



# Holyoke Public Schools

## Grade 8

### Thinking with Mathematical Models

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# Curriculum Maps Outline

## **Map Goals:**

1. To ensure that students are exposed to a rigorous curriculum in every school and every grade.
2. To have consistent instruction and assessment district wide.
3. To prepare students for the MCAS test.
4. To explain what is expected to be covered in each CMP or Investigations Unit.

## **Expectations:**

The district's expectation is for students to successfully meet the Massachusetts Mathematics Standards. In order to help facilitate this, teachers are required to follow the curriculum maps. The successful implementation of these maps requires teachers to thoroughly read each lesson in the TE and work through the project and problems in the map and the text prior to planning their lessons. Work should be kept in the binder with the curriculum map. Working through the math is an essential part of lesson planning, as it helps the teacher to better understand the concept being taught and the students' possible misunderstandings.

## **Feedback To Students:**

Feedback needs to happen daily in the classroom. There are many ways to give feedback. Conferencing, observations, questions asked during your opening, work time and closing are all forms of feedback.

## **Map Components:**

1. GENERAL PROBING QUESTIONS
2. UNIT SPECIFIC PROBING QUESTIONS
3. GOALS OF UNIT, CONTENT STANDARDS, & PERFORMANCE STANDARDS
4. PROJECT- to be done at end of unit and kept in the portfolio.
5. STUDENT MASTER – for project
6. INVESTIGATIONS
7. NOTEBOOK - includes: 3 Ring Binder, Bound Notebook, Portfolio
8. ACCOUNTABLE TALK – using probing questions
9. ON DEMAND ASSESSMENTS - to be done during teaching of unit.
10. STUDENT MASTERS- for on-demand assessments.

## Mathematics Evidence of Learning Artifacts

<b>Artifact</b>	<b>K - 1</b>	<b>2 – 5</b>	<b>6 - 8</b>
<b>3 Ring Binder</b>  <b>(3R)*</b>	<ul style="list-style-type: none"> <li>○ Student Work<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>○ Vocabulary</li> <li>○ Student sheets<sup>1</sup></li> </ul> <p style="text-align: center;"><b><u>All work should be dated and listed by investigation</u></b></p>	<ul style="list-style-type: none"> <li>○ Math books</li> <li>○ Vocabulary</li> <li>○ Core Problems<sup>1</sup></li> <li>○ Lab sheets</li> </ul> <p style="text-align: center;"><b><u>All work should be dated and listed by investigation</u></b></p>
<b>Marble Notebook</b>  <b>(MNB)</b>	<ul style="list-style-type: none"> <li>○ Journal entries<sup>2</sup></li> </ul>	<ul style="list-style-type: none"> <li>○ Table of Contents</li> <li>○ Problem of the day</li> <li>○ Journal entries</li> <li>○ Class work</li> </ul> <p style="text-align: center;"><b><u>All work should be dated and listed by investigation in the Table of Contents</u></b></p>	<ul style="list-style-type: none"> <li>○ Table of Contents</li> <li>○ Work time</li> <li>○ Journal entries</li> </ul> <p style="text-align: center;"><b><u>All work should be dated and listed by investigation in the Table of Contents</u></b></p>
<b>Portfolio<sup>3</sup></b>  <b>(P)</b>	<ul style="list-style-type: none"> <li>○ On-demand tasks</li> <li>○ Projects</li> <li>○ Teacher anecdotal notes</li> </ul>	<ul style="list-style-type: none"> <li>○ On-demand tasks</li> <li>○ Reflections</li> <li>○ Projects</li> </ul> <p style="text-align: center;"><b><u>All work should be dated and listed by investigation</u></b></p>	<ul style="list-style-type: none"> <li>○ On-demand tasks</li> <li>○ Reflections</li> <li>○ Projects</li> </ul> <p style="text-align: center;"><b><u>All work should be dated and listed by investigation</u></b></p>

\* Folders may be used in place of binders for these grade levels

<sup>1</sup> Send home at the end of each unit

<sup>2</sup> Use grade level math journals

<sup>3</sup> All documents should be kept for the entire year

# Accountable Talk

## Probing Assessment Questions

As students progress through this unit, they should be asked the following questions to assess their specific knowledge of the unit.

