

# Algebra 2

## Slope of waste pipes

Subject Area: Math

Grade Levels: 9-12

Date: Aug 25<sup>th</sup>-26<sup>th</sup>

Lesson Overview: Students will first complete a worksheet reviewing slope, rate of change, coordinates, and plotting points. The following day students will experiment with flow rates of pipes containing solid and liquid waste at different slopes and diameters of pipe.

### Materials Included in this Lesson

- Review worksheet (Day 1)
- Ticket Out the Door Ch 2.2
- Textbook for homework: p 79, 86, 89
- Worksheet-find slope, chart to record results (day 2)
- a pipe for each group (all same length)

### Other Materials for this Lesson

- large graph paper that can hold pipes
- toothpicks or thumbtacks
- stop watch
- popcorn cornel
- 1 cup for collecting waste

### Skills the Student will Learn

- Students will be able to find the slope between two points.
- Students will be able to plot the points correctly
- Students will be able to predict which pipe will be the most efficient, then after the experiment, they can see if their prediction was correct. And explain why.

### Student Deliverables

- Students will turn in a review worksheet (day 1)
- Students will turn in homework from book.
- Students will turn in worksheet #2 including a chart of the times it took each pipe to clear all waste.
- Students will turn in their hypothesis, as well as a statement if they were correct or not (and why) as to which pipe they think will be most efficient

Length of Lesson: 2 Days

## Activity Day One

1. Students will work in groups to complete a 2-page worksheet, which reviews rate of change, slope, steepness of lines, and graphing linear equations.

## Activity Day Two

1. **Warm up:** Students will start with warm up #7, where they review steepness of lines, average rate of change, and graphing lines.

2. Students will correct homework.

3. **Pre-experiment:** First, I will call up 3 volunteers as my mock group. I will go through an example of what my expectations with my mock group. Then, students will work in groups of 4 to complete the first column of the Day 2 worksheet. These problems will have them calculating slope of a line given two points (they will complete 6 of these problems). Students will check each others work to make sure they all have the same answers.

4. **Experiment:** Students will be given their materials (graph board, thumb tacks, 3 pipes, cups, waste, stopwatch) and will be asked to make a conjecture, as to which pipe will be most efficient in clearing all the waste. Next the students will be putting the thumbtacks on two coordinates from above, then placing a pipe on the thumbtacks. They will place a cup at the lower end of the pipe. While one person pours the waste in the top end of the pipe, another group member will be timing how long it takes for the waste to end up in the lower cup. All students will record the times in the chart. Students will repeat this process 5 more times.

5. **Conclusion:** Students will then accept or reject their original hypothesis, and explain why.

6. **Homework:** Students will complete their homework out of the book, which will focus on rate of change problems.

## Enrichment Suggestions

Students can go online and find the exact slopes that civil engineers use based on the size and length of pipe they will need for a given project.

## Student Resources

Students Textbook

School loop math department page, which includes links to different math web site resources:

<http://www.pghs.schoolloop.com/math>

## Foundation Academic Standards

1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and termination decimals) and take positive rational numbers to whole-number powers.

- 2.1 Use estimation to verify the reasonableness of calculated results.
- 2.4 Make and test conjectures by using both inductive and deductive reasoning.
- 5.1 Apply appropriate problem-solving strategies and critical thinking skills to work-related issues and tasks.

### CA State Standards

- 2.0 students solve system of linear equations and inequalities (in two or three variables) by substitution, with graphs, or with matrices
- 21.0 Students apply the method of mathematical induction to prove general statements about the positive integers

### Lesson Plan Relevance To Externship

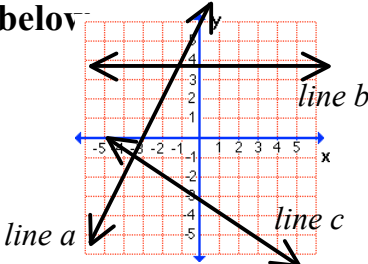
As a civil engineer, slope is used all the time when working on site plans. It is very important that the pipes for sewage, water drainage have the correct slopes to ensure there are not back ups or clogs in the pipes. Slope is used many other places as well, for example, the grading of the land (to ensure there are not low spots) and grading of parking lots, and handicap parking.

