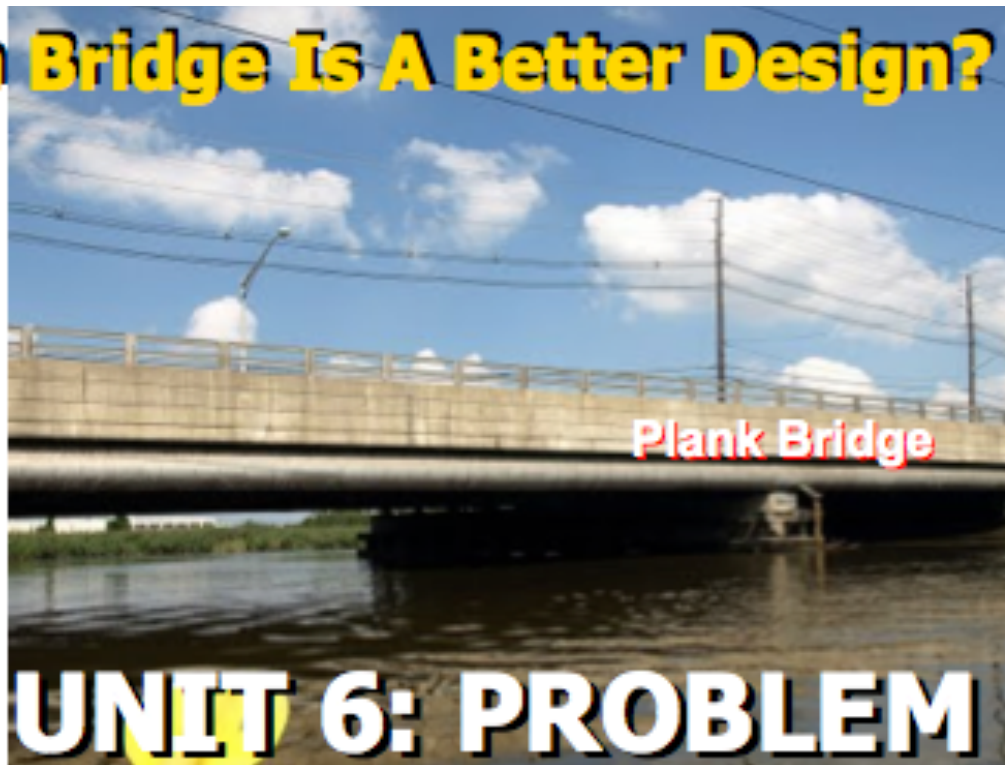


# ACE Engineering: Which Bridge Is A Better Design?

Arch Bridge



Plank Bridge



## UNIT 6: PROBLEM

Name: \_\_\_\_\_

Teacher: \_\_\_\_\_



Cardinal Ambrozic C.S.S. Mathematics Department



SOLVING LINEAR EQUATION | Grade 9 Academic Mathematics Student Workbook | MPM1D1

*"Making decisions in light of gospel values with an informed moral conscience"*

## Problem 6: Which Bridge Is A Better Design?

MPM1D1

Grade 9 Academic Mathematics: Principles of Mathematics



Tool Number	Lesson Title & Topics	Topics	Homework
6.1A	Introduction -SPT -Unit 4 to 6 -Solving Simple		pg. 193 #1 – 5 eol, 8, 9, 12, 17 pg. 200 #1, 2, 4 – 7, 9adf, 13, 18
6.1B	Solving Multi-Step Equations		pg. 193 #1 – 5 eol, 8, 9, 12, 17 pg. 200 #1, 2, 4 – 7, 9adf, 13, 18
6.1C	Solving Equations With Geometric Properties and Measurement		pg. 193 #1 – 5 eol, 8, 9, 12, 17 pg. 200 #1, 2, 4 – 7, 9adf, 13, 18
6.2	Assessment FOR Learning	Quiz	Pg. 200 (Section 4.2) #8, 9bce, 14, 15, 17, 20, 21
6.3	Solving Equations Involving Fractions		Pg. 208 #1, 3ac, 4bd, 5, 6b, 9, 10, 11
6.4	Solving Equations With CAS		NELSON Worksheet
6.5	Modelling With Algebra		Pg. 226 #1, 2, 3, 4, 7, 9, 11, 15,
6.6	Jazz/Review		Pg. 230 #1 - 17
6.7	SPT Pencil and Paper Test		
6.8	SPT Bridge		
6.9	SPT Bridge		

Parent/Guardian Signature: \_\_\_\_\_

## Tool 6.1 Solving Simple Equations

MPM1D1: Principles of Mathematics  
<http://www.dpcdsb.org/AMBRO>

**Minds On: Think, Pair, Share**

### THE MP3 PROBLEM

Mark recently purchased an MP3 player. The player came with 1000 songs already loaded.



As part of the purchase agreement, Mark is able to download 50 additional songs per day at no charge.

