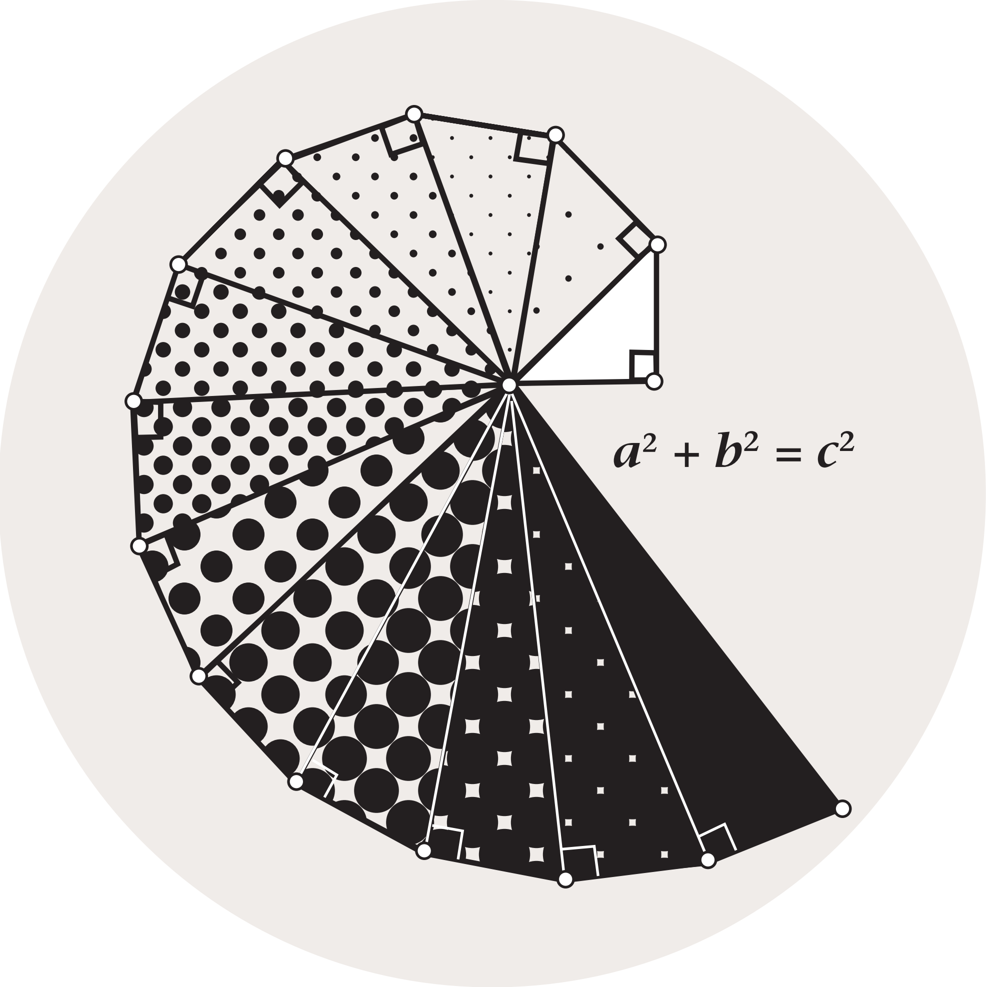
Module 2
Version 03
Section 1-3

Math 8

Module 2

Squares, Integers, and the Pythagorean Theorem



BRITISH COLUMBIA

OPEN SCHOOL BC

Section 1: Where in the World...?
Description of Nine Chapters on Mathematical Art
http://en.wikipedia.org/wiki/Nine_Chapters_on_the_Mathematical_Art

Section 3 Lesson A: The Pythagorean Theorem
Fence*, Photo by fotologic
http://www.flickr.com/photos/fotologic/273240525/in/set-72157594245913225/

and a white picket fence*, Photo by neoliminal
http://www.flickr.com/photos/neoliminal/518105915/

Two-story single-family home, Photo by SanjibLemar
http://commons.wikimedia.org/wiki/File:Two-story_single-family_home.jpg

Section 3 Lesson B: Pythagorean Triples
Door numbered 52, Photo by Hans Wolff
http://commons.wikimedia.org/wiki/File:Door_numbered_52.jpg

*Photos released under Creative Commons Attribution 2.0 Generic license
http://creativecommons.org/licenses/by/2.0/deed.en_CA

Additional photos by Christina Teskey

Project Manager: Christina Teskey, Jennifer Riddel (Open School BC)

Planning Team: Dane Allison (School District 8), Sonya Fern (School District 62), Duncan McDougall (Tutor Find Learning Centre), Shelley Moore (School District 38), Jennifer Riddel (Open School BC), Christina Teskey (Open School BC), Angela Voll

Writers: Dan Laidlaw (School District 73), Esther Moreno (School District 39), Angela Voll, Rusé Kampunzi, Clint Surry (School District 63), Christina Teskey (Open School BC)

Course Reviewers: Susan Robinson (School District 64), Clint Surry (School District 63)

Editor: Shannon Mitchell (Paper Hat Editing Services)

Production Technician: Beverly Carstensen

Art: Beverly Carstensen, Cal Jones, Max Licht, Sean Owen, Christine Ramkeesoon

Multimedia
Media Coordinator: Janet Bartz, Christine Ramkeesoon
Media Design: Janet Bartz
Flash Programming: Chris Manuel
Voice Talent: Wendy Webb
Video Scripting: Jennifer Riddel, Christina Teskey
Video Production: Caitlin Flanders, Chris Manuel, Sean Owen
Video Talent: Jennifer Riddel, Jeffrey Chan, Cameron Vieweg, Meghan Vieweg

Print History

Corrected, February 2010
Corrected, September 2009
New: August 2009

Contents

Course Overview

Welcome to Mathematics 8!

In this course you will continue your exploration of mathematics. You'll have a chance to practice and review the math skills you already have as you learn new concepts and skills. This course will help you to increase your ability to think mathematically.

Organization of the Course

The Mathematics 8 course is made up of four modules. These modules are:

Module 1: Exploring 2-D and 3-D Connections

Module 2: Squares, Integers, and the Pythagorean Theorem

Module 3: Data, Graphing, and Linear Equations

Module 4: Fractions, Ratios, and Probability

Organization of the Modules

Each module has three sections. The sections have the following features:

Pretest

This is for students who feel they already know the concepts in the section. It is divided by lesson, so you can get an idea of where you need to focus your attention within the section.

Lessons

Each section is divided into lessons. Each lesson is made up of the following parts:

Essential Questions

Essential Questions are based on the concepts in each lesson. This activity will help you organize information and reflect on your learning.

Warm-up

This is a brief drill or review to get ready for the lesson.

Explore

This is the main teaching part of the lesson. Here you will explore new concepts and learn new skills.

Try it! Activities

These are activities for you to complete to solidify your new skills. You will mark these using Solutions at the end of each module.

At the end of each module you will find:

Solutions

This contains all of the solutions to the Pretests, Warm-ups and Try it! Activities.

Templates

Templates to pull out, cut, colour, or fold in order to complete specific activities. You will be directed to these as needed.

Glossary

This is a list of key terms and their definitions.

More about the Pretest

There is a pretest at the beginning of each section. This pretest has questions for each lesson in the section. Complete this pretest if you think that you already have a strong grasp of the topics and concepts covered in the section. Mark your answers using Solutions found at the end of the module.

If you get all the answers correct (100%), you may decide that you can omit the lesson activities.

If you get all the answers correct for one or more lessons, but not for the whole pretest, you can decide whether you can omit the activities for those lessons.

Thinking Space

The column on the outside edge of most pages is called the Thinking Space. You can use this space to

- write questions about things you don't understand
- note things that you want to look at again
- respond to a question in the Thinking Space or the text
- draw pictures that help you understand the math
- identify words that you don't understand
- connect what you are learning to what you already know
- make your own notes or comments

Materials and Resources

There is no textbook required for this course. All of the necessary materials and exercises are found in the modules.

In some cases, you will be referred to templates to pull out, cut, colour, or fold. These templates will always be found near the end of the module, just in front of the answer key.

You will need a scientific calculator for some of the activities. A geometry set would also be helpful, although for many activities you can use a straightedge rather than a ruler. A protractor is available in the Appendix if you don't have one.

If you have Internet access, you might want to do some exploring online. The Math 8 Course Website will be a good starting point. Go to **http://www.openschool.bc.ca/courses/math/math8/mod2.html** and find the lesson that you're working on. You'll find relevant links to websites with games, activities, and extra practice. .

Icons

You will see a few icons used on the left-hand side of the page. These icons are used to signal a change in activity or to bring your attention to important instructions.

Explore Online

Essential Questions

Solutions

Use a Calculator

Module 2 Overview

Module 2 consists of three sections on the multiplication and division of positive and negative numbers, squares and square roots, and the Pythagorean Theorem.

Section Overviews

Section 2.1: Multiplying and Dividing Integers

In this first section you'll review multiplication and division and decide which operation to use in word problems. You'll also learn to multiply and divide with positive and negative numbers. Finally, you'll review the order of operations and use its principles to calculate the answers to questions that include integer multiplication and division.

Section 2.2: Squares and Square Roots

In the second section, you'll learn to recognize and list perfect squares through the use of a media tool called Shape Shifter. You'll be able to recognize the square root sign $\sqrt{}$ and use the square root button on your calculator. Using your calculator, you'll be able to find the square root of any whole number.

Section 2.3: The Pythagorean Theorem

In the final section, you'll learn the Pythagorean Theorem and be able to decide if a triangle is a right triangle. You'll identify Pythagorean Triples, and then use the Pythagorean Theorem to find the lengths of missing sides of right triangles.

Course Map

On the following page you'll find a course map. If you colour in the box for each section and lesson as you complete it, you'll easily be able to see how much of the course you've finished, and how much is still left to complete.

Mathematics 8

Module 1

Section 1
Nets and Views

- Lesson A: Visualizing in Three Dimensions
- Lesson B: Prisms and Cylinders and their Nets
- Lesson C: Top View, Side View, and Front View

Section 2
Calculations in 2-D and 3-D

- Lesson A: Total Area of the Net
- Lesson B: More about Area in 2-D and 3-D
- Lesson C: The Amount of Space

Section 3
Shapes and Design

- Lesson A: What is a Tessellation Anyways?
- Lesson B: Transformations in Tessellations
- Lesson C: Creating a Tessellation

Module 2

Section 1
Multiplying and Dividing Integers

- Lesson A: Should I Multiply or Divide?
- Lesson B: Mult. and Div. with Negative Numbers
- Lesson C: Expressions–More than one Operation

Section 2
Squares and Square Roots

- Lesson A: Perfect Squares
- Lesson B: Square Roots of Perfect Squares
- Lesson C: Estimating Square Roots
- Lesson D: Calculating Square Roots

Section 3
The Pythagorean Theorem

- Lesson A: The Pythagorean Theorem
- Lesson B: Pythagorean Triples
- Lesson C: Using the Pythagorean Theorem

Module 3

Section 1
Analyzing statistical graphs

- Lesson A: Types of Graphs and Data
- Lesson B: Adv. and Dis. of Graph Types
- Lesson C: Misleading Graphs

Section 2
Graphing on the Coordinate Plane

- Lesson A: Ordered Pairs and Linear Equations
- Lesson B: Tables of Values
- Lesson C: Relationships and Missing Values

Section 3
Linear Equations

- Lesson A: Algebra Tiles
- Lesson B: Solving Linear Equations Symbolically
- Lesson C: More Linear Equations

Module 4

Section 1
Multiplying and Dividing Fractions

- Lesson A: Proper, Improper Fractions, Mixed Numbers
- Lesson B: Multiplying Fractions
- Lesson C: Dividing Fractions
- Lesson D: Estimating and Solving Problems

Section 2
Ratios, Rates and Percents

- Lesson A: Ratios and Rates in Everyday Life
- Lesson B: Making Sense of Percents
- Lesson C: Solving Problems with Percents

Section 3
Probability

- Lesson A: The Probability of Independent Events
- Lesson B: Problem Solving with Probability

Section 1

Multiplying and Dividing Integers

In this section you will:

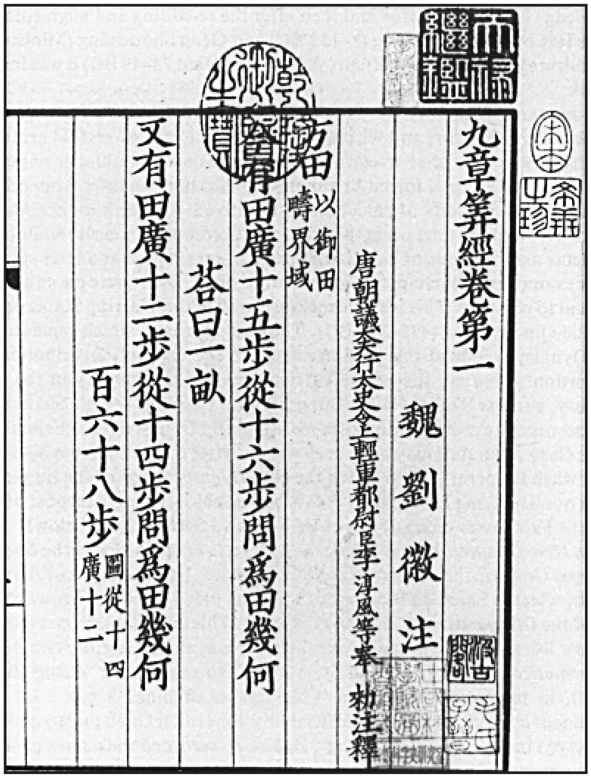
- learn when to multiply and when to divide
- multiply and divide with positive and negative numbers
- review order of operations

For this section you will need:

- crayon, marker, or coloured pencil

Where in the World...?

Mathematicians in China were contemplating the meaning and use of negative numbers as early as 100 BC.



九章筭經卷第一
魏 劉 徽 注
唐朝議大夫行太史令上輕車都尉臣李淳風等奉 勅注釋
方田（以御田疇界域）
今有田廣十五步從十六步問爲田幾何
荅曰一畝
又有田廣十二步從十四步問爲田幾何
百六十八步（圖從十四廣十二）

This image is from the famous Chinese book the *Jiu zhang suanshu* or the *Nine Chapters on the Mathematical Art*. In the book there is a description of using different coloured counting rods—red for positive numbers and black for negative numbers.

Many years later in India and in Europe, negative numbers were used in banking and trade to represent money lost and debts owed.

Positive and negative numbers allow us to give numbers a direction. Temperature can go up and temperature can go down. When you're walking on the sidewalk, you can go forward or you can go backward.

But what does it mean to multiply or divide negative numbers?

Section 1
Pretest

Complete this pretest if you think that you already understand the topics and concepts covered in this section. Mark your work using Solutions found at the end of the module.

If you get all the answers correct (100%), you may decide that you can omit the lesson activities.

If you get all the answers correct for one or more lessons, but not for the whole pretest, you can decide whether you can omit the activities for those lessons.

Lesson A: Should I Multiply or Divide?

1. You have 3 pies and 18 people. How many pieces should you cut each pie into to guarantee that each person will have at least one piece?

2. You have 320 CDs in your collection. You found a CD case that you like. It holds 40 CDs. How many cases do you need for your collection?

3. A health insurance plan advertises that its plan costs only $6 per day. How much does the plan cost per month? Assume that a month has 30 days.

Lesson B: Multiplying and Dividing With Negative Numbers

4. a. $-6 \times 7 =$

   b. $-12 \div (-2) =$

   c. $8 \times (-11) =$

   d. $150 \div (-3) =$

   e. $42 \div 6 =$

   f. $-9 \times (-8) =$

5. $\dfrac{(-3)(8)(-4)}{(6)(-2)} =$

Lesson C: Expressions With More Than One Operation

6. a. $\dfrac{(4)(-3)}{6} + (3)(7) =$

   b. $(-2)(7) - 18 \div 6 + 4 \times 9 =$

   c. $42 \div (-7) + 9 =$

   d. $-3 + 6 \times 9 =$

✓ Turn to Solutions at the end of the module and mark your work.

Lesson A

Should I Multiply or Divide?

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
What is multiplication?		
What is division?		
How do I know when to multiply or divide?		

Warm-up

1. 4 × 5 =
2. 21 ÷ 7 =
3. 3 × 8 =
4. 63 ÷ 9 =
5. 2 × 7 =
6. 18 ÷ 6 =
7. 4 × 4 =
8. 15 ÷ 5 =
9. 6 × 4 =
10. 72 ÷ 9 =
11. 30 ÷ 10 =
12. 11 × 8 =
13. 24 ÷ 3 =
14. 7 × 5 =
15. 70 ÷ 7 =
16. 6 × 6 =
17. 4 × 8 =
18. 56 ÷ 7 =
19. 20 ÷ 4 =
20. 5 × 5 =

If you have access to the Internet and want to get more practice with multiplication and division facts, go to the Math 8 website **http://www.openschool.bc.ca/courses/math/math8/mod2.html** and click on the link under *Lesson 2.1A: Should I Multiply or Divide?*

Turn to Solutions at the end of the module and mark your work.

Explore

Multiplication

You know lots about multiplication already.

If you have 4 groups with 3 items in each group, you can figure out the total number of items by multiplying.

$$4 \times 3 = 12$$

There are twelve items all together.

Perhaps in one of the other math courses you've taken, you've learned how to do problems like this one.

Example

Susan worked at a tulip farm last spring, packaging bulbs in boxes before they were sent to the store. She put 15 bulbs in every box. On her most productive day, she filled 42 boxes. How many bulbs did she pack?

Groups: boxes
Items: bulbs
\# of groups: Susan packed 42 boxes.
\# of items in one group: There were 15 bulbs in each box.
Total items: We don't know. Multiply to find out.

$42 \times 15 = 630$

Susan packed 630 bulbs.

Go to **http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html**, click on Module 2, and watch *Solving a Multiplication Word Problem*.

Thinking Space

Use this structure to solve the problem.

Groups: ____________________

Items: ____________________

# of groups: ______________________________

# of items in one group: ______________________________

Total items: __________

Thinking Space

Try It!

Activity 1

These are all multiplication problems.

1. This question is very similar to the example. Follow the example if you need help.

   Susan worked at a tulip farm last spring, packaging bulbs in boxes before they were sent to the store. She put 24 bulbs in every box. On her most productive day, she filled 370 boxes. How many bulbs did she pack?

   Fill in the blanks with the correct numbers.

Do these questions without a calculator.

Groups: boxes
Items: bulbs
# of groups: Susan packed ____________ boxes.

# of items in one group: There were ____________ bulbs in each box.

Total items: We don't know. Multiply to find out

________ × ________ = ________

Susan packed ________ bulbs.

2. In the winter, Amir feeds his cows four bales of hay every day. Spring is coming and he thinks that he will be able to put the cows out on the pasture in 45 days. How many bales of hay does he need?

   Fill in the blanks with the correct numbers.

Groups: days
Items: bales of hay
# of groups: Amir needs hay for ____________ days.

# of items in one group: He needs ____________ bales of hay each day.

Thinking Space

Total items: We don't know. Multiply to find out.

________ × ________ = ________

Amir needs ________ bales of hay.

3. A box of collectible trading cards contains 24 packs. Each pack has 15 trading cards. How many cards are in a box?

   Draw a picture that describes this situation.

   Fill in the blanks with the correct numbers.

   Groups: packs of trading cards
   Items: cards in each pack

   # of groups: ________ packs

   # of items in one group: ________ cards in each pack

   Total items: We don't know. Multiply to find out.

   ________ × ________ = ________

   There are ________ trading cards in a box.

Thinking Space

4. Alexis got a beading kit for her birthday. The kit contains six pouches of coloured of beads, and there are 22 beads in each pouch. How many beads are in the kit?

Draw a picture that describes this situation.

Fill in the blanks with the correct numbers.

Groups: pouches of beads
Items: beads

\# of groups: ________ pouches of beads

\# of items in one group: ________ beads in each pouch

Total items: We don't know. Multiply to find out.

________ × ________ = ________

There are ________ beads in the kit.

Thinking Space

5. Chris earns $9 per hour at the Burger Hut. He worked 21 hours last week. How much money did he make?

Draw a picture that describes this situation.

Fill in the blanks.

Groups: ______________________

Items: ______________________

\# of groups: ________

\# of items in one group: ________

Total items: We don't know. Multiply to find out.

________ × ________ = ________

Chris earned $ ________ last week.

Thinking Space

6. Jamie's band gets paid 5¢ every time someone buys one of their songs from an Internet music store. Their latest hit has been downloaded 3726 times since it was posted this morning. How much money have they made?

   Think about groups, items, and total when you solve the problem.

Turn to Solutions at the end of the module and mark your work.

Explore

Division

How did that go? Make sure you have checked your answers before you move on.

Division is the opposite of multiplication. If you have twelve items in four equal groups, you can figure out the number of items in each group by dividing.

$$12 \div 4 = 3$$

There are three items in each group.

Go to **http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html**, click on Module 2, and watch *Solving a Division Word Problem*.

When you work on this next set of questions, think about how they are different from the last set of questions.

Thinking Space

Try It!
Activity 2

These are all division problems.

1. One day at the tulip farm, Susan's boss bought pizza for everyone. They packed 60 000 tulips yesterday! With 24 tulips in each box, how many boxes did they fill?

Groups: boxes

Items: bulbs

Fill in the blanks with the correct numbers.

# of groups: We don't know. Divide to find out.

# of items in one group: There were ________ bulbs in each box.

Total items: There were ________ bulbs altogether.

________ ÷ ________ = ________

They filled ________ boxes with bulbs.

2. The calendar fundraiser is going well. The class keeps $3 for every calendar that they sell. They have set a fundraising goal of $465. How many calendars do they need to sell?

Draw a picture that describes this situation.

Thinking Space

Groups: calendars
Items: dollars for each calendar that they sell
# of groups: We don't know. Divide to find out.

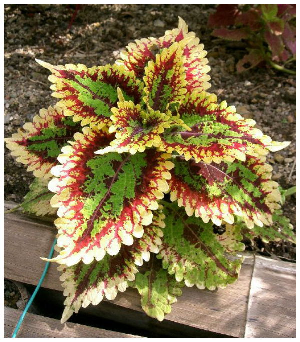
# of items in one group: The class earns $________ for each calendar that they sell.

Total items: The class wants to raise $________.

________ ÷ ________ = ________

They need to sell ________ calendars to reach their goal.

3. The landscaper for a housing development has 585 coleus seedlings ready to be transplanted.



How many seedlings can she plant at each one of 13 new houses?

Groups: new houses
Items: seedlings
# of groups: There are ________ new houses.
# of items in one group: We don't know. Divide to find out.

Total items: There are ________ seedlings.

________ ÷ ________ = ________

The landscaper can plant ________ coleus seedlings in each yard.

Thinking Space

4. Chris needs $648 to buy a new guitar. How many hours does he need to work at the Burger Hut, where he earns $9 per hour, to make that much money?

   Fill in the blanks.

   Groups: ____________

   Items: ____________

   # of groups: We don't know. Divide to find out.

   # of items in one group: ____________

   Total items: ____________

   ________ ÷ ________ = ________

   Chris needs to work for ________ hours to earn the money to buy the guitar.

5. Alexis has 56 beads left in her beading kit. She has worked out a design that she likes for a bracelet with 7 beads. How many bracelets can she make with the beads that she has left?

   Draw a picture that describes this situation.

Thinking Space

Fill in the blanks.

Groups: ____________

Items: ____________

# of groups: We don't know. Divide to find out.

# of items in one group: ____________

Total items: ____________

________ ÷ ________ = ________

Alexis can make ________ bracelets.

6. Nancy has noticed that she is nearly out of one brand of collectible trading cards at her store. One box, which contains 24 packs of cards, costs $18. How much does she pay for each pack of cards?

   Think about groups, items, and total when you solve the problem.

Turn to Solutions at the end of the module and mark your work.

Thinking Space

Explore

Deciding Whether to Use Multiplication or Division

How are multiplication questions different from division questions?

Think about groups, items in a group, and total.

If you need to find the total, you're doing a multiplication question.

If you know the total, you're doing a division question.

Thinking Space

Try It!

Activity 3

There are multiplication and division problems here.

1. Amir has 192 bales of hay. If he feeds his cows 4 bales every day, how many days will his hay last?

   Think about groups, items, and total when you solve the problem.

   Draw a picture that describes this situation.

   Fill in the blanks with the description and the correct number, or write "We don't know."

   Groups: ____________________

   Items: ____________________

   Total: ____________________

   ________ ÷ ________ = ________

   ____

   ____

Thinking Space

2. The class has sold 32 calendars so far in this year's fundraiser. The calendars sell for $14. How much money have they collected?

Think about groups, items, and total when you solve the problem.

Draw a picture that describes this situation.

Fill in the blanks with the description and the correct number, or write "We don't know."

Groups: ____________________

Items: ____________________

Total: ____________________

________ ÷ ________ = ________

____

____

Thinking Space

3. The 5 members of Jamie's band are celebrating. They have earned $700 selling their songs at an internet music store. How much money do they each get?

Think about groups, items, and total when you solve the problem.

Draw a picture that describes this situation.

Fill in the blanks with the description and the correct number, or write "We don't know."

Groups: ______________________

Items: ______________________

Total: ______________________

_______ ÷ _______ = _______

____

____

4. The new housing development is almost finished. There are 13 new houses. The landscaper wants to put a cedar hedge along the driveway of each new home. She needs 8 plants for each hedge. How many cedar plants does she need?

   Think about groups, items, and total when you solve the problem.

   Draw a picture that describes this situation.

   Fill in the blanks with the description and the correct number, or write "We don't know."

   Groups: ______________________________

   Items: ______________________________

   Total: ______________________________

   __________ ÷ __________ = __________

   ____

   ____

Turn to Solutions at the end of the module and mark your work.

You've finished Lesson A. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Lesson B

Multiplying and Dividing with Negative Numbers

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
When multiplying integers, how do I know if my answer will be positive or negative?		
What do I do when a question asks me to multiply and divide more than two numbers?		

Thinking Space

Warm-up

1. $-2 + 3 =$

2. $6 \times 7 =$

3. $3 - 8 =$

4. $36 \div 4 =$

5. $7 \times 3 =$

6. $4 - 7 =$

7. $9 \times 2 =$

8. $12 \div 4 =$

9. $-15 + 7 =$

10. $10 - 6 =$

11. $24 \div 6 =$

12. $15 \times 3 =$

13. $-2 - 5 =$

14. $6 + 5 =$

15. $27 \div 9 =$

16. $12 - 20 =$

17. $4 \times 8 =$

18. $-9 - 2 =$

19. $35 \div 7 =$

20. $-1 + 17 =$

✓ Turn to Solutions at the end of the module and mark your work.

Thinking Space

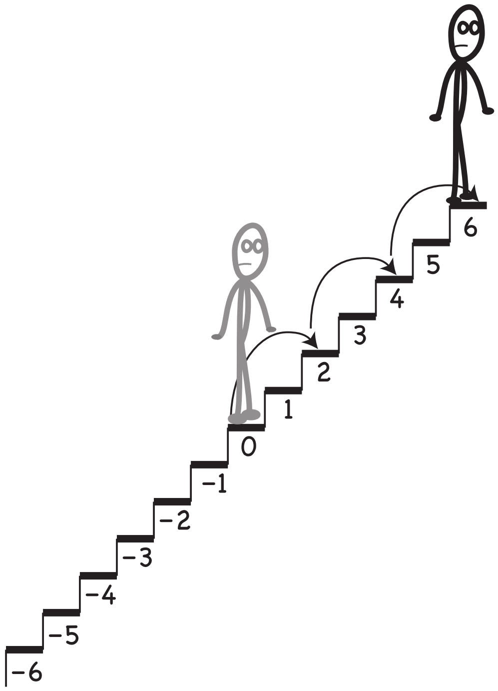
Explore

× and ÷ with a Positive Number and a Negative Number

There are lots of ways to think about positive and negative numbers. Perhaps you like thinking about temperature. The temperature can be +3° C. The temperature can be –4° C. The temperature can go up (move in a positive direction). The temperature can go down (move in a negative direction).

Maybe the money analogy is your favourite. You have $10 (that's +10). You owe $10 (that's –10). You earn money (move in a positive direction) and you spend money (move in a negative direction).