# AVG. RATE of CHANGE

Directions: Do each example and then fill in the appropriate notes that describe what you did.

## Examples

## Notes

<p><b>Ex1) Find the slope of each line below:</b></p> <p>A) line a: <math>m =</math></p> <p>B) line b: <math>m =</math></p> <p>C) line c: <math>m =</math></p>	
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Slope of nonvertical lines:

$$m = \frac{r - s}{u}$$

<p><b>Ex2) Find the slope.</b></p> <p>A) (6, -6) (-6, 6)                      B) (-9, 8) (-9, 2)</p> <p>C) (-10, -12) (2, -6)                D) <math>(\frac{1}{2}, 5)(\frac{1}{4}, 5)</math></p>	<p><u>Slope formula:</u></p> <p><math>m =</math> _____</p>
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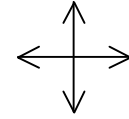
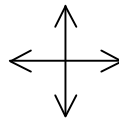
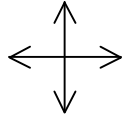
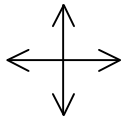
Draw each line and describe its slope:

Rising Line

Falling Line

Horizontal Line

Vertical Line



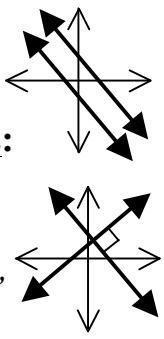
\_\_\_\_\_ Slope

\_\_\_\_\_ Slope

\_\_\_\_\_ Slope

\_\_\_\_\_ Slope

<p><b>Ex3) Which line is steeper? (Hint: compare the slopes)</b></p> <p>Line 1: <math>m = -2</math>      Line 3: (1, -4) and (5, 2)</p> <p>Line 2: <math>m = \frac{3}{5}</math>      Line 4: (-2, -5) and (1, -2)</p>	<p><u>Comparing Steepness of Lines:</u></p> <p>The _____ the absolute value of the slope, the _____ the line.</p>
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<p><b>Ex4) Parallel, perpendicular or neither?</b></p> <p>Line 1: (3, 6) and (2, -1)      Line 3: (2, -2) and (-2, 7)</p> <p>Line 2: (-1, 2) and (6, 1)      Line 4: (4, -5) and (5, 1)</p>	<p><u>Parallel Lines:</u></p> <p>The slopes of parallel lines are _____.</p> <p><u>Perpendicular Lines:</u></p> <p>The slopes of perpendicular lines are _____ and _____ of each other,</p> <p><math>m_1 = -</math> _____</p> 
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In Real Life Problems, Slope = Average Rate of Change

<p><b>Ex5) Find the average rate of change and its units given (2, 10) and (4, 16) where x is measured in years and y in inches.</b></p>
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# GRAPHING LINEAR EQUATIONS

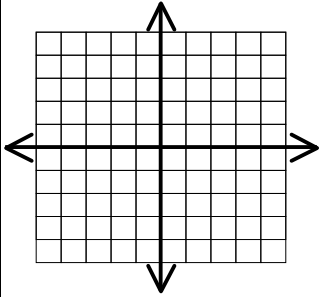
Notes Ch 2.3

Directions: Do each example and then fill in the appropriate notes that describe what you did.