- What are the key variables in this situation?
- What is the pattern relating the variables?
- What kind of equation will express the relationship?
- How can I use the equation to answer questions about the relationships?
- What patterns of change do the equations or expression represent?

## Probing Questions – Teacher’s Role

The teacher’s role in probing for understanding is to ask questions that will:

- *Clarify student understanding*
- *Get at the objective of the lesson*
- *Go deeper into the mathematics*
- *Uncover misconceptions and misunderstandings*
- *Compare and contrast*

## Probing Questions – Student’s Role

The students’ role is to be an active participant by:

- *Explaining their strategies*
- *Asking clarifying questions to teacher and other students*
- *Being active listeners*
- *Using the language of mathematics*

## Probing Questions - Suggestions

When probing for understanding the teacher and students can use one or more of these suggested questions:

- Why are you using  $< >$ ?
- What are the ways you could  $< >$ ?
- What else do you know?
- How do you know that?
- Can you show that?
- What convention did you use here?
- What can you do if you do not know?
- What standard does this work apply to?
- Is this always true?
- How does this connect to other mathematics we have learned?
- What is the same and what are the differences between  $< >$ ?
- Can you back that up?
- Where is the math in your sketch?
- What does the answer mean?
- Does the answer make sense?
- Could you have used another operation to solve this task?
- Can you give examples?
- Can you say it another way?
- What's the math?
- Tell me about the task in your own words?
- What are you trying to find?
- How did you make your estimate?
- Will your answer be an over-estimate or an under-estimate? Why?
- I noticed that you used  $< \dots >$  to help you understand the task. Can you show us what you did and tell us how it helped you?
- Where do you see  $< >$  in your  $<$ model, diagram, number line, chart, etc. $>$ ?
- How can we see  $< >$  in your  $<$ model, diagram, number line, chart, etc. $>$ ?

- You have used a representation that is different from others that I've seen. Can you show us your <model, diagram, number line, chart, etc.>, and tell us how it helped you?
- How did you decide to solve the task? Why did you choose that method?
- Did you try any method that didn't work?
- Tell us what you tried.
- Why didn't it work?
- Would it ever work?

# Goals, Content Standards, & Performance Standards

## Unit Goals:

- Recognize linear and nonlinear patterns from verbal descriptions, tables, and graphs and describe those patterns using words and equations.
- Write equations to express linear patterns appearing in tables, graphs, and verbal context.
- Write a linear equation when given specific information, such as two points or a point and the slope.
- Approximate linear data patterns with graph and equation models.
- Solve linear equations
- Develop an informal understanding of inequalities.
- Write equations describing inverse variation.
- Use linear and inverse variation equations to solve problems and to make predictions and decisions.

## Math Content Standards:

- (8.N.8) Demonstrate an understanding of the properties of arithmetic operations on rational numbers. Use the associative, commutative, and distributive properties; properties of the identity and inverse elements (e.g.,  $-7 + 7 = 0$ ;  $3/4 \times 4/3 = 1$ ); and the notion of closure of a subset of the rational numbers under an operation (e.g., the set of odd integers is closed under multiplication but not under addition).
- (8N9) Use the inverse relationships of addition and subtraction, multiplication and division, and squaring and finding square roots to simplify computations and solve problems, e.g. multiplying by  $1/2$  or  $0.5$  is the same as dividing by  $2$ .
- (8N12) Select and use appropriate operations—addition, subtraction, multiplication, division, and positive integer exponents—to solve problems with rational numbers (including negatives).
- (8P1) Extend, represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic expressions. Include arithmetic and geometric progressions, e.g., compounding.
- (8P6) Identify the roles of variables within an equation, e.g.,  $y = mx + b$ , expressing  $y$  as a function of  $x$  with parameters  $m$  and  $b$ .
- (8P8) Explain and analyze—both quantitatively and qualitatively, using pictures, graphs, charts, or equations—how a change in one variable results in a change in another variable in functional relationships, e.g.,  $C = d$ ,  $A = r^2$  ( $A$  as a function of  $r$ ),  $A_{\text{rectangle}} = lw$  ( $A_{\text{rectangle}}$  as a function of  $l$  and  $w$ ).