In this lesson we're going to think about stairs.



Start at 0.

Go up two stairs.

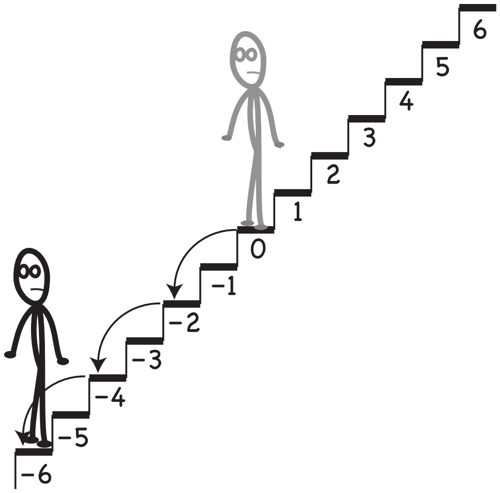
Do that three times.

Where are you?

+6

2 × 3 = 6

We knew that already.



Go back to 0.

Go down two stairs.

Do that three times.

Where are you?

–6

–2 × 3 = –6

Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html, click on Module 2, and watch *Multiplication Steps*.

When multiplying or dividing,
if the signs are DIFFERENT (one +, one –)
the answer is NEGATIVE.

Thinking Space

Try It!

Activity 1

1. Remember: If the signs are different, the answer is negative.

a. 4 × (–3) =

b. –4 × 3 =

c. 12 ÷ 1 =

d. –1 × 12 =

e. 12 ÷ (–4) =

f. –12 ÷ 4 =

g. 2 × (–6) =

h. –2 × 6 =

i. –12 ÷ 3 =

j. 12 ÷ (–3) =

k. 12 ÷ 3 =

l. –12 × 1 =

m. 12 × (–1) =

n. 12 ÷ 2 =

o. 12 ÷ (–2) =

p. 12 ÷ (–6) =

q. –12 ÷ 6 =

r. 3 × (–4) =

s. 4 × 3 =

t. 6 × 2 =

u. –6 × 2 =

v. 6 × (–2) =

2. Winter is coming and the temperature is dropping. The weather forecast says to expect the temperature to go down by 3°C every day for the next 5 days. How much colder will it be on the fifth day than it is today?

3. Margaret, Halim, and André have decided to close the store that they owned together. Their company is $900 in debt. They want to split the debt equally between the three of them. How much does each of them owe?

✓ Turn to Solutions at the end of the module and mark your work.

Thinking Space

Explore

× and ÷ with Two Negative Numbers

Do you remember doing "fact families"?

$$2 \times 3 = 6$$

$$3 \times 2 = 6$$

$$6 \div 2 = 3$$

$$6 \div 3 = 2$$

Let's look at the fact family that goes with 2 × (-3).

$$2 \times (-3) = -6$$

$$(-3) \times 2 = -6$$

$$-6 \div 2 = (-3)$$

$$-6 \div (-3) = 2$$

The first three facts in that list follow the rule we just learned. When the signs are different, the answer is negative.

Can you think of a rule about multiplying two negative numbers?

Look at the last fact. A negative number divided by a negative number is a positive number.

Multiplication and division of integers have the same rules for signs.

When multiplying or dividing,
if the signs are the SAME (both + or both –)
the answer is POSITIVE.

Thinking Space

Try It!

Activity 2

**When multiplying or dividing,
if the signs are the SAME (both + or both –)
the answer is POSITIVE.**

1. $4 \times 5 =$
2. $-4 \times (-5) =$
3. $4 \times (-5) =$
4. $20 \div 4 =$
5. $-20 \div (-5) =$
6. $-10 \times (-2) =$
7. $-20 \div (-2) =$
8. $20 \div 2 =$
9. $-1 \times (-20) =$
10. $3 \times (-8) =$
11. $-24 \div 8 =$
12. $-4 \times 6 =$
13. $24 \times (-1) =$
14. $24 \div (-4) =$
15. $2 \times (-12) =$
16. $-24 \div 3 =$

Thinking Space

17. $-24 \div 1 =$

18. $(-7 \times (-7) =$

19. $7 \times 7 =$

20. $49 \div (-7) =$

21. $49 \div 7 =$

22. $-5 \times (-5) =$

23. $5 \times 5 =$

24. $-25 \div (-25) =$

25. $-1 \times (-5) =$

26. $-4 \times (-4) =$

27. $4 \times 4 =$

28. $16 \div (-4) =$

29. $-16 \div 4 =$

30. $4 \div 2 =$

31. $4 \div (-2) =$

32. $-4 \div 2 =$

33. $-4 \div (-2) =$

34. $56 \div 8 =$

Turn to Solutions at the end of the module and mark your work.

Explore

× and ÷ with More Than Two Numbers

What about questions with more than two numbers?

$$2 \times 3 \times (-4) \qquad (2)(-3)(-4) \qquad \frac{12(-3)}{4}$$

$$(3)(-1)(-2)(-5)$$

$$\frac{12(-3)(5)}{(-6)(-15)} \qquad \frac{5(-2)(-1)(6)}{15}$$

Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html, click on Module 2, and watch *Simplifying*.

When an expression contains only the operations of multiplication and division, you can do the operations in any order that you like.

Did you notice anything about how negative signs affect the answer? If there is an *even* number of negative signs, the answer is *positive*. If there is an *odd* number of a negative signs, the answer is *negative*.

Let's look at a question with more operations.

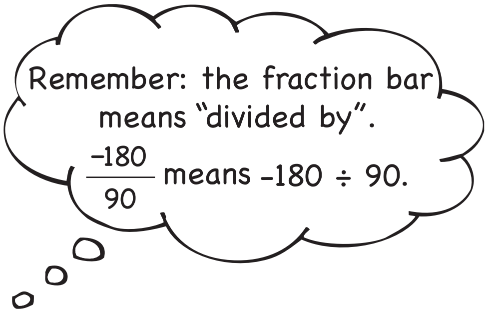
$$\frac{12(-3)(5)}{(-6)(-15)}$$

The numerator is the top of a fraction. The denominator is the bottom of a fraction.

Will this answer be positive or negative? The **numerator** will be negative and the **denominator** will be positive. A negative divided by a positive is negative. This answer will be negative.

There are a number of different ways to do this question. We're going to look at two of them.

$\frac{12(-3)(5)}{(-6)(-15)}$ Multiply everything that is in the numerator. Multiply everything that is in the denominator.



Remember: the fraction bar means "divided by". $\frac{-180}{90}$ means $-180 \div 90$.

$= \frac{-180}{90}$ Divide.

$= -2$

That method works, but sometimes the numbers get pretty big. This time, let's simplify by doing some of the division first.

$\frac{12(-3)(5)}{(-6)(-15)}$ There are an odd number of negative signs in the question. We know the answer will be negative. Take away all the negative signs and put one in front.

$= -\frac{12(3)(5)}{(6)(15)}$ When you simplify, remember to divide a number into both the numerator and denominator.

$= -\frac{{}^{2}\cancel{12}(3)(5)}{{}_{1}(\cancel{6})(15)}$ 6 divides into 12 twice. 6 divides into 6 once.

$= -\frac{2(3)(\cancel{5})^{1}}{(1)(\cancel{15})_{3}}$ 5 divides into both 5 and 15.

$= -\frac{2(\cancel{3})^{1}(1)}{(1)(\cancel{3})_{1}}$ 3 divides into both 3 and 3.

$= -\frac{2(1)(1)}{(1)(1)}$

$= -2$

Thinking Space

Try It!

Activity 3

These questions will be easier if you simplify first. Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html, click on Module 2, and watch the video *Simplifying* again if you want to review this.

When multiplying or dividing,
if there are an EVEN number of negative signs, the answer is POSITIVE.
If there are an ODD number of negative signs, the answer is NEGATIVE.

1. $\dfrac{12}{(3)(-1)(2)}$

2. $\dfrac{(3)(-3)(-7)}{(-9)}$

3. $(4)(5)(-1)$

4. $\dfrac{(-16)(25)(-2)}{(10)(-4)}$

5. $(2)(-5)(7)(-2)$

6. $\dfrac{(6)(-4)(2)}{-12}$

Thinking Space

7. $\dfrac{(24)(-14)}{(-8)(-7)(-1)}$

8. $\dfrac{(8)(-7)}{4(14)}$

9. $(-1)(2)(-3)(4)(-5)$

10. $\dfrac{(-15)(6)}{-9}$

11. $(5)(-3)(2)$

12. $\dfrac{(-21)(9)}{(7)(-3)}$

Go to **http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html**, click on Module 2, and watch *Solving Mixed Multiplication and Division* to see fully-worked solutions for some of these questions.

You've finished Lesson B. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Lesson C

Expressions With More Than One Operation

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
When there is more than one operation in an expression, how do I know what to do first?		

Warm-up

Answer the questions. Then look up each answer in the Decoder Table. Put the letter than matches the answer in the blank beside the questions.

For example: 1. –4 – 3 = –7, which matches A in the Decoder Table. Put an "A" in the blank beside 1.

A 1. $-4 - 3 = -7$

_____ 2. $\dfrac{(-5)(-1)(-2)(3)}{6}$

_____ 3. $18 \div 3 =$

_____ 4. $14 \div -7 =$

_____ 5. $-3 \times -4 =$

_____ 6. $(-6)(-8) =$

_____ 7. $-3 + 9 =$

_____ 8. $4 + 5 + 3 =$

_____ 9. $\dfrac{-21}{-3}$

_____ 10. $-8 + 6 =$

_____ 11. $\dfrac{18(7)(-4)}{(-14)(3)}$

_____ 12. $-5 + 30 =$

Decoder Table

A	–7
D	48
E	–1
F	7
G	9
H	–2
I	6
M	5
N	25
O	2
P	–5
S	12
T	–6
W	–25

Now unscramble the letters to solve the riddle. The A for question 1 has already been written in.

What do sea monsters eat?

				A							
9	**3**	**11**	**4**	**1**	**12**	**6**	**5**	**10**	**7**	**2**	**8**

Turn to Solutions at the end of the module and mark your work.

Thinking Space

Explore

Order of Operations

Something that tells us what to do with a number or numbers is called an operation.

Addition, subtraction, multiplication, and division are the operations that you know about already. These are called the basic operations.

You have probably done questions about adding and subtracting more than two numbers in other math courses.

In Lesson B, you learned about multiplying and dividing with more than two numbers.

What do you do with a question that involves many different operations?

BEDMAS: More Than Just a Weird Word

$$(-2)(3) \div 6 + 9 - 14 \div (9 - 2)$$

BEDMAS is an acronym that helps you to remember the order of operations.

BEDMAS
First, work out everything that is in brackets.

$$\begin{aligned} &(-2)(3) \div 6 + 9 - 14 \div \mathbf{(9 - 2)} \\ = &(-2)(3) \div 6 + 9 - 14 \div \quad 7 \end{aligned}$$

B**E**DMAS
Next, simplify all of the exponents. (There are no exponents in this question. You'll learn more about this in Section 2).

BE**DM**AS

Do all of the division and multiplication in the order they appear from left to right.

$$
\begin{aligned}
&= \mathbf{(-2)(3)} \div 6 + 9 - 14 \div 7\\
&= \quad \mathbf{-6} \quad \mathbf{\div 6} + 9 - \mathbf{14 \div 7}\\
&= \quad -1 \qquad\quad + 9 - \qquad 2
\end{aligned}
$$

BEDM**AS**

Finally, do the addition and subtraction.

$$
\begin{aligned}
&= \mathbf{-1 + 9} - 2\\
&= \mathbf{8 - 2}\\
&= 6
\end{aligned}
$$

Go to **http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html**, click on Module 2, and watch *Using Order of Operations*.

Thinking Space

Try It!
Activity 1

Solve the following.

1. $(-3)(7) =$
2. $4 \times 9 =$
3. $-13 \times 3 =$
4. $42 \div (-6) =$
5. $(8)(-1)(-4) =$
6. $12 + 6 =$
7. $15 \div 5 + 7 =$
8. $2 - 3 \times 4 =$
9. $3 + \frac{4}{2} =$
10. $-16 + (4)(3) =$
11. $-5 - (2)(-1)(-18) \div 4 =$
12. $6 \times 5 \div 3 =$
13. $18 \div 2 + 4 =$
14. $18 \div (2 + 4) =$

Thinking Space

15. 6 × 8 + 12 + 3 × 9 =

16. 3 + 11 × 4 + 12 ÷ 3 =

17. 7 – 3 × 5 =

18. (7 – 3) × 5 =

19. 36 ÷ 9 + 2 + 1 × 9 + 6 – 5 =

20. 6 × 7 ÷ 14 – 3 + 2 × 4 =

21. 5 – 1 + 2 – 4 × 3 ÷ 6 =

22. a. Make up a question that has an answer of 5. Use at least 3 numbers. Use at least 2 different operations.

Thinking Space

b. Show how to solve your question.

23. a. Make up a question that has an answer of –2. Use at least 4 numbers. Use at least 3 different operations.

b. Show how to solve your question.

24. a. Make up a question that uses all of these symbols exactly once.

1 2 3 4 5 6 7 8 9 + + – – × ÷

For example: 12 ÷ 3 + 4 – 5 × 6 + 7 – 89

b. Show how to solve your question.

Thinking Space

Turn to Solutions at the end of the module and mark your work.

You've finished Lesson C. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Section Summary

Completing this section has helped you to:

- learn when to multiply and when to divide
- multiply and divide with positive and negative numbers
- review order of operations

Section 2

Squares and Square Roots

In this section you will:

- recognize and list perfect squares
- recognize the square root sign √
- calculate the square roots of whole numbers

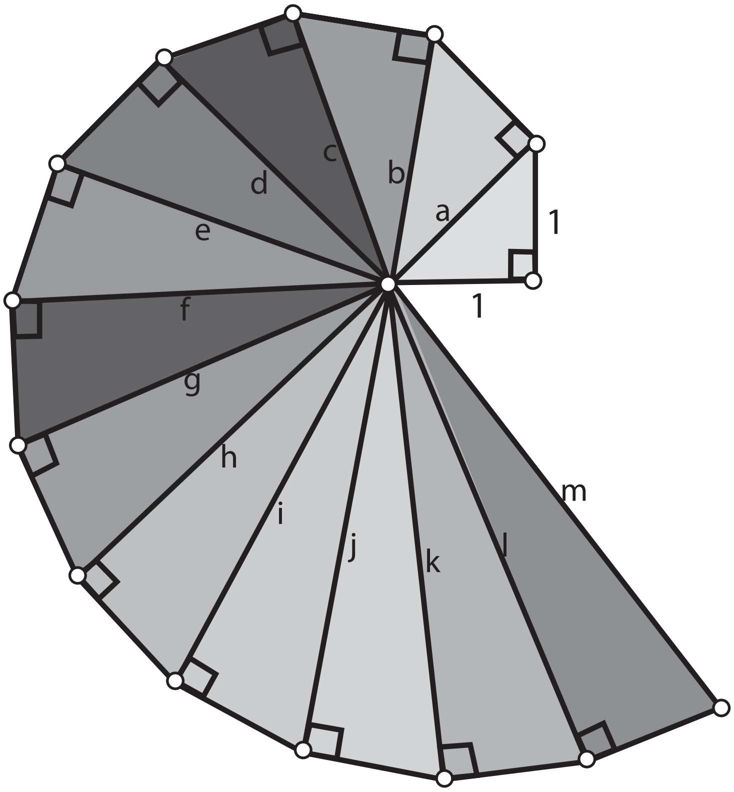
For this section you will need:

- calculator

Where in the World…?

Designing a house, sewing an outfit, installing new kitchen cabinets—if you know about squares and right angles, your project will look great.

You will learn the skills to solve problems like these in Section 2.



Section 2
Pretest

Complete this pretest if you think that you already understand the topics and concepts covered in this section. Mark your work using Solutions found at the end of the module.

If you get all the answers correct (100%), you may decide that you can omit the lesson activities.

If you get all the answers correct for one or more lessons, but not for the whole pretest, you can decide whether you can omit the activities for those lessons.

Lesson A: Perfect Squares

1. Circle the perfect squares.

54	18	4
16	27	37
25	81	5

Lesson B: Square Roots of Perfect Squares

2. What is the square root of 36?

3. a. 2^2 = ________ b. 5^2 = ________ c. 8^2 = ________

4. a. 9 = $\_\_\_\_\_\_\_\_^2$ b. 16 = $\_\_\_\_\_\_\_\_^2$ c. 49 = $\_\_\_\_\_\_\_\_^2$

5. a. $\sqrt{9} =$ _________ b. $\sqrt{64} =$ _________ c. $\sqrt{1} =$ _________

6. a. $11 = \sqrt{}$ b. $2 = \sqrt{}$ c. $5 = \sqrt{}$

7. a. $6 - 2^2 =$ _________ b. $(-3 + 5)^2 + 5 \times 3 =$ _________

Lesson C: Using the Pythagorean Theorem

8. Match each number on the left to its square on the right.

______ –2.5

______ 4

______ –7

______ 3

______ 1.1

______ –2

a. 16

b. 9

c. 1.21

d. 6.25

e. 49

f. 4

9. Complete each statement with =, <, or >

a. 2 ☐ 5

b. 3 – 8 ☐ 8 – 3

c. $3^2 - 3$ ☐ 6

d. (–2)(–3) ☐ 18 ÷ (–3)

10. Is $\sqrt{7}$ less than 2 or greater than 2? Why?

11. $\sqrt{39}$ and $\sqrt{43}$ are bigger than 6 and smaller than 7. List three more square roots that are between 6 and 7.

Lesson D: Calculating Square Roots

Use your calculator for these questions.

12. Solve.

a. $216^2 =$ ________ b. $3.4^2 =$ ________ c. $8.17^2 =$ ________

13. Solve.

Round your answers to the nearest thousandth.

a. $\sqrt{7} =$ ________ b. $\sqrt{24} =$ ________ c. $\sqrt{18} =$ ________

Turn to Solutions at the end of the module and mark your work.

Lesson A

Perfect Squares

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

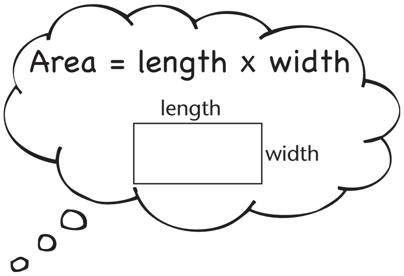
Essential Questions	Before the lesson: What I know	After the lesson: What I learned
Why are some numbers called "perfect squares"?		
How do **I** know when a number is not a perfect square?		
How are square numbers and square shapes related to each other?		

Warm-up

Before you start this lesson about perfect squares, practice some multiplication facts.

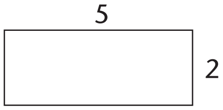
1. 2 × 3 =
2. 3 × 5 =
3. 3 × 3 =
4. 4 × 2 =
5. 4 × 5 =
6. 6 × 6 =
7. 7 × 3 =
8. 7 × 7 =
9. 8 × 4 =
10. 8 × 8 =
11. 9 × 6 =
12. 9 × 9 =

If you think you need some more practice with multiplication facts, go to the Math 8 website http://www.openschool.bc.ca/courses/math/math8/mod2.html and click on the link under *Lesson 2.1A: Should I Multiply or Divide?*

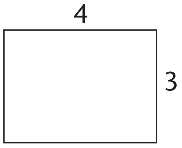


Find the area of these rectangles.

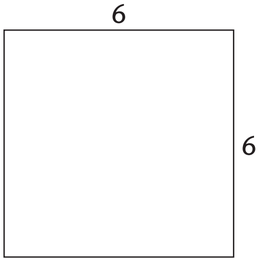
13.



14.



15.



16. Draw two rectangles with an area of 8. Remember to label the length of each side.

Turn to Solutions at the end of the Module and mark your work.

Thinking Space

Explore
The ShapeShifter Tool

Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/ma0822a1f_shapeshifter.html and open the *Shape Shifter* tool.

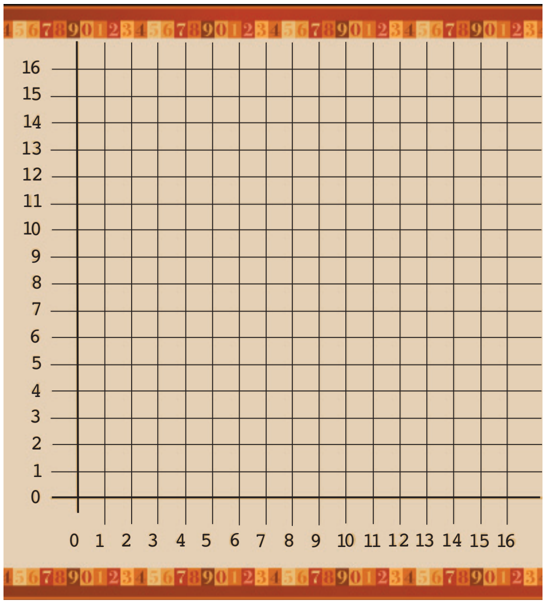
Click on the Rectangle button. Play with this tool for a while and discover how it works.

Thinking Space

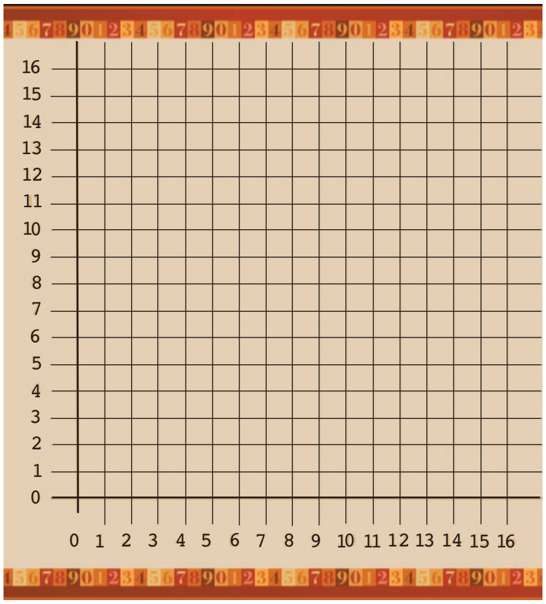
Try It!

Activity 1

1. Make Rectangle show “2 × 3”. Draw what you see.

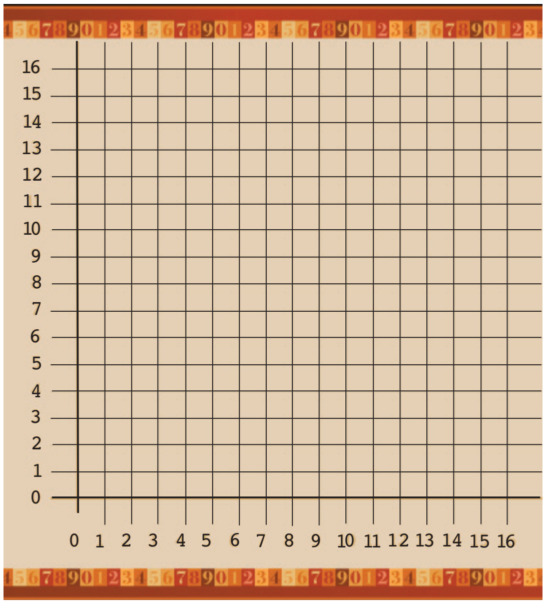


2. Make Rectangle show “3 × 3”. Draw what you see.

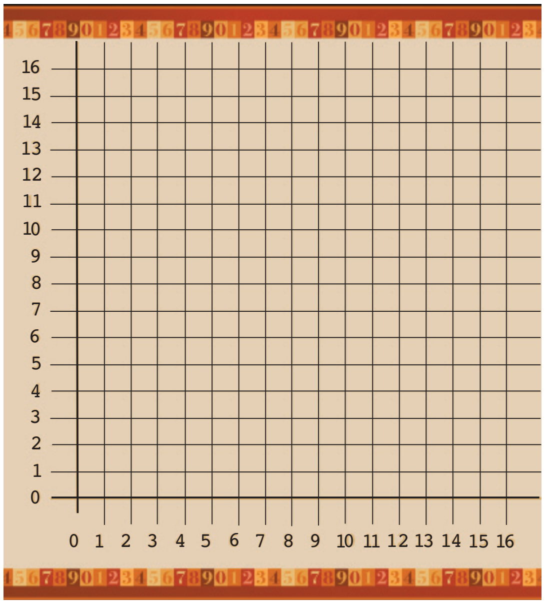


Thinking Space

3. Make Rectangle show a rectangle of area 12. Draw what you see.



4. Make Rectangle show a rectangle of area 12 in another way. Draw what you see.



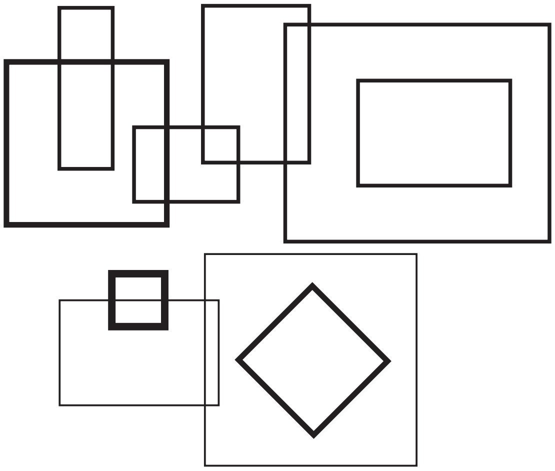
5. Are there any other ways to draw a rectangle with an area of 12?

Turn to Solutions at the end of the Module and mark your work.

Thinking Space

Explore

Squares



All of these shapes are rectangles. Some of the shapes are special rectangles called squares. What makes a square special?

All sides of a square are the same length. You probably knew that already.

Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/ma0822a1f_shapeshifter.html and open *Shape Shifter*.

Click on the Rectangle button and make it show 2 × 2.

The orange shape is a square. The area of the square is 4. The number 4 is called a perfect square.

Play with Rectangle and find some more perfect squares.

Try It!

Activity 2

1. Make a square with each side 3. Which perfect square did you find?

2. Try to make a square with area 8. Is 8 a perfect square?

3. Try to make a square with area 1. Is 1 a perfect square?

4. Try to make a square with area 7. Is 7 a perfect square?

5. Try to make a square with area 16. Is 16 a perfect square?

Turn to Solutions at the end of the Module and mark your work.

Explore
Perfect Squares

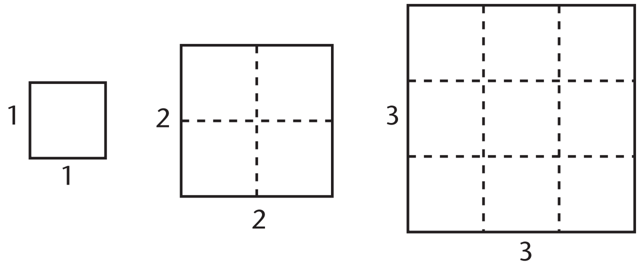
You've already been looking at some perfect squares. Maybe you have a pretty good idea about which numbers are perfect squares and which numbers aren't.

A perfect square is a number that is the area of a square whose sides are whole numbers.

That's a mouthful! Let's look at that one piece at a time.

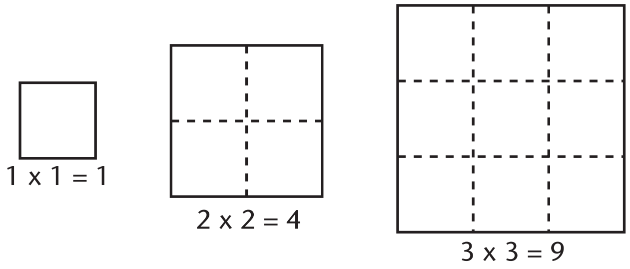
Whole numbers are: 0, 1, 2, 3, . . .

These are *squares whose sides are whole numbers*:



How can you find the area of a square? Multiply the length by the width. In a square, the length and the width are the same. We could have said "multiply the length by the length."

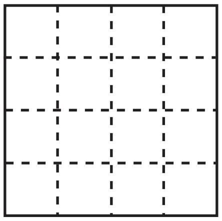
So, these numbers represent *the area of a square whose sides are whole numbers*.



