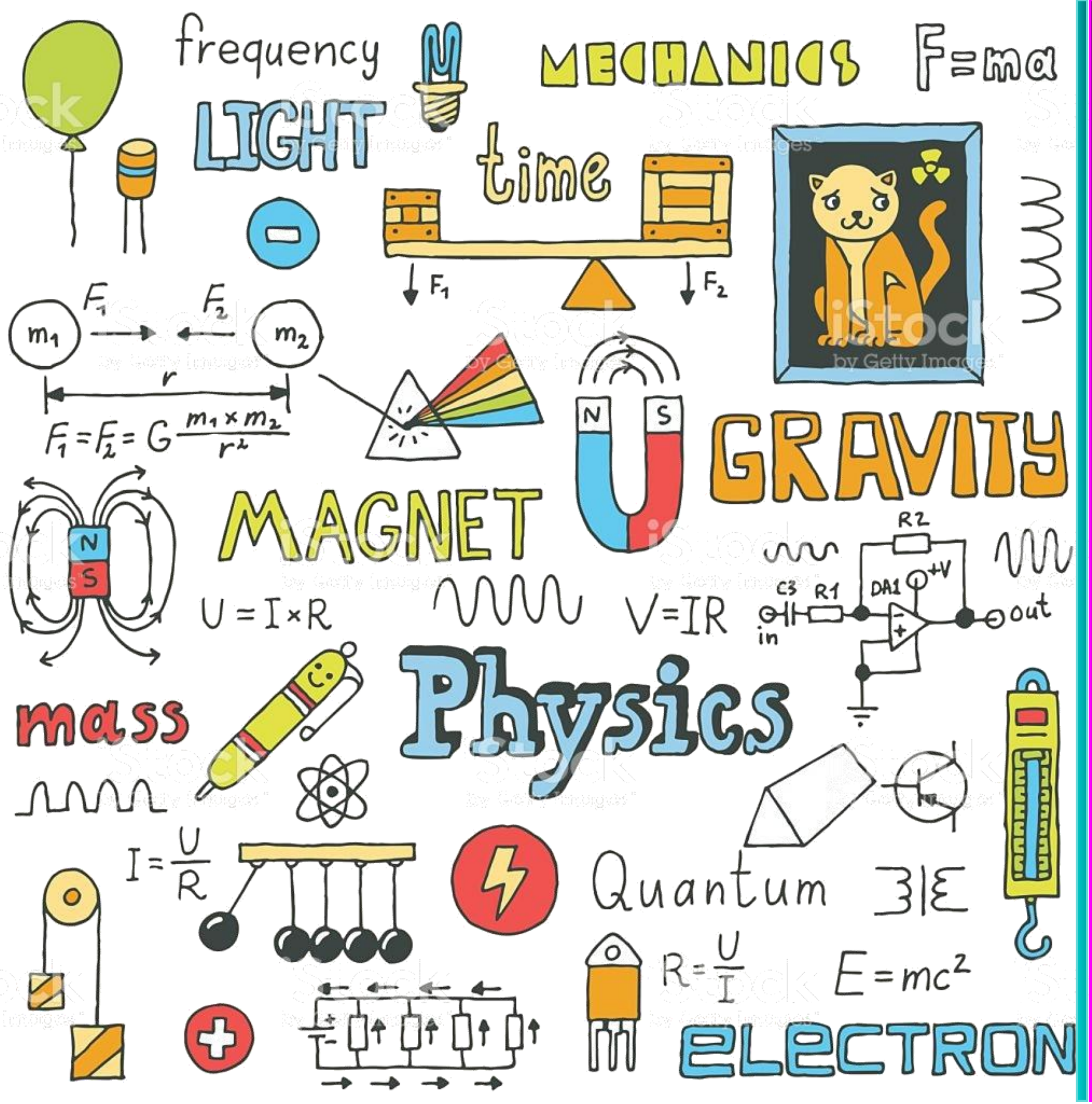

Physics
L3

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What are we going to talk about today?

