

Vector Components

Grade: 12
Subject: Physics 122
Date: 2014

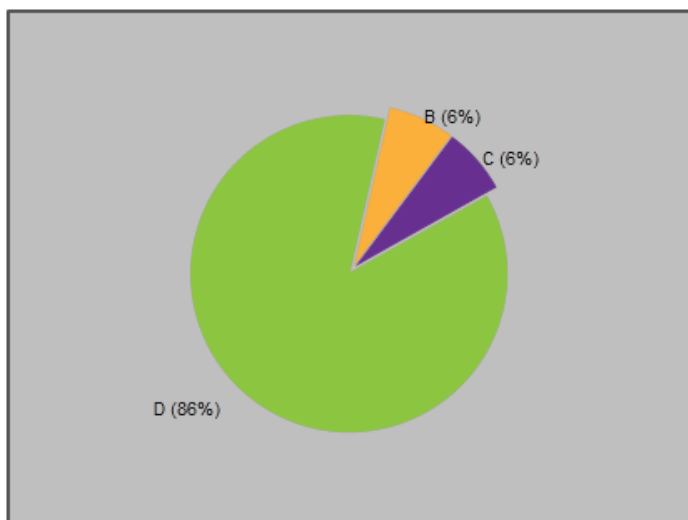
1 Calculate the perpendicular components of a velocity of 65 m/s [W41°N]

A $v_E = -43 \text{ m/s}; v_N = 49 \text{ m/s}$

B $v_E = 43 \text{ m/s}; v_N = -49 \text{ m/s}$ X

C $v_E = -49 \text{ m/s}; v_N = -43 \text{ m/s}$ X

D $v_E = -49 \text{ m/s}; v_N = 43 \text{ m/s}$



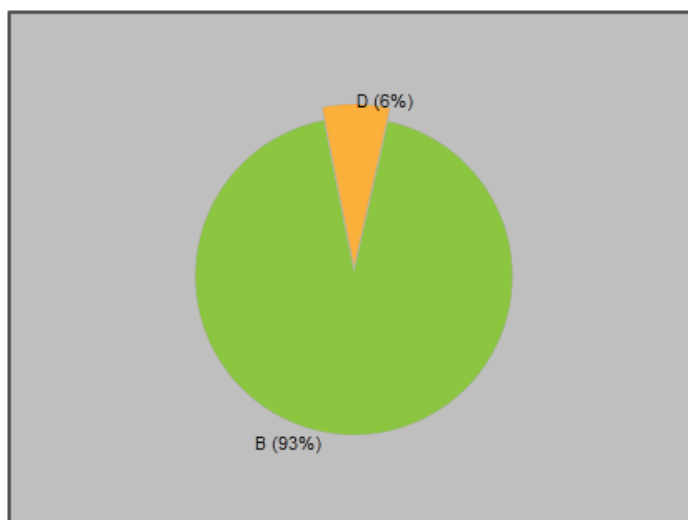
2 Calculate the perpendicular components of a the force
 $F = 3200 \text{ N [E}75^\circ\text{S]}$