## Examples

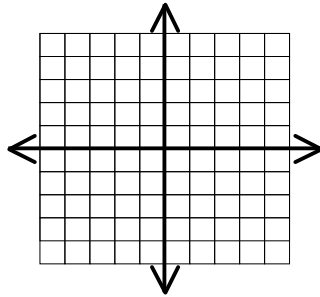
Ex 1)  $y = -\frac{2}{5}x + 1$

$m =$  \_\_\_\_\_  
 $y$ -intercept \_\_\_\_\_



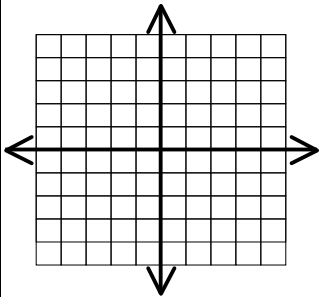
Ex 2)  $y = 3x$

$m =$  \_\_\_\_\_  
 $y$ -intercept \_\_\_\_\_



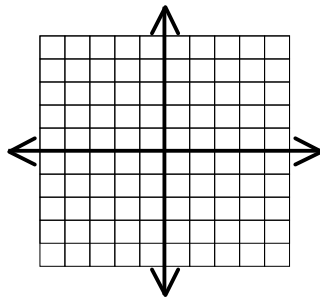
Ex 3)  $3x - 2y = 6$

$x$ -intercept \_\_\_\_\_  
 $y$ -intercept \_\_\_\_\_



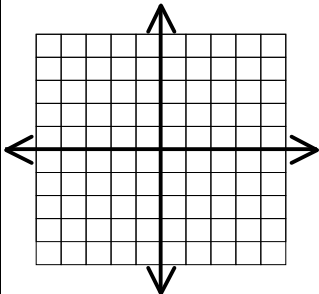
Ex 4)  $8x + 4y = -4$

$x$ -intercept \_\_\_\_\_  
 $y$ -intercept \_\_\_\_\_



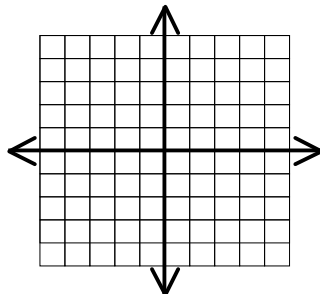
Ex 5)  $y = 0$

$m =$  \_\_\_\_\_  
 $y$ -intercept \_\_\_\_\_



Ex 6)  $x = -\frac{5}{2}$

$m =$  \_\_\_\_\_  
 $x$ -intercept \_\_\_\_\_



## Notes

Slope-Intercept Form:

$$y = mx + b$$

Write directions describing how to graph a line when the equation is written in slope intercept form.

Standard Form:

$$Ax + By = C$$

Write directions describing how to graph a line when the equation is written in standard form using the intercepts.

Horizontal Lines:

$$y = c$$

with  $y$ -intercept at \_\_\_\_\_.

Vertical Lines:

$$x = c$$

with  $x$ -intercept at \_\_\_\_\_.

## Algebra II – Chapter 2 Slope Project

Name \_\_\_\_\_

Date \_\_\_\_\_ Period \_\_\_\_\_

Class example:

	Coordinates	Slope of line containing coordinates	Equation of the line containing coordinates	Steepness of the line	Pipe #	Time it takes for waste to travel through the pipe
<u>A</u>	$(-15, -3)$ and $(10, 2)$					

Steps:

- 1) Assign roles to everyone in the group.
- 2) Use the given coordinates to find the slope of the line containing those points. Repeat this for all coordinates given (B-L)
- 3) Make an initial conjecture, which set will clear the waste most efficiently (fastest)

Initial Conjecture: \_\_\_\_\_

- 4) Have poster holder hold up graph board poster.
- 5) Start with set B. Carefully use the thumbtack to puncture the hole of the coordinates.
- 6) Put the toothpicks in the holes.
- 7) Set the pipe on the toothpicks. (one group member will need to hold the pipe in place (against the toothpicks) to make sure it doesn't slide, move or fall off)
- 8) Put the empty cup near the lower end of the pipe, so the waste can drain into the cup.
- 9) Have the timer ready to go.
- 10) Pour the popcorn kernel into the upper end of the pipe. Make sure to start the time as soon as someone starts pouring.
- 11) Stop the timer once the popcorn kernel clears the pipe. Do not move, shake or adjust the pipe to help the waste move.
- 12) Record the time in the chart.
- 13) Now repeat steps 5-11 for set C-L
- 14) Once you have completed the chart, answer the questions below.