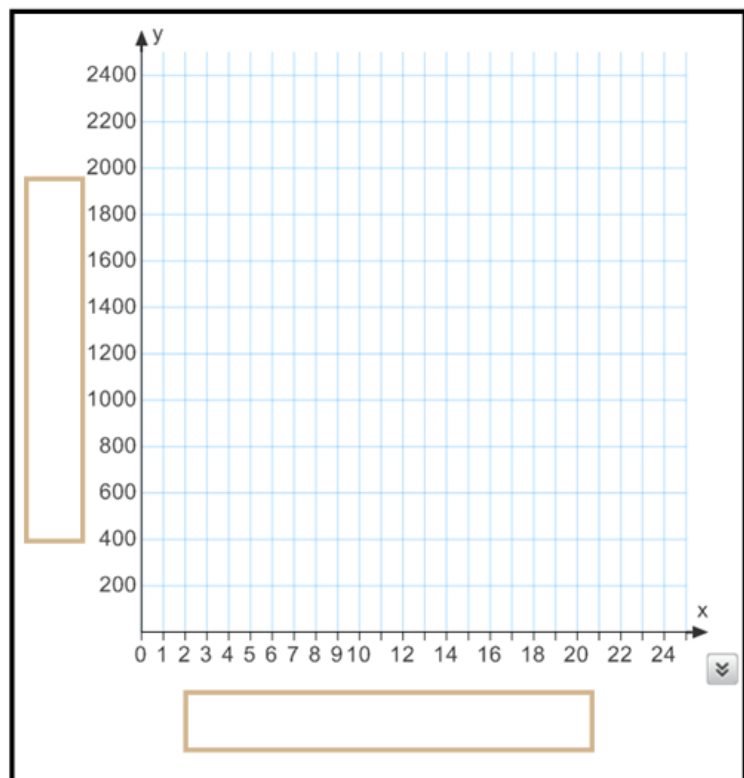
Independent Variable: \_\_\_\_\_

Dependent Variable: \_\_\_\_\_

#### Numerical Model

0	
5	
10	
15	
20	

#### Graphical Model



#### Algebraic Model

How many songs will be present after 1000 days?

How many days will it take Mark to download 11000 songs? Explain how you would solve this.

Describe the advantages and disadvantages of solving using the 1) Numerical 2) Graphical and 3) Algebraic Model

Numerical Model		Graphical Model		Algebraic Model	
<b>Pros</b>		<b>Pros</b>		<b>Pros</b>	
<b>Cons</b>		<b>Cons</b>		<b>Cons</b>	

**Action****Solving Equations By Inspection**

Solve the following word problems:

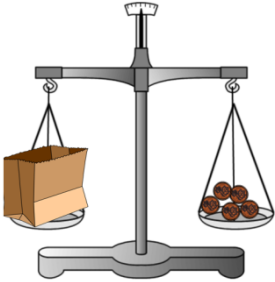

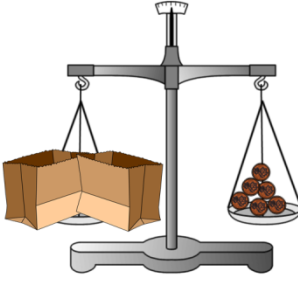

- a) I am thinking of a number. When I multiply the number by 5, I get 125. What is the number?
- b) I am thinking of a number. When I add 17 to the number, I get 125. What is the number?
- c) I am thinking of a number. When I add 3 to the number and divide by 2, I get 125. What is the number?

Solve for x by inspection

a)  $3x + 2 = 17$       b)  $2x - 5 = 1$       c)  $2 = 6x - 10$       d)  $7x + 1 = 22$

**Solving Equations Using A Balance**

For each of the following questions, x (the unknown) is represented by the bags. Find the value of the unknown (the value inside the bag).

a)	b)	c)	d)
			
Bag = _____	Bag = _____	Bag = _____	Bag = _____
In Algebraic Form:	In Algebraic Form:	In Algebraic Form:	In Algebraic Form:

## Solving Equations Using A Balance Assignment



geometer's  
sketchpad



Build the equation shown below. Keep the two sides balanced. How much does  $x$  weigh (Solve for the variable  $x$ )?

1)  $x - 5 = 2$

2)  $3 = 2x - 1$

3)  $2x - 5 = -1$

4)  $2x + 1 = -5$

5)  $2x - 2 = x + 5$

6)  $1 - 2x = -2 - 3x$

7)  $6 - x = 2x + 1$

8)  $x - 1 = -3x - 5$

9)  $2 - 3x = 10 - x$

10)  $-x - 11 = -4x - 2$

$4 - x = 2x - 2$

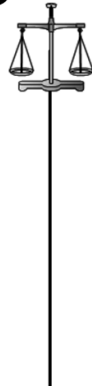
### Solving Equations Using Algebra Tiles

Solve for the unknown variable using algebra tiles.

$$2x + 3 = -3$$



$$4b - 3 = 5$$



$$3x - 5 = x - 9$$



### Solving Equations Algebraically

Solve for the unknown variable using algebra tiles.