A $F_E = 3091 \text{ N}; F_N = 828$ ✗

B $F_E = 828 \text{ N}; F_N = -3091 \text{ N}$

C $F_E = 3091 \text{ N}; F_N = -828 \text{ N}$

D $F_E = 828 \text{ N}; F_N = 3091 \text{ N}$ ✗



3 Use the perpendicular components to calculate the magnitude and direction of the acceleration vector:

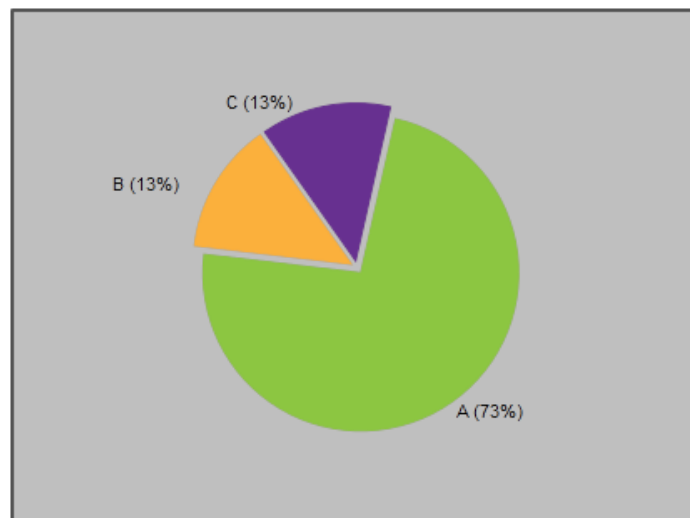
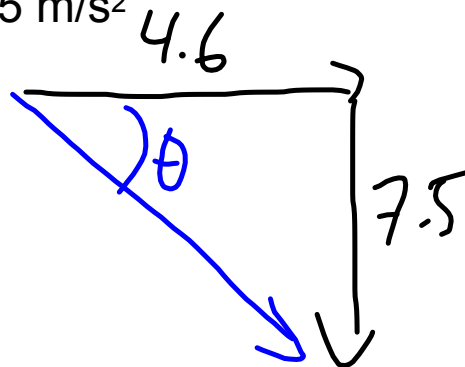
$$a_E = 4.6 \text{ m/s}^2 \text{ and } a_N = -7.5 \text{ m/s}^2$$

A 8.8 m/s^2 [E58°S]

B 8.8 m/s^2 [E58°N]

C 8.8 m/s^2 [E32°S]

D 8.8 m/s^2 [E32°N]



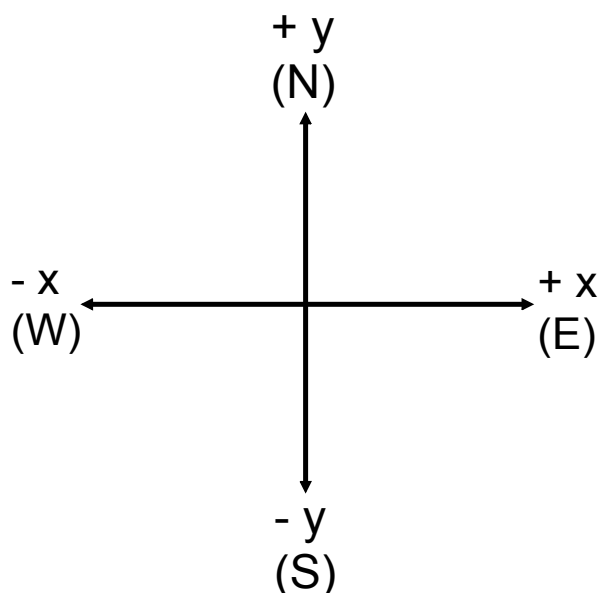
Adding Vectors Using Perpendicular Components

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

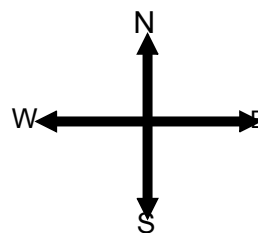
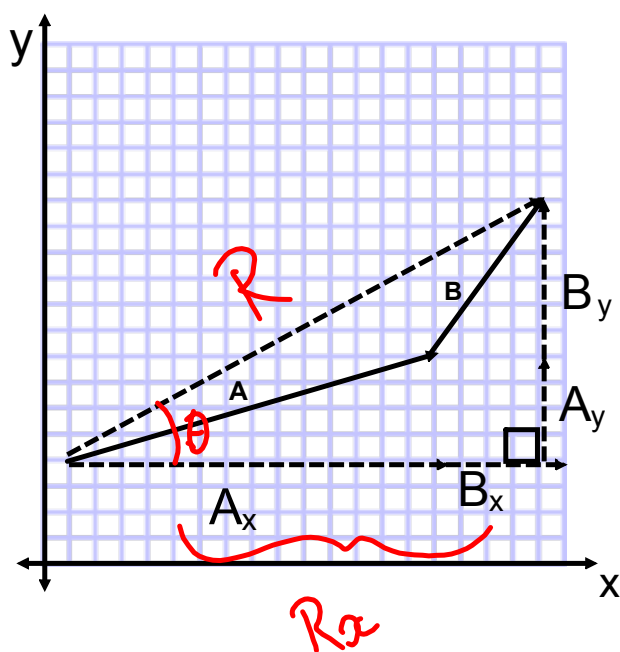
$$\mathbf{R}_x = \mathbf{A}_x + \mathbf{B}_x + \dots +$$