Roles:

- 1) timer and recorder \_\_\_\_\_
- 2) waste pourer \_\_\_\_\_
- 3) pipe holder \_\_\_\_\_
- 4) poster holder \_\_\_\_\_

	Coordinates	Slope of line containing coordinates	Equation of the line containing coordinates	Steepness of the line	Pipe #	Time it takes for waste to travel through the pipe
<u>B</u>	$(-8, 9)$ and $(12, -1)$					
<u>C</u>	$(-4, 2)$ and $(20, 8)$					
<u>D</u>	$(0, 12)$ and $(4, -8)$					

	Coordinates	Slope of line containing coordinates	Equation of the line containing coordinates	Steepness of the line	Pipe #	Time it takes for waste to travel through the pipe
E	$(16, -7)$ and $(1, 23)$					
F	$(-6, -11)$ and $(9, 4)$					
G	$(-22, -1)$ and $(22, 1)$					
H	$(-4, -1)$ and $(12, 23)$					
I	$(-12, -15)$ and $(9, -1)$					
J	$(-2, -19)$ and $(3, 21)$					
K	$(8, 15)$ and $(8, -4)$					
L	$(9, 6)$ and $(-13, 6)$					

Was your initial conjecture correct? Explain (including if you were wrong, which set was most efficient)

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Which set of coordinates contains the steepest line? Why?

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Are any of the lines perpendicular? Why or why not?

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If these lines are carrying waste into a sewage container, are all of the lines above realistic?