- (8P9) Use linear equations to model and analyze problems involving proportional relationships. Use technology as appropriate.
- (8P10) Use tables and graphs to represent and compare linear growth patterns. In particular, compare rates of change and x- and y-intercepts of different linear patterns.
- (8M1) Use models, graphs, and formulas to solve simple problems involving rates, e.g., velocity and density.

### **Performance Standards:**

- *(M3a) Discover, describe, and generalize patterns including linear, exponential, and simple quadratic relationships.*
- *(M3b) Represent relationships with tables, graphs in the coordinate plane, and verbal or symbolic rules.*
- *(M3b) Find solutions for unknown quantities in linear equations and in simple equations and inequalities.*

# Investigation 1: Exploring Data Patterns

<p><b><u>Objectives</u></b> Investigations 1.1 – 1.4</p>	<p><b><u>Pacing:</u></b> 4 days</p>
<p style="text-align: center;"><b><i>Evidence of Learning Artifacts</i></b></p> <p>Journal and Reflection questions should be posted and referred to at the beginning of the appropriate <i>Investigation</i>.</p> <p>Journal and Reflection entries need to be done in class as part of the closure and assessment</p>	<p><b><u>Vocabulary</u><sup>2</sup>:</b> <a href="#">Appendix 2</a>, Investigation 1</p>
	<p><b><u>Core Problems</u><sup>2</sup>:</b> <a href="#">Thinking With Mathematical Models</a>, Investigation 1 ACE Problems: # 1, 3 – 6, 8 – 9, 12 – 14, 18, 26</p>
	<p><b><u>Work Time</u><sup>1</sup>:</b> <a href="#">Thinking With Mathematical Models</a>, Problems 1.1 – 1.3</p>
	<p><b><u>Journal Entries</u><sup>1</sup>:</b> <a href="#">Appendix 3</a>, Inv 1.1 – 1.3</p>
	<p><b><u>On Demand Tasks</u><sup>3</sup>:</b> <a href="#">Appendix 5</a>, Investigation 1</p>
<p><b><u>Mathematical Reflection</u><sup>3</sup></b> <a href="#">Appendix 4</a>, MMR1:</p>	
<p style="text-align: center;"><b><i>Accountable Talk</i></b></p> <p>To promote learning, explore solutions, and justify reasoning, conversations between students and students or students and teacher must be accountable – accountable to the learning community, to the mathematics discipline, and to rigorous thinking.</p>	<p>As a result of this Investigation, students should be able to talk and manipulate the vocabulary of the Investigation in response to this type of question:</p> <ul style="list-style-type: none"> <li>○ How did you know that?</li> <li>○ What would be a good way to organize your information?</li> <li>○ How can you use ...?</li> <li>○ Can you show another way?</li> <li>○ How would you describe the pattern in words?</li> <li>○ What convention did you use?</li> </ul> <p>These are some recommended questions that you might use. Others can be found at the beginning of the map and on the probing question sheet in the district mathematics guide.</p>

1. *Marble Note Book*  
2. *3 Ring Binder*  
3. *Portfolio*

## Investigation 2: Linear Models and Equations

<p><b><u>Objectives</u></b> Investigations 2.1 – 2.3</p>	<p><b><u>Pacing:</u></b> 3 days</p>
<p style="text-align: center;"><b><i>Evidence of Learning Artifacts</i></b></p> <p>Journal and Reflection questions should be posted and referred to at the beginning of the appropriate <i>Investigation</i>.</p> <p>Journal and Reflection entries need to be done in class as part of the closure and assessment</p>	<p><b><u>Vocabulary</u></b><sup>2</sup>: <a href="#">Appendix 2</a>, Investigation 2</p> <hr/> <p><b><u>Core Problems</u></b><sup>2</sup>: <a href="#">Thinking With Mathematical Models</a>, Investigation 2 ACE Problems: # 1, 5, 6, 8, 12, 13, 20, 21,33</p> <hr/> <p><b><u>Work Time</u></b><sup>1</sup>: <a href="#">Thinking With Mathematical Models</a>, Problems 2.1 – 2.4</p> <hr/> <p><b><u>Journal Entries</u></b><sup>1</sup>: <a href="#">Appendix 3</a>, Inv 2.1 – 2.4</p> <hr/> <p><b><u>On Demand Tasks</u></b><sup>3</sup>: <a href="#">Appendix 5</a>, Investigation 2</p> <hr/> <p><b><u>Mathematical Reflection</u></b><sup>3</sup> <a href="#">Appendix 4</a>, MMR2:</p>
<p style="text-align: center;"><b><i>Accountable Talk</i></b></p> <p>To promote learning, explore solutions, and justify reasoning, conversations between students and students or students and teacher must be accountable – accountable to the learning community, to the mathematics discipline, and to rigorous thinking.</p>	<p>As a result of this Investigation, students should be able to talk and manipulate the vocabulary of the Investigation in response to this type of question:</p> <ul style="list-style-type: none"> <li>○ How did you know...?</li> <li>○ How can you create a rule to represent the pattern? Will this rule always work? Sometimes? Never?</li> <li>○ How can you justify...?</li> <li>○ Does your answer make sense?</li> <li>○ Can you draw me a diagram??</li> </ul> <p>These are some recommended questions that you might use. Others can be found at the beginning of the map and on the probing question sheet in the district mathematics guide.</p>

