LESSON STUDY
On
REAL-LIFE APPLICATIONS
Of
CALCULATING SLOPE

Authors of this Lesson: Jean Ballard, Chivonne Battle, Linda Douglas, and Stephen Hendrix

School/District: King William, New Kent, Mathews, and Gloucester

Strand: AFDA

Grade Level: 10-12

Title of Lesson: Real-life Applications of Calculating Slope

PLANNING AND PREPARATION

This is the _X_ First Teaching ____ Second Teaching.

Demographics of Mrs. Douglas's class. Record the number of students in each category:

	TOTAL	Black	White	Hispanic	Asian	Other
Female	2	1	1	0	0	0
Male	5	2	3	0	0	0

Title I: 0 LEP: 0 Special Needs: 3 Gifted/Talented: 0

Free/Reduced Rate (if available): Not available

PLANNING AND PREPARATION

This is the ____ First Teaching _X_ Second Teaching.

Demographics of Mr. Hendrix's class. Record the number of students in each category:

	TOTAL	Black	White	Hispanic	Asian	Other
Female	6	1	5	0	0	0
Male	11	2	9	0	0	0

Title I: 0 LEP: 0 Special Needs: 2 Gifted/Talented: 0

Free/Reduced Rate (if available): Not available

LESSON LOGISTICS

Title of Lesson: Real-life Applications of Calculating Slope

Lesson Objectives: Students will look at real-life applications of slope, including roofs, roads, handicap ramps, funiculars, cable cars, mountains for skiing, downhill cycling, and snowboarding/dirtboarding, roller coasters, skate ramps, and BMX jumps. They will go to various, selected websites and read about each of these, as well as look at pictures. They will answer questions about each of these topics, using a PowerPoint slideshow. They will measure the rise and run of a wheelchair ramp at school to see if the ramp meets ANSI specifications for wheelchair ramps. Finally, they will use rulers, protractors, and books to demonstrate the various gradients and degrees they have studied.

Related Standards of Learning (SOL)

Previous year(s): **ALGEBRA I STANDARD 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.
GEOMETRY STANDARD 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 distance, midpoint, and slope; b) applying slope to verify and determine whether lines are parallel or perpendicular; c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.

Current year: **ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.2**
The student will use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).

Following year: **ALGEBRA II STANDARD AII.7**
The student will investigate and analyze functions algebraically and graphically. Key concepts include
a) domain and range, including limited and discontinuous domains and ranges;
b) zeros;
c) x- and y-intercepts;
d) intervals in which a function is increasing or decreasing;
e) asymptotes;
f) end behavior;
g) inverse of a function; and

h) composition of multiple functions.
Graphing calculators will be used as a tool to assist in investigation of functions.

Prerequisite Mathematics Understanding:

1) Knowledge of slope as rise over run and how to calculate it
2) Knowledge of how to change a fraction to a decimal and a percent
3) Knowledge of the Pythagorean Theorem and how to use it
4) Knowledge of how to set up a proportion and solve it
5) Knowledge of how to read a ruler and protractor

Potential Roadblocks:

1) Getting confused and putting the "run" number over the "rise" number
2) Not interpreting the decimal number correctly as a percent
3) Putting the numbers in the wrong place in the Pythagorean Theorem
4) Not knowing what to look for when measuring the handicap ramp
5) Not setting up a proportion properly
6) Forgetting to cross-multiply when solving a proportion
7) Not reading a ruler or protractor properly

Curriculum Resources: websites (see attached sheet), PowerPoint slideshow (see attached sheets)

Supplies/Materials Needed: paper, pencil, calculator, computer(s), SmartBoard, rulers, protractors, spare books to use for demonstrating gradients and degrees, access to a wheelchair ramp (either in or out of class), access to art supplies for building models (optional), access to AUTOCAD (optional)

I. Engage, II. Explore, and III. Explain 360 Total Minutes (Four 90-minute periods)

Teacher Activity:

The teacher tells the students that they will be looking at real-life applications of slope by going on the Internet and looking at different websites on roof slopes (called pitches). They will read the information and look at pictures. Then they will answer questions about this topic using a PowerPoint slideshow. They will use rulers (foot-long) to demonstrate the different roof slopes.
Next, they will look at websites on road slopes (called gradients) and answer questions. After that, they will look at websites on wheelchair ramps and what is required for building these ramps. If they can, they should measure the rise and run of a ramp at school to see if the wheelchair ramp meets ANSI specifications. They will answer questions.
Finally, they will look at websites on funiculars, cable cars, mountains for skiing, downhill cycling, and snowboarding/dirtboarding, roller coasters, skate ramps, and BMX jumps and answer questions.