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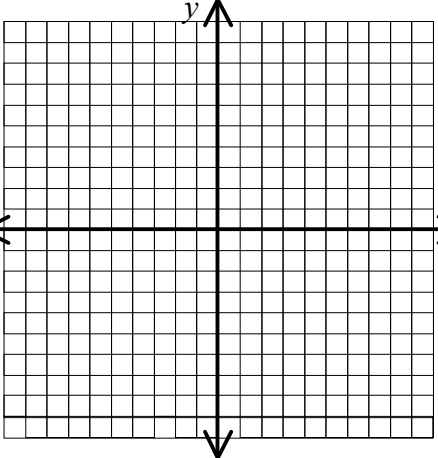
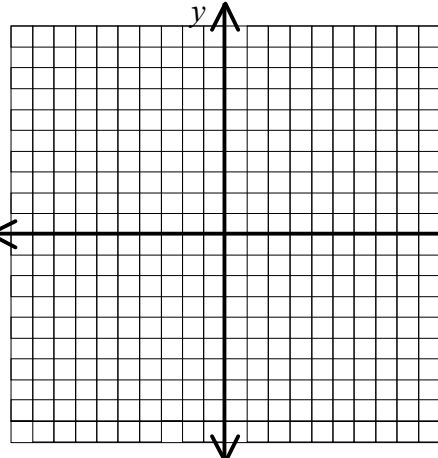
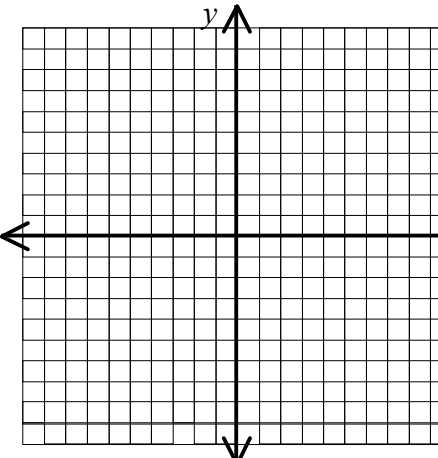
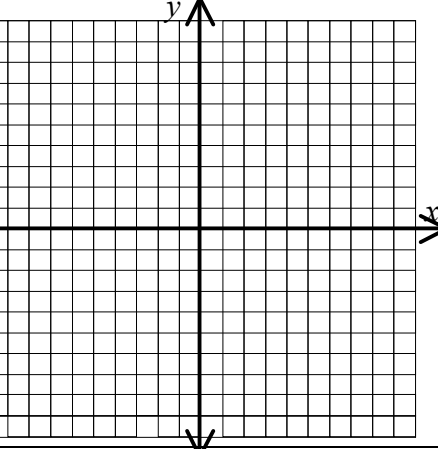
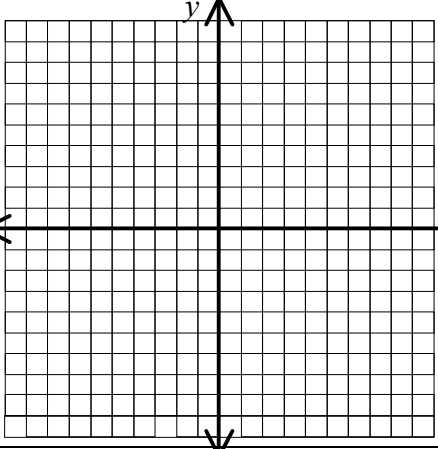
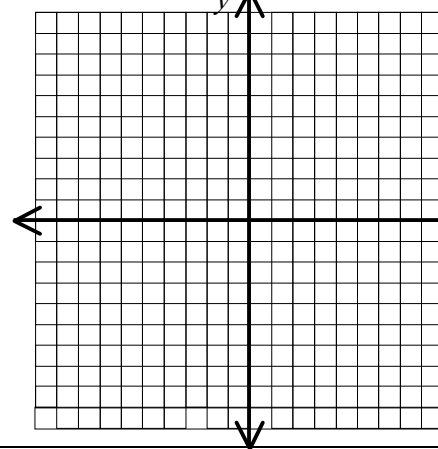
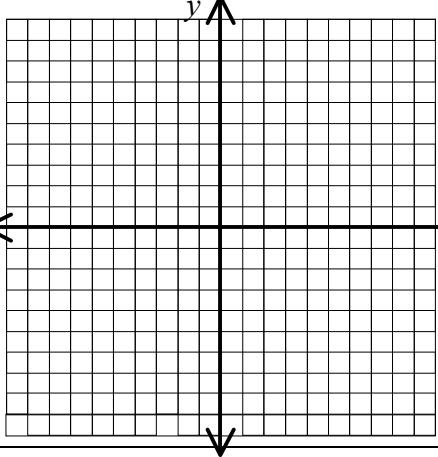
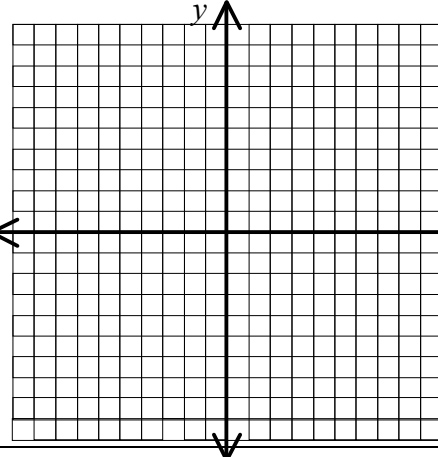
Algebra II – Chapter 2 Slope Project

Name \_\_\_\_\_

Homework

Date \_\_\_\_\_ Period \_\_\_\_\_

Graph each of the indicated lines from above. Write the corresponding equation (eq) on the line. Be sure to **SCALE** your graph correctly so your two coordinates fit on the graph.

A) eq: _____ 	B) eq: _____ 	C) eq: _____ 
F) eq: _____ 	H) eq: _____ 	I) eq: _____ 
J) eq: _____ 	K) eq: _____ 	L) eq: _____ 