Sci-Port: LOUISIANA'S Science Center

What's Your Vector

Grades: 8^{th} – 12^{th}

Duration: 60 minutes

Program Description

In this program, students will learn about forces and vectors used to represent them. We start with the representation of a force as an arrow with a length and a direction. This is a vector. Then we talk about the unit of measurement for force (Newton) and the tool used to measure it (spring scale). We practice reading the spring scale. We then use three spring scales to create a balanced set of forces along three lines. We use the parallelogram method of vector addition to add each of three pairs of forces together, showing that the result of two forces is equal and opposite to the third force (this must be preceded by a short discussion of parallelograms). Finally, we play an unusual game of tug-o-war in which three teams try to balance each others' forces. We physically show that when two teams lessen the angle between them, the third team must pull harder to keep the forces balanced.

Teacher participation is essential in this workshop.

Louisiana GLE:

High School Science:

Physical Science:

1. Measure the physical properties of different forms of matter in metric system units (e.g., length, mass, volume, temperature)
29. Differentiate between mass and weight
34. Demonstrate Newton's three laws of motion (e.g., inertia, net force using F = ma, equal and opposite forces)

Physics:

1. Measure and determine the physical quantities of an object or unknown sample using correct prefixes and metric system units (e.g., mass, charge, pressure, volume, temperature, density)

12. Model scalar and vector quantities
14. Add and resolve vectors graphically and mathematically to determine resultant/equilibrant of concurrent force vectors

Math:

8th grade:

24. Demonstrate conceptual and practical understanding of symmetry, similarity, and congruence and identify similar and congruent figures
25. Predict, draw, and discuss the resulting changes in lengths, orientation, angle measures, and coordinates when figures are translated, reflected across horizontal or vertical lines, and rotated on a grid
28. Apply concepts, properties, and relationships of adjacent, corresponding, vertical, alternate interior, complementary, and supplementary angles
30. Construct, interpret, and use scale drawings in real-life situations

9th grade:

18. Demonstrate and explain how the scale of a measuring instrument determines the precision of that instrument
21. Determine appropriate units and scales to use when solving measurement problems

10th grade:

11. Determine angle measurements using the properties of parallel, perpendicular, and intersecting lines in a plane
26. Generalize and represent patterns symbolically, with and without technology

Key Terms:

Vector: A quantity described by both its size and direction, written as an arrow where the length of the arrow is the size. (example, velocity is a vector: 12 miles per hour north; force is a vector: 12 Newtons acting downward)

Scalar: simply a numerical quantity (example: 12 jellybeans)

Force: A push or a pull (example, the pull of gravity on an object is its weight. Weight is a force.)

Resultant Force: The vector addition of two or more forces. The resultant vector is created by finding the diagonal of a parallelogram created by two other force vectors.

Parallelogram: a quadrilateral with opposing sides equal in length and parallel.

Parallelogram Method of Vector Addition: Finding the diagonal of a parallelogram created by two forces that act on the same object but in different directions. Complete the parallelogram. The resultant force is the diagonal of the parallelogram.

Connections to Permanent Exhibits:

Pulleys: These show that pulleys can reduce the amount of force required to pull oneself up. Located in Physical Sciences, 2nd floor. When a person is traveling neither up nor down, the resultant force must be zero.

Web Resources:

http://www.physchem.co.za/Vectors/Addition.htm By B. T. Sewell and G. R. Delpeirre

This Website was written by two doctorates who taught on the college level and now write interactive educational websites to support the science modules in the South African science

curriculum. The website has a series of graphics that show how to add vectors using the parallelogram method.

http://en.wikipedia.org/wiki/Vector_(spatial) Wikipedia This is an overview of vectors and has nice graphics you can borrow showing the parallelogram method of vector addition.

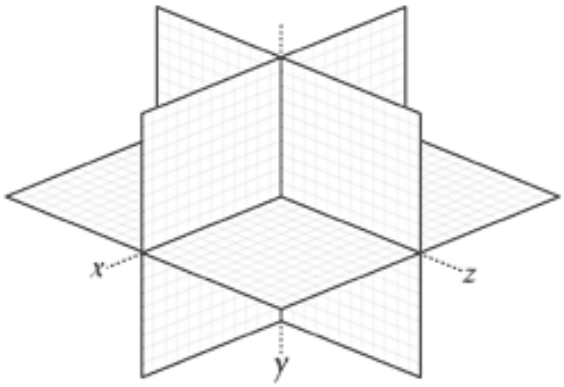
Pre-Visit Activity

Vec -> Touring

You may have heard of formation flying. You may have even seen the U.S. Navy's Blue Angels performing their formation flying show with their fighter jets. NASA wants to be able to do formation flying too. They want to fly three or more spacecraft at great distances apart in space, but have them be absolutely locked together in their positions as if they were welded onto a rigid frame. If they could do this, NASA scientists could use the fleet of spacecraft working together to look for Earth-sized planets around other stars and to study black holes, supernovas, and other violent events in the Universe.

Space Technology 7 will test an advanced technology that will allow NASA to fly several spacecraft in a very precise formation. Another name for ST7 is the Disturbance Reduction System.

Even in space, small forces can push spacecraft around and disturb their tight formation. ST7's Disturbance Reduction System will be able to detect these tiny movements of the spacecraft "off course" and figure out how to correct for them by firing tiny thrusters in the opposite direction. In other words, ST7 will calculate the vector (in this case, a force, with amount and direction) required to make the correction. Then it will calculate which of several thrusters to fire together that will combine to produce the desired result. In our game, we only have to worry about the X and Y directions. In space, we have to add another direction, Z. That makes it a lot harder!



It is technologies such as the Disturbance Reduction System that will help us learn more about the Universe, how it began, and whether there might be other Earth-like places out there. NASA's New Millennium Program is helping to choose, develop, and test these important technologies.

So have your students try to drive a car using vectors just like the Blue Angels.

This on-line game is found at
http://spaceplace.jpl.nasa.gov/en/kids/st7/vectouring/index.shtml

Post-Visit Activity

Vector Addition and Subtraction-Cut the Knot
In this on-line applet students have to help a joker climb stairs to get a ball. They must choose a set of vectors that provide the appropriate resultant. The applet gives the students their score at the end of the game.

This math interactive is found at
http://www.cut-the-knot.org/Games/Vectors.shtml