

## Multiple Representations: Using Linear Relations and their Multiple Representations

### Lesson Outline

<b><u>BIG PICTURE</u></b>			
Students will:			
<ul style="list-style-type: none"> <li>determine solutions to linear equations by a variety of methods (graphically, numerically, algebraically);</li> <li>connect first differences to rate of change;</li> <li>determine the point of intersection of two linear relations graphically and interpret it;</li> <li>pose a question on a chosen topic, conduct an investigation, and present a solution.</li> </ul>			
Day	Lesson Title	Math Learning Goals	Expectations
1	Solving Equations (Part 1) <i>Presentation file:</i> <b>The Equation Game</b>	<ul style="list-style-type: none"> <li>Activate prior learning about equations.</li> <li>Solve simple linear equations.</li> <li>Compare algebraic models to graphical models of linear relations.</li> </ul>	NA2.07, LR4.03 CGE 2a
2	Solving Equations (Part 2)	<ul style="list-style-type: none"> <li>Solve linear equations.</li> </ul>	NA2.07, LR1.01, LR4.03 CGE 2c, 5a
3	Solving Equations (Part 3)	<ul style="list-style-type: none"> <li>Solve linear equations.</li> <li>Make connections between graphical and algebraic models.</li> </ul>	NA2.07, LR4.01, LR4.03 CGE 4c, 5a
4	Planning a Special Event (Part 1)	<ul style="list-style-type: none"> <li>Graph a relationship from its equation.</li> <li>Review the meaning of rate of change and initial value in context.</li> <li>Connect first differences to the rate of change.</li> <li>Review the concept of continuous vs. discrete data.</li> </ul>	LR1.01, LR3.02, LR3.03, LR3.05, LR4.01, LR4.03 CGE 3c, 4b
5	Planning a Special Event (Part 2)	<ul style="list-style-type: none"> <li>Graph a relationship from its equation.</li> <li>Review the meaning of rate of change and initial value in context.</li> <li>Connect first differences to the rate of change.</li> <li>Review the concept of continuous and discrete data.</li> <li>Review independent and dependent variables.</li> </ul>	LR1.01, LR3.02, LR3.05, LR4.01, LR4.03, LR4.06 CGE 3c, 4b
6	Kitty's Kennel	<ul style="list-style-type: none"> <li>Explore a variety of purchase options, propose a purchase plan, and provide a rationale according to a specific criterion.</li> <li>Use graphing technology to investigate the solution.</li> <li>Model three linear relations with an equation and graph.</li> <li>Read and/or manipulate graphs, to determine the best choice.</li> </ul>	LR2.01, LR4.06 CGE 3c, 5b
7	Popping the Question	<ul style="list-style-type: none"> <li>Select a topic involving a two-variable relationship.</li> <li>Pose a question on the topic.</li> <li>Collect data to answer the question.</li> <li>Present its solution using appropriate representations of the data.</li> </ul>	LR4.07 CGE 3c, 4b, 4c
8		Instructional Jazz	
9		Instructional Jazz	
10		Assessment	



**Math Learning Goals**

- Activate prior learning about equations.
- Solve simple linear equations.
- Compare algebraic models to graphical models of linear relations.

**Materials**

- algebra tiles
- BLM 6.1.1, 6.1.2, 6.1.3

**Assessment Opportunities**

**Minds On ...**

**Pairs → Pair/Share/Concept Circles**

Students complete BLM 6.1.1 in pairs and share responses with another pair.

**Whole Class → Discussion**

Through discussion reinforce students' understanding of the difference between an expression (e.g.,  $3x + 4$ ) and an equation (e.g.,  $3x + 4 = 2$ ).

**Curriculum Expectations/Observation/Mental Note:** Diagnostic assessment: Ask students to create and solve an equation. They show an easy example and a more challenging example. They could choose one of the equations from the concept circle.

[The Equation Game.ppt](#)

Some students will understand how to solve simple equations. Students may already know how to algebraically solve equations without using algebra tiles.

**Word Wall**  
equation  
expression  
algebraic model  
graphical model

**Action!**

**Whole Class → Electronic Presentation**

Use the electronic presentation (or overhead algebra tiles) to show students how to play the Equation Game. Demonstrate that the same action is performed on both sides of the equal sign to keep the equation balanced.

**Pairs → The Equation Game**

Students play the game using equations on BLM 6.1.2.

**Individual → Practice**

Students complete BLM 6.1.3.

You may need to review operations with integers to enable students to be successful.

**Consolidate Debrief**

**Whole Class → Reflecting/Note Making**

Ask questions such as:

- What is an equation?
- When did we use a graphical model today? An algebraic model? (i.e., equation)
- Compare the two different models.
- What is the connection between coordinates on a graph of a linear relationship and the equation of the relationship?
- Why is equation solving useful?

**Home Activity or Further Classroom Consolidation**

Solve (and check solutions) for any three of the equations in the concept circles or make up three new ones to solve and check.

Practise integer skills and solving equations.

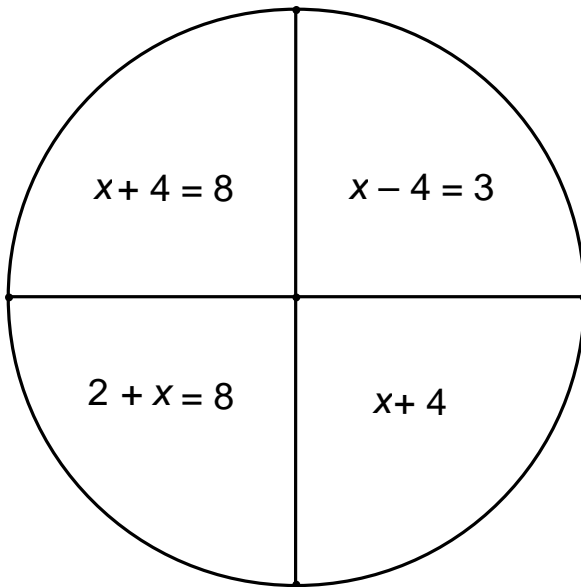
Provide appropriate practice questions.