Ch 2 : Motion in Two Dimension

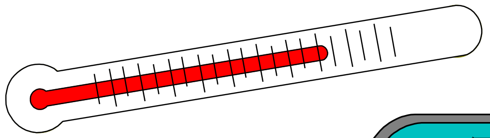
- **2.1 An Introduction to vectors:**
  - Vectors and Scalars
  - Drawing vectors
  - Multiplying vector by scalar
  - Addition and subtraction of vectors
  - The components of a vector
  - Vector Addition by Components

1.2 An introduction to vectors : Scalars quantities

Physical quantities

SCALAR | **VECTOR**

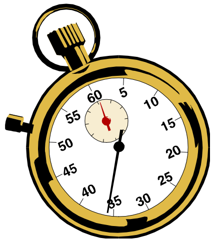
- A SCALAR is any quantity in physics that has MAGNITUDE, but NOT a direction associated with it.
- Magnitude : A numerical value with units

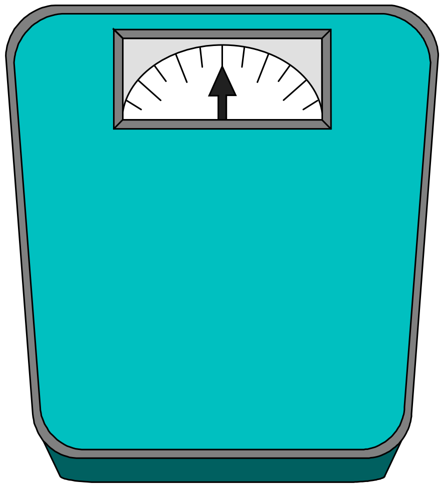


- For example: Temperature (5 Kelvin) is a scaler quantity.

  Time (5 second) is a scaler quantity.

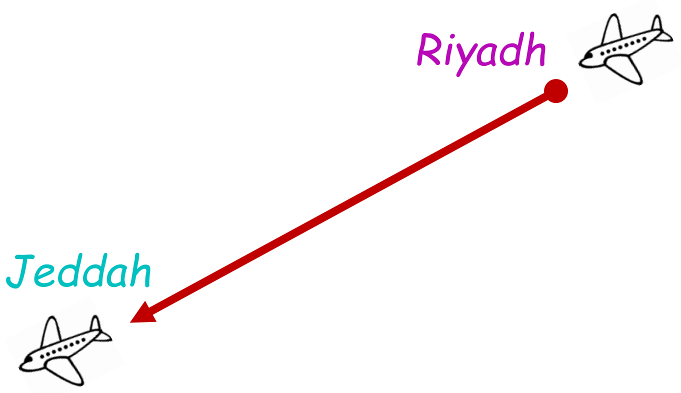
  Mass (50 Kg) is a scaler quantity.



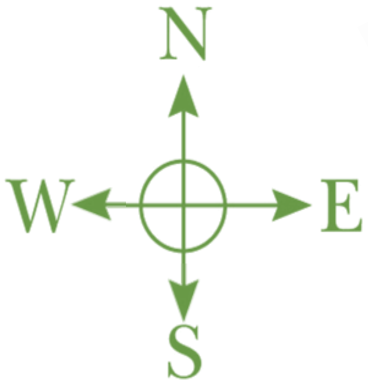


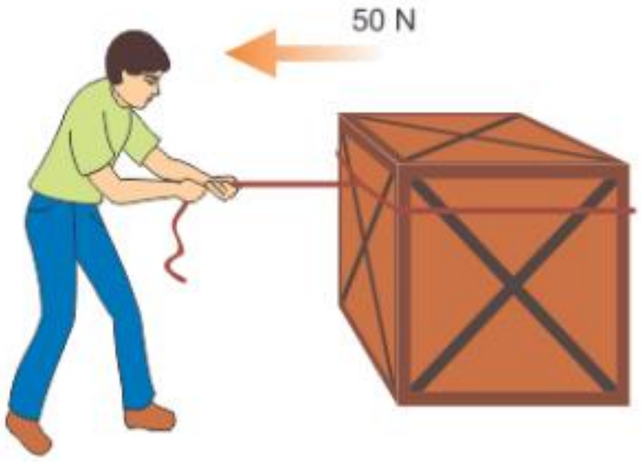
1.2 An introduction to vectors : Vector quantities

- A VECTOR is ANY quantity in physics that has BOTH MAGNITUDE and DIRECTION.