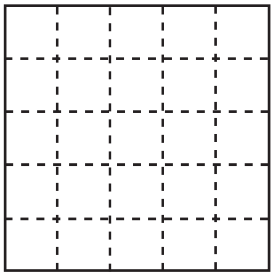
In other words, **1**, **4**, and **9** are perfect squares.

Thinking Space

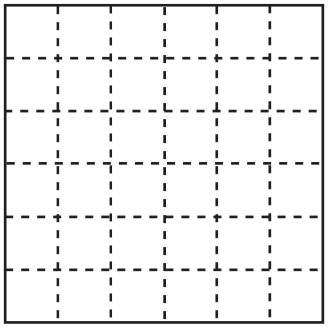
What are the next three perfect squares? Here are pictures that represent each one.



4 x 4 = 16



5 x 5 = 25



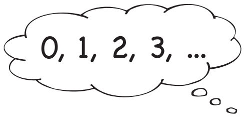
6 x 6 = 36

Look at the definition again:

A perfect square is a number that is the area of a square whose sides are whole numbers.

Do we need to keep drawing squares and finding their areas to find numbers that are perfect squares?

The area of a square is the length of its side times itself.



So, we can find perfect squares by taking any whole number and multiplying it by itself.

2 × 2 = 4 **4** is a perfect square.

5 × 5 = 25 **25** is a perfect square.

10 × 10 = 100 **100** is a perfect square.

Try It!
Activity 3

1. Multiply these numbers to find some more perfect squares.

3 × 3 =

6 × 6 =

1 × 1 =

9 × 9 =

4 × 4 =

2. Circle the perfect squares. Use the numbers you circled to complete the multiplication facts below.

121		22		100		144	
	55		16		6		56
25		1		71		12	
	63		64		49		8
9		81		4		36	

1 × 1 =

2 × 2 =

3 × 3 =

4 × 4 =

5 × 5 =

6 × 6 =

7 × 7 =

8 × 8 =

9 × 9 =

10 × 10 =

11 × 11 =

12 × 12 =

Turn to Solutions at the end of the Module and mark your work.

You've finished Lesson A. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Lesson B

Square Roots of Perfect Squares

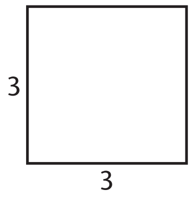
When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
How can I find the square of a number?		
What is a square root?		
How are squares and square roots related?		
What does a square root symbol look like, and what does it mean?		

Warm-up

1. What is the area?



2. Multiply.

a. 6 × 2 =

b. 3 × 4 =

c. 5 × 5 =

d. 2 × 3 =

e. 4 × 5 =

f. 4 × 4 =

g. 2 × 8 =

h. 3 × 5 =

i. 3 × 3 =

j. 3 × 12 =

k. 6 × 6 =

l. 4 × 9 =

m. 3 × 6 =

n. 2 × 9 =

Thinking Space

3. Circle the numbers that are perfect squares.

8 36
4 16
9 12
18 25
6 15

Turn to Solutions at the end of the Module and mark your work.

Explore

Squaring a Number

In the last lesson, you learned that if you pick a whole number (say, “3”) and multiply it by itself, the answer is called a perfect square.

For example: 3 multiplied by itself is 9.

9 is a perfect square.

$$3 \times 3 = 9$$

Another way to write this is: $3^2 = 9$

The little “2” that is written above the line means “multiply this number by itself.” When you’re reading an equation, say “squared.”

That little number is called an exponent.

3^4 means $3 \times 3 \times 3 \times 3$

5^3 means $5 \times 5 \times 5$

2^7 means $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$

You’ll learn more about this in Grade 9.

$$3^2 = 9$$

Read this as “three squared equals nine.”

$$4^2 = 16$$

Read this as “four squared equals sixteen.”

Thinking Space

Try It!

Activity 1

Answer these questions without your calculator.

Remember: 3^2 means the same as 3 × 3.

1. $1^2 =$

2. $2^2 =$

3. $3^2 =$

4. $4^2 =$

5. $5^2 =$

6. $6^2 =$

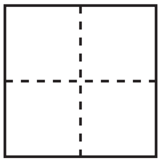
7. $7^2 =$

8. $8^2 =$

9. $9^2 =$

10. $10^2 =$

11. This picture shows 2^2.



2 x 2 = 4

Draw a picture to show 5^2.

Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html, click on Module 2, and watch *Using Order of Operations With Squares* to see two worked examples of expressions that involve many different operations.

12. Solve these expressions.

Remember BEDMAS.

Brackets

Exponents

Division and **M**ultiplication (in order from left to right)

Addition and **S**ubtraction (in order from left to right)

a. $2^2 + 1 =$

b. $(-2)(3)^2 - 4 =$

c. $(-4 + 7) + 4^2 - 18 \div 3 =$

Turn to Solutions at the end of the Module and mark your work.

Explore

Squares in ShapeShifter

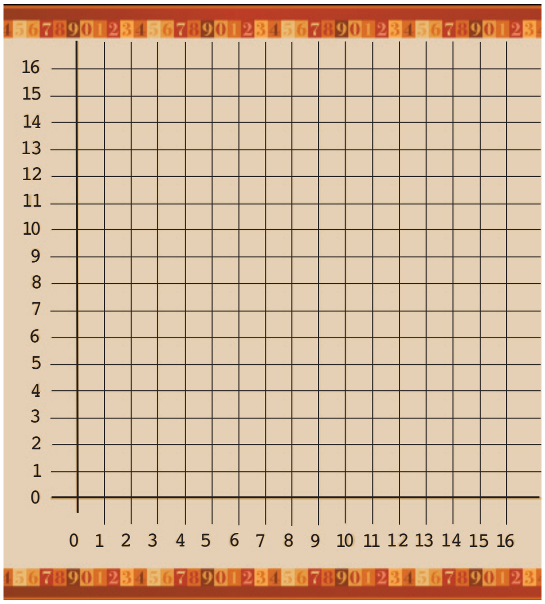
Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/ma0822a1f_shapeshifter.html and open *Shape Shifter.*

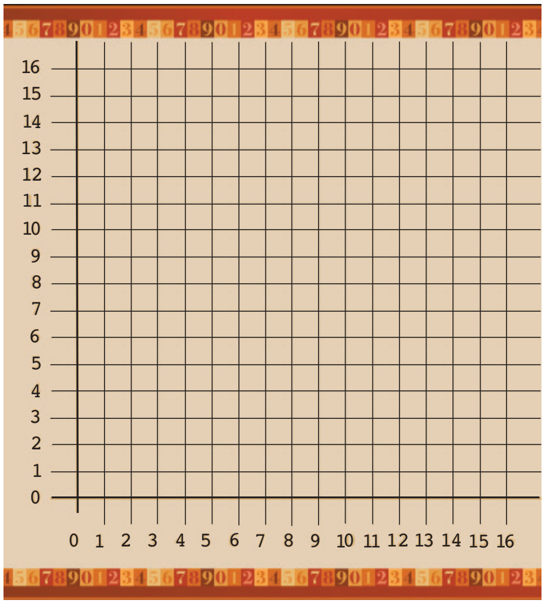
Click on the Rectangle button. Make as many different-sized squares as you can.

Thinking Space

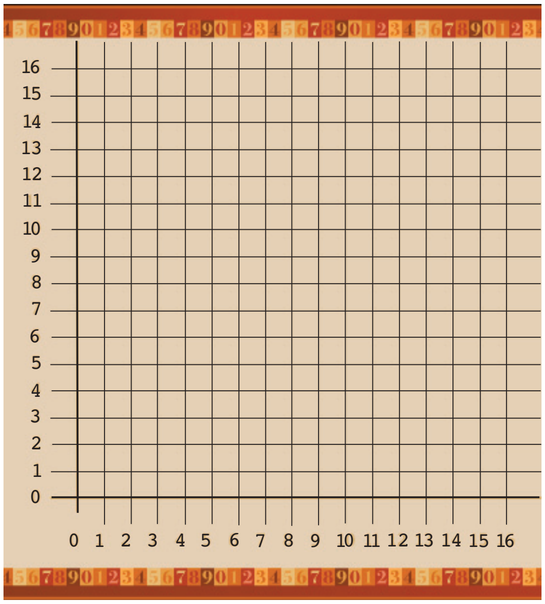
Try It!
Activity 2

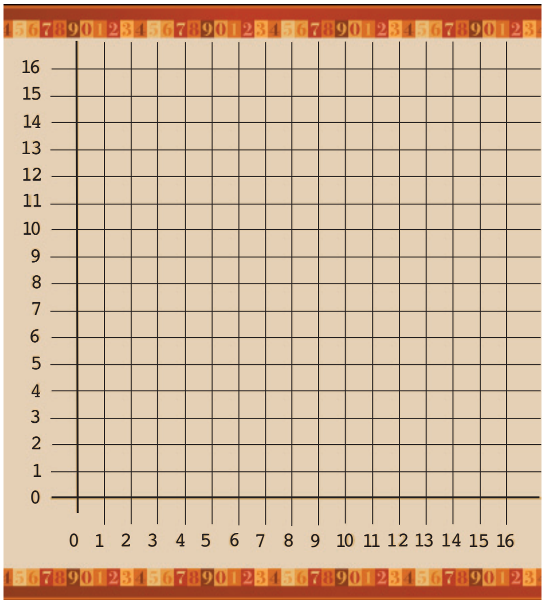
Draw four different squares in the blank Rectangle screens.





Thinking Space



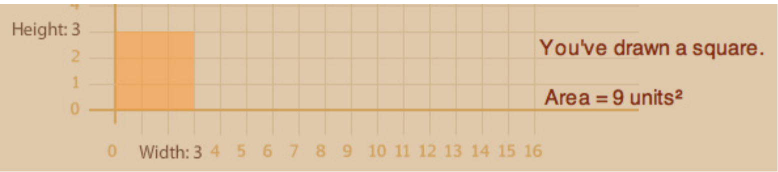


✓ Turn to Solutions at the end of the Module and mark your work.

Explore
Square Roots

This equation and this diagram represent the same idea.

$$3^2 = 9$$



You've drawn a square.

Area = 9 units^2

You already know that the answer when we multiply a whole number times itself is called a “perfect square.” The other number has a name too. That other number is the length of one side of the square. We could say that it is the **root** of the square. It is called the **square root**.

Try It!

Activity 3

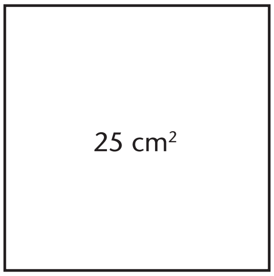
1. Use Rectangle to make a square with area 9. How long is the side of the square?

   What is the square root of 9?

2. Use Rectangle to make a square with area 4. How long is the side of the square?

   What is the square root of 4?

3. The area of this square is 25 cm^2. How long is each side?



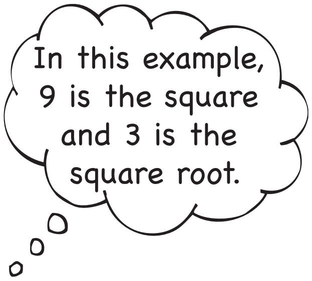
   What is the square root of 25?

✓ Turn to Solutions at the end of the Module and mark your work.

Explore

The Square Root Symbol

There are many ways to describe the relationship between the square and the square root.



In this example, 9 is the square and 3 is the square root.

$9 = 3^2$	Nine is three squared.
$3^2 = 9$	Three squared is nine.
$\sqrt{9} = 3$	The square root of nine is three.
$3 = \sqrt{9}$	Three is the square root of nine.

This symbol, $\sqrt{}$, means “the square root of.” It is called a **square root symbol**.

Thinking Space

Try It!

Activity 4

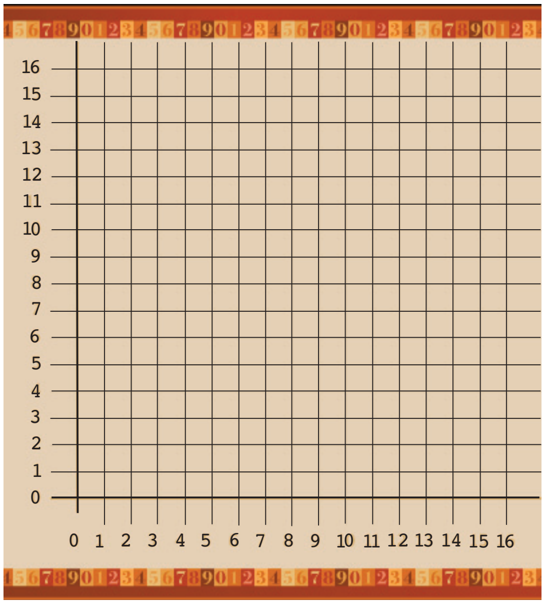
1. How many perfect squares are there between 1 and 100 (including 1 and 100)?

   List all the perfect squares between 1 and 100 (including 1 and 100).

   How can you be sure that your list is complete?

2. Draw a diagram to represent this equation:

   $\sqrt{25} = 5$



3. a. Four squared equals ________. $4^2 =$ ____

   b. Nine is ________ squared. $9 =$ ____^{2}

   c. ________ is the square root of four. ____ $= \sqrt{4}$

   d. One is the square root of ________. $1 = \sqrt{\_\_}$

   e. The square root of nine is ________. $\sqrt{9} =$ ____

   f. ________ is the square root of twenty-five. ____ $= \sqrt{25}$

Thinking Space

4. $1^2 =$ ______ $\sqrt{1} =$ ______

$2^2 =$ ______ $\sqrt{4} =$ ______

$3^2 =$ ______ $\sqrt{9} =$ ______

$4^2 =$ ______ $\sqrt{16} =$ ______

$5^2 =$ ______ $\sqrt{25} =$ ______

$6^2 =$ ______ $\sqrt{36} =$ ______

$7^2 =$ ______ $\sqrt{49} =$ ______

$8^2 =$ ______ $\sqrt{64} =$ ______

$9^2 =$ ______ $\sqrt{81} =$ ______

$10^2 =$ ______ $\sqrt{100} =$ ______

Turn to Solutions at the end of the Module and mark your work.

You've finished Lesson B. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Lesson C

Estimating Square Roots

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
How do I estimate the square root of a number that is not a perfect square?		

Thinking Space

Warm-up

1. a. $4^2 =$

   b. $6^2 =$

   c. $1^2 =$

   d. $8^2 =$

   e. $5^2 =$

2. a. $\sqrt{9} =$

   b. $\sqrt{81} =$

   c. $\sqrt{25} =$

   d. $\sqrt{49} =$

   e. $\sqrt{4} =$

3. a. $8^2 =$

   b. $16 = \underline{\quad\quad}^2$

   c. $\sqrt{25} =$

   d. $7 = \sqrt{\underline{\quad\quad}}$

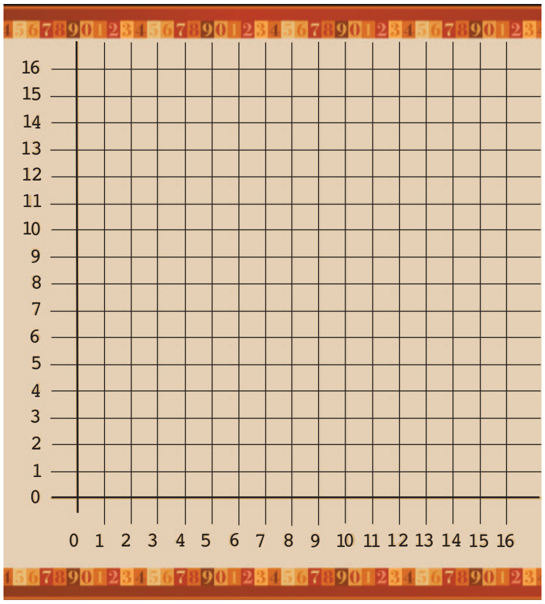
   e. $100 = \underline{\quad\quad}^2$

   f. $\sqrt{64} =$

Thinking Space

4. Draw a picture to represent this example.

$$2 = \sqrt{4}$$



Turn to Solutions at the end of the Module and mark your work.

Explore

Comparison Symbols: <, >, =

Later on in this lesson, you will be using comparison symbols to compare two numbers.

Let's review how they are used.

= Equals

You use this symbol all the time. It means that the expression on the left is equal to the expression on the right.

$27 = 27$ $2 + 3 = 5$ $6 = (-2)(-3)$ $-18 \div 3 = -6$

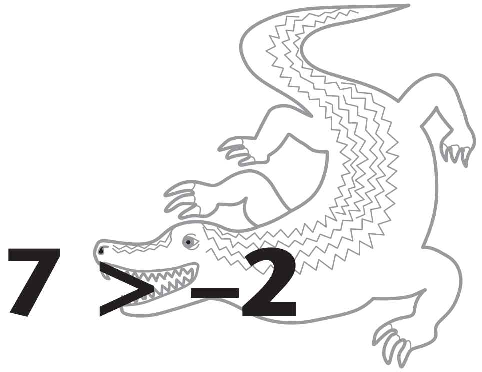
< Less Than and > Greater Than

You can use one of these symbols when the expression on the left is not equal to the expression on the right. The open side (the big side) of the symbol goes toward the expression that is bigger. The closed side (the small side) of the symbol goes toward the expression that is smaller.

$2 < 3$
2 is less than 3

$8 + 2 > 4$
8 plus 2 is greater than 4

Some people find it helpful to think of a greedy crocodile. Its mouth is always reaching for the bigger pile of fish!



Thinking Space

Try It!

Activity 1

Complete each statement with the correct comparison symbol: =, <, or >.

1. 7 ☐ $3 + 4$

2. -6 ☐ 5

3. 2 ☐ 3

4. $\sqrt{16}$ ☐ 4

5. 8 ☐ 3^2

6. $(-4)(-5)$ ☐ 12

7. 3 ☐ $\sqrt{25}$

8. $-6 + 5$ ☐ $5 - 6$

9. 6^2 ☐ 36

10. 5 ☐ $\sqrt{36}$

11. $-24 \div 4$ ☐ $3 - 10$

12. 2 ☐ 2^2

13. $(-15)^2$ ☐ $(-15) \times (-15)$

14. $\sqrt{9}$ ☐ $-2 + 5$

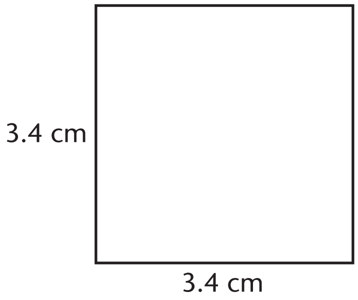
✓ Turn to Solutions at the end of the Module and mark your work.

Thinking Space

Explore

Not All Squares Are Perfect

You can take a line of any length you like and then use that line as the side of a square.



In fact—we can leave out the idea of a square shape and think about square numbers.

If you pick any number (say, 3.4) and multiply it by itself, the answer is called its square.

$3.4^2 = 3.4 \times 3.4 = 11.56$

3.4 squared is 11.56

11.56 is the square of 3.4

We could pick a negative number and multiply it by itself.

$(-3)^2 = (-3) \times (-3) = 9$

–3 squared is 9

9 is the square of –3

Wait a minute! that means that –3 is a square root of 9. In fact, every number has two square roots—one positive and one negative. The square roots of 9 are 3 and –3. The square roots of 16 are 4 and –4. You'll learn more about this in other math courses that you take.

Every number can be squared.

$-17^2 = 17 \times 17 = 289$

$(-17)^2 = (-17) \times (-17) = 289$

$1.7^2 = 1.7 \times 1.7 = 2.89$

$(-1.7)^2 = (-1.7) \times (-1.7) = 2.89$

When you square any number, positive or negative, the answer is always positive. Why is that?

Thinking Space

Try It!
Activity 2

Use your thinking space or some scrap paper to figure out these answers. You can use your calculator in the next lesson.

Remember: When a whole number is squared, the answer is called a perfect square.

1. $12^2 =$
2. $(-1.2)^2 =$
3. $5.1^2 =$
4. $0.2^2 =$
5. $(-23)^2 =$
6. $35^2 =$
7. $3.5^2 =$
8. $(-0.4)^2 =$
9. $20^2 =$

Circle the answers that are perfect squares.

Turn to Solutions at the end of the Module and mark your work.

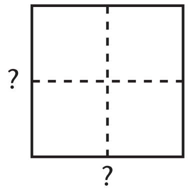
Explore

More Square Roots

We just learned that every number has a square. Does every number have a square root?

Let's look at a couple of squares that we already know a lot about. 4 and 9 are both perfect squares.

Think of a square with area 4.



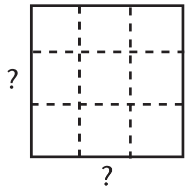
What is the root of this square?

In other words, how long is its side?

The length of the side is 2.

$$\sqrt{4} = 2$$

Think of a square with area 9.



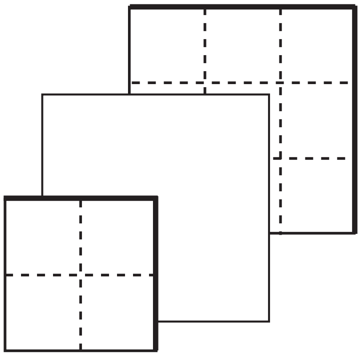
What is the root of this square?

In other words, how long is its side?

The length of the side is 3.

$$\sqrt{9} = 3$$

The expression $\sqrt{7}$ asks us to think about a square with area 7. What is the root of that square? How long is its side?



A square with area 7 is bigger than a square with area 4, and smaller than a square with area 9.

$$4 < 7 < 9$$

Thinking Space

So, the side length of the 7 square will be longer than the side of the 4-square. It will be shorter than the side of the 9-square.

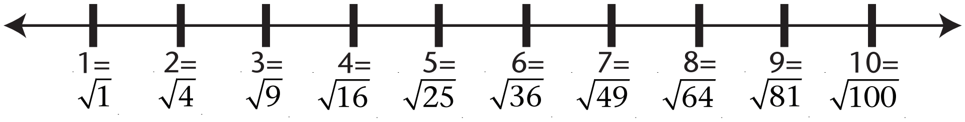
$$\sqrt{4} < \sqrt{7} < \sqrt{9}$$

The square root of 7 is between 2 and 3.

$$2 < \sqrt{7} < 3$$

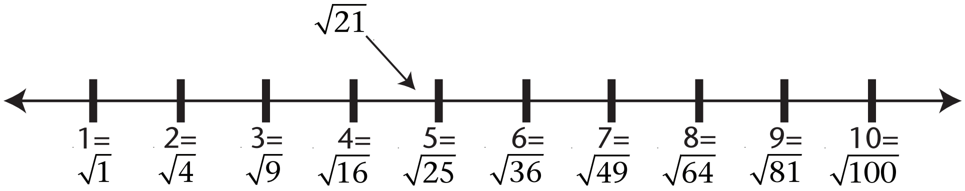
Make a number line that shows all integers from 1 to 10.

Now write $=\sqrt{\ }$ next to each number and fill in the numbers under the square root symbols.



This is a very useful tool for estimating square roots.

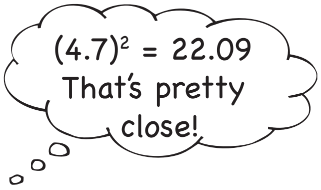
Where would $\sqrt{21}$ be on the number line?



21 is between 16 and 25	$16 < 21 < 25$
$\sqrt{21}$ is between $\sqrt{16}$ and $\sqrt{25}$	$\sqrt{16} < \sqrt{21} < \sqrt{25}$
$\sqrt{21}$ is between 4 and 5	$4 < \sqrt{21} < 5$

Can you estimate a value for $\sqrt{21}$? We know that $\sqrt{21}$ is between 4 and 5, so 4.5 would be a good guess.

Can we make a better guess than that? Is $\sqrt{21}$ closer to 4 or closer to 5? Look at the number line again. $\sqrt{21}$ is closer to 5. So 4.7 is a better guess.



Thinking Space

Try It!
Activity 3

1. Make a list of the first 10 perfect squares.

$1^2 =$ ________

$2^2 =$ ________

$3^2 =$ ________

$4^2 =$ ________

$5^2 =$ ________

$6^2 =$ ________

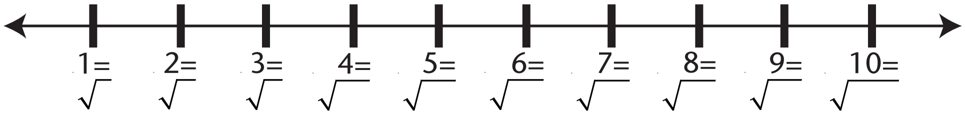
$7^2 =$ ________

$8^2 =$ ________

$9^2 =$ ________

$10^2 =$ ________

2. Complete this number line.



3. Use the number line you made to answer these questions. The first one is done for you.

a. $2 < \sqrt{7} < 3$ $\sqrt{7}$ is between 2 and 3

b. $4 < \sqrt{22} <$ ☐ $\sqrt{22}$ is between ☐ and ☐

c. ☐ < $\sqrt{13}$ < ☐ $\sqrt{13}$ is between ☐ and ☐

d. ☐ < $\sqrt{61}$ < ☐ $\sqrt{61}$ is between ☐ and ☐

e. ☐ < $\sqrt{74}$ < ☐ $\sqrt{74}$ is between ☐ and ☐

f. ☐ < $\sqrt{42}$ < ☐ $\sqrt{42}$ is between ☐ and ☐

g. ☐ < $\sqrt{5}$ < ☐ $\sqrt{5}$ is between ☐ and ☐

h. ☐ < $\sqrt{57}$ < ☐ $\sqrt{57}$ is between ☐ and ☐

i. ☐ < $\sqrt{29}$ < ☐ $\sqrt{29}$ is between ☐ and ☐

j. ☐ < $\sqrt{3}$ < ☐ $\sqrt{3}$ is between ☐ and ☐

k. ☐ < $\sqrt{32}$ < ☐ $\sqrt{32}$ is between ☐ and ☐

l. ☐ < $\sqrt{95}$ < ☐ $\sqrt{95}$ is between ☐ and ☐

4. a. Is $\sqrt{7}$ closer to 2 or closer to 3?

   b. Which of these numbers is the best estimate of $\sqrt{7}$?

   2.2 2.5 2.7

Turn to Solutions at the end of the Module and mark your work.

You've finished Lesson C. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Lesson D

Calculating Square Roots

For this lesson, you will need:

- calculator

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
How does my calculator’s square root button work?		
When I take the square root of a number that's not a perfect square, why is my calculator’s answer called an approximation?		

Thinking Space

Warm-up

1. a. $\sqrt{1} =$

   b. $\sqrt{4} =$

   c. $\sqrt{9} =$

   d. $\sqrt{16} =$

   e. $\sqrt{25} =$

   f. $\sqrt{36} =$

   g. $\sqrt{49} =$

   h. $\sqrt{64} =$

   i. $\sqrt{81} =$

   j. $\sqrt{100} =$

Use your calculator.

2. Compute these squares. Remember: $4.7^2 = 4.7 \times 4.7$

   a. $386^2 =$

   b. $29.4^2 =$

   c. $1.89^2 =$

   d. $29^2 =$

   e. $4.3^2 =$

   f. $1.6^2 =$

Thinking Space

3. Where should $\sqrt{2}$ be on this number line?

$\sqrt{2}$ is between ☐ and ☐

☐ $< \sqrt{2} <$ ☐

4. Practice rounding to the nearest thousandth to get ready for this lesson.

This is the thousandths place.	$\mathbf{2.86\underset{\uparrow}{7}\ 31}$
Look here for the clue.	$\mathbf{2.867\ \underset{\uparrow}{3}1}$
3 is less than 5, so keep the thousandths digit the same and drop the other ones. (If the next digit over had been 5 or greater, we would have changed the 7 to an 8.)	$\mathbf{2.867\ 31 \approx 2.867}$

That squiggly equals sign means "is approximately equal to."

Now it's your turn. Round these numbers to the nearest thousandth.

a. $1.863\ 95 \approx$

b. $4.217\ 36 \approx$

c. $0.981\ 6 \approx$

d. $93.812\ 493\ 7 \approx$

Thinking Space

e. 6.413 51 ≈

f. 15.218 75 ≈

g. 36.246 203 ≈

h. 7.812 84 ≈

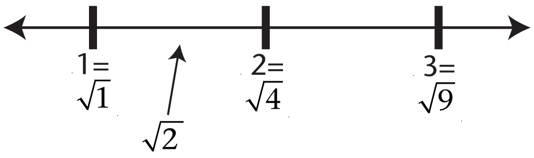
i. 63.512 1 ≈

✓ Turn to Solutions at the end of the Module and mark your work.