1 .Marble Note Book  
2.3 Ring Binder  
3. Portfolio

## Investigation 3: Inverse\_Variation

<p><b>Objectives</b> Investigations 3.1 – 3.2</p>	<p><b>Pacing:</b> 2 days</p>
<p style="text-align: center;"><b><i>Evidence of Learning Artifacts</i></b></p> <p>Journal and Reflection questions should be posted and referred to at the beginning of the appropriate <i>Investigation</i>.</p> <p>Journal and Reflection entries need to be done in class as part of the closure and assessment</p>	<p><b>Vocabulary <sup>2</sup>:</b> <a href="#">Appendix 2</a>, Investigation 3</p>
	<p><b>Core Problems <sup>2</sup>:</b> <u>Thinking With Mathematical Models</u>, Investigation 3 ACE Problems: # 1, 4 – 7, 10, 12,</p>
	<p><b>Work Time <sup>1</sup>:</b> <u>Thinking With Mathematical Models</u>, Problems 3.1 – 3.3</p>
	<p><b>Journal Entries <sup>1</sup>:</b> <a href="#">Appendix 3</a>, Inv 3.1 – 3.3</p>
	<p><b>On Demand Tasks <sup>3</sup>:</b> <a href="#">Appendix 5</a>, Investigation 3</p>
<p><b>Mathematical Reflection <sup>3</sup></b> <a href="#">Appendix 4</a>, MMR3:</p>	
<p style="text-align: center;"><b><i>Accountable Talk</i></b></p> <p>To promote learning, explore solutions, and justify reasoning, conversations between students and students or students and teacher must be accountable – accountable to the learning community, to the mathematics discipline, and to rigorous thinking.</p>	<p>As a result of this Investigation, students should be able to talk and manipulate the vocabulary of the Investigation in response to this type of question:</p> <ul style="list-style-type: none"> <li>○ What is your strategy?</li> <li>○ How could you check that ..... is correct?</li> <li>○ Could you begin with a different step?</li> <li>○ Does .... make sense given the information in the problem?</li> </ul> <p>These are some recommended questions that you might use. Others can be found at the beginning of the map and on the probing question sheet in the district mathematics guide.</p>

*1. Marble Note Book*

*2.3 Ring Binder*

*3. Portfolio*

## Appendix 1 Unit Project

<p style="text-align: center;"><b><i>Project</i></b><sup>1</sup></p> <p>Student work should be placed in portfolio</p>	<p>The project is the culminating assessment, which will allow students to apply what they learned about <u>linear relationships</u>. It is 2003 MCAS Question #28 to give students the experience of answering an open-response question.</p> <p>The student handout for the project can be found in <a href="#">Appendix 1</a></p>
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*1. portfolio*

