Physics 122/121

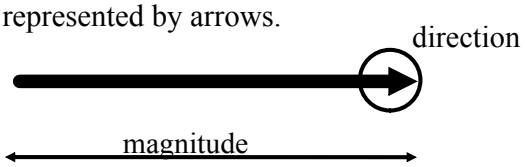
Unit 1

Applications of Vectors

VECTOR REVIEW

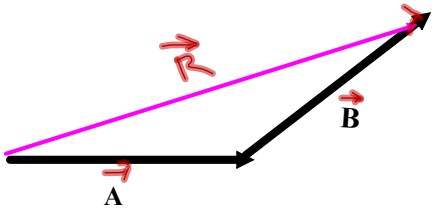
Vector quantities have both magnitude and direction. Some vector quantities are velocity, force, acceleration and momentum.

Vectors are represented by arrows.



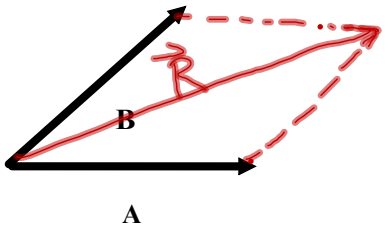
Graphical Methods of Adding Vectors

1. Tip-to-tail Method

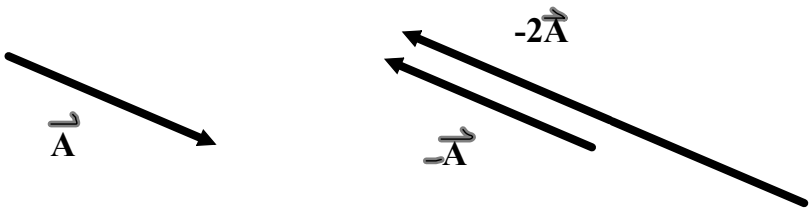


R - resultant (sum of vectors)

2. Parallelogram Method

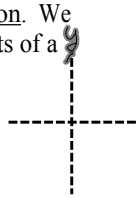


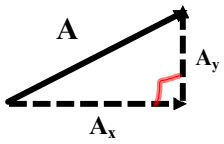
Negative Vectors



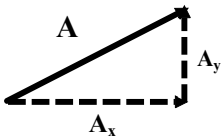
Components of a Vector Chapter 10

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.



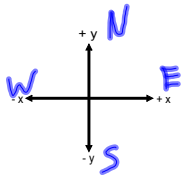


Use trigonometric ratios to determine the magnitudes of the components. The arrows of the components show their directions.



$\tan\theta = \frac{|A_y|}{|A_x|}$

Ex: Find the components of the following:



a) 95 km [E39°N]

East $= 95\cos 39° = 73.8$ km

North $= 95\sin 39° = 59.8$ km

b) 112 m/s [E77°S]

E $= 112\cos 77 = 25.1$ m/s

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

c) 1575 m [W22°S]

East $= -1575\cos 22 = -1460$ m

North $= -1575\sin 22 = -590$ m

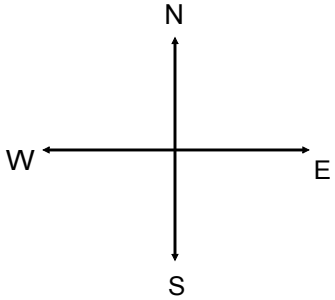
Adding Vectors Using Perpendicular Components

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

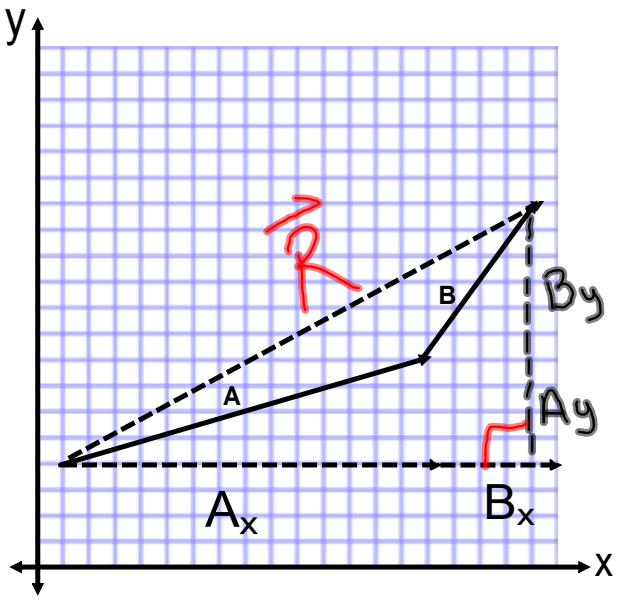
$\mathbf{R_x} = \mathbf{A_x} + \mathbf{B_X}$ (x → East)

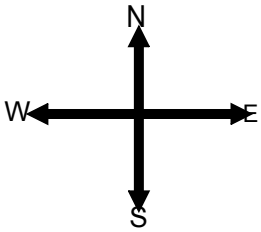
$\mathbf{R_y} = \mathbf{A_y} + \mathbf{B_y}$ (y → North)

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.

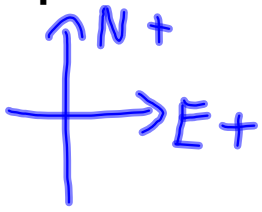


Consider the two vectors A and B.