- For example: Displacement (3 m, N).
  Velocity (100 m/s, WS).
  Force (50 N, W).





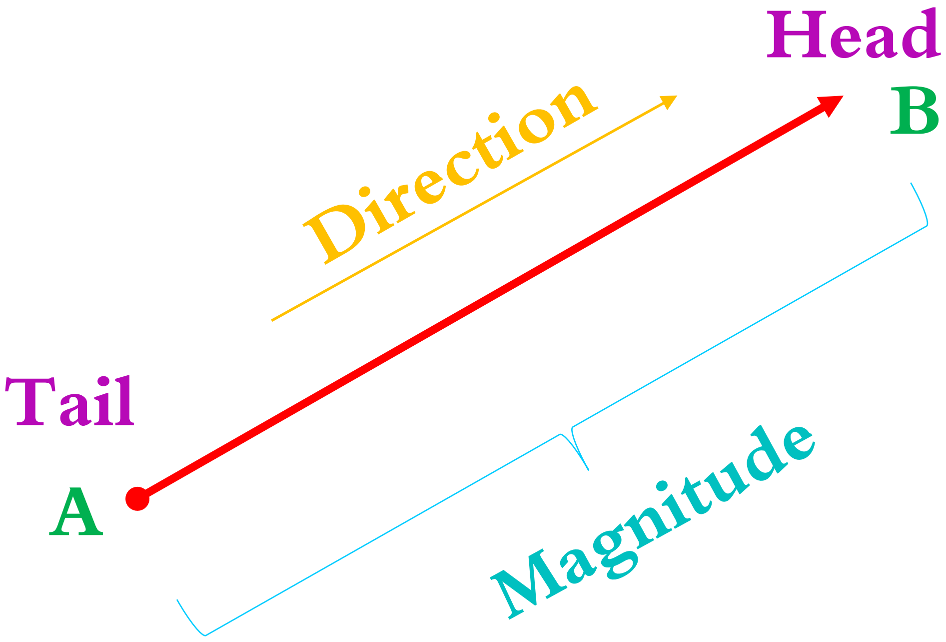
- Vectors are typically illustrated by drawing an ARROW above the symbol, e.g. :

$$\vec{v}, \vec{x}, \vec{a}, \vec{F}$$

A vector quantity represented by an arrow. The length of the vector represents the magnitude and the arrow indicates the direction of the vector.