Student Activity (thoughts, words, actions):

Students will look at different websites on roof slopes. They will read, look at pictures, and answer questions via a PowerPoint slideshow. Then they will use rulers to demonstrate different roof slopes.
Next, they will look at different websites on road slopes and answer questions.
After that, they will look at websites on wheelchair ramps and discover what is required for building these ramps. If possible, they should measure the rise and run of a ramp at school and determine if the wheelchair ramp meets ANSI specifications. Then they will answer questions.
Finally, they will look at websites on funiculars, cable cars, mountains for skiing, downhill cycling, and snowboarding/dirtboarding, roller coasters, skate ramps, and BMX jumps and answer questions.

Adaptations/Enrichments:

Here are several options for using the PowerPoint slideshow:

1) Have students go to a computer lab, access the PowerPoint slideshow online, click on the websites, and answer the questions.
2) Have students use "follow-along notes" from the PowerPoint slideshow.
3) Have students pick which topics they want to investigate, have them use the PowerPoint slideshow only on those topics, and have them present to their classmates what they've learned on those topics.
4) Have students create physical examples of each topic by collaborating with the art teacher.

Here are several options for bringing a handicap ramp to the classroom, if it is not possible to go measure the rise and run of a real handicap ramp at school:

1) The teacher can measure the rise and run of a real ramp at school and share those numbers with the students.
2) Bring in a model of a handicap ramp, and have the students measure it.
3) Have the students build a ramp in the classroom and measure it.
4) Have the students use AUTOCAD to measure a handicap ramp on the computer.

Students who want a challenge can make up their own math problems, similar to the ones presented in the PowerPoint slideshow!

IV. Elaborate (Summarize) 180 Minutes (Two 90-minute periods)

Teacher Activity:

The teacher will go over the answers to all of the questions on the PowerPoint slideshow by calling on different students to share with the rest of the class what they wrote down. The teacher will correct any wrong answers and misconceptions about each topic, as well as show connections to the students' lives. The teacher will find out how the students

measured the handicap ramp and whether they needed to use the Pythagorean Theorem to find the rise or run. The teacher will ask the students if the school's wheelchair ramp meets the ANSI specifications or not. Also, the teacher will help the students use the Pythagorean Theorem to find the length of the roof, when demonstrating the slopes of roofs using rulers. Finally, the teacher will make sure that the students know that when they are writing ratios, the units must be the same.

Student Activity (thoughts, words, actions):

Students will be called on to share their answers to the questions on the PowerPoint slideshow. They will correct any wrong answers and misconceptions they have about each topic. They also will explore how these topics relate to their lives. They will explain how they measured the handicap ramp and whether they used the Pythagorean Theorem to find the rise or run. They will tell whether or not they think the school's wheelchair ramp meets the ANSI specifications. They will see how to use the Pythagorean Theorem to find the length of the roof, when demonstrating slopes of roofs using rulers. Finally, they will be sure to know that ratios must be written with the same units.

V. Evaluate 90 Minutes (One 90-minute period)

Teacher Activity:

The teacher will be able to tell, after calling on different students to read their answers to the PowerPoint slideshow questions, who knows the material and understands the concepts, including use of the Pythagorean Theorem and writing ratios, and who still needs some help or further explanation. As a final show of understanding, the teacher will have the students use rulers, protractors, and stacks of books to demonstrate the various gradients and degrees they have studied as they have explored the different topics. The teacher will have the students show their math work on paper in order to show that their rulers demonstrate the proper grades of 1%, 5%, 8.3%, 10%, 12.5%, 20%, 62%, 78% and 122%, as well as 38 degrees, 50 degrees, 60 degrees, 70 degrees, and 83 degrees. The teacher will make sure that the students know what topic each gradient and degree corresponds to.

Student Activity (thoughts, words, actions):

Students should have a feel for whether they know the material and understand the concepts, including use of the Pythagorean Theorem and writing ratios, or if they still need more help or further explanation. As a final show of understanding, the students will use rulers, protractors, and stacks of books to demonstrate the various gradients and degrees they have studied as they have explored the different topics. They will show their math work on paper in order to show that their rulers demonstrate the proper grades of 1%, 5%, 8.3%, 10%, 12.5%, 20%, 62%, 78%, and 122%, as well as 38 degrees, 50 degrees, 60 degrees, 70 degrees, and 83 degrees. They should know what topic each gradient and degree corresponds to.