*Concept Practice  
Differentiated  
Exploration*

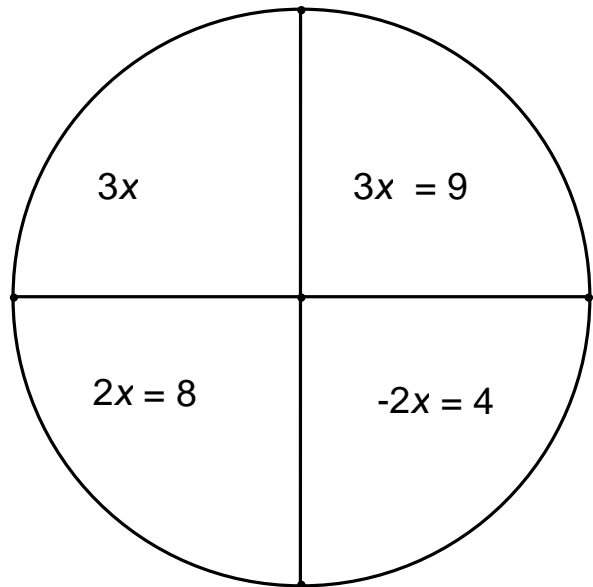
## 6.1.1: Concept Circles – Equations

1. Draw an "X" through the example that does not belong. Justify your answer.

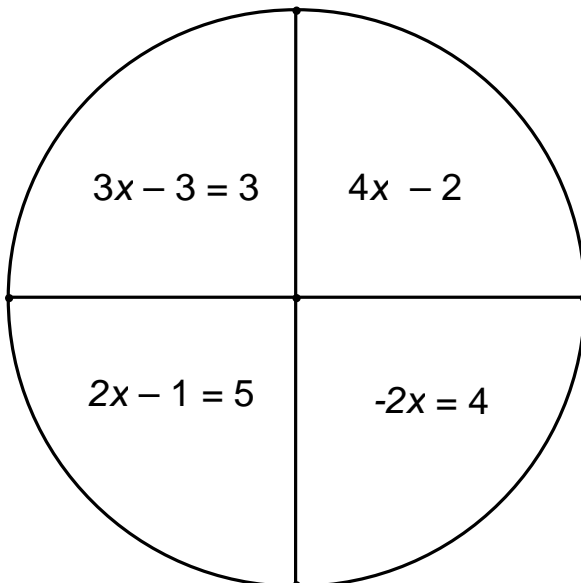
a)



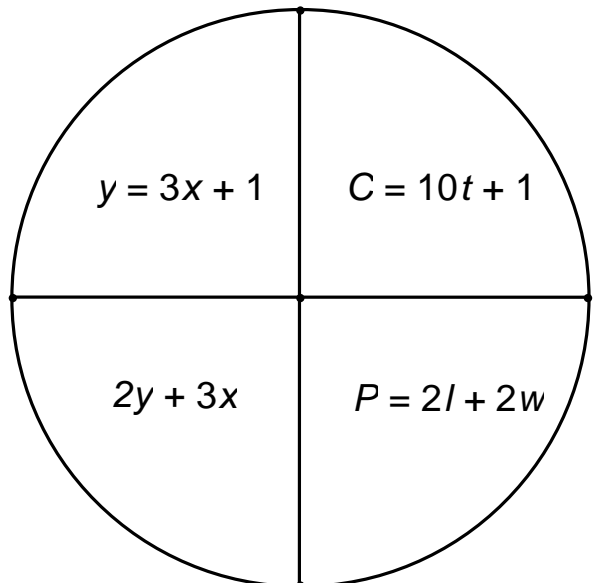
b)



c)



d)



2. Answer True (T) or False (F). Be prepared to justify your answer.

- Every equation has exactly two sides. \_\_\_\_
- Every equation has one equal sign. \_\_\_\_
- Every equation has one variable. \_\_\_\_

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## 6.1.2: The Equation Game

Solve each equation. Check your answer.

$$3x - 2 = 4$$

$$4x + 1 = -7$$

$$-4 = 2 + 2a$$

$$3 - b = -2$$

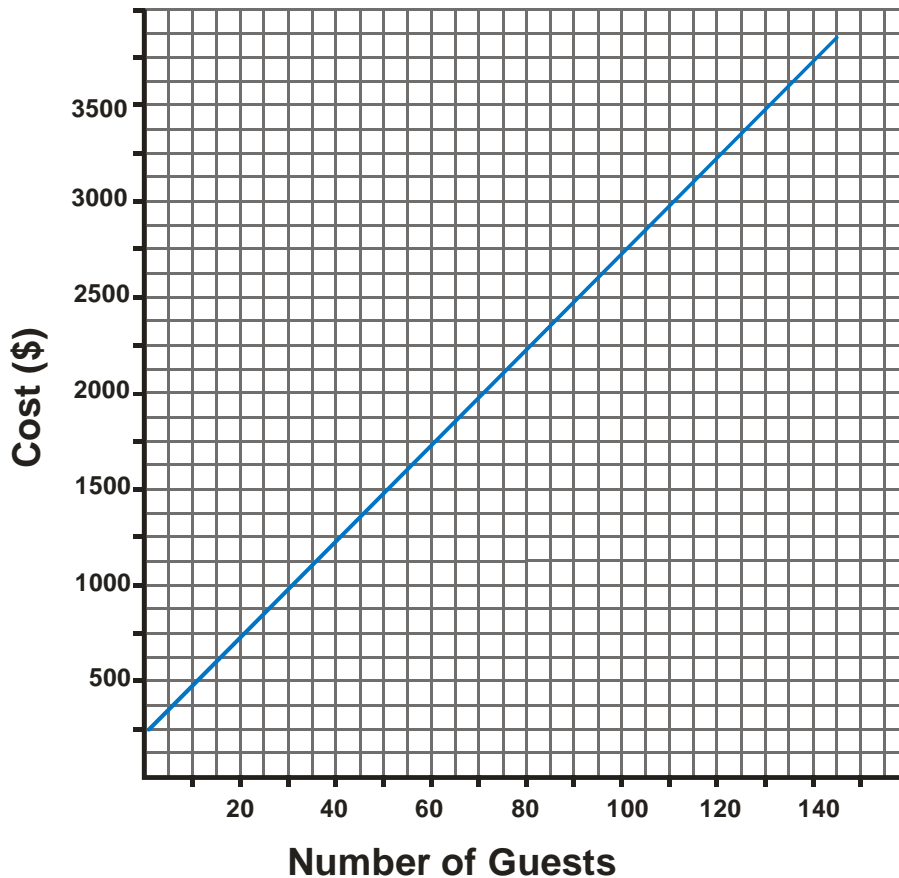
$$-4x + 1 = -3$$

$$3t + 6 = 9$$

### 6.1.3: Working with Equations

Jenise has inquired about the cost of renting a facility for her wedding. She used the data she received to draw the graph below.

**Cost of Holding a Wedding at a Facility**



1. Jenise said the graph shows a linear relationship. Justify Jenise's answer.
2. Does this relation represent a direct or partial variation? Explain your answer.
3. State the initial value and calculate the rate of change of this relation.

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### 6.1.3: Working with Equations (continued)

4. Use the graph to complete the table of values:

Number of Guests	Cost (\$)
10	
	1250
110	
	2500
0	
	3500
30	


5. Determine an equation for the relationship.
6. Solve the above equation to determine the number of guests Jenise could have for \$1750. Verify your answer using the graph.
7. Solve the equation to determine the cost for 175 guests. Show your work.

# The Equation Game (Presentation software file)

Equation Game.ppt


1

The Equation Game



2


Why is an equation like a balance scale?



$$2x - 1 = 3$$

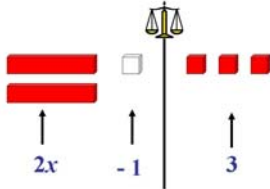
3

The equation game has one rule ...




... do the same action on both sides.

4

$$2x - 1 = 3$$



2x   -1   3

5

$$2x - 1 + 1 = 3 + 1$$


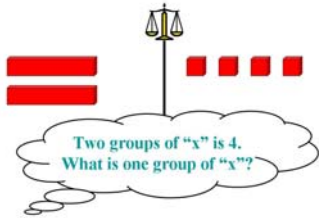
Why did we add one red tile to each side?

6

$$2x = 4$$


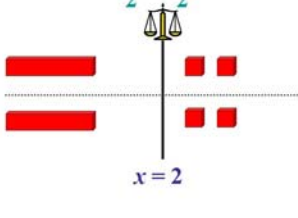
The action on both sides is... SIMPLIFY!

