Subject Area(s)  Geometry
Associated Unit  Slopes of Lines, Vectors
Lesson Title  Slope, Vectors, and Wind Pressure
Header  Insert Image 1 here, right justified to wrap

Image #1
ADA description: windward pressure on structure
Image file name: Roof Test.jpg
Source/Rights: Copyright@ http://trade ulaframe.co.uk/ UltraframeInfo/ UltraframeDVDConservatoryWindTests/WindTestsExplained/®_ http://www.ultraframeconservatories.co.uk/image/Roof%20Test.jpg_?

Grade Level  (9-10)
Lesson # 1 of 2
Lesson Dependency  The teacher must introduce the students to the relationship of slopes, vectors and wind pressure vectors.

Time Required  20 minutes for the TI-CBR motion detector activity, half hour for slope review and station problems, a half hour for vector lecture and station problems, with a 10 minute review of the lesson.

Summary  Students will practice walking the piecewise functions generated by a TI-CBR Motion Detector as a lesson introduction to today's lesson. Concepts to be stressed will be identifying the positive slope, negative slope, and any horizontal slope sections of the graph. Students should be able to identify which part of the graph represents a student walking toward the motion detector, walking away from the motion detector, standing in one location and a rate of change while walking toward or away from the motion detector. By selecting a portion of the piecewise function, students can determine if we have a formula that will identify the exact slope of the line segment. Introduce the slope formula with graph paper for each student. Two coordinates can be identified and a segment drawn to connect each point. Using the two coordinates, we can draw in a right triangle and identify the run/rise or slope of the graph. Introduce the slope formula and put the points in the formula to see if we get the same slope as counting out run/rise on the graph. Ask students to consider real world applications of slope, such as the pitch of a roof, ramps attached to buildings, run/rise ratio of stairs and how each can vary. Ask students to consider why some areas of the country have steeper slopes on their roofs, or if all stairs always have the same ratio. Let students practice several problems on slope before introducing Vectors.
Define scalar and vector quantities as well as examples of each term, and then let students give some examples for each of these terms. Give the definitions for vector, magnitude and direction. For today’s lesson, students will be introduced to writing the component form of a vector and finding the vector’s magnitude. Let the students practice sample problems and then provide examples of wind pressure vectors.

**Engineering Connection**

The student’s will identify wind pressure vectors on the windward and leeward sides of a building structure.

**Engineering Category** Extreme Wind

**Keywords** wind pressure, windward, leeward

**Educational Standards**

**Geometry TEKS**

- G.1 The student understands the structure of, and relationships within, and axiomatic system. (B) Recognize the historical development of geometric systems and know mathematics is developed for a variety of purposes.
- G.5 The student uses a variety of representations to describe geometric relationships and solve problems. (C) Uses properties of transformations and their compositions to make connections between mathematics and the real world, such as tessellations.
- G.7 The student understands that coordinate systems provide convenient and efficient ways of representing geometric figures and uses them accordingly. (A) Use two-dimensional coordinate systems to represent line segments. (C) Derive and use formulas involving length, slope, and midpoint.

**Pre-Requisite Knowledge**

The student should be able to use Algebra I skills, such as graphing on a coordinate plane, and know the correct notation for coordinates.
Learning Objectives
After this lesson, students should be able to:

- Compute slope using the slope formula and determine if the slope is positive, negative, or zero.
- Identify slope as a construction term referring to the pitch of a roof.
- Write a component vector.
- Find the magnitude of a vector.
- Identify the wind pressure terms of windward and leeward.
- Read a map indicating wind pressure for USA

Introduction / Motivation
The TI-CBR Motion Detector gets students attention quickly and assists them in their understanding of rate of change, and how to interpret piecewise graphs. After reviewing slope applications and formula, introduce students to vectors.

Lesson Background & Concepts for Teachers
This topic can be taught with slope, translations or trigonometry in the Geometry class. The second lesson on vectors can be used to find direction when the class studies Trigonometry in the second semester.

