Module 5
Version 03
Sections 1–2

Math 7

Module 5

Patterns

BRITISH COLUMBIA

OPEN SCHOOL BC

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Module 5 Table of Contents

Course Overview

Welcome to Mathematics 7!

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

Organization of the Course

The Mathematics 7 course is made up of seven modules. These modules are:

Module 1: Numbers and Operations

Module 2: Fractions, Decimals, and Percents

Module 3: Lines and Shapes

Module 4: Cartesian Plane

Module 5: Patterns

Module 6: Equations

Module 7: Statistics and Probability

Organization of the Modules

Each module has either two or 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.
Section Challenge	This is a real-world application of the concepts and skills to be learned in the section. You may want to try the problem at the beginning of the section if you're feeling confident. If you're not sure how to solve the problem right away, don't worry—you'll learn all the skills you need as you complete the lessons. We'll return to the problem at the end of the section.

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

Student Inquiry	Inquiry 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.
Practice	These are activities for you to complete to solidify your new skills. Mark these activities using the answer key at the end of the module.

At the end of each module you will find:

Resources	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 for the module.
Answer Key	This contains all of the solutions to the Pretests, Warm-ups and Practice activities.

Thinking Space

The column on the right hand side of the lesson pages is called the Thinking Space. Use this space to interact with the text using the strategies that are outlined in Module 1. Special icons in the Thinking Space will cue you to use specific strategies (see the table below). Remember, you don't have to wait for the cues—you can use this space whenever you want!

Just Think It: Questions	Write down questions you have or things you want to come back to.
Just Think It: Comments	Write down general comments about patterns or things you notice.
Just Think It: Responses	Record your thoughts and ideas or respond to a question in the text.
Sketch It Out	Draw a picture to help you understand the concept or problem.
Word Attack	Identify important words or words that you don't understand.
Making Connections	Connect what you are learning to things you already know.

More About the Pretest

There is a pretest at the beginning of each section. This pretest has questions for each lesson in the sections. 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 the key 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.

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 calculator for some of the activities and a geometry set for Module 3 and Module 7.

If you have Internet access, you might want to do some exploring online. The Math 7 Course Website will be a good starting point. Go to:

http://www.openschool.bc.ca/courses/math/math7/mod5.html

and find the lesson that you're working on. You'll find relevant links to websites with games, activities, and extra practice. Note: access to the course website is not required to complete the course.

Icons

In addition to the thinking space 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

Warm-up

Explore

Practice

Answer Key

Use a Calculator

Module 5 Overview

Does carbon in the atmosphere affect climate change? If you eat more chocolate, do you get more zits? Do people who play lots of videogames have better problem solving skills?

You may be wondering what these questions have in common, and how they're related to math. Well, they all involve patterns and relationships. Recognizing, interpreting, extending and creating patterns are all very important math skills.

In this module you'll explore some different types of patterns and relationships. You'll try some different methods for expressing patterns in order to make them easier to understand. Once you understand how a pattern works, you can begin to make predictions based on the pattern. Pretty soon you'll see how patterns are related to graphing, algebra, statistics, and many other things in the world around you.

Section 5.1: Patterns, Variables, and Expressions

Scientists, sociologists, doctors, and mathematicians spend a lot of time investigating patterns. They ask themselves (and their data) lots of questions.

Is there *really* a pattern here?

Can we describe the pattern?

Does our understanding of the pattern help us discover new information or predict future results?

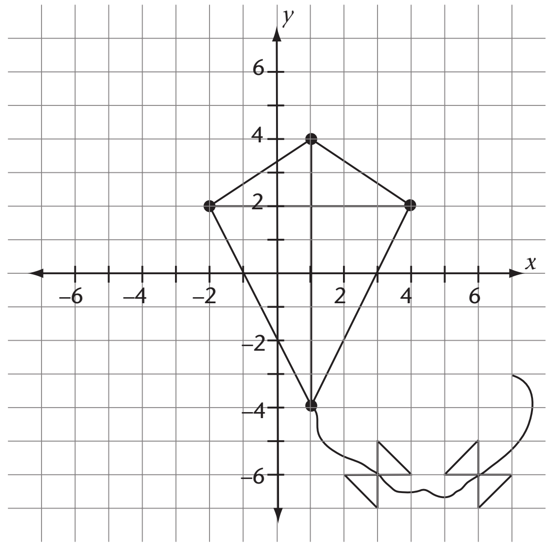
In this section you'll start looking at simple patterns and relationships between objects and numbers. You'll learn to describe patterns using the language of math. Then, you'll use your understanding of patterns to get new information, or predict future results.

Section 5.2: Graphing Linear Equations

This doesn't look like a kite.

Connect in order: (1, 4), (4, 2), (1, –4), (–2, 2), (1, 4).
Join (1, 4) to (1, –4). Join (–2, 2) to (4, 2).
Connect in order: (3, –5), (3, –7), (2, –6), (4, –6), (3, –5).
Connect in order: (6, –5), (6, –7), (7, –6), (5, –6), (6, –5).
Connect in order with a squiggly line: (1, –4), (3, –6), (6, –6), (7, –3).

But this does!



There is a pattern in that list of coordinates, but it's difficult to notice. A graph helps us to see the pattern. If we can see the pattern, we can begin to understand it. We can use our understanding of the pattern to discover new information and predict future results.

In this section you'll collect, organize, and display data. Using the tables and graphs you create, you'll look for patterns and make observations and predictions about the data you collected.

Section
1

Section 5.1: Patterns, Variables, and Expressions

Contents at a Glance

Learning Outcomes

By the end of this section you will be better able to:

- describe, in words, how a pattern is changing
- predict the next number in a pattern of numbers
- translate a mathematical expression into words
- translate an English expression into a mathematical expression
- define the terms variable, constant, coefficient, term, and expression
- substitute a value for a variable and evaluate an expression

Pretest 5.1

Complete this pretest if you think that you already have a strong grasp of the topics and concepts covered in this section. Mark your answers using the key 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 5.1A

1. Describe each pattern with words. Then continue the pattern. (1 mark each)

   a. 7, 4, 1, ______, ______

   b. 3, 6, 12, ______, ______

Lesson 5.1B

1. Match each expression to its description. (1 mark each)

a. $p + 7$	a number decreased by seven
b. $7p$	7 more than a number
c. $p - 7$	seven times a number

2. For each expression, underline each term. Then fill in the chart. For each expression, answer the following question. (0.5 mark for each blank)

	How many terms?	What are the variables?	List any coefficients.	Is there a constant term? What is it?
$3x + 4$				
$2p + 3q - 5$				
$2w$				

3. Write an expression that means: (1 mark each)

a. 2 less than a number

b. a number increased by 6

c. half of a number

Lesson 5.1C

1. Evaluate each expression for $j = 2$ and $k = 5$. (2 marks each)

a. $6 - j$

b. $4k$

c. $3j + k$

d. $2(k - 1)$

2. The price of a bag of corn is $\$1.25c$, where c represents the number of ears of corn in one bag. (2 marks each)

   a. How much does one ear of corn cost?

   b. How much does 6 ears of corn cost?

Turn to the Answer Key at the end of the Module and mark your answers.

Section Challenge

The new community centre has finally opened and everyone wants to try out the big new pool. It costs $3.00 to get in. If you buy an annual membership for $75, it only costs $1.00 each time you want to swim.

Caldon swims about twice a month. His sister, Diane goes to the pool once each week.

Is it worthwhile for Caldon to buy a membership? Is membership a bargain for Diane?

Lesson 5.1A: See a Pattern

Student Inquiry

This activity will help you get ready for, learn, and review the information in the upcoming lesson.

When you turn this page over, you will find a chart containing the inquiry outcomes for this lesson. You may be able to answer some of these questions already! Start by writing down your thoughts before the lesson.

When you finish the lesson, answer each question and give an example.

Student Inquiries	BEFORE THE LESSON	AFTER THE LESSON
	What I already know about this question:	What I thought at the end: My final answer, and examples:
Can I describe the relationship between two numbers?		answer
		example
Can I describe how a pattern of numbers is changing?		answer
		example
How do I predict the next number in a pattern of numbers?		answer
		example
What are some words that describe a pattern of numbers going up? Going down?		answer
		example

Lesson 5.1A: See a Pattern

Thinking Space

Introduction

Patterns are all around us. Maybe there's a pattern on the shirt you're wearing. Maybe there's a tile pattern on your floor. If you have ever said to someone, "I knew you were going to say that!" then you can recognize patterns in behaviours.

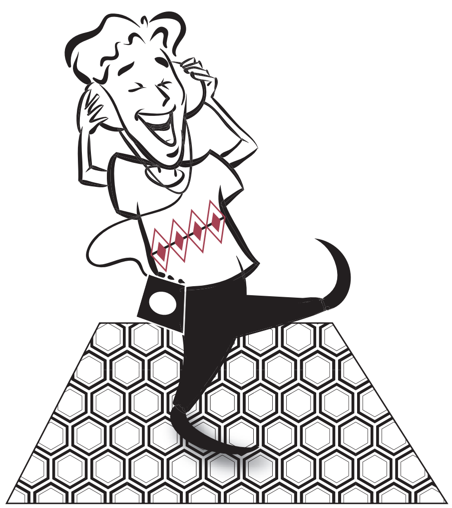
If you have ever been able to hum along with a song you're hearing for the first time, you can recognize patterns in rhythm and melody. Patterns come in many forms—behaviors, music, art, and in nature. So, what do we mean by the word pattern?

A **pattern** is a *predictable* sequence.

When you see or hear a pattern, you can predict what comes next.

When you were working on the stained glass window design for the Section Challenge for Module 4, were you able to predict what it was going to look like before you were done?

What are some other patterns you can think of?



Explore Online

Looking for more practice or just want to play some fun games? If you have internet access, go to the Math 7 website at:

http://www.openschool.bc.ca/courses/math/math7/mod5.html

Look for *Lesson 5.1A: See a Pattern* and check out some of the links!

Warm-up

Continue the patterns:

1. O, Δ, Δ, O, Δ, Δ, O, ______, ______
2. Breakfast, lunch, dinner, breakfast, lunch, ___________, ___________
3. 1, 2, 3, 4, ______, ______
4. 5, 10, 15, ______, ______
5. 10, 6, 7, 3, 4, 0, 1, -3, ______, ______

Turn to the Answer Key at the end of the Module and mark your answers.

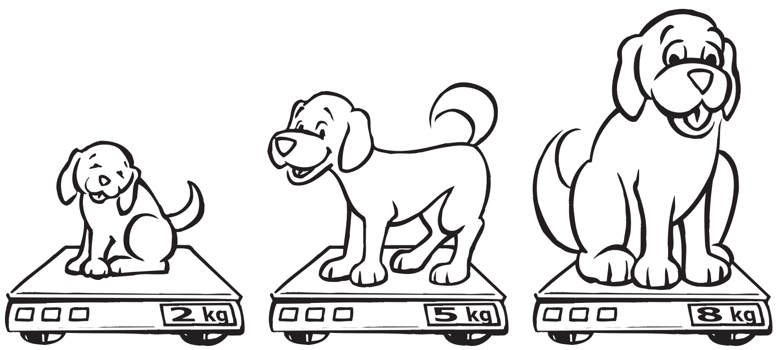
Explore

Later in this section you will learn how to describe some patterns using math. Right now, let's take a close look at the way we describe patterns and relationships using words.

Thinking Space

Example 1

Ranjot took her puppy to the vet once a month for a check-up. At each visit the puppy was weighed.



There are lots of ways to describe this pattern.

- *At each visit, the puppy weighed 3 kg more.*
- *The puppy's weight increased by 3 kg.*
- *The puppy is gaining 3 kg per month.*
- *Add 3 each time.*

Can you predict how much the puppy will weigh at the next check-up?

The puppy will probably weigh about 11 kg at the next check-up.

At the last check-up, the puppy's weight was 8 kg.

8 kg + 3 kg = 11 kg

Example 2

Thinking Space

Michael had a great garden last year and he filled up his root cellar. He hopes that his family will be able to eat garden vegetables all winter.

At the beginning of September, he had 17 baskets of carrots.

At the beginning of October, he had 13 baskets of carrots.

At the beginning of November, he had 9 baskets of carrots.

Describe this pattern.

- *The number of baskets of carrots goes down by 4 each month.*
- *Subtract 4 each time.*
- *Michael's store of carrots is decreasing by 4 baskets each month.*
- *Each time Michael counts, there are 4 fewer baskets than before.*

How many baskets of carrots can Michael expect to find at the beginning of December?

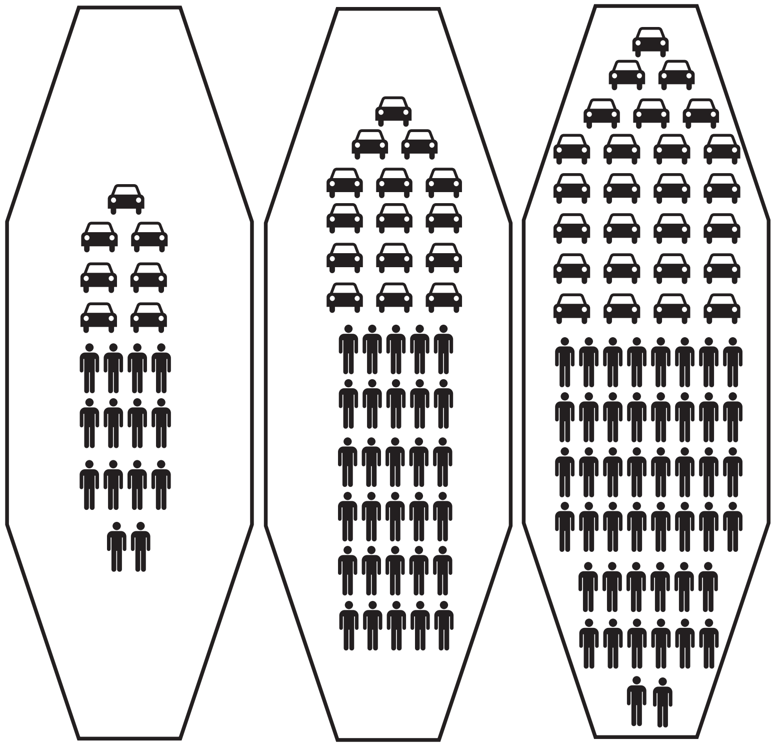
He will probably find 5 baskets at the beginning of December.

Does he have enough to get through the winter?

Thinking Space

Example 3

Gareth works on a small ferry. He has noticed this pattern on some recent trips.



Is there a connection between the number of cars and the number of people?

- *The number of cars is half the number of people.*
- *The number of cars is always less than the number of people.*
- *The number of people is more than the number of cars.*
- *There are twice as many people as cars.*

If 18 cars drove onto the ferry, how many people could you expect to see?

You could expect to see 36 people.

If you noticed 24 people on the deck, how many cars would you expect to see driving off the ferry?

You would probably see 12 cars driving off the ferry.

Look back at the different ways we described patterns of numbers. Have a look at the chart below. Can you think of any other words that describe patterns? Add them to the chart.

Thinking Space

Some words that describe patterns that go UP	Some words that describe patterns that go DOWN
more	less
increased by	goes down
gaining	decreasing
add	fewer
twice	subtract
	half

Practice 1

1. Jana is counting the number of E. coli bacteria in her sample every twenty minutes. Describe this pattern in two ways.

Results:

Time	Bacteria Count (cells per mL)
2:00	3000
2:20	6000
2:40	12,000
3:00	24,000

2. When Evan was 5 years old, his brother Tosh was 9.

   When Tosh was 17, Evan was 13.

   Can you describe this pattern in two ways?

✔ Turn to the Answer Key at the end of the Module and mark your answers.

Lesson 5.1B: Write an Expression

Student Inquiry

This activity will help you get ready for, learn, and review the information in the upcoming lesson.

When you turn this page over, you will find a chart containing the inquiry outcomes for this lesson. You may be able to answer some of these questions already! Start by writing down your thoughts before the lesson.

When you finish the lesson, answer each question and give an example.

Student Inquiries	BEFORE THE LESSON What I already know about this question:	AFTER THE LESSON What I thought at the end: My final answer, and examples:
Can I describe the meaning of a mathematical expression using words?		answer
		example
Can I turn an English expression into a mathematical expression?		answer
		example
What is a variable and how is it used?		answer
		example
What do these words mean: constant, coefficient, term, expression?		answer
		example

Lesson 5.1B: Write an Expression

Thinking Space

Introduction

We've looked at some of the ways you can use words to describe patterns of numbers.

- *four more cats*
- *four years older*
- *four kilograms heavier*
- *four centimetres taller*

Each phrase uses different words, but the pattern of the numbers in each of those situations is the same.

Now we're going to describe patterns with symbols—the symbols of math. This will let us concentrate on the pattern of the numbers without the other details of the situation.

Explore Online

Looking for more practice or just want to play some fun games? If you have internet access, go to the Math 7 website at:

http://www.openschool.bc.ca/courses/math/math7/mod5.html

Look for *Lesson 5.1B: Write an Expression* and check out some of the links!

Warm-up

Continue the patterns:

In this lesson, you will be thinking about how numbers are related to each other. You already know a lot about how numbers are related.

1. What number does each statement describe?

   a. a number that is 3 more than 9

   b. a number that is 5 less than 11

   c. a number that is half of 8

   d. This number increased by 6 is 2.

2. Darian walks 17 blocks to get to school. Teagan walks 11 blocks. Who walks farther? How much farther?

Turn to the Answer Key at the end of the Module and mark your answers.

