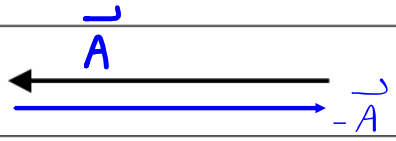
Vectors and Two Dimensional Motion

Name some vector quantities

Position, velocity, acceleration, (force)

Graphic representation of a vector quantity



Attributes (general characteristics) of a vector

1. magnitude

Represented by length

2. direction

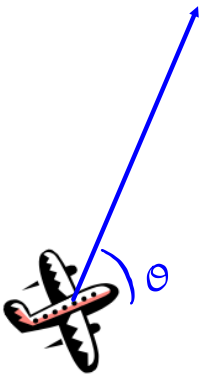
Represented by angle

Drawing Vectors

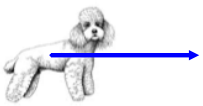
1. Draw a frame of reference if needed and choose a scale
2. Mark angle with protractor
3. Draw vector to scale with arrowhead

Draw the following vectors. State the scale used.

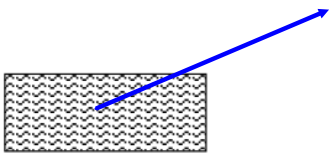
1. A plane flies at 200 m/s, 65° north of east.



2. A dog walks east for 20. m.



3. A box is dragged with a force of 30. N at an angle of $20.^0$ with the horizontal.



Adding Vectors

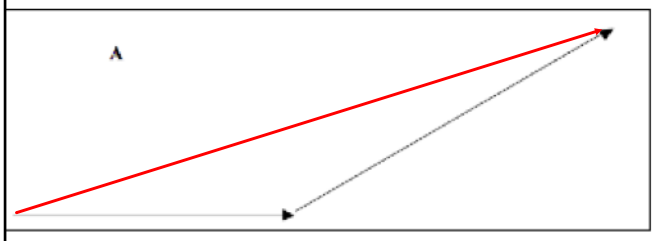
Component Vector: One of the vectors to be added

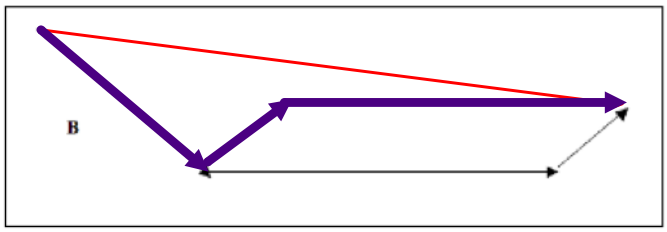
Resultant Vector: The vector that is the sum of the component vectors

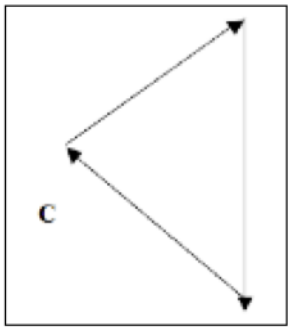
	Components	Addition of Components	Resultant
1)	5 → 8 →	5 → 8 →	13 →
2)	5 → 8 ←	5 → 8 ←	3 ←

$||\vec{r}|| = 3$

3). Draw the following vectors.