### Unit Project Scoring Guide

Score	Description
<b><u>4</u></b>	The student response demonstrates an exemplary understanding of the Patterns, Relations, and Algebra concepts involved in extending, representing, and analyzing a pattern by using tables, graphs and symbolic expressions.
<b><u>3</u></b>	The student response demonstrates a good understanding of the Patterns, Relations, and Algebra concepts involved in extending, representing, and analyzing a pattern by using tables, graphs, and symbolic expressions. Although there is significant evidence that the student is able to recognize and apply the concepts involved, some aspect of the response is flawed. As a result, the response merits 3 points.
<b><u>2</u></b>	The student response demonstrates a fair understanding of the Patterns, Relations, and Algebra concepts involved in extending, representing, and analyzing a pattern by using tables, graphs, and symbolic expressions. While some aspects of the task are completed correctly, others are not. The mixed evidence provided by the student merits 2 points.
<b><u>1</u></b>	The student response demonstrates only a minimal understanding of the Patterns, Relations, and Algebra concepts involved in extending, representing, and analyzing a pattern by using tables, graphs, and symbolic expressions.
<b><u>0</u></b>	The student response contains insufficient evidence of an understanding of the Patterns, Relations, and Algebra concepts involved in extending, representing, and analyzing a pattern by using tables, graphs, and symbolic expressions to merit any score points.

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

DATE: \_\_\_\_\_

Thinking With Mathematical Models Project: Circumference of a Circle

- *BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.*
- *Show all work (diagrams, tables, and computations) on your answer sheet.*
- *If you do the work in your head, explain in writing how you did the work.*

The table below shows how  $C$ , the circumference of a circle, depends on  $d$ , its diameter

$d$ units	$C$ units
1	3.14
2	6.28
3	9.42
4	12.56
⋮	⋮
10	31.4

An equation that shows the relationship between the diameter of a circle and its circumference is  $C = \pi d$ , where 3.14 is used for  $\pi$ .

- A What is the circumference of a circle with a diameter of 6 units?
- B What is the diameter of a circle with a circumference of 26.69 units?
- C On the grid in your Student Answer Booklet, draw a line graph on a coordinate plane showing the relationship between the diameter of a circle and its circumference. Be sure to label the axes.
- D Explain how you could use your graph to approximate the circumference of a circle with a diameter of 9 units.

## 2003 MCAS Grade 8 Mathematics

### Student Work: Question #28 - Score Point 4

A. 18.84

$$\pi \cdot d = 18.84$$

B. 8.5

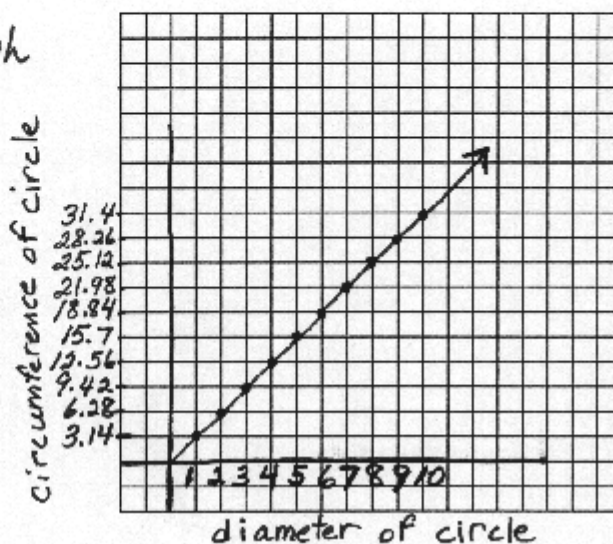
$$26.69 \div \pi = 8.5$$

C. on Graph

D. The line on the graph

has a slope of 3.14.

Go to the right on the X axes 9 units and go up until you hit the line and approximate the circumference of the circle where the line hits 9 on the X axes.



## 2003 MCAS Grade 8 Mathematics

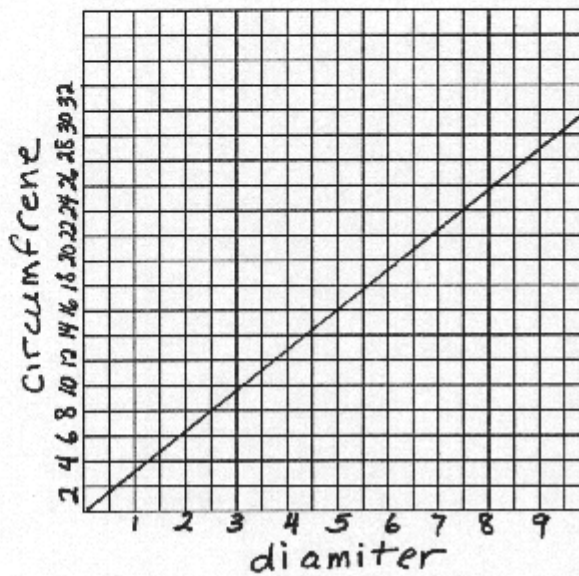
### Student Work: Question #28 - Score Point 3

A. 18.84

B. 83.8066

D. You find the point on the graph where the line passes straight above 9 on the x axis.

C.