$$3x + 5 = 20$$

$$2x - 3 = 4x + 5$$

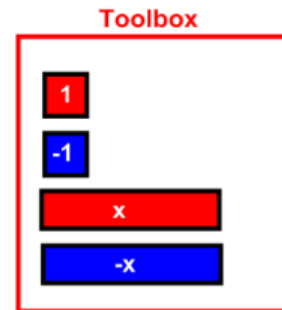
$$-4(u + 6) = 2(3u - 4)$$

$$3(p + 7) - (4p - 1) = -5(2p - 3) + 1$$

## Back to the MP3 Problem

Using any method from the previous screens, answer the following questions from the MP3 problem:

- a) How many songs will be present in the mp3 after 365 days?  
b) How many days will it take to have 57,623 song?



### Consolidation

a)  $4x + 5 = 9$

b)  $18 = 3 - 5x$

c)  $3x = 2x + 8$

d)  $-x = x + 6$

e)  $2 + 7x = 2x - 3$

f)  $-5 + 9x = 11 + 5x$

g)  $8x - 4 - 3x = 11 + 4x$

h)  $4(x - 3) = 3x$

i)  $-3(2x - 5) = -x + 5$



$$2(x + 8) = 3(2x - 4)$$

$$-4(u + 6) = 2(3u - 4)$$

$$3(p + 7) - (4p - 1) = -5(2p - 3) + 1$$

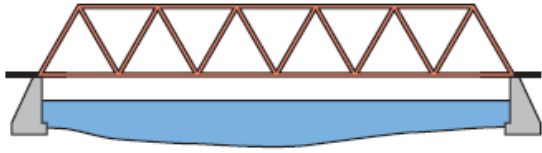
Homework list:

pg. 193 #1 – 5 eol, 8, 9, 12, 17

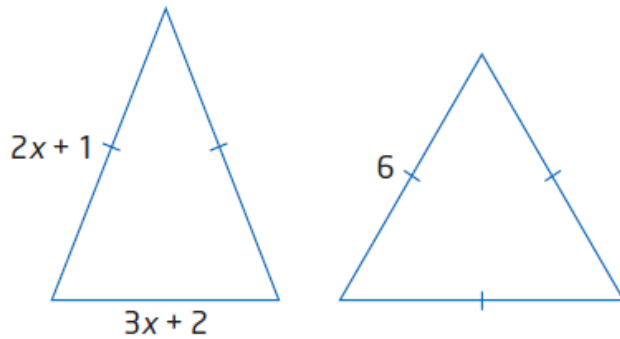
pg. 200 #1, 2, 4 – 7, 9adf, 13, 18

### Problem 1

One type of truss design commonly used to build bridges is known as the Warren truss pattern. This features a series of equilateral or isosceles triangles.

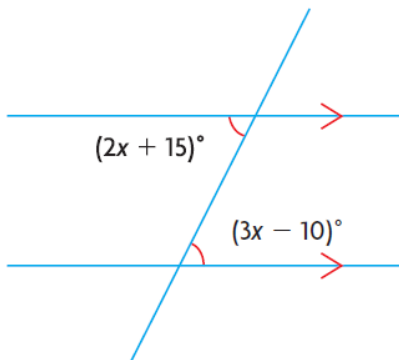


An isosceles triangle and an equilateral triangle have the same perimeter. Find the side lengths of each triangle.

