

Exercise walk-through

1.1

Scalars and Vectors

AP Physics C: Mechanics

Vectors and components

Resolve every **vector** onto the axes
with **unit vectors** $\hat{i}, \hat{j}, \hat{k}$:

Components

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

Add vectors axis by axis to get the
resultant .



Speedometer

Vectors are added component by component

components

resolve every vector onto the axes first: $v_x = v \cos \theta$, $v_y = v \sin \theta$

adding

add the x's, add the y's – never add magnitudes

magnitude

$$|\vec{v}| = \sqrt{v_x^2 + v_y^2 + v_z^2}$$

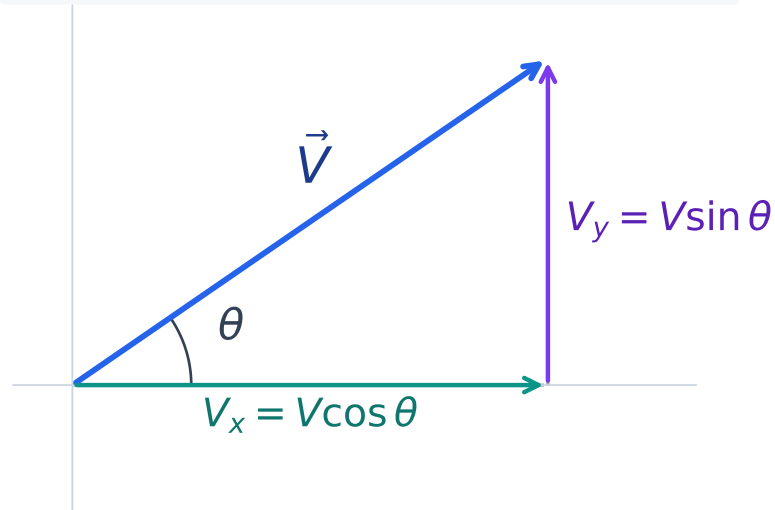
direction

$\theta = \tan^{-1}(v_y/v_x)$ – and check the quadrant against the signs of the components

A **scalar** carries only size (mass, time, energy); a **vector** carries size and direction. Half the sign errors in this course come from treating one as the other.

Resolving a vector into its x and y components

$$|\vec{V}| = \sqrt{V_x^2 + V_y^2} \cdot V_x = V \cos \theta, V_y = V \sin \theta$$



Resolving a vector into its x and y components

Two ways to multiply vectors

Dot product $\rightarrow$ a *scalar*

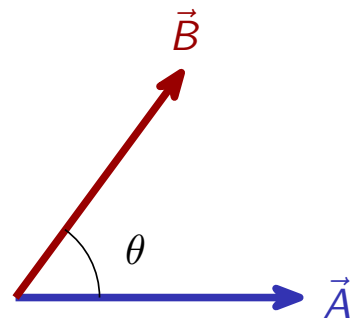
$$\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}| \cos \theta$$

Work is defined this way.

Cross product $\rightarrow$ a *vector*

$$|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}| \sin \theta$$

$\perp$ to both (right-hand rule). Torque and angular momentum use this.



Exercise 2.1

2.1 State whether each is a scalar or a vector: (a) speed, (b) velocity, (c) mass, (d) acceleration. [2]

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2.1

(a)

- scalar

(b)

- vector

(c)

- scalar

(d)

- vector

Exercises 2.2-2.4

2.2 A displacement has magnitude 20 m at 60° above the x -axis. Find its x - and y -components. [2]

2.3 A vector has components $A_x = 6$ and $A_y = 8$. Find its magnitude. [2]

2.4 Add $\vec{A} = (5, 2)$ and $\vec{B} = (-1, 3)$ by components, and give the magnitude of the resultant. [2]

Exercises 2.2-2.4

2.2 A displacement has magnitude 20 m at 60° above the x -axis. Find its x - and y -components. [2]

2.2

- $A_x = 20 \cos 60^\circ = 10 \text{ m}$; $A_y = 20 \sin 60^\circ = 17 \text{ m}$
-

2.3 A vector has components $A_x = 6$ and $A_y = 8$. Find its magnitude. [2]

2.3

- $A = \sqrt{6^2 + 8^2} = \sqrt{100} = 10$
-

2.4 Add $\vec{A} = (5, 2)$ and $\vec{B} = (-1, 3)$ by components, and give the magnitude of the resultant. [2]

2.4

- $(5 - 1, 2 + 3) = (4, 5)$; magnitude $= \sqrt{4^2 + 5^2} = \sqrt{41} \approx 6.4$

Exercises 3.1-3.2

3.1 Which quantity is a vector?

[1]

☐

A speed

B distance

C acceleration

D mass

3.2 A vector of magnitude 12 makes an angle of 30° with the x -axis. Its x -component is closest to

[1]

☐

A 6.0

B 10.4

C 12

D 0

Exercises 3.1-3.2

3.1 Which quantity is a vector?

[1]

☐

A speed

B distance

C acceleration

D mass

3.1 C

- acceleration is a vector; the others are scalars

3.2 A vector of magnitude 12 makes an angle of 30° with the x -axis. Its x -component is closest to

[1]

☐

A 6.0

B 10.4

C 12

D 0

3.2 B

- $12 \cos 30^\circ = 10.4$

Exercise 3.3 (a)

3.3 A vector has components $A_x = 9$ and $A_y = 12$.

(a) Find the magnitude of the vector.

[2]

Exercise 3.3 (a)

3.3 A vector has components $A_x = 9$ and $A_y = 12$.

(a) Find the magnitude of the vector.

[2]

(a)

- $A = \sqrt{9^2 + 12^2} = \sqrt{225} = 15$

Exercise 3.3 (b)

3.3 A vector has components $A_x = 9$ and $A_y = 12$.

(b) Find the angle it makes with the x -axis.

[1]

Exercise 3.3 (b)

3.3 A vector has components $A_x = 9$ and $A_y = 12$.

(b) Find the angle it makes with the x -axis.

[1]

(b)

- $\theta = \tan^{-1}(12/9) = 53^\circ$

Exercise 3.4 (a)

3.4 Two velocity vectors are $\vec{v}_1 = (4, 0) \text{ m s}^{-1}$ and $\vec{v}_2 = (0, -3) \text{ m s}^{-1}$.

(a) Find the components of the resultant.

[1]

Exercise 3.4 (a)

3.4 Two velocity vectors are $\vec{v}_1 = (4, 0) \text{ m s}^{-1}$ and $\vec{v}_2 = (0, -3) \text{ m s}^{-1}$.

(a) Find the components of the resultant.

[1]

(a)

- $(4, -3) \text{ m s}^{-1}$

Exercise 3.4 (b)

3.4 Two velocity vectors are $\vec{v}_1 = (4, 0) \text{ m s}^{-1}$ and $\vec{v}_2 = (0, -3) \text{ m s}^{-1}$.

(b) Find the magnitude and direction of the resultant.

[2]

Exercise 3.4 (b)

3.4 Two velocity vectors are $\vec{v}_1 = (4, 0) \text{ m s}^{-1}$ and $\vec{v}_2 = (0, -3) \text{ m s}^{-1}$.

(b) Find the magnitude and direction of the resultant.

[2]

(b)

- magnitude $\sqrt{4^2 + 3^2} = 5 \text{ m s}^{-1}$; direction $\tan^{-1}(3/4) = 37^\circ$ below the x -axis