FOCUS

1. What is the slope of a line that goes through the points (-4, -7) and (1, 8)?
2. What is the slope of a line for the equation $4x + 3y = 12$?
3. What are some "real world" representations of slope? Name as many as possible.

FOCUS Solutions

1. What is the slope of a line that goes through the points (-4, -7) and (1, 8)? ***3***
2. What is the slope of a line for the equation $4x + 3y = 12$? ***-4/3***
3. What are some "real world" representations of slope? Name as many as possible.

Roofs ***Roads*** ***Ramps*** ***Ski Slopes***

What Else???

Slope Information

1. Slope of a Straight Line
2. Calculating Slope
3. Slope of a Line (Coordinate Geometry)
4. The Slope of a Line
5. Point Slope Form

SLOPE

Real-life Applications

Roof Pitch

- What's the standard term for roof pitch?

How to measure roof pitch

- What does 5/12 mean?

How to calculate roof pitch

- What happens when we increase the top number in the roof pitch?

- What's the difference between an A-framed roof, a stick-framed roof, and a truss-framed roof?

Roof Systems

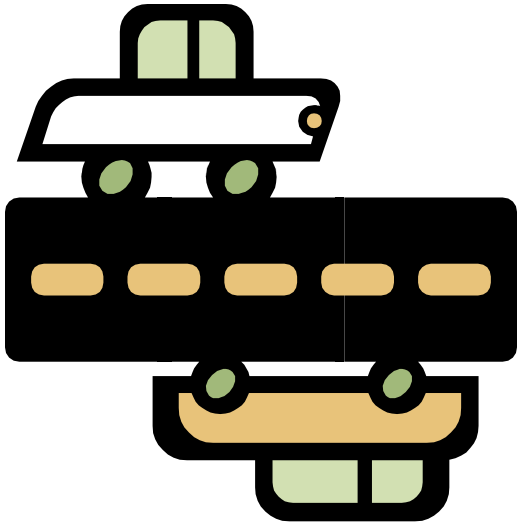
A-frame roof

- What is a RiR-trussed roof rafter? What is its purpose?

Truss types

Road Grades

- What's the grade of a road that's flat?



Road Gradients

- What's the preferable grade of main roads? secondary roads? driveways?

Road Grades

- What's the maximum grade allowed on a road on average? For rural roads? for short distances?

- What's the maximum grade allowed for a railway without cable or cogs?

Max grade

- What happens to the gradient number as we climb higher?

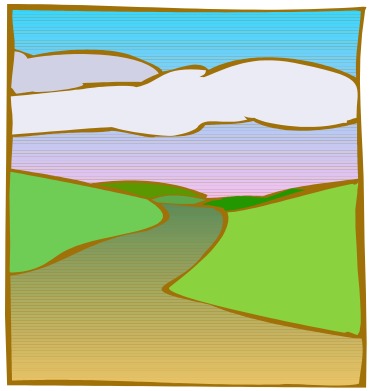
- If a road has a 5% grade over a 1000-foot run, how high will you travel vertically over that run?

50 feet

- If a road rises 26 feet over a distance of 500 feet, what is its grade?

5.2%

- Why do you think road builders have to worry about the grade of the road?



- What's the necessary grade of the road from the curb or ditch to the center of the road for proper drainage during a rainstorm?

General wheelchair ramp information

- Why do you think we have regulations for building wheelchair ramps?

Americans with Disabilities Act

- What is the regulation slope ratio for a wheelchair ramp?

How to build a wheel chair ramp

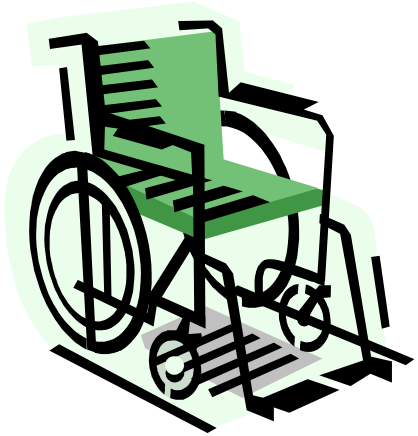
- Someone is building a wheelchair ramp up to a front door that is 20 inches off the ground. Since material (wood, stone, brick, concrete) is expensive, the builder wants to use the least amount of material, but also meet the ANSI minimum length requirement. What length must the ramp be? ***240" or 20 feet***

- Can it be any shorter than that? ***No***

YOU Decide!