Explore

Thinking Space

Let's look at a very simple relationship between numbers.

2	5
7	10
–2	1

The number on the right is
3 more than
the number on the left.

That sentence does a great job of describing the relationship between the pairs of numbers. For each row, that sentence is true. The specific numbers change, but that sentence still describes the relationship.

Can we do the same job with numbers and symbols?

"3 more than"—That sounds like adding 3. Let's try it. The number on the right is:

$$2 + 3$$

That works, but only for the first row. What's going on? The sentence was accurate for every row, but our numbers and symbols aren't. Isn't math supposed to be *better* at describing patterns of numbers?

Read that sentence again. *The number on the right is 3 more than the number on the left.* It doesn't say, "The number on the right is 3 more than 2." We need a symbol that will do the same job as the phrase *the number on the left.*

That's what a **variable** is for. A variable is a symbol in an expression. It is usually a letter. A variable stands for a number that might change.

Number starts with "n", so we'll use the letter n for our variable. Our variable n will be doing the same job as the phrase, *the number on the left.*

We're ready to try again. Describe the relationship using numbers and symbols. The number on the right is:

$$n + 3$$

We did it! We have expressed the idea, *3 more than the number on the left*, using only symbols.

Look at the examples below. In each case the numbers and symbols express the same idea as the descriptions that use words.

Thinking Space

$n + 3$	three more than a number
$3n$	a number multiplied by three
$n - 3$	three less than a number
$\frac{n}{3}$	a number divided by three

When you understand these examples, try the practice activity.

Practice 1

Match each description in words to the numbers and symbols that express the same idea.

$n - 6$	twice a number
$n + 3$	a number times five
$2n$	five more than a number
$n + 5$	a number decreased by six
$\frac{n}{4}$	four less than a number
$4 - n$	a number divided by four
$5n$	half of a number
$n - 4$	three more than a number
$\frac{n}{2}$	four minus a number

Turn to the Answer Key at the end of the Module and mark your answers.

Explore

The groups of numbers and symbols that we have been looking at have a name—they are called **expressions**.

Expressions have parts that are added together. Each part that is added is called a **term**. The following expression has two terms. Each term in the expression is underlined.

$$\underline{2x} + \underline{1}$$

The first term is "2x". You already know about variables. The variable here is x. The number in front of the x is called the **coefficient** of x. This term means "2 times x," even though the × is missing.

The second term is "1". There is no variable here. Nothing in this term can ever change, so we call this a **constant** term.

Let's look at one more expression before you do some practice with these new words.

$$\underline{3m} + \underline{5n} - \underline{7}$$

How many terms are in this expression? *three terms*

What are the variables in this expression? *m and n*

What are the coefficients? *3 and 5*

Let's take a close look at that last term before we answer the next question. Remember, terms are pieces of an expression that are *added* together. At the very beginning of this course, you learned that subtracting means the same as adding the negative of a number.

What is the constant? *−7*

Thinking Space

Right! So
$3m + 5n - 7$
means the same as
$3m + 5n + (-7)$.

Practice 2

1. For each expression, underline each term. Then fill in the chart. The first one has been done for you.

	How many terms?	What are the variables?	List any coefficients.	Is there a constant term? What is it?
$m + 4$	2	m	none	4
$2x - 9$				
$-3s$				
$5 + p$				
$x + 3y + 7$				
$b + 2$				
$4t$				

2. Write an expression with two terms. One term has a variable, w, and a coefficient, 7. The other term is a constant, 5.

Turn to the Answer Key at the end of the Module and mark your answers.

Explore

Thinking Space

Now you're going to write some of your own expressions.

Example 1

Remember the brothers Evan and Tosh from Lesson A? Tosh is 4 years older than Evan.

How old is Tosh when Evan is 4?

How old is Tosh when Evan is 15?

We can figure out Tosh's age by adding four to Evan's age. We need an expression that means "add four to Evan's age". You can choose any letter you like for the variable. We'll use e as a variable meaning Evan's age.

Tosh's age is: $e + 4$

We could also have written $4 + e$. The order of the terms doesn't matter.

2 + 3 means the same as 3 + 2

Example 2

Think about Evan and Tosh again. Evan's age is 4 years **less** than Tosh's age.

How old is Evan when Tosh is 13?

How old is Evan when Tosh is 35?

We can figure out Evan's age by subtracting four from Tosh's age.

Use t as a variable meaning Tosh's age. Write an expression for Evan's age.

Evan's age is: $t - 4$

Can we change the order of terms here? We must be very careful and remember that $t - 4$ actually means $t + (-4)$.

$t - 4$ and $4 - t$ do NOT have the same meaning!

3–2 is NOT the same as 2–3

Example 3

Milos likes to drive fast! Last summer when he was in Germany, he rented a sports car and drove on the Autobahn. His speed was 125 km per hour.

How far did he drive in one hour?

How far did he drive in four hours?

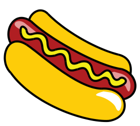
We figure out the distance by multiplying Milos' speed by the number of hours he was driving.

Use t as a variable meaning time measured in hours. Write an expression for the distance Milos travels at this speed.

$$125t$$

Another Example!

Hotdogs at the park cost $2.50 each.



How would you figure out the cost of two hotdogs?

How would you figure out the cost of seven hotdogs?

We figure out the cost of the hotdogs by multiplying the price of one hotdog by the number of hotdogs we are buying.

Use the variable h to describe the number of hotdogs we're buying. Write an expression for the cost of the hotdogs.

$$2.50h$$

Drinks at the park cost $1.25 each. Use the variable d to describe the number of drinks we're buying. Write an expression for the cost of the drinks.

$$1.25d$$

Now we can combine these expressions and write one expression to describe the total cost of the hotdogs and the drinks.

$$2.50h + 1.25d$$

Expressions like these tell the computer at the grocery checkout how to calculate your total.

Thinking Space

Leave out the × symbol. 125t still means "125 times t."

Yet Another Example!

A paintball birthday party costs $25 plus $6 for every player.

How much does a party with seven players cost?

How much does a party with twelve players cost?

You can calculate the cost of the party in two steps:

1. multiply $6 by the number of players
2. then add $25

Use p as a variable meaning the number of players. Write an expression for the cost of the party.

$$6p + 25$$

Try this!

You have $100 to spend on the party. Use the expression $6p + 25$ to figure out how many people you can invite.

Thinking Space

If you're not sure how to solve the problem, don't worry ... it's coming soon!

Practice 3

1. Augustin is 6 years younger than Maggie.

   a. Choose a variable to represent Maggie's age. Write an expression for Augustin's age.

   b. Choose a variable to represent Augustin's age. Write an expression for Maggie's age.

2. Quyen noticed that the number of bags of popcorn she sells is usually about half of the number of people in the theatre. Write an expression for the bags of popcorn she can expect to sell.

3. Write an expression for each phrase.

   a. four less than a number

   b. a number increased by three

   c. twice a number

   d. one more than twice a number

   e. two fewer than a number

   f. a number divided by five

   g. three less than twice a number

4. Write a phrase to describe each expression.

   a. $3n$

   b. $5 + n$

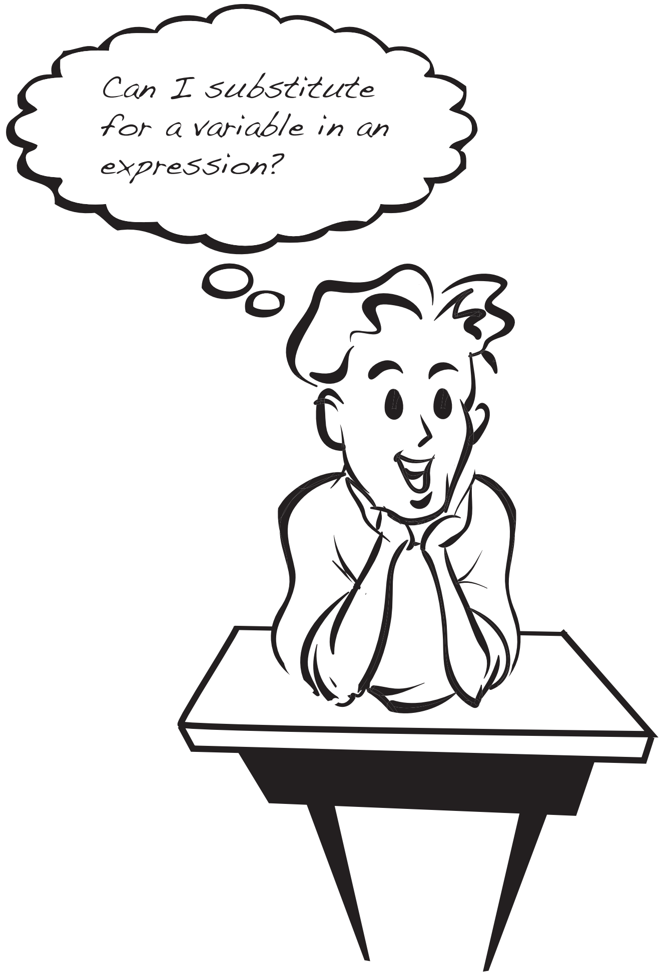
   c. $n - 2$

   d. $\frac{n}{3}$

Turn to the Answer Key at the end of the Module and mark your answers.

Lesson 5.1C: Evaluate an Expression

Student Inquiry



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When you finish the lesson, answer each question and give an example.

Student Inquiries	BEFORE THE LESSON	AFTER THE LESSON
	What I already know about this question:	What I thought at the end: My final answer, and examples:
Can I substitute for a variable in an expression?		answer
		example
After I substitute, can I evaluate an expression?		answer
		example
When I substitute and evaluate, do I present my work so that others can understand what I've done?		answer
		example

Lesson 5.1C: Evaluate an Expression

Thinking Space

Introduction

It's been a busy section so far.

We started out looking at patterns and describing those patterns with words. Then we thought about the words we used to describe the patterns. What words do we use for increasing patterns? What words do we use for decreasing patterns?

Next, we learned how variables, coefficients, and constants combine to make terms. Terms combine to make expressions.

Now we are going to use expressions—those ideas of patterns—to discover more information about the patterns and predict future results.

Explore Online

Looking for more practice or just want to play some fun games? If you have internet access, go to the Math 7 website at:

http://www.openschool.bc.ca/courses/math/math7/mod5.html

Look for *Lesson 5.1C: Evaluate an Expression* and check out some of the links!

Warm-up

We'll start with a review of what you've learned so far.

1. $2x + 5$

   a. How many terms does this expression have?

   b. What is the variable in this expression?

   c. What is the coefficient of x?

   d. Is there a constant? If yes, what is it?

2. Let j = Jim's age now

   Write an expression that means:

   a. Jim's age in 3 years

   b. 3 times Jim's age

   c. one more than 3 times Jim's age

3. Complete these questions without a calculator. Remember: (6)(2) means 6 x 2.

   a. (6)(2)

   b. 7 – 1

   c. 6 – 10

   d. 8 + 3

   e. 15 ÷ 3

   f. (4)(8)

   g. –3 + 9

   h. 5(7)

   i. 16 ÷ 2

   j. –2 + 6

   k. 21 ÷ 7

   l. 5 + 9

   m. $\frac{1}{2}(10)$

   n. 12 ÷ 4

   o. 4 – 9

   p. (9)(3)

   q. –1 + 3

   r. $\frac{1}{3}(12)$

   s. 20(6)

   t. –5 – 6

Turn to the Answer Key at the end of the Module and mark your answers.

Explore

Thinking Space

When the idea of a pattern is written as an expression, we can use it to find out anything we like about the pattern.

One way to learn more about the pattern is to find the value of the expression for a specific value of the variable. Finding the value of an expression once we know the value of the variable is called **evaluating** the expression.

Evaluate the expression **4*t* + 3** when $t = 2$.	$4t + 3$
First, replace the *t* with brackets.	$4(\quad) + 3$
Fill-in the value for *t*. In this question, $t = 2$.	$\underline{4(2)} + \underline{3}$
Now we work it out. If you don't know what to do first, underline the terms.	$4(2) + 3$
The first term tells us to multiply. Do that.	$= 8 + 3$
Now the first term is 8. There is nothing to do there.	
The second term is 3—nothing to do there either.	
Each term has been evaluated. Now we can combine the terms.	$= 11$
Your finished work should look like this:	$4(2) + 3$ $= 8 + 3$ $= 11$

Try this one:

What is the value of $2p + 1$ when $p = -3$?

First, substitute with brackets.	$2(-3) + 1$
Second, evaluate each term.	$= -6 + 1$
Finally, combine terms.	$= -5$

Thinking Space

We'll do one more together. This time there are two variables. What is the value of $4m + 5n - 7$ when $m = 6$ and $n = 2$?

First, substitute with brackets.	$4(6) + 5(2) - 7$
Second, evaluate each term.	$= 24 + 10 - 7$
Finally, combine terms.	$= 34 - 7$ $= 27$

Evaluating expressions isn't just part of math homework. Dr. John Current evaluates expressions all the time.

Doctors often need to know the surface area of a person's body. This helps them figure out how much fluid the body needs and the dosages of certain medications. You know how to calculate the area of squares, triangles, and many other shapes. However, the surface of your body is a much more complicated shape. The calculations are also complicated. Unfortunately, the calculations are often inaccurate for babies and very young children.

Dr. John Current realized that there was a simple relationship between the surface area of a baby's skin and the baby's weight. The surface area of a baby is an expression that uses a variable, w, for the baby's weight (in grams). The body surface area (in cm^2) is:

$$1321 + 0.3433w$$

When Dr. Current needs to know the BSA (body surface area) for a baby that weighs 6000 g, he evaluates his formula.

First, he substitutes with brackets.	$1321 + 0.3433(6000)$
Second, he evaluates each term.	$= 1321 + 2059.8$
Finally, he combines terms.	$= 3380.8$

Practice 1

Work neatly in the space provided or on a separate sheet of paper.

Remember the steps:

> **First, substitute with brackets.**
> **Second, evaluate each term.**
> **Finally, combine terms.**

1. What is the value of each expression when $b = 4$?

   a. $b - 7$

   d. $3b - 4$

   b. $3 + 2b$

   e. $6b$

   c. $6 + b$

   f. $9 - 5b$

2. Evaluate the expression $4 + 2n$ for each value of n.

   a. $n = 3$

b. $n = 5$

c. $n = 0$

d. $n = 2.3$

e. $n = \frac{3}{4}$

3. Find the value of each expression for $f = 3$, $g = -2$, and $h = 1$.

a. $f + 2h$

b. $g + h + 4$

c. $2f - 3h$

d. $-8f + 4h - 3$

e. $g + 5h + 6.8$

4. Evaluate $3p - 2q$.

a. $p = 3.4$, $q = 4$

b. $p = 7$, $q = 5.6$

c. $p = 1.4$, $q = 2.1$

5. This expression represents the cost of hotdogs and drinks at the park: $2.50h + 1.25d$.

   The variable h represents the number of hotdogs. The variable d represents the number of drinks. What is the total cost of five hotdogs and three drinks? Remember to show your steps.

Turn to the Answer Key at the end of the Module and mark your answers.

Section Summary

The next time you read a magazine or listen to the radio, try to notice patterns. Is your favourite song moving up the charts or down? Is there a trend in the weather? Has the price of oil reached a new high? How does attendance at the local fair compare with last year? Did Olympic athletes break new records?

Think about a definition for each of these new words. Look in the Glossary if you need some help.

- expression
- term
- coefficient
- constant
- variable

Section Challenge

Have you been able to figure out if Caldon and Diane should buy pool memberships? Review the challenge problem below. Then answer the questions on the next page for some hints on solving this problem.

The new community centre has finally opened and everyone wants to try out the big new pool. It costs $3.00 to get in. If you buy an annual membership for $75, it only costs $1.00 each time you want to swim.

Caldon swims about twice a month. His sister, Diane goes to the pool once each week.

Is it worthwhile for Caldon to buy a membership? Is membership a bargain for Diane?

Work neatly on a separate sheet of paper.

1. Without a membership, it costs $3.00 for each swim at the pool. Choose your own variable. Write an expression for the cost of swimming without a membership.

2. If you buy an annual membership for $75, it costs $1 each time you want to swim. Choose your own variable. Write an expression for the cost of swimming with a membership. (Look at the example of the paintball party in Lesson B if you want help thinking about this.)

3. Caldon swims about twice a month. There are 12 months in a year, so Caldon swims about 24 times in a year.

   a. Use your expression from Question 1. How much does it cost Caldon to swim for a year without a membership?

   b. Use your expression from Question 2. How much does it cost Caldon to swim for a year with a membership?

   c. Would it be cheaper for Caldon to buy a membership?

4. Diane goes to the pool once each week. There are 52 weeks in a year, so Diane swims about 52 times in a year.

   a. Use your expression from Question 1. How much does it cost Diane to swim for a year without a membership?

   b. Use your expression from Question 2. How much does it cost Diane to swim for a year with a membership?

   c. Would it be cheaper for Diane to buy a membership?

Section 5.2: Graphing Linear Equations

Section 2

Contents at a Glance

Learning Outcomes

By the end of this section you will be better able to:

- collect data and organize it in a chart
- create a table of values from data
- plot points on a graph using data from a table of values
- define the terms interpolation, extrapolation, and linear relation
- create a table of values using an expression
- compare and contrast the characteristics of an expression and a graph
- describe the pattern shown on a graph
- use interpolation and extrapolation answer questions about data in a graph

Pretest 5.2

Complete this pretest if you think that you already have a strong grasp of the topics and concepts covered in this section. Mark your answers using the key 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.

