$$5\left(\frac{t}{5}\right) = 5(-7)$$

$$t = -35$$

- iii)

$$5c - 1 = 2.4$$

$$5c - 1 + 1 = 2.4 + 1$$

$$5c = 3.4$$

$$\frac{5c}{5} = \frac{3.4}{5}$$

$$c = 0.68$$

2. a) Milan's steps:

$$4(3.2s + 5.7) = -6$$

$$\frac{4(3.2s + 5.7)}{4} = \frac{-6}{4}$$

$$3.2s + 5.7 = -1.5$$

$$3.2s + 5.7 - 5.7 = -1.5 - 5.7$$

$$3.2s = -7.2$$

$$\frac{3.2s}{3.2} = \frac{-7.2}{3.2}$$

$$s = -2.25$$

- b) Daria's steps:

$$4(3.2s + 5.7) = -6$$

$$4(3.2s) + 4(5.7) = -6$$

$$12.8s + 22.8 = -6$$

$$12.8s + 22.8 - 22.8 = -6 - 22.8$$

$$12.8s = -28.8$$

$$\frac{12.8s}{12.8} = \frac{-28.8}{12.8}$$

$$s = -2.25$$

3. a) $b = -12.4$

b) $t = -10.2$

c) $w = 29.6$

d) $x = -2.5$

4. a) Let l represent the length of the shorter side in centimetres. $2(3.1 + l) = 8.4$

b) $l = 1.1$; the length of the shorter side is 1.1 cm.

5. Algebraic solution:

$$3r + 3 = r + 7$$

$$3r + 3 - r = r + 7 - r$$

$$2r + 3 = 7$$

$$2r + 3 - 3 = 7 - 3$$

$$2r = 4$$

$$\frac{2r}{2} = \frac{4}{2}$$

$$r = 2$$

6. Algebraic solution:

$$2x - 3 = 6 - x$$

$$2x - 3 + x = 6 - x + x$$

$$3x - 3 = 6$$

$$3x - 3 + 3 = 6 + 3$$

$$3x = 9$$

$$\frac{3x}{3} = \frac{9}{3}$$

$$x = 3$$

7. a) $a = 16$

b) $m = \frac{1}{15}$

c) $x = \frac{880}{63}$

d) $g = -5.5$

e) $x = \frac{4}{3}$

f) $p = 3.4$

8. a) Let k represent the distance driven in kilometres.
 $200 = 25 + 0.35k$
 b) $k = 500$; for a distance of 500 km, the cost will be the same for the two companies.

9. The student forgot to multiply 5.4 by 3.5 and multiply 1.2 by 2.5 in line 2. The result of $7v - 7.5v$ should be $-0.5v$ instead of $0.5v$ in line 4.

Correction:

$$3.5(2v - 5.4) = 2.5(3v - 1.2)$$

$$7v - 18.9 = 7.5v - 3$$

$$7v - 7v - 18.9 = 7.5v - 7v - 3$$

$$-18.9 + 3 = 0.5v - 3 + 3$$

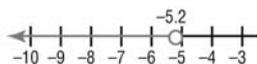
$$0.5v = -15.8$$

$$\frac{0.5v}{0.5} = \frac{-15.8}{0.5}$$

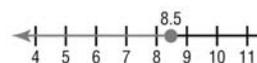
$$v = -31.8$$

10. a) Let a years represent the age of a person being admitted. $a \geq 18$
 b) Let h represent the height of a person in centimetres admitted to the ride. $h \geq 90$
 c) Let c represent the amount that Horton can spend in dollars. $c \leq 50$
 d) Let y years represent the age of a player for the game. $y \geq 5$
11. a) $x \leq -5$ b) $x < 1$
 c) $x > 3.5$ d) $x \geq 1\frac{2}{3}$

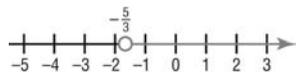
12. a) i)



ii)



iii)



iv)



- b) i) Neither -3 nor 5 are possible solutions.
 ii) Both 5 and -3 are possible solutions.
 iii) 5 is a possible solution.
 iv) Neither 5 nor -3 are possible solutions.

13. Answers will vary. For example:

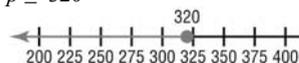
a) $h < -3; -10, -\frac{9}{2}, -7.5$

b) $k > -3; 0, \frac{12}{5}, -1.5$ c) $y < 5; 4, \frac{1}{2}, 3.5$

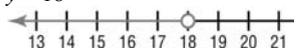
14. a) No b) No
 c) No d) Yes

15. a) Let p represent the number of students that can attend the prom. $400 + 30p \leq 10\,000$

b) $p \leq 320$



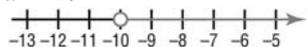
16. a) $y < 18$



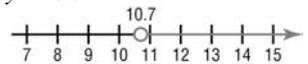
b) $y > -2$



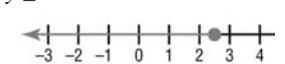
c) $x > -10$



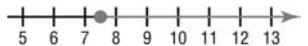
d) $y > 10.7$



e) $y \leq 2.5$



f) $a \geq 7.5$



Unit 6: Practice Test, page 310

1. Algebraic solution:

$$15 + 2d = 5d + 6$$

$$15 + 2d - 2d = 5d + 6 - 2d$$

$$15 = 3d + 6$$

$$15 - 6 = 3d + 6 - 6$$

$$3d = 9$$

$$\frac{3d}{3} = \frac{9}{3}$$

$$d = 3$$

2. a) $x = 2.1$ b) $x = \frac{52}{7}$ or $7\frac{3}{7}$

c) $r = -25.8$

d) $w = 18.6$

e) $c = -17$

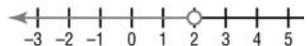
f) $m = -1.2$

3. a) Let n represent the number of meals.

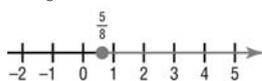
$$100 + 15n = 25 + 20n$$

b) $n = 15$

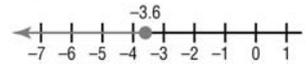
4. a) $t < 2$



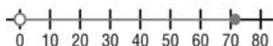
b) $t \geq \frac{5}{8}$



c) $m \leq -3.6$



5. a) Let k represent the distance the business person can travel, in kilometres. $24.95 + 0.35k \leq 50$
 b) $k \leq 71.57$



6. a) The student forgot to multiply 2 by 4 in line 2.
 Correction:

$$\frac{1}{4}c - 2 = 3$$

$$\frac{1}{4}c - 2 + 2 = 3 + 2$$

$$\frac{1}{4}c = 5$$

$$4 \times \frac{1}{4}c = 4 \times 5$$

$$c = 20$$
- b) The student should not change the inequality symbol when subtracting 4 in line 2. The negative sign for -12 should stay in line 5.

Correction:

$$x + 4 < -8 - 2x$$

$$x + 4 - 4 < -8 - 2x - 4$$

$$x < -2x - 12$$

$$x + 2x < -2x - 12 + 2x$$

$$3x < -12$$

$$3x \div 3 < -12 \div 3$$

$$x < -4$$

Cumulative Review Units 1-6, page 312

1. a) About 1.9 b) 0.9
 c) $\frac{4}{5}$ d) 0.02
 e) About 5 f) 2.1
 g) 1.6 h) About 0.5
2. a) -8
 b) 1
 c) $-33\,497$
 d) -304
 e) 18
3. a) $-2\frac{13}{24}$ b) $-11\frac{3}{20}$
 c) -4.42 d) $\frac{7}{18}$
 e) -34.43 f) $-\frac{1}{8}$
 g) 3
4. a) When the term number increases by 1, the term value increases by 2.
 b) $v = 2n + 3$ d) 51
 e) Term number 115

5. a)

x	y
1	1
2	4
3	7
4	10

- b) As x increases by 1, y increases by 3.
6. a) i) Vertical ii) Horizontal
 iii) Oblique
7. a) Graph B b) Graph C
 c) Graph A
8. a) About 5.5 days b) About 1600 km
9. a) Coefficient: 3; variable: x ; degree: 1; constant: -6
 b) Coefficients: 4, -2 ; variable: n ; degree: 2; constant: 5
 c) Coefficients: none; variable: none; degree: 0; constant: 19
 d) Coefficients: -1 , -21 ; variable: a ; degree: 2; constant: 7
10. a) $-7a + 1$ b) $y^2 + 2y - 4$
 c) $2c - 10cd + d + 4$ d) $6m^2 - 2n^2 + 2m - 3n$
11. a) $10s^2 - 6s + 3$ b) $3x^2 - 8x + 6$
 c) $-t^2 + 14t + 2$ d) $n^2 + n - 6$
 e) $x^2 + 4y^2 + 9xy - 7$
 f) $-3a^2 - 4b^2 + 5ab - 15b + 8a + 6$
12. a) $27s^2 - 63s + 36$ b) $7w^2 + 8w - 5$
 c) $21m^2 - 63m$ d) $2d - 3$
13. a) $x = 0.8$ b) $a = -10.8$
 c) $s = -4.2$ d) $c = 24$
 e) $n = 5.1$ f) $c = -\frac{7}{8}$
 g) $d = 6$ h) $v = -44.6$
 i) $t = 10$ j) $r = 6$
14. b) i) Both ii) Both
 iii) -4 only iv) Neither
15. a) $x < -4$ b) $x < -2$
 c) $b \geq 3.3$ d) $n \geq 72$
 e) $m \leq -38$ f) $t < -7.5$
 g) $s \geq 11$
16. a) $140 + 15n \leq 210$, n is an integer
 b) $n \leq 4.\bar{6}$, n is an integer

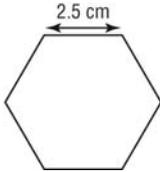
Unit 7 Similarity and Transformations, page 314

Unit 7: Start Where You Are, page 317

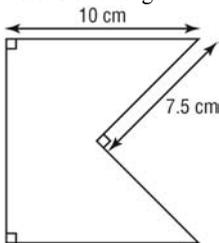
1. a) $\angle ACB = 76^\circ$
 b) $\angle GEF = 36^\circ$; $\angle GFE = 108^\circ$
 c) $\angle HJK = \angle KHJ = 72^\circ$

7.1 Scale Diagrams and Enlargements, page 323

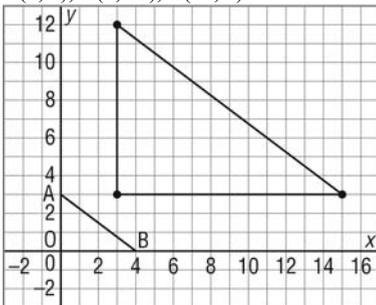
4. a) 4 b) 1.5
 5. a) 36 cm b) 205 mm
 c) 6.51 cm d) 171 mm
 e) 10 cm
 6. a) 210 cm by 150 cm b) 350 cm by 250 cm
 c) 61 cm by 44 cm d) 74 cm by 53 cm
 7. About 1.6
 8. About 7.5
 9.