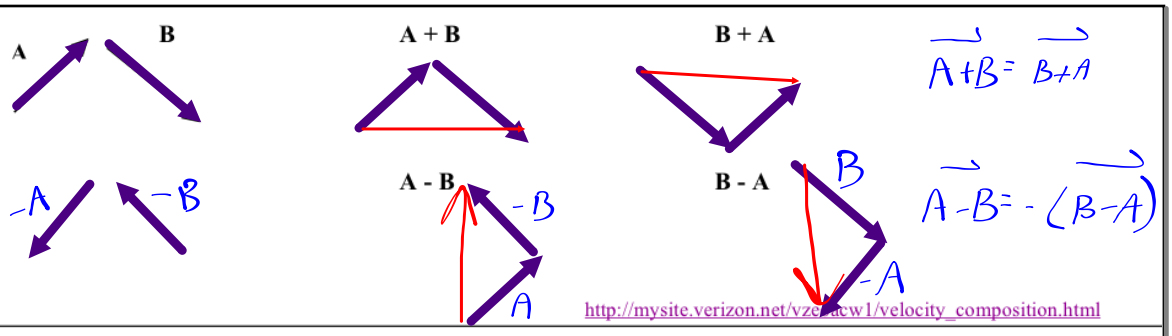


4. When adding vectors . . .
   a) component vectors can be translated (moved) without changing magnitude or direction
   b) component vectors can be placed in any order but must be placed head to tail
   c) the resultant vector is drawn from the tail of the first vector to the head of the last vector
   d) if the component vectors form a closed figure, there is no resultant.
5. A resultant vector is determined by finding its magnitude and direction.
6. Which angle represents the direction of the resultant vector?

   angle at origin
7. Compare the placement of the component vectors with the placement of the resultant vector.

   Component vectors: tip to tail

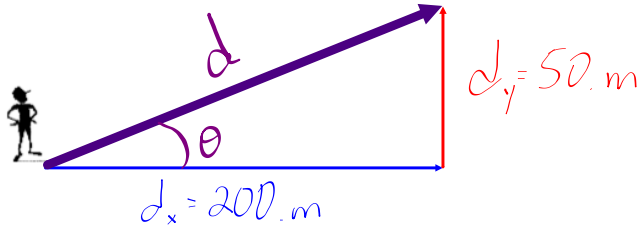
   Resultant vector: start to end



http://mysite.verizon.net/vze...ew1/velocity_composition.html

3. A man walks 200. m east and then walks 50. m north.
   a) How far has he walked?
   b) Where is he in relation to where he started?

Graphical Method



Mathematical Method

Magnitude: $||\vec{d}|| = \sqrt{d_x^2 + d_y^2} = \sqrt{(200\,m)^2 + (50\,m)^2}$

Direction: $\tan\theta = \frac{opp}{adj}$

$\theta = \tan^{-1}\left(\frac{50}{200}\right) = 14°$

Resultant: 210m 14° N of E

Concurrent Vectors

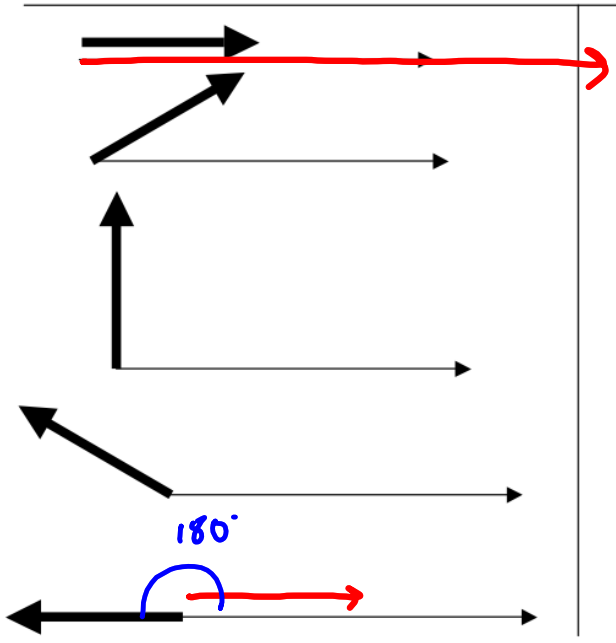
Concurrent Vectors: component vectors that are placed tail to tail (or head to head)

Sketch the resultant of the concurrent vectors below.

Conclusion:

Concurrent vectors must be placed head to tail first (in any order) before the resultant can be found. (vector slide)

Sketch the resultant of the concurrent vectors below.



Based on the results of your drawings at left, answer the following questions:

1. What is the relationship between the magnitude of the resultant and the angle between the concurrent vectors?

as θ ↑, $||R||$ ↓

2. What angle between concurrent vectors gives a :

a) maximum resultant ? 0°

b) minimum resultant? 180°

3. Two forces of 12 N and 4 N act concurrently on an object. What are the possible values for the resultant force? Sketch vector diagrams to support your answer.

http://www.walter-fendt.de/ph11e/resultant.htm
http://physics.bu.edu/~duffy/java/VectorAdd.html

Resolving a Vector into Components

1. Prof. Einstein walked 13.6 m in a direction 55.0° north of east as shown.

a) How far did he travel north?

b) How far did he travel east?