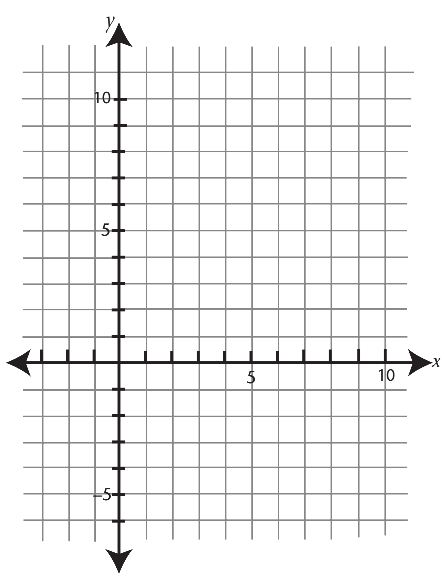
There are no pre-test questions from Lesson A.

Lesson 5.2B

1. a. Complete the table of values. (3 marks)

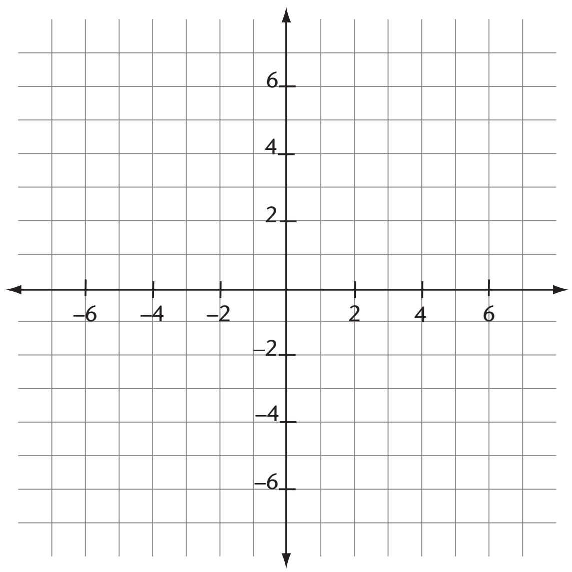
n	$3n + 2$
0	
1	
3	

b. Graph this linear relation. (3 marks)

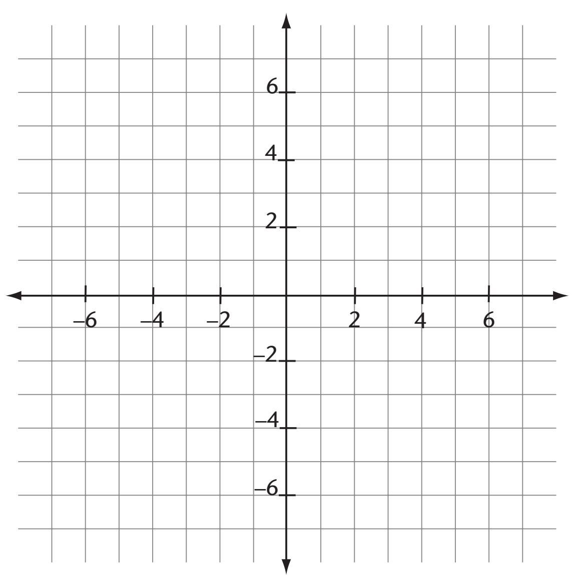


2. Draw a graph for each expression. Plot four points for each graph. (4 marks each)

a. $n - 4$



b. $2n - 2$

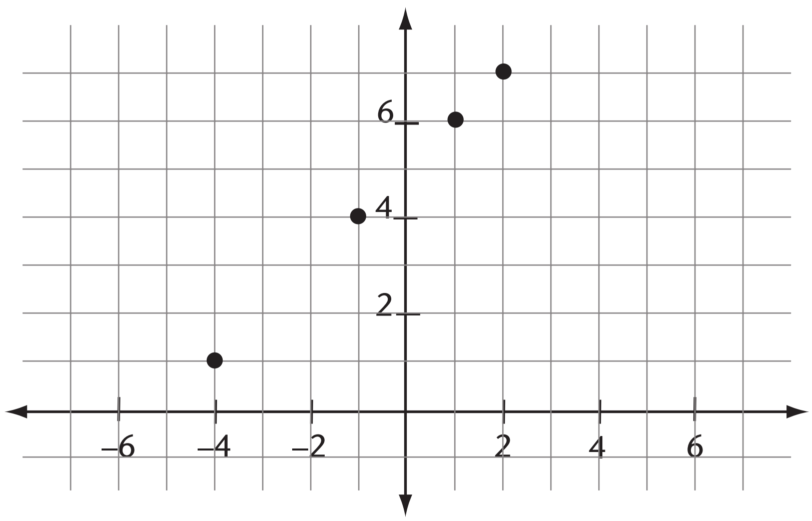


3. Use your graphs from question 2 to answer the following questions: (1 mark each)

   a. When the expression $n - 4$ equals -5, what does n equal?

   b. When the expression $2n - 2$ equals 8, what does n equal?

4. Choose the expression that matches the graph. (2 marks)



   a. $5n$

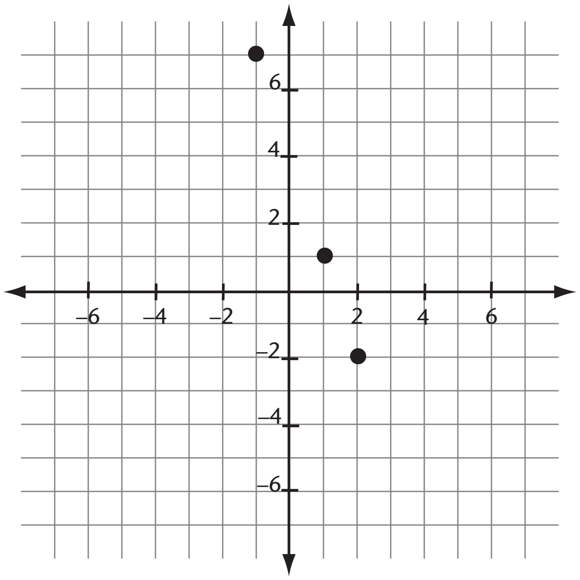
   b. $n - 5$

   c. $n + 5$

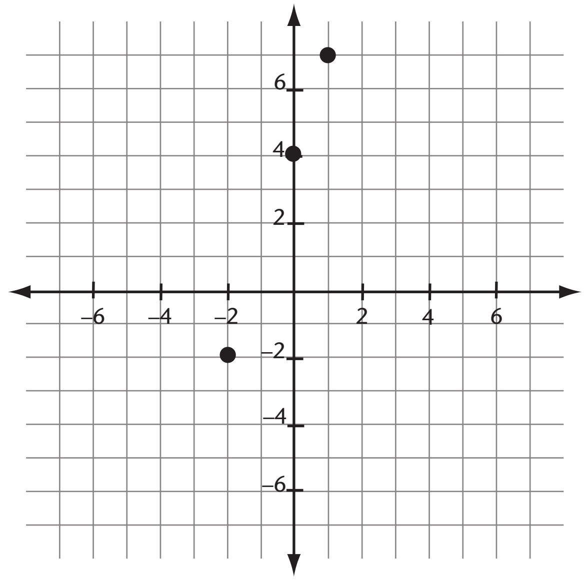
   d. $5 - n$

5. Choose the graph that matches the expression, $3n + 4$. (2 marks)

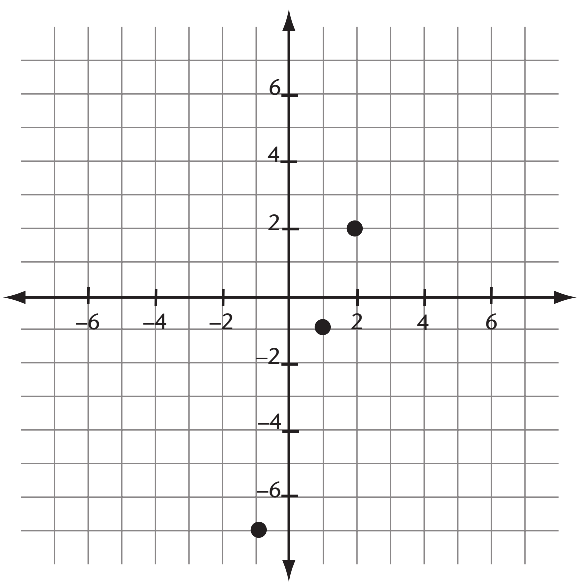
a.



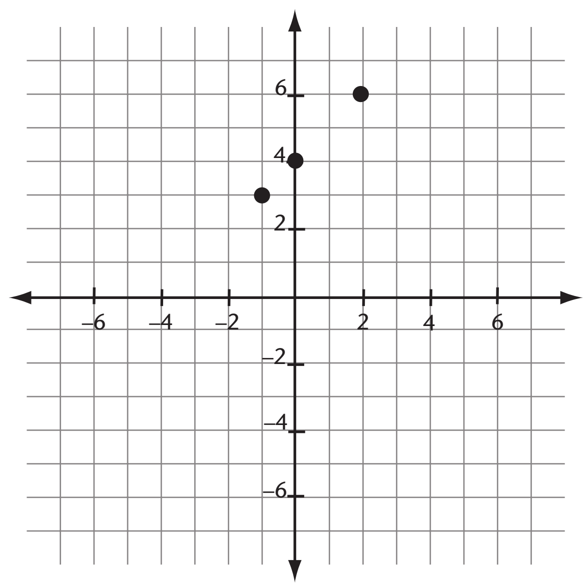
b.



c.

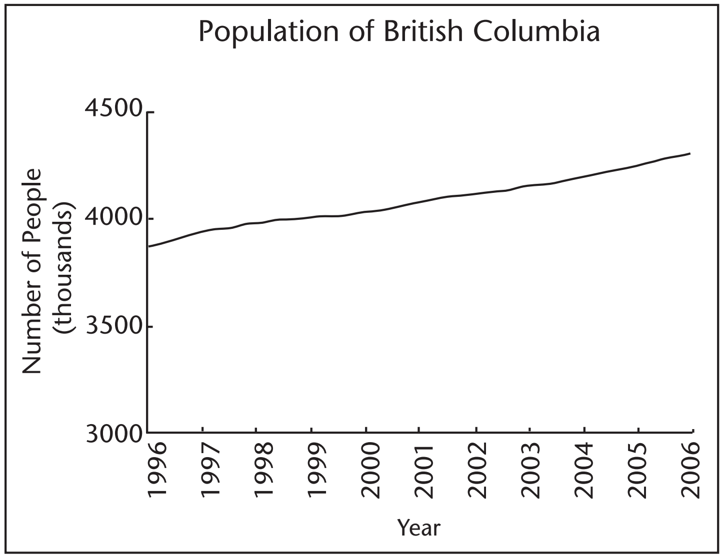


d.



Lesson 5.2C

This graph shows the population of BC from 1996 to 2006.



1. Describe in words how the population of BC has changed in that time. (2 marks)

2. What was the approximate population of BC in 2001? (2 marks)

3. What do you think the population will be in 2010? (2 marks)

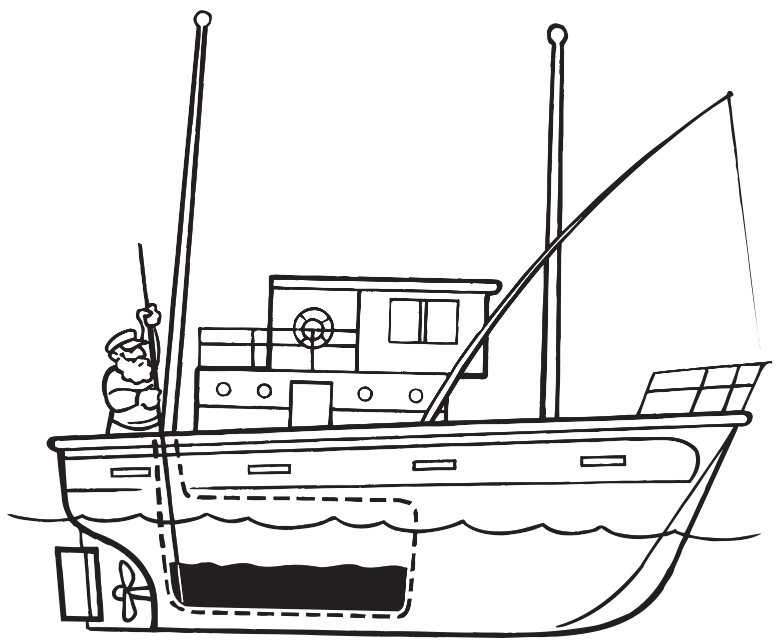
Turn to the Answer Key at the end of the Module and mark your answers.

Section Challenge

Norm bought an antique fish boat last spring. Old fish boats don't have fuel gauges. Instead, Norm dips a stick into the fuel tank to check if his tank is getting low.

The stick is called a dipstick. Using the dipstick to check the level of the fuel tank is called "dipping the tank."

The first time Norm dipped the tank, the level of the fuel tank was 10 cm. It's a good thing he was near the fuel dock; his tank was almost empty! It took 875 litres of fuel to fill the tank.



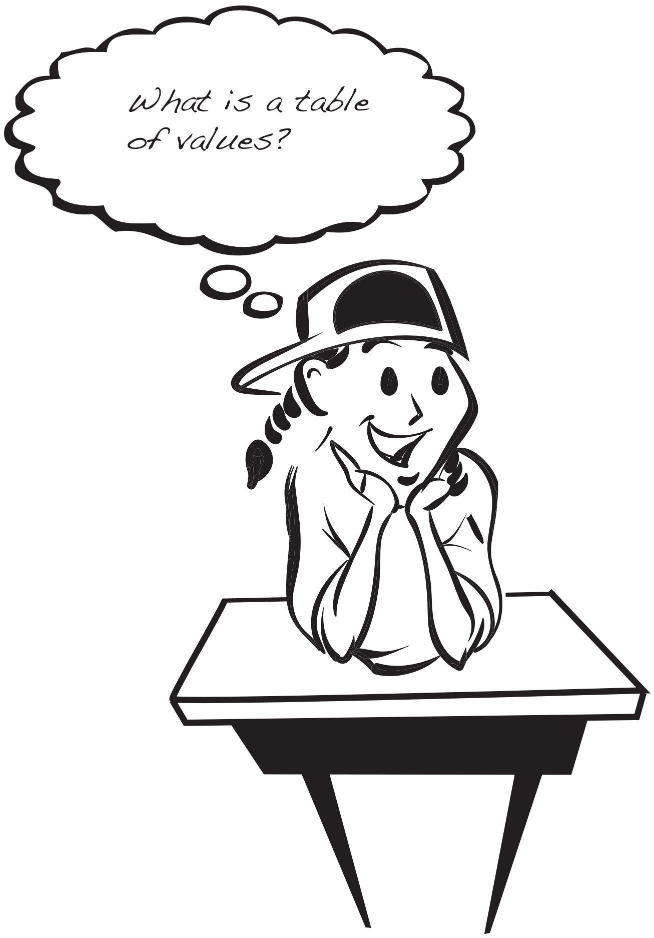
The next time he dipped the tank, the dipstick showed a level of 70 cm. The attendant at the fuel dock charged him for 125 litres.

The third time that Norm bought fuel, he paid for 375 litres after the dipstick showed a level of 50 cm.

Can you help Norm figure out how much fuel he used on his last trip? Before he left, the dipstick showed a level of 65 cm. He dipped the tank when he got back, and the level was 40 cm.

Lesson 5.2A: Tower of Toilet Paper

Student Inquiry



This activity will help you get ready for, learn, and review the information in the upcoming lesson.

When you turn this page over, you will find a chart containing the inquiry outcomes for this lesson. You may be able to answer some of these questions already! Start by writing down your thoughts before the lesson.

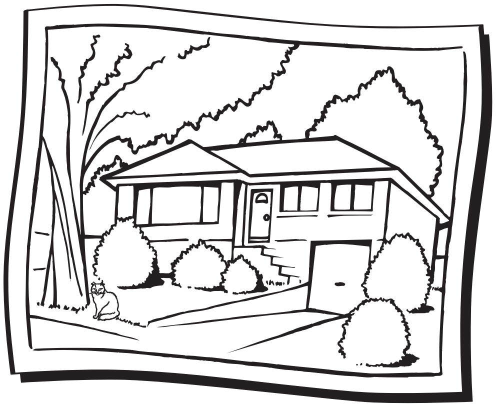
When you finish the lesson, answer each question and give an example.