7

$$2x = 4$$



Two groups of "x" is 4. What is one group of "x"?

8

$$2x = 4$$


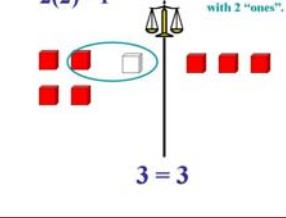
$$x = 2$$

9

$$2x - 1 = 3$$


How can you check your answer?

10

$$2x - 1 = 3$$


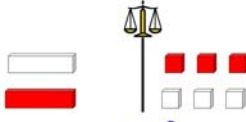
Replace each "x" with 2 "ones".

$$2(2) - 1 = 3$$

$$3 = 3$$

11

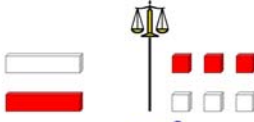
... what if?  $-x = 3$



$$x = -3$$

If two sides of an equation are equal then the opposites of the two sides are equal.

12

$$-x = 3$$


$$x = -3$$

When you change the signs of both sides, how are you following the one rule of the Equation Game?

13

Play the Equation Game with a partner

Solve each equation.  
Check your solution.

- $3x - 2 = 4$
- $4x + 1 = -7$
- $-4 = 2 + 2a$
- $3 - b = -2$
- $-4x + 1 = -3$
- $3t + 6 = 9$



**Math Learning Goals**

- Solve linear equations.

**Materials**

- algebra tiles
- BLM 6.2.1, 6.2.3
- BLM 6.2.2 (Teacher)

**Assessment Opportunities**

**Minds On ...**

**Whole Class → Literacy Strategy**

Complete a Frayer Model definition chart for *linear equation* (BLM 6.2.1 and 6.2.2).

**Action!**

**Pairs → Practice/Pair Relay**

Pair students heterogeneously.

Make a set of the questions on BLM 6.2.3 for each pair, distributing the first question to start.

Each pair completes the first question with their partner. One member verifies with the teacher that the answer is correct before receiving the next question.

If the solution is incorrect, teachers may prompt students so that they can find their mistake. The pair corrects their solution and checks again for correctness.

Provide individual help and encouragement as the students are involved in the relay.

**Curriculum Expectation/Observation/Mental Note:** Observe students as they solve and check equations in order to provide further instruction, if needed.



**Consolidate Debrief**

**Whole Class → Discussion**

Help students make connections with solving equations in context. Students work on BLM 6.2.3.

Word Wall  
linear equation

*Practice*

**Home Activity or Further Classroom Consolidation**

Complete practice problems involving linear equations.

Provide appropriate practice problems.



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## 6.2.1: Frayer Model – Definition Chart

<b>Definition</b> (in own words)	<b>Facts/Characteristics</b>
<b>Examples</b>	<b>Non-examples</b>

Linear  
Equation

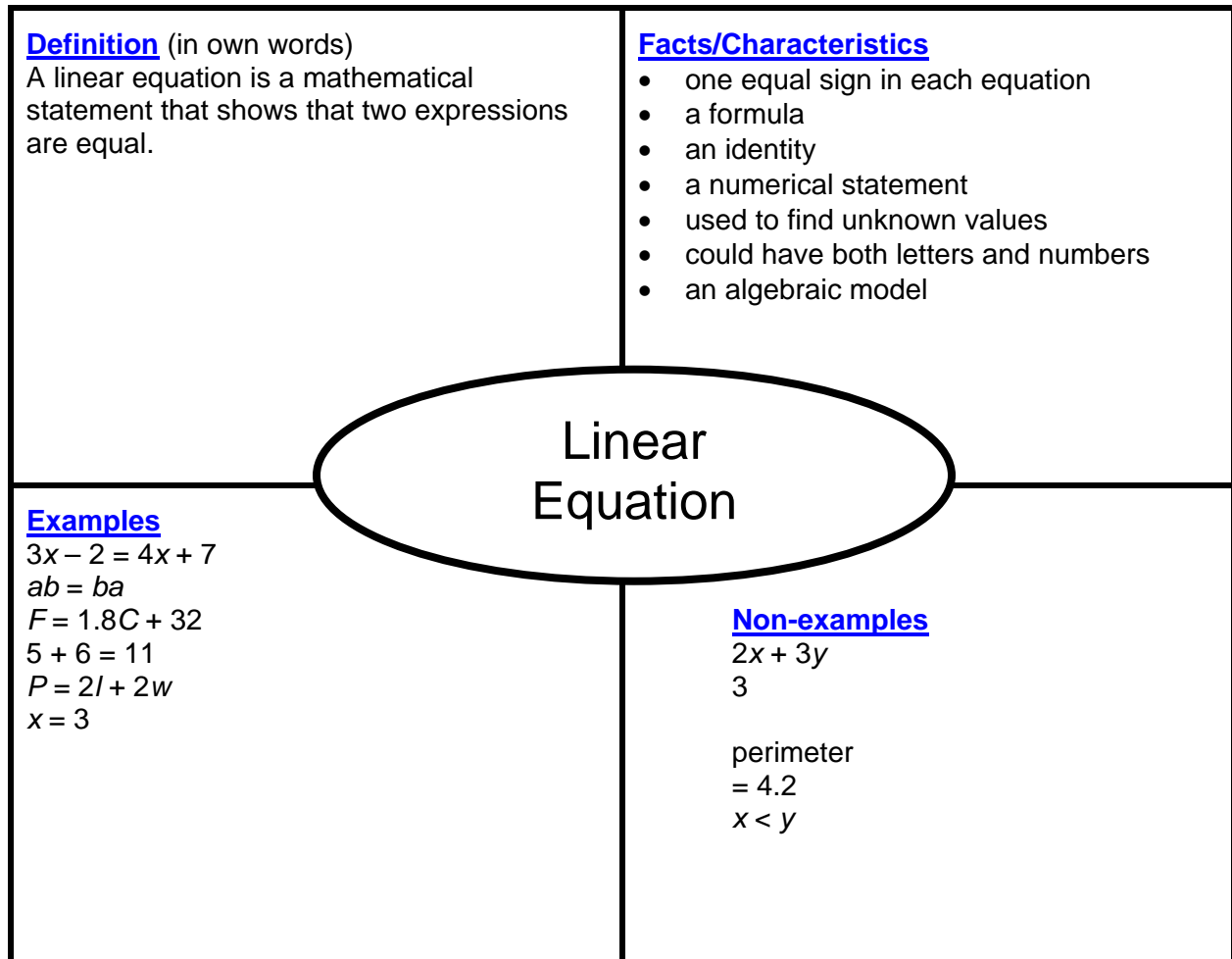
## 6.2.2: Frayer Model – Definition Chart (Teacher)

### Purpose

- To help learners develop their understanding of concepts

### Method

- Choose a concept – write the concept in the centre of the graphic
- Complete the chart (before/after/during discussion)
- Add word to Word Wall
- Display sample student work



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## 6.2.3: Solving Equations Relay

1. Lui knows that the area of a rectangle is  $225 \text{ cm}^2$  and the length of the rectangle is 45 cm. Lui needs to find the width of the rectangle.

Lui has started the problem by using the formula for the area of a rectangle.  
Finish the solution by solving the equation.