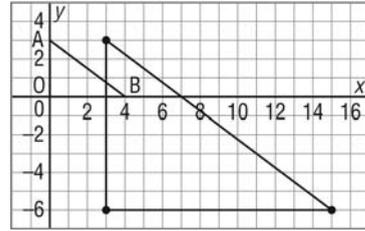
11. a) Diagram C
 i) The scale factor is 2.
 ii) Each side is 2 times the length of the corresponding side on the original diagram.
 b) Diagrams C and D
 i) The scale factor for both diagrams is 1.5.
 ii) Each side is 1.5 times the length of the corresponding side on the original diagram.
 12. a) 320 b) 11.2 m
 14. Dimensions of enlargement are marked on diagram:



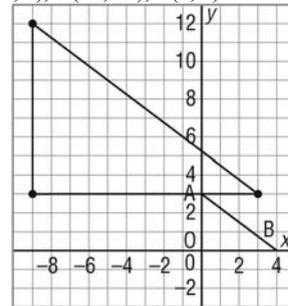
15. There are 3 possible enlargements of $\triangle ABC$.
 a) $O(3, 3)$, $A(3, 12)$, $B(15, 3)$



- b) $O(3, -6)$, $A(3, 3)$, $B(15, -6)$



- $O(-9, 3)$, $A(-9, 12)$, $B(3, 3)$

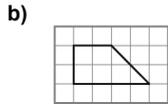
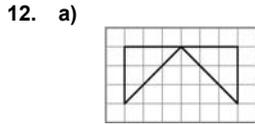


16. a) 80 000 microns, or 0.08 m, or 8 cm, or 80 mm
 b) 12 500

7.2 Scale Diagrams and Reductions, page 329

4. a) 0.025 b) 0.04
 c) 0.002 d) 0.016
 5. a) $\frac{1}{5}$ b) $\frac{3}{4}$
 6. a) $\frac{3}{5}$ b) $\frac{2}{3}$
 c) $\frac{17}{63}$ d) $\frac{1}{250}$
 e) $\frac{3}{40}$
 7. $\frac{1}{2}$; 0.5
 8. Rectangle C; each side of rectangle C is $\frac{1}{4}$ the corresponding length on the larger rectangle.
 9. Triangle B is a reduction of triangle A; the scale factor for the reduction is $\frac{1}{3}$.
 10. Polygon C is a reduction of polygon B; the scale factor for the reduction is $\frac{2}{3}$.

11. a) 25 cm b) 3.6 cm
 c) 10 cm d) 0.16 m, or 16 cm
 e) 48 cm



13. a) 4.55 mm b) 16 m

14. Length: $\frac{1}{200} \times 18 \text{ m} = 0.09 \text{ m}$, or 9 cm

Width: $\frac{1}{200} \times 9 \text{ m} = 0.045 \text{ m}$, or 4.5 cm

15. Length: $0.002 \times 99 \text{ m} = 0.198 \text{ m}$, or 19.8 cm

Width: $0.002 \times 54 \text{ m} = 0.108 \text{ m}$, or 10.8 cm

19. a) 1:50, or $\frac{1}{50}$, or 0.02

b) i) Length: 2.75 m; width: 1.5 m

ii) Length: 2.5 m; width: 1.25 m

c) 1.5 m

d) $\$4.99/\text{m} \times 27 \text{ m} = \134.73

20. a) 0.004 b) 60 m

c) 19 m

7.3 Similar Polygons, page 341

4. a) $AB = 12$ b) $BC = 20$

c) $CD = 9$ d) $DE = 5.6$

5. a) $x = 12.5$ b) $y = 32.1$

c) $z = 8\bar{3}$ d) $a = 0.0525$

6. Square IJKL ~ square QRST:

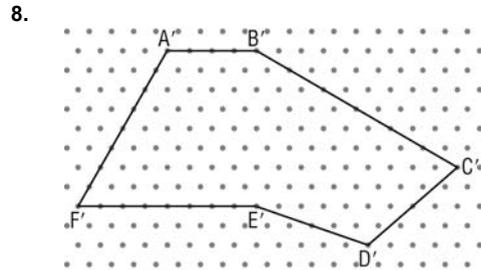
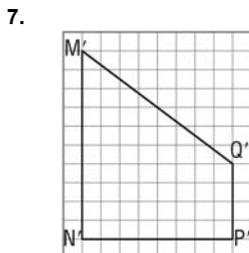
$$\frac{IJ}{QR} = \frac{JK}{RS} = \frac{KL}{ST} = \frac{LI}{TQ} = 2; \angle I = \angle Q, \angle J = \angle R,$$

$$\angle K = \angle S, \angle L = \angle T$$

Quadrilateral ABCD ~ quadrilateral QPMN:

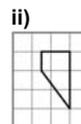
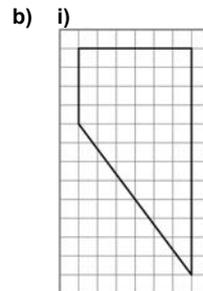
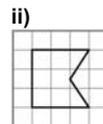
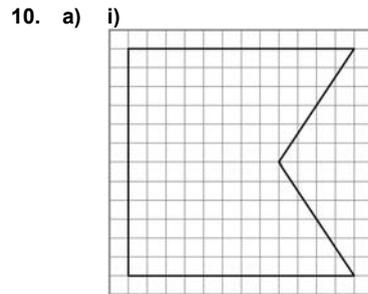
$$\frac{AB}{QP} = \frac{BC}{PM} = \frac{CD}{MN} = \frac{DA}{NQ} = \frac{1}{2}; \angle A = \angle Q, \angle B = \angle P,$$

$$\angle C = \angle M, \angle D = \angle N$$



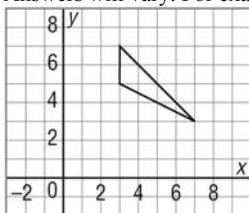
9. Rectangle EFGH ~ rectangle IJKM since the corresponding sides are proportional.

$$\frac{EF}{IJ} = \frac{FG}{JK} = 1.5625$$

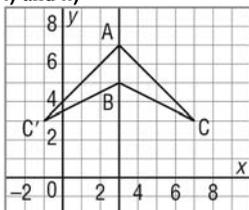


11. a) No; some corresponding angles are not equal.
 b) Yes; the corresponding sides are proportional and the corresponding angles are equal.

6. a) The vertical line through the centre of the tessellation is a line of symmetry.
 b) The vertical line through the centre of the blanket is a line of symmetry.
7. a) Answers will vary. For example:



- b) i) and ii)

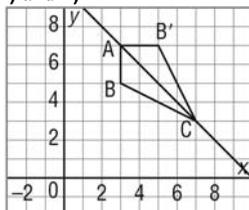


iii) $A(3, 7)$, $B(3, 5)$, $C(7, 3)$, $C'(-1, 3)$

iv) The line of symmetry is the vertical line through 3 on the x-axis.

- c) For one side:

- i) and ii)

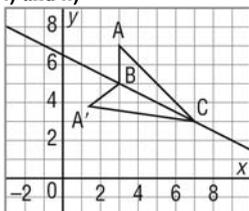


iii) $B'(5, 7)$

iv) The line of symmetry is the line through AC.

For the other side:

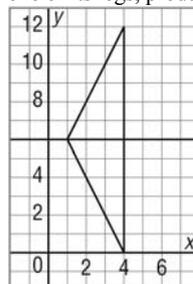
- i) and ii)



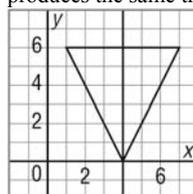
iii) $A'(1.4, 3.8)$

iv) The line of symmetry is the line through BC.

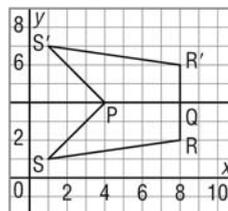
- d), e) A scalene triangle always produces a shape that is a quadrilateral with line symmetry. Right triangles or isosceles triangles may reflect to produce another triangle instead of a quadrilateral. A right triangle, when reflected in one of its legs, produces another triangle.



An isosceles triangle, when reflected in its height, produces the same triangle.



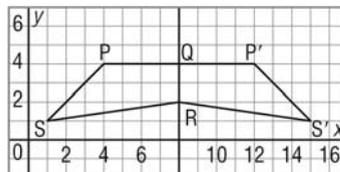
8. a)



The larger shape has coordinates: $R(8, 2)$, $S(1, 1)$, $P(4, 4)$, $S'(1, 7)$, $R'(8, 6)$.

It is a pentagon with a line of symmetry through PQ.

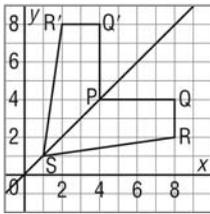
- b)



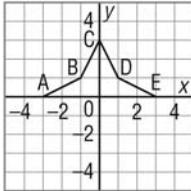
The larger shape has coordinates: $R(8, 2)$, $S(1, 1)$, $P(4, 4)$, $P'(12, 4)$, $S'(15, 1)$

It is a hexagon with a line of symmetry through QR.

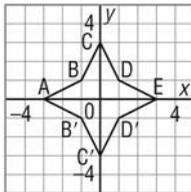
- c) The larger shape has coordinates: $P(4, 4)$, $Q(8, 4)$, $R(8, 2)$, $S(1, 1)$, $R'(2, 8)$, $Q'(4, 8)$
 It is a hexagon with a line of symmetry through PS.