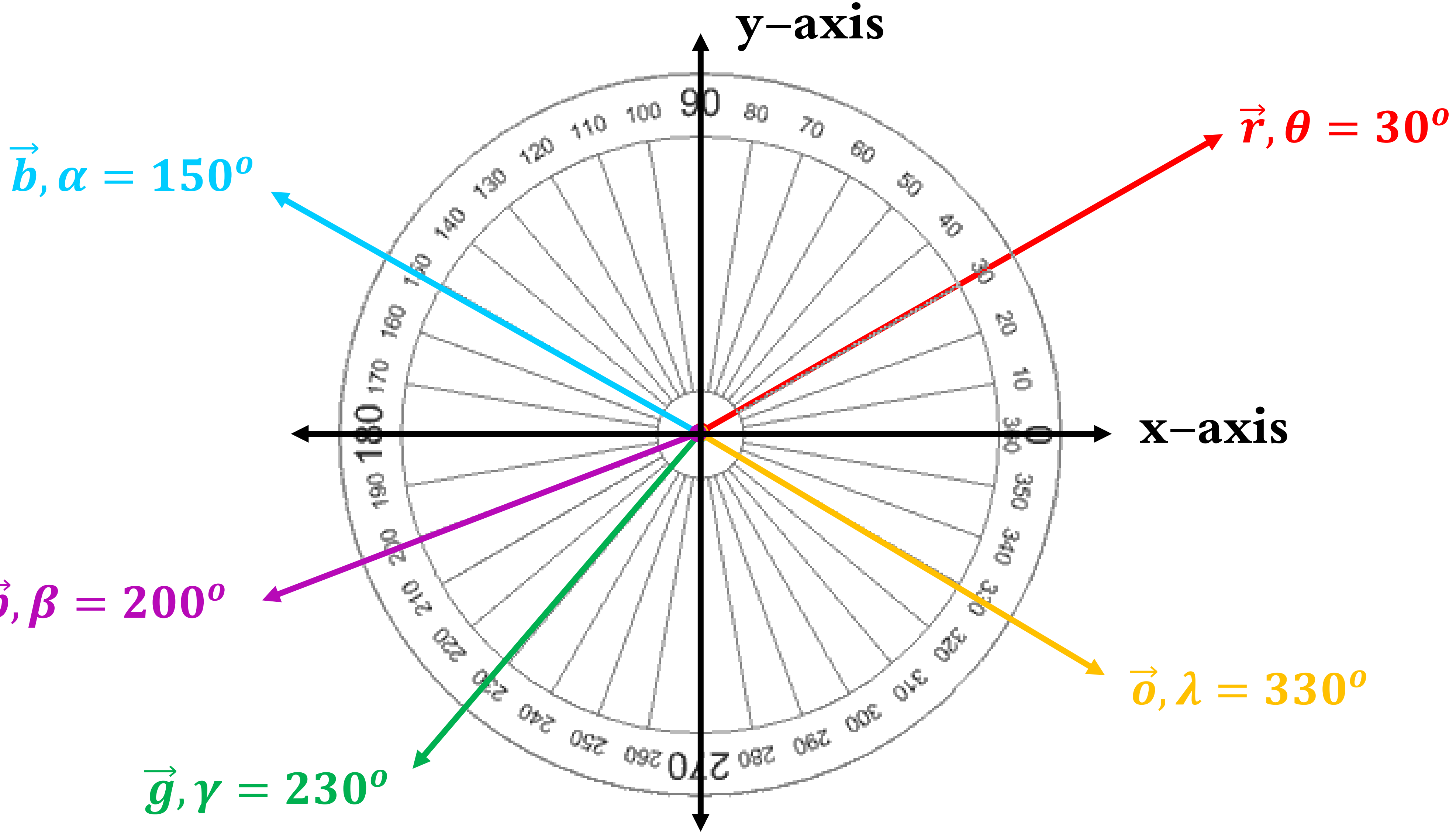
The point A is often called the "tail" of the vector, and B is called the vector's "head".

Magnitude: The magnitude of a vector is the length of the vector, it is a numerical value with units, the magnitude of a vector $\vec{b}$ is written as b or $|\vec{b}|$

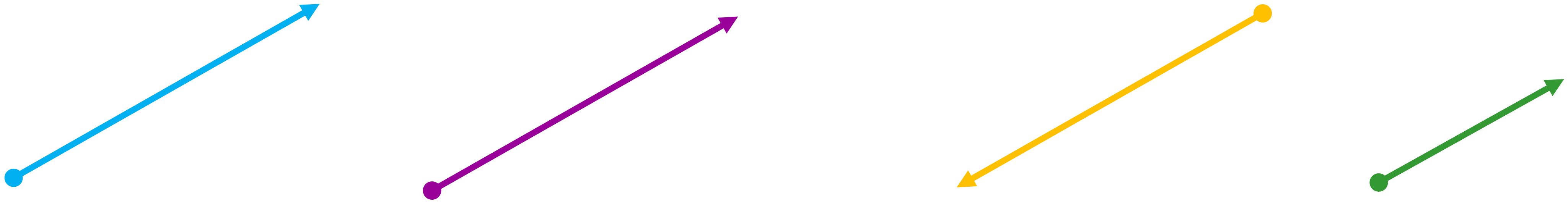


1.2 An introduction to vectors : Drawing vectors (Direction)

Direction: **Expressed as an angle measured clockwise from the positive x–axis**



1.2 An introduction to vectors : Drawing vectors (Direction)



Blue : $\vec{b}, \phi_1 = 30^o$

Purple: $\vec{p}, \phi_2 = 30^o$

Orange: $\vec{o}, \phi_3 = 210^o$

Green: $\vec{g}, \phi_4 = 30^o$

Blue and purple vectors have same magnitude and direction so they are equal. ($\vec{b} = \vec{p}$)