Insert Image # or Figure # here, [note position: left justified]

Figure # 2
ADA Description: TI-CBR2™
Caption: Figure #.TI-CBR2™ Sonic Motion Detector
Associated Activities

- By grouping students in pairs, one student can draw a piecewise function graph and the other student will then interpret the information on the graph. The students can switch duties and interpret another piecewise function.
- Use a worksheet to let students determine the component form of a vector and its magnitude.
- Students could use Google images to find and print examples of windward and leeward wind pressure on building structures.

Lesson Closure

Review applications of slope and the slope formula. Review concepts of scalar and vector quantities with students. Giving examples of each and asking them to distinguish between them. Examples of scalar are the weight of a box, length of a building. Examples of vector are a force of 30 pounds acting on a wall at a 50° angle, or walking east at 3 mph. To find the magnitude of a vector, students use the Pythagorean Theorem. Refer to a picture showing the wind pressure vectors and discuss windward and leeward pressure.

Assessment

One option is to divide the class into groups of 3 or 4 students and have them write a quiz with one word problem on slope, one on vector component, and a vector magnitude problem. They could also ask another group to explain why wind pressure is a vector. The groups then exchange their papers and take another group’s quiz.

Attachments

Slope/Vector lesson
Define ethics and apply it to ethics in engineering. It is now a topic/course on many engineering campuses with essays and links on the web. Engineers, companies, governments consider social responsibility versus legal liability. A problem with the design of a new phone could be based on this conjecture. Should the problem be addressed before the sale of the product or plan to deal with problems as they occur?

Other

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Geometry 9th, 10th Grade
Summer 2009
Extreme Wind Project Study at UTA
Lesson Title: Slopes, Vectors, and Wind Pressure, Oh My!
Learning Objectives

- Review slope formula, positive, negative, zero and undefined slopes
- Encourage students to identify examples of slope, i.e. pitch of roof, ramps, stairs, and rate of change
- Introduce Vectors, terminology, use of wind vectors to indicate wind pressure
- Introduce students to Piecewise functions

Before reviewing the slope formula, a TI-CBR motion detector will be connected to the presenter in the classroom. Students would be asked to consider what the graph would like it we walked toward an object, stood still so many feet or meters from an object, or what if we were to walk backward. They will then be asked if speed would alter the graph.

Volunteers will be asked to hold the math textbook before them and then try and duplicate the pattern on the screen. It will be okay for them to get suggestions from the class, and the class will be encouraged to look at this as a class objective. Options would be to set the class in teams and encourage the teams to see whom could walk the pattern correctly first.

Examples of possible options on the CBR Ranger are on paper. Once students begin to understand how they must walk to duplicate the pattern on the CBR. Each team can put in words how a graph would look if you were walking toward an object, walking away, standing still or vary your pace. As a class we can review their observations, and then ask why we were using the 1st quadrant for our graphs. We can also determine why time was on the horizontal axis and distance was on the vertical axis. Students should then determine whether time depends upon distance or if distance depends upon time.

The CBR also allows the option of the student walking their own pattern to be displayed on the screen. As students develop an understanding for rate of change, they can then review the slope formula.
Slopes

Vocabulary: slope, run, rise

Slope - is the ratio of the change in the y-coordinates to the corresponding change in the x-coordinates.

Rise - is the difference in the y values of two points on a line.

Run - is the difference in the x values of two points on a line.

Piecewise Function – usually defined by more than one formula, using a formula for each interval.

Slope \( m = \frac{\text{change in y coordinate}}{\text{change in x coordinate}} = \frac{y_2 - y_1}{x_2 - x_1} \), \( x_2 \neq x_1 \)

Examples:

Find the slope of the segment joining (-2, 3) and (6, 5)

\((-2, 3) \quad (x_2, y_2)\)

\((6, 5) \quad (x_1, y_1)\)

Slope \( m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5 - 3}{6 - (-2)} \)

\( = \frac{2}{8} = \frac{1}{4} \)

Verify that the answer is the same, regardless of which point is \((x_1, y_1)\).

Review slopes of a vertical line is undefined, horizontal line is zero, and positive slopes rise to the right, negative slopes fall to the right. Give examples of each, allowing students to practice.

