Two-Dimensional Motion and Vectors

- Without air resistance, any object that is thrown of launched into the air and is subject to gravity, will follow are parabolic path.
- The velocity of any object in two-dimensional motion can be separated into horizontal and vertical components.

MCHS Honors Physics 2014-15

Scalars and Vectors

- Previous discussion of motion was limited to two directions (one dimension).
- Mathematically, we described these directions with a positive or negative sign.
- That method works only for motion in a straight line…what do we do with objects that do not travel along a straight line?

Scalars and Vectors

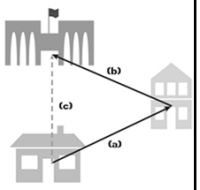
- Physical quantities can be categorized as either a scalar quantity or a vector quantity:
- A scalar is a quantity that has magnitude but no direction.
  - » Examples of scalar quantities are speed, volume, and the number of people in this class.
- A vector is a physical quantity that has both direction and magnitude.
  - » Displacement, velocity, and acceleration are vector quantities.

Scalars and Vectors

- When writing a vector, you can distinguish it from a scalar by drawing an arrow above the abbreviation for a quantity, such as $\vec{v}$=3.5 m/s to the northeast.
- We use diagrams to describe vectors. Vectors are shown as arrows that point in the direction of the vector.
- The length of a vector arrow in a diagram is proportional to the vector's magnitude.

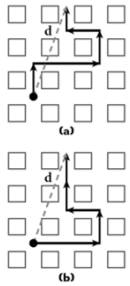
Scalars and Vectors

- A resultant vector represents the sum of two or more vectors
- When adding vectors, you must make certain that they have the same units and describe similar quantities.
  - The answer found by adding two vectors in this way is called the resultant.
  - Vectors can be added graphically



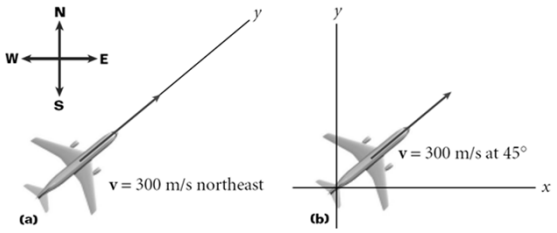
Properties of Vectors

- Vectors can be moved parallel to themselves in a diagram
- When two or more vectors act at the same point, it is possible to find a resultant vector that has the same net effect as the combination of the individual vectors.
- Vectors can be added in any order
- To subtract a vector, add its opposite
- Multiplying or dividing vectors by scalars results in vectors



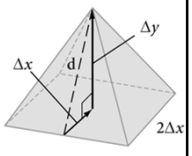
Coordinate Systems in 2 Dimensions

- To diagram the motion of an object in more than one dimension, we use vectors and both the x-axis and y-axis simultaneously.



Determining Resultant Manitude

- Use the Pythagorean theorem to find the magnitude of the resultant
- Imagine a tourist climbing a pyramid in Egypt.
- The tourist knows the height and width of the pyramid and would like to know the distance covered in a climb from the bottom to the top of the pyramid.
- Assume that the tourist climbs directly up the middle of one face.



Determining Resultant Direction and Magnitude

- Use the sine, cosine, and tangent functions to find the direction of the resultant.

DEFINITION OF THE SINE FUNCTION FOR RIGHT TRIANGLES

$$\sin\theta = \frac{\text{opp}}{\text{hyp}} \qquad \text{sine of an angle} = \frac{\text{opposite leg}}{\text{hypotenuse}}$$

DEFINITION OF THE COSINE FUNCTION FOR RIGHT TRIANGLES

$$\cos\theta = \frac{\text{adj}}{\text{hyp}} \qquad \text{cosine of an angle} = \frac{\text{adjacent leg}}{\text{hypotenuse}}$$

DEFINITION OF THE TANGENT FUNCTION FOR RIGHT TRIANGLES

$$\tan\theta = \frac{\text{opp}}{\text{adj}} \qquad \text{tangent of angle} = \frac{\text{opposite leg}}{\text{adjacent leg}}$$