Student Inquiries	BEFORE THE LESSON	AFTER THE LESSON
	What I already know about this question:	What I thought at the end: My final answer, and examples:
Can I collect data and organize it in a chart? What is a table of values?		answer
		example
How do I figure out how much of the Cartesian plane to use when I'm drawing a graph?		answer
		example
How do I plot points on a graph using data from a table of values?		answer
		example
What does interpolation mean?		answer
		example
What does extrapolation mean?		answer
		example

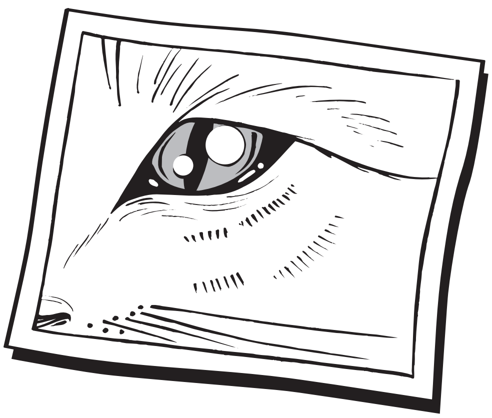
Lesson 5.2A: Tower of Toilet Paper

Thinking Space

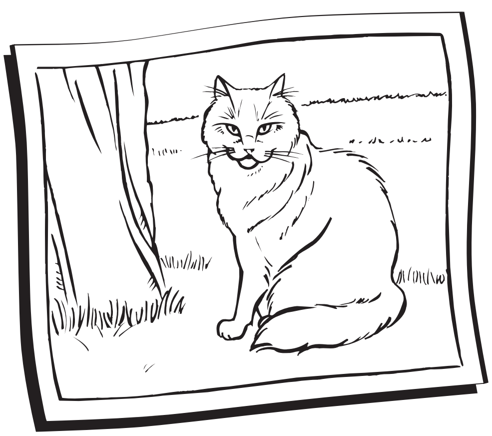
Introduction



Look at this picture of Whiskers, the cat. Whiskers is in the picture, but we can't really see him very well. We're zoomed out too far.



This is also a picture of Whiskers,but we're WAY too close.

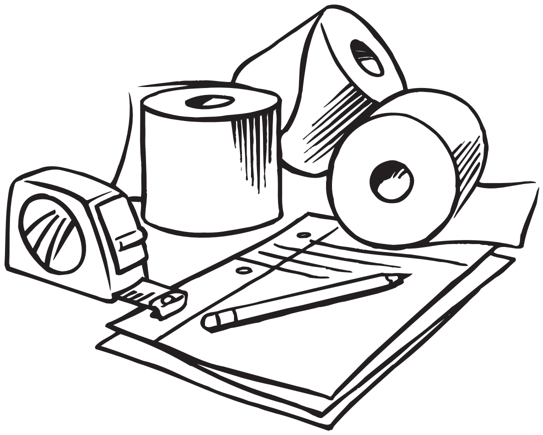


This is more like it.

We can see all of Whiskers and a little bit of his surroundings. Nice picture!

We need to think about the same kinds of things when we use the Cartesian plane to display a picture of data. We need to be zoomed in just right.

Before we can get started, you should go and gather all the supplies you'll need for this lesson.



- 7 rolls of toilet paper
- a measuring tape marked in centimetres
- graph paper
- paper
- pencil

Warm-up

Practise plotting some points to get ready for making the graph in this lesson.

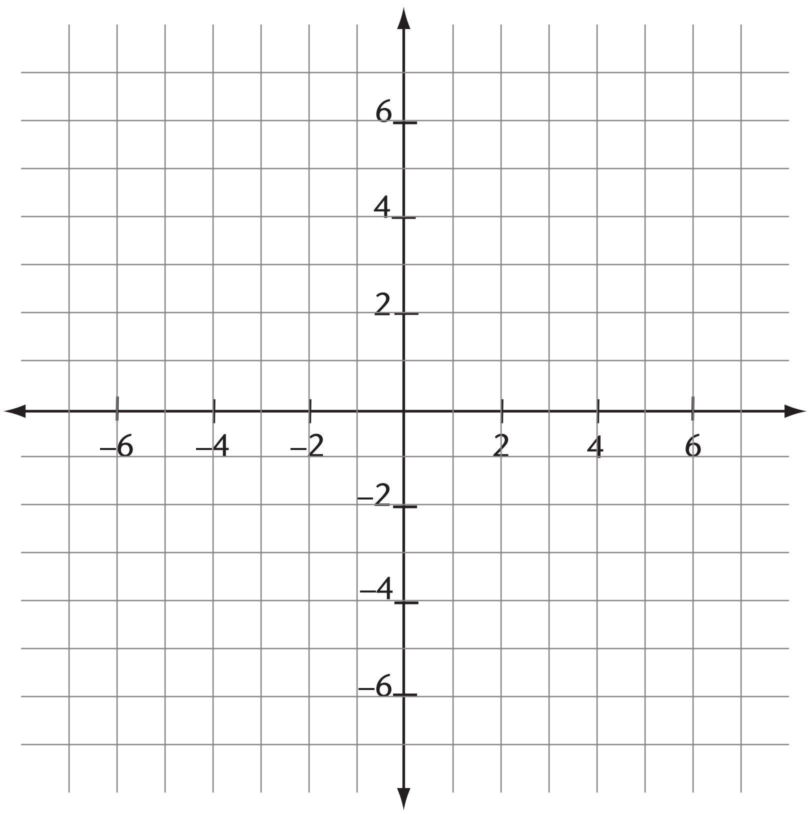
Plot and label these points on the graph below.

A(–4, –2)

B(–1, 0)

C(2, 2)

D(5, 4)



Turn to the Answer Key at the end of the Module and mark your answers.

Thinking Space

We did this in Module 4.

Explore

Thinking Space

Let's do an activity!

You're going to be measuring the height of towers of toilet paper. You'll need a way to record the information you're collecting. A good way to collect information is to create a **table of values** like this:

number of rolls of toilet paper	height of tower (cm)

You should create your own table of values on a piece of paper. Now follow the instructions below.

1. Make a tower of toilet paper two rolls high.

2. Measure the height of the tower in centimetres and record the measurement in your table of values. An example is shown below:

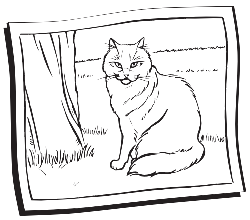
number of rolls of toilet paper	height of tower (cm)
2	21 cm
	*your measurement might be different

3. Make a tower of toilet paper four rolls high. Measure its height and record the measurement in your table of values.

4. Make a tower of toilet paper six rolls high. Measure its height and record the data in your table of values.

Thinking Space

This isn't a very complicated pattern. You probably know quite a lot about what is going on in this situation already. However, it's nice to learn new techniques with easy situations first. Then we can use the new technique on more difficult data.



Now, we're going to make a picture of our data. The Cartesian plane is an excellent tool for this job, but we need to make sure that we're zoomed in just right. Just like with the pictures of Whiskers the cat, if we're zoomed out too far we can't see any details. If we're too close, we can't see the whole picture.

I remember Whiskers from the Introduction.

Which numbers should the x-axis include? The x-coordinate will show the number of rolls of toilet paper in the towers. Negative numbers don't make any sense in this experiment. We can safely start the x-axis at 0. Your tallest tower was 6 rolls high, but we don't want to be zoomed in too close. Let's make the x-axis go up to 8. We'll need to see every number (1, 2, 3, …), but they can be spread out across the page.

Can you have −3 rolls of toilet paper in a tower?

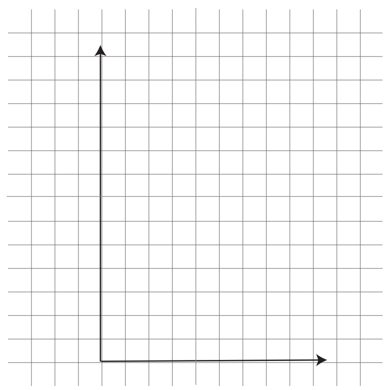
What about the y-axis? The y-coordinate will be the height of each tower. Negative numbers don't make any sense here either. We can start at 0. Your tallest tower was probably close to 60 cm or so. Let your y-axis go up to 80. We don't need to see every number here. Labelling the axis every 5 cm (5, 10, 15, …) will do.

Draw and label axes on your graph paper.

We have gathered data.

number of rolls of toilet paper	height of tower (cm)
2	21 cm
4	
6	
8	

We have framed the picture.

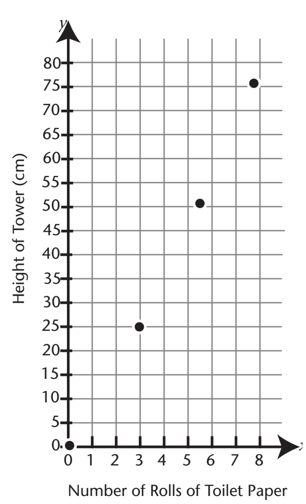


Now we can draw the picture of our data. That just means we're going to plot some points. The first row of data on your chart will be your first point. The x-coordinate is the number of rolls of toilet paper. The y-coordinate is the height of the tower.

Plot the points that go with your other towers of toilet paper.

You know that a tower of 0 rolls of toilet paper will be 0 cm high. Add this information to your table of values. Plot a point at the origin.

Your graph should look something like this:



Thinking Space

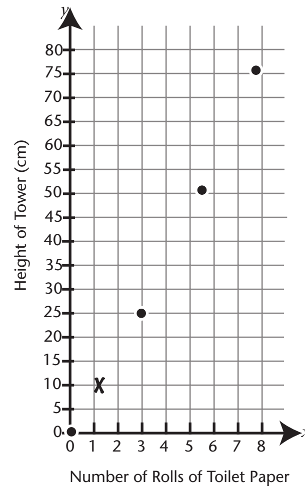
We're only using Quadrant I of the Cartesian Plane.

Remember: your data is different, so your graph might look a bit different.

Thinking Space

It's a picture of the data you collected. It very clearly communicates the relationship between the number of toilet paper rolls in the tower and the height of the tower.

Can you use your graph to guess the height of one roll of toilet paper? Mark your guess on *your* graph with an "x". An example is shown below.



Check your guess. Measure the height of one roll of toilet paper. Record the measurement on your chart. Plot the point on your graph. Were you close? Making a guess by looking between two points on your graph is called **interpolating**.

Use your graph to guess the height of seven rolls of toilet paper. Mark your guess on the graph, then check your guess. Making a guess by looking past the end of your data is called **extrapolating**.

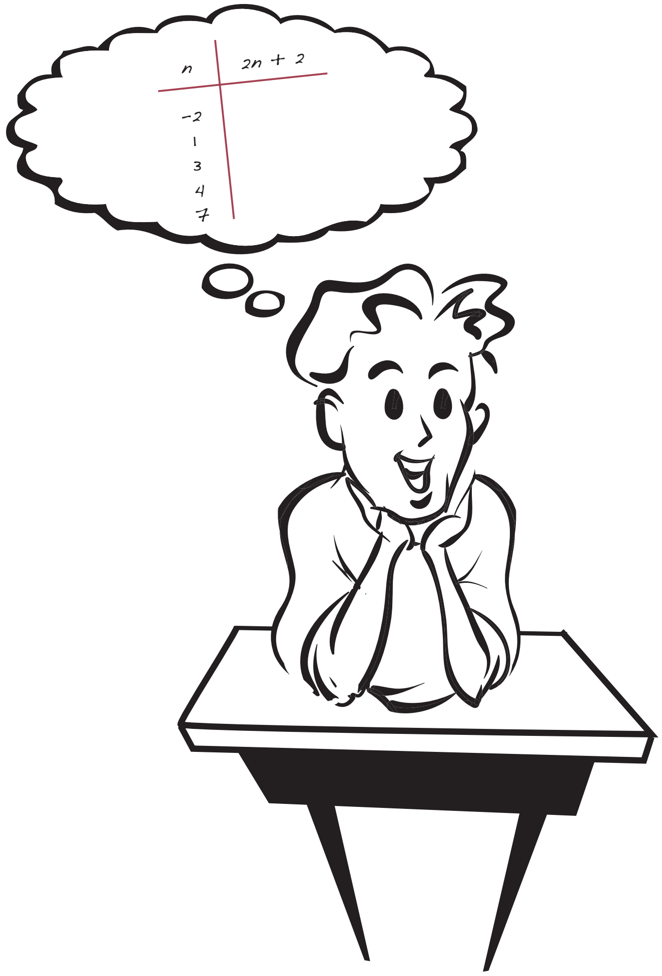
!

Interior means inside. **Int**erpolate means to look inside the data.

Exterior means outside. **Ext**rapolate means to look outside the data.

Lesson 5.2B: Graphing an Expression

Student Inquiry



This activity will help you get ready for, learn, and review the information in the upcoming lesson.

When you turn this page over, you will find a chart containing the inquiry outcomes for this lesson. You may be able to answer some of these questions already! Start by writing down your thoughts before the lesson.

When you finish the lesson, answer each question and give an example.

Student Inquiries	BEFORE THE LESSON What I already know about this question:	AFTER THE LESSON What I thought at the end: My final answer, and examples:
How do I create a table of values using an expression?		answer
		example
How do I make a graph of an expression?		answer
		example
What is a linear relation?		answer
		example
How is an expression and a graph the same? How are they different?		answer
		example

Lesson 5.2B: Graphing an Expression

Thinking Space

Introduction

Once we have written the idea of a pattern as an expression, we can learn anything we like about the pattern. We can evaluate the expression for any value of the variable. However, it would be a lot of work to evaluate an expression for many different values of the variable.

With a graph, we can see a picture of the pattern. We can understand what is going on everywhere in the pattern all at once.

Explore Online

Looking for more practice or just want to play some fun games? If you have internet access, go to the Math 7 website at:

http://www.openschool.bc.ca/courses/math/math7/mod5.html

Look for *Lesson 5.2B: Graphing an Expression* and check out some of the links!

Warm-up

You will be using your skills with graphs and evaluating expressions in this lesson. Here's a little practice before we get started.

Evaluate each expression for $j = 2$ and $k = 1$.

1. a. $3j + 5$

2. b. $6k - 2$

3. c. $5j$

4. d. $j + 2k + 3$

Turn to the Answer Key at the end of the Module and mark your answers.

Explore

Thinking Space

If we want to understand the expression $2n + 3$, we could make a graph. A good place to start is to make a table of values. First, choose some values for n. (Some values for n have already been chosen for you and written in the table of values.)

n	$2n + 2$
–2	
1	
3	
4	
7	

Now, evaluate the expression for each value of n. Record your answers in the table of values.

n	$2n + 2$
–2	–1
1	5
3	9
4	11
7	17

We will use the horizontal axis (the x-axis) to represent values of the variable, n. We will use the vertical axis (the y-axis) to represent values of the expression, $2n + 2$.

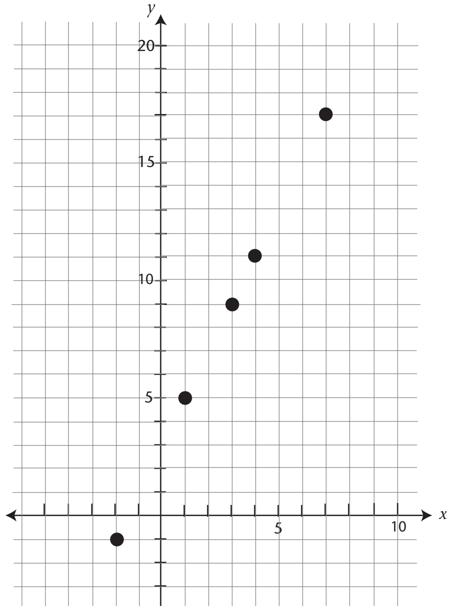
Think about how long the axes should be. If the x-axis goes from –5 to 10 and the y-axis goes from –5 to 20, we should have lots of room to display our data. Make the axes on your graph paper.

When $n = –2$, the value of the expression is –1. So, the first point to plot is (–2, –1). You can think of these numbers as a question and an answer. If you ask, "What happens when $n = –2$?" the expression answers, "–1."

Plot the next two points. Their coordinates are (1, 5) and (3, 9).

Put a ruler or the edge of a piece of paper along the points on your graph. Do you notice something?

Plot the rest of the points. All of the points lie in a straight line. The picture of the relationship between 'n' and '$2n + 3$' forms a straight line. We say that $2n + 3$ is a **linear** relation.



Thinking Space

Does your graph look like this one?

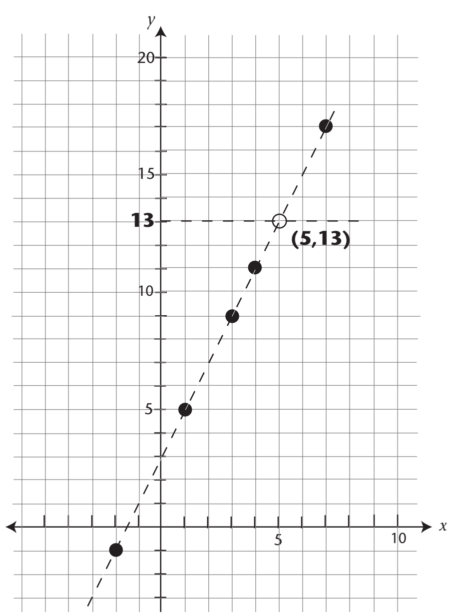
It is easy to interpolate and extrapolate from the graph of a linear relation (a graph that forms a straight line). We *know* where all of the other points are going to be.

You can use your graph to help answer questions about the expression.

> When the expression $2n + 3$ equals 13,
> what is the value of n?

The first coordinate is the value of n. That's the part we don't know. The second coordinate is the value of the expression. For this question, the value of the expression is equal to 13. So, we're looking for a point whose coordinates are (__ , 13).

There is only one point that is in line with our other points AND has coordinates (__ , 13). It is (5, 13).



Thinking Space

When the expression $2n + 3$ equals 13, the value of n is 5.