Supply students with graph paper, with equations on them. Ask how they would go about finding the slope of the first graph. Would it matter which two points we selected? Where should the points be located?
Ask students for real life applications of slope: ramps, roofs of homes or buildings, stairs, graphs of data. Ask students if there is a reason why homes have steeper roofs than other homes. (Snowfall accumulation)

Ask if it makes a difference if steps have slope of 4, ¼, 2/3, 1/1, etc. What about handicap ramps or ramps for delivery of supplies to businesses? How do you determine the appropriate slope?

Model a problem solving slope problem with the class, and then use stations to work #2-4. Students will be able to check answers at each station and then move to the next station. Refer to example of piecewise graph and relate it to slope.

Example to work with the class: We will graph the line that represents each problem, and then find the slope of that line. Samantha is driving from Dallas to Corpus Christi, TX. At 1:30 pm, she is 90 miles from Dallas. At 4pm, she is 240 miles from Dallas. Graph the line that represents the distance traveled and find the miles per hour she is driving if her speed is constant. Determine the values for your x and y axis.

Answer: 60 mph
Station #1  A pilot traveling at a constant rate of speed flies 210 miles by 2:30AM and 770 miles by 6 AM. Graph the line that represents the pilot’s distance flown. Find and interpret the slope of the line.

Answer: 160 mph
Station #2  An in-line skater traveling at a constant speed travels 10 miles in 1 hour and 25 miles in 2 ½ hours. Graph the line that represents the skater’s distance traveled. What is the rate of change represented in the graph?

Answer: 10 mph

Station #3
Give a description of the piecewise function above.

A person starts at 4 feet from motion detector; walks away 10 more feet in about 6 seconds and stands still for almost 4 seconds and begins to return to the starting position at 2 rates of speed.
**Vectors**

Vector – a quantity with both length and direction.  
Component form – lists the horizontal and vertical change from the initial point to the terminal point.  
Magnitude – length of the vector  
Direction – angle it makes with the horizontal line

### SCALAR
- size, length, or velocity
- length of building
- cat that weighs 12 lbs.
- area of a rug

### VECTOR
- force, acceleration
- a ball travelling 30 mph south
- car travelling east at 70 mph
- a north wind of 42 mph

*Students will have a copy of this worksheet to work the odd problems together with the teacher. Students will then work the even problems with a partner and answers will be compared. The blank graphs are from www.TheMathWorksheetSite.com*
Write vectors in component form.

Example 1  Write the component form of vector $\overrightarrow{BC}$.

Find the change in $x$-values and the corresponding change in $y$-values.

$B \ (3, \ 8) \quad (x_1, \ y_1)$

$C \ (6, \ 2) \quad (x_2, \ y_2)$

$\overrightarrow{BC} = <x_2 - x_1, \ y_2 - y_1>$

$= <6 - 3, \ 2 - 8>$

$= <3, \ -6>$

Example 2  Plot the following points. Draw $\overrightarrow{TU}$ and write it in component form. Then find the magnitude of the vector.

$T \ (7, \ -3)$

$U \ (4, \ 2)$

$<-3, \ 5>$ component form

$\sqrt{(4 - 7)^2 + (2 - (-3))^2} = \sqrt{34}$ magnitude

Graphs from TheMathWorksheetSite.com
Practice

1. Write the component form of MN.
   
   \( M (2, 1) \)
   
   \( N (4, 6) \)  \(<2, 5>\) component form

2. Plot the following points. Draw AB and write it in component form. Then find the magnitude of the vector.
   
   \( A (8, 1) \)
   
   \( B (2, 5) \)  \(<-6, 4>\) component form
   
   \( \sqrt{52} = 7.2 \) magnitude
Direction will be addressed when the chapter on Trigonometry is taught in the spring and a problem solving worksheet can be used for finding the direction of a vector.

Show examples of wind vectors from internet sites. Discuss wind pressure issues on structures.

http://hurricanehotline.org/windforces.JPG

The various types of damage to a structure are demonstrated above when wind pressure overwhelms the structural integrity.
Windward pressure - direction from which the wind is blowing.
Leeward pressure - is the direction downwind.

This graphic illustrates windward and leeward pressure points.


Extreme wind damage to a structure can be partial to total destruction of the building.

http://pasc.met.psu.edu/PA_Climatologist/extreme/Wind/wind%20damage%20to%20house.

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