## 2003 MCAS Grade 8 Mathematics

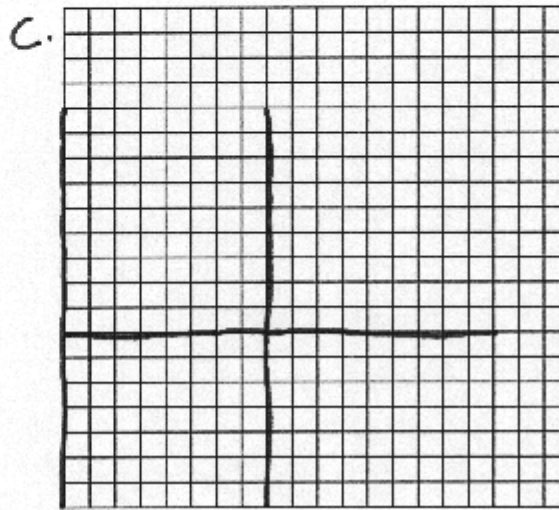
### Student Work: Question #28 - Score Point 2

A:  $C = 3.14 (6)$   
 $C = 18.84$

B:  $\frac{26.69}{3.14} = \frac{3.14 (d)}{3.14}$

$d = 8.5$

D: You could see where it goes next if you continue the line.



# 2003 MCAS Grade 8 Mathematics

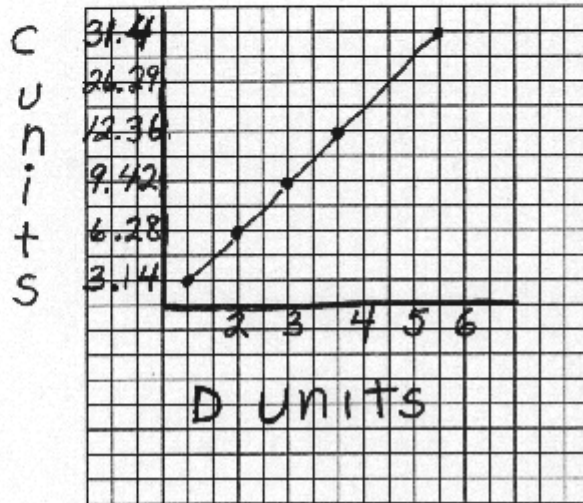
## Student Work: Question #28 - Score Point 1

A - 26.29

B - 6

C -

D - you can use your graph by using the numbers and the data and also by using the lines and where its plotted.



## Appendix 2 Vocabulary

### **Investigation 1:**

- breaking weight, coefficient, constant term, coordinate graph, coordinate pair, dependent variable, independent variable, length, linear equation, linear model, linear relationship, patterns of change, rate, rate of change, slope, table, variable, width, y-intercept

### **Investigation 2:**

- –additive inverse, average speed, demand, direct variation, inequality, mathematical model, multiplicative inverse, point of intersection, profit, proportion, ratio, rise, run, scale, scatter plot

### **Investigation 3:**

- inverse variation, surface area

# Appendix 3 Journal Entries

## **Investigation 1:**

### ***Investigation 1.1:***

Was the increase in the number of pennies constant? If not, how did you make your predictions for other bridge thicknesses?

### ***Investigation 1.2:***

How can you tell from your table that the graph will be curved?

### ***Investigation 1.3:***

How is any linear relationship represented in a table? In a graph? In an equation?

## **Investigation 2:**

### ***Investigation 2.1***

Using a mathematical model (on a graph), how do you find the slope and y-intercept?

### ***Investigation 2.2***

How can you find the slope if you are given a table of (x,y) data values?

### ***Investigation 2.3***

When given the value of one variable, how can you use a graph to estimate the value of the other variable?

