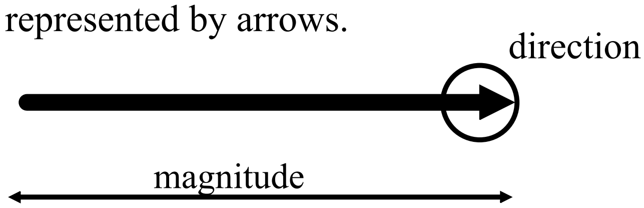
Physics 122/121

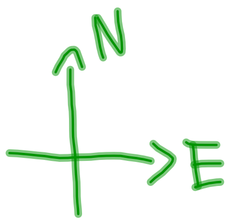
Applications of Vectors

VECTOR REVIEW

Vector quantities have both magnitude and direction. Some vector quantities are velocity, force, acceleration and momentum.

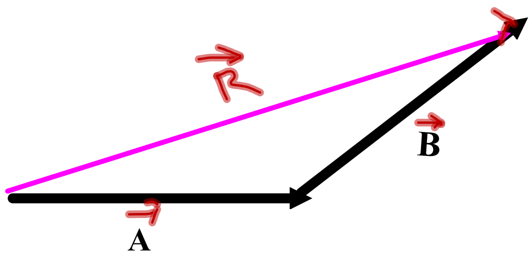
Vectors are represented by arrows.





Graphical Methods of Adding Vectors

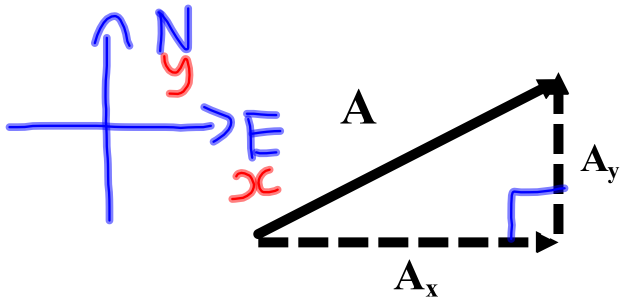
1. Tip-to-tail Method



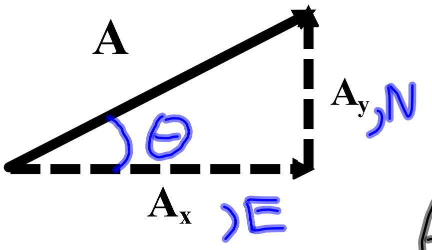
R - resultant (sum of vectors)

Components of a Vector

A vector can be expressed as the sum of two other vectors, called the components of the vector. The process of finding the components of a vector is called vector resolution. We will always be finding the perpendicular components of a vector.



Use trigonometric ratios to determine the magnitudes of the components. The arrows of the components show their directions.

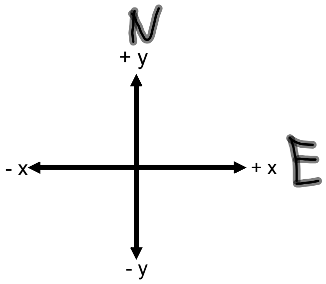


$$A_y = A\sin\theta$$

$$A_x = A\cos\theta$$

$$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$

Ex: Find the components of the following:



a) 95 km [E39°N]

East: $95\cos 39° = 74$ Km

North: $95\sin 39 = 60$ Km

b) 112 m/s [E77°S]

East: $112\cos 77 = 25$ m/s

North: $-112\sin 77 = -109$ m/s

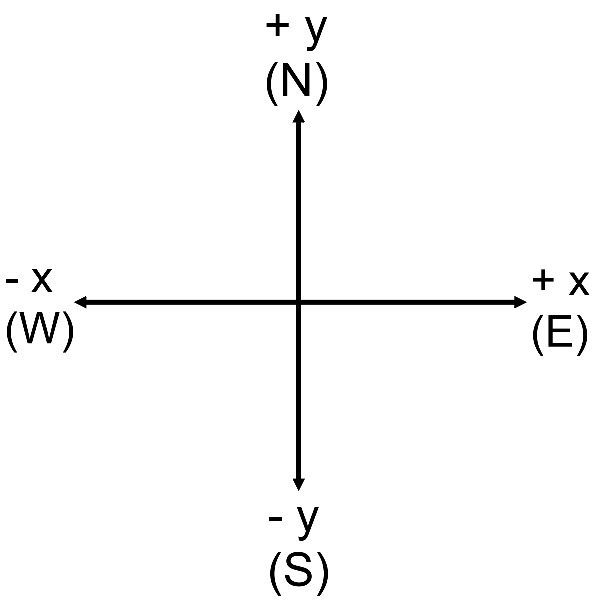
c) 1575 m [W22°S]