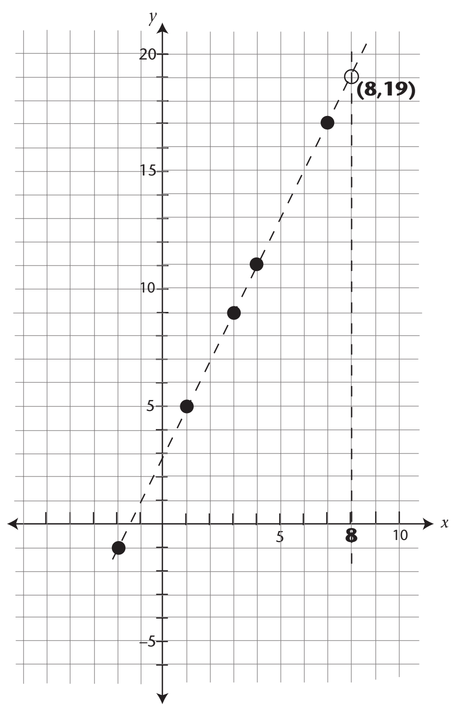
Let's check our work by evaluating the expression for the value $n = 5$.

First, substitute with brackets.	$2(5) + 3$
Second, evaluate each term.	$= 10 + 3$
Finally, combine terms.	$= 13$

The answer is 13, just as we expected.

When $n = 8$,
what is the value of the expression?

Look for a point that is in line with the other points AND has coordinates (8, __).



The point we're looking for is (8, 19). When $n = 8$, the value of the expression is 19.

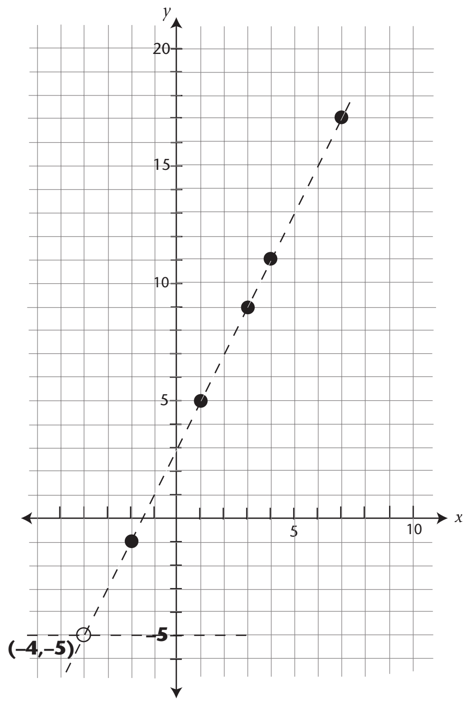
Does evaluating the expression give the same answer?

First, substitute with brackets.	$2(8) + 3$
Second, evaluate each term.	$= 16 + 3$
Finally, combine terms.	$= 19$

Yes! Once again, the graph and the expression agree.

When the expression equals –5, what is the value of *n*?

Thinking Space



When the expression equals –5, the value of *n* is –4.

Let's see what the expression says when *n* = –4.

First, substitute with brackets.	2(–4) + 3
Second, evaluate each term.	= –8 + 3
Finally, combine terms.	= –5

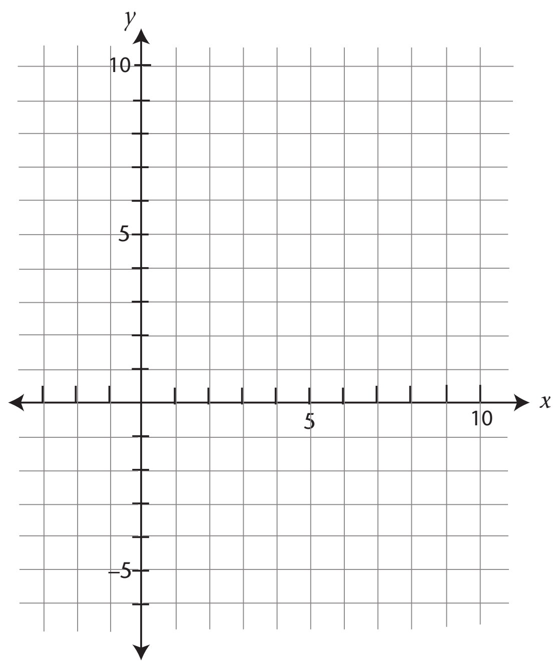
Evaluating the expression confirms the answers we get from the graph every time. The graph and the expression tell us *exactly* the same thing.

Practice 1

1. a. Complete this table of values for the relation $7 - n$.

n	$7 - n$
–2	
1	
5	
8	

b. Graph the relation $7 - n$.



2. Use your graph from Question 1 answer these questions. Check your answers by evaluating the expression.

   a. When the expression $7 - n$ equals 5, what is n?

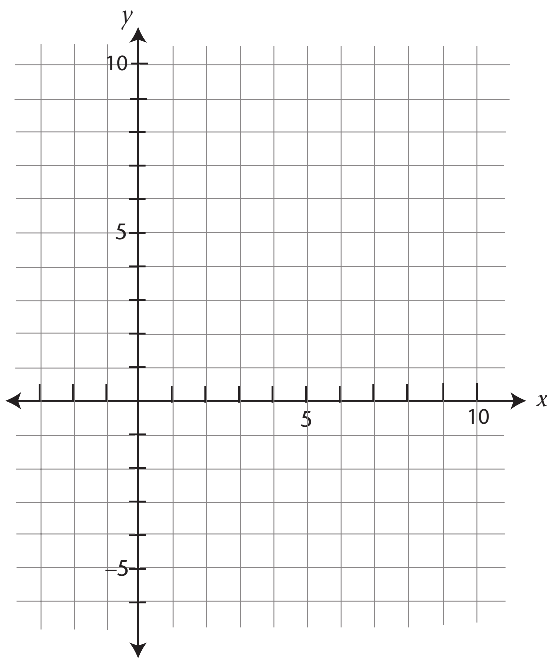
   b. When the expression $7 - n$ equals 0, what is n?

   c. When $n = -1$, what is the value of the expression $7 - n$?

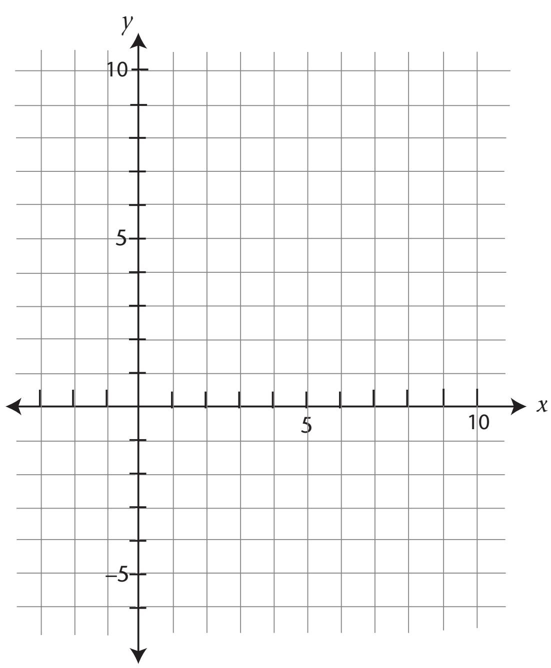
3. For each expression, make a table of values and draw a graph.

   Plot 4 points for each graph.

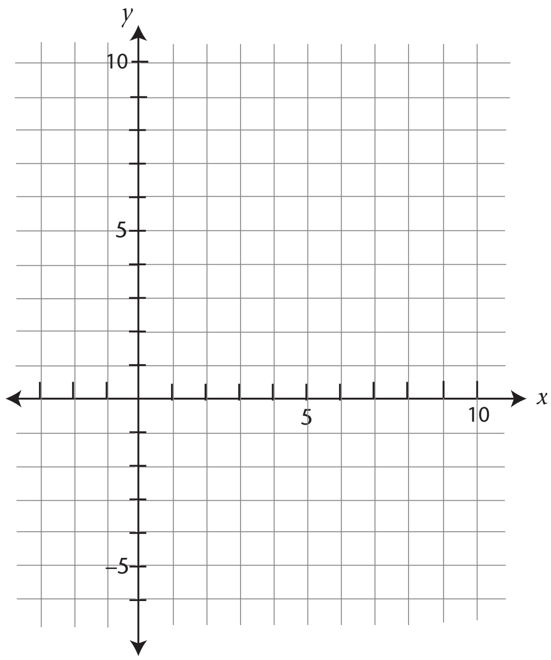
   a. $n + 3$



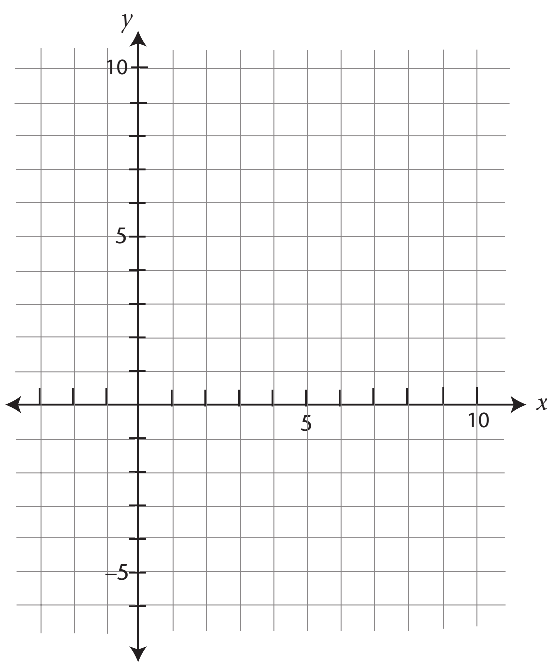
   b. $1 - n$



c. $2n + 1$



d. $3 - 2n$

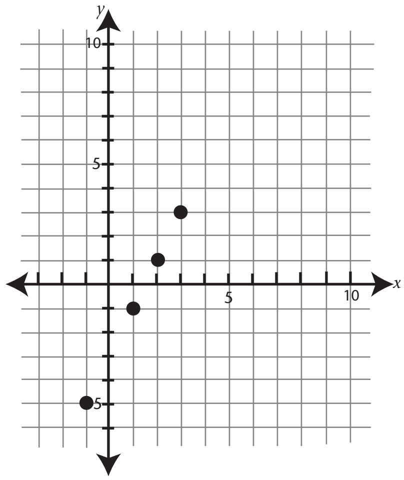


Turn to the Answer Key at the end of the Module and mark your answers.

Explore

We know now that a graph and an expression are two ways to describe the same idea.

Which of these expressions describes the same idea as this graph?



a. $2n + 1$

b. $n - 4$

c. $2n - 3$

d. $n + 5$

Thinking Space

Pick any two points on the graph. For this example, we'll use (–1, –5) and (2, 1).

We're looking for an expression that describes the same idea as this graph. When $n = -1$, the value of the expression should be –5. When $n = 2$, the expression should equal 1.

When I'm making a graph from an expression, the first coordinate is the value of the variable and the second coordinate is the value of the expression.

Let's start checking:

$2n + 1$	Let $n = -1$	$2(-1) + 1$
		$= -2 + 1$
		$= -1$

That doesn't work. When $n = -1$, the value of the expression we're looking for should be –5. This is not the expression that goes with our graph. Cross it off the list.

Thinking Space

Check the next one:

$n - 4$	Let $n = -1$	$(-1) - 4$
		$= -1 - 4$
		$= -5$

Good! When $n = -1$, this expression equals –5. Let's check our other point to be sure.

Let $n = 2$	$(2) - 4$
	$= 2 - 4$
	$= -2$

We need an expression that equals 1 when $n = 2$. This one doesn't work, so cross this one off the list, too.

Let's check another one:

$2n - 3$	Let $n = -1$	$2(-1) - 3$
		$= -2 - 3$
		$= -5$

That's good, but we still need to check the other point. The graph and the expression MUST match in TWO PLACES before you can be sure they describe the same thing.

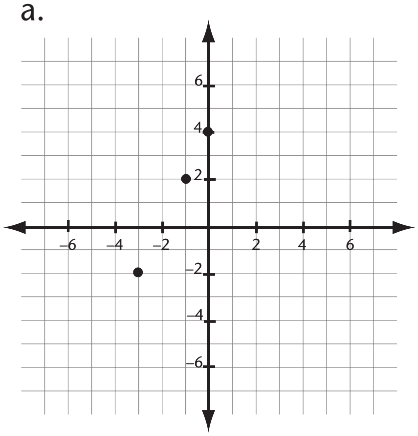
Let $n = 2$	$2(2) - 3$
	$= 4 - 3$
	$= 1$

Perfect! Now we know that $2n - 3$ is the expression that goes with this graph.

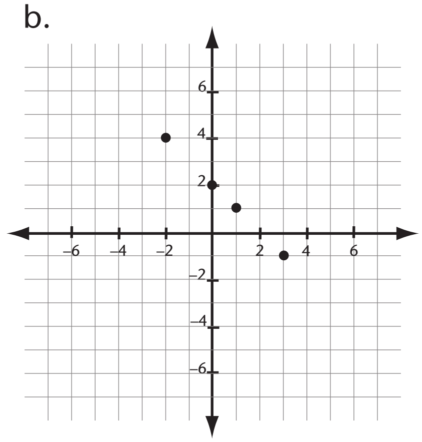
Let’s try another example. Which of these graphs describes the same relationship as the expression 4 – n?

Thinking Space

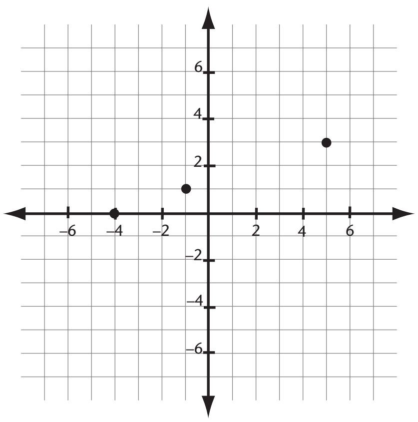
a.



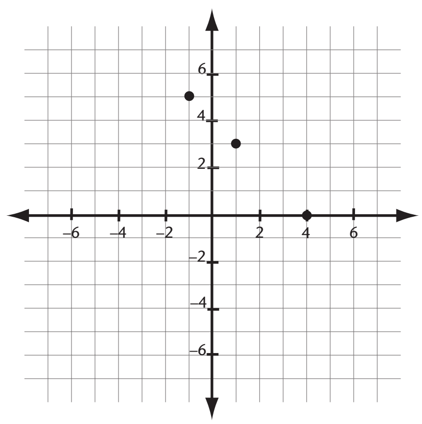
b.



c.



d.

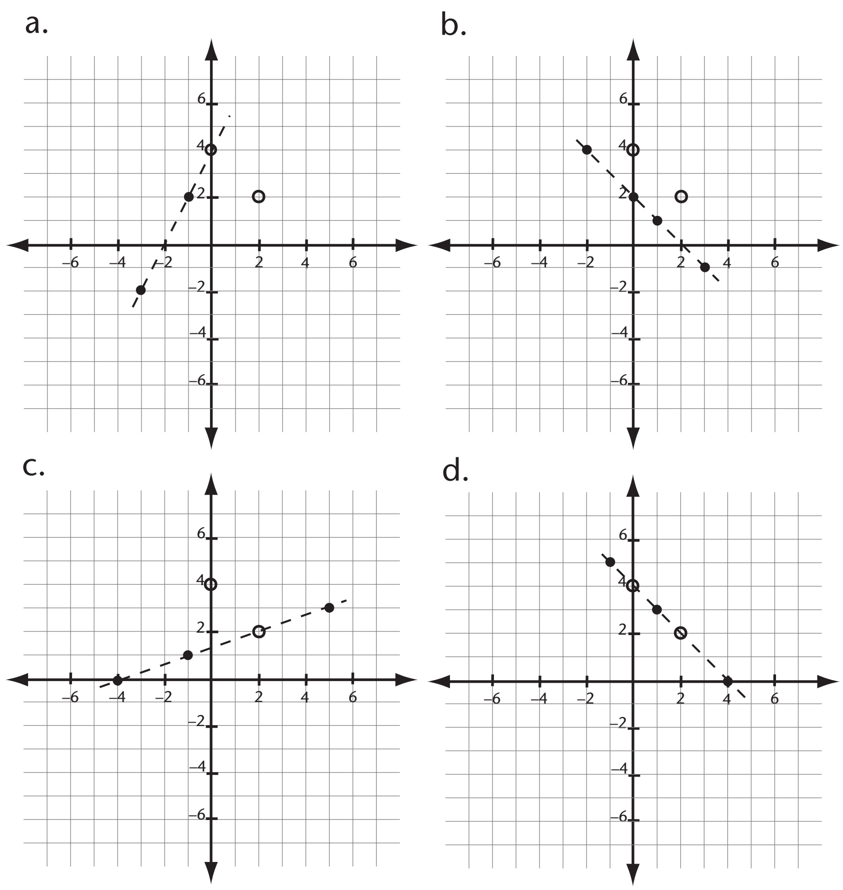


Just like in the previous example, we need to find TWO PLACES where the expression and the graph say the same thing. Then we’ll know that we have a match.

Pick any two values for n and evaluate the expression.

Let n = 0	Let n = 2
4 – (0)	4 – (2)
= 4 – 0	= 4 – 2
= 4	= 2
The point (0, 4) must be on the graph that goes with this expression.	The point (2, 2) must be on the graph that goes with this expression.

Now plot these points on the graphs that we have to choose from.



Our two points lie in a straight line with the points on Graph d.