### ***Investigation 2.4***

Describe a strategy you would use when determining the attendance at an attraction, given the probability of rain.

## **Investigation 3**

### ***Investigation 3.1***

Is the relationship between Length and Width in a rectangle a linear relationship? How can you tell?

### ***Investigation 3.2***

In an inverse relationship what happens to the value of y as the value of x gets close to zero?

### ***Investigation 3.3***

Given a set of data, how can you determine if the data represents an inverse variation?

# Appendix 4 Reflections

## MMR1

What are the advantages and disadvantages of each representation for finding patterns and making predictions?

## MMR2

How would you find the equation for a linear relationship

- a. from a verbal description?
- b. from a table of values?
- C. from a graph?

## MMR3

How is an inverse relationship similar to a linear relationship? How is it different? (support your answers using tables, graphs and equations).

# Appendix 5 On Demand Tasks

## CMP2: Thinking With Mathematical Models

<p><b><i>On-Demand Tasks</i></b></p> <p><b><u><i>Additional Practice &amp; Skills</i></u></b></p> <p><b><u><i>Workbook</i></u></b></p> <p><b><u><i>Assessment Resources</i></u></b></p> <p>In class individualized On-Demand tasks assess knowledge of mathematical facts, operations, concepts, and skills, and their efficient application to problem solving. The results of these different forms of assessment provide rich profiles of students' achievements in mathematics and serve as the basis for identifying curricula and instructional approaches to best develop their talents.</p>	<p><a href="#"><u><i>After Inv. 1</i></u></a> <i>Assessment Resources</i> pg1 “Check Up” #1]</p> <p><a href="#"><u><i>After Inv. 2</i></u></a> <i>Assessment Resources</i> pg2 “Partner Quiz” #1]</p> <p><a href="#"><u><i>After Inv. 3</i></u></a> <i>Assessment Resources</i> pg10 “Unit Test” #3]</p>
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## HPS Mathematics Scoring Rubric

Score	Description
<u>4</u>	The response shows a <b><u>comprehensive</u></b> understanding of the mathematical concept(s) and/or procedures embodied in the task(s). It indicates that the student has <b><u>completed the task(s)</u></b> correctly, using mathematically sound procedures. It contains <b><u>clear, complete explanations</u></b> and/or <b><u>adequate work required</u></b> .
<u>3</u>	The response shows a <b><u>general</u></b> understanding of the mathematical concept(s) and/or procedures embodied in the task(s). It indicates that the student has <b><u>completed the task(s)</u></b> , using mathematically sound procedures. It contains <b><u>complete explanations</u></b> and/or <b><u>adequate work required</u></b> .
<u>2</u>	The response shows a <b><u>basic</u></b> understanding of the mathematical concept(s) and/or procedures embodied in the task(s). It addresses <b><u>most aspects of the task(s)</u></b> , using mathematically sound procedures. It may contain a correct solution but provides <b><u>incomplete procedures, reasoning and/or explanations</u></b> . It may reflect <b><u>some misunderstandings</u></b> of the underlying mathematical concepts and/or procedures.
<u>1</u>	The response shows a <b><u>minimal</u></b> understanding of the mathematical concepts and/or procedures embodied in the task(s). It addresses <b><u>some elements of the task(s)</u></b> correctly but reaches an <b><u>inadequate solution and/or provides reasoning that is faulty or incomplete</u></b> . It exhibits <b><u>multiple flaws related to a misunderstanding of important aspects</u></b> of the task(s), misuse of mathematical procedures, or faulty mathematical reasoning. It reflects a <b><u>lack of essential understanding</u></b> of the underlying mathematical concepts. It may contain a correct numerical answer but <b><u>the required work is not provided</u></b> .
<u>0</u>	The response is <b><u>completely incorrect, irrelevant, or incoherent</u></b> , or contains a correct response arrived at using an <b><u>obviously incorrect procedure</u></b> .