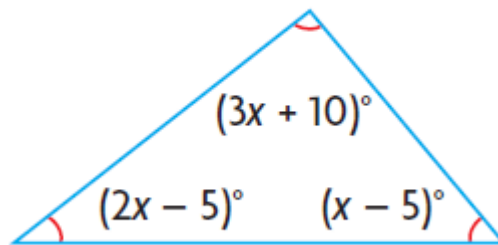


### Problem 2

A



B



## Tool 6.3 Solving Equations Involving Fractions

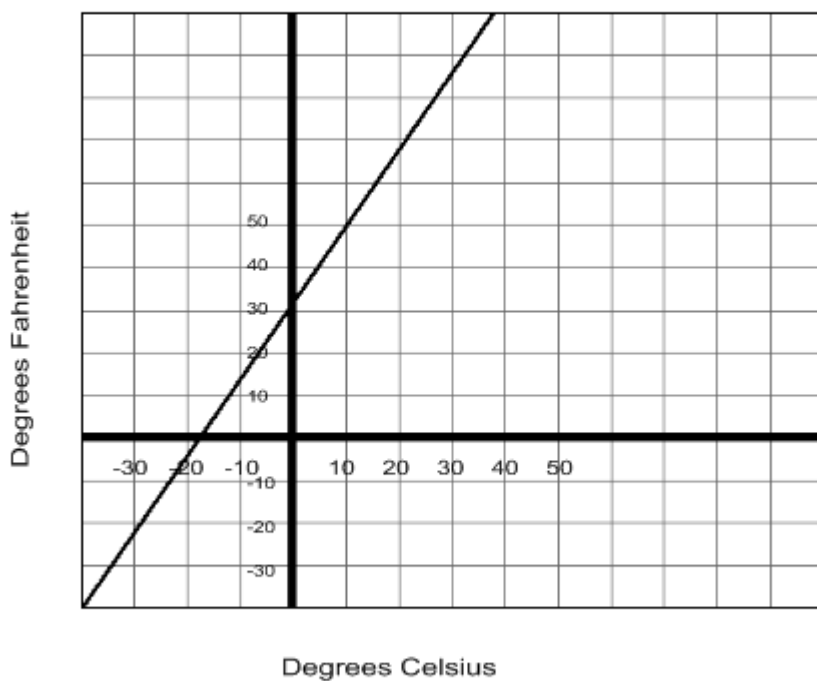
MPM1D1: Principles of Mathematics

<http://www.dpcdsb.org/AMBRO>

### Minds On: Think, Pair, Share

Anisha is planning a trip to Florida for summer vacation. She has looked online to find typical temperatures for the area, but each one is given in degrees Fahrenheit instead of Celsius.

Using the graphical model, Anisha tries to estimate the temperature conversions for 40°F, 55°F, and 82°F using the graph below.



$$40^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$$

$$55^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$$

$$F = \frac{9}{5}C + 32$$

**Action: Solving Equations**

$$\frac{x+2}{3} = \frac{x-4}{5}$$

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

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

## Consolidate: Temperature Conversions

Using the algebraic model, help Anisha by calculating the temperature conversions for  $40^{\circ}\text{F}$ ,  $55^{\circ}\text{F}$ , and  $82^{\circ}\text{F}$ .

$$F = \frac{9}{5}C + 32$$

$$40 = \frac{9}{5}C + 32$$

$$55 = \frac{9}{5}C + 32$$

$$82 = \frac{9}{5}C + 32$$

Homework:

Pg. 208 #1, 3ac, 4bd, 5, 6b, 9, 10, 11

## 6.4 Solving Simple Equations

MPM1D1: Principles of Mathematics

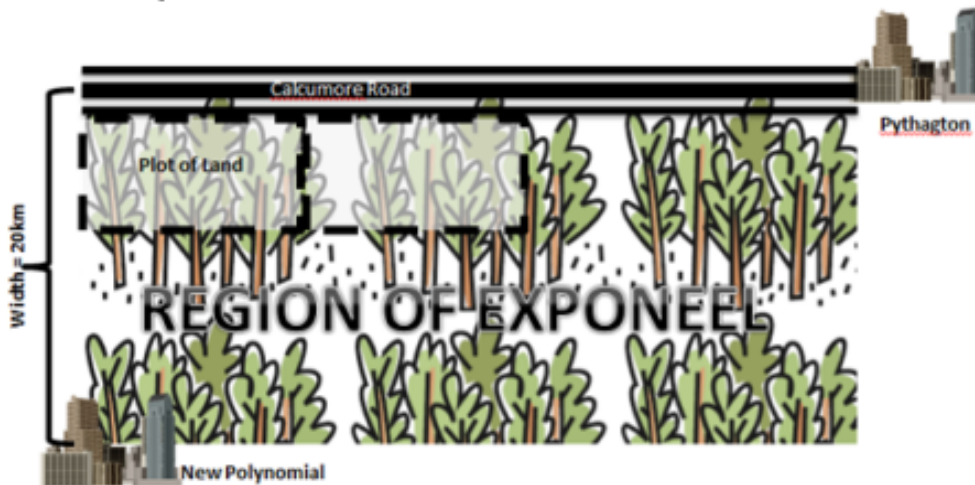
<http://www.dpcdsb.org/AMBRO>

Minds On: Think, Pair, Share

Word	Description
<input type="text"/>	Ten plus four times a number
<input type="text"/>	The difference of Double a number and 4
<input type="text"/>	Five less than triple a number
<input type="text"/>	A number divided by four is 10
<input type="text"/>	Dami's age four years ago was ten
<input type="text"/>	Four more than double a number
<input type="text"/>	The sum of two consecutive number is 5
<input type="text"/>	Four less than a number

## Problem 1

The region of Exponeel is being divided into separate land plots for agriculture. Each piece of land has to have a length that is three less than twice the width.



- If the width of each plot is represented by  $x$ , find an expression for the **length**.
- Determine an expression for the **perimeter** of one plot of land. Expand and simplify the expression.
- Find the dimensions of the plot, if its total perimeter must be 29 km.

**Problem 2**

Two consecutive numbers have a sum of 127. Determine the numbers.

**Problem 3**

Sunny, Chantel and Thayany are neighbours.

Sunny is twice as old as Chantel, and Thayany is three years younger than Sunny. The sum of their ages is 102. How old are they?