### Lui's Solution:

$$A = l w$$

But  $A = 225 \text{ cm}^2$  and  $l = 45 \text{ cm}$ , so:

$$225 = 45 w \text{ (... now **you** solve the equation)}$$



2. The formula for the perimeter of a rectangle is:  $P = 2l + 2w$

The length of a rectangle is 4.2 cm and its perimeter is 20 cm.

Solve an equation to find the width of the rectangle.

### Partial Solution:

$$P = 2l + 2w$$

$$20 = 2(4.2) + 2w$$

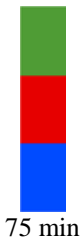
$$20 = 8.4 + 2w \text{ (... now **you** solve the equation)}$$



3. Solve for the unknown. Check your answer.

a)  $3x - 5 = 4$

b)  $3.2 = 2a - 2$



**Math Learning Goals**

- Solve linear equations.
- Make connections between graphical and algebraic models.

**Materials**

- algebra tiles
- BLM 6.3.1

**Assessment Opportunities**

**Minds On ...**

**Pairs → Practice**

Students practise solving problems with equations. Students use one sheet of paper between them. Student A does the first question while student B observes. When both students agree on the solution, the paper is shifted to B, who does question 2 while A observes. Repeat for several questions.

**Curriculum Expectations/Observation/Worksheet:** Pairs self-assess for accuracy and form.

Select 4–6 questions from the textbook or prepare a worksheet.



**Action!**

**Whole Class → Discussion**

Help students make connections between algebraic and graphical models by doing the first question on BLM 6.3.1 together.

**Differentiated Groups → Developing Understanding**

Some students may need to further develop understanding of solving equations.

Use students' self-assessment to form homogeneous groups for developing understanding.

Assign appropriate exercises to meet the needs of the different groups.

Some groups may complete BLM 6.3.1.

Advise students that they need to ask themselves the question, Which variable do I know the value of and which do I need to find?

**Consolidate Debrief**

**Pairs → Practice**

Pair students heterogeneously. Students continue to work on BLM 6.3.1 and provide other questions.

**Home Activity or Further Classroom Consolidation**

*Application*

Complete the questions.

Select appropriate practice questions.

## 6.3.1: Mathematical Models

Each situation has a **graphical** model (graph), an **algebraic** model (equation) and a **numerical** model (table of values). Choose either the graphical model or the algebraic model to complete the table of values. Show your work and justify your choice of model.

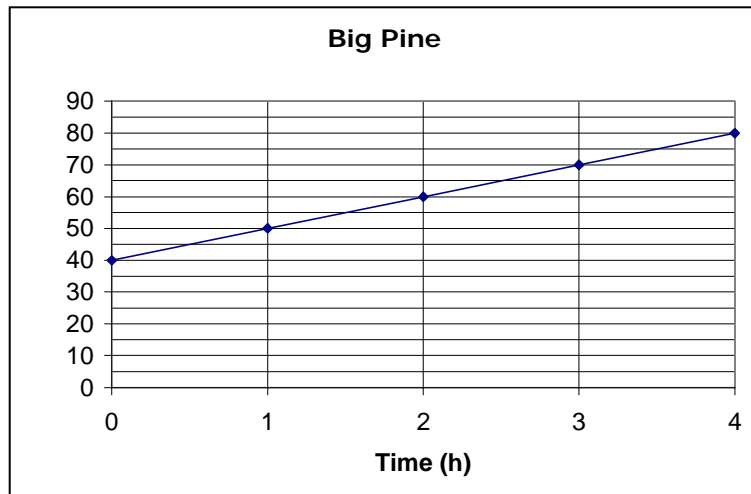
1. Big Pine Outfitters charges a base fee of \$40 and \$10 per hour of use.

$C$  represents the total cost (\$) and  $t$  represents the numbers of hours the canoe is used.

**Algebraic Model:**

$$C = 40 + 10t$$

**Graphical Model:**



**Numerical Model:**

	$t$ (h)	$C$ (\$)
a)	0	
b)		70
c)		230

**Solutions:**

a)

b)

c)

## 6.3.1: Mathematical Models (continued)

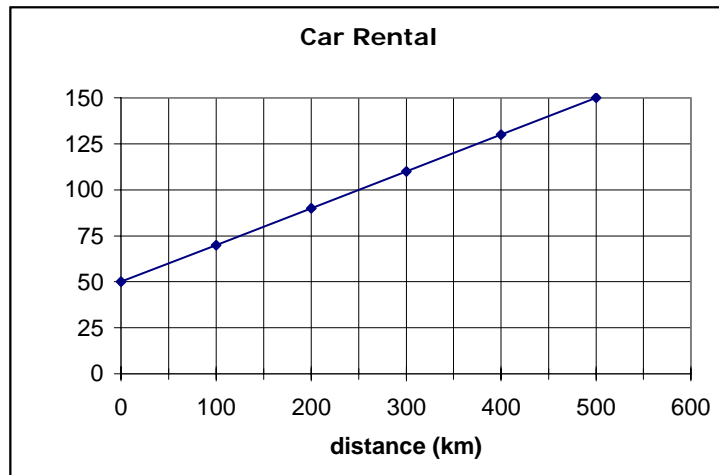
2. A rental car costs \$50 per day plus \$0.20 for each kilometre it is driven.

$C$  represents the total cost (\$) and  $d$  represents the distance (km).

**Algebraic Model:**

$$C = 50 + 0.2d$$

**Graphical Model:**



**Numerical Model:**

	$d$ (km)	$C$ (\$)
a)	250	
b)	1000	
c)		300

**Solutions:**

a)

b)

c)

Justify your choice.

## 6.3.1: Mathematical Models (continued)

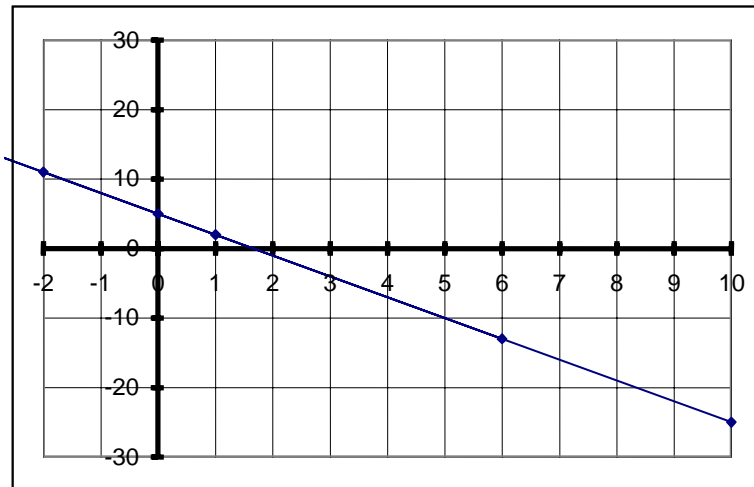
3.

**Algebraic Model:**

$$y = -3x + 5$$

(label the axes)

**Graphical Model:**



**Numerical Model:**

	<b>x</b>	<b>y</b>
a)	0	
b)	6	
c)		-55

**Solutions:**

a)

b)

c)

Justify your choice.

### Challenge

Describe a situation that could be modelled with the given graph or equation.



**Math Learning Goals**

- Graph a relationship from its equation.
- Review the meaning of rate of change and initial value in context.
- Connect first differences to the rate of change.
- Review the concept of continuous vs. discrete data.