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



$\vec{A} = ?$

$A_x = 6.4\ cm$

$A_y = 7.7$

$A^2 = A_x^2 + A_y^2 = \sqrt{(6.4)^2 + (7.7)^2}$

$= 10\ cm$

$\theta = \tan^{-1}\dfrac{|A_y|}{|A_x|} = \tan^{-1}\left(\dfrac{7.7}{6.4}\right) = 50^\circ$

$\vec{A} = 10\ cm\ E\ 50^\circ\ N$

Vector Addition Worksheet - also do the following:

B-A
E-C
2A+F-3B
3D-2C-A

} #2

$$\underline{2A + C}$$

$$R_x = 2A_x + C_x = 2(6.4) + (-3.09)$$

$$R_x = 9.71$$

$$R_y = 2A_y + C_y = 2(7.7) + (9.51) = 24.91$$

$$R = \sqrt{R_x^2 + R_y^2}$$

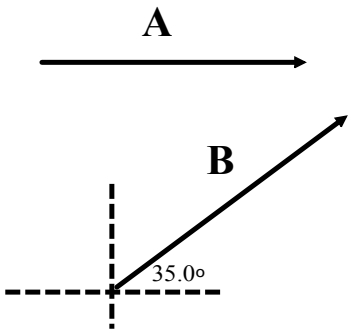
$$R = \sqrt{(9.71)^2 + (24.91)^2}$$

$$R = \underline{\underline{26.7}}$$

$$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) = \tan^{-1}\left(\frac{24.91}{9.71}\right) = \underline{\underline{69°}}$$

$$\vec{R} = 26.7\,[E\,69°\,N]$$

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

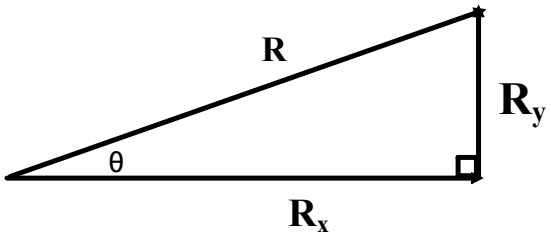


$\mathbf{A_x} = +\ 1.60$ km
$\mathbf{A_y} = 0$ km

$\mathbf{B_x} = (3.40\text{ km})(\cos 35.0^o)$
$\mathbf{B_x} = +\ 2.785$ km

$\mathbf{B_y} = (3.40\text{ km})(\sin 35.0^o)$
$\mathbf{B_y} = +\ 1.95$ km

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



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

$R = 4.80$ km

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

$\theta = 24.0^o$

R = 4.80 km, E24.0°N

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]

Addition and Subtraction of Vectors

If **A** = 56 km [E29°N], **B** = 44 km [E81°S], **C** = 65 km [W45°S] find:

a) 2A + C

* Calculate E-W and N-S comp.

$A_E = 56\cos 29 = 48.98$ Km

$A_N = 56\sin 29 = 27.15$ Km

$C_E = -65\cos 45 = -45.96$ Km

$C_N = -65\sin 45 = -45.96$ Km

$$\vec{R} = \sqrt{R_E^2 + R_N^2} \qquad \theta = \tan^{-1}\left(\frac{R_N}{R_E}\right)$$

$R_E = 2A_E + C_E$

$= 2(49) + (-46) = 52$ Km

$R_N = 2A_N + C_N$

$= 2(27) + (-46) = 8$ Km

$\theta = \tan\left(\frac{8}{52}\right) = 9°$

$$\vec{R} = \sqrt{(52)^2 + (8)^2} = 53\text{Km}\,[E\,9°\,N]$$

b) A - C

Motion Equations

$$v_{avg} = \frac{d_f - d_o}{t_f - t_o} \qquad a = \frac{v_f - v_o}{t_f - t_o} = \frac{\Delta v}{\Delta t}$$

$$v_f = v_o + at$$

$$\Delta d = v_{avg}\,\Delta t$$

$$d = v_o t + \frac{1}{2} a t^2$$

$$v_f^2 = v_o^2 + 2ad$$

Remember that everything is a vector (sign of the variable depends on its direction) except time and that the change in time can never be negative!

Applications of Vectors

What is the average velocity of a person who walks 325 m [N] and then 478 m [E20^{o}N] in 185 seconds?

What is the average velocity of a car that drives 66 km [E], 52 km [W33^{o}N], and 45 km [W73^{o}S] in 3.1 hours?

What is the acceleration of a glider that goes from 10 m/s N to 10 m/s E in 2.5 seconds?

What is the average force on the glider if it has a mass of 92 kg?

A 18 kg object experiences two forces. F_1 = 35 N [E25^{o}N] and F_2 = 46 N [E75^{o}N]. What is the acceleration of the object?

An object initially has a velocity of 25 m/s [E62^{o}N] and experiences an acceleration of 5.5 m/s^{2} [E12^{o}N] for 15 seconds. What is the displacement in that time?

An object initially has a velocity of 15 m/s [W42^{o}N] and experiences an acceleration of 3.1 m/s^{2} [E75^{o}S] for 12.6 seconds. What is the displacement in that time?

As you hike along a trail you track your location from base camp. When you are 8.4 km [W18^{o}N] a call for help comes in from a location 5.5 km [E65^{o}S]. How far are the stranded hikers from you and what bearing should you set to go help them?

An inept boating tour guide takes you to a point 26 km [E33^{o}N] from port when in fact you should be located 30 km [E33^{o}S]. To get to your proper destination in 0.75 hours, with what velocity should the tour boat travel?