# Summative Performance Task: Bridge Designing

## Project 6

Unit 6: Solving Equations

MPM1D1: Grade 9 Academic Mathematics | Principles of Mathematics



**NAME:** \_\_\_\_\_

**SECTION:** \_\_\_\_\_

### Introduction

The City of Brampton is considering building a large bridge on Castlemore Rd. from Clarkway Dr. to Huntington Rd to alleviate traffic. You work for the Ambrozic Civil Engineer Company (ACE Co.) and are trying to win the bid for this project. In order to bid you must determine what bridge type works best for the city.



Through surveillance it was found that at any given moment, the maximum number of cars that will be on the bridge at one time is 100. Your task is to determine which bridge design is best for the project (Plank Bridge or Arch Bridge) and how many layers of concrete will be needed to withstand 100 cars.

### Bridge Designs

There are many different types of bridge designs which serve different purposes. The factors that determine the bridge design includes the type of traffic (i.e. more trucks or cars), what is under the bridge, the aesthetics and the cost.

	<p><b>Beam or Plank Bridge</b></p>
	<p><b>Arch Bridge</b></p>
	<p><b>Cable-Stayed Bridge</b></p>
	<p><b>Suspension Bridge</b></p>

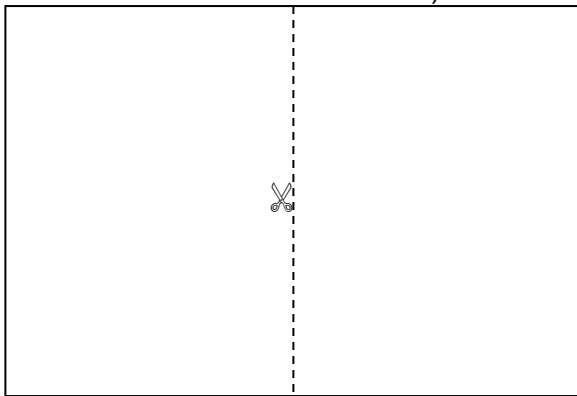
Source: Images are taken from: NOVA Online <http://www.pbs.org/wgbh/nova/bridge/build.html>

Before a bridge is constructed, engineers design models to ensure that the bridge can withstand the stress of the load from cars and people.

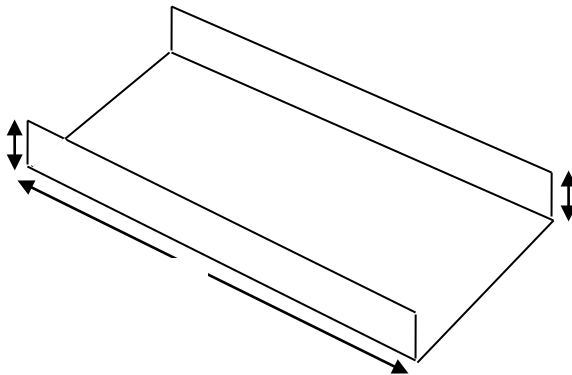
During this task you will determine what is the most structurally sound bridge. You will compare both the arch bridge with the plank bridge and you will determine how many cars your bridge can hold.

### Preparation Instructions – Teacher Notes

1. Have the materials manager collect 30 linking cubes, a piece of masking tape, a plastic cup and 6 pieces of paper. (Your teacher may have already cut the paper for you by cutting a standard sheet of 8.5" x 11" in half as shown below).



2. Fold 5 pieces of paper as shown below. These will be call you bridge planks.

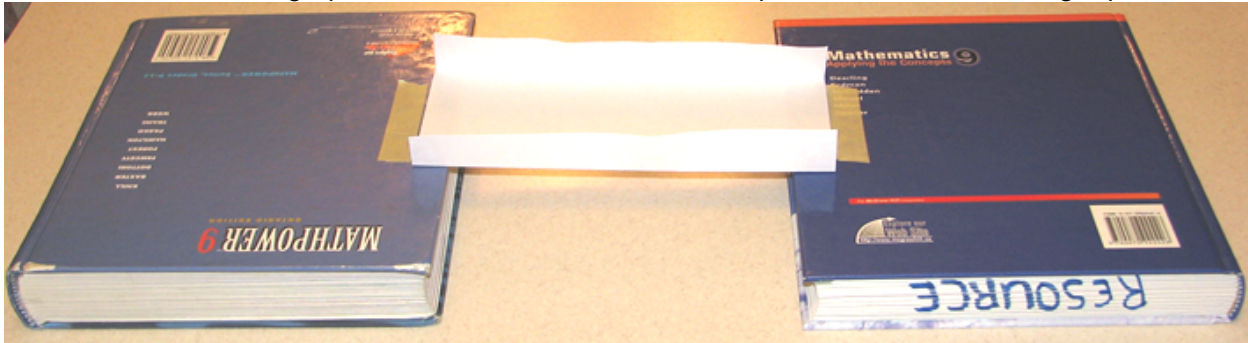


3. Place a piece of masking take 2 cm from the edge of two textbooks. Make sure the spines of each book are facing outside as shown below.