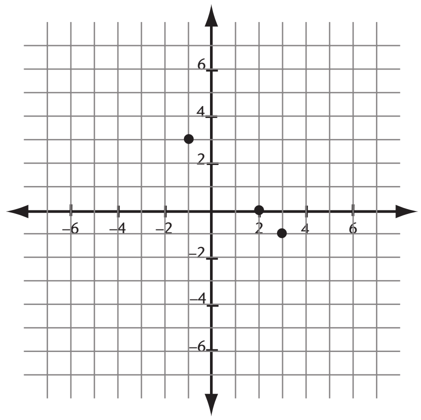
Graph d describes the same relationship as the expression $4 - n$.

Go over these examples one more time. Then try the practice exercises. Remember: The expression and the graph must say the same thing in TWO PLACES. Then you know that you have a match.

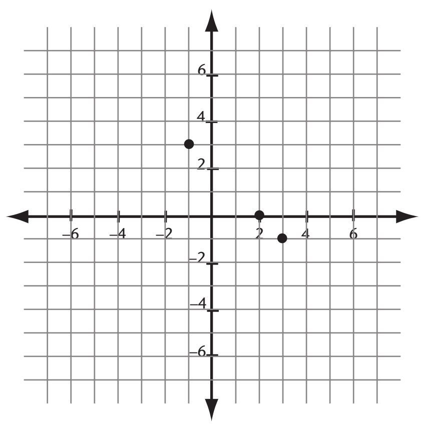
Thinking Space

Practice 2

1. *True* or *False*: This graph and the expression $n + 3$ describe the same relationship.



2. Which expression describes the same relationship as this graph?



   a. $2n + 5$

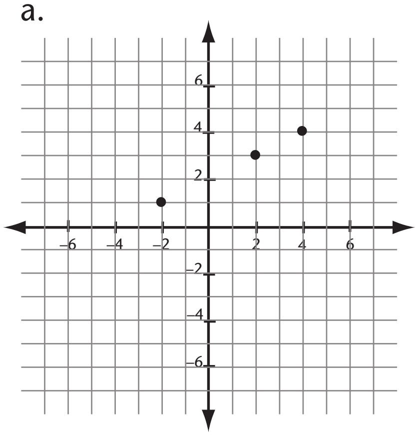
   b. $n + 1$

   c. $n - 2$

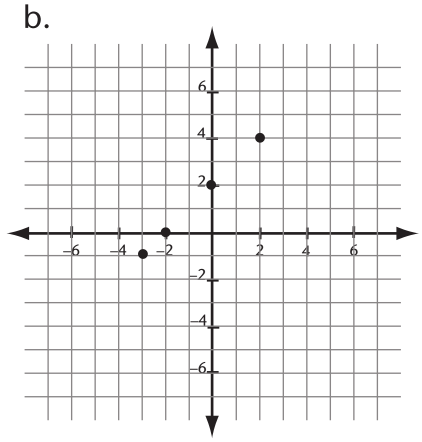
   d. $2 - n$

3. Choose the graph that describes the same relationship as the expression $n + 2$.

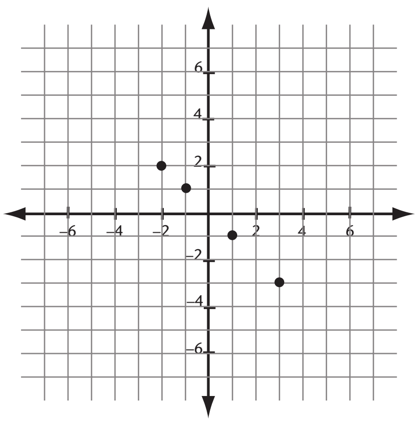
a.



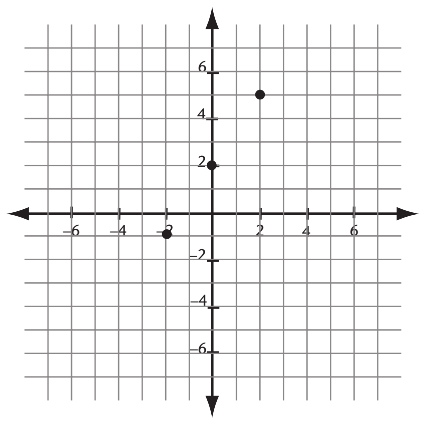
b.



c.



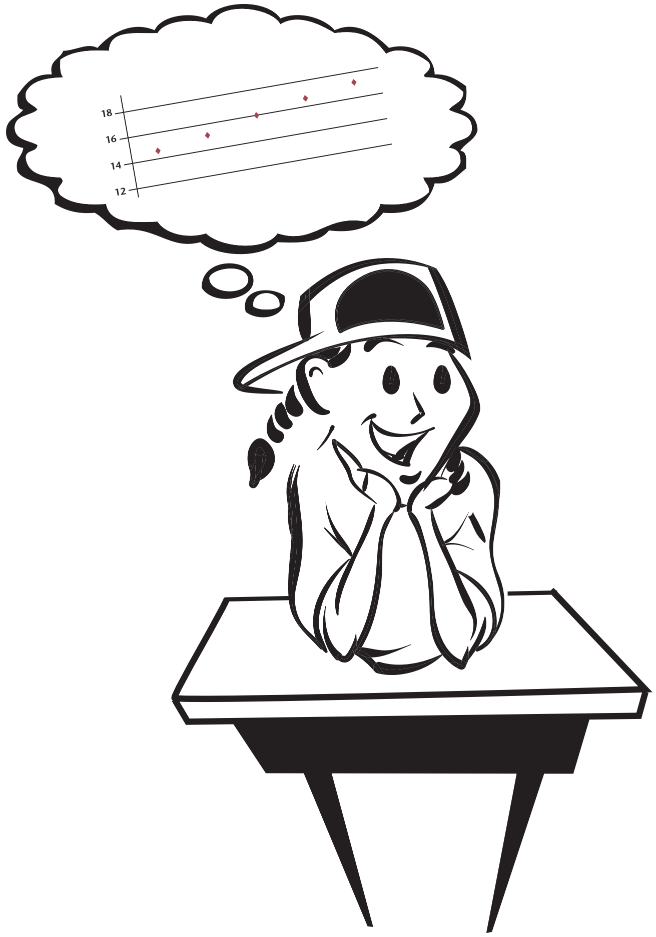
d.



Turn to the Answer Key at the end of the Module and mark your answers.

Lesson 5.2C: Reading Graphs of Linear Relationships

Student Inquiry



This activity will help you get ready for, learn, and review the information in the upcoming lesson.

When you turn this page over, you will find a chart containing the inquiry outcomes for this lesson. You may be able to answer some of these questions already! Start by writing down your thoughts before the lesson.

When you finish the lesson, answer each question and give an example.

Student Inquiries	BEFORE THE LESSON	AFTER THE LESSON
	What I already know about this question:	What I thought at the end: My final answer, and examples:
Can I use words to describe the pattern shown on a graph?		answer
		example
How does using interpolation and extrapolation help me answer questions about data in a graph?		answer
		example

Lesson 5.2C: Reading Graphs of Linear Relationships

Thinking Space

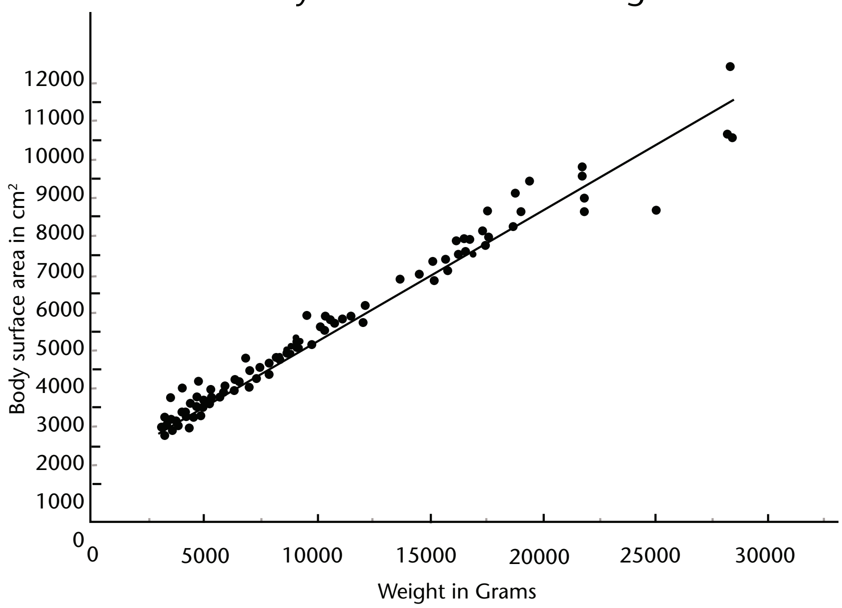
Introduction

Towers of toilet paper and linear expressions are useful for showing how linear relationships work. The pattern of the data forms a perfectly straight line.

A graph of real data rarely forms a perfectly straight line. When Dr. Current was studying the relationship between a baby's weight and body surface area, he used a graph.

I remember Dr. Current from Lesson 5.1C.

Body Surface Area vs. Weight



Even though the points on his graph do not lie in a perfectly straight line, he noticed a linear pattern. He was able to make good predictions about future results.

In this lesson, you will use your skills of interpolating and extrapolating with graphs of linear relationships to answer questions about real data from real situations. You will need a ruler for this lesson.

Warm-up

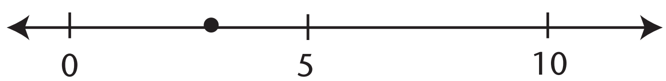
When reading graphs of real data, it's usually not possible to know the *exact* coordinates of a point. We use the information on the axes to *estimate* the coordinates.

Remember, the axes on a graph are just two number lines working together.

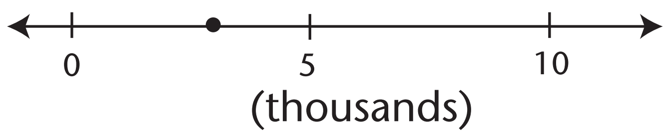
Estimate the number represented by the dot on each of these number lines. Keep an eye on the description of what the number line represents.

For example:

The point on this number line represents approximately 3.



The point on this number line represents approximately 3000.

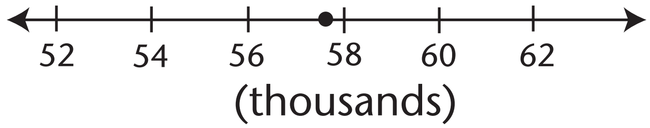


Thinking Space

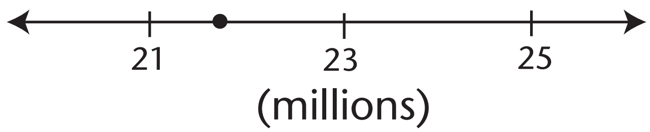
In Module 4, we got ready for plotting points on the Cartesian Plane by marking points on number lines.

Estimate the number represented by the dot on each of these number lines.

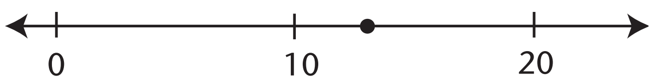
1.



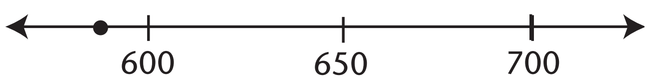
2.



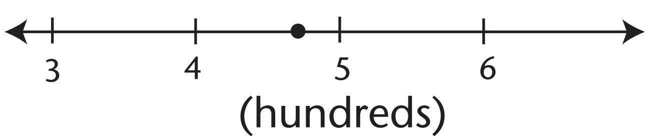
3.



4.



5.

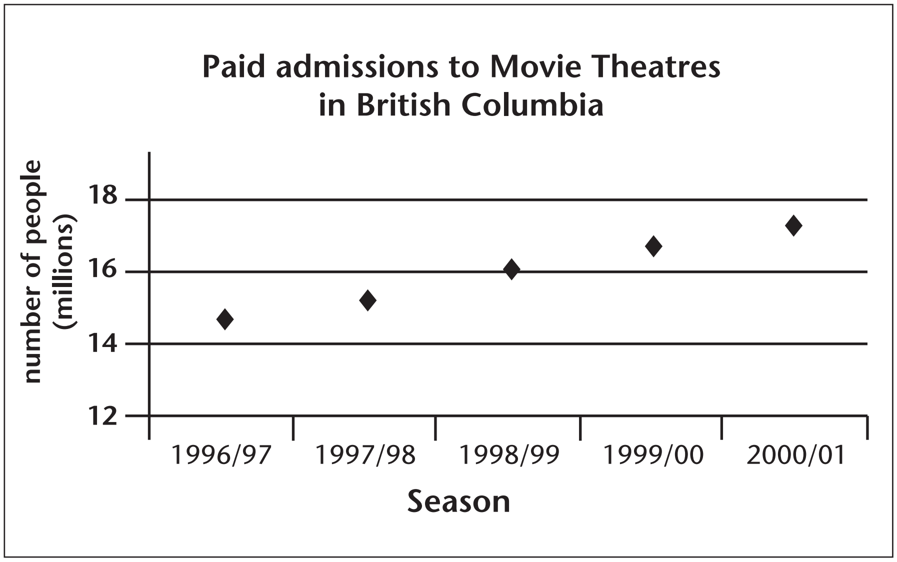


Turn to the Answer Key at the end of the Module and mark your answers.

Explore

Thinking Space

This graph shows the number of paid admissions to movie theatres in BC from the 1996/97 season to the 2000/01 season.

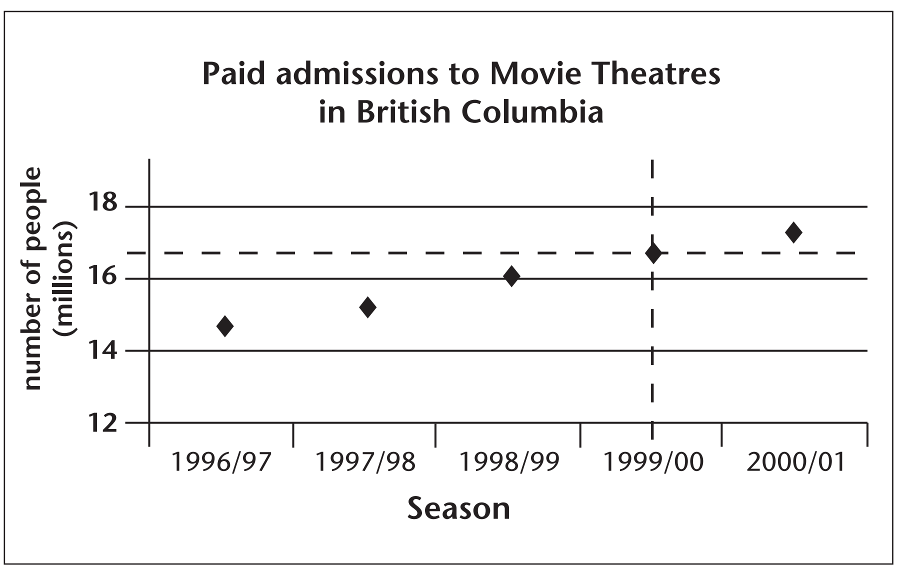


Describe in words how the number of people going to the movies has been changing.

Every year more people go to the movies.

The number of people going to the movies increases every year.

Approximately how many people went to the movies in BC during the 1999/2000 season? Use a ruler to draw lines on the graph to help you estimate the coordinates of the point.



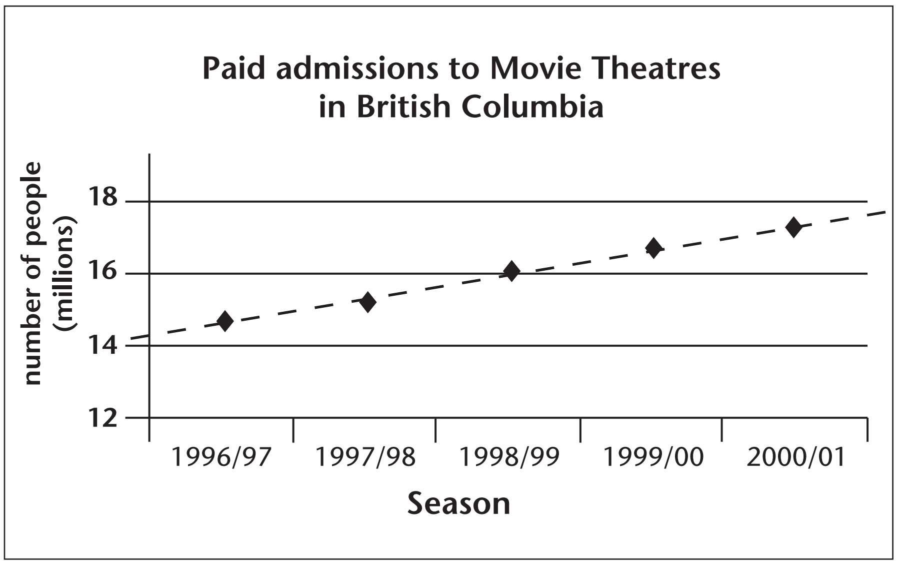
Thinking Space

The answer seems to be somewhere between 16 million and 17 million. So approximately 16,500,000 people went to the movies that year.

This graph shows the most recent data available. When do you think the number of people going to the movies in BC reached 18 million?

The pattern formed by the points is similar to patterns we have seen before. It seems to be a linear relationship. Draw a straight line that is close to all of the points to help us extrapolate.