Blue and orange vectors have same magnitude but different direction. ($\vec{b} = -\vec{o}$)

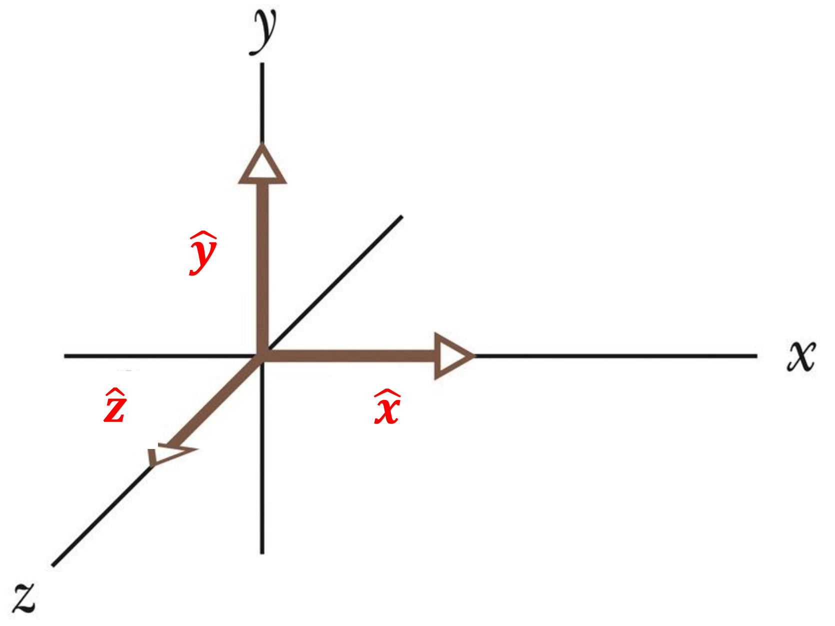
Blue and green vectors have same direction but different magnitude.

Two vectors are equal if they have the same direction and magnitude.

A unit vector

- Has magnitude 1
- Has a particular direction
- Lacks both dimension and unit
- Is labeled with a hat (^): $\hat{x}$,$\hat{y}$ and $\hat{z}$

The unit vectors point along axes.



Where:

$\hat{x}$ a vector of length one in the +x direction

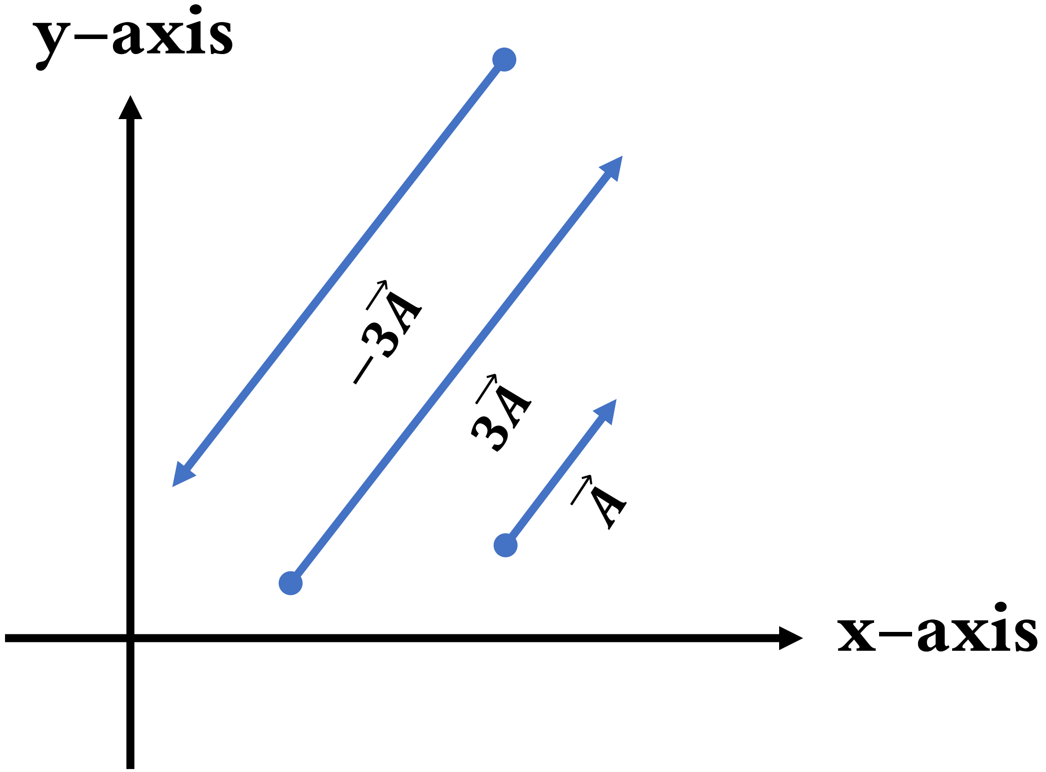
$\hat{y}$ a vector of length one in the +y direction

