Lesson Title	Vector Components and Vector Addition
Length of Lesson	2 days
Created By	Kimberley Leggett; Michael Hamilton
Subject	Science
Grade Level	11th, 12th (Physics)
State Standards	Physics: 2 a; 1 a
DOK Level	DOK 3
DOK Application	Use concepts to solve non-routine problems; construct; formulate; Predict; Interpret
National Standards	9-12: B: Physical Science; A: Science as Inquiry
Graduate Research Element	Vectors and vector techniques are used daily in my research while using FEA (Finite Element Analysis) software.

Student Learning Goal:

State Standards for 9 – 12th Physics

Inquiry: 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations: (a) Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic.

Physical Science: 2. Develop an understanding of concepts related to forces and motion: (a) Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies.

- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)

National Science Education Standards of Content 9-12

A: Science as Inquiry: Abilities necessary to do Scientific Inquiry

- Identify questions and concepts that guide scientific investigation
- Use technology and mathematics to improve investigations and communications

B: Motions and Forces

- **Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship *F=ma*, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.**

Materials Needed (supplies, hand-outs, resources):

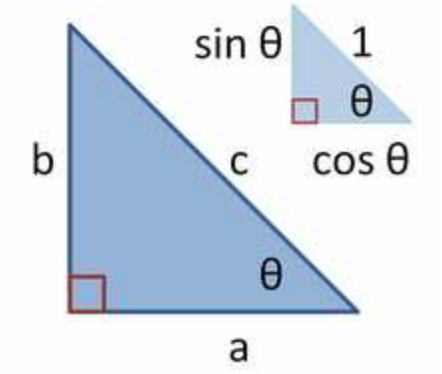
Writing utensils, notebook paper, GPS units, Computer Lab with google earth access, calculators

Lesson Performance Task/Assessment:
To use the magnitude and direction from the GPS units to calculate the components of the vectors

Lesson Relevance to Performance Task and Students:
The relevance is to be able to resolve vectors into components and vector addition using the Pythagorean Theorem.

Anticipatory Set/Capture Interest:
We will use google earth to input the coordinates the students get from their GPS units. This will allow the students to visual see the types of technology that use vectors and its components for a real world application

Guided Practice:
The instructor will talk about the Pythagorean Theorem and how to capture data points with the GPS units. In a right triangle with sides *a*, *b* and hypotenuse *c*, trigonometry determines the sine and cosine of the angle



θ between side *a* and the hypotenuse as:

$$\sin\theta = \frac{b}{c}, \quad \cos\theta = \frac{a}{c}.$$

An example will be demonstrated on how to use the GPS units and google earth

Independent Practice:
The students will be separated into groups depending on the number of GPS units and computers. The students will locate a starting position, capture the GPS data points and then walk in a straight line for a distance they decide and capture another set of data points. Then they will rotate some degrees from this position and walk however far they would like and capture another set of data points. This information will then be put into Google earth so the students can see how the information from the GPS unit can show their locations. The students will use this information to calculate the vector components and the angle they rotated.

Remediation and/or Enrichment:
R: Individual IEP; partner help throughout the lesson, fewer parts of the assignment
E: More intense calculations containing more known and unknown information

Check(s) for Understanding:
Homework will be collected and graded

Closure:
Vector components and vector addition must be completely understood before moving to the next topic since future learning is dependent on this knowledge

Possible Alternate Subject Integrations:
Math – Geometry or Trigonometry

Teacher Notes:
Below are links to a few other sites for more information on vector resolution:
http://www.physicsclassroom.com/class/vectors/u3l1e.cfm
http://www.sasked.gov.sk.ca/docs/physics/u1b3phy.html