Mathematical Method

$\cos\theta = \frac{adj}{hyp}$ $\cos\theta = \frac{d_x}{d}$ $d_x = d\cdot\cos\theta$

$= 13.6m \cos 55^\circ$

$= 7.80m$

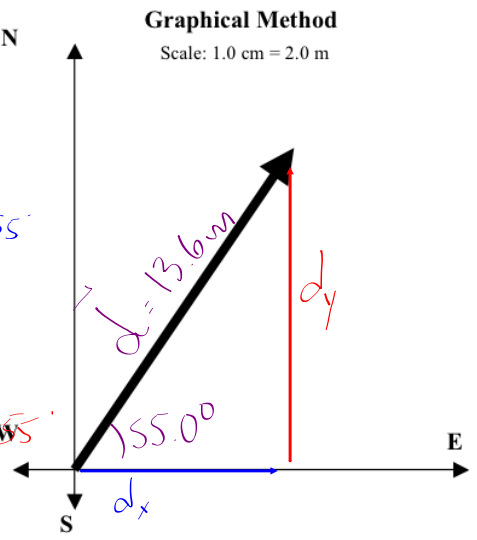
$\sin\theta = \frac{opp}{hyp}$ $\sin\theta = \frac{d_y}{d}$ $d_y = d\sin\theta$

$= 13.6m \sin 55^\circ$

$= 11.1m$

Graphical Method

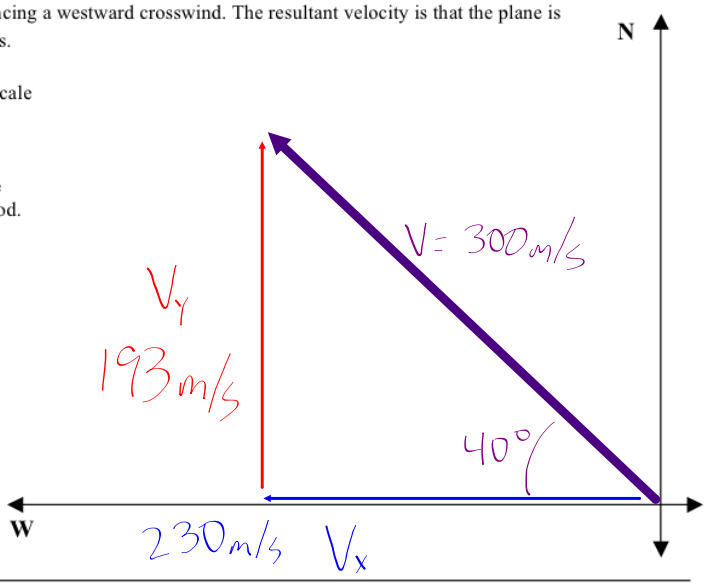
Scale: 1.0 cm = 2.0 m



2. A plane attempting to head due north is experiencing a westward crosswind. The resultant velocity is that the plane is heading 40.0° north of west at a speed of 300. m/s.

a) Draw the resultant velocity vector using the scale of 1.0 cm = 50. m/s.

b) Determine the component velocities (i.e. the plane's speed and the wind's speed) using the graphical method and the mathematical method.



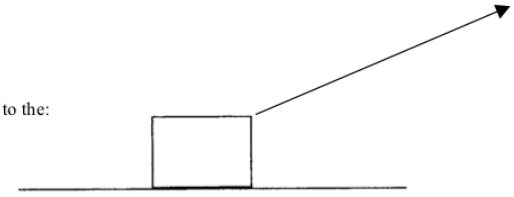
3. A cannonball is launched with a speed of 450 m/s at an angle of 35° above the horizontal.

a) Sketch an appropriate vector diagram showing the resultant velocity and its horizontal and vertical components.
(Diagram does not need to be drawn to scale but should be roughly to scale.)

b) Calculate the horizontal and vertical components of the cannonball's velocity.

4. A person drags a crate across the floor with a force of 200. N at an angle of 20.°above the horizontal as shown (not to scale).

a) Sketch an appropriate vector diagram showing the horizontal and vertical components of the force.



b) As the angle of the force increases, what will happen to the:

i) resultant force?

ii) horizontal component of the force?

iii) vertical component of the force?