$\hat{z}$ a vector of length one in the +z direction

1.2 An introduction to vectors : Multiplying vector by scalar

- Multiplying a vector by m, increases its magnitude by a factor of m, but does not change its direction.

- Multiplying a vector by (– m), increases its magnitude by a factor of m and the direction changes to the opposite direction.
- e.g. m=3

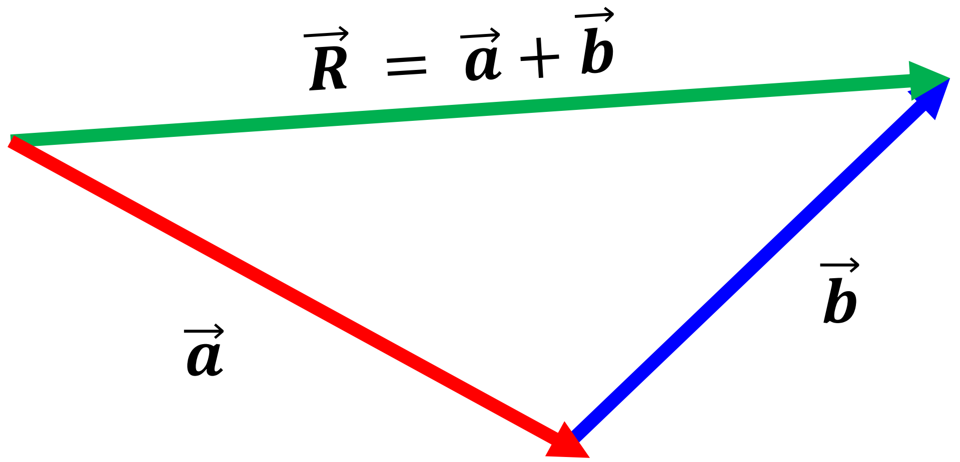


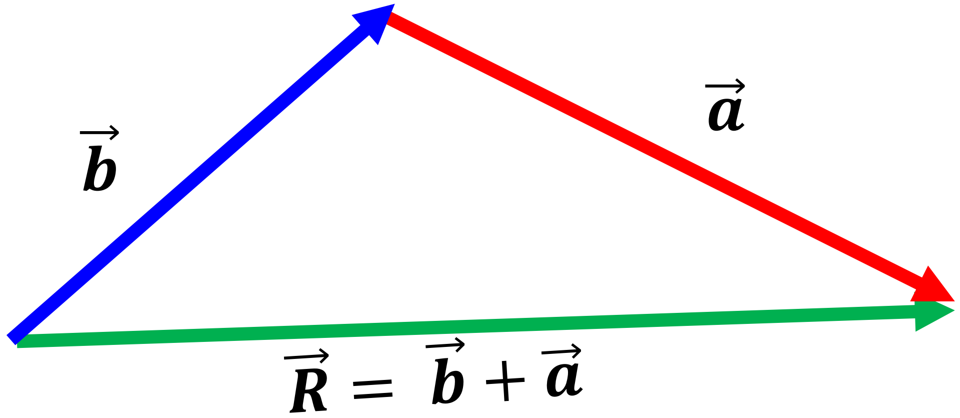
1.2 Addition and subtraction of vectors : (Graphical method)

Addition vectors: The vector sum of two vectors in a plane is obtained by placing the tail of the second vector at the head of the first vector

