

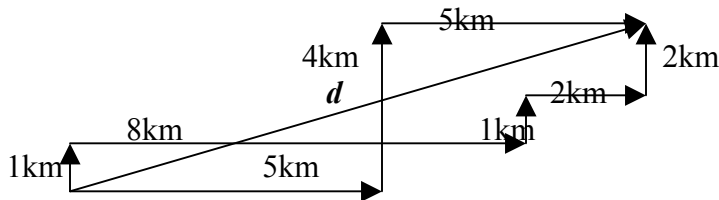
Physics

Lesson Plan #4
Vector Addition
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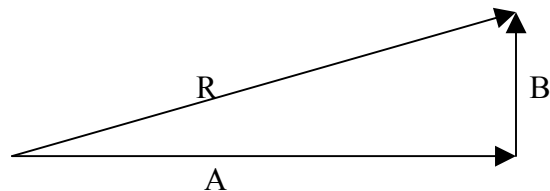
Properties of Vectors

Objectives: How to represent vector quantities graphically and algebraically; Determine the sum of vectors both graphically and algebraically

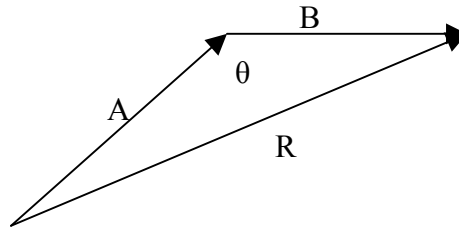
- Graphical Representation
 - o Learned in previous chapter
 - o Arrow with head indicate direction
 - o Length to indicate magnitude
- Algebraic Representation
 - o Displacement + direction in words
 - $d = 50$ km, southwest
- Resultant Vector
 - o Sum of two or more vectors



- Graphical Addition of Vectors
 - o Using the above example and graph paper, ruler and protractor
 - o Draw 5km E, 4km N and 5km E, draw Resultant
 - o Draw 1km N, 8km E, 1km N, 2km E, 2km N, draw resultant
 - o Magnitude of resultant is found by measuring the length of the resultant
 - o Direction is found using protractor
 - Answer would be 10.77 km 24° north of east
- Special cases
 - o If right angles are involved then the Pythagorean theorem can be used – $R^2 = A^2 + B^2$

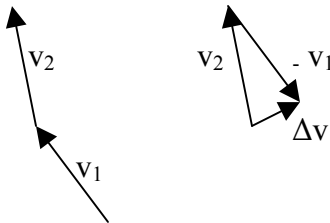


- Where there is no right angle the Law of Cosines can be used –
 $R^2 = A^2 + B^2 - 2AB\cos\theta$



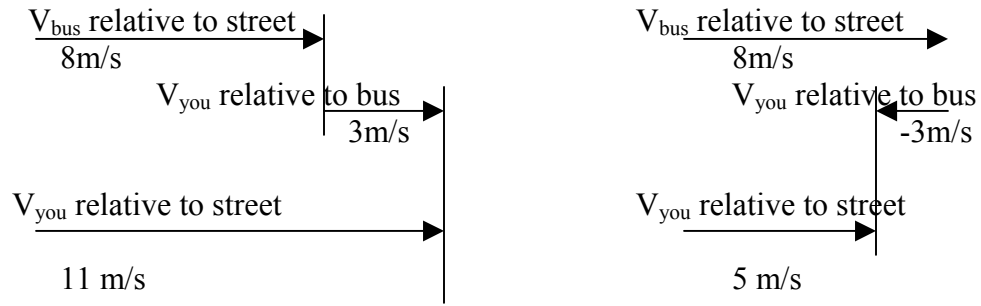
- Subtracting Vectors

- Vectors can be multiplied by scalar numbers
 - Changes the magnitude not the direction
 - Unless you multiply by a negative number
 - You can use this to subtract 2 vectors