9. a)



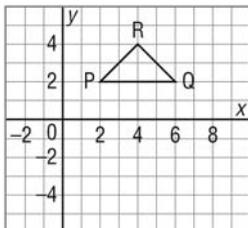
b)



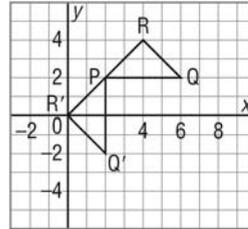
- c) $A(-3, 0)$, $B(-1, 1)$, $C(0, 3)$, $D(1, 1)$, $E(3, 0)$,
 $D'(1, -1)$, $C'(0, -3)$, $B'(-1, -1)$
- d) The shape has 4 lines of symmetry: x -axis, y -axis, the line through points B' and D , the line through points B and D'

10. Pentagon A is the reflection image in the horizontal line through 7 on the y -axis.
 The line of symmetry is the horizontal line through 7 on the y -axis.
 Pentagon C is the reflection image in the vertical line through 5 on the x -axis.
 The line of symmetry is the vertical line through 5 on the x -axis.
 Pentagon D is the reflection image in the horizontal line through 3 on the y -axis.
 The line of symmetry is the horizontal line through 3 on the y -axis.

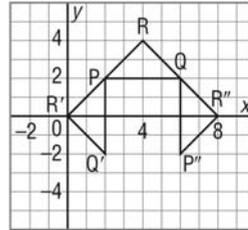
11. a)



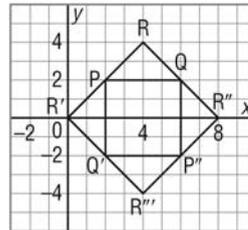
b)



c)



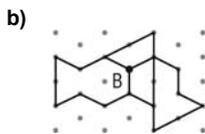
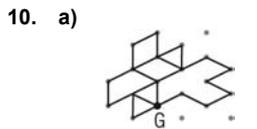
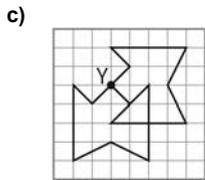
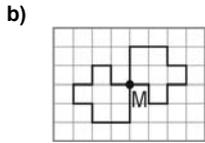
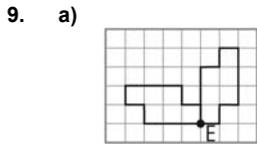
d)



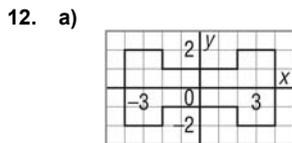
- e) The final shape has 4 lines of symmetry: x -axis, the vertical line through 4 on the x -axis, the line through the points $(2, 2)$ and $(6, -2)$ and the line through the points $(6, 2)$ and $(2, -2)$.

7.6 Rotations and Rotational Symmetry, page 365

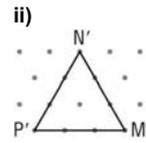
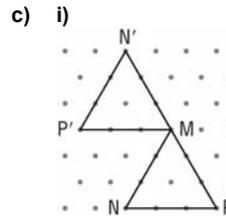
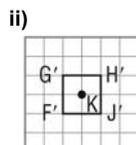
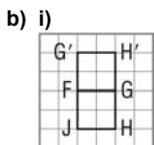
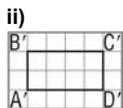
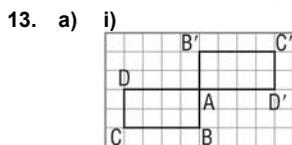
4. a) 120° b) 72°
 c) 40° d) 30°
5. a) 6 b) 18
 c) 8 d) 10
6. a) 3; 120° b) 5; 72°
 c) 4; 90° d) 8; 45°
7. a) Yes; the snowflake has rotational symmetry of order 6 and the angle of rotation symmetry is 60° .
 b) No; the picture does not have rotational symmetry.
8. a) Yes; the shape has rotational symmetry of order 4 and the angle of rotation symmetry is 90° .
 b) Yes; the shape has rotational symmetry of order 6 and the angle of rotation symmetry is 60° .



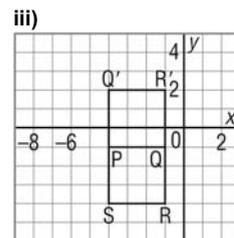
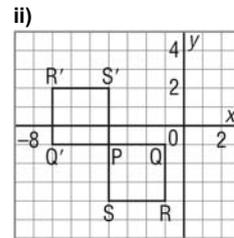
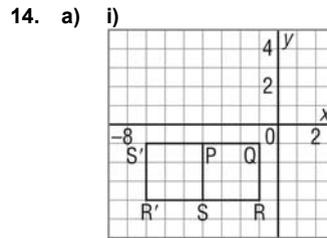
11. a) The tessellation has rotational symmetry of order 4 about a point where the heads of 4 lizards meet.
 b) Rotational symmetry of order 15 about the centre



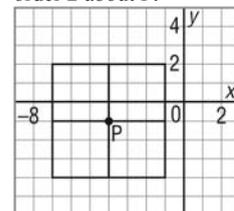
- b) The shape formed is a dodecagon that has rotational symmetry of order 2.



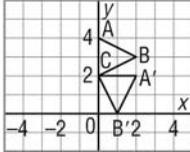
- d) In parts a, b, and c, the image is the same in part ii. It is because each shape is rotated about the centre of the shape through the angle of rotation symmetry.



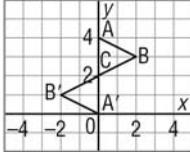
- b) The shape formed has rotational symmetry of order 2 about P.



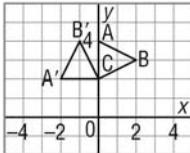
15. a) i)



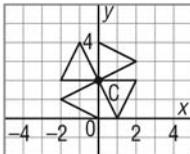
ii)



iii)

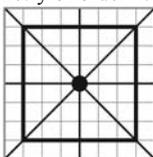


b) The shape formed has rotational symmetry of order 4 about C.

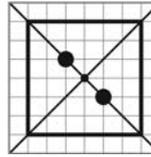


7.7 Identifying Types of Symmetry on the Cartesian Plane, page 373

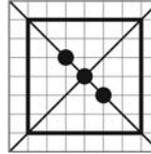
3.
 - a) Rotational symmetry of order 2
 - b) Rotational symmetry of order 2
 - c) Line symmetry: the horizontal line through the centre is a line of reflection.
 - d) Line symmetry: the horizontal line through the centre is a line of reflection.
4.
 - a) 8 lines of symmetry through the centre; rotational symmetry of order 8 about the centre
 - b) 5 lines of symmetry through the centre; rotational symmetry of order 5 about the centre
 - c) No line symmetry; no rotational symmetry
 - d) No lines of symmetry; rotational symmetry of order 5 about the centre
5. This face has 4 lines of symmetry and rotational symmetry of order 4:



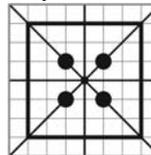
This face has 2 lines of symmetry and rotational symmetry of order 2.



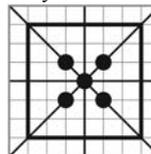
This face has 2 lines of symmetry and rotational symmetry of order 2.



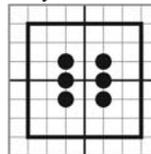
This face has 4 lines of symmetry and rotational symmetry of order 4.



This face has 4 lines of symmetry and rotational symmetry of order 4.

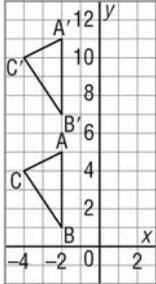


This face has 2 lines of symmetry and rotational symmetry of order 2.

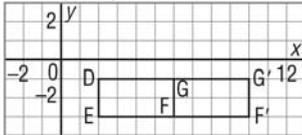


6.
 - a) Square D is a rotation of 180° ; Square A is a rotation of 90° counterclockwise.
 - b) Square B is a reflection in the vertical line through 5 on the x -axis; Square C is a reflection in the x -axis.
7.
 - a) By reflection in the y -axis
 - b) By reflection in the line through $(1, -1)$ and $(-1, 1)$ and by a 180° rotation about the origin
 - c) By reflection in the x -axis
 - d) By reflection in the line through $(-1, -1)$ and $(1, 1)$ and by a 180° rotation about the origin
8.
 - a) By reflection in the x -axis, and by a 180° rotation about the point $(-2.5, 0)$
 - b) By 90° clockwise rotation about the point $(2, 3)$
9. The diagram formed by $\triangle FGH$ and $\triangle F'G'H'$ has rotational symmetry of order 2.

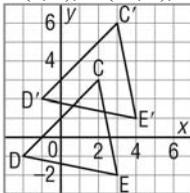
10. a) The diagram has 1 line of symmetry, which is the vertical line through the centre of the diagram.
 b) The diagram has rotational symmetry of order 2 about the centre of the diagram.
11. a) $A(-2, 5)$, $B(-2, 1)$, $C(-4, 4)$, $A'(-2, 11)$, $B'(-2, 7)$, $C'(-4, 10)$. There is no symmetry.



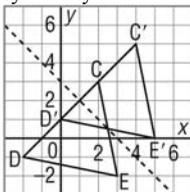
- b) Vertices are: $D(2, -1)$, $E(2, -3)$, $F(6, -3) = E'$, $G(6, -1) = D'$, $G'(10, -1)$, $F'(10, -3)$
 The diagram has line symmetry and rotational symmetry. The line of symmetry is the vertical line through 6 on the x -axis and the 2 rectangles are related by rotational symmetry of order 2 about $(6, -2)$.



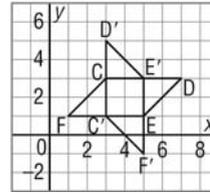
12. a)-c) Vertices are: $C(2, 3)$, $D(-2, -1)$, $E(3, -2)$, $C'(3, 6)$, $D'(-1, 2)$, $E'(4, 1)$



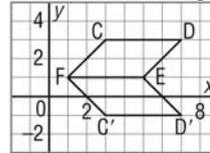
- d) The translation does not result in any symmetry because there is no axis of symmetry and there is no line of symmetry.
 e) The translation R_2, U_2 results in a line of symmetry.



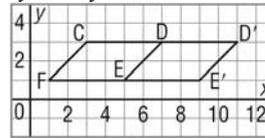
13. a), b) i) The diagram has rotational symmetry of order 4 about $(4, 2)$.



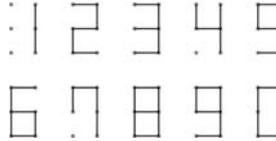
- ii) The diagram has a line of symmetry, which is the horizontal line through 1 on the y -axis.



- iii) The diagram does not have line or rotational symmetry.