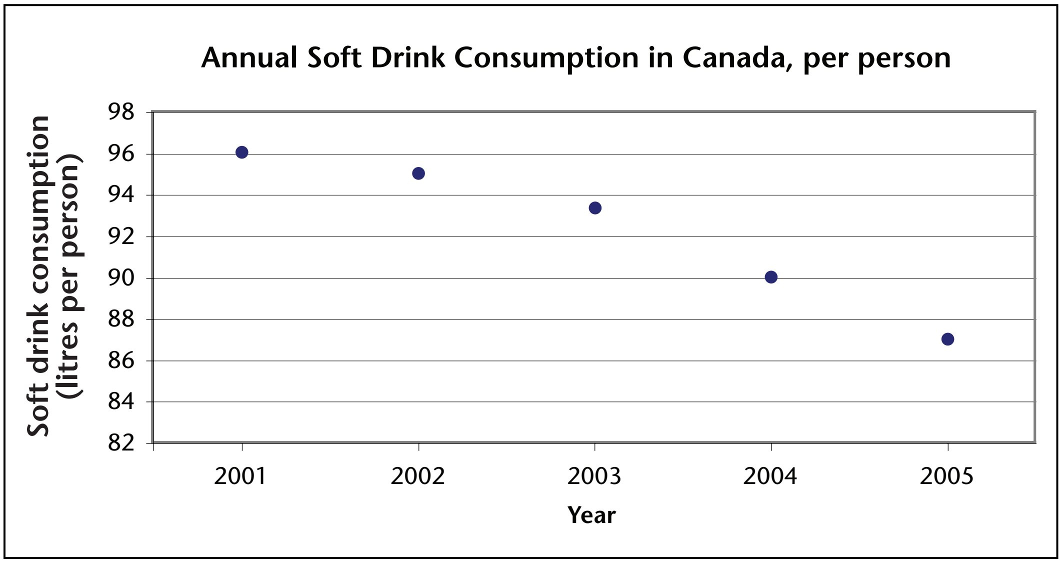
If some points are above the line, some points should also be below the line. Position your line so that there is an equal number on each side of the line. This new line is called the *trend line*, or *line of best fit*. The trend line gives us an approximate, or "best guess" answer to our question about theatre attendance.



It looks like movie attendance was close to 18 million during the 2001/2002 season. We could confidently predict that attendance was over 18 million during the 2002/2003 season.

Practice 1

1. This graph displays information about the amount of soft drinks Canadians drink. Use your graph reading skills to answer these questions.

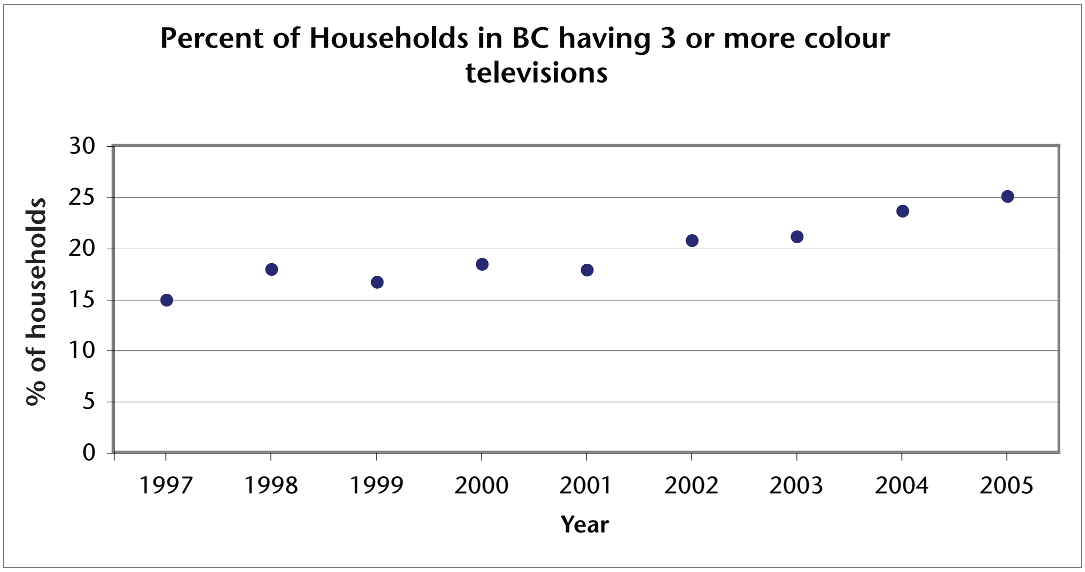


a. Describe the pattern you notice on this graph.

b. Approximately how many litres of soft drinks did the average Canadian drink in 2003?

c. How many litres of soft drinks do you think the average Canadian drank in 2007?

2. This graph displays information about the percentage of households in British Columbia that have three or more televisions.



a. Describe the pattern you notice on this graph.

b. What percentage of households in BC had three or more TVs in 2004?

c. When do you think the percentage of households in BC with three or more TVs will reach 30%?

Turn to the Answer Key at the end of the Module and mark your answers.

Section Summary

Thinking Space

Making a graph of data really does make it easier to understand the pattern.

First, organize the data into a **table of values**. The data can come from an experiment (like measuring towers of toilet paper), or we can fill the table of values after evaluating an expression.

Next, think about the axes for the graph. What does the horizontal axis represent? What does the vertical axis represent? How long should the axes be to give the best view of the data?

Then plot the points, one point for each row of the table of values. Do you see a pattern forming? If the points lie in a straight line, this is the graph of a **linear relation**.

If there is a pattern, we can make good guesses about missing data by looking between points. That's called **interpolating**. We can predict future results by extending the pattern and looking past the end of the data. That's called **extrapolating**.

!

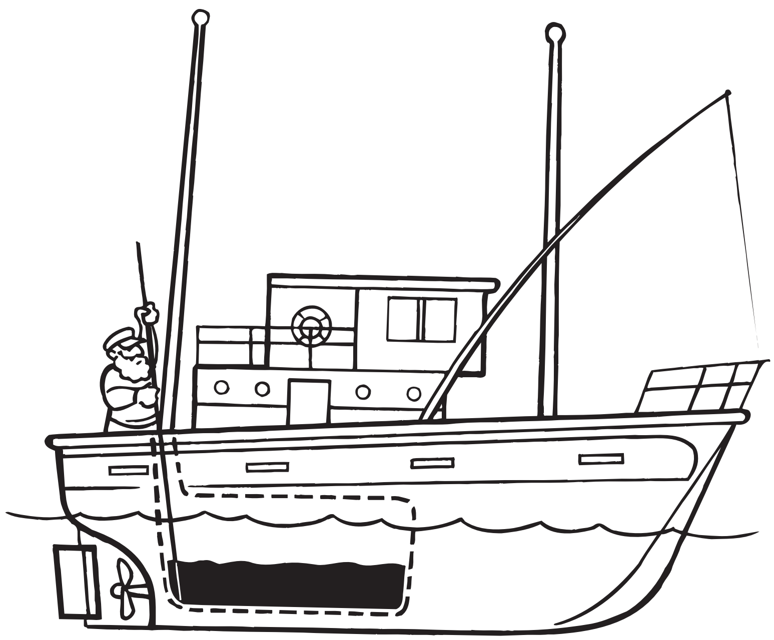
I should make sure I understand all of this new vocabulary before I move on to the section Challenge.

Section Challenge

Norm bought an antique fish boat last spring. Old fish boats don't have fuel gauges. Instead, Norm dips a stick into the fuel tank to check if his tank is getting low.

The stick is called a dipstick. Using the dipstick to check the level of the fuel tank is called "dipping the tank."

The first time Norm dipped the tank, the level of the fuel tank was 10 cm. It's a good thing he was near the fuel dock; his tank was almost empty! It took 875 litres of fuel to fill the tank.



The next time he dipped the tank, the dipstick showed a level of 70 cm. The attendant at the fuel dock charged him for 125 litres of gas.

The third time that Norm bought fuel, he paid for 375 litres after the dipstick showed a level of 50 cm.

Can you help Norm figure out how much fuel he used on his last trip? Before he left, the dipstick showed a level of 65 cm. He dipped the tank when he got back, and the level was 40 cm.

A graph will help you to understand the relationship between Norm's dipstick reading and the amount of fuel he needs in his tank.

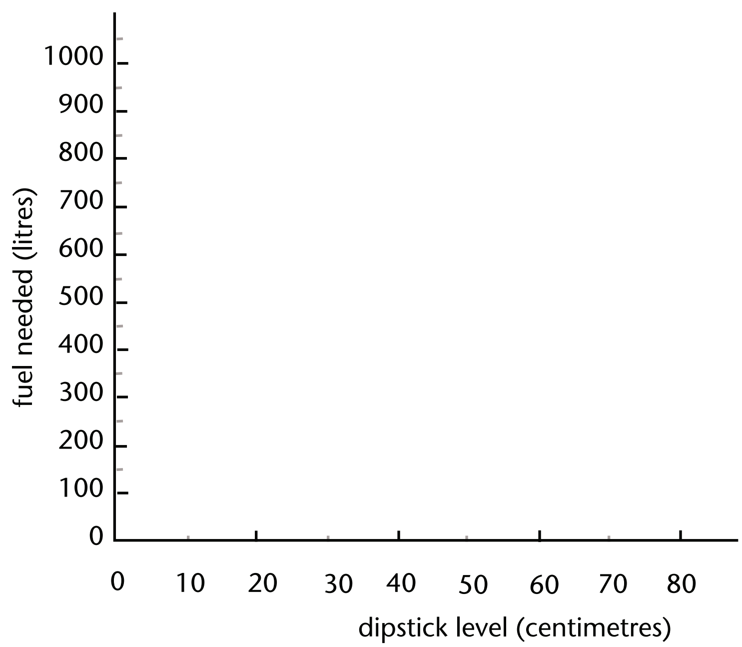
1. We have information about three different times that Norm dipped the fuel tank. Organize the data into a table of values.

Norm's dipstick reading (centimetres	amount of fuel he needs in his fuel tank (litres)

2. Think about the axes you need for your graph. The horizontal axis will represent the dipstick reading. If the lowest value is 0 and the highest is 80, that will be enough room to plot the points.

   The vertical axis will represent the amount of fuel that Norm needed to fill his tank. This axis needs to show values from about 0 to 1000.

   Plot the three points on the graph.
   Use a ruler to draw a line through all of the points. This line will help you interpolate.



3. When the dipstick showed a level of 65 cm at the beginning of the trip, how much fuel did Norm's tank need?

4. When Norm dipped the tank and got a reading of 40 cm, how much fuel did he need?

5. How much fuel did Norm use on his recent trip?

Answer Key Table of Contents

Answer to Pretest 5.1

Lesson 5.1A

1. a. answers will vary

   Each number is 3 less than the one that came before.

   The numbers are going down by 3s.

   7, 4, 1, **–2**, **–5**

   b. answers will vary

   Each number is is twice what came before.

   The numbers are doubling.

   3, 6, 12, **24**, **48**

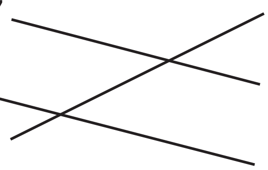
Lesson 5.1B

1.

a. $p + 7$ — a number decreased by seven

b. $7p$ — 7 more than a number

c. $p - 7$ — seven times a number



2.

	How many terms?	What are the variables?	List any coefficients.	Is there a constant term? What is it?
$3x + 4$	**2**	***x***	**3**	**4**
$2p + 3q - 5$	**3**	***p***	**2, 3**	**–5**
$2w$	**1**	***w***	**2**	**no constant term**

3. You can choose any variable you like. These answers use the variable "n".

   a. $n - 2$

   b. $n + 6$

   c. $\frac{n}{2}$

Lesson 5.1C

1. a. 6 – (2)
   = 4

   b. 4(5)
   = 20

   c. 3(2) + (5)
   = 6 + 5
   = 11

   d. 2((5) – 1)
   = 2(4)
   = 8

2. The price of a bag of corn (in dollars) is \$1.25*c*, where *c* represents the number of ears of corn in one bag.

   a. Let *c* = 1
   \$1.25(1)
   = \$1.25
   One ear of corn costs \$1.25.

   b. Let *c* = 6
   \$1.25(6)
   = \$7.5
   Six ears of corn cost \$7.50

Answer to Lesson 5.1A Warm-up

1. …, Δ, Δ
2. …, dinner, breakfast
3. …, 5, 6
4. …, 20, 25
5. …, –2, –6

Answer to Lesson 5.1A Practice 1

1. *Answers may vary.*

   The number of E. coli bacteria is doubling every twenty minutes.

   Each time Jana counts, there are twice as many bacteria as there were before.

2. *Answers may vary.*

   Tosh is 4 years older than Evan.

   Evan is 4 years younger than Tosh.

   Evan's age increased by 4 is Tosh's age.

Answer to Lesson 5.1B Warm-up

1. a. 12

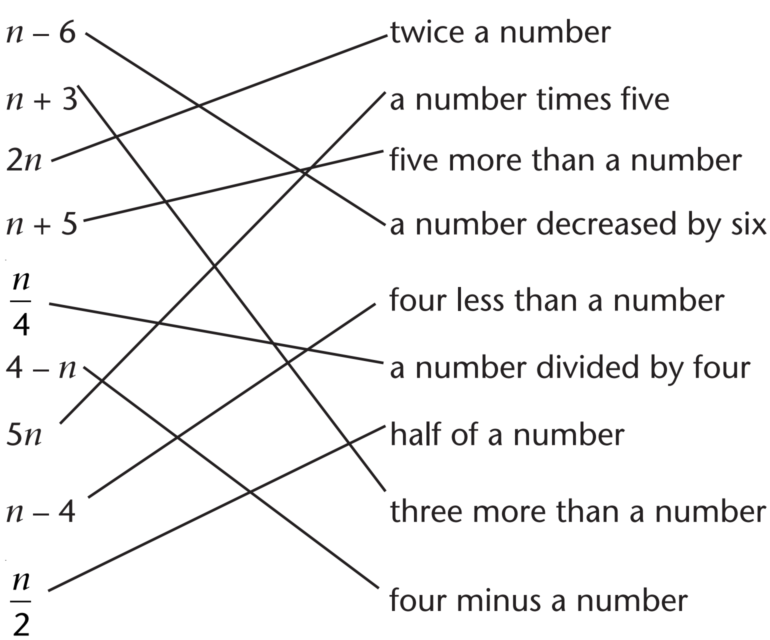
   b. 6

   c. 4

   d. –4

2. Darian walks 6 blocks farther than Teagan.

Answer to Lesson 5.1B Practice 1



Answer to Lesson 5.1B Practice 2

1.

	How many terms?	What are the variables?	List any coefficients.	Is there a constant term? What is it?
$m + 4$	2	***m***	none	4
$2x - 9$	**2**	***x***	**2**	**–9**
$-3s$	**1**	***s***	**–3**	**no constant term**
$5 + p$	**2**	***p***	**none**	**5**
$x + 3y + 7$	**3**	***x, y***	**3**	**7**
$b + 2$	**2**	***b***	**none**	**2**
$4t$	**1**	***t***	**4**	**no constant term**

2. $7w + 5$ or $5 + 7w$

Answer to Lesson 5.1B Practice 3

1. a. Augustin's age is 6 less than Maggie's age. Use m as a variable meaning Maggie's age.
   Augustin's age is $m - 6$
   b. Maggie's age is 6 more than Augustin's age. Use a as a variable meaning Augustin's age.
   Maggie's age is $a + 6$.

2. Use p as a variable meaning the number of people in the theatre. Quyen can expect to sell $\frac{1}{2}p$ bags of popcorn.

3. a. $n - 4$
   b. $n + 3$

c. $2n$
d. $2n + 1$
e. $n - 2$
f. $\frac{n}{5}$
g. $2n - 3$

4. Answers may vary but should resemble one of these options.
   a. three times a number
      triple a number
   b. five more than a number
      a number increased by five
      a number plus five
   c. two less than a number
      a number decreased by two
   d. a number divided by three
      one-third of a number

Answer to Lesson 5.1C Warm-up

1. a. 2
   b. x
   c. 2
   d. 5
2. a. $j + 3$
   b. $3j$
   c. $3j + 1$
3. a. 12
   b. 6
   c. –4
   d. 11
   e. 5
   f. 32
   g. 6
   h. 35
   i. 8
   j. 4
   k. 3
   l. 14
   m. 5
   n. 3
   o. –5
   p. 27
   q. 2
   r. 4
   s. –120
   t. –11

Answer to Lesson 5.1C Practice 1

1. a. $(4) - 7$
   $= -3$

   b. $3 + 2(4)$
   $= 3 + 8$
   $= 11$

   c. $6 + (4)$
   $= 10$

   d. $3(4) - 4$
   $= 12 - 4$
   $= 8$

   e. $6(4)$
   $= 2$

   f. $9 - 5(4)$
   $= 9 - 20$
   $= -17$

2. a. $4 + 2(3)$
   $= 4 + 6$
   $= 10$

   b. $4 + 2(5)$
   $= 4 + 10$
   $= 14$

   c. $4 + 2(0)$
   $= 4 + 0$
   $= 4$

   d. $4 + 2(2.3)$
   $= 4 + 4.6$
   $= 8.6$

   e. $4 + 2\left(\frac{3}{4}\right)$

   $= 4 + \frac{6}{4}$

   $= 4 + \frac{3}{2}$

   $= \frac{8}{2} + \frac{3}{2}$

   $= \frac{11}{2}$

   $= 5\frac{1}{2}$

3. a. $(3) + 2(1)$
   $= 3 + 2$
   $= 5$

   b. $(-2) + (1) + 4$
   $= -2 + 1 + 4$
   $= -1 + 4$
   $= 3$

   c. $2(3) - 3(1)$
   $= 6 + 3$
   $= 3$

d. $-8(3) + 4(1) - 3$
$= -24 + 4 - 3$
$= -20 - 3$
$= -23$

e. $(-2) + 5(1) + 6.8$
$= -2 + 5 + 6.8$
$= -3 + 6.8$
$= 9.8$

4. a. $3(3.4) - 2(4)$
$= 10.2 - 8$
$= 2.2$

b. $3(7) - 2(5.6)$
$= 21 - 11.2$
$= 9.8$

c. $3(1.4) - 2(2.1)$
$= 4.2 - 4.2$
$= 0$

5. $2.50(5) + 1.25(3)$
$= 7.50 + 3.75$
$= 11.25$

Five hotdogs and three drinks cost $11.25

Answer to Section Challenge 5.1

1. $3s$
2. $75 + s$ or $75 + 1s$ or $1s + 75$ or $s + 75$
3. a. $3(24) = 72$ It will cost Caldon $72 to swim for a year without a membership.

   b. $75 + (24) = 99$ It will cost Caldon $99 to swim for a year with a membership.

   c. It would not be cheaper for Caldon to buy a membership.
4. a. $3(52) = 156$

   b. $75 + (52) = 127$

   c. It would be cheaper for Diane to buy a membership.