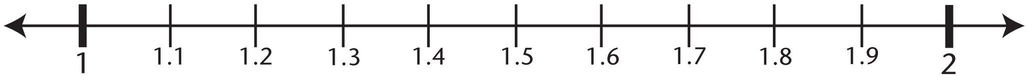
Explore

Irrational Numbers

In the last lesson you learned that $\sqrt{2}$ is between 1 and 2.



But where between 1 and 2? Is it closer to 1.2 or 1.7? Let's zoom in on that number line.



Start computing some squares. You can use your calculator for this.

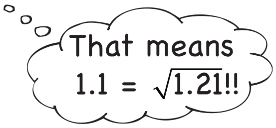
$1.1^2 = 1.21$

$1.2^2 = 1.44$

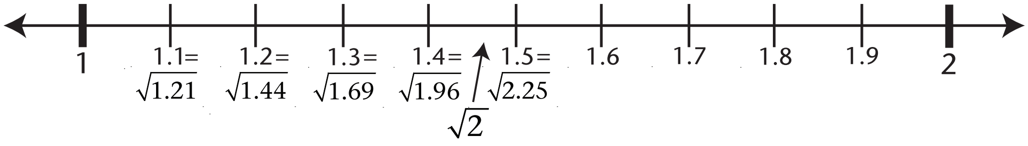
$1.3^2 = 1.69$

$1.4^2 = 1.96$

$1.5^2 = 2.25$

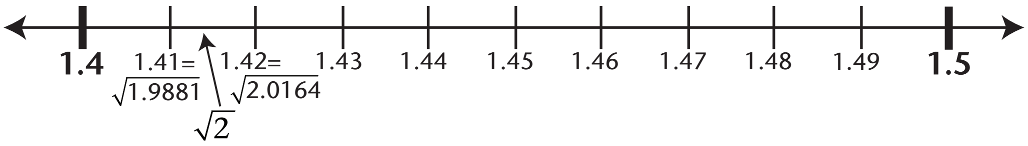


Add these numbers to your number line.



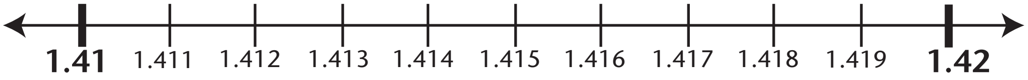
2 is between 1.96 and 2.25. So $\sqrt{2}$ must be somewhere between 1.4 and 1.5.

Let's try to be more precise. Zoom in on that section of the number line and start computing squares.



We didn't have to go very far that time! $\sqrt{2}$ must be somewhere between 1.41 and 1.42.

We could keep doing that—getting a more precise answer by zooming in on the number line and figuring out where $\sqrt{2}$ is.



But we could do it FOREVER and never find a decimal number that was exactly equal to the square root of 2.

How do we know that we could do this forever? Read about the proof at the Math 8 website http://www.openschool.bc.ca/courses/math/math8/mod2.html. Click on the link under *Lesson 2.2D: Calculating Square Roots.*

An irrational number is a number that can't be represented by any fraction, not even a decimal fraction. If we try to write an irrational number with decimals, the fractional part would go on forever without a pattern.

$\sqrt{2}$ is an irrational number.

So are $\sqrt{3}$, $\sqrt{5}$, $\sqrt{7}$, $\sqrt{86}$, and $\sqrt{101}$.

Only perfect squares have "nice" square roots. Their square roots are whole numbers like 3 or 14 or 648.

All other numbers have irrational square roots.

Thinking Space

Try It!

Activity 1

Circle the irrational numbers.

$\sqrt{64}$

$\sqrt{14}$ $\sqrt{49}$

$\sqrt{16}$ $\sqrt{2}$

$\sqrt{21}$ $\sqrt{4}$

$\sqrt{7}$

Turn to Solutions at the end of the Module and mark your work.

Explore

Calculating Square Roots

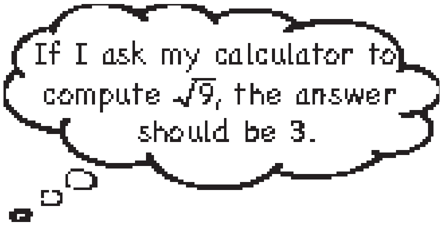
Find the square root symbol on your calculator.

$$\sqrt{}$$

Sometimes it has its own button. Sometimes it is an extra function on a button.

Look in the Appendix to see an example of a square root button on a calculator.

Every calculator works a little bit differently, so experiment with yours until you know how the square root function works. Test it with some square roots that you already know.



What happens when you ask your calculator for an irrational number, like $\sqrt{2}$?

The digits after the decimal point go on forever. Your calculator will probably show you as many digits as it can fit in the display window.

Thinking Space

Try It!

Activity 2

You may use your calculator.

1. First, use estimation to check that your calculator is giving you reasonable answers. Then, write down your calculator's answers for these questions. The first one is done for you.

   This squiggly line ≈ means "approximately equal to."

This is a lot of digits! How many digits does your calculator show?

a. $\underline{\mathbf{1}} < \sqrt{2} < \underline{\mathbf{2}}$

$\sqrt{2} \approx$ **1.4142135623730950488016887242097**

b. $\square < \sqrt{7} < \square$

$\sqrt{7} \approx$ ____________________

c. $\square < \sqrt{18} < \square$

$\sqrt{18} \approx$ ____________________

d. $\square < \sqrt{95} < \square$

$\sqrt{95} \approx$ ____________________

e. $\square < \sqrt{34} < \square$

$\sqrt{34} \approx$ ____________________

f. $\square < \sqrt{42} < \square$

$\sqrt{42} \approx$ ____________________

g. $\square < \sqrt{27} < \square$

$\sqrt{27} \approx$ ____________________

Thinking Space

2. Why do you think that the calculator's answer is called an approximation?

✓ Turn to Solutions at the end of the Module and mark your work.

Explore

Rounding

The calculator's answer is called an approximation.

No matter how many decimal places your calculator provides, we could have a more precise answer with just one more decimal place.

But that's okay. Depending on the application, two or three decimal places are usually enough.

The calculator gives this approximation for $\sqrt{5}$.

$$\sqrt{5} \approx 2.236068$$

$(2.236068)^2 = 5.0000001$
That not exactly 5!
This square root is
an approximation.

Round the number to the nearest hundredth. Look in the Warm-up section if you need to review rounding.

$$\sqrt{5} \approx 2.24$$

Round the number to the nearest thousandth.

$$\sqrt{5} \approx 2.236$$

Thinking Space

Try It!

Activity 3

Use your calculator for these questions.

1. Find a decimal approximation for these square roots. Round your answers to the nearest thousandth.

   a. $\sqrt{19}$ =

   b. $\sqrt{7}$ =

   c. $\sqrt{24}$ =

   d. $\sqrt{73}$ =

   e. $\sqrt{48}$ =

   f. $\sqrt{51}$ =

   g. $\sqrt{11}$ =

   h. $\sqrt{15}$ =

   i. $\sqrt{41}$ =

2. Find a decimal approximation for these square roots. Round your answers to the nearest hundredth.

   a. $\sqrt{3}$ =

   b. $\sqrt{48}$ =

   c. $\sqrt{33}$ =

d. $\sqrt{26}$ =

e. $\sqrt{12}$ =

f. $\sqrt{22}$ =

g. $\sqrt{55}$ =

h. $\sqrt{93}$ =

i. $\sqrt{37}$ =

Turn to Solutions at the end of the Module and mark your work.

You've finished Lesson D. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Section Summary

Completing this section has helped you to:

- learn how to use the Shape Shifter Rectangle tool
- find the squares of numbers
- recognize perfect squares
- find the square roots of numbers
- learn about the square root symbol

Section 3

The Pythagorean Theorem

In this section you will:

- learn the Pythagorean Theorem
- decide if a triangle is a right triangle
- identify Pythagorean Triples
- find the lengths of missing sides of a right triangle

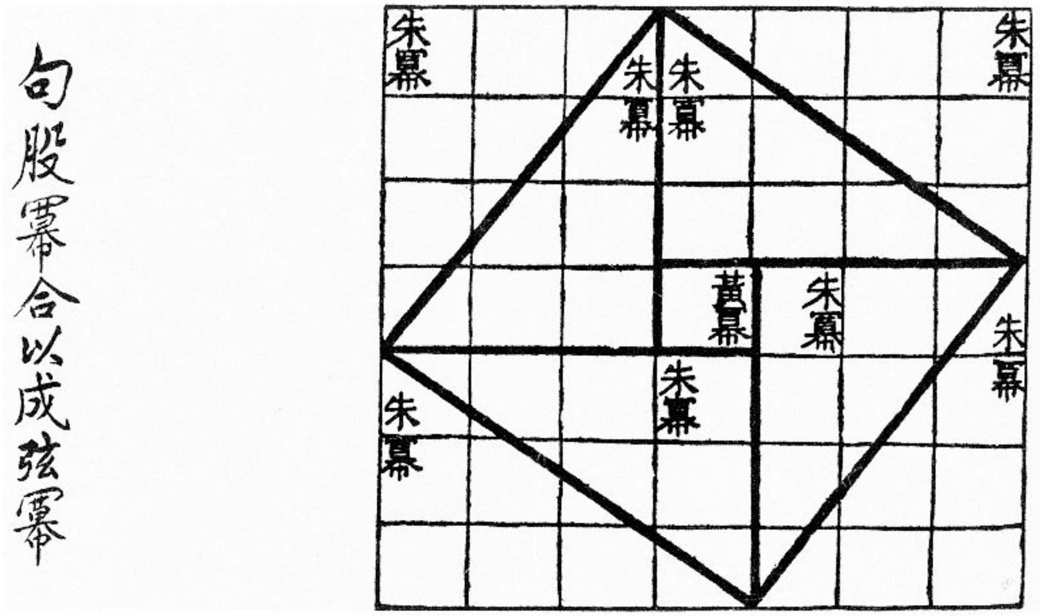
For this section you will need:

- 2 sheets of graph paper from the Appendix
- coloured pencils
- scissors
- calculator

Where in the World...?

Right angles are very important. They're everywhere!

Many different societies in the ancient world had techniques to build and check for right angles—the Greeks, the Egyptians, the Babylonians, and the Chinese. It's possible that the Mayans and the Aztecs knew how to do calculations for right triangles, but we don't know enough about their mathematics to be sure.



Section 3
Pretest

Complete this pretest if you think that you already understand the topics and concepts covered in this section. Mark your work using the Solutions found at the end of the module.

If you get all the answers correct (100%), you may decide that you can omit the lesson activities.

If you get all the answers correct for one or more lessons, but not for the whole pretest, you can decide whether you can omit the activities for those lessons.

Lesson A: The Pythagorean Theorem

1. Draw a right triangle.

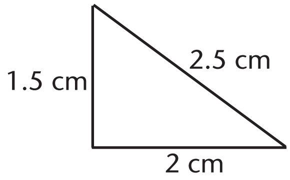
   Label the legs of the triangle ‘a’ and ‘b’.

   Label the hypotenuse of the triangle ‘c’.

   State the Pythagorean Theorem.

Lesson B: Pythagorean Triples

2. Is this triangle a right triangle? Why or why not? Prove this using the Pythagorean Theorem.



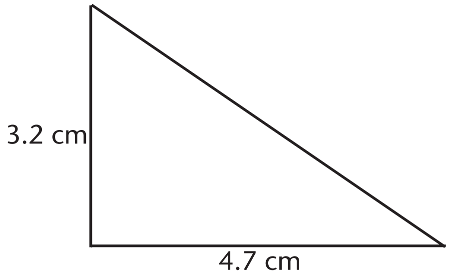
3. Do the numbers 1.5, 2.0, and 2.5 form a Pythagorean Triple? Why or why not?

4. Is 3, 4, 7 a Pythagorean Triple? Why or why not?

5. Is 9, 12, 15 a Pythagorean Triple? Why or why not?

Lesson C: Using the Pythagorean Theorem

6.



Use the Pythagorean Theorem to find the length of the hypotenuse.

Round your answer to the nearest tenth.

7. The length of the hypotenuse of a right triangle is 20 cm. The length of one of the legs is 12cm. How long is the other leg?

✓ Turn to the Solutions at the end of the module and mark your work.

Lesson A

The Pythagorean Theorem

For this lesson, you will need:

- 2 sheets of graph paper from the Appendix
- coloured pencils
- scissors

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

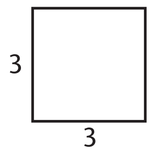
Essential Questions	Before the lesson: What I know	After the lesson: What I learned
Why are 90° angles important? They have a special name. What is it?		
What are the names of the sides of a right triangle?		
What does the Pythagorean Theorem say about right triangles?		

Thinking Space

Warm-up

Review what you learned in Section 1 about the area of squares to get ready for this lesson.

1. What is the area of this square?

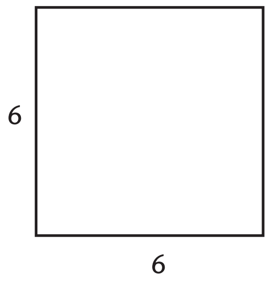


a. 3

b. 6

c. 3^2 __________

2. What is the area of this square?



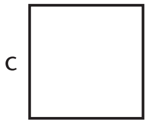
a. 6^2

b. 24

c. 12 __________

3. One side of a square is 5 cm long. What is its area?

4. We don't know very much about this square. The letter *c* represents the length of one side.



Which expression represents the area of this square?

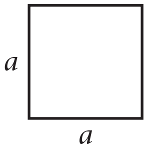
a. $2c$

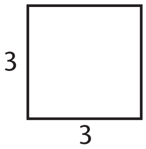
b. c^2

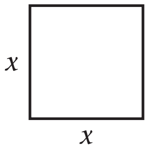
c. $4c$

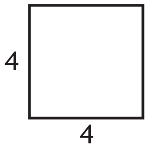
d. There isn't enough information to answer question. __________

5. Match each square to its area.

______


______


______


______


a. x^2

b. a^2

c. 4^2

d. 9

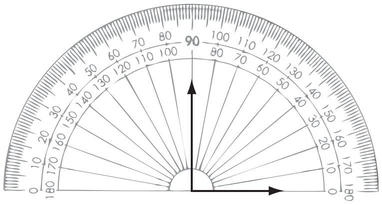
Turn to Solutions at the end of the Module and mark your work.

Thinking Space

Explore

Right Angles

An angle that measures 90° is called a **right angle**.



Why is a 90° angle so important? Why does it have a special name?

Look at these two fences.

This fence is not going to last much longer.

This fence will be up for a long time. The posts are at right angles to the ground. The crossbeam forms a right angle with the posts.

A carpenter who is building a house needs to make sure that the walls form a right angle with the floor; otherwise the building will fall over.

The corners of this page are right angles.

This symbol is used to mark a right angle.

Thinking Space

Try It!

Activity 1

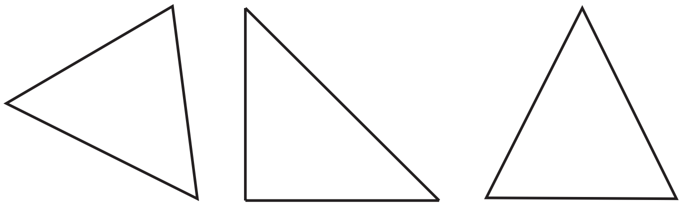
Use the corner of a piece of paper to help you find the right angles in this picture. Mark the right angles that you find.

✓ Turn to Solutions at the end of the Module and mark your work.

Explore

Right Triangles

Do you know which triangle here is a right triangle? Why is it called a right triangle?



A **right triangle** is a triangle with one right angle.

Try It!

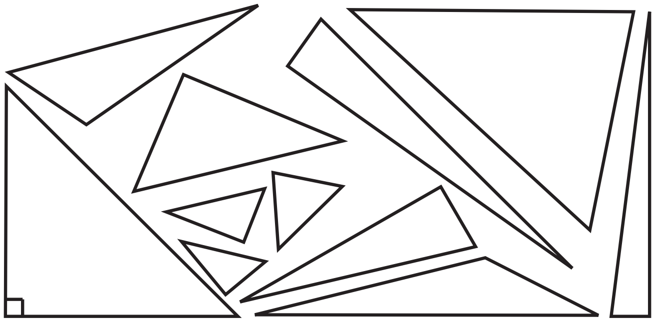
Activity 2

Find all of the right triangles. Mark the right angles with this symbol:

∟

One has already been done.

Hint: You can use the corner of a piece of paper to help you find the right angles.

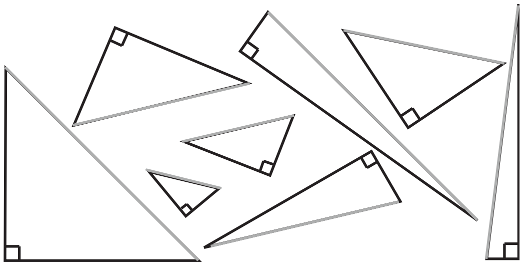


Turn to Solutions at the end of the Module and mark your work.

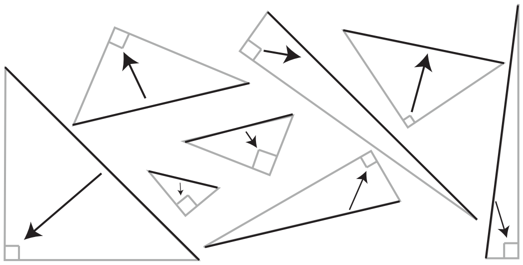
Thinking Space

Explore
The Hypotenuse

The sides of a right triangle that form the right angle are called the legs.



There is one side of a right triangle that is not a leg. It's called the hypotenuse. It's always the longest side of a right triangle, and it's the side that is opposite the right angle.



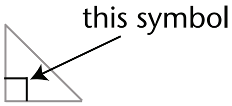
Try It!
Activity 3

Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/ma0822a1f_shapeshifter.html and open the *Shape Shifter* tool. Click on the Triangle button. Play with this tool for a while and discover how it works.

Vertices are the corners of a triangle. The word **vertices** is the plural of the word **vertex**.

Move the vertices until you have made a right triangle.

This symbol will appear when you have made a right triangle.



Record the lengths of each side in the chart.

Shade the box with the longest side.

Repeat with other right triangles until the chart is full.

Leg	Leg	Hypotenuse
10	8	12.81

Turn to Solutions at the end of the Module and mark your work.

Thinking Space

Explore

Squares and Right Triangles

For this lesson you will need:

- 2 sheets of graph paper from the Appendix
- coloured pencils
- scissors

In this activity you're going to build a proof of a famous mathematical theorem.

Step 1: Draw a right triangle. You need to decide how big it will be.

It doesn't matter how long the legs are. However, this activity will be easier to follow along with if the legs are of different sizes.

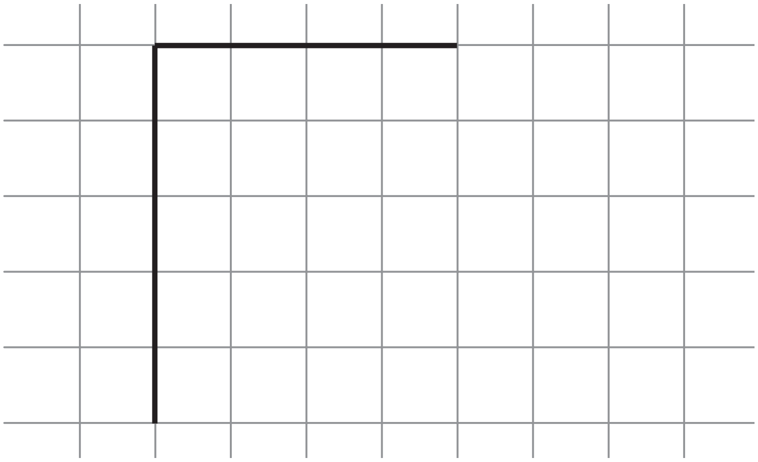
You will be repeating this triangle on your graph paper, so don't make your triangle too big. Choose a number between 2 and 6 for each leg of your triangle.

Fill in the blanks:

One leg of my triangle will be ___ units long.

The other leg of my triangle will be ___ units long.

Using the grid on your graph paper as a guide, draw the two legs of your right triangle in the upper left hand corner of the page.



In this example, one leg is 4 units long and the other is 5 units long. Your triangle can be different as long as it has a right angle.

Thinking Space

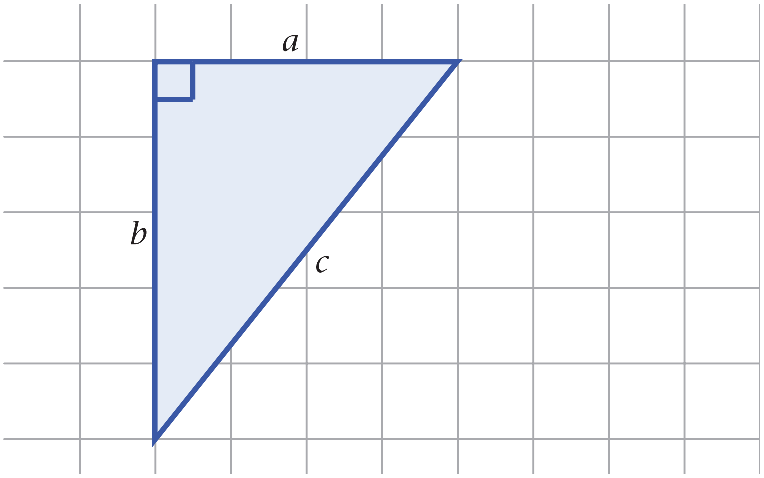
Step 2: Draw the hypotenuse of your triangle.

Colour the triangle blue.

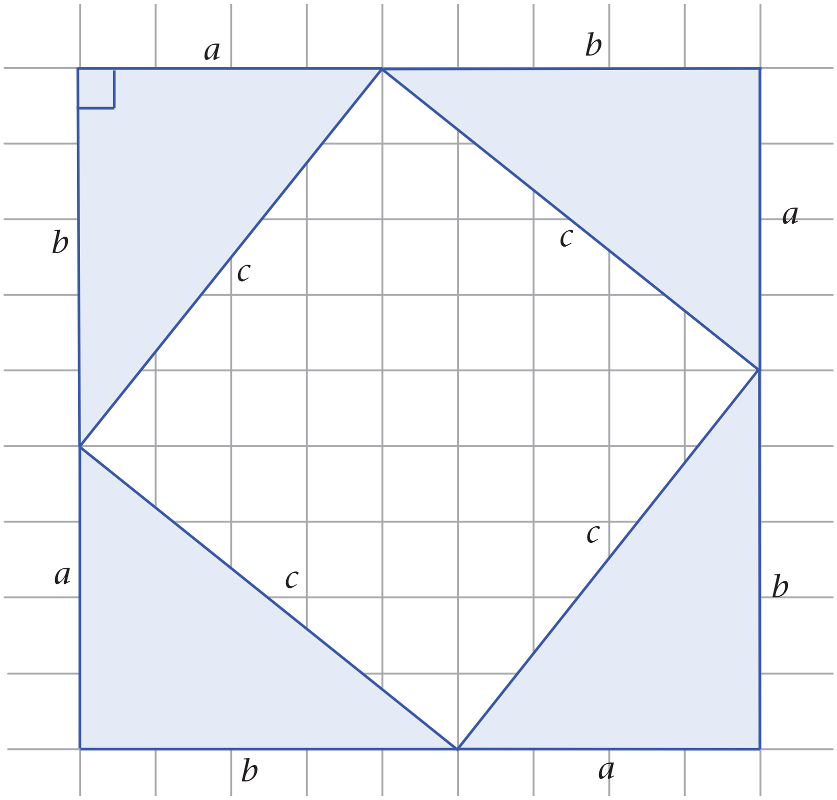
Label the short leg *a*.

Label the long leg *b*.

Label the hypotenuse *c*.



Step 3: Using the picture as a guide, draw three copies of your triangle. Colour them blue. Label the sides as you did in Step 2.

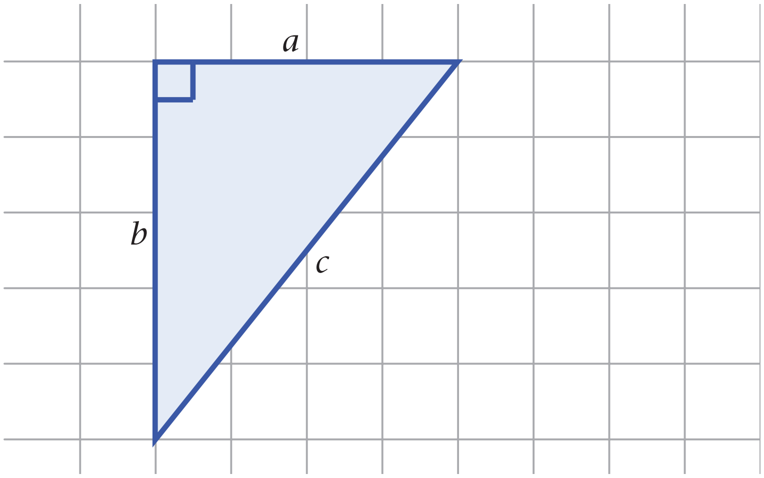


Thinking Space

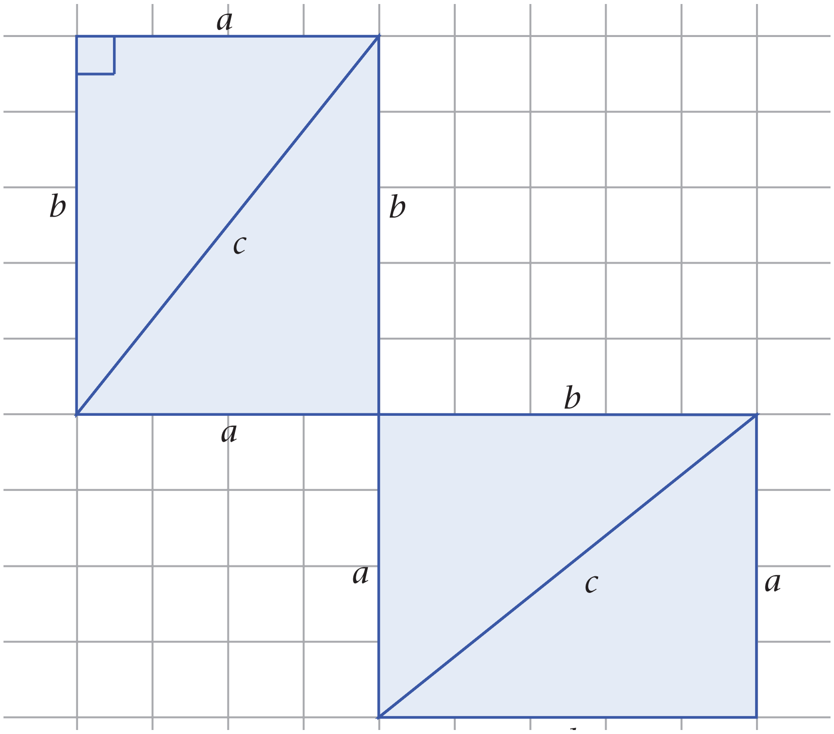
Examine the large square you have made. Can you see that the length of each side is $a + b$?

Look at the smaller white square inside. The length of each side of this square is c. The area of this square is c^2. Write "c^2" in the middle of the square.

Step 4: On another sheet of graph paper, repeat Steps 1 and 2 with the same size of triangle that you have been using so far.

