

Performance Based Learning and Assessment Task

Create A Ramp Design

I. ASSESSMENT TASK OVERVIEW & PURPOSE:

The students are asked to create a model of a handicap ramp that follows the guidelines set forth in the Americans with Disabilities Act. In doing this, they will have to work with converting from feet to inches, comparing fractions, and finding slope.

II. UNIT AUTHOR:

Cynthia Gillespie, Staunton River High School, Bedford County Virginia

III. COURSE:

Algebra 1

IV. CONTENT STRAND:

Algebra

V. OBJECTIVES:

The student will be able to

- Construct a diagram to scale using the given restrictions
- Determine the slope of the line segments in their diagram and compare fractions to determine if the slopes fall within the given restrictions
- Write the linear equation (with limited domain) of their line segments

VI. REFERENCE/RESOURCE MATERIALS:

Graph Paper

Colored Pencils

Calculator (if needed)

VII. PRIMARY ASSESSMENT STRATEGIES:

The task includes an assessment component that performs two functions: (1) for the student it will be a checklist and provide a self-assessment and (2) for the teacher it will be used as a rubric. The assessment rubric for the task is intended to evaluate the diagram and ensure that all guidelines were followed and all slopes are within the restrictions.

VIII. EVALUATION CRITERIA:

Teacher assessment and benchmarks are attached at the end of this document.

IX. INSTRUCTIONAL TIME:

1 hour

Create A Ramp Design

Strand Algebra

Mathematical Objective(s)

- The student will be able to construct a diagram to scale using the given restrictions
- The student will be able to determine the slope of the line segments in their diagram and compare fractions to determine if the slopes fall within the given restrictions
- The student will be able to write the linear equation (with limited domain) of their line segments

Related SOL

- A.6 The student will graph linear equations and linear inequalities in two variables, including
- a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and
 - b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.

NCTM Standards

- compare and order fractions
- analyze functions of one variable by investigating rates of change
- explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope
- use symbolic algebra to represent and explain mathematical relationships
- identify and describe situations with constant or varying rates of change and compare them
- carry out simple unit conversions, such as from centimeters to meters, within a system of measurement
- make decisions about units and scales that are appropriate for problem situations involving measurement
- solve problems involving scale factors, using ratio and proportion

Additional Objectives for Student Learning:

- 4.2 The student will
- a) compare and order fractions and mixed numbers;
- 4.7 The student will
- b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles)
- G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include
- a) investigating and using formulas for finding slope;
- AFDA.4 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, and words.

Materials/Resources

Graph Paper

Poster Board/Paper for display

Colored Pencils

Calculator (if needed)

Activity Description and Grading Rubric

Assumption of Prior Knowledge

- Students know how to compare fractions.
- Students know how to convert between feet and inches.
- Students know how to find the slope of a line.
- Students know how write the equation of a line.
- One possibly difficulty the students will have will be writing the solutions as a piecewise functions with limited domain.

Introduction: Setting Up the Mathematical Task

How many of you have seen a ramp at a building? What would happen if the ramp was really steep? What would happen if the ramp was really long?

The Americans with Disabilities Act (ADA) has set forth some guidelines so that a ramp is not too steep or too long. The steepness of a ramp is the same as the slope. In today's task, you will be asked to draw a diagram, to scale, of a handicap ramp following the ADA guidelines (see guidelines listed at the end of this document). You will be required to determine the slope of the ramp pieces and show that they follow the ADA guidelines.

The ADA is summarized at the following link. I have also attached more information about the ADA on the last two pages of this document. http://en.wikipedia.org/wiki/Wheelchair_ramp#References

(Teacher Side Note: This activity is based on the fact that the slanted ramp length is equal to the horizontal distance. Using the Pythagorean Theorem, these two numbers are not exactly the same but they are close enough to make this activity still realistic. This might be something worth discussing with your students.)