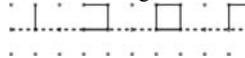
14. a)



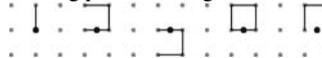
- Digits 1 and 3 have a horizontal line of symmetry.
 Digits 1, 2, and 5 have rotational symmetry of order 2.
 Digits 4, 6, 7, and 9 have no line or rotational symmetry.

- Digits 8 and 0 have both horizontal and vertical lines of symmetry and rotational symmetry of order 2.

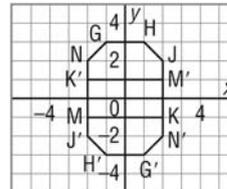
- b) Digits 1, 3, 8, and 0 can be completed by reflecting these halves of the digits in the dotted line in this diagram.



- c) Digits 1, 2, 5, 8, and 0 can be completed by rotating part of the digit about each dot shown.



15. a)

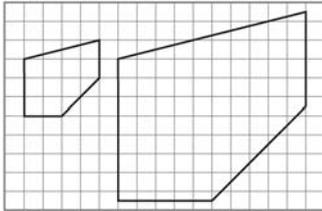


- b) $G(-1, 3)$, $H(1, 3)$, $J(2, 2)$, $N'(2, -2)$, $G'(1, -3)$, $H'(-1, -3)$, $J'(-2, -2)$, $N(-2, 2)$

- c) The larger shape has line symmetry about the x -axis and the y -axis, and rotational symmetry of order 2 about the origin.

Unit 7: Review, page 377

1. a) 9 cm by 15 cm b) 7.5 cm by 12.5 cm
 c) 4.5 cm by 7.5 cm d) 12.6 cm by 21 cm
- 2.

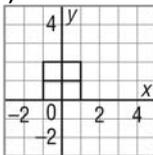


3. a) $\frac{2}{3}$ b) 96 cm
4. About 10.4 m
5. About 2.4 m and about 3.1 m
6. Pentagon Z is similar to the red pentagon. The ratios of the corresponding sides are all equal to $\frac{10}{9}$.
7. a) 6 m b) 4 m
 c) About 5.3 m
8. a) 2 cm b) 2.8 cm
9. 46.4 m
10. About 35.6 m
11. In similar triangles, the ratios of the corresponding sides are proportional.

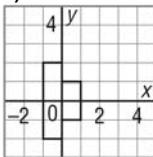
$$\frac{25}{25+12.5} = \frac{x}{22.5}$$

$$x = 15 \text{ m}$$

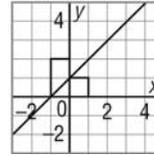
12. a) 1 b) 0
 c) 2 d) 3
13. a) i)



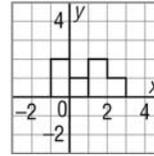
ii)



iii)



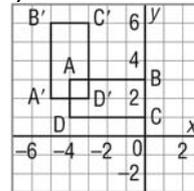
b)



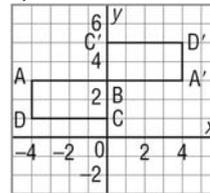
- c) i) A(-1, 2), B(0, 2), C(0, 1), D(1, 1), E(1, 0), F(-1, 0), A'(1, 2), D'(-1, 1)
 ii) A(-1, 2), B(0, 2), C(0, 1), D(1, 1), E(1, 0), F(-1, 0), A'(-1, -2), B'(0, -2), C'(0, -1), D'(1, -1)
 iii) A(-1, 2), B(0, 2), C(0, 1), D(1, 1), E(1, 0), F(-1, 0)
- d) i) 4 lines of symmetry
 ii) 1 line of symmetry
 iii) 1 line of symmetry
 b) 0 lines of symmetry

14. a) 3 b) 2
 c) 6 d) 8

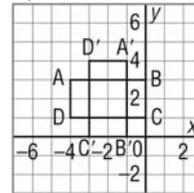
15. a) i)



ii)

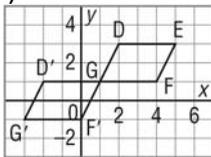


iii)

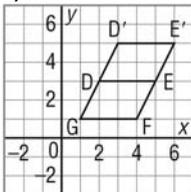


- b) i) The diagram has no rotational symmetry.
 ii) The diagram has rotational symmetry of order 2 about B(0, 3).

- iii) The diagram has rotational symmetry of order 4 about $(-2, 2)$.
16. i) 1 line of symmetry: the line through the points $(-6, 0)$ and $(0, 6)$
 ii) No line symmetry
 iii) 4 lines of symmetry: the vertical line through -2 on the x -axis, the horizontal line through 2 on the y -axis, the line through the points $(-3, 1)$ and $(-1, 3)$, the line through the points $(-3, 3)$ and $(-1, 1)$
17. a) 1 line of symmetry: the line through the points $(-2, 2)$ and $(2, -2)$; rotational symmetry of order 2 about the origin
 b) 1 line of symmetry: the vertical line through 0.5 on the x -axis
18. a) Rotational symmetry of order 3 about the centre; 3 lines of symmetry
 b) 1 line of symmetry: the vertical line through the centre
19. a) i)



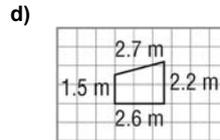
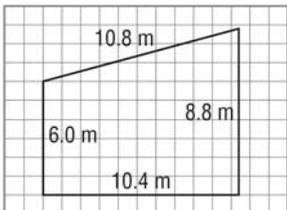
ii)

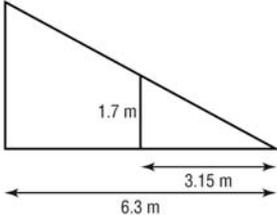


- b) i) Yes; rotational symmetry of order 2 about $G(1, 1)$.
 ii) Yes; rotational symmetry of order 2 about $(3.5, 3)$.

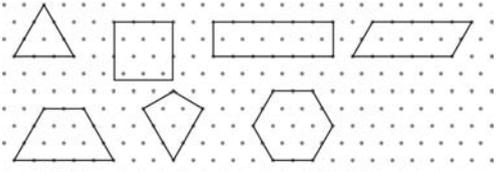
Unit 7: Practice Test, page 380

1. a) 8.1 m b) 5.2 m
 c)

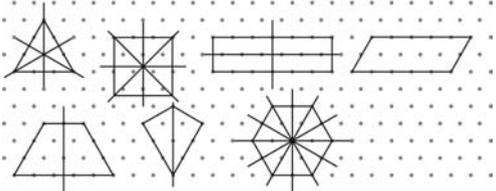


2. a) 
- b) The corresponding angles in the triangles are equal.
 c) The height of the tree is 3.4 m.

3. a)



b) i)

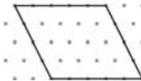


- ii) Equilateral triangle: rotational symmetry of order 3; angle of rotation symmetry 120°
 Square: rotational symmetry of order 4; angle of rotation symmetry 90°
 Rectangle: rotational symmetry of order 2; angle of rotation symmetry 180°
 Parallelogram: rotational symmetry of order 2; angle of rotation symmetry 180°
 Regular hexagon: rotational symmetry of order 6; angle of rotation symmetry 60°

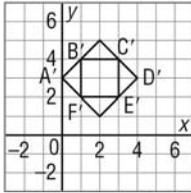
c) Answers will vary. For example:



d) Answers will vary. For example:



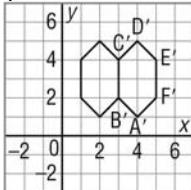
4. a) i)



ii) $A'(0, 3)$, $B'(1, 4)$, $C'(3, 4)$, $D'(4, 3)$, $E'(3, 2)$, $F'(1, 2)$

iii) 4 lines of symmetry: the vertical line through 2 on the x -axis, the horizontal line through 3 on the y -axis, the line through the points (0, 1) and (4, 5), the line through the points (0, 5) and (5, 0); and rotational symmetry of order 4 about (2, 3)

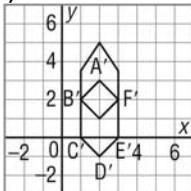
b) i)



ii) $A'(4, 1)$, $B'(3, 2)$, $C'(3, 4)$, $D'(4, 5)$, $E'(5, 4)$, $F'(5, 2)$

iii) 2 lines of symmetry: the vertical line through 3 on the x -axis, the horizontal line through 3 on the y -axis; and rotational symmetry of order 2 about (3, 3)

c) i)



ii) $A'(2, 3)$, $B'(1, 2)$, $C'(1, 0)$, $D'(2, -1)$, $E'(3, 0)$, $F'(3, 2)$

iii) 2 lines of symmetry: the vertical line through 2 on the x -axis, the horizontal line through 2 on the y -axis; and rotational symmetry of order 2 about (2, 2)

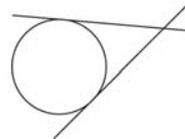
Unit 8 Circle Geometry, page 382

8.1 Properties of Tangents to a Circle, page 388

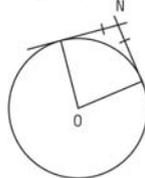
3. a) QR b) CE
 4. a) 90° b) 90°
 5. a) 90° b) 67°
 c) 43°

6. a) 5 b) 12
 c) 20
 7. a) $d^\circ = 62^\circ$, $e^\circ = 55^\circ$ b) $d^\circ = 57^\circ$, $e^\circ = 21^\circ$
 8. a) $a \doteq 8.5$ b) $a \doteq 7.9$
 9. $a \doteq 11.5$, $b \doteq 5.3$

11. Answers may vary. For example: Both the line perpendicular to AB at P and the line perpendicular to CD at Q pass through the centre of the circle. The intersection of these two lines is the centre of the circle.
 12. About 139 km
 13. About 196 km
 14. $x \doteq 10.8$; $y \doteq 10.4$; $z^\circ = 60^\circ$
 15. a) Two tangents
 b) All other lines from this point would intersect the circle twice or not at all.



- c) Each of the lines intersects the circle at exactly one point.
 16. a) The distances from N to the two points of tangency are equal.

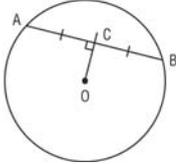


- b) The lengths of the two tangents are equal.
 c) $x = y \doteq 19.4$
 17. 5 cm
 18. 2835 km
 19. About 61.7 cm
 20. About 8.5 cm
 21. 50 cm
 22. a) About 6 m
 b) The actual strap should be slightly longer to be able to join the ends of the strap.