**Materials**

- BLM 6.4.1

**Assessment Opportunities**

**Minds On ...**

**Whole Class → Discussion**

Review creating a table of values and finding the rate of change from a table of values.

For the table of values use increments of 25.

For the graph use increments of 25 on the x-axis and increments of 200 on the y-axis.

**Action!**

**Whole Class → Discussion/Practice**

Discuss how to:

- graph an equation by making a table of values from an equation;
- relate the differences (dependent variable differences divided by independent variable differences) to the graph's rate of change;
- determine the meaning of *point*, *rate of change*, and *initial value* in context;
- answer questions related to solving the equation and then verifying the answers using the graph;
- review the concept of continuous vs. discrete data.

Do the first part of question 1 with the students and then they can complete BLM 6.4.1.

**Curriculum Expectations/Observation/Rubric:** Assess students' ability to use proper conventions for graphing.

Reminder: *Continuous data* is data that is measured, and *discrete data* is data that is counted. When both variables in a relationship are continuous, a solid line is used to model the relationship. If either of the variables in a relationship are discrete, a dashed line is used to model the relationship.

**Consolidate Debrief**

**Whole Class → Discussion**

Discuss the answers to BLM 6.4.1.

To relate rate of change to first differences, discuss the need for the independent variable values to go up by the same amount in the table of values.

**Home Activity or Further Classroom Consolidation**

Complete the practice questions.

Use BLM 6.4.1 as a guide in preparing further practice questions, e.g., use different menus and equations.

*Application  
Concept Practice*



## 6.4.1: Planning a Special Event

Maxwell's Catering Company prepares and serves food for large gatherings. They charge a base fee of \$100 for renting the facility, plus a cost per person based on the menu chosen.

**Menu 1** is a buffet that costs \$10 per person.

**Menu 2** is a three-course meal that costs \$14 per person.

**Menu 3** is a five-course meal that costs \$18 per person.

1. Complete the table of values for each relation: [\*Note:  $n$  must go up by equal increments]

**Menu 1:  $C = 10n + 200$**

$n$ No. of people	$C$ Cost (\$)	First Difference
25		
50		
75		
100		
125		

\* $n$  goes up by 25

**Menu 2:  $C = 14n + 200$**

$n$ No. of people	$C$ Cost (\$)	First Difference
0		
50		
100		
150		
200		

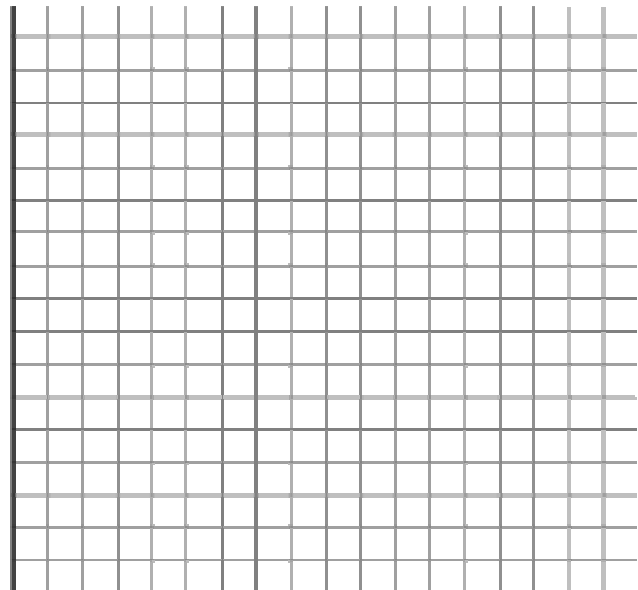
\* $n$  goes up by 50

**Menu 3:  $C = 18n + 200$**

$n$ No. of people	$C$ Cost (\$)	First Difference

\* $n$  goes up by \_\_\_\_

2. a) Graph the 3 relations on the same set of axes. Use an appropriate scale, labels, and title.
- b) Explain whether to use dashed or solid lines to draw these graphs.



## 6.4.1: Planning a Special Event (continued)

3. a) Identify the rate of change and the initial amount of the **Menu 1** line. How do these relate to the total cost?

What does it mean in this problem?	
Rate of change:	
Initial amount:	

- b) Identify the rate of change and the initial amount of the **Menu 2 and 3** lines.

Line	Rate of change	Initial amount
2		
3		

4. a) Examine the first differences and the increment in  $n$ .

Line	Increment in $n$	First Differences	<u>First Differences</u> Increment in $n$
1	25		
2	50		
3			

- b) How do they relate to the graph and the equation?

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## 6.4.1: Planning a Special Event (continued)

5. Compare the three graphs. How are the graphs the same? different?

Same	Different

6. a) For **Menu 2**, what does the ordered pair (120, 1780) mean?

- b) For **Menu 3**, what does the ordered pair (80, 1540) mean?

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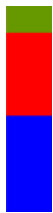
### 6.4.1: Planning a Special Event (continued)

7. Seventy people are expected to attend a school event. How much will it cost for each menu?

Menu	Cost (show your work)
1	
2	
3	

8. Vadim and Sheila are planning a celebration. They have \$3000 to spend on dinner. They would like to have **Menu 3**. What is the greatest number of guests they can have?

9. Logan's Plastics employs 50 people. Each year the company plans a party for its employees.
- Find the cost for **Menu 2** and write your answer as the ordered pair (50, C).
  - Find the cost for **Menu 3** and write your answer as the ordered pair (50, C).
  - How many more dollars will Logan's Plastics have to pay if they choose **Menu 3** instead of **Menu 2**?



75 min

**Math Learning Goals**

- Graph a relationship from its equation.
- Review the meaning of rate of change and initial value in context.
- Connect first differences to the rate of change.
- Review the concept of continuous and discrete data.
- Review independent and dependent variables.

**Materials**

- BLM 6.5.1, 6.5.2, 6.5.3

**Assessment Opportunities**

**Minds On ...**

**Whole Class → Discussion**

Take up the students' solutions to the work from the previous Home Activity.

**Action!**

**Pairs → Peer Coaching**

Students work in partners to complete BLM 6.5.1 using the method of A coaches B, then B coaches A. Circulate to help students.

**Learning Skill (Teamwork)/Rating Scale:** Assess students' collaborative skills as they work together and coach each other.

**Consolidate Debrief**

**Whole Class → Connecting/Note Making**

As students share their answers to BLM 6.5.1, review the following key ideas:

- rate of change = dependent variable differences/independent variable differences
- initial condition is represented by the point on the graph  $(0, b)$
- any point on the graph represents the coordinates: (independent variable, dependent variable)
- review the concept of continuous and discrete data

Students make notes, as appropriate.

**Curriculum Expectations/Quiz:** Students complete a quiz (BLM 6.5.2).

**Home Activity or Further Classroom Consolidation**

Complete worksheet 6.5.3, Cooling It!

*Application  
Concept Practice*

## 6.5.1: An Environmental Project

### A coaches B

For a project on the environment, you have decided to gather data on two similar types of vehicles – an SUV and a minivan. Compare the distance that the vehicles can travel on a full tank of gasoline. For each kilometre a vehicle is driven, the gasoline is used at the given rate.

