Oh My Vector!

An introduction to vectors and forces

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LESSON SOURCE: *http://www.phy6.org/stargaze/Lvector.htm*
DATE LESSON TO BE TAUGHT: 11th through 14th day of 4 week unit.
GRADE LEVEL: 10-12
CONCEPT(S): The purpose of this lesson is to teach students a new concept of vectors. They will understand the point behind using them and applications to which they are useful. Also introduce the idea that the students can relate their trigonometric identities to vectors to solve force problems.
OBJECTIVES:
SWBAT

- Define and state the purpose of vectors in mathematics and physics.
- Use vector addition for representing the sum of two motions taking place simultaneously.
- Resolve vectors into components along the directions of given axes, in two or three dimensions.
- Add two or more vectors, using components
- Relate trigonometry functions and vectors to solving tension problems.

TEKS: §111.35. Precalculus (P.6) The student uses vectors to model physical situations. The student is expected to: (A) use the concept of vectors to model situations defined by magnitude and direction; and (B) analyze and solve vector problems generated by real-life situations.

§112.47. Physics (4) Science concepts. The student knows the laws governing motion. The student is expected to: (A) generate and interpret graphs describing motion including the use of real-time technology; (B) analyze examples of uniform and accelerated motion including linear, projectile, and circular; (C) demonstrate the effects of forces on the motion of objects; (D) develop and interpret a free-body diagram for force analysis; and (E) identify and describe motion relative to different frames of reference.

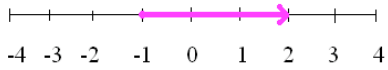
MATERIALS LIST and ADVANCED PREPARATIONS:
Per Student:

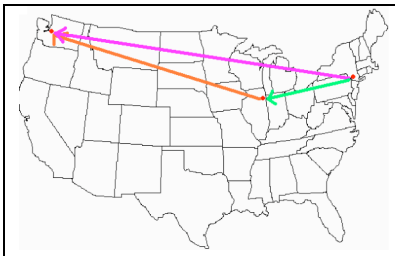
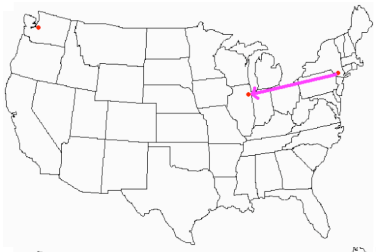
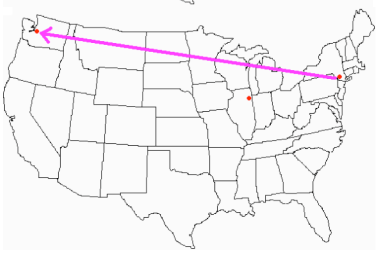
- 1 graphing calculator
- 1 vector worksheet
- 1 tension homework problem
- Paper for solutions
- A pen or pencil

SAFETY:
There is no foreseen safety issue with this lesson, just make sure all students are on task to prevent any problems.

ENGAGEMENT

What the Teacher Will Do	Eliciting Questions Formative Assessment	Student Responses

	"Today we discuss **vectors**, mathematical objects which have not only a **magnitude** (a size) the way ordinary numbers have, but also a **direction** (in which they point)."	-Students are listening to the discussion.
Draw something like this on the board:  	For each number on the numberline we can put an arrow on the line (the distance from zero to that number) Arrows to the right (say) for positive numbers, to the left for negative ones. For example, this figure shows a vector with a magnitude and direction of +3 (3 for the numerical value or size of the vector, and + for the direction it is facing).	
	<u>Vectors</u> are mathematical objects that represent arrows in any direction--in the plane, even in 3 dimensions!	
	Vectors allow us to represent **velocities**. We fly in an airplane and meanwhile the wind pushes it sideways--how are we progressing relative to the ground? Vectors help answer that.	
Sketch on the board a map of the US and use it to explain.	Similarly, **forces, accelerations, magnetic fields** from several sources, all are added like vectors. Engineers who put up a bridge or a building and want to make sure all forces balance, etc., need vectors. The simplest kind of example is **displacement**. You take a pencil and displace it from **New York** to **Chicago**, then from **Chicago** to **Seattle**. The	

	final effect is the same as if we displaced the pencil from **New York** to **Seattle**. The displacement from New York to Chicago is **this** arrow.	
	From Chicago to Seattle -- **this** arrow	
	From New York to Seattle -- **this arrow**, and we say it is the **vector sum** of the other two arrows.	
	It may look like a strange way of adding--but that is also how you add velocities, and forces, and magnetic fields.	
	What is the graphical method of adding two vectors?	- Place the tail of the second at the head of the first--the sum is from the tail of the first to the head of the second.
	Does it make any difference which of the two is added first and which second?	-No.
	Why?	-Students won't know this yet.
	Say we add two vectors **a** and **b**. Adding **a** + **b** gives one triangle Adding **b** + **a** gives a mirror-image triangle. Both triangles can be combined to a single parallelogram (show on the blackboard). In either case, the	

	sum is the diagonal of the parallelogram--the same diagonal in both cases. When do vectors add like numbers? But vectors along a line can have two directions!	 - When they all are along the same line. - That is right--vectors in one direction are counted +, in the other -

EXPLORATION

What the Teacher Will Do	Eliciting Questions Formative Assessment	Student Responses
Hand out the Vector Worksheet and split students into groups of two to work on the problems.		-Students productively work on the worksheet.

EXPLANATION

What the Teacher Will Do	Eliciting Questions Formative Assessment	Student Responses
Once students are done with the worksheet assign each group a problem number to write the solution to up on the board. Since some of the students probably could not solve one or more of the problems, the teacher could walk them through the solution.		-Students write their solutions on the board.

ELABORATION

What the Teacher Will Do	Eliciting Questions Formative Assessment	Student Responses
Introduce the concept of tension by relating it to vectors.	Tension is a type of force that is usually expressed as a vector. For example, if I'm pulling on a string, the force	

	vector is pointing towards me and the magnitude is the amount of tension in the rope. Another example is the game of "tug of war." If my team is pulling to the right and the other team is pulling to the left, the vectors directions point in different ways. This means that if both teams are pulling with the same magnitude (but different direction) the system will be at equilibrium and no one will lose. If my team pulls with more force (puts more tension on the rope) than the other team, my vectors magnitude and direction outweigh the other teams magnitude and direction and my team wins.	
Introduce the concept of using tension at angles to a flat surface. Hand out homework problem for day two.	You can also use vectors to find the angle or side of a system. For example, think of a ladder against a straight wall. Suppose you want to find the angle at which the ladder is leaning on the wall. You can use trigonometry and vectors to solve the problem.	

EVALUATION

What the Teacher Will Do	Eliciting Questions Summative Assessment	Student Responses
Have students turn in worksheets from day one on day two. Have students turn in homework problem from day two on the next day.		-Students turn in worksheets.