- You measure a ramp and discover that it is 160 in. long and 10 in. high. Does this ramp meet the ANSI requirements?

  Yes, it has a 1:16 ratio which is less than the required 1:12 ratio.



What did we find out?

- Is the school's ramp's slope less than or equal to a 1:12 ratio?

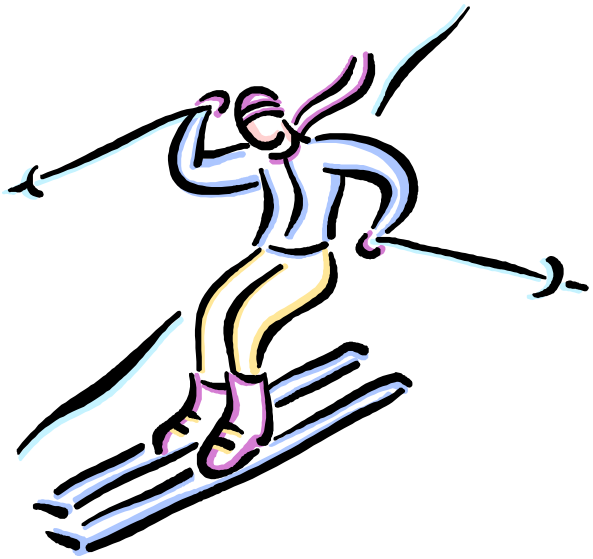
Avalanches

- At what steepness do avalanches occur?

Answer Here!

Skiing, anyone?

- What is the steepness of the typical ski slope in degrees?



Check this out!

- Is it possible to ski at 90 degrees steepness?

What is a funicular?

- Why can funiculars travel at steeper than 90 degrees?

- Look at these.

Other Real Life Applications of Slope

- Mountain Boarding
- Roller Coasters
- Land Gradients

Can you think of any more?

Name_____Date_____Block_____

Calculating Slope Worksheet

Directions: Use rulers, protractors, and stacks of books to demonstrate the various gradients and degrees listed in the tables below. Measure the rise and run to calculate slope and gradient.

	% grade	rise	run	slope = rise/run	% grade = slope * 100	
Ex.:	**25%**	*6 inches*	*24 inches*	*6/24 = 0.25*	*0.25 * 100 = 25%*	✓
	1%					
	5%					
	8.3%					
	10%					
	12.5%					
	20%					
	62%					
	78%					
	122%					

	Degrees of gradient	rise	run	slope = rise/run	% grade = slope * 100	
Ex.:	**25°**	*6 inches*	*12 $^{7}/_{8}$ inches*	*6/12 $^{7}/_{8}$ = 0.47*	*0.47 * 100 = 47%*	✓
	38°					
	50°					
	60°					
	70°					
	83°					

Slope Web Site List

http://www.themathpage.com/Alg/slope-of-a-line.htm

http://mathforum.org/cgraph/cslope/calculate.html

http://www.mathopenref.com/coordslope.html

http://www.wtamu.edu/academic/anns/mps/math/mathlab/int_algebra/int_alg_tut15_slope.htm

http://www.freemathhelp.com/point-slope.html

http://www.hometips.com/diy-how-to/roof-pitch-measuring.html

http://roofgenius.com/roofpitch.htm

http://www.diynetwork.com/remodeling/frame-by-frame-the-roof/index.html

http://architecture.about.com/od/periodsstyles/ig/House-Styles/A-frame-Style.htm

http://www.truswood.com/roof%20trusses.htm

http://medical-reports.com/Roadgradients.html

http://en.wikibooks.org/wiki/Fundamentals_of_Transportation/Grade

http://answers.yahoo.com/question/index?qid=20070317185904AAOoDBs

http://www.a1-wheelchair-ramps.com/info

http://www.ada.gov/

http://home.howstuffworks.com/home-improvement/construction/projects/build-wheelchair-ramp.htm

http://www.ussartf.org/avalanches.htm

http://pistehors.com/backcountry/wiki/Avalanches/Slope-Steepness

http://www.ski.com/interactive/maps.aspx

http://www.usatoday.com/travel/news/2007-02-01-jackson-hole-forbes_x.htm

http://www.merriam-webster.com/dictionary/funicular

http://europeforvisitors.com/switzaustria/articles/funiculars_cable_cars_cogwheels.htm

http://www.nationmaster.com/encyclopedia/Mountain-boarding

http://www.myphysicslab.com/RollerSimple.html

http://www.ordnancesurvey.co.uk/oswebsite/education/teachingresources/mapwork/investigatinggradients.html