8.2 Properties of Chords in a Circle, page 397

3. a) $d^\circ = 90^\circ$ b) $e = 5$
 c) $f = 7$
 4. a) $x^\circ = 50^\circ$, $y^\circ = 90^\circ$ b) $x^\circ = 22^\circ$, $y^\circ = 136^\circ$
 c) $x^\circ = y^\circ = 35^\circ$
 5. a) $a = b \doteq 9.5$ b) $a \doteq 5.7$, $b \doteq 11.5$
 6. $b \doteq 7.5$
 7. a) $r \doteq 2.2$ b) $r = 6$

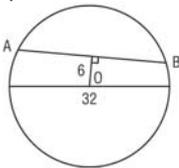
8. The distances between the centre and all chords of the same length are equal.
9. Draw two chords and their perpendicular bisectors. The intersection point of the perpendicular bisectors is the centre of the circle.
10. a) $s \doteq 3.8$ b) $s \doteq 7.3$
11. 9.6 cm
12. a) Parts i, ii, and iii
b) i) About 6.5 cm ii) About 5.4 cm
 iii) 0 cm
- 13.



14. About 15.3 cm
15. a) About 5.1 cm
b) The congruent chords are equidistant from the centre of the circle.
17. About 39.0 km
18. About 3.0 m
19. a) About 21.3 cm; about 4.7 cm
b) Two answers; the water level could be below or above the centre of the bowl

Unit 8: Mid-Unit Review, page 403

1. a) $x^\circ = 22^\circ, y^\circ = 90^\circ$ b) $x^\circ = 46^\circ, y = 33^\circ$
2. About 10.4
3. About 35.4 cm
4. $m^\circ = 19^\circ$
5. a) About 19.6 b) About 6.2
6. a) b) About 29.7 cm

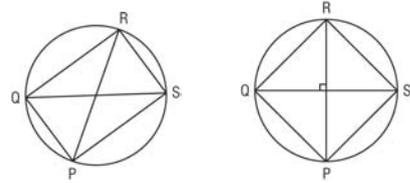


7. About 26.2 cm

8.3 Properties of Angles in a Circle, page 410

3. a) Inscribed angle: $\angle DFE$; central angle: $\angle DOE$
b) Inscribed angle: $\angle PRQ$; central angle: $\angle POQ$
c) Inscribed angles: $\angle NJM$ and $\angle NKM$; central angle: $\angle NOM$
4. a) $x^\circ = 65^\circ$ b) $x^\circ = 90^\circ$
c) $x^\circ = 40^\circ$ d) $x^\circ = 58^\circ$

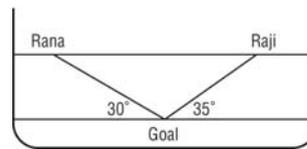
5. a) $y^\circ = 140^\circ, z^\circ = 70^\circ$ b) $y^\circ = 25^\circ, z^\circ = 130^\circ$
c) $y^\circ = 27^\circ, z^\circ = 42^\circ$
6. a) $x^\circ = 80^\circ, y^\circ = 50^\circ$ b) $x^\circ = 25^\circ, y^\circ = 65^\circ$
7. a) A rectangle b) A square



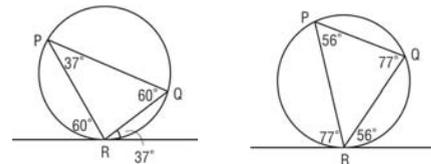
8. a) b)
-

9. a)
-

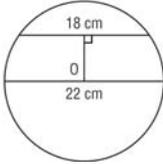
- b) About 7.2 cm
11. a) $x^\circ = 40^\circ, y = 40^\circ$
b) $x^\circ = 45^\circ, y^\circ = 40^\circ$
c) $x^\circ = 58^\circ, y^\circ = 116^\circ$
12. Yes
13. a)



- b) Raji
14. 45°
15. a) $\angle QRS = \angle QPR$ and $\angle PRT = \angle PQR$
b) For example:



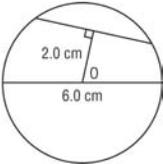
Unit 8: Review, page 418

- $x^\circ = 90^\circ, y = 65^\circ$
 - $a \doteq 9.7, y^\circ = 36^\circ$
 - $a = b \doteq 17.9$
- Since $7^2 + 13^2 \neq 16^2$, $\angle HPO \neq 90^\circ$. So, the wire HP is not a tangent.
- Draw a line perpendicular to the radius OP at the point P. This line is a tangent using the Tangent-Radius Property.
- About 14.1 cm
- $x \doteq 6.2$
 - $x \doteq 3.9$
- 

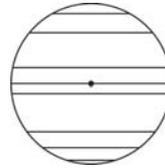
b) The chord is about 6.3 cm from the centre of the circle.

- $x^\circ = 35^\circ, y^\circ = 110^\circ$
 - $x^\circ = y^\circ = 45^\circ$
- About 3.5 cm
- $x^\circ = y^\circ = 90^\circ$
 - $x^\circ = y^\circ = 60^\circ$
 - $x^\circ = 15^\circ, y^\circ = 75^\circ$
- About 34.6 cm

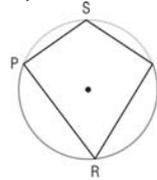
Unit 8: Practice Test, page 420

- $x \doteq 6.6$ cm, $y = 34^\circ$
- $x^\circ = 61^\circ, y^\circ = 90^\circ, z^\circ = 30.5^\circ$
- 

- About 4.5 cm
 - CD is shorter than AB.
- The central angle of a semicircle is 180° . The inscribed angle is one-half of the central angle, which is 90° .
 - The longest chord is the diameter. The farther away a chord is from the centre of the circle, the shorter the chord.



- Parts i and ii
 - About 13.9 cm
 - About 10.6 cm
- to c)



d) $\angle PRQ$ and $\angle PSQ$ have a sum of 180° .

Unit 9 Probability and Statistics, page 422

9.1 Probability in Society, page 427

- Experimental probability; decision is based on Andrei's past experience.
 - Theoretical probability; the more tickets you buy, the greater your chance of winning.
 - Experimental probability; decision is based on Anita's past experience.
 - Subjective judgment; decision is based on Doug's feelings.
- Claudia will continue to perform at the same level and the next math quiz will have the same difficulty.
 - Omar will leave work at the same time and the traffic patterns will be the same every day.
- If Winona doesn't go canoeing, her decision will be based on probability (it is likely that it will rain). If she does go, her decision will be based on subjective judgment (the feeling that it will not rain).
- Theoretical probability and subjective judgment
- More money should be spent to increase the probability of recovering a stolen vehicle.
 - Because the probability of recovering a stolen vehicle is so low, there are better ways of spending money than on solving this problem.
- Vanessa made the assumption that the same types of birds visit her birdfeeder at different times of the day, every day.
 - The percent of birds that are cardinals would change.
- Kathryn assumes that the next 10 people she meets are a fair representation of the community.

- b) The next 10 people may favour one candidate very strongly over the other, making the number of those who support Choo greater than or less than 7.
10. Since there is such a small chance the blood was not the suspect's, it is very likely the suspect committed the crime. There is a chance the blood belongs to someone else, so the jury should not convict a possibly innocent man.
11. a) The experimental probability may convince the teenager to try the treatment. He may also use subjective judgment about whether to try the treatment, depending on his personal beliefs of the effectiveness of acne treatment.
- b) He would be assuming that he will respond to the treatment in a way that is similar to the response of other people who tried the treatment. His response to the treatment may differ from most people's.
14. The student is assuming that it is equally likely for Shaquille to miss as to make the shot, which ignores Shaquille's skill level in free throws. His skill makes it more likely that he will make free throws.
16. The Farmer's Almanac makes the assumption that long range weather patterns can be predicted from previous years' weather patterns.
17. a) This gives the impression that it is much more dangerous to travel by car than by plane. This information could be misleading because there are more people travelling by road than by air.
- b) We need to know how many people travelled by plane and by car in 2004.

9.2 Potential Problems with Collecting Data, page 435

3. a) Privacy b) Use of language
c) Cultural sensitivity d) Time
4. a) **Part a:** Since the survey is not anonymous, the students may hesitate to respond negatively (to the principal) or positively (to avoid seeming to flatter the principal in front of their friends).
Part b: The principal should give students a written survey and ask them to return it anonymously to his/her office. The question should ask: "Are you enjoying school?"
- b) **Part a:** The statement presents the most ethical option and no reasons for choosing another option, which may affect the results in favour of turning the wallet in.
Part b: The statement could be made into a

question: "If you find a \$20-bill, do you keep it or turn it in?"

- c) **Part a:** Some people would not be aware of the cultural importance of head covering.
Part b: Brenda should ask if students are aware of the cultural significance of someone covering her or his head, and then ask the question.
- d) **Part a:** Carlos will probably run out of time before he asks every student.
Part b: Carlos should choose a representative sample of the students to survey.
5. a) Students will think Parinder's question asks about how much time they spend on the computer at school and at home.
- b) "How much time do you spend on the school computers?"
- c) The school administration could be interested in the results to plan the school's budget for new computers.
6. a) No; many students who are bullied are afraid to tell people, especially in a non-anonymous environment.
- b) An anonymous survey
7. a) On a warm August evening, the fans may not immediately see the point of building an indoor stadium, so many may respond negatively.
- b) On a very cold November evening, Trinity may receive many more responses in favour of an indoor stadium.
8. a) i) The use of the words "violent criminal"; bias toward using DNA tests
ii) The use of the words "gas guzzling"; negative description of SUVs
iii) The question emphasizes the positive aspect of spell checks.
- b) i) Do you think that DNA evidence should be allowed in courts?
ii) Are you in favour of banning SUVs?
iii) Do you think students should be allowed to use spell check?
9. a) No
b) Rebecca should have asked if her friends had any problems with their service provider, what service providers they had in the past, and whether they are satisfied with their current service providers.
10. a) Ethics: The survey designers didn't tell Sasha that promotional emails might be sent to the email address he provided. This reflects poorly on the brands advertised on the website.

- b) Tell people their email addresses may be used for future correspondence and allow people then to indicate whether they wish to receive such emails.
11. Finding the favourite ice cream flavour of Canadian teens by surveying each teen would be expensive and time-consuming.
 13. a) Privacy: People may not want to admit how much or how little they spend on clothes. Timing: Depending on the month in which Bridget interviews people, there may be clothing sales because a new season begins or for a holiday season shopping. Ethics: People may want to know *why* Bridget is asking them.
b) Privacy: Bridget could ask people to write a number on a slip of paper and leave it on her desk later. Timing: Bridget could ask at different months in the year. Ethics: Bridget could tell people why she is doing this survey.
 15. Personal interviews: time-consuming, costly, and do not allow for anonymity; phone interviews: seen as invasive, so low response rate; email surveys: often returned by those with strong opinions about the issues
 16. a) Some people may not understand the religious significance of the holiday.