$$\mathbf{R}_y = \mathbf{A}_y + \mathbf{B}_y + \dots +$$

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.



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

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$

Applying Vector Addition to Mechanics Questions

- In this section we will use many of the same mathematics from grade 11 (our review), except now vector quantities will be given in two dimensions and we will need to perform the resultant calculation at the end of the problem.
- Many questions follow a similar format of:
 - > Break vectors into components
 - > Perform formula(e) in each dimension separately.
 - > Use the Pythagorean Theorem and tangent to determine the final answer.

If $A = 28 \text{ m [E}75^\circ\text{N]}$, $B = 35 \text{ m [E}24^\circ\text{S]}$, $C = 22 \text{ m [W}50^\circ\text{N]}$, and $D = 40 \text{ m [W}30^\circ\text{S]}$ Find:

$$4C + 3D \quad \{160 \text{ m [W}2.6^\circ\text{N}]\}$$

$$C = 22 \text{ m [W}50^\circ\text{N]}$$

$$D = 40 \text{ m [W}30^\circ\text{S]}$$

$$C_E = -22 \cos 50^\circ = -14.1 \text{ m} \quad C_N = 22 \sin 50 = 17 \text{ m}$$

$$D_E = -40 \cos 30^\circ = -35 \text{ m} \quad D_N = -40 \sin 30 = -20 \text{ m}$$

$$R_E = 4C_E + 3D_E$$

$$= 4(-14.1) + 3(-35)$$

$$R_E = -161 \text{ m}$$

$$R_N = 4C_N + 3D_N$$

$$= 4(17) + 3(-20)$$

$$R_N = 8 \text{ m}$$

$$|\vec{R}| = \sqrt{(R_E)^2 + (R_N)^2} = \sqrt{(-161)^2 + (8)^2}$$

$$|\vec{R}| = \underline{161 \text{ m}}$$

$$\theta = \tan^{-1} \left| \frac{R_N}{R_E} \right| = \tan^{-1} \frac{8}{161}$$

$$\theta = \underline{2.8^\circ}$$

$$\boxed{\vec{R} = 161 \text{ m [W}2.8^\circ\text{N]}}$$

 Physics 122: Application of Vectors Examples

1. What is the average velocity of a car that drives 66 km [E], 52 km [W33°N], and 45 km [W73°S] in 3.1 hours?

$$\vec{v}_{\text{avg}} = \frac{\vec{d}}{t} \quad \leftarrow \text{add all displacement vectors together.}$$

* Break up to perpendicular components.

$$\vec{d}_1 = 66 \text{ km [E]}; \quad \vec{d}_2 = 52 \text{ km [W } 33^\circ \text{N]}; \quad \vec{d}_3 = 45 \text{ [W } 73^\circ \text{S]}$$

$$d_{1E} = 66 \cos 0 = \underline{\underline{66}} \quad d_{1N} = 66 \sin 0 = \underline{\underline{0}}$$

$$d_{2E} = -52 \cos 33 = \underline{\underline{-44}} \quad d_{2N} = 52 \sin 33 = \underline{\underline{28}}$$

$$d_{3E} = -45 \cos 73 = \underline{\underline{-13}} \quad d_{3N} = -45 \sin 73 = \underline{\underline{-43}}$$