Adding Vectors Using Perpendicular Components

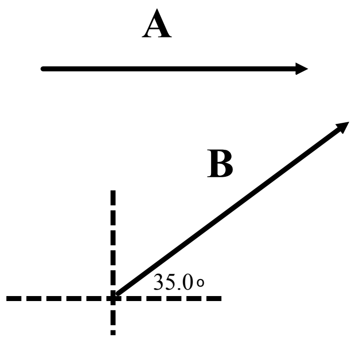
1. Resolve each vector into its perpendicular components.
2. Add corresponding vector components.

$$\mathbf{R}_x = \mathbf{A}_x + \mathbf{B}_X$$
$$\mathbf{R}_y = \mathbf{A}_y + \mathbf{B}_y$$

3. Sketch $\mathbf{R}_x$ and $\mathbf{R}_y$ tip-to-tail.
4. Use the Law of Pythagoras and a trig ratio to determine the magnitude and direction of the resultant.



Example - Find the resultant of 1.60 km, east and 3.40 km, E35.0° N

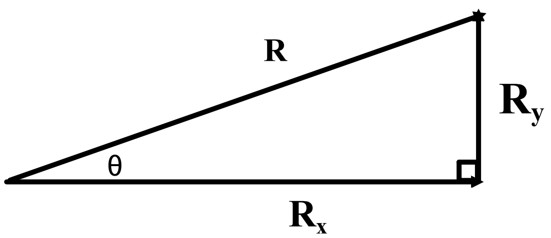


$\mathbf{A_x}$ = + 1.60 km
$\mathbf{A_y}$ = 0 km

$\mathbf{B_x}$ = (3.40 km)(cos 35.0°)
$\mathbf{B_x}$ = + 2.785 km

$\mathbf{B_y}$ = (3.40 km)(sin 35.0°)
$\mathbf{B_y}$ = + 1.95 km

$\mathbf{R_x}$ = 1.60 km + 2.785 km = 4.385 km
$\mathbf{R_y}$ = 0 km + 1.950 km = 1.950 km



$$R = \sqrt{(4.385)^2 + (1.950)^2}$$

R = 4.80 km

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

θ = 24.0°

R = 4.80 km, E24.0°N

Vector Addition and Subtraction of Vector Components - Look at the Worksheet

Part II

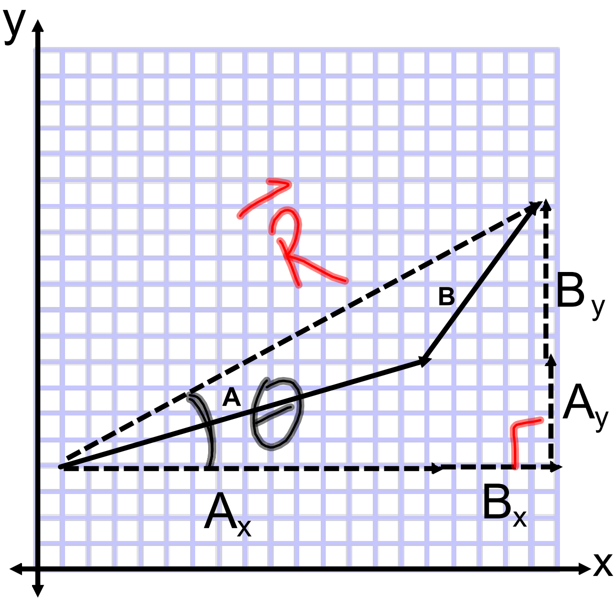
a) $\vec{R} = 19.8$ [E 59° N]

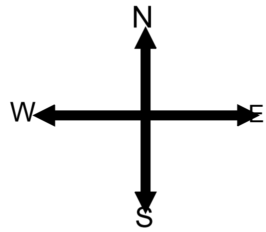
b) $\vec{R} = 19$ [E 44° S]

c) $\vec{R} = 16$ [W 82° N]

d) $\vec{R} = 20.8$ [W 87° S]

Consider the two vectors A and B.





$$\theta = \tan^{-1}\left(\frac{\text{North}}{\text{East}}\right)$$

$$F_E = -25\,N \quad , \quad F_N = 42\,N$$

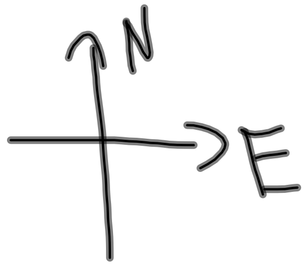
$$|F| = \sqrt{(F_E^2) + (F_N)^2}$$

$$= \sqrt{625 + 1764}$$

$$= \underline{\underline{49\,N}}$$

$$\theta = \tan^{-1}\left|\frac{F_{North}}{F_{East}}\right|$$

$$= \tan^{-1}\left|\frac{42}{-25}\right| = \tan^{-1}(1.68)$$



$$\theta = 59^\circ$$

$$\vec{F} = 49\,N\ [W\ 59^\circ\ N]$$