9.3 Using Samples and Populations to Collect Data, page 440

3. a) Residents of Comox aged 13 to 25 years
b) All 1-L juice cartons
c) All schools managed by the board
d) All First Nations people in Nunavut
4. a) Census b) Sample
5. a) People who ride buses
b) All residents of Canada over the age of 18
c) Parents or guardians
d) People who have had relatives or friends in the emergency room
6. a) James; Courtney only surveyed a small sample.
b) Courtney's friends may not be representative of the grade 9 students.
7. a) It would be very time-consuming to test every AAA battery and there would be none left to sell.
b) It would be difficult to find every single First Nations child in Canada, requiring a lot of time and people.
8. a) Sample b) Sample
c) Sample d) Census
9. a) Invalid b) Invalid
10. a) All students in the high school
- b) Sample
- c) Ask a sample that is representative of the students in the high school. Include students of different grades, gender, ethnicity, and so on.
11. a) The topping your family wants on a pizza
b) Typical prices for a skateboard

Unit 9: Mid-Unit Review, page 444

1. a) 90% of a person's lies will be detected, not 1 out of 10 people will be able to lie undetected.
b) His reaction to the test will be different from most other people's.
2. 1 in 20 is a fairly small chance, so we probably don't need to worry about the WAIS collapsing. However, 1 in 20 is far from impossible, and considering the gravity of the situation if WAIS were to collapse, we should do everything possible to avoid it.
3. a) i) Do you find listening to music helps you relax while studying?
ii) Do you find listening to music distracting when you're trying to study?
b) Do you support listening to music while studying?
4. a) Privacy: The survey is not anonymous.
b) Many student smokers would lie and claim that they do not smoke, thus skewing the results toward a low number of student smokers.
5. a) i) People may refuse to disclose how much they earn.
ii) Well-educated parents who choose to stay home with children may resent the question.
iii) Change "years of post-secondary education" to levels of education, or number of courses at each level.
iv) Surveying a very large sample would take a lot of time and would be costly.
b) i) People may lie about the amount of money they make.
ii) People may be reluctant to answer or may answer dishonestly.
iii) People's answers may not reflect their true situations if the questions are unclear.
iv) Ahmed may not get as many results as he hopes for.
6. Asking students on a Monday morning if they enjoy going to school
7. a) Students who regularly eat at the cafeteria
b) Students who are enrolled in phys-ed classes
c) Students who drive to school

- d) Students who go to or participate in football games
- 8. a) Too time-consuming
- b) Too many DVD players to conduct a census; moreover, DVD player prices change often.
- c) It is probably impossible to catch all the northern pike in Misaw Lake, and doing so could devastate the local ecosystem.
- 9. a) Census b) Sample

9.4 Selecting a Sample, page 448

- 3. a) Not a representative sample: People who do not enjoy shopping are not likely to be in a mall.
- b) Not a representative sample: The majority of the cafeteria’s customers are likely to be students, not teachers.
- c) Not a representative sample: The neighbourhood sampled has a high crime rate, and probably has a different police presence than neighbourhoods with lower crime rates.
- d) Not a representative sample: The survey targets those people (not necessarily teenagers) already interested in fitness and willing to take the time to participate.
- 4. a) Not appropriate b) Not appropriate
- c) Appropriate d) Appropriate
- e) Not appropriate
- 5. a) i) No ii) Yes
- iii) Yes
- b) i) The arena should survey residents of the surrounding community who skate or want to learn to skate.
- 6. a) Stratified random sampling: Survey 100 Canadian citizens from each of the income tax brackets.
- b) Simple random sampling: Have a computer randomly select 300 student IDs and poll those students.
- 7. No
- 8. a) Surveying 300 15-year-olds
- b) Survey 300 randomly selected members of the population
- 9. a) People who work for companies that make fur coats
- b) A group of people from homes where people always recycle
- 10. a) No, the number of people in the sample is probably too small to represent the Canadian population.

- b) The survey may have been conducted at a climate change rally.
- c) Survey Canadian citizens using simple random sampling.
- 11. Self-selected sampling and convenience sampling
- 12. a) i) Randomly select student ID numbers.
- ii) Inspect every 10th phone in the assembly line.
- iii) Randomly select a high school and then a grade within that high school and survey every student in that grade.
- iv) Divide the orchard into 8 equal plots of land and survey 5 apple trees from each plot.
- b) Answers will vary. For example:
 - i) Course offerings
 - ii) Making sure there are no defects in the cell phones
 - iii) The most popular music artist among teenagers
 - iv) The average number of apples produced per season

Unit 9: Start Where You Are, page 453

- 1. Left box: has many spelling or grammatical errors; right box: ideas are mostly in an order that makes sense

Unit 9: Review, page 458

- 1. a) Mustafa Abaz
- b) Assumptions: The sample surveyed is representative of the voting population. Nothing would happen before the election to change the popularity of the candidates.
- 2. Experimental probability: The players’ past results indicate that they have a very good team with a very high probability of winning. Subjective judgment: Darrell strongly believes that the winning streak cannot last.
- 3. a) The chance of winning (1 in 3) is relatively high for a lottery, so there is a good chance of winning.
- b) The chance of winning is still less than 50%, so it’s better to not risk money on what will likely be a loss.
- 5. a) i) Use of language: The question is biased toward increasing the minimum wage.
- ii) Ethics: The student used the results of the survey for something other than what she had claimed.
- iii) Bias: It is not clear how the 1000 cars are tested.

- iv) Timing: During November, not many people in the northern hemisphere think about outdoor pools.
 - b) i) More people surveyed will be in favour of increasing the minimum wage.
 - ii) It may not affect the data collection, but participants may feel frustrated or angry.
 - iii) There could be a defect later on in the assembly that might not be discovered.
 - iv) There would be fewer people who are in favour of building a new outdoor pool.
6. a) The best quality camera for its price. "What do you think is the best digital camera for its price?"
 - b) The question avoids bias by not leading the reader to answer one way or another.
 7. a) Pregnant teens may not want to admit that they are pregnant.
 - b) There could be different cultural opinions regarding teen pregnancy that should be taken into account.
 - c) Raheem must word the question in a way that does not support or condemn teen pregnancy.
 8. a) "What is your favourite fruit: apple, orange, or banana?"
 - b) "What is your favourite fruit?"
 10. Census; if even one parachute is no longer working, a person could die.
 11. a) Testing every brand of battery would be very time-consuming and would use up the batteries.
 - b) A sample of randomly selected brands would most likely represent the population.
 12. a) i) Too time-consuming
 - ii) Time-consuming and difficult if people do not wish to share that information
 - b) Determining brands of calculators used by students in your math class
 13. No; people who do not watch the TV show are excluded and only those who feel strongly about the competition would be likely to pay to vote.
 14. a) Yes
 - b) Depends on the size of the school.
 - c) No
 15. a) Simple random sampling of the entire country's voting population
 - b) Convenience sampling near several local tennis courts
 16. a) Which brand of chewing gum do you recommend most?
 - b) Get the membership list of the province's dental association and call every 10th dentist.
 - c) Phone interviews; bar graph

- d) The total number of dentists who selected a particular brand, divided by the total number of dentists surveyed

Unit 9: Practice Test, page 460

1. Shawnie: experimental probability; Owen: subjective judgment; Jovana: theoretical probability
2. a) Assumptions: The next team she plays is as skilled as the previous teams; her own team's skill level will not change.
- b) If Hannah's team plays a team that is better than previous teams, or if Hannah's team loses a player, the chance of winning will be lower (a probability less than 0.875). If Hannah's team plays a team that is worse than previous teams, or if Hannah's team improves, the chance of winning will be higher (greater than 0.875).
3. a) If Manroop surveys people on a Monday morning at work, she would probably get a larger number of depressed people than if she surveyed people on a Saturday night. Also, time of the year may change responses since many people are depressed in the winter when there is less light.
- b) People may not want to give such personal information to a stranger. Manroop should conduct an anonymous survey.
- c) Use of language: "Satisfaction with life" does not necessarily mean happiness. The data might not reflect how happy or depressed Canadians are, but how much satisfaction they feel.
4. a) The cost of a new snowboard
- b) Asking students in a grade 9 drama class to determine the most popular movie in a high school
5. a) Collect vials of water from 3 water fountains and 3 taps that are randomly selected from around the school. This sample would be representative of the school's entire water supply, assuming that any contamination in the water supply would affect all water fountains and taps.
- b) Have the computer randomly select 50 student ID numbers and survey those students.
- c) Randomly select 10 students from each grade and weigh their backpacks.
6. Emile could have problems with language if he asks questions in a way that would lead toward a certain answer. He could also have cultural sensitivity problems if he asks groups that have religious objections to shopping on Sundays.

