

Performance Based Learning and Assessment Task

Plumbing Task

I. ASSESSMENT TASK OVERVIEW & PURPOSE:

The student will be able to understand and interpret slope in a real-world plumbing situation. The student will apply the use of slope to their prior knowledge of measurements to determine how they will solve a homeowner's problem.

II. UNIT AUTHOR:

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III. COURSE:

Algebra 1

IV. CONTENT STRAND:

Number sense, Measurement, and Algebra and Functions

V. OBJECTIVES:

- The learner will be able to understand the meaning of slope when applied to a real-world situation.
- The learner will be able to translate a real-life scenario into algebraic expressions or recognize patterns.
- The learner will be able to communicate their ideas clearly and effectively to ensure understanding of a topic.

VI. REFERENCE/RESOURCE MATERIALS:

Students will need to research the Virginia Plumbing Code online. The appropriate pages that students should find are attached. Students will also be using graphing calculators to ensure the accuracy of their calculations.

VII. PRIMARY ASSESSMENT STRATEGIES:

Students will be assessed on their completion of the research findings as well as solving the task. Students will need to ensure their answers make sense in the scheme of the problem. They will be assessed on their explanations to the homeowner as well as their presentation to the class. The students need to include visuals to help people understand what they are talking about.

VIII. EVALUATION CRITERIA:

Students will assess themselves using the attached rubric. The teacher will then assess the student using the same rubric.

IX. INSTRUCTIONAL TIME:

This task should take approximately 2 hours not including students' presentations to the class.

Plumbing Task

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Number sense, Measurement, and Algebra and Functions

Mathematical Objective(s)

The student will be able to understand and interpret the meaning of slope in a real-world situation. The student will then apply this meaning of slope to a real-world situation.

Related SOL

- A.6 a (determine and understanding slope)
- A.6 b (applying slope to different situations)
- A.1 (translating verbal situations into algebraic expressions, inequalities, or equations)

NCTM Standards:

- Judge the reasonableness of numerical computations and their results
- Analyze functions of one variable by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior
- Interpret representations of functions of two variables
- Use symbolic algebra to represent and explain mathematical relationships
- Draw reasonable conclusions about situations being modeled
- Approximate and interpret rates of change from graphical and numerical data
- Make decisions about units and scales that are appropriate for problem situations involving measurement
- Solve problems that arise in mathematics and other contexts
- Monitor and reflect on the process of mathematical problem solving
- Organize and consolidate mathematical thinking through communication
- Recognize and apply mathematics in contexts outside of mathematics
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others

Materials/Resources

- Use of classroom computers and internet to research and investigate plumbing code
- Classroom graphing calculators
- Personal use of measuring tape to measure distances at home

Assumption of Prior Knowledge

Students are expected to know what slope is and how its definition can be applied to real world situations. They are also expected to know how many inches are in foot and how to convert back and forth very quickly. Students extending the task into creating an equation will have already been taught how to write equations given certain data. Many students may mix up inches and feet and forget to convert their findings back to feet to make sure their answer is plausible.

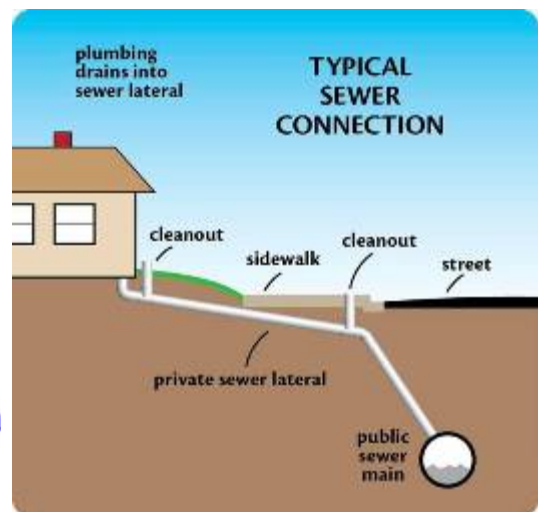
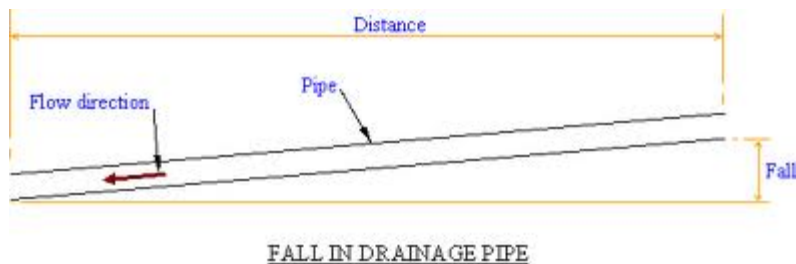
Introduction: Setting Up the Mathematical Task

The teacher will have a discussion with students about building a house and the necessary aspects that homeowners and contractors need to consider. They may ask, “How many of you have known someone

Plumbing Task

who has built their own house? What kinds of things need to be taken into consideration when building a house? Specifically, what considerations need to be made when thinking about the plumbing of a new house?" The teacher will listen to student responses and discussion.