The resultant vector $\vec{R} = \vec{a} + \vec{b}$ is the vector drawn from the tail of $\vec{a}$ to tip of $\vec{b}$.

$$\vec{R} = \vec{a} + \vec{b} = \vec{b} + \vec{a}$$ (commutative law)

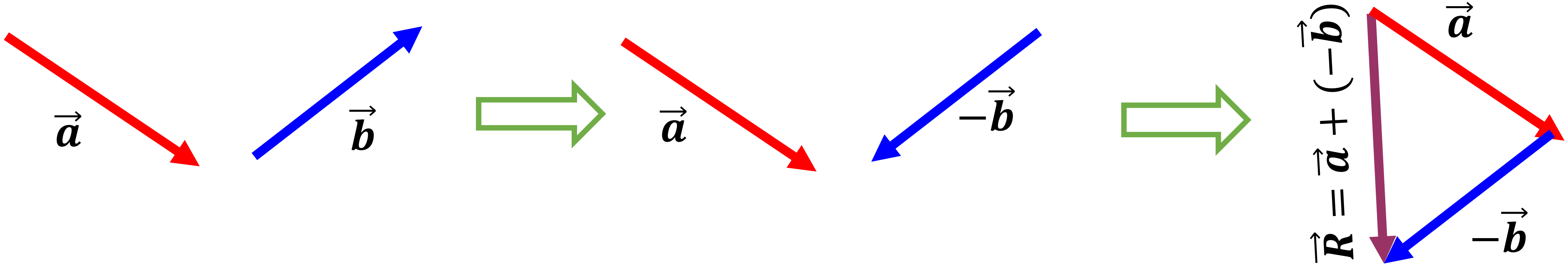




1.2 Addition and subtraction of vectors: (Graphical method)

subtraction vectors: To subtract a vector $\vec{a}$ from a vector $\vec{b}$ reverse the direction $\vec{b}$ of and then add the reversed $\vec{b}$ to $\vec{a}$

$$\vec{R} = \vec{a} + (-\vec{b})$$

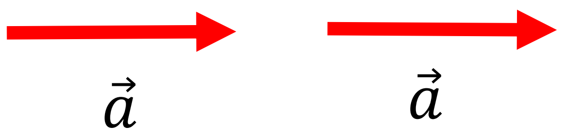


Not that :

$$\vec{a} + (-\vec{b}) \neq \vec{b} + (-\vec{a})$$

1.2 Addition and subtraction of vectors: (Graphical method)

Ex1: Using the graphical method find the following : (Find the resultant)

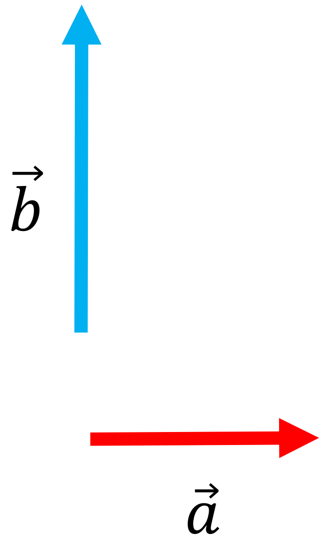


$$\vec{R}_1 = \vec{a} + \vec{a} = 2\vec{a}$$

$$\vec{R}_2 = \vec{a} + (-\vec{a}) = 0$$

1.2 Addition and subtraction of vectors: (Graphical method)

Ex2: Using the graphical method find the following : (Find the resultant)

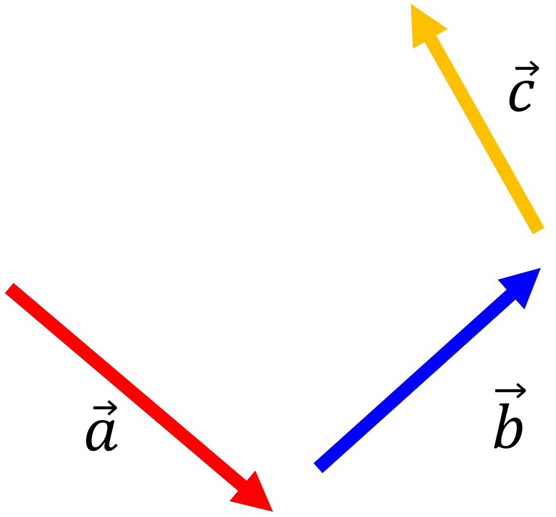


$$\vec{R}_1 = \vec{a} + \vec{b}$$

$$\vec{R}_2 = \vec{a} + \left(-\vec{b}\right)$$

1.2 Addition and subtraction of vectors: (Graphical method)

Ex3: Using the graphical method find the following : (Find the resultant)