Cumulative Review Units 1-9, page 464

1. a) 0.8 b) $\frac{6}{5}$
 c) 8.9 d) 2.1
 e) $\frac{10}{3}$ f) 1
 g) 5.5 h) 2.1
2. 978 m^2
3. No; -43
4. $6^6 = 46\,656$
5. a) $225, 89.25, -223.94, 3 \times (-22.39)$
 b) $225 + 89.25 + (-223.94) + 3 \times (-22.39)$
 c) $\$23.14$
6. -0.63
7. a)

t	0	1	2	3	4
d	0	3	6	9	12

 b) Yes, because time and distance are not discrete.
 c) The relation is linear; the graph is a straight line.
 d) $d = 3t$
 e) 45 m
 f) About 5.6 min
8. a) About $\$140$ b) About 15 weeks
 c) For example, Colton may change the number of hours he works per week
9. a) $-2n^2 - 9n + 13$ or $-10n^2 - 5n + 3$
10. a) $6x^2 + 7x$ b) 24 cm^2
11. b) $t = 5$
12. b) Jerry can ride the pedicab for about 15 min.
13. a) 9.4 cm by 8 cm
 b) 8.225 cm by 7 cm
 c) 16.45 cm by 14 cm
14. a) $\frac{1}{40}$ b) 0.045 m by 0.03 m
15. About 8.2 m
16. a) Line symmetry about the horizontal line through 5 on the y -axis
 b) Line symmetry about the vertical line through 4 on the x -axis
 c) Line symmetry about the line through AD; line symmetry about the line through (0, 1) and (4, 5); rotational symmetry of order 2 about the midpoint of AD
17. a) Yes, rotational symmetry of order 2 with an angle of 180° .
 b) ii) 90° clockwise about $(-2, -3)$: $(-1, 1)$, $(-1, -3)$, $(-2, -3)$, $(-2, -4)$, $(-6, -4)$, $(-6, -2)$, $(-3, -2)$, $(-3, 1)$
 180° about Q: $(-2, -2)$, $(-2, -4)$, $(-6, -4)$, $(-6, -6)$, $(-10, -6)$, $(-10, -4)$, $(-6, -2)$; rotational symmetry of order 2 around Q

270° clockwise about $(-4, -4)$: $(-2, -2)$, $(-2, -4)$, $(-4, -4)$, $(-4, -6)$, $(-6, -6)$, $(-6, -2)$

18. About 15.0 cm
19. About 10.1 cm
20. $x^\circ = 250^\circ, y^\circ = 110^\circ, z^\circ = 55^\circ$
21. About 18.5 cm
22. About 125 cm
23. $x^\circ = 65^\circ, y^\circ = 50^\circ, z^\circ = 130^\circ$
24. a) The other team will be the same skill level as the previous teams.
 b) If the other team is better than previous teams, Bao's team is more likely to lose; if the other team is worse, Bao's team is more likely to win.
26. a) On-line survey
 b) Not valid, because readers of a fashion magazine would be more likely to spend money on clothing than the average person.
27. a) Too time-consuming
 b) Too time-consuming
28. a) Sample b) Census

Illustrated Glossary

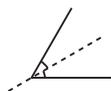
acute angle: an angle measuring less than 90°

acute triangle: a triangle with three acute angles



algebraic expression: a mathematical expression containing a variable; for example, $6x - 4$ is an algebraic expression

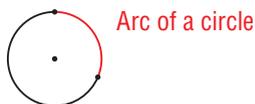
angle bisector: the line that divides an angle into two equal angles



angle of rotation symmetry: the minimum angle required for a shape to rotate and coincide with itself

approximate: a number close to the exact value of an expression; the symbol \doteq means “is approximately equal to”

arc: a segment of the circumference of a circle



area: the number of square units needed to cover a region

average: a single number that represents a set of numbers (see *mean*, *median*, and *mode*)

bar graph: a graph that displays data by using horizontal or vertical bars

bar notation: the use of a horizontal bar over a decimal digit to indicate that it repeats; for example, $1.\bar{3}$ means 1.333 333 ...

base: the side of a polygon or the face of an object from which the height is measured

base of a power: see *power*

bias: a prejudice that is in favour of or against a topic

binomial: a polynomial with two terms; for example, $3x - 8$

bisector: a line that divides a line segment or an angle into two equal parts

capacity: the amount a container can hold

Cartesian Plane: another name for a coordinate grid (see *coordinate grid*)

census: a data collection method using each member of the population

central angle: an angle whose arms are radii of a circle

certain event: an event with probability 1, or 100%

chance: probability expressed as a percent

chord: a line segment that joins two points on a circle

circle graph: a diagram that uses sectors of a circle to display data

circumference: the distance around a circle, also the perimeter of the circle

coefficient: the numerical factor of a term; for example, in the terms $3x$ and $3x^2$, the coefficient is 3

common denominator: a number that is a multiple of each of the given denominators; for example, 12 is a common denominator for the fractions $\frac{1}{3}$, $\frac{5}{4}$, $\frac{7}{12}$

common factor: a number that is a factor of each of the given numbers; for example, 3 is a common factor of 15, 9, and 21

commutative property: the property of addition and multiplication that states that numbers can be added or multiplied in any order; for example,

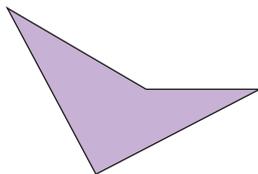
$$3 + 5 = 5 + 3; 3 \times 5 = 5 \times 3$$

composite number: a number with three or more factors; for example, 8 is a composite number because its factors are 1, 2, 4, and 8

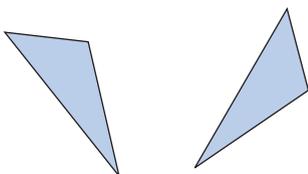
composite object: the result of combining one or more objects to make a new object

composite shape: the result of combining one or more shapes to make a new shape

concave polygon: has at least one angle greater than 180°



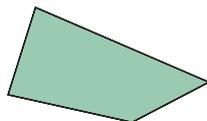
congruent: shapes that match exactly, but do not necessarily have the same orientation



consecutive numbers: integers that come one after the other without any integers missing; for example, 34, 35, 36 are consecutive numbers, so are -2 , -1 , 0, and 1

constant term: the number in an expression or equation that does not change; for example, in the expression $4x + 3$, 3 is the constant term

convex polygon: has all angles less than 180°



coordinate axes: the horizontal and vertical axes on a grid

coordinate grid: a two-dimensional surface on which a coordinate system has been set up

coordinates: the numbers in an ordered pair that locate a point on a coordinate grid (see *ordered pair*)

corresponding angles: matching angles in similar polygons

corresponding lengths: matching lengths on an original diagram and its scale diagram

corresponding sides: matching sides of similar polygons

cube: an object with six congruent square faces

cube number: a number that can be written as a power with an integer base and exponent 3; for example, $8 = 2^3$

cubic units: units that measure volume

data: facts or information

database: an organized collection of facts or information, often stored on a computer

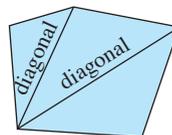
degree of a polynomial: the value of the greatest exponent of a term in a polynomial

degree of a term: the value of the exponent of the term

denominator: the term below the line in a fraction

dependent variable: a variable whose value is determined by the value of another (the independent) variable

diagonal: a line segment that joins two vertices of a shape, but is not a side



diameter: the distance across a circle, measured through its centre; or the line segment that joins two points on the circle and passes through its centre

digit: any of the symbols used to write numerals; for example, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9

dimensions: measurements, such as length, width, and height

discrete data: data that can be counted

distributive property: the property stating that a product can be written as a sum or difference of two products; for example, $a(b + c) = ab + ac$, $a(b - c) = ab - ac$

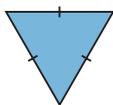
dividend: the number that is divided

divisor: the number that divides into another number

double bar graph: a bar graph that shows two sets of data

equation: a mathematical statement that two expressions are equal

equilateral triangle: a triangle with three equal sides



equivalent: having the same value; for example, $\frac{2}{3}$ and $\frac{6}{9}$; 3:4 and 9:12

estimate: a reasoned guess that is close to the actual value, without calculating it exactly

evaluate: to determine the value of a numerical expression

even number: a number that has 2 as a factor; for example, 2, 4, 6

event: any set of outcomes of an experiment

experimental probability: the probability of an event calculated from experimental results

exponent: see *power*

expression: a mathematical statement made up of numbers and/or variables connected by operations

extrapolate: to estimate a value that lies beyond data points on a graph

factor: to factor means to write as a product; for example, $20 = 2 \times 2 \times 5$

formula: a rule that is expressed as an equation

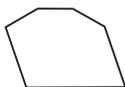
fraction: an indicated quotient of two quantities

frequency: the number of times a particular number occurs in a set of data

greatest common factor (GCF): the greatest number that divides into each number in a set; for example, 5 is the greatest common factor of 10 and 15

height: the perpendicular distance from the base of a shape to the opposite side or vertex; the perpendicular distance from the base of an object to the opposite face or vertex

hexagon: a six-sided polygon



horizontal axis: the horizontal number line on a coordinate grid

hypotenuse: the side opposite the right angle in a right triangle

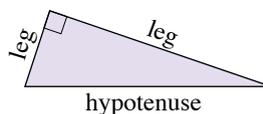


image: the shape that results from a transformation

impossible event: an event that will never occur; an event with probability 0, or 0%

improper fraction: a fraction with the numerator greater than the denominator; for example, both $\frac{6}{5}$ and $\frac{5}{3}$ are improper fractions

independent events: two events in which the result of one event does not depend on the result of the other event

independent variable: a variable whose value is not determined by the value of another variable, and whose value determines the value of another (the dependent) variable

inequality: a statement that one quantity is greater than (or less than) another quantity; or a statement that one quantity is greater than or equal to (or less than or equal to) another quantity

inscribed angle: an angle in a circle with its vertex and the endpoints of its arms on the circle



inscribed polygon: a polygon whose vertices lie on a circle

inspection: solving an equation by finding the value of the variable by using addition, subtraction, multiplication, and division facts

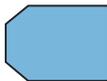
integers: the set of numbers ... -3, -2, -1, 0, +1, +2, +3, ...

interpolate: to estimate a value that lies between 2 data points on a graph

inverse operation: an operation that reverses the result of another operation; for example, subtraction is the inverse of addition, and division is the inverse of multiplication

irrational number: a number that *cannot* be written in the form $\frac{m}{n}$, $n \neq 0$, where m and n are integers

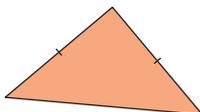
irregular polygon: a polygon that does not have all sides equal or all angles equal



isometric: equal measure; on isometric dot paper, the line segments joining 2 adjacent dots in any direction are equal

isometric drawing: a representation of an object as it would appear in three dimensions

isosceles triangle: a triangle with two equal sides



legend: part of a circle graph that shows what category each sector represents

legs: the sides of a right triangle that form the right angle (see *hypotenuse*)

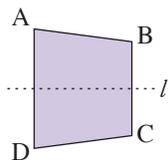
like terms: terms that have the same variables; for example, $4x$ and $-3x$ are like terms

line graph: a graph that displays data by using points joined by line segments

line of best fit: a line that passes as close as possible to a set of plotted points

line segment: the part of a line between two points on the line

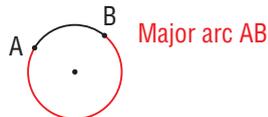
line symmetry: a shape that can be divided into 2 congruent parts, so that the parts coincide when the shape is folded along a line of symmetry



linear relation: a relation that has a straight-line graph

lowest common multiple (LCM): the lowest multiple that is the same for two numbers; for example, the lowest common multiple of 12 and 21 is 84

major arc: the longer of the two arcs between two points on a circle



mass: the amount of matter in an object

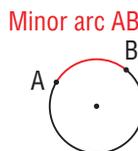
mean: the sum of a set of numbers divided by the number of numbers in the set

measure of central tendency: a single number that represents a set of numbers (see *mean*, *median*, and *mode*)

median: the middle number when data are arranged in numerical order; if there is an even number of data, the median is the mean of the two middle numbers

midpoint: the point that divides a line segment into two equal parts

minor arc: the shorter of the two arcs between two points on a circle



mixed number: a number consisting of a whole number and a fraction; for example, $1\frac{1}{18}$ is a mixed number

mode: the number that occurs most often in a set of numbers

monomial: a polynomial with one term; for example, 14 and $5x^2$ are monomials

multiple: the product of a given number and a natural number; for example, some multiples of 8 are 8, 16, 24, ...