**SUV**  $G = 80 - 0.20d$ , where  $G$  represents the amount of gasoline remaining in litres and  $d$  represents the number of kilometres driven

**Minivan**  $G = 65 - 0.15d$ , where  $G$  represents the amount of gasoline remaining in litres and  $d$  represents the distance travelled in kilometres

1. Create a table of values showing the amount of gasoline remaining for up to 400 km.

**Note:**  $d$  must go up by the same amount each time.

**SUV**

$d$ (distance in km)	$G$ (gasoline remaining in litres)	First Difference
0		
100		
200		
300		
400		

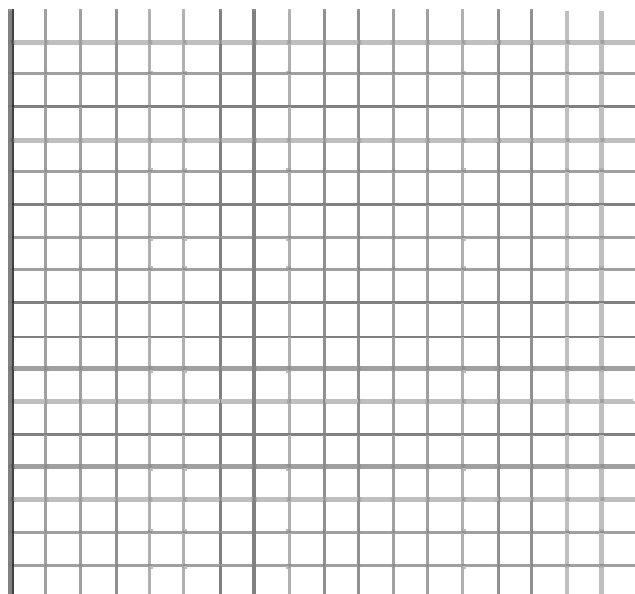
Independent variable:

**Minivan**

$d$ (distance in km)	$G$ (gasoline remaining in litres)	First Difference

Dependent variable:

2. a) Graph the relations on the same set of axes.  
Use an appropriate scale, labels, and a title.
- b) Explain how you know that this data is continuous.



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## 6.5.1: An Environmental Project (continued)

### B coaches A

3. Identify the rate of change and the initial value of the SUV.

What does it mean in this problem?	
Rate of change:	
Initial value:	

4. Examine the differences. How do they relate to the graph and the equation?

(Hint: calculate  $\frac{G \text{ differences}}{d \text{ differences}}$ .)

5. Compare the graphs. How are the graphs...

a) the same?

b) different?

6. For the minivan, what does the ordered pair (100, 50) mean?

7. If the SUV is driven 250 km, how much gasoline is left?





## 6.5.2: The Cellular Phone Problem Quiz

Two cellular phone companies have a monthly payment plan. They charge a flat fee plus a fee for each minute used.

**Call-A-Lot plan**     $C = 0.50t + 20$     Where  $C$  represents the total monthly cost and

**Talk-More plan**     $C = 0.25t + 25$      $t$  represents the number of minutes.

1. Create a table of values showing the total charges for a month for up to 30 minutes. (Remember to make time go up by the same amount for each interval.)

**Call-A-Lot**

$t$ (time in minutes)	$C$ (cost in \$)	First Difference

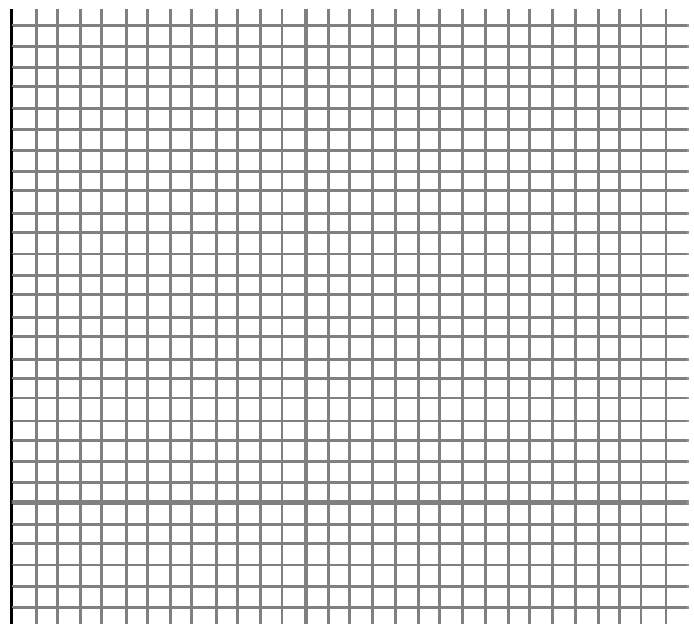
**Talk-More**

$t$ (time in minutes)	$C$ (cost in \$)	First Difference

2. a) Graph the relations on the same set of axes.  
Use an appropriate scale.

b) Independent variable:

Dependent variable:



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## 6.5.2: The Cellular Phone Problem Quiz (continued)

3. Identify the rate of change and the initial value of the **Call-A-Lot** line. Explain what each means in this problem.

What does it mean in this problem?	
Rate of change:	
Initial value:	

4. Examine the differences. How do they relate to the graph and the equation?

(Hint: calculate  $\frac{C \text{ differences}}{t \text{ differences}}$ ).

5. Compare the graphs. How are the graphs...

a) the same?

b) different?

6. For Talk-More, what does the ordered pair (8, 27) mean?

7. One month, Leslie used 13 minutes on the **Talk-More** plan. How much did it cost her?

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## 6.5.2: The Cellular Phone Problem Quiz (continued)

8. Arjun had a bill of \$29 last month on the **Call-A-Lot** plan. How many minutes did he use the phone?
9. Marsha thinks that she will use an average of 12 minutes each month.
- Find the cost for the **Call-A-Lot** plan and write as the ordered pair (12, C).
  - Find the cost for the **Talk-More** plan and write as the ordered pair (12, C).
  - Which plan is better for Marsha and how much will she save with this plan?

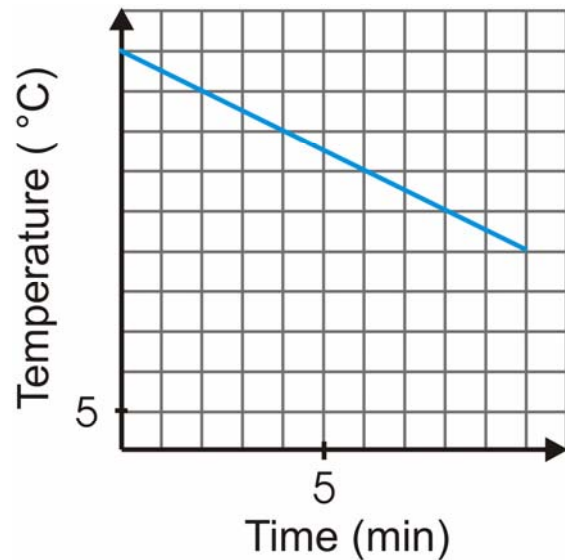
### 6.5.3: Cooling It!

Denis measured the temperature of a cup of hot water as it cooled. He then made the graph on the right. **Complete the scale**, and then answer the following questions about the graph.

- a) One of the points on the graph is (6, 35). Explain the meaning of this point, in the context of Denis' measurements.

- b) Independent variable:

Dependent variable:



- c) Explain why this is continuous data.

- d) Use your graph to determine the temperature after 3.5 minutes.