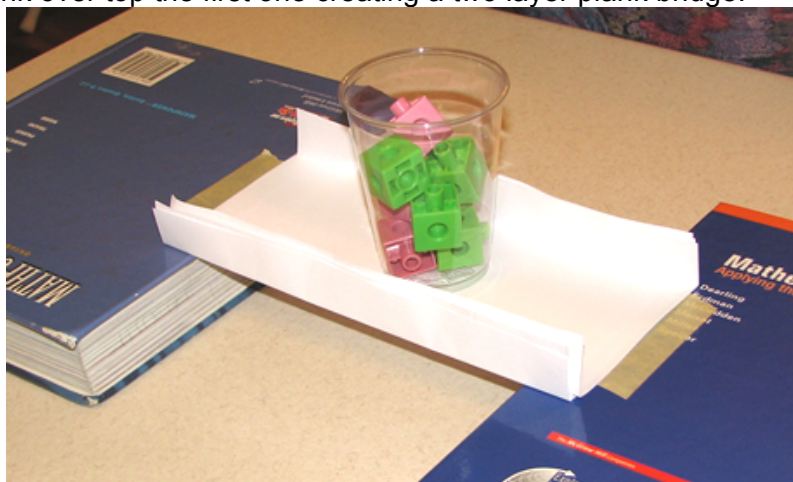


### Beam Bridge Instructions –Teacher Notes

- Place the first bridge plank such that the ends of each plank touch the masking tape as shown below.



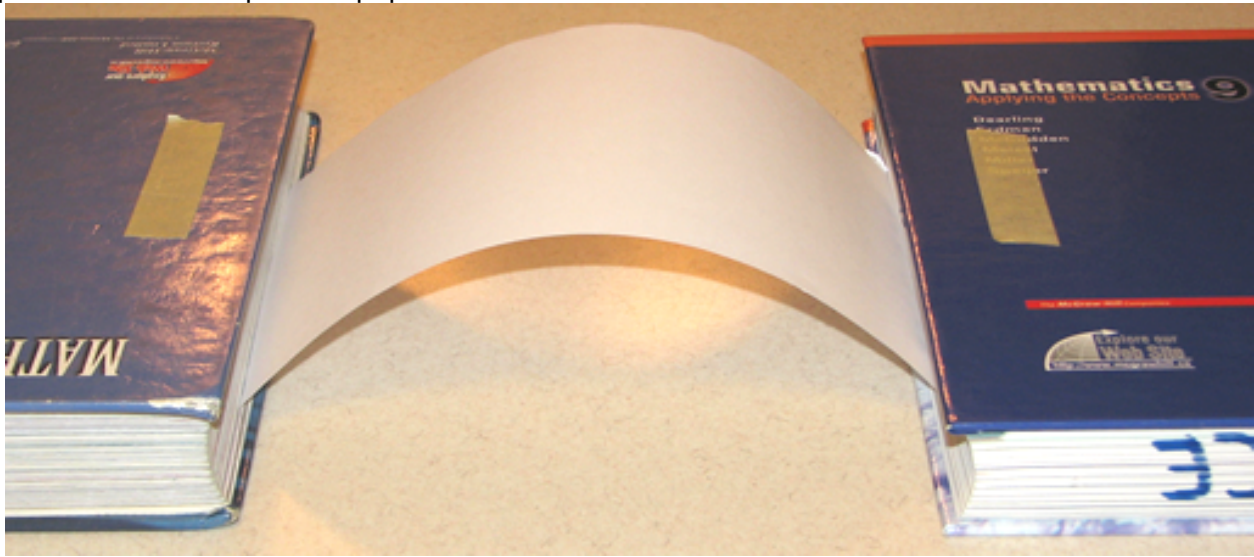
- Next, place the plastic cup in the middle of the Beam Bridge.
- Place a linking cube into the cup gently. Continue placing **one** linking cube at a time until the bridge collapses. The bridge must touch the desk for it to be considered a collapse.
- Record this data on the data collection sheet provided.
- Place another plank over top the first one creating a two layer plank bridge.



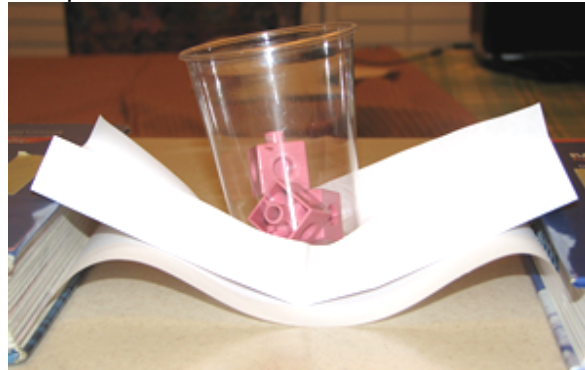
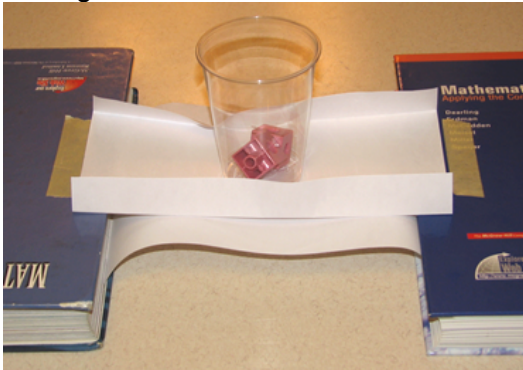
- Place the empty cup in the middle of the bridge.
- Repeat step 6 – 7
- Repeat steps 8 – 10 for a 3, 4, and 5 layer plank beam bridge.