natural numbers: the set of numbers 1, 2, 3, 4, 5, ...

negative number: a number less than 0

net: a pattern that can be folded to make an object

non-perfect square: a fraction or a decimal that is not a perfect square

numerator: the term above the line in a fraction

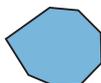
numerical coefficient: the number by which a variable is multiplied; for example, in the expression $4x + 3$, 4 is the numerical coefficient

obtuse angle: an angle whose measure is greater than 90° and less than 180°

obtuse triangle: a triangle with one angle greater than 90°



octagon: an eight-sided polygon



odd number: a number that does not have 2 as a factor; for example, 1, 3, 7

operation: a mathematical process or action such as addition, subtraction, multiplication, division, or raising to a power

opposite numbers: two numbers with a sum of 0; for example, 2.4 and -2.4 are opposite numbers

order of operations: the rules that are followed when simplifying or evaluating an expression

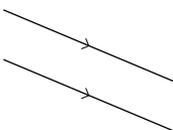
order of rotational symmetry: the number of times a shape coincides with itself during a rotation of 360°

ordered pair: two numbers in order, for example, (2, 4); on a coordinate grid, the first number is the horizontal coordinate of a point, and the second number is the vertical coordinate of the point

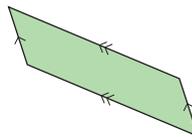
origin: the point where the x -axis and the y -axis intersect

outcome: a possible result of an experiment or a possible answer to a survey question

parallel lines: lines on the same flat surface that do not intersect



parallelogram: a quadrilateral with both pairs of opposite sides parallel



part-to-part ratio: a ratio that compares a part of the whole to another part of the whole

part-to-whole ratio: a ratio that compares a part of the whole to the whole

pentagon: a five-sided polygon



percent: the number of parts per 100; the numerator of a fraction with denominator 100

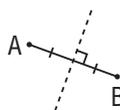
perfect square: a number that is the square of a number; for example, 16 is a perfect square because $16 = 4^2$

perimeter: the distance around a closed shape

perpendicular: lines or line segments that intersect at right angles

perpendicular bisector: the line that is perpendicular to a line segment and divides it into two equal parts

The broken line is the perpendicular bisector of AB.



pi (π): the ratio of the circumference of a circle to its diameter; $\pi = \frac{\text{circumference}}{\text{diameter}}$

plane: a flat surface with the property that a line segment joining any two points lies completely on its surface

point of tangency: the point where a tangent intersects a circle (see *tangent*)

polygon: a closed shape that consists of line segments; for example, triangles and quadrilaterals are polygons

polyhedron (plural, polyhedra): an object with faces that are polygons

polynomial: one term or the sum of terms whose variables have whole-number exponents; for example, $x^2 + 3xy - 2y^2 + 5x$

population: the set of all things or people being considered

power: an expression of the form a^n , where a is the base and n is the exponent; it represents a product of equal factors; for example, $4 \times 4 \times 4$ can be written as 4^3

power of a power: a power that is raised to a power; for example, $(3^2)^4$

power of a product: a product that is raised to a power; for example, $(3 \times 4)^5$

power of a quotient: a quotient that is raised to a power; for example, $\left(\frac{5}{6}\right)^3$

prediction: a statement of what you think will happen

prime number: a whole number with exactly two factors, itself and 1; for example, 2, 3, 5, 7, 11, 29, 31, and 43

probability: the likelihood of a particular outcome; the number of times a particular outcome occurs, written as a fraction of the total number of outcomes

product: the result when two or more numbers are multiplied; or the expression of one number multiplied by another

proper fraction: a fraction with the numerator less than the denominator; for example, $\frac{5}{6}$

proportion: a statement that two ratios are equal; for example, $r:24 = 3:4$

Pythagorean Theorem: the rule that states that, for any right triangle, the area of the square on the hypotenuse is equal to the sum of the areas of the squares on the legs

Pythagorean triple: three whole-number side lengths of a right triangle

quadrant: one of four regions into which coordinate axes divide a plane

quadrilateral: a four-sided polygon



quotient: the result when one number is divided by another; or the expression of one number divided by another

radius (plural, radii): the distance or line segment from the centre of a circle to any point on the circle

random sample: a sampling in which all members of the population have an equal chance of being selected

range: the difference between the greatest and least numbers in a set of data

rate: a comparison of two quantities measured in different units

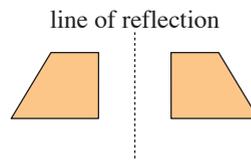
ratio: a comparison of two or more quantities with the same unit

rational number: any number that can be written in the form $\frac{m}{n}$, $n \neq 0$, where m and n are integers

reciprocals: two numbers whose product is 1; for example, $\frac{2}{3}$ and $\frac{3}{2}$

rectangle: a quadrilateral that has four right angles

reflection: a transformation that is illustrated by a shape and its image in a line of reflection



reflex angle: an angle between 180° and 360°

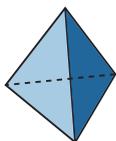


regular polygon: a polygon that has all sides equal and all angles equal

regular prism: a prism with regular polygons as bases; for example, a cube

regular pyramid: a pyramid with a regular polygon as its base; for example, a tetrahedron

regular tetrahedron: an object with four congruent triangular faces; a regular triangular pyramid



relation: a rule that relates two quantities

repeating decimal: a decimal with a repeating pattern in the digits to the right of the decimal point; it is written with a bar above the repeating digits; for example, $\frac{1}{15} = 0.0\overline{6}$

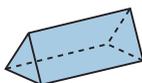
rhombus: a parallelogram with four equal sides

right angle: a 90° angle

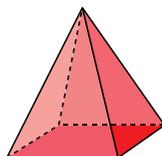
right cylinder: an object with two parallel, congruent, circular bases



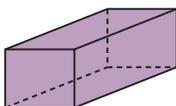
right prism: an object that has two congruent and parallel faces (the *bases*), and other faces that are rectangles



right pyramid: an object that has one face that is a polygon (the *base*), and other faces that are triangles with a common vertex



right rectangular prism: a prism that has rectangular faces

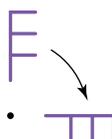


right rectangular pyramid: a pyramid with a rectangular base

right triangle: a triangle that has one right angle



rotation: a transformation in which a shape is turned about a fixed point



rotational symmetry: the property of a shape that it coincides with itself after a rotation of less than 360° about its centre

sample: a portion of the population

scale: the numbers on the axes of a graph

scale diagram: a diagram that is an enlargement or a reduction of another diagram

scale factor: the ratio of corresponding lengths of two similar shapes

scalene triangle: a triangle with all sides different

sector: part of a circle between two radii and the included arc

semicircle: half a circle

similar polygons: polygons with the same shape; one polygon is an enlargement or a reduction of the other polygon

simplest form: a ratio with terms that have no common factors, other than 1; a fraction with numerator and denominator that have no common factors, other than 1

spreadsheet: a computer-generated arrangement of data in rows and columns, where a change in one value results in appropriate calculated changes in the other values

square: a rectangle with four equal sides

square number: a number that can be written as a power with an integer base and exponent 2; for example, $49 = 7^2$

square root: a number which, when multiplied by itself, results in a given number; for example, 5 is a square root of 25

statistics: the branch of mathematics that deals with the collection, organization, and interpretation of data

straight angle: an angle measuring 180°

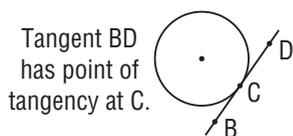


supplementary angles: two angles whose sum is 180°

surface area: the total area of the surface of an object

symmetrical: having symmetry (see *line symmetry*)

tangent: a line that intersects a circle at only one point



term: a number, a variable, or the product of numbers and variables; for example, -5 , y , $7a^2$

terminating decimal: a decimal with a certain number of digits after the decimal point; for example, $\frac{1}{8} = 0.125$

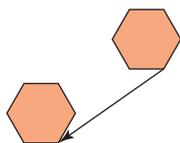
tessellate: to use congruent copies of a shape to cover a plane with no overlaps or gaps

theoretical probability: the number of favourable outcomes written as a fraction of the total number of possible outcomes

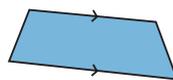
three-dimensional: having length, width, and depth or height

transformation: a translation, rotation, or reflection

translation: a transformation that moves a point or a shape in a straight line to another position on the same flat surface



trapezoid: a quadrilateral that has exactly one pair of parallel sides



triangle: a three-sided polygon

trinomial: a polynomial with three terms; for example, $3x^2 - 5x + 8$

two-dimensional: having length and width, but no thickness, height, or depth

two-term ratio: a comparison of two quantities with the same unit

unit fraction: a fraction that has a numerator of 1

unit price: the price of one item, or the price of a particular mass or volume of an item

unit rate: a quantity associated with a single unit of another quantity; for example, 6 m in 1 s is a unit rate; it is written as 6 m/s

valid conclusions: results of data collection that represent what is typical of the population

variable: a letter or symbol representing a quantity that can vary

vertex (plural, vertices): the point where 2 sides of a shape meet, or the point where 3 or more edges of an object meet

vertical axis: the vertical number line on a coordinate grid

volume: the amount of space occupied by an object

whole numbers: the set of numbers 0, 1, 2, 3, ...

x-axis: the horizontal number line on a coordinate grid

y-axis: the vertical number line on a coordinate grid

zero pair: two opposite numbers whose sum is equal to zero; for example, -4.1 and 4.1

zero property: the property of addition that states that adding 0 to a number does not change the number; for example, $3 + 0 = 3$; for multiplication, multiplying a number by 0 results in the product 0; for example, $3 \times 0 = 0$

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