Student Exploration

- Students will work individually to diagram two ramp designs.
- Students will determine the slope of each piece of ramp and make sure it is less than $\frac{1}{12}$.
- Students will determine the linear equation (using point – slope form of a line) and the limited domain for each piece of their diagram.
- The teacher will circulate around the room to ensure that the students understand the Americans with Disabilities Act guidelines correctly.
- The teacher will also circulate around the room and ask guiding questions
 - Clarifying
 - Do you understand the ADA restrictions?
 - Do you understand how to convert from feet to inches?
 - Do you understand how to find the slope of the ramp?
 - Orienting
 - Do all of your ramps have a slope less than $\frac{1}{12}$?
 - Prompting Mathematical Reflection
 - What is the highest porch that one ramp of 30 feet could reach?
- If students finish these two diagrams, slopes, and equations quickly,
 - Have them create a third diagram that has no two ramps with equal slopes.
 - Have them create a diagram that has only 2 ramps or one with 4 ramps.
- Extension
 - Determine the total amount of sheet metal you would need for your design construction. The ramp must be 5 feet wide.
 - Determine the cost of building your entire ramp
 - The ramp must be 5 feet wide
 - The ramp must include a handrail that is 3 feet high on both sides of the ramp
 - 36 in. x 36 in. x 0.025 in. Diamond Tread Aluminum Sheet in Silver is \$39.88 each
 - $\frac{1}{2}$ in. x 36 in. Aluminum Round Rod is \$7.21 each
- Once all students are done with their diagrams and all related work, the students will post their designs around the room and do a gallery walk. During the gallery walk, students will be required to find the slope of at least two classmates' designs and verify that the slopes are no more than $\frac{1}{12}$.
- At the end of this project, the teacher will collect all the work and grade it using the rubric.

Assessment List and Benchmarks

Students will complete two diagrams along with all the calculations. The students will be able to self-assess their work using the same rubric as the teacher. The students will also do a gallery walk to view and find the slopes of classmates work.

Create A Ramp Design

In the U.S.A, the Americans with Disabilities Act (ADA) requires a slope of no more than 1:12 for wheelchairs and scooters for business and public use, which works out to 12 inches (1 foot) of ramp for each 1 inch of rise. (This is also approximately 12 inches across for each 1 inch of rise.) For example, a 20 inch rise requires a minimum of 240 inches (20 feet) in length of ramp. Additionally, ADA limits the longest single span of ramp, prior to a horizontal rest platform, to 30 feet. Ramps can be as long as needed, but no single run of ramp can exceed 30 feet before there is a horizontal rest platform (that can be any length).

(http://en.wikipedia.org/wiki/Wheelchair_ramp#References)

You have been contracted to build a straight ramp/rest platform to a building with a 3 foot high porch and you have to cover a distance of 40 feet. You want to give your client at least two options. Draw two diagrams (to scale) on graph paper of a possible ramp/rest platform combination. Label the slope of each portion of the ramp, including the rest platforms. (remember it can be no more than 1:12).

- Put the graphs on one side of your poster and label each piece with a letter.
- Determine the slope of each piece of the graph on the back side of the poster (and compare fractions to make sure the slope is no more than 1/12)
- For both diagrams, write the linear equation and limited domain for each piece of the ramp/rest platform. Use the point – slope form of a line and then convert it to slope – intercept form of a line.

After everyone is done, we will display the ramps around the room and do a gallery walk. During the gallery walk, students will be required to find the slope of at least two classmates' designs and verify that the slopes are no more than 1/12.

All of your work will be collected at the end to be graded for accuracy. (see the grading rubric)