The teacher will show pictures similar to the ones below:



The teacher will then ask the students about different observations they may make because of the pictures. Hopefully the students will notice that there has to be a slant (slope) for the water to run out of the pipe without being forced to the sewer. The teacher will then explain that this will allow the water to fall using gravity instead of any other means. The teacher will ask what the students think these "other means" may be. (Answers could be similar to adding a pump in different spots, having a different type of septic systems such as an above ground septic, etc).

Students will be told to read the following task:

You are a plumber on a new construction job. You need to make sure you buy the appropriate amount of pipe to go from two different toilets to the sewer main hookup. Since you don't yet know the depth of the sewer connection, you need to determine different lengths of 3" pipe necessary for placing a bathroom. The crawl space is approximately 2 feet from the bottom of the toilet to the ground. You will create a list of different lengths of pipe with different sewer connection depths. Then you will research the cost of the 3" pipe to determine where to buy the pipe. You will present your findings to the plumbing company that hired

Plumbing Task

you (our classmates). You will need to create an organized presentation (poster, Powerpoint, etc.) to help your construction company staff understand all that you have found.

Students will then be reminded that there are laws and codes about plumbing. The students will need to research these codes for Virginia before they can begin determining whether or not the job will be able to be done. They will also need to research the type of 3" pipe necessary for sewer drain and its cost.

The research should take about 20 to 30 minutes for students to find and read through the appropriate plumbing code. It should then take the students approximately 15 to 20 minutes to solve the practice problems. Then students will work with their group for approximately 30 minutes to solve the overall task. Finally, to research the cost of pipe and create the presentation, the students may take approximately 45 minutes.

Student Exploration

Paired Work

The students will work in pairs (to be determined by the teacher) the entire time throughout this project. The teacher will continually monitor student progress and assist student pairs individually as needed. Students will begin by researching the current Virginia Plumbing Code to understand the slope necessary for them to solve the problem. Students will complete the "Research Findings" sheet as a log for their understanding. Using this knowledge, students will then complete the "Practice" sheet to aid in using the given slope. They will then be given the "Task" sheet and be asked to devise and execute a plan to determine appropriate pipe lengths for different sewer depths. Finally, the students will create a presentation and deliver it to the plumbing company (classmates) to explain their findings.

Whole Class Sharing/Discussion

Students will present their findings to their whole class after completing their task. These findings will include pictures and/or models to help other students visualize their responses.

Student/Teacher Actions:

The students should first research the Virginia Plumbing Code to determine the horizontal slope of sanitary drainage pipe. They will begin thinking about what the slope means in this situation and how to apply it. They will need to note that the slope is comparing inches to feet and remember this throughout the task. Students should discuss their findings with their partner and determine strategies for finding different pipe lengths and distances. Students will use calculators to help ensure the accuracy of their calculations. Once the students determine the pipe lengths and distances, they will research what type of pipe to purchase and prices. Finally, they will present their findings to the class.

Monitoring Student Responses

Students will present their findings by creating a presentation (poster, Powerpoint, etc.) to present to the plumbing staff using the appropriate language to explain their findings.

Students who finish early will be asked to extend this task by creating a generalized equation to determine whether or not any given distance from the sewer pipe or depth of the sewer pipe would work.

Assessment List and Benchmarks

While researching, students will complete the "Research Findings" sheet to help them stay on task and begin to understand what is being asked of them.

Students will complete the "Practice" sheet while working on this task.

Students will be asked to create some form of visual representation to support their findings (ex: a model drawn to scale, a table, an equation, etc).

Plumbing Task

Students will self-assess using the same rubric the teacher will use to assess student progress. The students will also include a brief synopsis of their own contributions to the project. The teacher will then assess the student using the rubric provided.

Plumbing Task

Group Member Names: _____

Period: _____

Directions: You need to research the most current Virginia Plumbing Code to determine the minimum slope of a horizontal sanitary drainage pipe.

Research Findings

1. What is the minimum slope for a 3" drainage pipe? (Be sure to include your units)
2. What does this slope mean? In other words, how can I apply this to a plumbing situation? Please use complete sentences.
3. What attribute of the pipe causes a change in the slope? Why would this allow the slope to change?
4. When the pipe begins leaving the underside of the house, what kind of slope is this (positive, negative, zero, undefined)? Why do you think the writers of the plumbing code didn't write it this way?