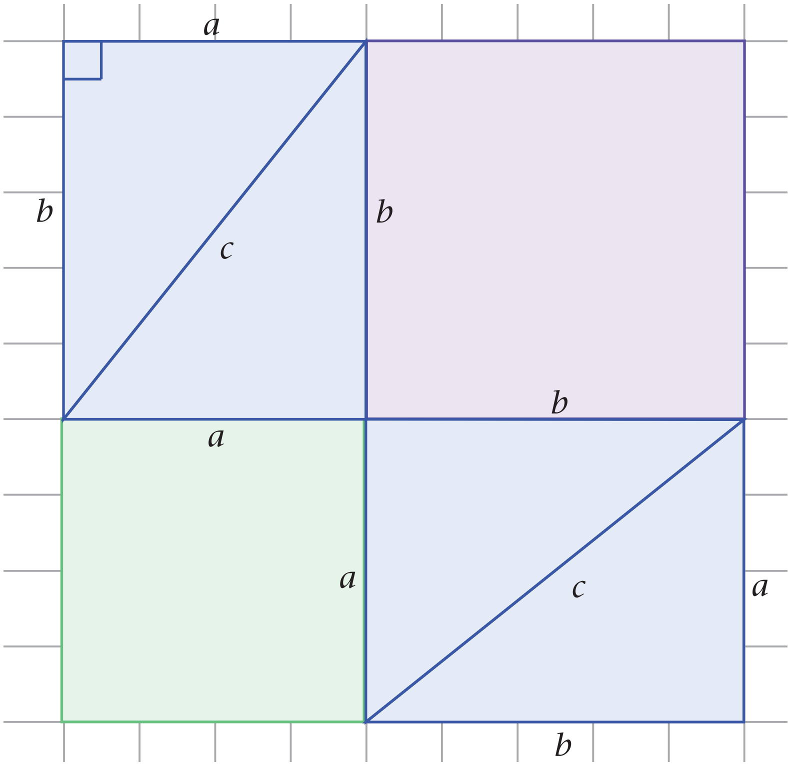


Step 5: Using the picture as a guide, draw three copies of your triangle. Colour them blue. Label the sides.



Thinking Space

Step 6: Using the picture as a guide, draw a square that encloses all of your triangles.

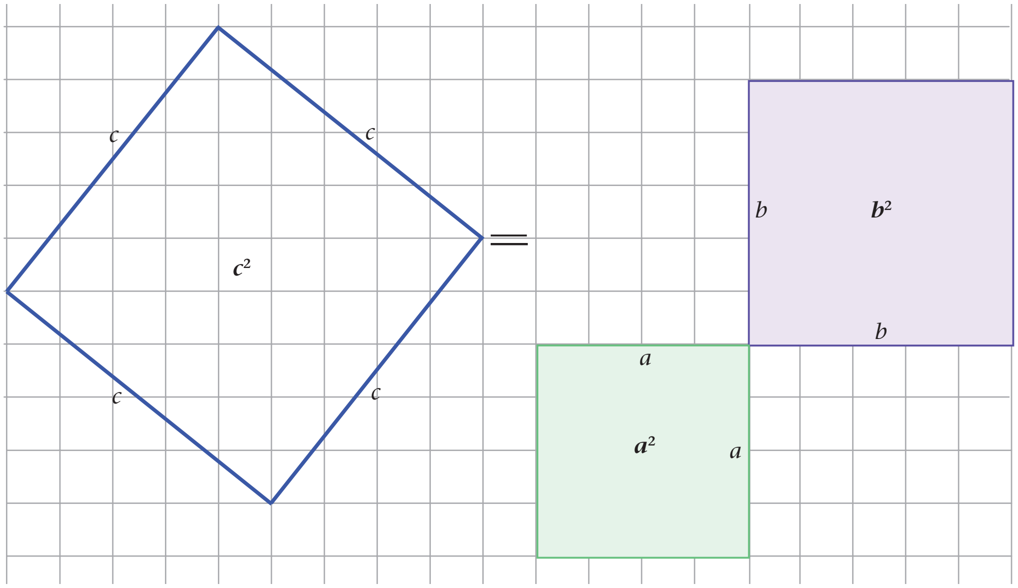


Now there are two squares inside your big square. Colour the smaller one green. Colour the other one purple.

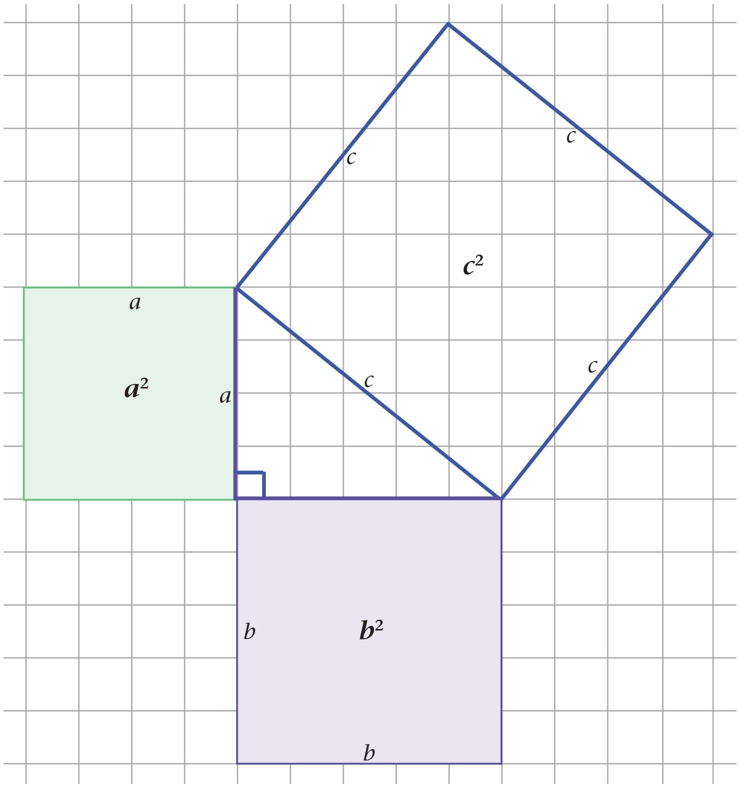
The length of each side of the green square is a. Its area is a^2. Write "a^2" in the middle of the green square.

The length of each side of the purple square is b. Its area is b^2. Write "b^2" in the middle of the purple square.

Examine the large square you have made. Can you see that the length of each side is $a + b$? It is exactly the same size as the first square you made!



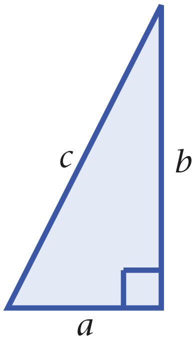
Step 7: Cut out one of your blue triangles. Cut out the squares. Arrange them as shown in the picture.



Try that activity again with right triangles of a different size. Maybe one leg is 3 squares long and the other is 7. Make four identical right triangles, and do the activity again.

Thinking Space

You have just done a geometric proof of the Pythagorean Theorem!



The Pythagorean Theorem

$$a^2 + b^2 = c^2$$

Even though Pythagoras was not the first to understand this property of right triangles, he was the first (we think) to express it in a general way that applies to all right triangles. That is why the theorem is named after him.

If you have internet access, go to the Math 8 website at **http://www.openschool.bc.ca/courses/math/math8/mod2.html** and click on the link under *Lesson 2.3A: The Pythagorean Theorem*.

You've finished Lesson A. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Lesson B

Pythagorean Triples

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
How can I use the Pythagorean Theorem to check that an angle is a right angle?		
What are Pythagorean Triples?		

Thinking Space

Warm-up

1. State the Pythagorean Theorem.

2. Circle the whole numbers.

4 $\frac{1}{2}$ **7.3**

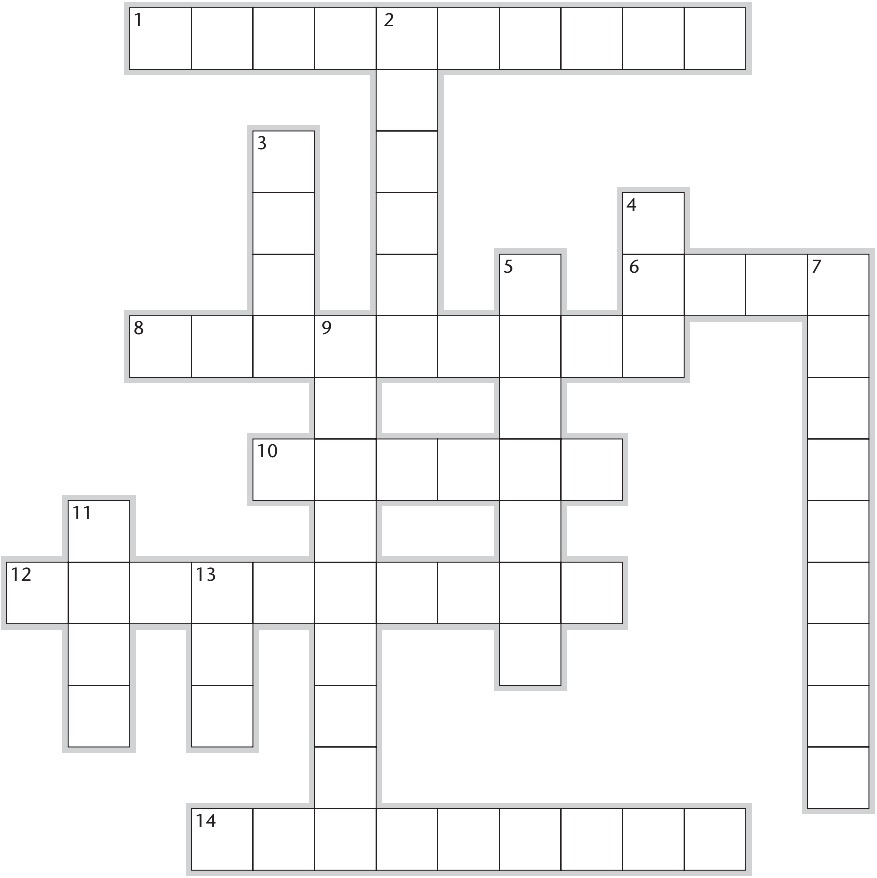
5.1 **6** $\frac{1}{3}$

1.21 **23**

Thinking Space

3. Solve the clues in the crossword puzzle. Write out the answers in words.

   There are no spaces or dashes in crossword puzzle answers. If your answer is 41, write “FORTYONE” in the puzzle.



Across

1. 5^2
6. 3^2
8. 7^2
10. $9^2 + 3^2$
12. $8^2 - 1^2$
14. $8^2 + 1$

Down

2. $6^2 - 4^2$
3. 2^2
4. 1^2
5. 4^2
7. 9^2
9. 6^2
11. $3^2 - 2^2$
13. $3^2 + 1^2$

Turn to Solutions at the end of the Module and mark your work.

Thinking Space

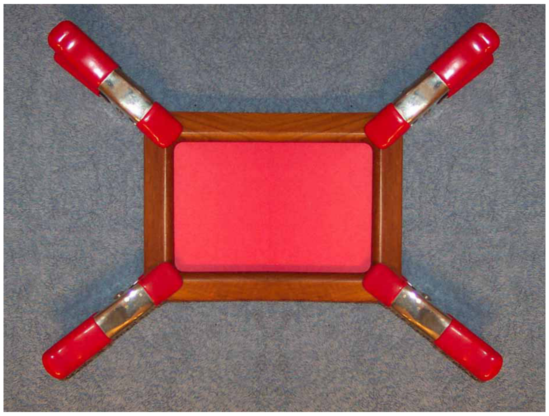
Explore

Using the Pythagorean Theorem

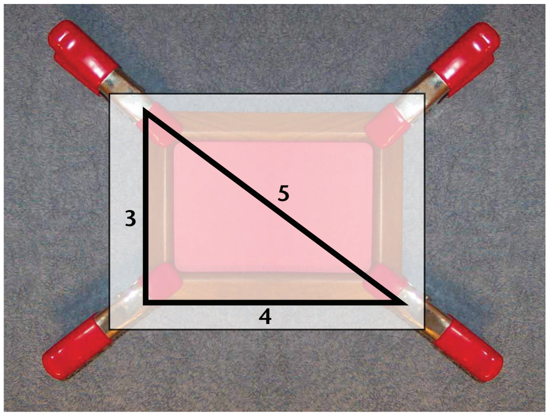
We can use the Pythagorean Theorem to check if an angle is a right angle.

Ken's Picture Frame

Ken is making picture frames. He has cut the wood for the frame and has it all clamped together. Before he glues it, he wants to make sure that the corners are right angles.



First, he measures the legs. They are 3 inches and 4 inches. Then he measures the diagonal, which is the hypotenuse of the right triangle. It is 5 inches.



We'll use the Pythagorean Theorem to find out if that corner is a right angle.

$$a^2 + b^2 = c^2$$

Fill in the lengths that Ken measured.

$$3^2 + 4^2 \overset{?}{=} 5^2$$

a and *b* represent the legs of the triangle
c represents the hypotenuse

Thinking Space

We don't know yet if the left side of the equation equals the right side. Put a ? over the equals sign.

Calculate the square of each number.

$$9 + 16 \overset{?}{=} 25$$

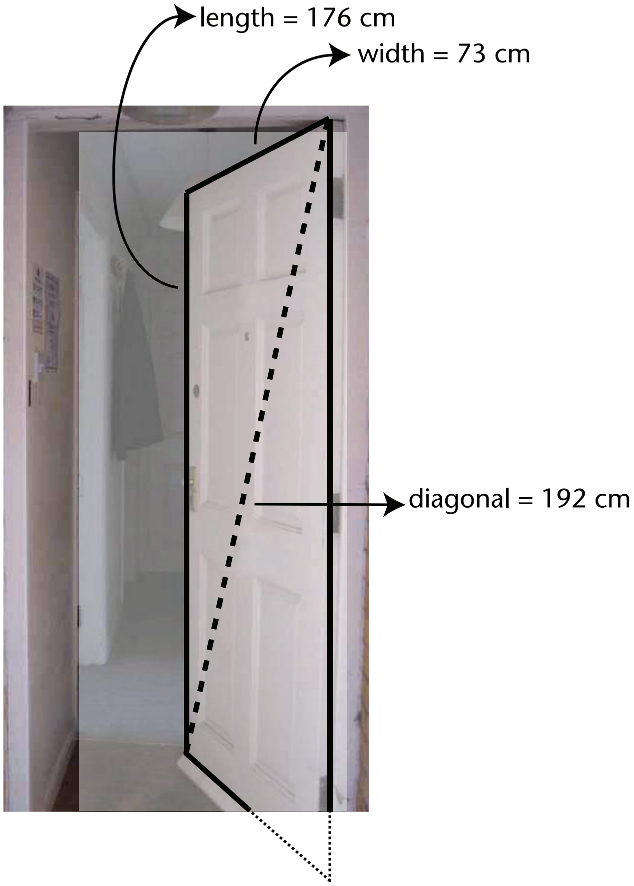
That's true! We don't need the question mark any more. Ken knows that corner of his picture frame is a right angle. He can glue it now.

$$25 = 25$$

Alexa's Door

Alexa is fixing a door. The corners weren't right angles and it didn't swing properly through the door frame.

She's been sanding the edges for a while now, and she thinks she's nearly done. She measures the lengths of the edges and the length of the diagonal, which is the hypotenuse of the right triangle.



Thinking Space

Use the Pythagorean Theorem to check. $a^2 + b^2 = c^2$

Fill in the lengths that Alexa measured.

c represents the hypotenuse $176^2 + 73^2 \overset{?}{=} 192^2$

We don't know yet if the left side of the equation equals the right side.

Put a ? over the equals sign.

Use your calculator.

Figure out the square of each number.

$30\,976 + 5329 \overset{?}{=} 36\,864$

That's not true! You don't need the question mark anymore and you can cross out the equals sign. Alexa knows that corner of her door is not a right angle. She still has to do a bit more sanding.

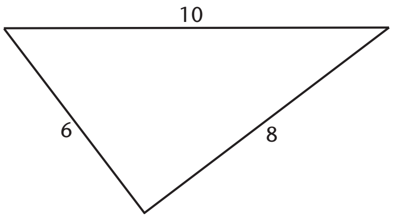
$36\,305 \neq 36\,864$

Try It!

Activity 1

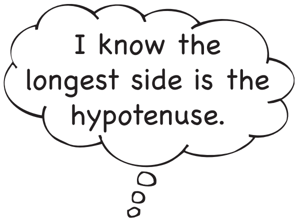
Drawings can be deceiving! When there are no right angle markings, triangles may not always look like right triangles.
Use the Pythagorean Theorem to decide if these are right triangles or not.

1.



Use the Pythagorean Theorem to check. $a^2 + b^2 = c^2$

Fill in the lengths.
Put a ? over the equals sign.



$\_\_\_\_^2 + \_\_\_\_^2 \overset{?}{=} \_\_\_\_^2$

Figure out the square of each number. $\_\_\_\_ + \_\_\_\_ \overset{?}{=} \_\_\_\_$

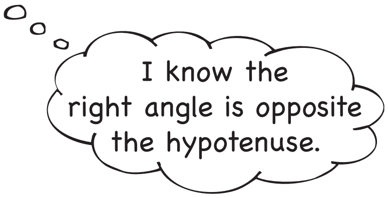
Is that true?

If it's not true, cross out the equals sign. $\_\_\_\_ = \_\_\_\_$

Is this triangle a right triangle or not?

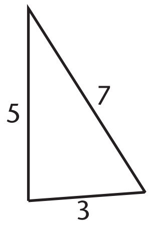
If this is a right triangle, which angle is a right angle?

Mark the right angle.



2.

Thinking Space



Use the Pythagorean Theorem to check.

Fill in the lengths.
Put a ? over the equals sign. $\_\_\_\_^2 + \_\_\_\_^2 \overset{?}{=} \_\_\_\_^2$

Figure out the square of each number. $\_\_\_\_^2 + \_\_\_\_^2 \overset{?}{=} \_\_\_\_^2$

Is that true?

If it's not true, cross out the equals sign. $\_\_\_\_ = \_\_\_\_$

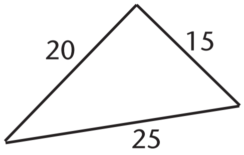
Is this triangle a right triangle or not?

If this is a right triangle, which angle is a right angle?

Mark the right angle.

To see fully-worked solutions to the last two problems, go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html, click on Module 2, and watch *Is It a Right Triangle?*

3.



Use the Pythagorean Theorem to check.

Is this triangle a right triangle or not?

If this is a right triangle, which angle is a right angle?

Mark the right angle.

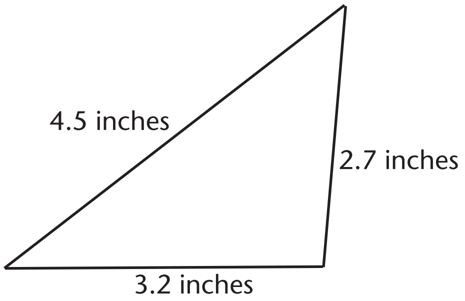
Thinking Space

4. Draw a picture of a triangle with sides 13, 5, and 12 cm long. Is this a right triangle? Use the Pythagorean Theorem to check.

5. Draw a picture of a triangle with sides 11, 14, and 6 cm long. Is this a right triangle? Use the Pythagorean Theorem to check.

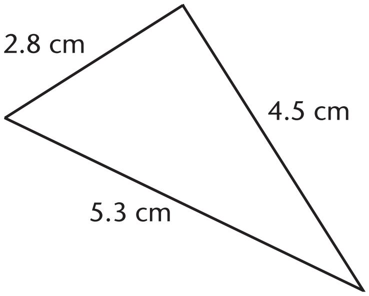
Thinking Space

6. a. Is this triangle a right triangle? Use the Pythagorean Theorem to check.



b. Does this triangle have a hypotenuse? If not, why not? If so, how long is it?

7. a. Is this triangle a right triangle? Use the Pythagorean Theorem to check.



b. Does this triangle have a hypotenuse? If not, why not? If so, how long is it?

Turn to Solutions at the end of the Module and mark your work.

Explore
Pythagorean Triples

Look back at the example of Ken's picture frame.

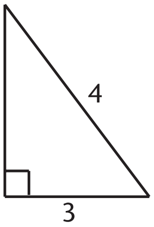
"Satisfy" means that the numbers make the equation true.

When three whole numbers **satisfy** the Pythagorean Theorem, these numbers are called a **Pythagorean Triple.**

Ken's picture frame measurements, 3, 4, and 5 inches form a Pythagorean Triple.

Alexa's door frame measurements do not satisfy the Pythagorean Theorem. These numbers are not a Pythagorean Triple.

Can you tell which number in the Pythagorean Triple 3, 4, 5 is the length of the hypotenuse? The hypotenuse is always the longest side. In this triple, 3 and 4 are the lengths of the legs. The length of the hypotenuse is 5.



Look at this triangle. Can we use the Pythagorean Triple 3, 4, 5 to solve this triangle? Could the missing measurement be 5?

No! If the missing measurement is 5, then one of the legs would be the longest side. The hypotenuse is ALWAYS the longest side.

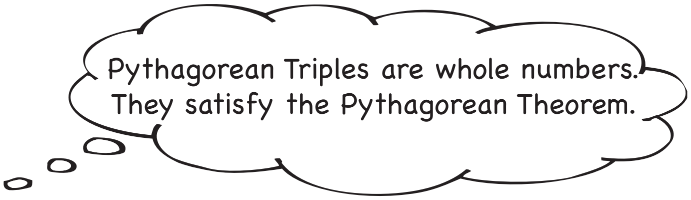
Thinking Space

Try It!

Activity 2

1. These are the measurements of the triangles from Activity 1.

   6, 8, 10
   3, 5, 7
   25, 15, 20
   13, 5, 12
   11, 14, 6
   2.7 inches, 3.2 inches, 4.5 inches
   2.8 cm, 4.5 cm, 5.3 cm



   List the three
   Pythagorean Triples
   you find.

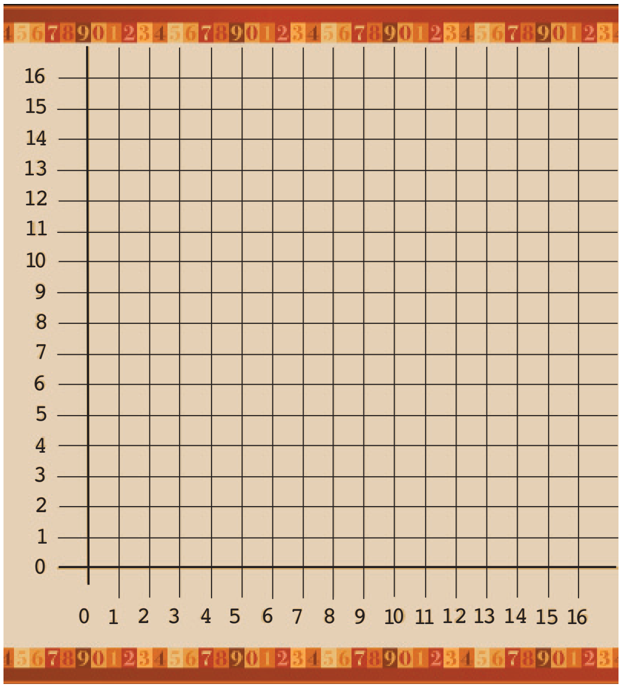
Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/ma0822a1f_shapeshifter.html and open the *Shape Shifter* tool. Click on the Triangle button.

2. Make a right triangle.

   Adjust the vertices so that one leg of your right triangle is 5 units long.

   Adjust the other leg until the lengths of both legs and the hypotenuse are whole numbers. These three numbers are a Pythagorean Triple.

Draw the triangle that you made.

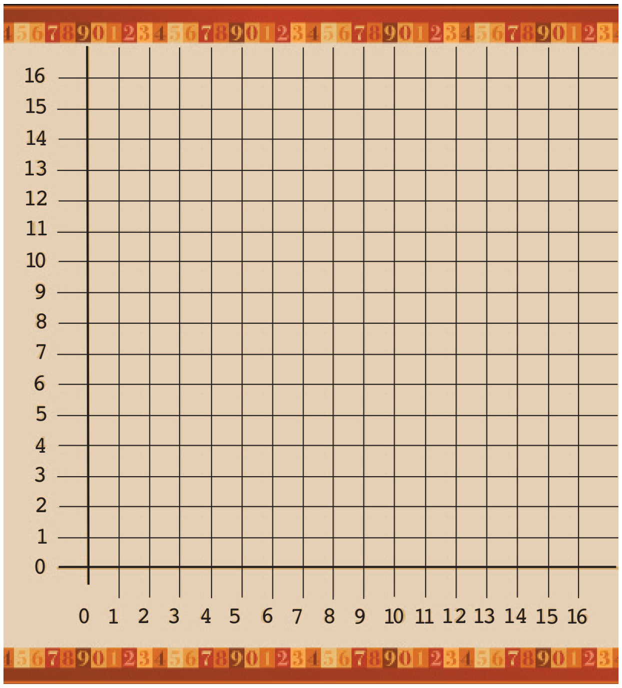


3. Using the Shape Shifter tool, make a right triangle.

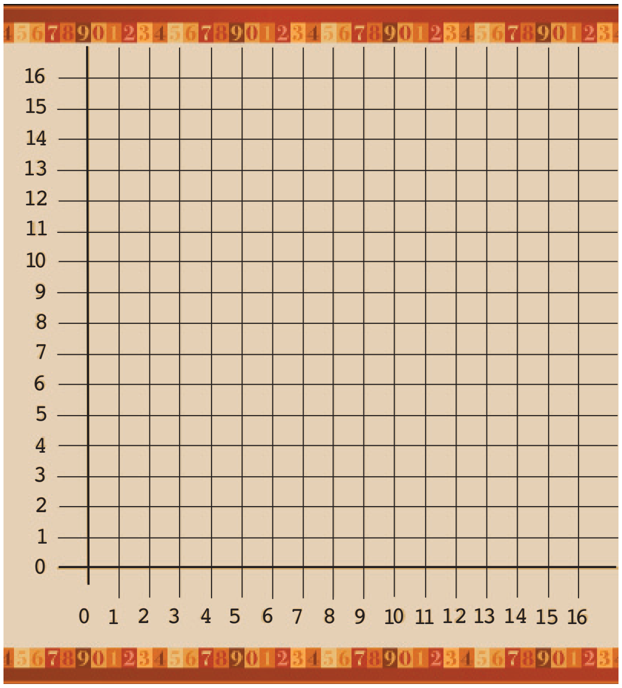
   Adjust the vertices so that one leg of your right triangle is 12 units long.

   Find two different Pythagorean Triples that include the number 12.

Draw your first triangle.



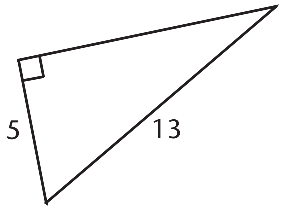
Draw your second triangle.

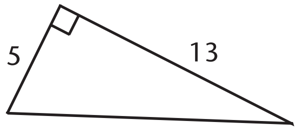


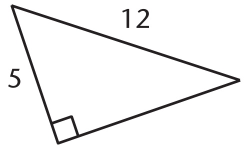
4. a. In the Pythagorean Triple 5, 12, 13, which number is the length of the hypotenuse?

b. Which one of these triangles can be solved using the 5, 12, 13 Pythagorean Triple?

Circle your answer. Write in the length of the missing side.







Thinking Space

Turn to Solutions at the end of the Module and mark your work.

You've finished Lesson B. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Lesson C

Using the Pythagorean Theorem

For this lesson you will need:

- calculator

When you turn the page over, you'll find the Essential Questions for this lesson. Fill out the first column before you start working on the lesson. This will help you think about what you already know about the lesson topics.

When you're finished the lesson, go back to the Essential Questions page and fill in the second column. Be sure to keep your page in a safe place while you're working through the lesson.

Essential Questions	Before the lesson: What I know	After the lesson: What I learned
How can I use the Pythagorean Theorem to find a missing measurement on a right triangle?		
How is finding the length of a missing leg of a right triangle different from finding the length of a missing hypotenuse?		

Thinking Space

Warm-up

Use your calculator to answer these questions.

1. Round your answers to the nearest hundredth.

   a. 4.7^2 = ____________________

   b. 294^2 = ____________________

   c. $\sqrt{49.6}$ = ____________________

   d. $\sqrt{0.25}$ = ____________________

   e. 15.3^2 = ____________________

   f. $\sqrt{885}$ = ____________________

2. Do not use your calculator. Use your answers from question 1 to answer these questions.

   a. 7.042 = ____________________

   b. $\sqrt{22.09}$ = ____________________

   c. $\sqrt{86\,436}$ = ____________________

   d. $\sqrt{234.09}$ = ____________________

   e. 29.75^2 = ____________________

   f. 0.5^2 = ____________________

3. Do you remember how to find the value of a variable?

   $j + 3 = 7$

   Subtract 3 from each side.