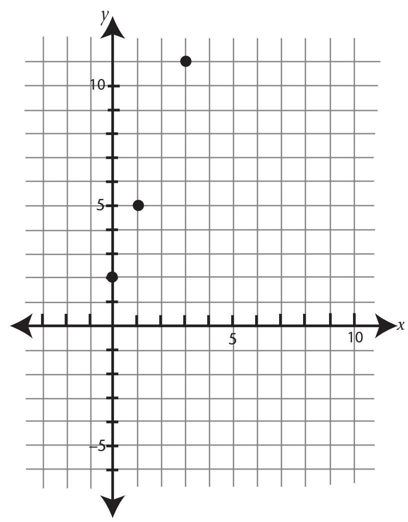
Answer to Pretest 5.2

Lesson 5.2B

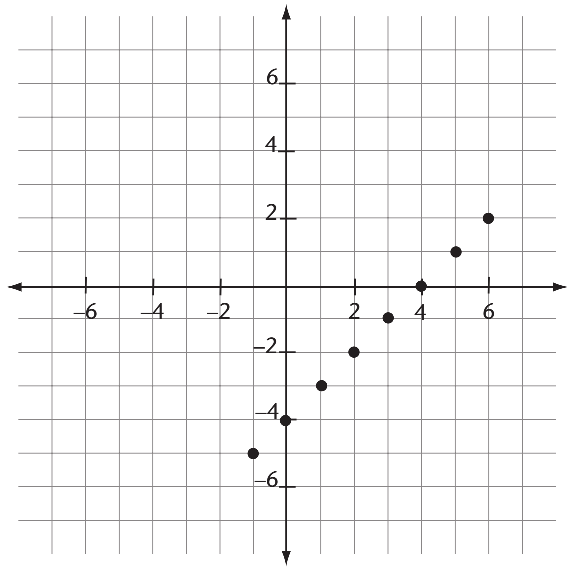
1. a.

n	$3n + 2$
0	2
1	5
3	11

b.

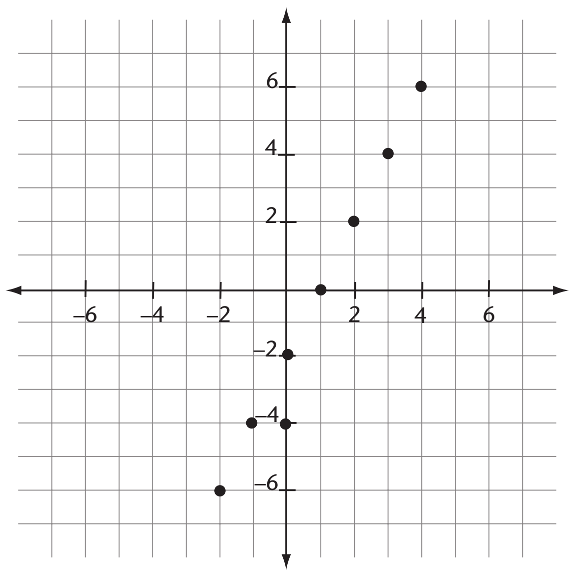


2. a.



Your answer should include 4 of these points.

b.



3. a. –1
   b. 5

4. c

5. b

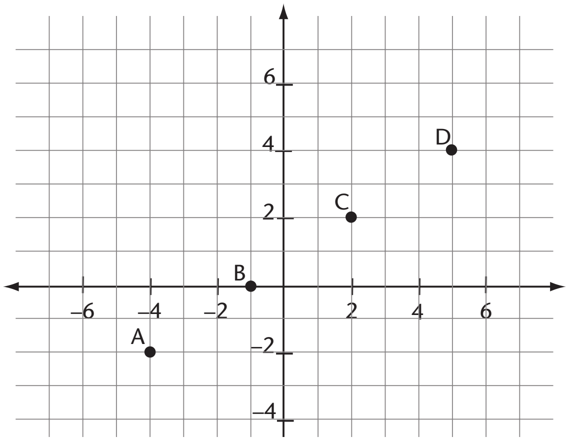
Lesson 5.2C

1. The population of BC has been increasing.

2. about 4,100,000

3. any answer between 4,500,000 and 4,700,000 is reasonable

Answer to Lesson 5.2A Warm-up



Answer to Lesson 5.2B Warm-up

1. 3(2) + 5
   = 6 + 5
   = 11

2. 6(1) – 2
   = 6 – 2
   = 4

3. 5(2)
   = 10

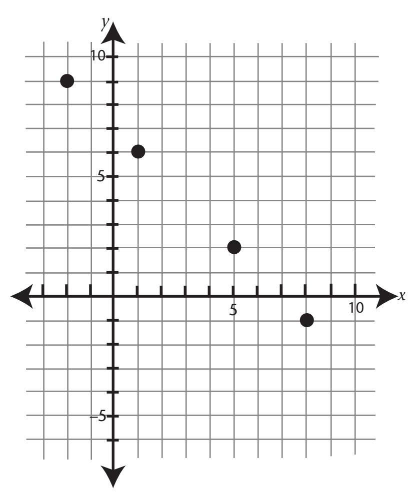
4. (2) + 2(1) + 3
   = 2 + 2 + 3
   = 4 + 3
   = 7

Answer to Lesson 5.2B Practice 1

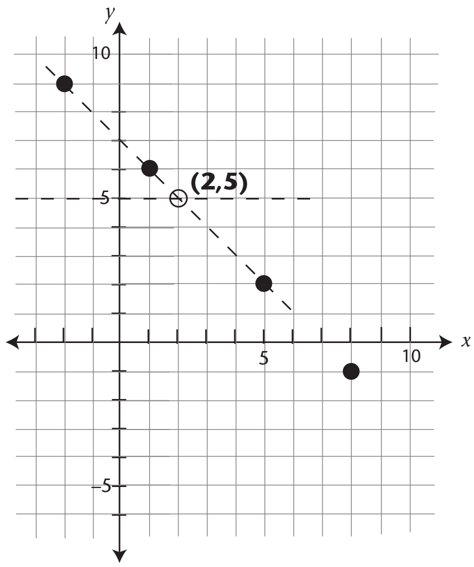
1. a.

n	$7 - n$
–2	**9**
1	**6**
5	**2**
8	**–1**

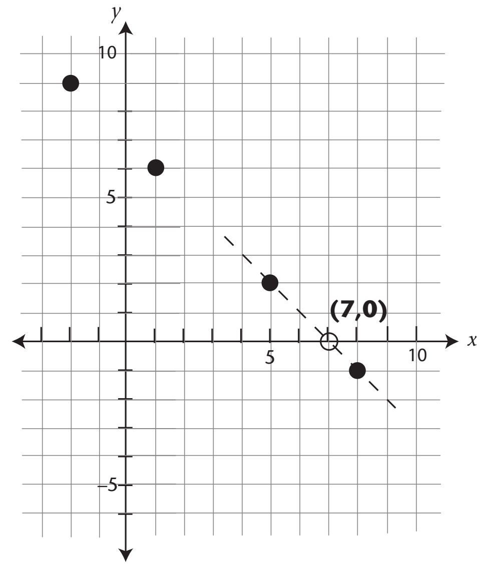
b.



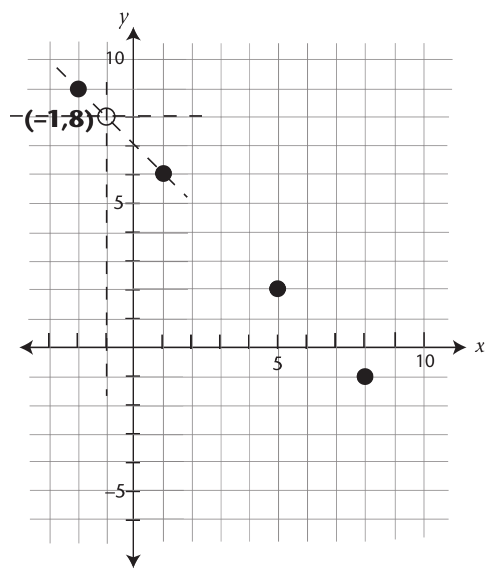
2. a. *n* is 5



b. *n* is 7



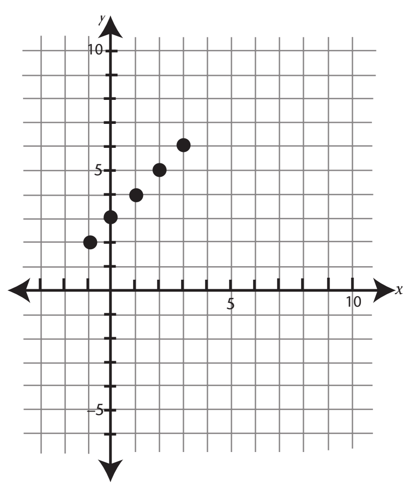
c. The value of the expression is 8.



3. Your graphs should each have 4 points.

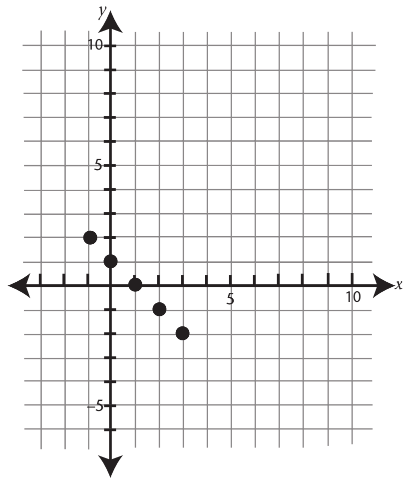
a.

n	*n* + 3
–1	2
0	3
1	4
2	5
3	6



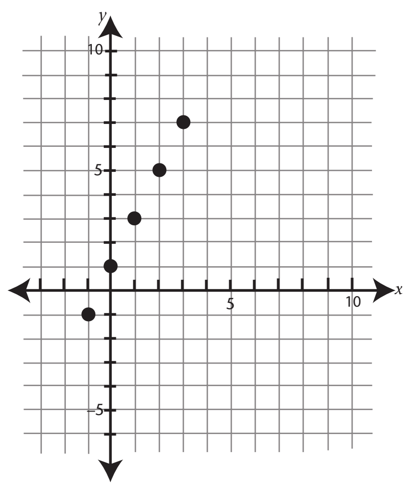
b.

n	$1 - n$
–1	2
0	1
1	0
2	–1
3	–2



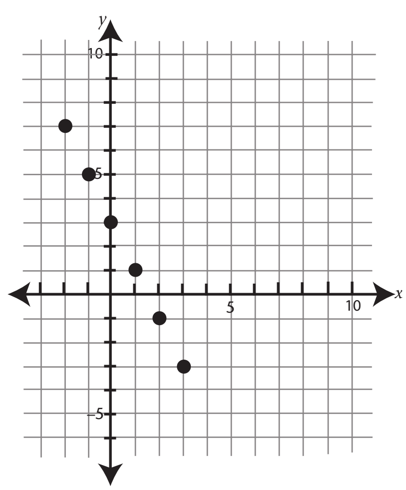
c.

n	$2n + 1$
–1	–1
0	1
1	3
2	5
3	7



d.

n	$3 - 2n$
–2	7
–1	5
0	3
1	1
2	–1
3	–3



Answer to Lesson 5.2B Practice 2

1. False

2. d

3. b

Answer to Lesson 5.2C Warm-up

1. The point on this number line seems to be about halfway between 57,000 and 58,000. It represents approximately 57,500.

2. This point is about halfway between 21 million and 22 million. It represents approximately 21.5 million or 21,500,000.

3. This point is less than halfway between 10 and 20. It represents approximately 13.

4. The point is a bit less than 600. It represents approximately 590.

5. This point seems to be about halfway between 450 and 500. It represents approximately 475.

Answer to Lesson 5.2C Practice 1

1. a. Canadians drink fewer soft drinks each year.
   The amount of soft drinks that Canadians drink is decreasing.
   b. The average Canadian drank about 93 litres of soft drinks in 2003.
   c. If the pattern shown on this graph continues, the average Canadian probably drank about 83 litres of soft drinks in 2007. (Any answer between 82 and 85 is ok.)

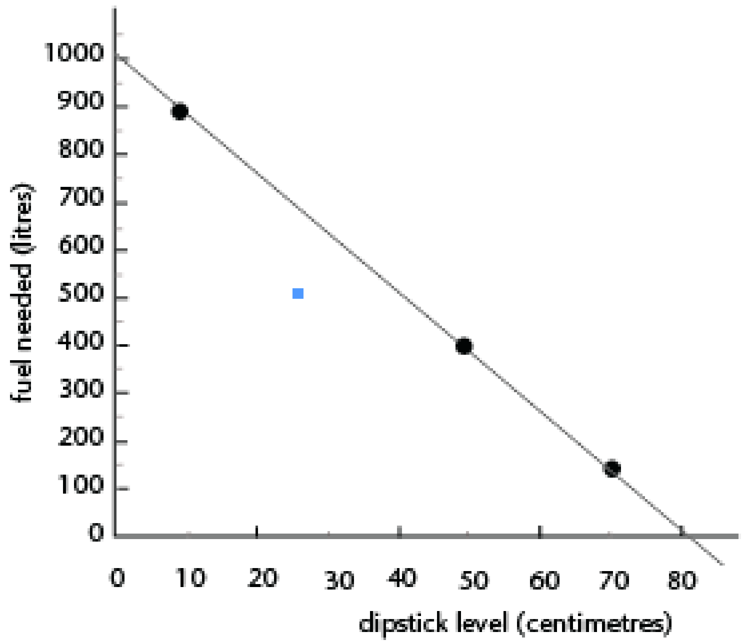
2. a. From year to year, the percentage goes up and down. Over time the percentage of households in BC with 3 or more TVs is increasing.
   b. about 24%
   c. Any answer between 2008 and 2012 is ok.

Answer to Section Challenge 5.2

1.

Norm's dipstick reading (centimetres	amount of fuel he needs in his fuel tank (litres)
10	875
70	125
50	375

2.



3. Norm needed a little less than 200 litres of fuel.
4. Norm needed about 500 litres of fuel.
5. He used approximately 300 litres of fuel on his last trip.

Module 5 Glossary

Coefficient

The number in front of the variable. In the expression 2x, 2 is the coefficient and x is the variable. The expression means "2 times x."

Constant

A term with no variable. If the term has no variable, it can't ever change. It is constant.

Expression

A group of numbers and symbols that expresses the idea of a pattern. Examples of expressions are:

$7x$	$2p - 3q + 7$
$9t + 3v$	$a - b + 3c$
$7d - 3$	$2m - n$
$x + 2y - 3$	$4j + 1$

Extrapolate

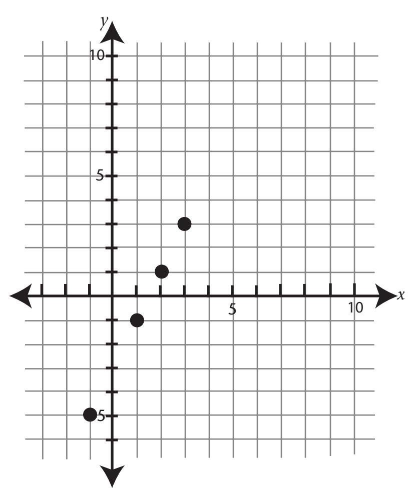
Making a guess by looking past the end of the data

Interpolate

Making a guess by looking between two points on a graph

Linear Relation

When the graph of the relationship between a variable and an expression forms a straight line, we call the expression a linear relation. For example, this graph shows us that $2x - 3$ is a linear relation.



Pattern

A predictable sequence

Table of Values

A way to organize related numbers when doing an experiment or evaluating an expression

Term

An expression is made up of parts that are added together.

$3g + 7h - 5$ has three terms

$3g$, $7h$, and -5 are the terms

Variable

A symbol in an expression, usually a letter of the alphabet, that represents a number that might change

Thinking Space

Remember, subtracting just means "adding the negative of a number." When we talk about the parts of an expression that are added together, we mean the ones that are subtracted too.