Directions: You need to research the most current Virginia Plumbing Code to determine the minimum slope of a horizontal sanitary drainage pipe.

Research Findings-Answer Key

1. What is the minimum slope for a 3" drainage pipe? (Be sure to include your units)

The minimum slope for a 3" drainage pipe is $\frac{1}{8}$ inch per foot. This could also be written as $\frac{\frac{1}{8}\text{in}}{1\text{ foot}}$ or $\frac{.125\text{ in}}{1\text{ foot}}$.

2. What does this slope mean? In other words, how can I apply this to a plumbing situation? Please use complete sentences.

This slope means that for every 1 foot increment of diagonal run pipe, there must be an $\frac{1}{8}$ of an inch change in elevation. For example, if the pipe needed to go down one inch into the ground, 8 feet of pipe would be required.

3. What attribute of the pipe causes a change in the slope? Why would this allow the slope to change?

The size or diameter of the pipe is what causes a change in slope. This could be caused because the wider a pipe is, the more water flows through it. (Answers may vary on this.)

4. When the pipe begins leaving the underside of the house, what kind of slope is this (positive, negative, zero, undefined)? Why do you think the writers of the plumbing code didn't write it this way?

This is a negative slope. The writers of the plumbing code didn't write it with negatives because it would be too confusing. (Answers may vary on this.)

Sewer Connection Practice

Directions: Answer the following questions using your knowledge from your plumbing code research.

1. How many feet of 3" pipe is needed to run if there is one foot of depth change?
2. How many feet of 3" pipe is needed to run if there is 1/2 foot of depth change?
3. Create a line graph to comparing the amount of 3" pipe to depth change for each ½ foot.
4. If a sewer connection is located six feet in the ground, how much diagonal 3" drain pipe can be run?
5. If a diagonal sewer pipe that is 3" in diameter is 50 feet long, how deep in the ground is the sewer connection in feet and inches?
6. Would a toilet be able to be placed 150 feet away from a sewer connection that is 3 feet in the ground if you are running 3" pipe? Why or why not?
7. Would a toilet be able to be placed 425 feet away from a sewer connection that is approximately 4 ½ feet in the ground if you are running 3" pipe? Why or why not?
8. Fill in the chart below for the depth change necessary for 3" pipe being run.

Plumbing Task

Running Pipe (in feet)	Depth Change (in feet and inches)
75 feet	
153 feet	
295 feet	
52 feet	
15 feet	

Sewer Connection Practice-Answer Key

Directions: Answer the following questions using your knowledge from your plumbing code research.

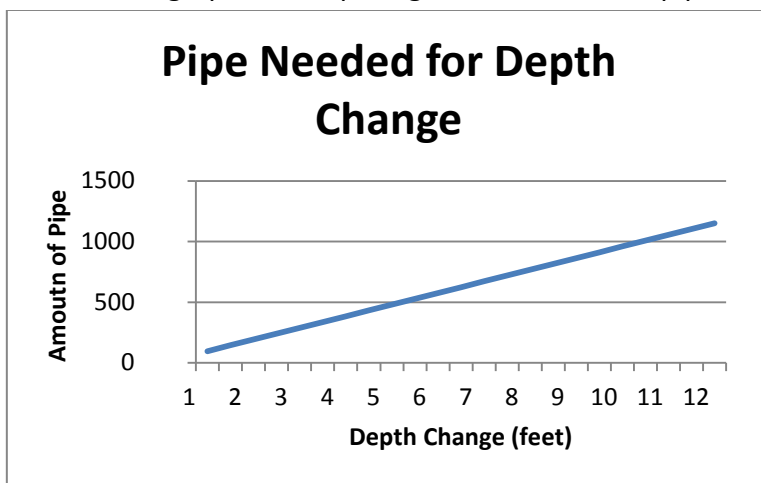
9. How many feet of 3" pipe is needed to run if there is one foot of depth change?

96 feet

10. How many feet of 3" pipe is needed to run if there is 1/2 foot of depth change?

48 feet

11. Create a line graph to comparing the amount of 3" pipe to depth change for each ½ foot.



Depth Change (feet)	Amount of Pipe (feet)		Depth Change (feet)	Amount of Pipe (feet)
1	96		7	672
1 1/2	144		7 1/2	720
2	192		8	768
2 1/2	240		8 1/2	816
3	288		9	864
3 1/2	336		9 1/2	912
4	384		10	960
4 1/2	432		10 1/2	1008
5	480		11	1056
5 1/2	528		11 1/2	1104
6	576		12	1152
6 1/2	624		12 1/2	1200

12. If a sewer connection is located six feet in the ground, how much diagonal 3" drain pipe can be run?

576 feet

Plumbing Task

13. If a diagonal sewer pipe that is 3" in diameter is 50 feet long, how deep in the ground is the sewer connection in feet and inches?