   $j + 3 - 3 = 7 - 3$

   $j = 4$

   Sometimes you might know the answer without doing the algebra steps. That's great! Show your work anyway. It's important to learn how to work logically. Then you'll know exactly what to do when the questions get more difficult.

Thinking Space

Do these questions without your calculator. Show all the steps.

a. $x + 2 = 5$

b. $23 + v = 86$

c. $g + 153 = 2655$

d. $14 + m = 39$

e. $8 + t = 549$

f. $d + 350 = 522$

4. I'm thinking of a number. If I square my number, the answer is 16. What number am I thinking of?

✓ Turn to Solutions at the end of the Module and mark your work.

Explore

Algebra with Squares and Square Roots

The variable in an equation is just a number that you don't know yet.

$$x^2 = 16$$

You read this equation by saying "x squared equals 16".

You can think of the equation like this: "I'm thinking of a number. If I square the number, the answer is 16. What is the number?"

If you can't think of the answer, start at the beginning with 1.

What is 1^2? ......not 16!

What is 2^2? ......not 16!

What is 3^2? ......not 16!

What is 4^2? 16! We found it! If $x^2 = 16$, then x must be 4.

Because 16 has two square roots, −4 is also an answer, but we'll only work with positive roots here.

It's not a bad method, but it only works with perfect squares. What would you do with this one?

$$k^2 = 15$$

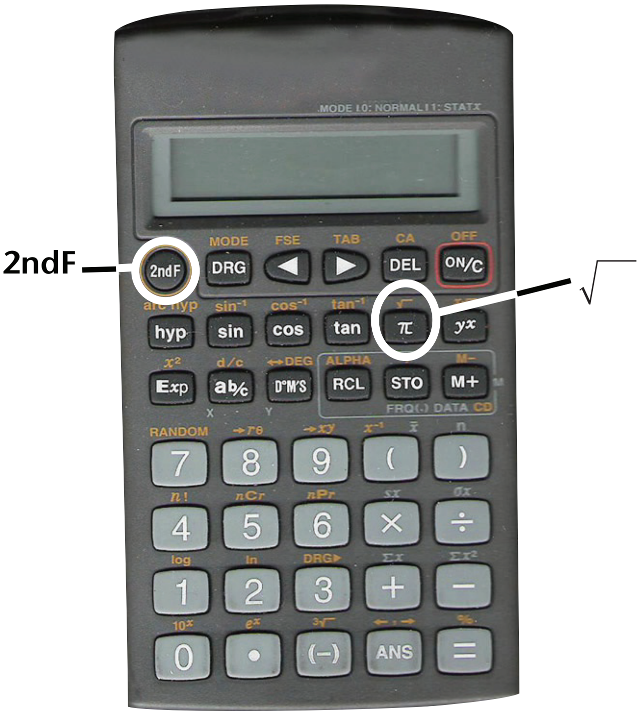
We need a way to find out what k equals. Is there something that we can do to k^2 that will leave us with k?

Go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html, click on Module 2, and watch *Understanding Squares and Square Roots*.

Take the square root of each side.

$$\sqrt{k^2} = \sqrt{15}$$

Here's an example of where you might find the square root button on a calculator.



On the calculator shown here, you have to press the 2nd function button first and then press the square root button.

Use your calculator to find $\sqrt{15}$. Round your answer to the nearest hundredth.

$$\sqrt{k^2} = \sqrt{15}$$

$$k \approx 3.87$$

Thinking Space

Try It!
Activity 1

For this Activity you will need:

- calculator

Find the value of these variables by taking the square root of both sides of the equation.

Show all of your steps.

1. You don't need your calculator to do any of these ones. Why not?

a. $x^2 = 9$

b. $b^2 = 25$

c. $k^2 = 100$

d. $a^2 = 49$

e. $j^2 = 1$

f. $n^2 = 36$

Thinking Space

Use your calculator for these questions.

2. Round your answers to the nearest hundredth.

a. $x^2 = 10$

b. $b^2 = 22$

c. $k^2 = 107$

d. $a^2 = 53$

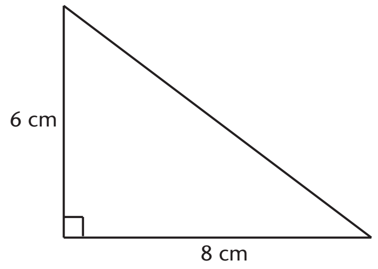
e. $j^2 = 8$

f. $n^2 = 63$

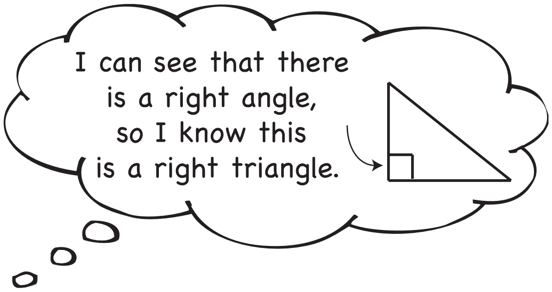
Turn to Solutions at the end of the Module and mark your work.

Explore

Finding the Length of the Hypotenuse



How long is the hypotenuse of this triangle?



We know that this is a right triangle.

The Pythagorean Theorem tells us how the lengths of the legs of a right triangle are related to length of the hypotenuse. If we fill in the two sides that we know, we can figure out the third.

$$a^2 + b^2 = c^2$$

The lengths of the legs of the triangle are 6 and 8.

$$(6)^2 + (8)^2 = c^2$$

We don't know how long the hypotenuse is.

$$36 + 64 = c^2$$

Don't think about the variable. Figure out as much as you can.

$$100 = c^2$$

Take the square root of both sides.

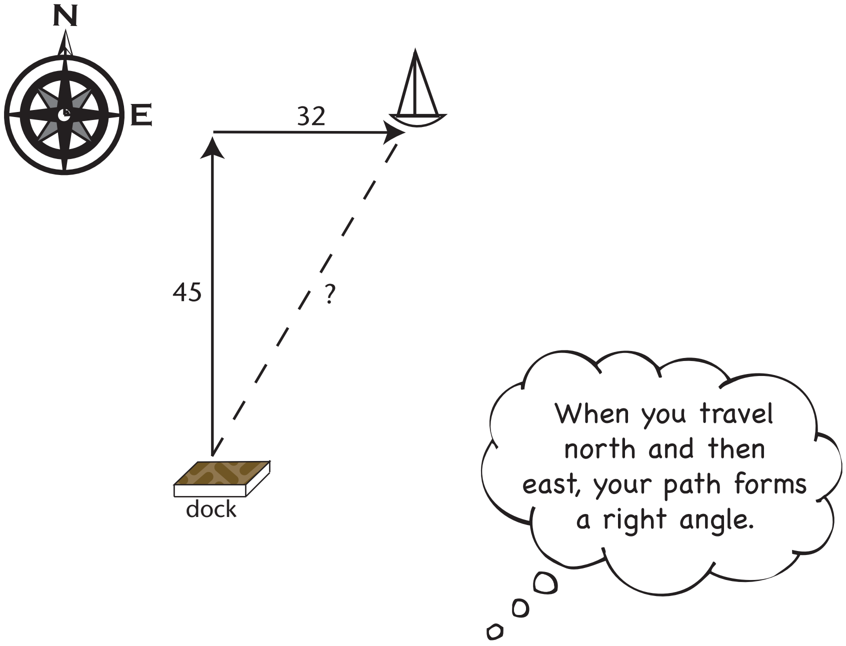
$$\sqrt{100} = \sqrt{c^2}$$

The hypotenuse of the triangle is 10 cm long.

$$10 = c$$

Go to your **http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html**, click on Module 2, and watch *Finding the Length of the Hypotenuse.*

The SS Minnow left the dock this afternoon. It sailed north for 45 nautical miles, then it sailed east for 32 nautical miles. How far away from the dock is the SS Minnow? Round your answer to the nearest nautical mile.



We know that this is a right triangle.

We can use the Pythagorean Theorem to describe the relationship of the lengths of the sides.

$$a^2 + b^2 = c^2$$

The lengths of the legs of the triangle are 45 and 32.

$$(45)^2 + (32)^2 = c^2$$

We don't know how long the hypotenuse is.

Don't think about the variable. Figure out as much as you can.

$$2025 + 1024 = c^2$$

$$3049 = c^2$$

Take the square root of both sides.

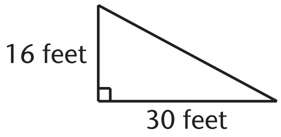
$$\sqrt{3049} = \sqrt{c^2}$$

$$55.218 \approx c$$

The SS Minnow is approximately 55 nautical miles away from the dock.

Try It!
Activity 2

1. Find the length of the hypotenuse of this right triangle.



2. A right triangle has legs that are 27 m and 53 m long.

   Draw a picture of this triangle.

   How long is the hypotenuse?

   Round your final answer to the nearest tenth of a metre.

Thinking Space

3.

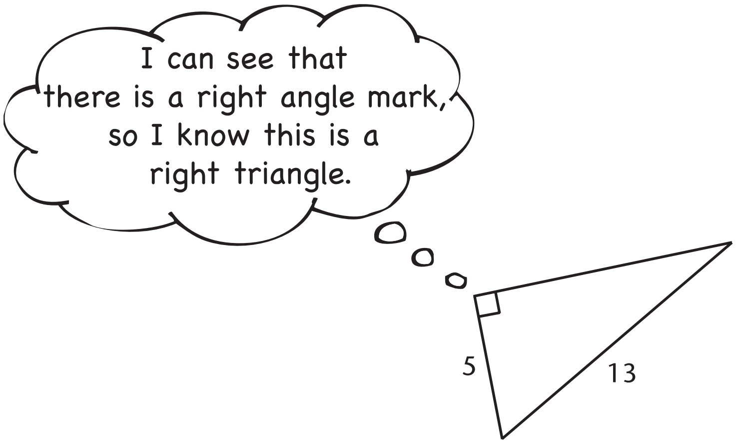
If these corners are not right angles, the drawer will not slide in and out of the dresser properly.

Khira measured the width and the length of the drawer. How long should the hypotenuse be? Round your answer to the neared tenth of a centimetre.

Turn to Solutions at the end of the Module and mark your work.

Explore

Finding the Length of a Leg of a Right Triangle



How long is the other leg of this triangle?

We know that this is a right triangle.

The Pythagorean Theorem tells us how the lengths of the three sides of a right triangle are related to each other. If we fill in the two sides that we know, we can figure out the third.

$$a^2 + b^2 = c^2$$

The length of one of the legs is 12. Substitute 12 for *a* or *b*. It doesn't matter which one. (Here we've substituted 12 for *b*.)

$$a^2 + (12)^2 = (13)^2$$

The length of the hypotenuse is 13. Substitute 13 for *c*. The hypotenuse is ALWAYS *c*.

Don't think about the variable. Figure out as much as you can.

$$\begin{aligned} a^2 + 144 &= 169 \\ a^2 + 144 - 144 &= 169 - 144 \\ a^2 &= 169 - 144 \\ a^2 &= 25 \end{aligned}$$

Thinking Space

Take the square root of both sides. $\sqrt{a^2} = \sqrt{25}$

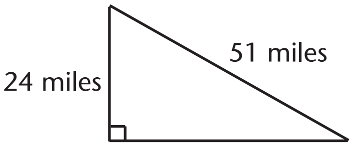
The length of the other leg is 5. $a = 5$

Go to **http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html**, click on Module 2, and watch *Finding the Length of a Right Triangle Leg.*

Thinking Space

Try It!
Activity 3

1. Find the length of the other leg.



2. A right triangle has a hypotenuse that is 15 cm long. One of its legs is 7 cm long.

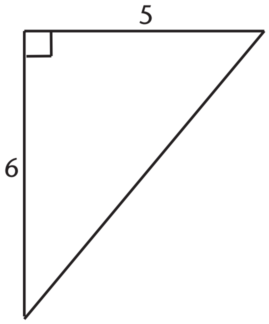
   Draw a picture of this triangle. Figure out the missing measurement.

   Round your answer to the nearest tenth of a centimetre.

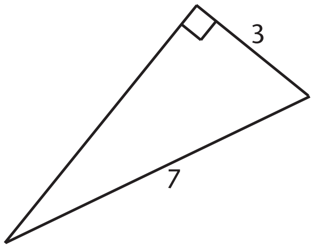
Thinking Space

3. Find the length of the missing side for each of these triangles. All measurements are in centimeters. Round your answers to the nearest tenth.

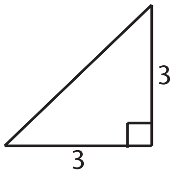
a.



b.

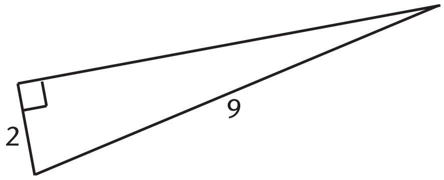


c.

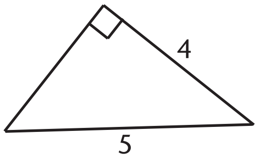


d.

e.

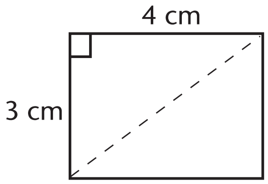


f.

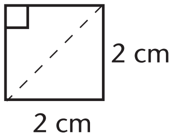


4. Find the length of each diagonal. Round your answers to the nearest hundredth.

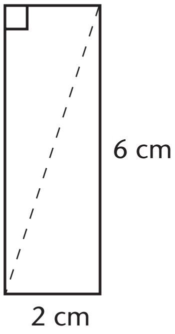
a.



b.



c.



Turn to Solutions at the end of the Module and mark your work.

You've finished Lesson C. Now it's time to return to the Essential Questions from the beginning of the lesson and complete the final column.

Thinking Space

Section Summary

Completing this section has helped you to:

- learn the Pythagorean Theorem
- decide if a triangle is a right triangle
- identify Pythagorean Triples
- find the lengths of missing sides of a right triangle

Appendix

Solutions

Section 1

Pretest

Lesson A: Should I Multiply or Divide?

1. $\frac{18}{3} = 6$ Each pie needs to be cut into 6 pieces.

2. $\frac{320}{40} = 8$ Eight cases are needed to hold the CD collection.

3. $6 \times 30 = 180$ The health plan costs $180 per month.

Lesson B: Multiplying and Dividing With Negative Numbers

4. a. $-6 \times 7 = -42$
   b. $-12 \div -2 = 6$
   c. $8 \times -11 = -88$
   d. $150 \div -3 = -50$
   e. $42 \div 6 = 7$
   f. $-9 \times -8 = 72$

5. $\frac{(-3)(8)(-4)}{(6)(-2)} = -8$

Lesson C: Expressions With More Than One Operation

6. a. $\frac{(4)(-3)}{6} + (3)(7) = 19$
   b. $(-2)(7) - 18 \div 6 + 4 \times 9 = 19$
   c. $42 \div (-7) + 9 = 3$
   d. $-3 + 6 \times 9 = 51$

Lesson A: Should I Multiply or Divide?

Warm-up

1. 4 × 5 = 20
2. 21 ÷ 7 = 3
3. 3 × 8 = 24
4. 63 ÷ 9 = 7
5. 2 × 7 = 14
6. 18 ÷ 6 = 3
7. 4 × 4 = 16
8. 15 ÷ 5 = 3
9. 6 × 4 = 24
10. 72 ÷ 9 = 8
11. 30 ÷ 10 = 3
12. 11 × 8 = 88
13. 24 ÷ 3 = 8
14. 7 × 5 = 35
15. 70 ÷ 7 = 10
16. 6 × 6 = 36
17. 4 × 8 = 32
18. 56 ÷ 7 = 8
19. 20 ÷ 4 = 5
20. 5 × 5 = 25

Try It! Activity 1

1. Groups: boxes

Items: bulbs

\# of groups: Susan packed **370** boxes.

\# of items in one group: There were **24** bulbs in each box.

370 × **24** = **8880**

Susan packed **8880** bulbs.

2. Groups: days

Items: bales of hay

\# of groups: Amir needs hay for **45** days.

\# of items in one group: He needs **4** bales of hay each day.

45 × **4** = **180**

Amir needs **180** bales of hay.

3.

Groups: packs of trading cards
Items: cards in each pack
# of groups: **24** packs
# of items in one group: **15** cards in each pack
24 × **15** = **360**
There are **360** trading cards in a box.

4.

Groups: pouches of beads
Items: beads
# of groups: **8** pouches of beads
# of items in one group: **22** beads in each pouch
8 × **22** = **132**
There are **132** beads in the kit.

5.

Groups: the hours that Chris worked
Items: the dollars that Chris earned per hour
# of groups: **21**
# of items in one group: **9**
21 × **9** = **189**
Chris earned **$189** last week.

6. There are 3726 groups with 5¢ in each group. Multiply to find the total.

   3726 × 5¢ = 18 630¢ = $186.30

   The band has made $186.30.

Try It! Activity 2

1. Groups: boxes
Items: bulbs
# of items in one group: There were **24** bulbs in each box.
Total items: There were **60 000** bulbs altogether.
60 000 ÷ 24 = 2500
They filled **2500** boxes with bulbs.

2. Groups: calendars
Items: dollars for each calendar that they sell
# of items in one group: The class earns $**3** for each calendar that they sell.
Total items: The class wants to raise $**465**.
465 ÷ 3 = 155
They need to sell **155** calendars to reach their goal.

3. Groups: new houses
Items: seedlings
# of groups: There are **13** new houses.
Total items: There are **585** seedlings.
585 ÷ 13 = 45
The landscaper can plant **45** coleus seedlings in each yard.

4. Groups: the hours that Chris works
Items: dollars ($) that Chris earns
# of items in one group: **9**
Total items: **648**
648 ÷ 9 = 72
Chris needs to work for **72** hours to earn the money to buy the guitar.

5.

Groups: bracelets

Items: beads

# of items in one group: **7**

Total items: **56**

56 ÷ 7 = 8

Alexis can make **8** bracelets.

6. The items in this question are dollars. There are $18 in total.

   The groups are the packs of cards. There are 24 packs of cards.

   Divide to find the number of items in one group (the number of dollars per pack).

   18 ÷ 24 = 0.75

   Nancy pays $0.75 for each pack of cards.

Try It! Activity 3

1.

Groups: The number of days.
We don't know.
Divide to find the number of groups.

Items: Bales of hay needed for each day — 4.

Total: 192 bales of hay in total

192 ÷ 4 = 48

Amir has enough hay to feed his cows for **48** days.

2.

Groups: The calendars — 32.

Items: Dollars for each calendar — $14.

Total: Total amount of money they have collected.
(We don't know. Multiply to find the total.)

32 × 14 = $448

The class has collected **$448**.

3.

Groups: The band members — 5

Items: Dollars ($) each band member gets.
(We don't know. Divide to find the number of items in each group.)

Total: Total amount in dollars ($) that the band earned. The total is 700.

700 ÷ 5 = 140

Each band member gets **$140**.

4.

Groups: The cedar hedges — 13

Items: Number of plants in each hedge. — 8

Total: Total number of plants needed.
(We don't know. Multiply to find the total.)

13 x 8 = 104

The landscaper needs **104** cedar plants.

Lesson B: Multiplying and Dividing with Negative Numbers

Warm-up

1. –2 + 3 = 1
2. 6 × 7 = 42
3. 3 – 8 = –5
4. 36 ÷ 4 = 9
5. 7 × 3 = 21
6. 4 – 7 = –3
7. 9 × 2 = 18
8. 12 ÷ 4 = 3
9. –15 + 7 = –8
10. 10 – 6 = 4
11. 24 ÷ 6 = 4
12. 15 × 3 = 45
13. –2 – 5 = –7
14. 6 + 5 = 11
15. 27 ÷ 9 = 3
16. 12 – 20 = –8
17. 4 × 8 = 32
18. –9 – 2 = –11
19. 35 ÷ 7 = 5
20. –1 + 17 = 16

Try It! Activity 1

1. a. 4 × –3 = –12
   b. –4 × 3 = –12
   c. 12 ÷ 1 = 12
   d. –1 × 12 = –12
   e. 12 ÷ –4 = –3
   f. –12 ÷ 4 = –3
   g. 2 × –6 = –12
   h. –2 × 6 = –12
   i. –12 ÷ 3 = –4
   j. 12 ÷ –3 = –4
   k. 12 ÷ 3 = 4
   l. –12 × 1 = –12
   m. 12 × –1 = –12
   n. 12 ÷ 2 = 6
   o. 12 ÷ –2 = –6
   p. 12 ÷ –6 = –2
   q. –12 ÷ 6 = –2
   r. 3 × –4 = –12
   s. 4 × 3 = 12
   t. 6 × 2 = 12
   u. –6 × 2 = –12
   v. 6 × –2 = –12
2. –3 × 5 = –15 It will be 15° C colder on the fifth day than it is today.
3. –900 ÷ 3 = –300 Each person owes $300.

Try It! Activity 2

1. 4 × 5 = 20
2. –4 × –5 = 20
3. 4 × –5 = -20
4. 20 ÷ 4 = 5
5. –20 ÷ –5 = 4
6. –10 × –2 = 20
7. –20 ÷ –2 = 10
8. 20 ÷ 2 = 10
9. –1 × –20 = 20
10. 3 × –8 = –24
11. –24 ÷ 8 = –3
12. –4 × 6 = –24
13. 24 × –1 = –24
14. 24 ÷ –4 = –6
15. 2 × –12 = –24
16. –24 ÷ 3 = –8
17. –24 ÷ 1 = –24
18. –7 × –7 = 49
19. 7 × 7 = 49
20. 49 ÷ –7 = –7
21. 49 ÷ 7 = 7
22. –5 × –5 = 25
23. 5 × 5 = 25
24. –25 ÷ –25 = 1
25. –1 × –5 = 5
26. –4 × –4 = 16
27. 4 × 4 = 16
28. 16 ÷ –4 = –4
29. –16 ÷ 4 = –4
30. 4 ÷ 2 = 2
31. 4 ÷ –2 = –2
32. –4 ÷ 2 = –2
33. –4 ÷ –2 = 2
34. 56 ÷ 8 = 7

Try It! Activity 3

1. $\dfrac{12}{(3)(-1)(2)} = -2$

2. $\dfrac{(3)(-3)(-7)}{(-9)} = -7$

3. $(4)(5)(-1) = -20$

4. $\dfrac{(-16)(25)(-2)}{(10)(-4)} = -20$

5. $(2)(-5)(7)(-2) = 140$

6. $\dfrac{(6)(-4)(2)}{-12} = 4$

7. $\dfrac{(24)(-14)}{(-8)(-7)(-1)} = 6$

8. $\dfrac{(8)(-7)}{4(14)} = -1$

9. $(-1)(2)(-3)(4)(-5) = -120$

10. $\dfrac{(-15)(6)}{-9} = 10$

11. $(5)(-3)(2) = -30$

12. $\dfrac{(-21)(9)}{(7)(-3)} = 9$

Go to **http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html**, click on Module 2, and watch *Solving Mixed Multiplication and Division* to see fully worked out solutions for some of these questions.

Lesson C: Expressions with More than One Operation

Warm-up

A 1. $-4 - 3 = \mathbf{-7}$

P 2. $\dfrac{(-5)(-1)(-2)(3)}{6} = \mathbf{-5}$

I 3. $18 \div 3 = \mathbf{6}$

H 4. $14 \div -7 = \mathbf{-2}$

S 5. $-3 \times -4 = \mathbf{12}$

D 6. $(-6)(-8) = \mathbf{48}$

I 7. $-3 + 9 = \mathbf{6}$

S 8. $4 + 5 + 3 = \mathbf{12}$

F 9. $\dfrac{-21}{-3} = \mathbf{7}$

H 10. $-8 + 6 = \mathbf{-2}$

S 11. $\dfrac{18(7)(-4)}{(-14)(3)} = \mathbf{12}$

N 12. $-5 + 30 = \mathbf{25}$

What do sea monsters eat?

FISH AND SHIPS

Try It! Activity 1

1. $(-3)(7) = -21$
2. $4 \times 9 = 36$
3. $-13 \times 3 = -39$
4. $42 \div -6 = -7$
5. $(8)(-1)(-4) = 32$
6. $12 + 6 = 18$
7. $15 \div 5 + 7 = 10$
8. $2 - 3 \times 4 = -10$
9. $3 + \frac{4}{2} = 5$
10. $-16 + (4)(3) = -4$
11. $-5 - (2)(-1)(-18) \div 4 = -14$
12. $6 \times 5 \div 3 = 10$
13. $18 \div 2 + 4 = 9 + 4 = 13$
14. $18 \div (2 + 4) = 18 \div 6 = 3$
15. $6 \times 8 + 12 + 3 \times 9 = 87$
16. $3 + 11 \times 4 + 12 \div 3 = 51$
17. $7 - 3 \times 5 = 7 - 15 = -8$
18. $(7 - 3) \times 5 = 4 \times 5 = 20$
19. $36 \div 9 + 2 + 1 \times 9 + 6 - 5 = 16$
20. $6 \times 7 \div 14 - 3 + 2 \times 4 = 8$
21. $5 - 1 + 2 - 4 \times 3 \div 6 = 4$

22. Answers will vary. For example:

$3 \times 4 - 7$ or $5 \times (4 - 3)$

$= 12 - 7$ $\quad$ $= 5 \times 1$

$= 5$ $\quad$ $= 5$

23. Answers will vary. For example:

$3 \times 4 + 1 - 15$ or $2 \times (6 - 7)$

$= 12 + 1 - 15$ $\quad$ $= 2 \times (-1)$

$= 13 - 15$ $\quad$ $= -2$

$= -2$

24. a. Answers will vary. Make sure you have used all 9 digits and the required operations, as in the example provided

    b. Answers will vary. Check over your answer to make sure that you have solved it correctly.

Solutions

Section 2

Pretest

Lesson A: Perfect Squares

1.

54	18	[✓ 4]
[✓ 16]	27	37
[✓ 25]	[✓ 81]	5

Lesson B: Square Roots of Perfect Squares

2. 6

3. a. $2^2 = \mathbf{4}$ b. $5^2 = \mathbf{25}$ c. $8^2 = \mathbf{64}$

4. a. $9 = \mathbf{3}^2$ b. $16 = \mathbf{4}^2$ c. $49 = \mathbf{7}^2$

5. a. $\sqrt{9} = \mathbf{3}$ b. $\sqrt{64} = \mathbf{8}$ c. $\sqrt{1} = \mathbf{1}$

6. a. $11 = \sqrt{\mathbf{121}}$ b. $2 = \sqrt{\mathbf{4}}$ c. $5 = \sqrt{\mathbf{25}}$

7. a. $6 - 2^2 = \mathbf{2}$ b. $(-3 + 5)^2 + 5 \times 3 = \mathbf{19}$

Lesson C: Using the Pythagorean Theorem

8.

d	–2.5
a	4
e	–7
b	3
c	1.1
f	–2

a. 16
b. 9
c. 1.21
d. 6.25
e. 49
f. 4

9. a. $2 < 5$
   b. $3 - 8 < 8 - 3$
   c. $3^2 - 3 = 6$
   d. $(-2)(-3) > 18 \div (-3)$

10. $\sqrt{7}$ is greater than 2. $2 = \sqrt{4}$ and $\sqrt{7}$ is bigger than $\sqrt{4}$.