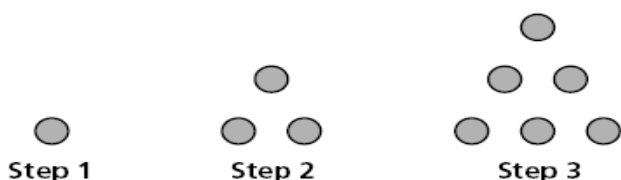
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## Investigation 1

- *BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.*
- *Show all work (diagrams, tables, and computations) on your answer sheet.*
- *If you do the work in your head, explain in writing how you did the work.*

1. The party room at a miniature golf course is decorated with golf ball patterns like:

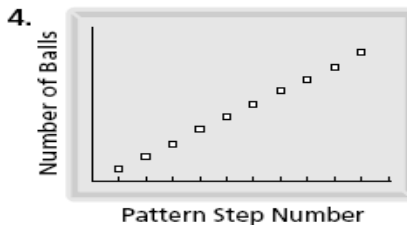
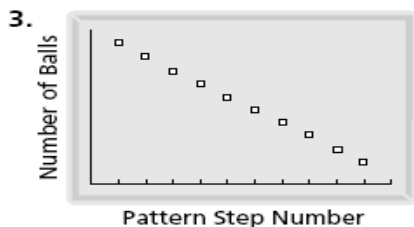
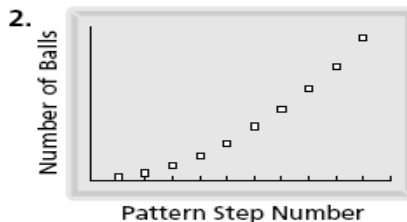
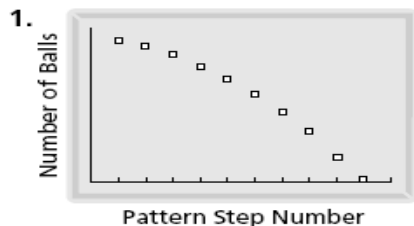


a. Complete this table showing the number of golf balls in the next 5 steps of the pattern.

**Golf Ball Patterns**

Pattern Step Number	1	2	3	4	5	6	7	8
Number of Balls Used	1	3	6					

b. For each graph, explain why the graph does or does not match the pattern relating *number of balls used* to *pattern step number*. Explain the reasons for your choice.



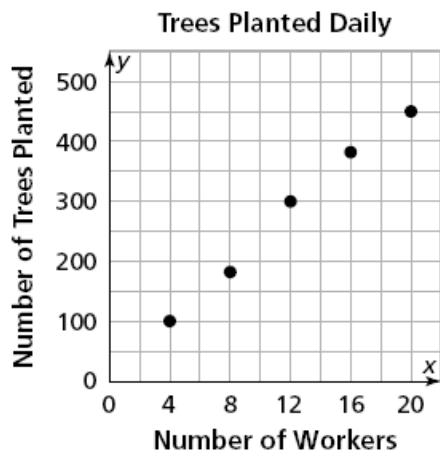
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## Investigation 2

- *BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.*
- *Show all work (diagrams, tables, and computations) on your answer sheet.*
- *If you do the work in your head, explain in writing how you did the work.*

1. The number of seeding trees that can be planted in one day depends on the number of students in the work group. Data from several different work groups are shown in the next graph.



- Draw a line that estimates the pattern in (*workers, trees*) data.
- Write an equation for your graph model relating trees planted to number of workers.
- Use your linear model to estimate how many trees will be planted by a work crew of 14. Show how you find your answer.
- Use your linear model to estimate how many workers will be required to plant 270 trees. Show how you find your answer.
- What is the slope of your linear model? What does that slope tell about the relationship between the variables?

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### Investigation 3

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all work (diagrams, tables, and computations) on your answer sheet.**
- **If you do the work in your head, explain in writing how you did the work.**

3. A group of Metropolis Middle School students volunteered to work all day helping to build a new city playground. A local pizzeria offered to supply eight large pizzas for their lunch. The volunteers share the pizza equally.

a. Complete the following table.

**Pizza for Volunteers**

Number of Volunteers	1	2	4	8	16	32
Amount of Pizza per Volunteer	8					

b. Is the relationship between the amount of pizza per volunteer and the number of volunteers linear, inverse, or some other pattern? Give an explanation justifying your answer.

c. Write an equation relating amount of pizza per volunteer  $P$  to number of volunteers  $n$ .

d. Find the amount of pizza per volunteer if there are 12 volunteers.

# NOTES