0.52 feet or 6 ¼ inches

14. Would a toilet be able to be placed 150 feet away from a sewer connection that is 3 feet in the ground if you are running 3" pipe? Why or why not?

No, the sewer connection would need to be 1.5 feet in the ground.

15. Would a toilet be able to be placed 425 feet away from a sewer connection that is approximately 4 ½ feet in the ground if you are running 3" pipe? Why or why not?

Yes, there needs to be 4.4 feet of depth change for 425 feet.

16. Fill in the chart below for the depth change necessary for 3" pipe being run.

Running Pipe (in feet)	Depth Change (in feet and inches)
75 feet	9 3/8 inches
153 feet	19 1/8 inches = 1 foot 7 1/8 inches
295 feet	36 7/8 inches = 3 feet 7/8 inch
52 feet	6 ½ inches
15 feet	1 7/8 inches

Plumbing Task

Group Member Names: _____

Period: _____

Overall Task

You are a plumber on a new construction job. You need to make sure you buy the appropriate amount of pipe to go from two different toilets to the sewer main hookup. Since you don't yet know the depth of the sewer connection, you need to determine different lengths of 3" pipe necessary for placing a bathroom. The crawl space is approximately 2 feet from the bottom of the toilet to the ground. You will create a list of different lengths of pipe with different sewer connection depths. Then you will research the cost of the 3" pipe to determine where to buy the pipe. You will present your findings to the plumbing company that hired you (our classmates). You will need to create an organized presentation (poster, Powerpoint, etc.) to help your construction company staff understand all that you have found.

Plumbing Task

Name: _____ Partner Name: _____ Period: _____

Plumbing Task Rubric

Number	Element	Point Value	Earned Assessment	
			Self-Graded	Teacher Grade
1	Researched the Virginia Plumbing Code and determined the slope of the horizontal drainage pipe for 3 inch pipe	2		
2	Determined the meaning of the slope in the context	2		
3	Identified an attribute that could cause a change in slope and why changes in this attribute would have different slopes	2		
4	Completed the practice questions with correct calculations	4		
5	Created a graph comparing the depth change and the pipe length appropriate.	2		
6	Created a list of at least 3 different pipe lengths and sewer connection distances.	3		
7	Created a visual representation to present to the class	4		
8	Presented student findings to the class in a clear and concise manner	4		
Totals				
What I did to contribute to the project:				
What my partner did to contribute to the project:				
Something I learned from the project:				

Plumbing Task

#	Element	0	1	2
1	The student researched the Virginia Plumbing Code and determined the slope of the horizontal drainage pipe for 3 inch pipe.	The student did not find the slope of horizontal drainage pipe.	The student found the incorrect slope of horizontal drainage pipe.	The student found the correct slope of horizontal drainage pipe.
2	Determined the meaning of the slope in the context.	No meaning of slope was identified	Explained the definition of slope but did not relate to context	Determined the appropriate meaning of slope in the context
3	Identified an attribute that could cause a change in slope and why changes in this attribute would have different slopes	Did not identify or explain an attribute with different slopes	Only identified or explained why change in the attribute would cause change in slope	Identified the attribute and why they caused a change in the slope
4	Completed the practice questions with correct calculations	0 Did not complete any of the practice problems	2 Completed the practice problems with less than 80% accuracy	4 Completed the practice problems with 80% or higher accuracy
5	Created a graph comparing the depth change and the appropriate pipe length.	Did not create a graph to compare depth change and pipe length.	Created a graph without labels or a title comparing depth change and pipe length.	Created a graph with labels and a title comparing depth change and pipe length.
6	Created a list of at least 3 different pipe lengths and sewer connection distances.	1 Created a list with only 1 pipe length and 1 sewer distance	2 Created a list with 2 pipe lengths and sewer distances	3 Created a list with at least 3 different pipe lengths and sewer distances
7	Created a visual representation to present to the class	0 Did not create a visual representation to present to the class	2 Created a visual representation that contains findings, but is not visually appealing and has no models	4 Created a visual representation that is visually appealing with models and descriptions of findings
8	Presented student findings to the class in a clear and concise manner	0 Did not present findings to the class	2 Presented findings to the class, but rushed and was not mathematically correct	4 Presented clear and concise findings to the class using appropriate mathematical vocabulary