11. Any three of: $\sqrt{37}, \sqrt{38}, \sqrt{40}, \sqrt{41}, \sqrt{42}, \sqrt{44}, \sqrt{45}, \sqrt{46}, \sqrt{47}, \sqrt{48}$

Lesson D: Calculating Square Roots

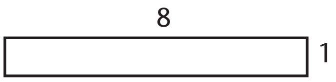
12. a. 216^2 = **46 656** b. 3.4^2 = **11.56** c. 8.17^2 = **66.7489**

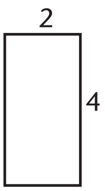
13. a. $\sqrt{7}$ = **2.646** b. $\sqrt{24}$ = **4.899** c. $\sqrt{18}$ = **4.243**

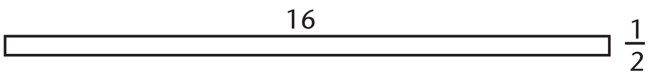
Lesson A: Perfect Squares

Warm-up

1. $2 \times 3 = 6$
2. $3 \times 5 = 15$
3. $3 \times 3 = 9$
4. $4 \times 2 = 8$
5. $4 \times 5 = 20$
6. $6 \times 6 = 36$
7. $7 \times 3 = 21$
8. $7 \times 7 = 49$
9. $8 \times 4 = 32$
10. $8 \times 8 = 64$
11. $9 \times 6 = 54$
12. $9 \times 9 = 81$
13. Area= $2 \times 5 = 10$
14. Area = $3 \times 4 = 12$
15. Area = $6 \times 6 = 36$
16. Your answer could include any of these. Did you think of any other ones?

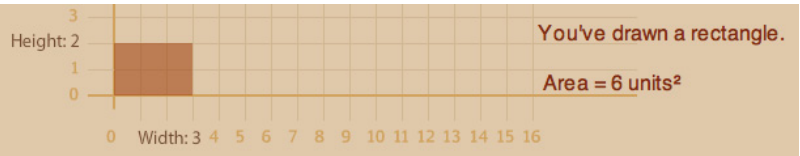






Try It! Activity 1

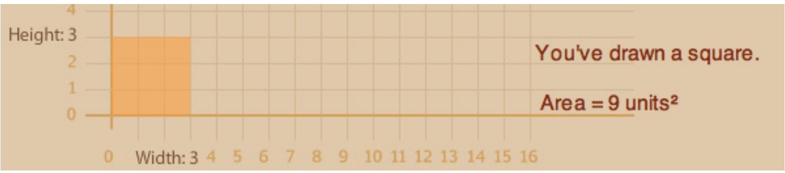
1.



You've drawn a rectangle.

Area = 6 units^2

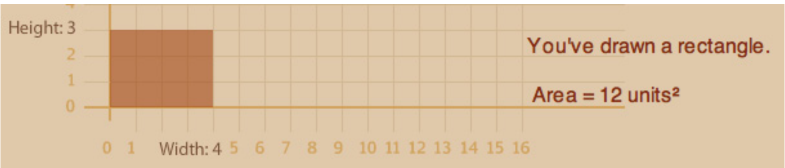
2.



You've drawn a square.

Area = 9 units^2

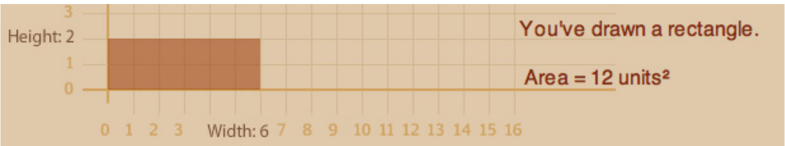
3.



You've drawn a rectangle.

Area = 12 units^2

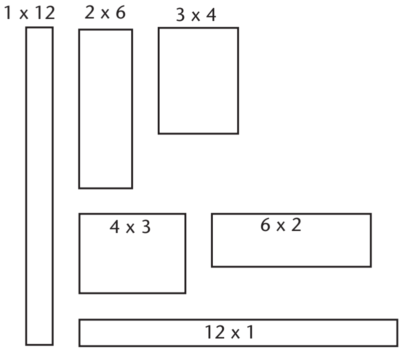
4.



You've drawn a rectangle.

Area = 12 units^2

5. Your answers for questions 3, 4, and 5 could be any two of these.



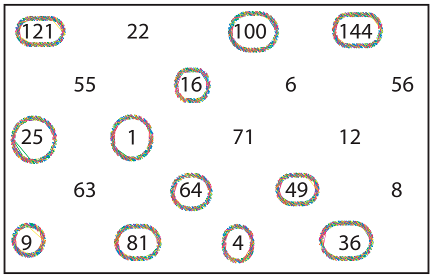
Try It! Activity 2

1. 9
2. I can't make a square that has an area of 8. 8 is not a perfect square
3. Yes, a square with sides of length 1 has area 1. 1 is a perfect square.
4. I can't make a square that has an area of 7. 7 is not a perfect square.
5. Yes, a square with sides of length 4 has area 16. 16 is a perfect square.

Try It! Activity 3

1. 3 × 3 = 9
   9 × 9 = 81
   6 × 6 = 36
   4 × 4 = 16
   1 × 1 = 1

2.



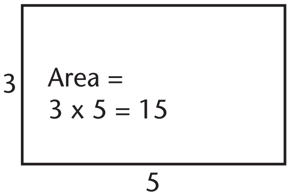
1 × 1 = 1
3 × 3 = 9
5 × 5 = 25
7 × 7 = 49
9 × 9 = 81
11 × 11 = 121

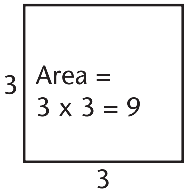
2 × 2 = 4
4 × 4 = 16
6 × 6 = 36
8 × 8 = 64
10 × 10 = 100
12 × 12 = 144

Lesson B: Square Roots of Perfect Squares

Warm-up

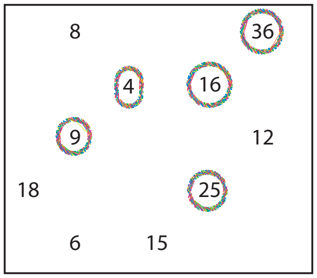
1.





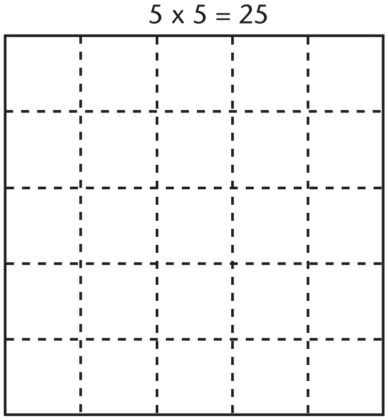
2. a. 6 × 2 = 12
   b. 3 × 4 = 12
   c. 5 × 5 = 25
   d. 2 × 3 = 6
   e. 4 × 5 = 20
   f. 4 × 4 = 16
   g. 2 × 8 = 16
   h. 3 × 5 = 15
   i. 3 × 3 = 9
   j. 3 × 12 = 36
   k. 6 × 6 = 36
   l. 4 × 9 = 36
   m. 3 × 6 = 18
   n. 2 × 9 = 18

3.



Try It! Activity 1

1. $1^2 = 1$
2. $2^2 = 4$
3. $3^2 = 9$
4. $4^2 = 16$
5. $5^2 = 25$
6. $6^2 = 36$
7. $7^2 = 49$
8. $8^2 = 64$
9. $9^2 = 81$
10. $10^2 = 100$
11.



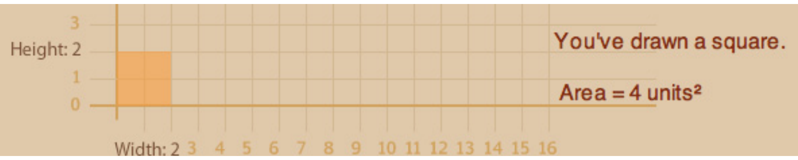
12. a. $2^2 + 1$
$= 4 + 1$
$= 5$

b. $(-2)(3)^2 - 4$
$= (-2)(9) - 4$
$= -18 - 4$
$= -22$

c. $(-4 + 7) + 4^2 - 18 \div 3$
$= 3 + 4^2 - 18 \div 3$
$= 3 + 16 - 18 \div 3$
$= 3 + 16 - 6$
$= 13$

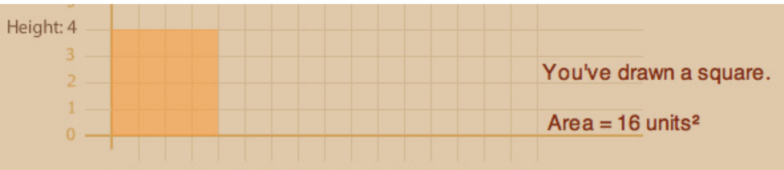
Try It! Activity 2

Your drawings might be different, but they should all be squares.



You've drawn a square.

Area = 4 units²



You've drawn a square.

Area = 16 units²

Try It! Activity 3

1. The length of the side of the square is 3.
   The square root of 9 is 3.
2. The length of the side of the square is 2.
   The square root of 4 is 2.
3. Each side is 5 cm long. 5 is the square root of 25.

Try It! Activity 4

1. 10

   1, 4, 9, 16, 25, 36, 49, 64, 81, 100

   Answers may vary. Your answer might be something similar to this:

   I squared all of the integers in order, without skipping any. One squared is one, two squared is four, etc. When I got to 100, I stopped.

2.

You've drawn a square.

Area = 25 units²

3. a. Four squared equals **sixteen**. $4^2 = \mathbf{16}$

   b. Nine is **three** squared. $9 = \mathbf{3}^2$

   c. **Two** is the square root of four. $\mathbf{2} = \sqrt{4}$

   d. One is the square root of **one**. $1 = \sqrt{1}$

e. The square root of nine is **three**. $\sqrt{9} = \mathbf{3}$

f. **Five** is the square root of twenty-five. $\mathbf{5} = \sqrt{25}$

4.

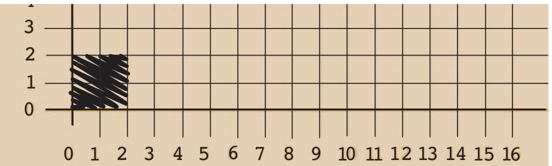
$1^2 = 1$	$\sqrt{1} = 1$
$2^2 = 4$	$\sqrt{4} = 2$
$3^2 = 9$	$\sqrt{9} = 3$
$4^2 = 16$	$\sqrt{16} = 4$
$5^2 = 25$	$\sqrt{25} = 5$
$6^2 = 36$	$\sqrt{36} = 6$
$7^2 = 49$	$\sqrt{49} = 7$
$8^2 = 64$	$\sqrt{64} = 8$
$9^2 = 81$	$\sqrt{81} = 9$
$10^2 = 100$	$\sqrt{100} = 10$

Lesson C: Estimating Square Roots

Warm-up

1. a. $4^2 = 16$
   b. $6^2 = 36$
   c. $1^2 = 1$
   d. $8^2 = 64$
   e. $5^2 = 25$
2. a. $\sqrt{9} = 3$
   b. $\sqrt{81} = 9$
   c. $\sqrt{25} = 5$
   d. $\sqrt{49} = 7$
   e. $\sqrt{4} = 2$
3. a. $8^2 = 64$
   b. $16 = 4^2$
   c. $\sqrt{25} = 5$
   d. $7 = \sqrt{49}$
   e. $100 = 10^2$
   f. $\sqrt{64} = 8$

4.



Try It! Activity 1

1. $7 = 3 + 4$
2. $-6 < 5$
3. $2 < 3$
4. $\sqrt{16} = 4$
5. $8 < 3^2$
6. $(-4)(-5) > 12$
7. $3 < \sqrt{25}$
8. $-6 + 5 = 5 - 6$
9. $6^2 = 36$
10. $5 < \sqrt{36}$
11. $-24 \div 4 > 3 - 10$
12. $2 < 2^2$
13. $(-15)^2 = (-15) \times (-15)$
14. $\sqrt{9} = -2 + 5$

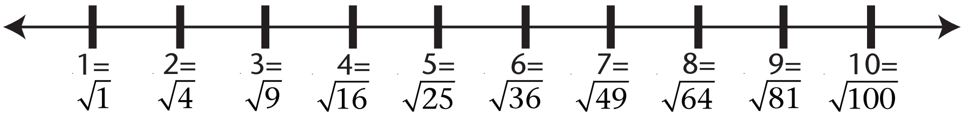
Try It! Activity 2

1. $12^2 = 12 \times 12 =$ **144**
2. $(-1.2)^2 = (-1.2) \times (-1.2) =$ **1.44**
3. $5.1^2 = 5.1 \times 5.1 =$ **26.01**
4. $0.2^2 = 0.2 \times 0.2 =$ **0.04**
5. $(-23)^2 = (-23) \times (-23) =$ **529**
6. $35^2 = 35 \times 35 =$ **1225**
7. $3.5^2 = = 3.5 \times 3.5 =$ **12.25**
8. $(-0.4)^2 = (-0.4) \times (-0.4) =$ **0.16**
9. $20^2 = 20 \times 20 =$ **400**

The answers to questions 1, 5, 6, and 9 should be circled.

Try It! Activity 3

1. $1^2 = 1$
   $2^2 = 4$
   $3^2 = 9$
   $4^2 = 16$
   $5^2 = 25$
   $6^2 = 36$
   $7^2 = 49$
   $8^2 = 64$
   $9^2 = 81$
   $10^2 = 100$
2.



3.	a.	$2 < \sqrt{7} < 3$	$\sqrt{7}$ is between **2** and **3**
	b.	$4 < \sqrt{22} < \mathbf{5}$	$\sqrt{22}$ is between **4** and **5**
	c.	$\mathbf{3} < \sqrt{13} < \mathbf{4}$	$\sqrt{13}$ is between **3** and **4**
	d.	$\mathbf{7} < \sqrt{61} < \mathbf{8}$	$\sqrt{61}$ is between **7** and **8**
	e.	$\mathbf{8} < \sqrt{74} < \mathbf{9}$	$\sqrt{74}$ is between **8** and **9**
	f.	$\mathbf{6} < \sqrt{42} < \mathbf{7}$	$\sqrt{42}$ is between **6** and **7**
	g.	$\mathbf{2} < \sqrt{5} < \mathbf{3}$	$\sqrt{5}$ is between **2** and **3**
	h.	$\mathbf{7} < \sqrt{57} < \mathbf{8}$	$\sqrt{57}$ is between **7** and **8**
	i.	$\mathbf{5} < \sqrt{29} < \mathbf{6}$	$\sqrt{29}$ is between **5** and **6**
	j.	$\mathbf{1} < \sqrt{3} < \mathbf{2}$	$\sqrt{3}$ is between **1** and **2**
	k.	$\mathbf{5} < \sqrt{32} < \mathbf{6}$	$\sqrt{32}$ is between **5** and **6**
	l.	$\mathbf{9} < \sqrt{95} < \mathbf{10}$	$\sqrt{95}$ is between **9** and **10**

4. a. $\sqrt{7}$ is closer to 3

   b. 2.7 is the best estimate.

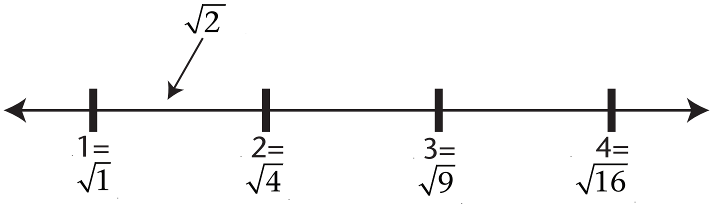
Lesson D: Calculating Square Roots

Warm-up

1. a. $\sqrt{1} = 1$
   b. $\sqrt{4} = 2$
   c. $\sqrt{9} = 3$
   d. $\sqrt{16} = 4$
   e. $\sqrt{25} = 5$
   f. $\sqrt{36} = 6$
   g. $\sqrt{49} = 7$
   h. $\sqrt{64} = 8$
   i. $\sqrt{81} = 9$
   j. $\sqrt{100} = 10$

2. a. $386^2 = 148\,996$
   b. $29.4^2 = 864.36$
   c. $1.89^2 = 3.5721$
   d. $29^2 = 841$
   e. $4.3^2 = 18.49$
   f. $1.6^2 = 2.56$

3.



$\sqrt{2}$ is between **1** and **2**

$\mathbf{1} < \sqrt{2} < \mathbf{2}$

4. a. 1.863 95 ≈ 1.864

   b. 4.217 36 ≈ 4.217

   c. 0.981 6 ≈ 0.982

   d. 93.812 493 7 ≈ 93.812

   e. 6.413 51 ≈ 6.414

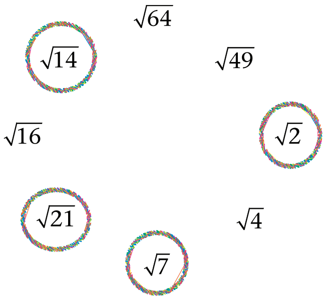
   f. 15.218 75 ≈ 15.219

   g. 36.246 203 ≈ 36.246

   h. 7.812 84 ≈ 7.813

   i. 63.512 1 ≈ 63.512

Try It! Activity 1



Try It! Activity 2

1. Your calculator probably doesn't show this many decimal places. That's ok. Check to see that the digits you have are correct.

   a. $\underline{\mathbf{1}} < \sqrt{2} < \underline{\mathbf{2}}$ $\sqrt{2} \approx 1.4142135623730950488016887242097$

   b. $\mathbf{2} < \sqrt{7} < \mathbf{3}$ $\sqrt{7} \approx 2.6457513110645905905016157536393$

c. $\mathbf{4} < \sqrt{18} < \mathbf{5}$ $\sqrt{18} \approx 4.2426406871192851464050661726291$

d. $\mathbf{9} < \sqrt{95} < \mathbf{10}$ $\sqrt{95} \approx 9.7467943448089639068384131998996$

e. $\mathbf{5} < \sqrt{34} < \mathbf{6}$ $\sqrt{34} \approx 5.8309518948453004708741528775456$

f. $\mathbf{6} < \sqrt{42} < \mathbf{7}$ $\sqrt{42} \approx 6.480740698407860230965967436088$

g. $\mathbf{5} < \sqrt{27} < \mathbf{6}$ $\sqrt{27} \approx 5.1961524227066318805823390245176$

2. Answers will vary. A possible answer: Since my calculator can only show a certain number of digits, it will never be the exact answer.

Try It! Activity 3

1. a. $\sqrt{19} = 4.359$
   b. $\sqrt{7} = 2.646$
   c. $\sqrt{24} = 4.899$
   d. $\sqrt{73} = 8.544$
   e. $\sqrt{48} = 6.928$
   f. $\sqrt{51} = 7.141$
   g. $\sqrt{11} = 3.317$
   h. $\sqrt{15} = 3.873$
   i. $\sqrt{41} = 6.403$

2. a. $\sqrt{3} = 1.73$
   b. $\sqrt{48} = 6.93$
   c. $\sqrt{33} = 5.74$
   d. $\sqrt{26} = 5.10$
   e. $\sqrt{12} = 3.46$
   f. $\sqrt{22} = 4.69$
   g. $\sqrt{55} = 7.42$
   h. $\sqrt{93} = 9.64$
   i. $\sqrt{37} = 6.08$

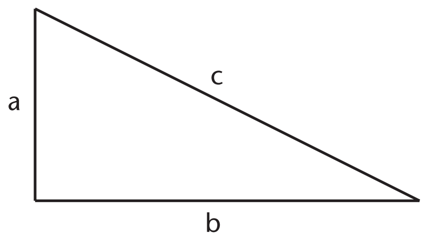
Solutions

Section 3

Pretest

Lesson A: The Pythagorean Theorem

1.



Pythagorean Theorem: $a^2 + b^2 = c^2$

Lesson B: Pythagorean Triples

2.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 1.5^2 + 2.0^2 &\overset{?}{=} 2.5^2 \\ 2.25 + 4 &\overset{?}{=} 6.25 \\ 6.25 &= 6.25 \end{aligned}$$

Yes, this triangle is a right triangle because the lengths of the sides satisfy the Pythagorean Theorem.

3. The numbers in a Pythagorean Triple must be whole numbers. The numbers 1.5, 2.0, and 2.5 do not form a Pythagorean Triple even though they satisfy the Pythagorean Theorem.

4.

$$\begin{aligned} 3^2 + 4^2 &\overset{?}{=} 7^2 \\ 9 + 16 &\overset{?}{=} 49 \\ 25 &\neq 49 \end{aligned}$$

The numbers do not satisfy the Pythagorean Theorem.

No, 3, 4, 7 is not a Pythagorean Triple.

5.

$$\begin{aligned} 9^2 + 12^2 &\overset{?}{=} 15^2 \\ 81 + 144 &\overset{?}{=} 225 \\ 225 &= 225 \end{aligned}$$

The numbers satisfy the Pythagorean Theorem.

The numbers are all whole numbers.

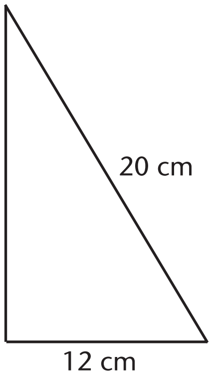
Yes, 9, 12, 15 is a Pythagorean Triple.

Lesson C: Using the Pythagorean Theorem

6.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 3.2^2 + 4.7^2 &= c^2 \\ 10.24 + 22.09 &= c^2 \\ 32.33 &= c^2 \\ \sqrt{32.33} &= \sqrt{c^2} \\ 5.7 &= c \end{aligned}$$

7.



$$\begin{aligned} a^2 + b^2 &= c^2 \\ 12^2 + b^2 &= 20^2 \\ 144 + b^2 &= 400 \\ b^2 &= 400 - 144 \\ b^2 &= 256 \\ \sqrt{b^2} &= \sqrt{256} \\ b &= 16 \end{aligned}$$

OR

$$\begin{aligned} a^2 + b^2 &= c^2 \\ a^2 + 12^2 &= 20^2 \\ a^2 + 144 &= 400 \\ a^2 &= 400 - 144 \\ a^2 &= 256 \\ \sqrt{a^2} &= \sqrt{256} \\ a &= 16 \end{aligned}$$

Lesson A: The Pythagorean Theorem

Warm-up

1. c. 3^2

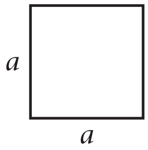
2. a. 6^2

3. Area = 5 cm × 5 cm = 25 cm^2

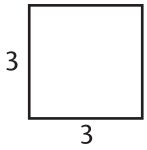
4. b. c^2

5.

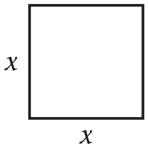
b



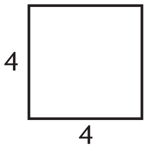
d



a



c



a. x^2

b. a^2

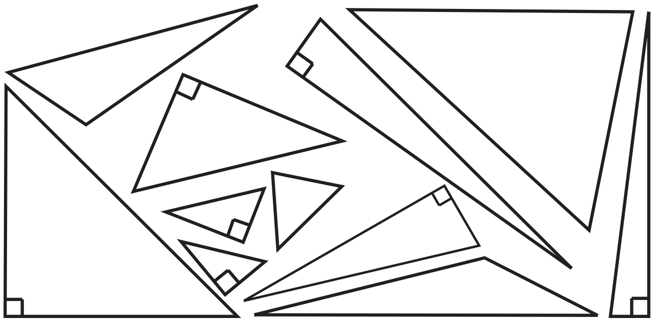
c. 4^2

d. 9

Try It! Activity 1

There are many more right angles in this picture than just the ones shown here. How many did you find?

Try It! Activity 2



Try It! Activity 3

This chart shows only a few possible solutions.

Leg	Leg	Hypotenuse
10	8	12.81
5	8	9.43
14	2	14.14
4	14	14.56
13	11	17.03
8	15	17
6	7	9.22

Although Triangle shows only a limited number of solutions, there is an infinite (yes, really!) number of correct answers to this question. However, for every line in your chart, the hypotenuse should be the longest side. The "Hypotenuse" column should be shaded in for every row in your chart.

Lesson B: Pythagorean Triples

Warm-up

1. $a^2 + b^2 = c^2$

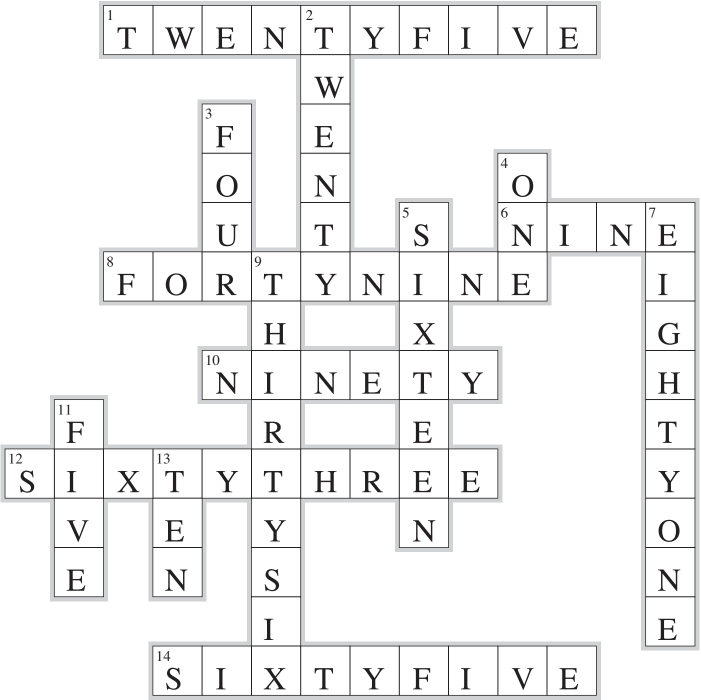
2.

[✓ 4] $\frac{1}{2}$ 7.3

5.1 [✓ 6] $\frac{1}{3}$

1.21 [✓ 23]

3.



Try It! Activity 1

To see fully worked out solutions to questions 1 and 2, go to http://media.openschool.bc.ca/osbcmedia/ma08/course/html/math08_ui.html, click on Module 2, and watch *Is It a Right Triangle*?

1.

Use the Pythagorean Theorem to check. $a^2 + b^2 = c^2$

I know the longest side is the hypotenuse.

Fill in the lengths.
Put a ? over the equals sign.

$$6^2 + 8^2 \overset{?}{=} 10^2$$

Figure out the square of each number. $36 + 64 \overset{?}{=} 100$

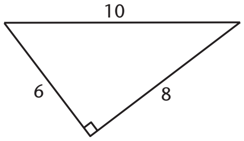
Is that true?

If it's not true, cross out the equals sign. $100 = 100$

Is this triangle a right triangle or not? Yes, this is a right triangle.

If this is a right triangle, which angle is a right angle?

Mark the right angle.



2.

Use the Pythagorean Theorem to check. $a^2 + b^2 = c^2$

Fill in the lengths.
Put a ? over the equals sign. $5^2 + 3^2 \overset{?}{=} 7^2$

Figure out the square of each number. $25 + 9 \overset{?}{=} 49$

Is that true?

If it's not true, cross out the equals sign. $34 \neq 49$

Is this triangle a right triangle or not? No, this is not a right triangle.

3.

Use the Pythagorean Theorem to check.

$$a^2 + b^2 = c^2$$

$$20^2 + 15^2 \overset{?}{=} 25^2$$

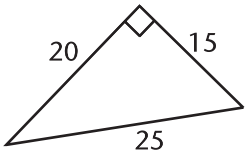
$$400 + 225 \overset{?}{=} 625$$

$$625 = 625$$

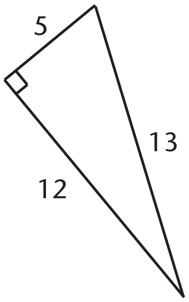
Is this triangle a right triangle or not? Yes, this is a right triangle.

If this is a right triangle, which angle is a right angle?

Mark the right angle.



4.



$$a^2 + b^2 = c^2$$

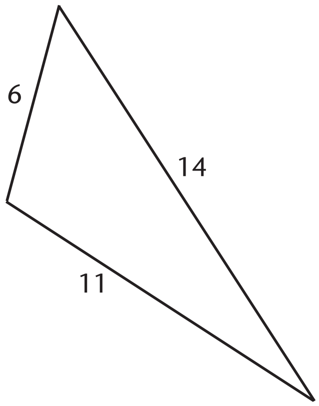
$$12^2 + 5^2 \overset{?}{=} 13^2$$

$$144 + 25 \overset{?}{=} 169$$

$$169 = 169$$

Is this triangle a right triangle or not? Yes, this is a right triangle.