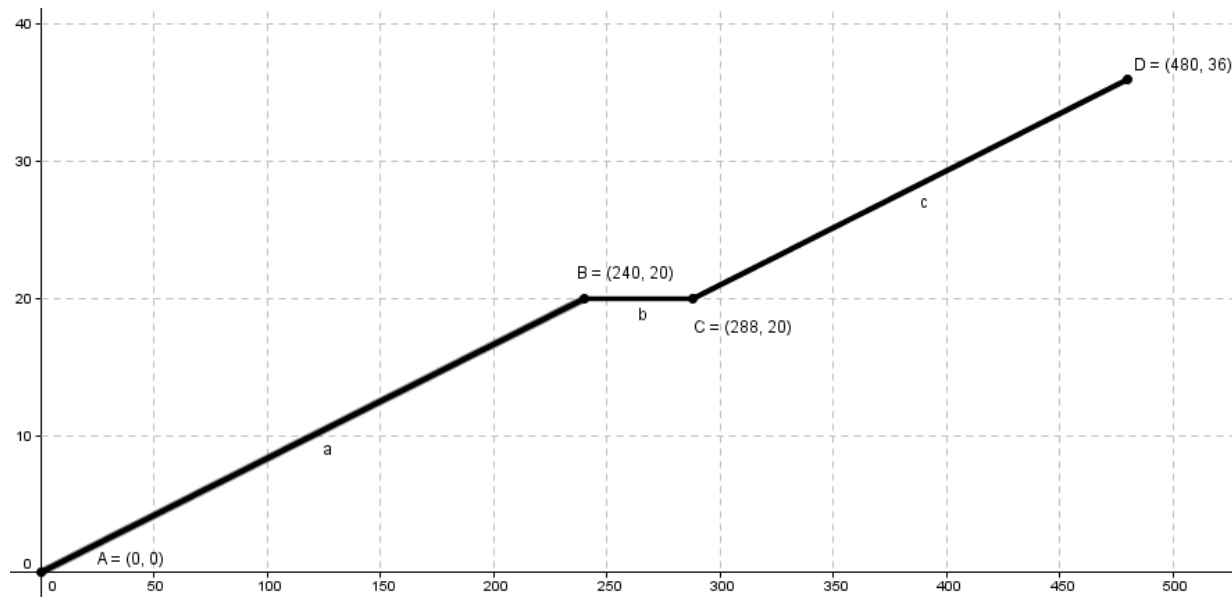
Create A Ramp Design: Grading Rubric

#	Element Graded	0 points	1 point	2 points	Assessment	
					Self	Teacher
1	Display is Neat	Things scribbled out and spelling errors	Some erasure marks and at least one spelling error	No erasure marks and no spelling errors		
2	Drawn to Scale	No scale was utilized	A scale appeared to be used but not labeled	Scale is labeled and used correctly		
3	Length and Height (of ramp 1)	Ramp/platform did not reach 40 feet long or 3 feet high	Ramp/platform reached either 40 feet long or 3 feet high (but not both)	Ramp/platform reached 40 feet long and 3 feet high		
4	Length and Height (of ramp 2)	Ramp/platform did not reach 40 feet long or 3 feet high	Ramp/platform reached either 40 feet long or 3 feet high (but not both)	Ramp/platform reached 40 feet long and 3 feet high		
5	Slope (of ramp 1)	Did not find the slope	Found the slope of some but not all pieces of the ramp/platform	Found the slope of all pieces of the ramp/platform		
6	Slope (of ramp 2)	Did not find the slope	Found the slope of some but not all pieces of the ramp/platform	Found the slope of all pieces of the ramp/platform		
7	Follow ADA guideline	Most slopes are more than 1/12 and some ramps exceed 30 feet in length	Some slopes are more than 1/12 and no ramps exceed 30 feet in length	All slopes are less than 1/12 and no ramps exceed 30 feet in length		
8	Gallery Walk	Found the slopes of 0 ramp/platforms	Found all the slopes of only 1 ramp/platform	Found all the slope of 2 different ramp/platforms (from 2 different classmates)		
TOTAL (out of 16)						

Create A Ramp Design: Benchmark

Scale on both is in inches.

Design #1: (created with GeoGebra)



Slopes for Design #1:

$$a = \frac{20 - 0}{240 - 0} = \frac{20}{240} = \frac{1}{12}$$

$$b = \frac{20 - 20}{288 - 240} = \frac{0}{48} = 0 < \frac{1}{12}$$

$$c = \frac{36 - 20}{480 - 288} = \frac{16}{192} = \frac{1}{12}$$

Linear Equation for Design #1:

$$a: y - 0 = \frac{1}{12}(x - 0); y = \frac{1}{12}x$$

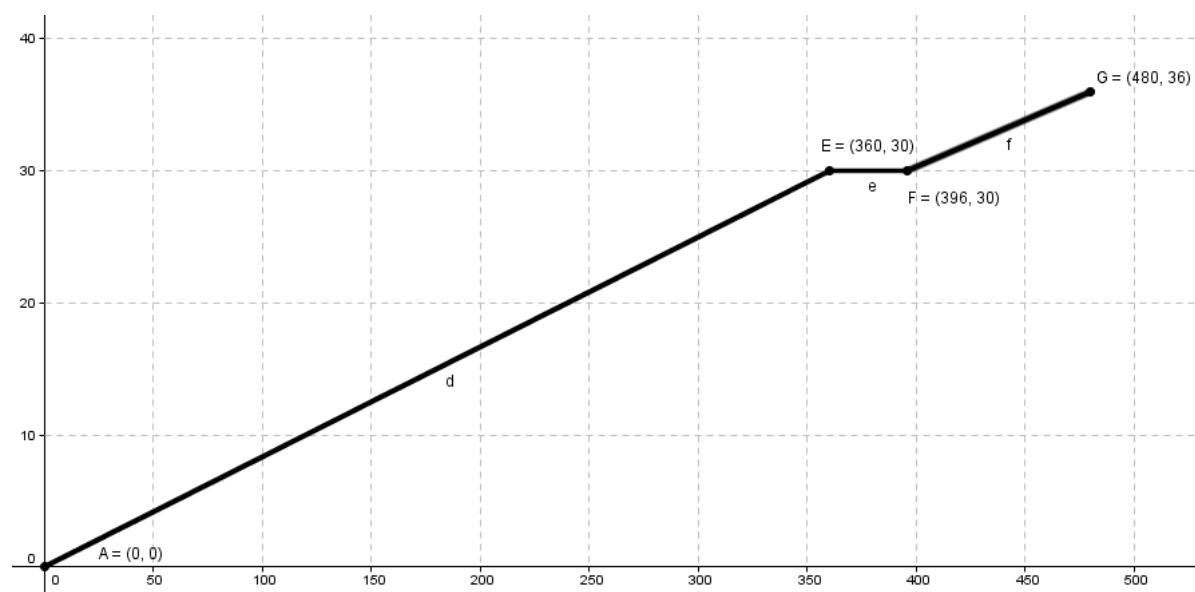
$$b: y - 20 = 0(x - 240); y = 20$$

$$c: y - 20 = \frac{1}{12}(x - 288); y = \frac{1}{12}x - 4$$

Piecewise Function for Design #1:

$$y = \begin{cases} \frac{1}{12}x & 0 \leq x < 240 \\ 20 & 240 \leq x < 288 \\ \frac{1}{12}x - 4 & 288 \leq x < 480 \end{cases}$$

Design #2: (created with GeoGebra)



Slopes for Design #2:

$$a = \frac{30 - 0}{360 - 0} = \frac{30}{360} = \frac{1}{12}$$

$$b = \frac{30 - 30}{396 - 360} = \frac{0}{36} = 0 < \frac{1}{12}$$

$$c = \frac{36 - 30}{480 - 396} = \frac{6}{84} = \frac{1}{14} < \frac{1}{12}$$

Linear Equation for Design #2:

$$a: y - 0 = \frac{1}{12}(x - 0); y = \frac{1}{12}x$$

$$b: y - 30 = 0(x - 360); y = 30$$

$$c: y - 30 = \frac{1}{14}(x - 396); y = \frac{1}{14}x - \frac{12}{7}$$

Piecewise Function for Design #2:

$$y = \begin{cases} \frac{1}{12}x & 0 \leq x < 360 \\ 30 & 360 \leq x < 396 \\ \frac{1}{14}x - \frac{12}{7} & 396 \leq x < 480 \end{cases}$$

Americans with Disabilities Act (ADA)

Wheelchair ramp (http://en.wikipedia.org/wiki/Wheelchair_ramp#References)

From Wikipedia, the free encyclopedia

A **wheelchair ramp** is an inclined plane installed in addition to or instead of stairs. Ramps permit wheelchair users, as well as people pushing strollers, carts, or other wheeled objects, to more easily access a building.