- e) Identify the rate of change and the initial value and explain what they mean in this problem.

What do they mean in this problem?	
Rate of change:	
Initial value:	

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### 6.5.3: Cooling It! (continued)

- f) Write an equation to model Denis' data. Use  $T$  for temperature and  $t$  for time.
- g) Use your equation to determine the temperature of the water after:
- i) 3.5 minutes
  - ii) 20 minutes
- h) Your results for 20 minutes may conflict with what you know about cooling water. Explain. What does this tell you about the limitations of this linear model?
- i) Use your equation to predict when the temperature will be  $39^{\circ}\text{C}$ .



**Math Learning Goals**

- Explore a variety of purchase options, propose a purchase plan, and provide a rationale according to a specific criterion.
- Use graphing technology to investigate the solution.
- Model three linear relations with an equation and graph.
- Read and/or manipulate graphs to determine the best choice.

**Materials**

- graphing calculators
- BLM 6.6.1, 6.6.2, 6.6.3

**Assessment Opportunities**

**Minds On ...**

**Pairs → Understanding the Problem**

In pairs, students work through BLM 6.6.1.

Reinforce the concept of the point of intersection of linear relations and the meaning of the point of intersection in context.

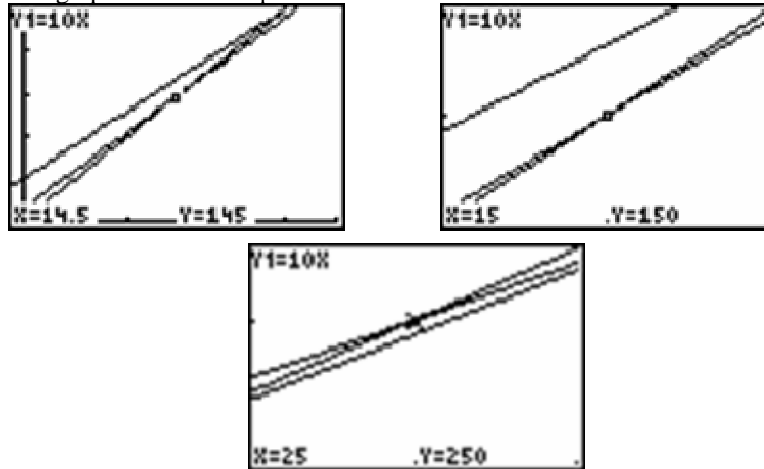
**Action!**

**Individual → Performance Task**

**Curriculum Expectations/Mathematical Processes/Rubric:** Students complete the worksheet and submit.

Discuss the various options for solving the problem on BLM 6.6.2. Point out that the Lees will be away for weeks but the Kennel information is given in terms of days. Is there any information that is not needed or cannot be used?

The graphical model is provided below:



To clarify the scenario for students, answer questions without providing a strategy for solving the problem.

Notice that the fourth kennel is for dogs only (BLM 6.6.2).

Circulate to assist students with the graphing calculator. Some students may be more comfortable using charts and grid paper.

**Consolidate Debrief**

**Whole Class → Discussion**

It is expected that the students may not complete the task. Discuss briefly any concerns they have encountered to this point.

**Home Activity or Further Classroom Consolidation**

Revisit this problem with the following question:

Tanya needs to put her cat in a kennel while she is away for 12 days. Toby plans to board his kitten for 3 weeks, and the family does not know if they will be away for 2 or 3 weeks. Which kennel should these people choose for their cats?

*Application  
Concept Practice*

## 6.6.1: The Landscaping Problem

A law office plans to do some landscaping around their building. They have two estimates:

**Company A:** \$240 for a full landscape plan, plus \$30 per hour to do the work

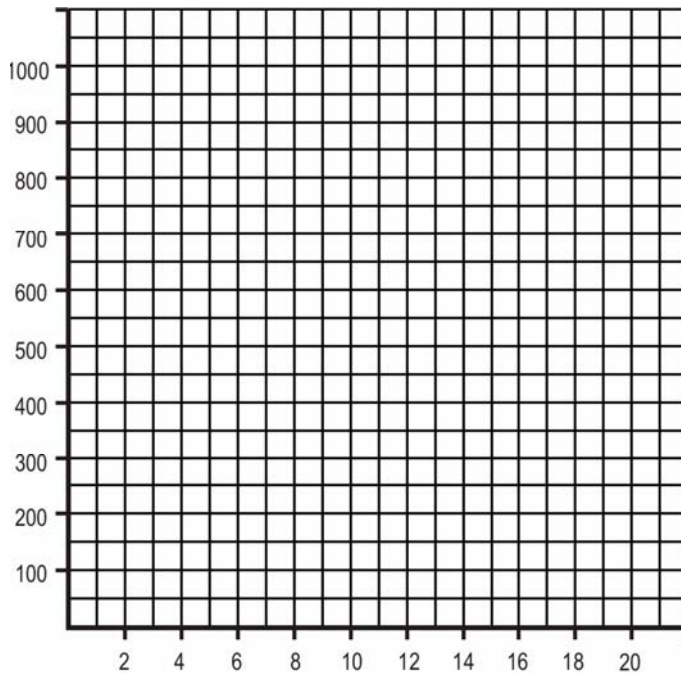
**Company B:** \$60 per hour to do the work (which includes the landscape plan)

1. Complete the table of values for each company.

Company A	
Time (h)	Cost (\$)
0	
2	
4	
6	
8	
10	
12	
14	
16	

Company B	
Time (h)	Cost (\$)
0	
2	
4	
6	
8	
10	
12	
14	
16	

2. Display this data on the grid below. Label carefully and use a different colour for each company.



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### 6.6.1: The Landscaping Problem (continued)

3. At what point on the graph is the cost the same for both companies?  
(You need both time and cost.)
  
4. What characteristics does that point have on the graph?
  
  
  
  
  
  
  
  
  
  
5. If the job took 6 hours, which company would you choose? Explain your answer.
  
  
  
  
  
  
  
  
  
  
6. If the job took 12 hours, which company would you choose? Explain your answer.
  
  
  
  
  
  
  
  
  
  
7. Complete each of the following sentences:  
I would choose **Company A** if...

I would choose **Company B** if...



## 6.6.2: Kitty's Kennel Costs

The Lees and their children are planning to be away for 4 to 6 weeks. They need to board their cat, Kitty. They want to spend the least amount of money possible.



The Lees have researched the costs of local kennels and have clipped the following ads from their local newspaper.

<p><b>Cozy Kennel</b> for Dogs and Cats</p> <ul style="list-style-type: none"><li>* Individual pens</li><li>* Top quality food</li><li>* Individual daily attention</li></ul> <p>Just <b>\$10/day</b> for small dogs and cats; <b>\$15/day</b> for mid-size to large dogs</p>	<p><b>Feline Holidays</b></p> <p>Let us pamper your cat while you are away!</p> <p><b>\$15</b> fixed fee (includes nail clipping and combing) <b>\$9/day</b> for all the food and attention your cat needs.</p>	<p><b>Pet Paradise</b></p> <p>Board your cat or dog here. They'll love it.</p> <p>Just <b>\$8/day</b>, plus</p> <p><b>\$50</b> fixed fee (includes regular grooming during your pet's stay)</p>	<p><b>Bow Wow Weekend</b></p> <ul style="list-style-type: none"><li>* Give your dog a holiday</li><li>* Daily exercise and grooming</li></ul> <p><b>\$80</b> for a 3-day weekend, plus <b>\$8</b> per extra day.</p>
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### Your job is to:

- make a recommendation to the Lees about where they should board their cat and support your answer with evidence;
- show the Lees how to analyse their situation and decide which kennel meets their requirements;
- explain your process to them so that if they change their minds later and want to use a different kennel or change the length of their time away, they understand how to do the calculations themselves.