## Arch Bridge Instructions –Teacher Notes

1. The next design is to create an arch bridge. Using the same textbooks and setup as the last bridge, place the unfolded piece of paper between the textbooks to form an arch as shown below.



2. Place one of the planks from the last activity on top of the arch making sure the ends of the plank coincide with the tape.
3. Place the empty cup in the middle of the plank.
4. Add linking cubes, **one** at a time until the bridge collapses.



5. Record this data on the data collection sheet provided.
6. Place another plank over top the first one creating a two layer plank bridge.
7. Place the empty cup in the middle of the bridge.
8. Repeat step 4 – 5
9. Repeat steps 6 – 8 for a 3, 4, and 5 layer plank arch bridge.

Data Tables

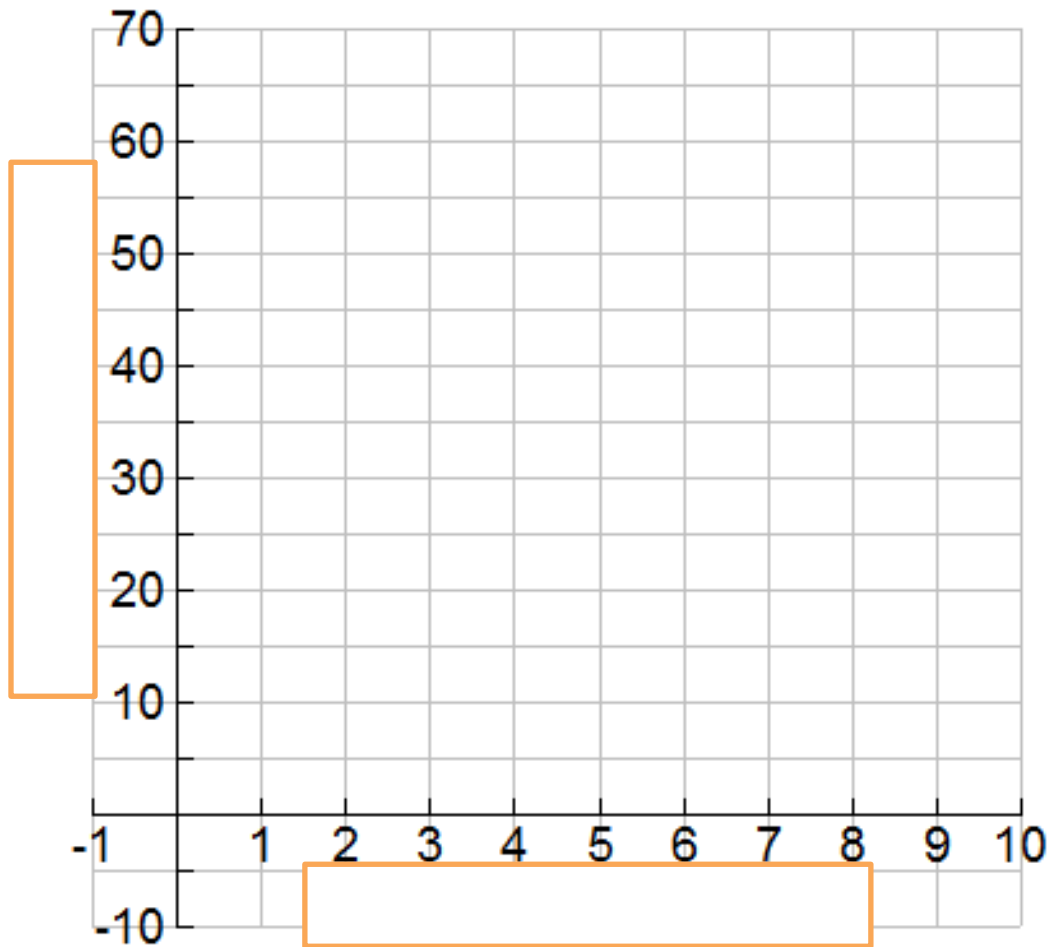
1. Place the data from your investigation on the tables below

BEAM BRIDGE	
Number of Planks	Number of Cubes

ARCH BRIDGE	
Number of Planks	Number of Cubes

Graphs:

2. Use this grid for the questions below.



## Applications | Communication

3. What variable is the x-variable (independent) (Circle one): **Number of Planks** or **Number of Cubes**
4. What variable is the y-variable (dependent) (Circle one): **Number of Planks** or **Number of Cubes**
5. Create a scatter plot from the data of both bridges using a different colour for each data set. Label axes with appropriately.
6. Create lines of best fit for both sets of data using a different colour for each line.