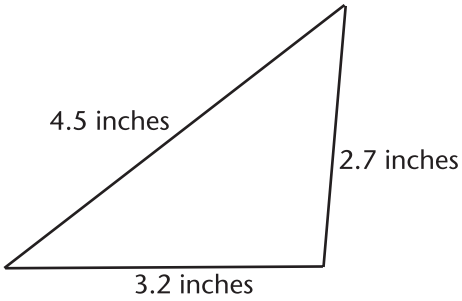
5.



$$a^2 + b^2 = c^2$$
$$6^2 + 11^2 \overset{?}{=} 14^2$$
$$36 + 121 \overset{?}{=} 196$$
$$157 \neq 196$$

Is this triangle a right triangle or not? No, this is not a right triangle.

6. a.

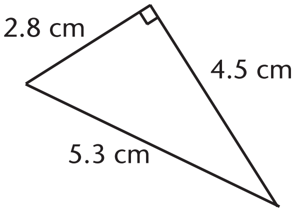


$$a^2 + b^2 = c^2$$
$$2.7^2 + 3.2^2 \overset{?}{=} 4.5^2$$
$$7.29 + 10.24 \overset{?}{=} 20.25$$
$$17.53 \neq 20.25$$

No, this is not a right triangle.

b. A hypotenuse is the longest side of a right triangle. This is not a right triangle, so this triangle does not have a hypotenuse.

7. a.



$$a^2 + b^2 = c^2$$
$$2.8^2 + 4.5^2 \overset{?}{=} 5.3^2$$
$$7.84 + 20.25 \overset{?}{=} 28.09$$
$$28.09 = 28.09$$

Yes, this is a right triangle.

b. This is a right triangle, so this triangle does have a hypotenuse. A hypotenuse is the longest side of a right triangle.

The hypotenuse is 5.3 cm long.

Try It! Activity 2

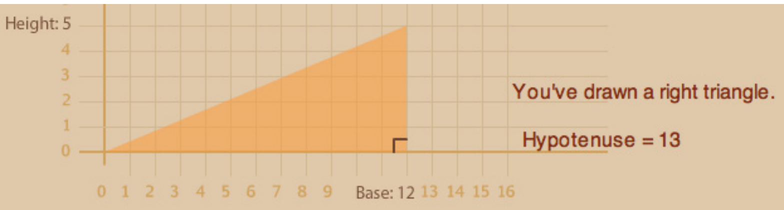
1. The triangles in questions 1, 2, 4, and 7 are right triangles, but the lengths of the sides in question 7 are not whole numbers.

   The triangles in questions 1, 2, and 4 have side lengths that form Pythagorean Triples.

   The Pythagorean Triple in question 1 is 6, 8, 10.

   The Pythagorean Triple in question 2 is 15, 20, 25.

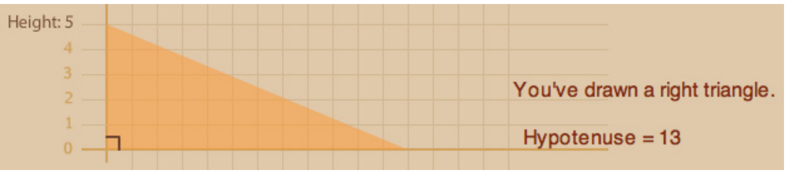
   The Pythagorean Triple in question 4 is 5, 12, 13.

2. 

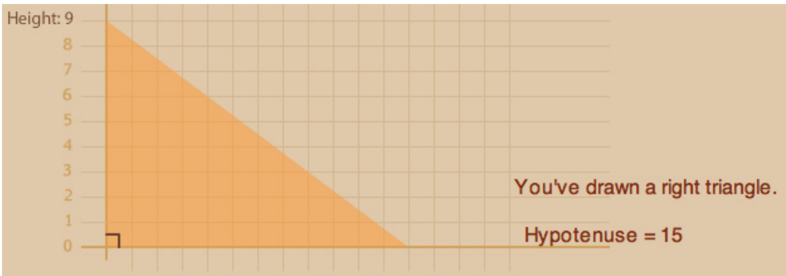
   5, 12, 13 is a Pythagorean Triple.

   Note: 3, 4, 5 is not the correct answer. The question specifies that one of the legs is 5 units long. In this triple, 5 is the hypotenuse.

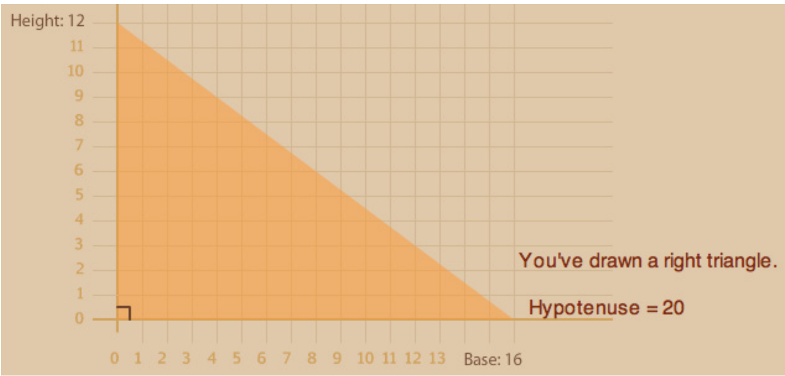
3. Your answer should include any two of these Triples.



   5, 12, 13 is a Pythagorean Triple.



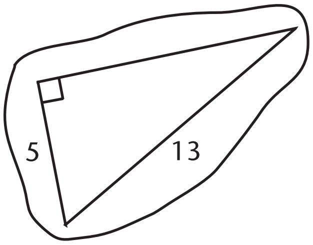
   9, 12, 15 is a Pythagorean Triple.

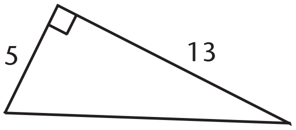


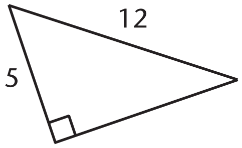
12, 16, 20 is a Pythagorean Triple.

4. a. The hypotenuse is the longest side. The length of the hypotenuse is 13.

   b.







Lesson C: Using the Pythagorean Theorem

Warm-up

1. a. $4.7^2 = 22.09$
   b. $294^2 = 86\ 436$
   c. $\sqrt{49.6} = 7.04$
   d. $\sqrt{0.25} = 0.5$
   e. $15.3^2 = 234.09$
   f. $\sqrt{885} = 29.75$

2. a. $7.04^2 = 49.6$
   b. $\sqrt{22.09} = 4.7$
   c. $\sqrt{86\ 436} = 294$
   d. $\sqrt{234.09} = 15.3$
   e. $29.75^2 = 885$
   f. $0.5^2 = 0.25$

3. a.

$$\begin{aligned} x + 2 &= 5 \\ x + 2 - 2 &= 5 - 2 \\ x &= 5 - 2 \\ x &= 3 \end{aligned}$$

b.

$$\begin{aligned} 23 + v &= 86 \\ 23 + v - 23 &= 86 - 23 \\ v &= 86 - 23 \\ v &= 63 \end{aligned}$$

c.

$$\begin{aligned} g + 153 &= 2655 \\ g + 153 - 153 &= 2655 - 153 \\ g &= 2655 - 153 \\ g &= 2502 \end{aligned}$$

d.

$$\begin{aligned} 14 + m &= 39 \\ 14 + m - 14 &= 39 - 14 \\ m &= 39 - 14 \\ m &= 25 \end{aligned}$$

e.

$$\begin{aligned} 8 + t &= 549 \\ 8 + t - 8 &= 549 - 8 \\ t &= 549 - 8 \\ t &= 541 \end{aligned}$$

f.

$$\begin{aligned} d + 350 &= 522 \\ d + 350 - 350 &= 522 - 350 \\ d &= 522 - 350 \\ d &= 172 \end{aligned}$$

4. $4 \times 4 = 16$

$(-4) \times (-4) = 16$

That means $4^2 = 16$ and $(-4)^2 = 16$

The number you are thinking of is either 4 or –4.

Try It! Activity 1

1. Answers will vary. A typical answer might be: It's possible to think of these numbers in your head. **Note**: When you have worked with square numbers for a while, they are easy to recognize.

a.

$$\begin{aligned} x^2 &= 9 \\ \sqrt{x^2} &= \sqrt{9} \\ x &= 3 \end{aligned}$$

b.

$$\begin{aligned} b^2 &= 25 \\ \sqrt{b^2} &= \sqrt{25} \\ b &= 5 \end{aligned}$$

c.

$$\begin{aligned} k^2 &= 100 \\ \sqrt{k^2} &= \sqrt{100} \\ k &= 10 \end{aligned}$$

d.

$$\begin{aligned} a^2 &= 49 \\ \sqrt{a^2} &= \sqrt{49} \\ a &= 7 \end{aligned}$$

e.

$$\begin{aligned} j^2 &= 1 \\ \sqrt{j^2} &= \sqrt{1} \\ j &= 1 \end{aligned}$$

f.

$$\begin{aligned} n^2 &= 36 \\ \sqrt{n^2} &= \sqrt{36} \\ n &= 6 \end{aligned}$$

2. a.
$$\begin{aligned} x^2 &= 10 \\ \sqrt{x^2} &= \sqrt{10} \\ x &= 3.16 \end{aligned}$$

b.
$$\begin{aligned} b^2 &= 22 \\ \sqrt{b^2} &= \sqrt{22} \\ b &= 4.69 \end{aligned}$$

c.
$$\begin{aligned} k^2 &= 107 \\ \sqrt{k^2} &= \sqrt{107} \\ k &= 10.34 \end{aligned}$$

d.
$$\begin{aligned} a^2 &= 53 \\ \sqrt{a^2} &= \sqrt{53} \\ a &= 7.28 \end{aligned}$$

e.
$$\begin{aligned} j^2 &= 8 \\ \sqrt{j^2} &= \sqrt{8} \\ j &= 2.83 \end{aligned}$$

f.
$$\begin{aligned} n^2 &= 63 \\ \sqrt{n^2} &= \sqrt{63} \\ n &= 7.94 \end{aligned}$$

Try It! Activity 2

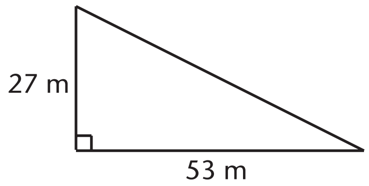
1. $a^2 + b^2 = c^2$

I know that the legs are 16 and 30. In the Pythagorean Theorem, *a* and *b* are the legs of the triangle.

$$\begin{aligned} 16^2 + 30^2 &= c^2 \\ 256^2 + 900^2 &= c^2 \\ 1156 &= c^2 \\ \sqrt{1156} &= \sqrt{c^2} \\ 34 &= c \end{aligned}$$

The length of the hypotenuse is 34 feet.

2.



I know that the legs are 27 and 53. In the Pythagorean Theorem, *a* and *b* are the legs of the triangle.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 27^2 + 53^2 &= c^2 \\ 729^2 + 2809^2 &= c^2 \\ 3538 &= c^2 \\ \sqrt{3538} &= \sqrt{c^2} \\ 59.481 &= c \end{aligned}$$

The hypotenuse is 59.5 m long.

3.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 43^2 + 34^2 &= c^2 \\ 1849^2 + 1156^2 &= c^2 \\ 3005 &= c^2 \\ \sqrt{3005} &= \sqrt{c^2} \\ 54.8 &= c \end{aligned}$$

The hypotenuse should be 54.8 cm long.

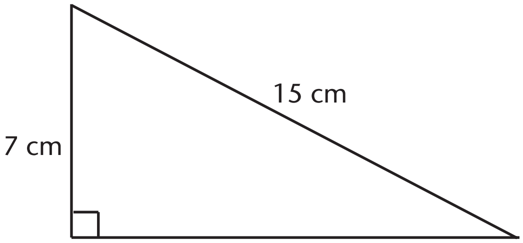
Try It! Activity 3

1.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 24^2 + b^2 &= 51^2 \\ 576 + b^2 &= 2601 \\ b^2 &= 2601 - 576 \\ b^2 &= 2025 \\ \sqrt{b^2} &= \sqrt{2025} \\ b &= 45 \end{aligned}$$

The other leg is 45 miles long.

2.



$$\begin{aligned} a^2 + b^2 &= c^2 \\ a^2 + 7^2 &= 15^2 \\ a^2 + 49 &= 225 \\ a^2 &= 176 \\ \sqrt{a^2} &= \sqrt{176} \\ a &= 13.3 \end{aligned}$$

The other leg is 13.3 cm long.

3. a. The missing side is the hypotenuse. The length of the missing side is 7.8 cm.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 5^2 + 6^2 &= c^2 \\ 25 + 36 &= c^2 \\ 61 &= c^2 \\ \sqrt{61} &= \sqrt{c^2} \\ 7.8 &= c \end{aligned}$$

The length of the missing side is 7.8 cm.

b. The missing side is a leg.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 3^2 + b^2 &= 7^2 \\ 9 + b^2 &= 49 \\ b^2 &= 49 - 9 \\ b^2 &= 40 \\ \sqrt{b^2} &= \sqrt{40} \\ b &= 6.3 \end{aligned}$$

The length of the missing side is 6.3 cm.

c. The missing side is the hypotenuse.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 3^2 + 3^2 &= c^2 \\ 9 + 9 &= c^2 \\ 18 &= c^2 \\ \sqrt{18} &= \sqrt{c^2} \\ 4.2 &= c \end{aligned}$$

The length of the missing side is 4.2 cm.

d. The missing side is the hypotenuse.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 2^2 + 2^2 &= c^2 \\ 4 + 4 &= c^2 \\ 8 &= c^2 \\ \sqrt{8} &= \sqrt{c^2} \\ 2.8 &= c \end{aligned}$$

The length of the missing side is 2.8 cm.

e. The missing side is a leg.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 4 + b^2 &= 81 \\ b^2 &= 81 - 4 \\ b^2 &= 77 \\ \sqrt{b^2} &= \sqrt{77} \\ b &= 8.8 \end{aligned}$$

The length of the missing side is 8.8 cm.

f. The missing side is a leg.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 4^2 + b^2 &= 5^2 \\ 16 + b^2 &= 25 \\ b^2 &= 25 - 16 \\ b^2 &= 9 \\ \sqrt{b^2} &= \sqrt{9} \\ b &= 3 \end{aligned}$$

Did you notice that this triangle could be solved with a Pythagorean Triple? The length of the missing side is 3 cm.

4. a.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 4^2 + 3^2 &= c^2 \\ 16 + 9 &= c^2 \\ 25 &= c^2 \\ \sqrt{25} &= \sqrt{c^2} \\ 5 &= c \end{aligned}$$

Did you see the Pythagorean Triple?
The length of the diagonal is 5 cm.

b.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 2^2 + 2^2 &= c^2 \\ 4 + 4 &= c^2 \\ 8 &= c^2 \\ \sqrt{8} &= \sqrt{c^2} \\ 2.83 &= c \end{aligned}$$

The length of the diagonal is 2.83 cm.

c.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 2^2 + 6^2 &= c^2 \\ 4 + 36 &= c^2 \\ 40 &= c^2 \\ \sqrt{40} &= \sqrt{c^2} \\ 6.32 &= c \end{aligned}$$

The length of the diagonal is 6.32 cm.

Glossary

area

Area is the number of square units that fit inside a 2-D shape.

axis (axes)

The axes are the lines that show the number scale on a graph. The x-axis is horizontal, and the y-axis is vertical. Axis is singular and axes is plural.

bar graph

A bar graph is a graph that uses vertical or horizontal rectangular bars to show the quantity being measured. The longer (or higher) the bar, the higher value it represents.

basic operations

Basic operations include addition, subtraction, multiplication, and division.

bias

Bias occurs when a particular outcome is favoured over another.

circle graph/pie chart

A circle graph or pie chart are visual representations of data amounts that together form a total amount or a single quantity.

circumference

Circumference is the distance around a circle.

coefficient

A coefficient is a number that multiplies a variable in a mathematical expression.

> For example, in the expression $3x - 7$, the number 3 is a coefficient. In the expression $\frac{x}{5} + 8$, the coefficient is $\frac{1}{5}$.

constant/constant term

A constant or constant term is a number in a mathematical expression that has no variable attached to it. The number can't be changed.

> For example, in the expression $3x - 7$, the constant is 7. In the expression $\frac{x}{5} + 8$, the constant is 8.

continuous data

Continuous data is data that is part of a set of numbers that can be infinitely divided into smaller and smaller fractions.

> For example, time or distance information can be thought of as continuous because they exist in units smaller than we can measure.

coordinates

Coordinates are a set of numbers that can be used to describe a location of a point on a coordinate plane.

coordinate plane or Cartesian plane

A coordinate plane or Cartesian plane is a rectangular area with one or more axes. The plane is designed to show data in a visual way. It is named after its inventor, René Descartes.

congruent

Congruent means “equal to.”

cross section

A cross section is a section cut from a prism or a cylinder. The cut is made parallel to the base.

cylinder

A cylinder is a three-dimensional or 3-D shape which has two circular bases that are parallel to each other and the same distance apart.

data

Data are numbers that represent measurements. Data may represent money, time, distances, or any other amounts.

degrees

Degrees are the measurement of the size of an angle or part of a circle. A full circle is 360 degrees, also written as 360°.

denominator

The denominator is the bottom number in a fraction. It represents the total number of equal parts.

> For example, in the fraction $\frac{3}{4}$ where 4 is the denominator, an object or group has been divided into 4 equal parts. (See also **numerator**.)

diameter

In a circle, the diameter is a straight line from one edge of the circle to the other, which passes through the centre of the circle.

discrete data

Discrete data is data that is grouped into separate categories, with no information existing between the categories.

distributive property

The distributive property states that if you add two numbers and then multiply the sum by another number, you'll get the same result as if you multiply each of the two numbers by the other number and then add the products.

For example, $4(2 + 5) = (4)(2) + (4)(5)$.

equation

An equation is a pair of mathematical expressions that are joined by an equals sign (=), and so they represent the same amounts. An equation is a mathematical "complete sentence".

equilateral triangle

An equilateral triangle is a triangle with three equal sides. In an equilateral triangle, all of the interior angles are 60°.

equivalent

When two things are equivalent they have the same value.

For example $\frac{1}{2}$ and $\frac{2}{4}$ are equivalent expressions

event

An event is a specific outcome from the sample set of all possible outcomes.

For example, drawing a five of hearts from a normal deck of 52 cards is an event.

expression

An expression is a mathematical phrase. An expression is made of terms. Terms are joined by the mathematical operators plus or minus (+ or –) into expressions.

For example, $5x – 7$ is a two-term expression.

extrapolate

To extrapolate means to estimate quantities or data beyond the last amounts measured; to extend a graph line beyond the last data point. (See also **interpolate**.)

favourable outome

A favourable outcome means achieving a desired result in a probability experiment.

fraction

A fraction is a number that represents part of a whole.

For example, $\frac{1}{2}$ represents one part out of a total of two parts.

graph

A graph is a visual representation of data using lines, bars, symbols, or areas.

heptagon

A heptagon is a seven-sided closed figure.

hexagon

A hexagon is a six-sided closed figure.

histogram

A histogram is a vertical bar graph.

hypotenuse

1. the side of a right triangle that is not a leg.
2. the longest side of a right triangle.
3. the side of a right triangle that is opposite the right angle.

icon

An icon is a small symbol that represents a quantity of items for a pictograph or in a graph legend. Usually a picture or line drawing of the item is used as an icon.

improper fraction

An improper fraction is a fraction where the numerator is larger than the denominator.

For example, $\frac{7}{5}$ is an improper fraction.

independent event

In a probability experiment, an independent event is when the outcome of one event does not influence or change the possible outcome of another event.

intercept

The intercept is the location where a line graph intersects an axis.

interior angles

Interior angles are angles that are inside a figure. For polygons, interior angles are at each vertex.

interpolate

To interpolate means to estimate the data amounts between data points that were measured. (See also **extrapolate**.)

interval

An interval is the amount between two values; their difference.

irregular polygon

An irregular polygon is a closed figure where all the sides are not equal and all the angles are not equal.

isosceles triangle

An isosceles triangle is one with two equal sides.

legs

Legs refer to:

1. the sides of a right triangle that form the right angle.
2. the parts of the body that the feet are attached to.

line graph

A line graph is a graph using a straight, bent, or curved line to show continuous data.

linear equation/linear relation

A linear equation or linear relation is an equation, table, description or graph that shows the relationship between two variables and forms a straight-line graph.

misinterpret

To misinterpret means to misunderstand or to gain a false impression from a conversation, picture, data or text.

misleading information

Misleading information is information (such as a graph) that is technically correct but would give most viewers an inaccurate impression.

misrepresent

To misrepresent is to present information falsely, visually or in words.

mixed number

A mixed number is a number composed of a whole number and a fraction.

For example, $2\frac{1}{3}$ is a mixed number.

model

1. To model is to create a representation of real-life data.
2. A model is the graph, map, computer program or another item that represents data.

net

A net is a two-dimensional or 2-D construction of a three-dimensional or 3-D object.

numerator

The numerator is the top number in a fraction. It represents the number of equal parts you are working with.

For example, in the fraction $\frac{3}{4}$ where 3 is the numerator, you are working with only 3 of the parts out of 4 total. (See also **denominator**.)

octagon

An octagon is an eight-sided closed figure.

operations

When we do something with a number or numbers, it is called an operation. Addition, subtraction, multiplication, and division are basic operations.

ordered pair

An ordered pair is a pair of numbers (x, y) that represent the values that satisfy a relation and also represent a location on the graph of the relation.

origin

The origin is the point (0,0) on a two-dimensional graph at which the axes intersect.

outcome

The outcome is the result of a single trial or experiment.

pentagon

A pentagon is a five-sided closed figure.

percent

A percent is a fraction of a whole, expressed as a fraction out of 100.

perfect square

A perfect square is a number that represents the area of a square whose sides are whole numbers.

For example, if a square has sides of length 3, its area is 9, and 9 is a perfect square.

It is also the result when a whole number is multiplied by itself.

For example, $5 \times 5 = 25$, and 25 is a perfect square.

perspective

Perspective is the viewer's perception, visually or psychologically.

pictograph

A pictograph is a graph that uses icons or symbols to represent the amount measured in each category, instead of using an axis to show the measurements.

pie chart

See **circle graph**.

plane

A plane is a two-dimensional or 2-D surface.

point

A point is a location on a coordinate plane which can be represented by an ordered pair (x, y).

polygon

A polygon is a closed geometric shape made of 3 or more line segments.

prism

A prism has three-dimensional or 3-D shapes that have the same cross section along a length.

proper fraction

A proper fraction is a fraction whose numerator is less than its denominator.

> For example, $\frac{2}{3}$ is a proper fraction.

probability

Probability is the chance or likelihood that a particular event will occur. Probabilities are often listed as ratios (e.g. 1:2 or 2 to 5), fractions (e.g. $\frac{3}{5}$) or percents (e.g. 15%)

proportion

A proportion is a pair of equal ratios.

Pythagorean Theorem

The Pythagorean Theorem describes the relationship among the lengths of the three sides of a right triangle: $a^2 + b^2 = c^2$

Pythagorean Triple

A Pythagorean Triple is a set of three whole numbers that satisfy the Pythagorean Theorem.

> For example, the numbers 3, 4, and 5 form one Pythagorean Triple. The first two numbers in a Pythagorean Triple are the measurements of the legs, and the third (the largest number) is the measurement of the hypotenuse.

quadrilateral

A quadrilateral is a four-sided closed figure.

radius

In a circle, the radius is the distance from the center to the edge of the circle.

random experiment

A random experiment is a a process leading to at least two outcomes with some uncertainty about which will occur.

rate

A rate is a comparison of two quantities in which each quantity is measured in different units. For example $8 per dozen roses (or $8.00/12 roses) is a rate. (See also **unit rate**.)

ratio

A ratio is a comparison of two or more numbers. Ratios are written with a ":" (e.g. 2:3), using words (e.g. 2 to 3), or as a fraction (e.g. $\frac{2}{3}$).

reciprocal

A reciprocal is a number that you multiply a fraction by so that the result equals one. If you start with a whole number, put it over 1 first. The easiest way to find it is to just flip the fraction over.

For example, the reciprocal of $\frac{4}{5}$ is $\frac{5}{4}$.

rectangular prism

A rectangular prism is a six-sided three-dimensional or 3-D shape made up of rectangles.

regular polygon

A regular polygon is a closed figure with all sides equal and all angles equal.

right angle

A right angle is an angle that measures 90°.

right triangle

A right triangle has one right angle.

round/round off

To round or round off is to remove unwanted place values at the right end of a number, adjusting the first remaining place value if necessary. (See also **truncate**.)

sample space

A sample space includes all the possible outcomes resulting from a probability experiment.

satisfy

To satisfy means to replace variables with values that make an equation into a true statement.

> For example, $y = 3x$ can be satisfied with the ordered pair (2, 6), but cannot be satisfied with (4, 9).

square root

The square root symbol tells us to take the square root of the number that's inside.

> For example, $5^2 = 25$. The square root of 25 is 5.

square root symbol

$\sqrt{}$ This symbol tells us to take the square root of the number that's inside.

> For example: $\sqrt{4} = 2$

surface area

Surface area refers to the total area of the net of a three-dimensional or 3-D object. The units are squared, for example, cm^2, m^2.

term

A term is an item in an expression that is a constant, or variable, or coefficient-and-variable combination. (See also **expression**.)

tessellation

A tessellation is a tiling pattern that covers an entire plane without overlapping or leaving gaps.

three-dimensional (3-D)

Three-dimensional refers to an object that has length, width and depth, or a representation of an object that has the appearance of depth.

triangular prism

A triangular prism is a five-sided three-dimensional or 3-D shape with two triangles that are parallel and equal to each other and joined by rectangles.

truncate

To truncate means to remove unwanted place values at the right end of a number without adjusting the remaining place value. (See also **round/round off.**)

two-dimensional (2-D)

Two-dimensional refers to an object that has length and width, but no depth.

unit rate

A unit rate is a rate where the second term is 1.

For example, wages are often given as a unit rate.

$10.00/hr represents $10.00 earned for every 1 hour worked.

unknown

An unknown is the value(s) that provide the solution to an equation. (See also **variable.**)

variable

A variable is a value that is unknown or that could change. It is often represented in an expression by a letter such as x, but could be represented by a word or other symbol. (See also **unknown**.)

vertex (vertices)

In a closed figure, the vertex refers to the point where two sides meet. Vertex is singular and vertices is plural.

view

The view refers to a two-dimensional or 2-D drawing of a three-dimensional or 3-D object from one particular position—front view, side view, top view, bottom view, etc.

volume

The volume is the amount of space an object takes up. The units are cubed, for example, cm^3, m^3.

x-axis

The *x*-axis is the horizontal axis of a coordinate plane. (See also **coordinate plane** and **axis**.)

y-axis

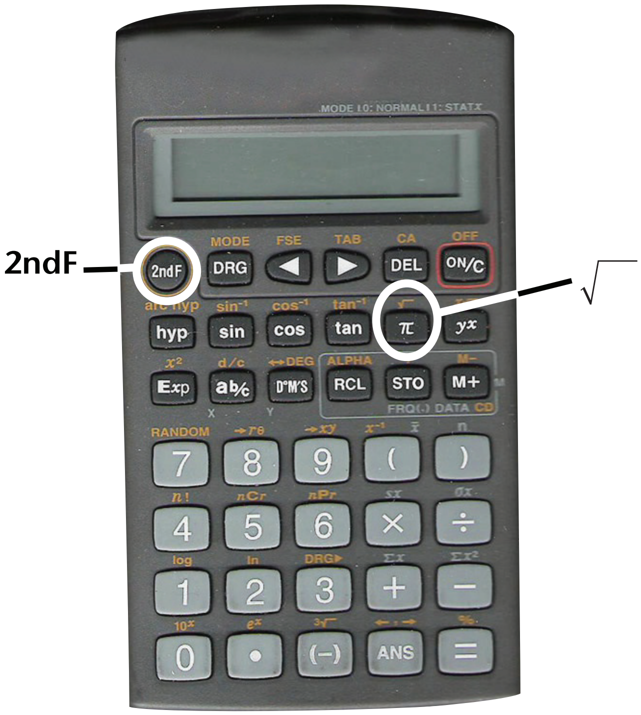
The *y*-axis is the vertical axis of a coordinate. See also **coordinate plane** and **axis**.)

Templates

Section 2 | Lesson D: Calculating Square Roots

Explore

Calculating Square Roots



Warm-up

Module 2 Project

Dissection Templates