### Your report must include:

- reasons for **excluding** any of the advertisements;
- your **best guess** (hypothesis) based on the information given in the advertisements before examining the data thoroughly;
- the **procedures** that you used to compare the information in the advertisements (including how you made use of technology);
- **recommendations** to the Lees about where they should board their cat and evidence to support your answer.

## 6.6.2: Kitty's Kennel Costs (continued)



### (A) Clarify the Problem

Examine the advertisements carefully and list any important information. Which kennel should not be considered? Explain.

Make a hypothesis about which kennel you feel is the best choice for the Lees. Briefly explain your reasoning.

### (B) Create Models

Define the variables.

\_\_\_\_\_ represents the cost of boarding Kitty  
 \_\_\_\_\_ represents the number of \_\_\_\_\_  
*days/weeks*

Write an equation for each advertisement that is appropriate to investigate.

Rewrite each of the equations in  $y = \square x + \square$  form for inputting into the graphing calculator.

	Cozy Kennel	Feline Holidays	Pet Paradise
Equation			
Graphing Calculator Equation			

Create a **graphical model** for each of the kennels that is appropriate for Kitty.

Show all graphs on the same grid and label them clearly.

Reproduce the graph you see on the graphing calculator below.

Indicate the window you used.

You may need to adjust your window and zoom in using different windows to see the information you need.



<b>WINDOW</b> Xmin = 0 Xmax = Xscl = Ymin = 0 Ymax = Yscl = Xres = 1
---

## 6.6.2: Kitty's Kennel Costs (continued)



### (C) Manipulate the Model

If the Lees decide to be away for less than 4, 5, or 6 weeks, list the kennel costs: Hint: Use the **TRACE** feature on your calculator.

Number of Weeks	Cozy Kennel	Feline Holidays	Pet Paradise
4			
5			
6			

Explain where Kitty should stay if the Lees are going away for:

(a) 4 weeks

(b) 5 weeks

(c) 6 weeks

You see an advertisement for a new kennel in their neighbourhood. It charges a \$50 initial fee that includes a flea check and treatment, plus \$10/day.

Should the Lees consider this new kennel or reject it? Give reasons for your answer that demonstrates your understanding of the effects of changes in rates and in initial conditions.

### (D) Reconsider the Original Problem

Where do you think the Lees should board their cat? Explain your reasoning.

### (E) Communicate the Ideas

Write your report.

### 6.6.3: Kitty's Kennel Costs Rubric

Criteria	Below Level 1	Level 1	Level 2	Level 3	Level 4
<b>Representing</b> Represents the information algebraically and graphically	- no model provided or the model does not represent the data	- represents the information with limited effectiveness	- represents the information with some effectiveness	- represents the information with considerable effectiveness	- represents the information with a high degree of effectiveness
<b>Connecting</b> Makes connections between the representations and the context of the problem	- connections are not made or the connections are not appropriate	- makes limited connections between the representations and the context of the problem	- makes some connections between the representations and the context of the problem	- makes considerable connections between the representations and the context of the problem	- makes insightful connections between the representations and the context of the problem
<b>Problem Solving</b> Uses critical/creative thinking processes to infer and form conclusions	- inferences and conclusions are not formed or do not match the data	- uses limited critical/creative thinking processes to infer and form conclusions	- uses some critical/creative thinking processes to infer and form conclusions	- uses considerable critical/creative thinking processes to infer and form conclusions	- uses insightful critical/creative thinking processes to infer and form conclusions
<b>Communicating</b> Presents and justifies a solution with clarity	- does not present or justify a solution or the solution is unclear	- presents and justifies a solution with limited clarity	- presents and justifies a solution with some clarity	- presents and justifies a solution with considerable clarity	- presents and justifies a solution with a high degree of clarity



**Math Learning Goals**

- Select a topic involving a two-variable relationship.
- Pose a question on the topic.
- Collect data to answer the question.
- Present its solution using appropriate representations of the data.

**Materials**

- BLM 6.7.1 (Teacher)
- BLM 6.7.2
- graph paper
- graphing calculator

**Assessment Opportunities**

**Minds On ...**

**Whole Class → Discussion**

Use broad-based questioning to discuss the Kitty’s Kennel problem from the previous day. Connect the points of intersection of the graphs to the recommendations for choosing the best kennel.

Using BLM 6.7.1 as a guide, pose open-ended questions and discuss with the class how and where they could find the appropriate data to confirm relationships.

It is expected that this task will take more than one day for students to complete.

Revisit Unit 3 for appropriate relationship concepts. This lesson adds the complexity of the algebraic model.

**Action!**

**Pairs → Exploration**

Students choose a relationship and pose a question about the relationship.

They collect data following the steps suggested on BLM 6.7.1 and hand in a rough copy for peer editing.

Depending on complexity of questions posed, this activity could use more than one period.

**Consolidate Debrief**

**Pairs → Peer Editing**

Students peer edit a different pair’s work (BLM 6.7.2). See *Think Literacy: A Cross-Curricular Approach, Mathematics* pp. 86–89.

**Communicating/Performance Task/Checklist:** Assess the poster/presentation using a checklist from BLM 6.7.1.



**Home Activity or Further Classroom Consolidation**

Make improvements to your graphic solutions based on feedback from your peers.

Produce a final presentation or display.

Could use part of an Instructional Jazz day for presentations.

*Reflection*

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## 6.7.1: Answering Questions by Collecting Data (Teacher)

### Steps to follow to complete assignment

Step 1 – Select a topic that involves a relationship between two variables.

Example: Number of hours spent on the Internet and final mark

Step 2 – Pose a question relating to the data.

Example: Does the number of hours you spend on the Internet affect your final mark?

Step 3 – Collect data to answer the question.

Sources: Stats Canada, TSN website, newspaper, collect a survey, conduct an experiment, etc.

Step 4 – Organize and present the data numerically, graphically, and (if linear) algebraically.

Step 5 – Describe the result and any trends orally or by making a poster display or using presentation software.

### Other Ideas for Relationships to Explore

- Number of shots on goal vs. number of goals scored in the NHL
- Olympic or World Championship winning times vs. time span (*Choose an event.*)
- Size of population vs. time span (in years)
- Growth rates (up to 18) vs. age
- Use of Internet in schools vs. time (in years)

## 6.7.2: Peer Editing Worksheet

Writer's Name: \_\_\_\_\_

Mathematical Task Being Evaluated	Response	
	Yes	No
Is there a relationship between the two variables chosen?		
Is there a question posed?		
Is the question posed appropriate for the topic chosen?		
Has data been collected?		
Is the data collected appropriate for the chosen question?		
Is there a numerical and graphical model to represent the relation?		
Has the graphical model been presented properly? (i.e., labelled, titled, with appropriate scale)		
Has the question been answered?		
Comments		
Strengths:		
Areas of Improvement:		
Suggested Next Steps:		
Peer Editor's Name:		