Beam Bridge	Arch Bridge
From the Beam Bridge line of best fit, choose two points <b>from the line of best fit</b> . Calculate the slope using these two points.	From the Arc Bridge line of best fit, choose two points <b>from the line of best fit</b> . Calculate the slope using these two points.
Explain the significance of the slope in the context of this activity.	
What is the initial value of this relationship (y-intercept)	What is the initial value of this relationship (y-intercept)
Explain the significance of the y-intercept in the context of this activity.	
Write an algebraic equation model for the Beam Bridge.	Write an algebraic equation model for the Arc Bridge.
How many layers of concrete are required to hold 100 cars? Show work below.	How many layers of concrete are required to hold 100 cars? Show work below.

## Thinking

7. Which bridge presents a better design? Offer mathematical proof using data you collected and calculations you did.
8. Public Civil Engineer Co. plans on bidding on this bridge project. It claims that their bridge design is better, more stable and less costly than the plank or arch bridge from ACE Co. The equation that represents the number of cars the bridge can support is given below. Is this bridge a better bridge at  $y=100$  cars? Justify your answer.

$$5(x + 3) - 3y = -13(x - 3)$$



<b>Thinking</b>					
<b>Reasoning and Proving</b>					
<b>Criteria</b>	<b>Below Level 1</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Makes inferences, draws conclusions and gives justifications (Question 8)		Makes limited connections to the problem-solving process and models presented when justifying answers	Makes some connections to the problem-solving process and models presented when justifying answers	Makes direct connections to the problem-solving process and models presented when justifying answers	Makes direct and insightful connections to the problem-solving process and models presented when justifying answers
Interprets mathematical language, charts, and graphs (Compares arch and plank equation to determine better design)		Misinterprets a critical element of the information, but makes some reasonable statements	Misinterprets part of the information, but makes some reasonable statements	Interprets the information correctly and makes reasonable statements	Interprets the information correctly, and makes insightful statements
<b>Application</b>					
<b>Connecting</b>					
Relates mathematical ideas to situations drawn from other contexts (explains initial value are slope)		Transfers ideas to other contexts and makes limited connections	Transfers ideas to other contexts and makes simple connections	Transfers ideas to other contexts and makes appropriate connections	Transfers ideas to other contexts and makes unique, original or insightful connections
<b>Communication</b>					
<b>Representing</b>					
Creates a model to represent the problem  (e.g., numerical, algebraic, graphical, physical, or scale model, by hand or using technology)		Creates a model that represents the problem with limited effectiveness; representing little of the range of the data	Creates a model that represents the problem with some effectiveness; representing some of the range of the data	Creates a model that represents the problem with considerable effectiveness; representing most of the range of the data	Creates a model that represents the problem with a high degree of effectiveness; representing the full range of the data
Uses clear language to make presentations, and to explain and justify solutions when reporting for various purposes and different audiences		Uses unclear language to make presentations, and to explain and justify solutions when reporting for various purposes and different audiences	Uses language that is somewhat unclear to make presentations, and to explain and justify solutions when reporting for various purposes and different audiences	Uses clear language to make presentations, and to explain and justify solutions when reporting for various purposes and different audiences	Uses clear and precise language to make presentations, and to explain and justify solutions when reporting for various purposes and different audiences



## 1.RLS: Reflecting on Learning Skills

Students should be aware of the importance that these skills have on your performance. After receiving your marked assessment, answer the following questions. Be honest with yourself. Good Learning Skills will help you now, in other courses and in the future.

- E – Always
- G – Sometimes
- S – Need Improvement
- N – Never

### Organization

- E G S N I came prepared for class with all materials
- E G S N My work is submitted on time
- E G S N I keep my notebook organized.

### Work Habits

- E G S N I attempt all of my homework
- E G S N I use my class time efficiently
- E G S N I limit my talking to the math topic on hand
- E G S N I am on time
- E G S N If I am away, I ask someone what I missed,
- E G S N I complete the work from the day that I missed.

### Team Work

- E G S N I am an active participant in pairs/group work
- E G S N I co-operate with others within my group
- E G S N I respect the opinions of others

### Initiative

- E G S N I participate in class discussion/lessons
- E G S N When I have difficulty I seek extra help
- E G S N After I resolve my difficulties, I reattempt the problem
- E G S N I review the daily lesson/ideas/concepts

### Works Independently

- E G S N I attempt the work on my own
- E G S N I try before seeking help
- E G S N If I have difficulties I ask others but I stay on task
- E G S N I am committed to tasks at hand

Yes No I know all the different ways available in my school, where I can seek extra help.

Yes No I tried my best.

What will I do differently in the next unit to improve?

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