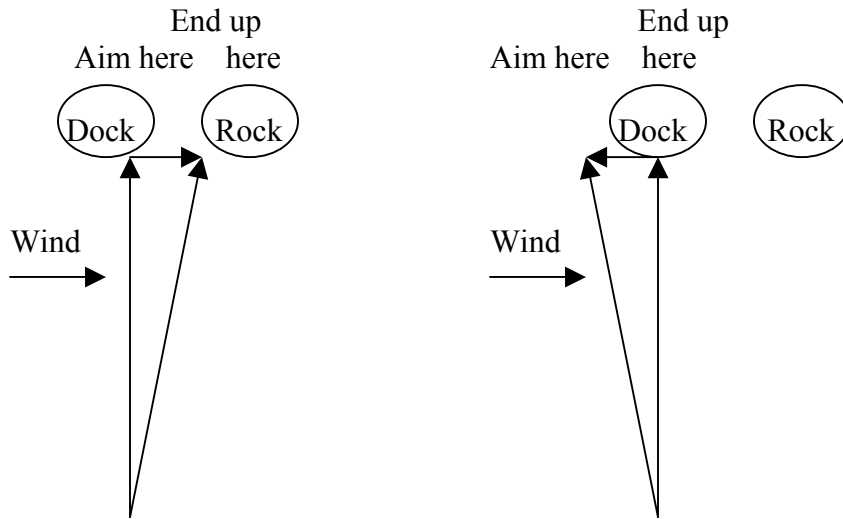


○ Relative Velocities

- What motions are we under going sitting in the classroom?
 - Earth rotates around it's axis
 - Earth revolves around the sun
 - The solar system rotates around the center of the galaxy
 - The galaxy is in motion with a local group of galaxies
 - The universe is expanding
- You can use graphical addition of vectors to solve relative motion problems
- You are traveling on a school bus that is moving at 8 m/s. You walk toward the front at 3m/s (relative to the bus)
 - What is your speed relative to the street?



- Concept can be used in two dimensions
 - Take a sailboat – a side wind will move the boat forward, but also move the boat slightly sideways. To reach a particular destination, the skipper must steer a course that will counter act the sliding.



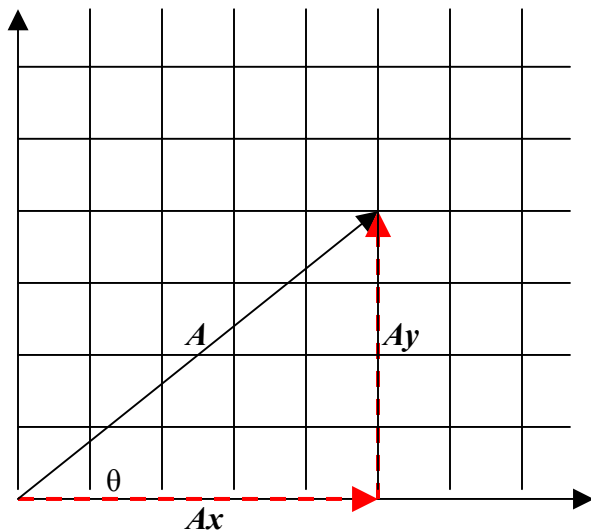
- You can add vectors at arbitrary angles using the graphical method

Components of Vectors

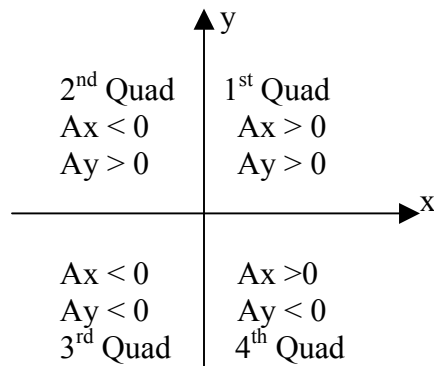
Objectives: Establish a coordinate system in problems involving vector quantities; Use the process of resolution of vectors to find the components of vectors; Determine algebraically the sum of 2 or more vectors by adding the components of the vectors.

- Choosing a Coordinate System
 - Using an x-y coordinate system - there is no right way to set it up (as long as the axis are at right angles to each other)
 - By convention, x increases as it moves to the right from the origin, and y is 90° counterclockwise from the x axis and increases as y moves away from the origin
 - On maps, x points East and y points North

- On problems involving motion through the air, y is the vertical motion and x is the horizontal motion
- On problems on an incline, $+x$ is set in the direction of motion and y perpendicular to the x axis
- Components
 - A vector can be broken up into x & y components



- Here vector A is resolved into two component vectors, A_x which is parallel to the x axis and A_y which is parallel to the y axis
- $A = A_x + A_y$
- Vector resolution is the process of breaking a vector into its components. (A_x & A_y are called components)
- Algebraic calculations use only the components of vectors – not the vectors themselves
- Use trigonometry to find the components
 - $A_x = A \cos \theta \rightarrow \cos \theta = \frac{\text{adjacent} \cdot \text{side}}{\text{hypotenuse}} = \frac{A_x}{A}$
 - $A_y = A \sin \theta \rightarrow \sin \theta = \frac{\text{opposite} \cdot \text{side}}{\text{hypotenuse}} = \frac{A_y}{A}$
 - When the angle that a vector makes with the x axis is larger than 90° (vector is in 3rd or 4th quadrant) the sign of one or more components is negative.



○ Algebraic Addition of Vectors

- Two or more vectors may be added by first resolving each vector into its x & y component
- Add the x components together, add the y components together
- For a right triangle, use the Pythagorean theorem

- $R^2 = R_x^2 + R_y^2$

- The angle or direction of the resultant can be found

by $\tan \theta = \frac{R_y}{R_x}$