A wheelchair ramp can be permanent, semi-permanent or portable. Permanent ramps are designed to be bolted or otherwise attached in place. Semi-permanent ramps rest on top of the ground or concrete pad and are commonly used for the short term. Permanent and semi-permanent ramps are usually of aluminum, concrete or wood. Portable ramps are usually aluminum and typically fold for ease of transport. Portable ramps are primarily intended for home and building use but can also be used with vans to load an unoccupied mobility device or to load an occupied mobility device when both the device and the passenger are easy to handle.

Ramps must be carefully designed in order to be useful. Many jurisdictions have established minimum widths and maximum slopes. A less steep rise can be easier for a wheelchair user to navigate, as well as safer in icy climates.

Wheelchair ramps (or other ways for wheelchair users to access a building, such as a wheelchair lift) are required in new construction for public accommodations in the United States by the Americans with Disabilities Act.

Design Regulations

In the U.S.A, the Americans with Disabilities Act (ADA) requires a slope of no more than 1:12 for wheelchairs and scooters for business and public use, which works out to 1 foot of ramp for each inch of rise. For example, a 20 inch rise requires a minimum of 20 foot in length of ramp. Additionally, ADA limits the longest single span of ramp, prior to a rest or turn platform, to 30 feet. Ramps can be as long as needed, but no single run of ramp can exceed 30 feet. Residential Applications usually are not required to meet ADA standards (ADA is a commercial code).

The UK's guidelines as recommended by the DDA are a maximum of 1:12 for ramps (with exceptions for existing buildings) "Ramps should be as shallow as possible. The maximum permissible gradient is 1:12 [...], with the occasional exception in the case of short, steeper ramps when refitting existing buildings."

In Hong Kong, wheelchair ramp may not exceed a 1:12 slope for wheelchairs except in some situations under the Barrier Free Access (BFA) terms.

In Australia, the Australian Standards Council requires a wheelchair ramp to have a maximum incline of 1 in 14. This means that for every 14 meters traveled horizontally, the ramp rises 1 meter. The wheelchair ramp must also have a minimum width of 1,000mm.

ADA Ramp Guidelines & Wheelchair Ramp Specifications (<http://www.modular-wheelchair-ramps.com/modular-ramps/ada-guidelines.aspx>)

The Americans with Disabilities Act (ADA)

ADA Code is Federal Law that provides Wheelchair Ramp Specifications and ADA Ramp guidelines that most business must meet or risk penalties and legal action. Penalties for violating ADA ramp requirements can be up to \$5000 per violation with no warning. Typically, residential handicap ramps are not required to be compliant with ADA guidelines. However, they are a good reference point for suitable wheelchair ramp lengths. Contact your local building inspectors for local requirements, ADA Standards and additional information.

- **ADA Ramp Guidelines Require a 1:12 wheelchair ramp slope ratio, or ADA ramp slope of 4.8 degrees, which equals 1 Foot of wheelchair ramp for each Inch of rise. For instance, a 20 inch rise requires a 20 foot wheelchair ramp.**
- **ADA Specifications Require a Minimum 5' x 5' Flat area at the top and bottom of the handicap ramp.**
- **ADA Standards Require wheelchair ramps to have a Minimum 36 inches of clear space across the wheelchair ramp.**
- **ADA Standards Require a Minimum Platform size of 5' x 5'.**
- **ADA Guidelines for Wheelchair Ramps allow a Maximum run of 30 feet of wheelchair ramp before a rest or turn platform.**
- **ADA Ramp Guidelines Require handrails that are between 34" and 38" in height on both sides of the wheelchair ramps.**

Most States have their own version of ADA Guidelines and ADA Ramp Requirements, which may be more restrictive than the Federal Law. Massachusetts & California ADA ramp Guidelines require handicap ramps for Businesses to have a 48 inch minimum usable width.

Please note: These ADA guidelines are only intended to highlight our interpretation of some of the ADA Ramp Specifications or ADA ramp guidelines and is not intended to supersede or replace ADA guidelines, specifications or ADA requirements. If you need to meet ADA standards, we suggest you consult a professional ADA Compliance Consultant or your local building inspector. Local building codes may be more restrictive than ADA codes.