$$\vec{R}_1 = \vec{a} + \vec{b} + \vec{c}$$

$$\vec{R}_2 = \vec{a} + \left(-\vec{b}\right) + \vec{c}$$

Checkpoint 1:

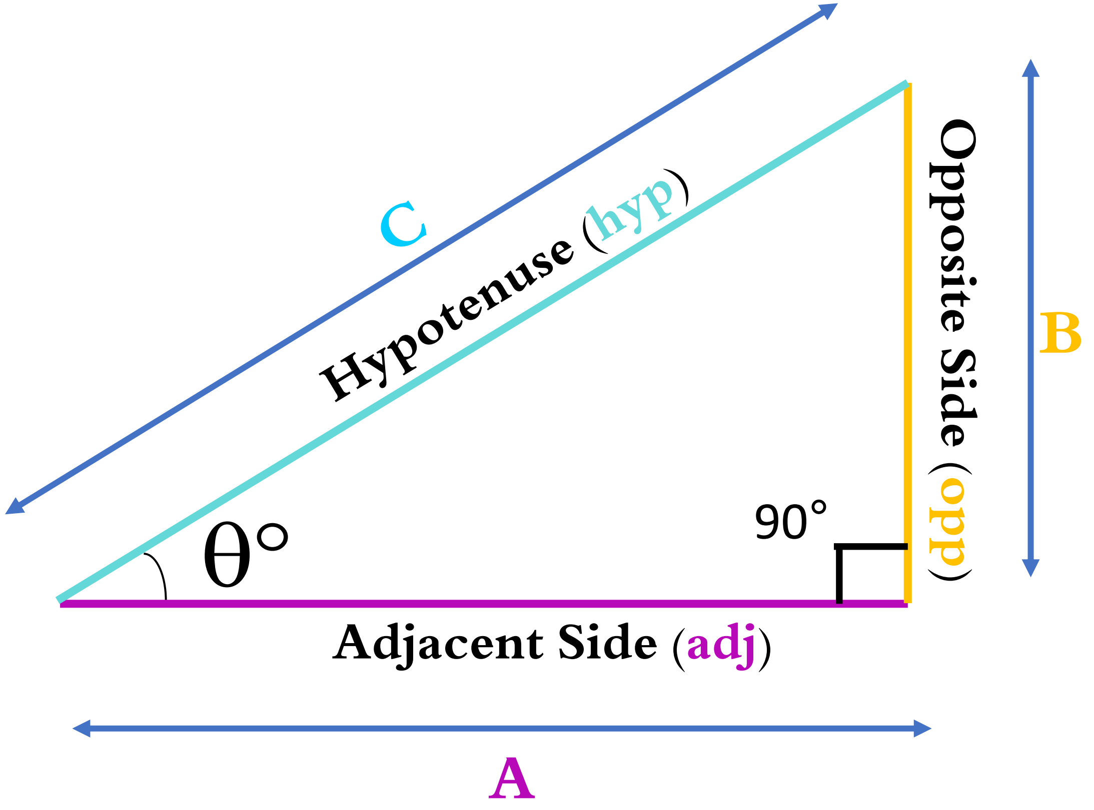
If a vector $\vec{A} = 4\hat{x} - 5\hat{y}$ and $\vec{B} = 4\hat{x} + 5\hat{y}$, then $\vec{A} - \vec{B} =$ ...

(a) $0\hat{x} - 10\hat{y}$
(b) $8\hat{x} + 0\hat{y}$
(c) $8\hat{x} + 10\hat{y}$
(d) $0\hat{x} - 10\hat{y}$

Trigonometry Review

- A triangle with a 90° angle
- Pythagorean Theorem:

$$C^2 = A^2 + B^2$$



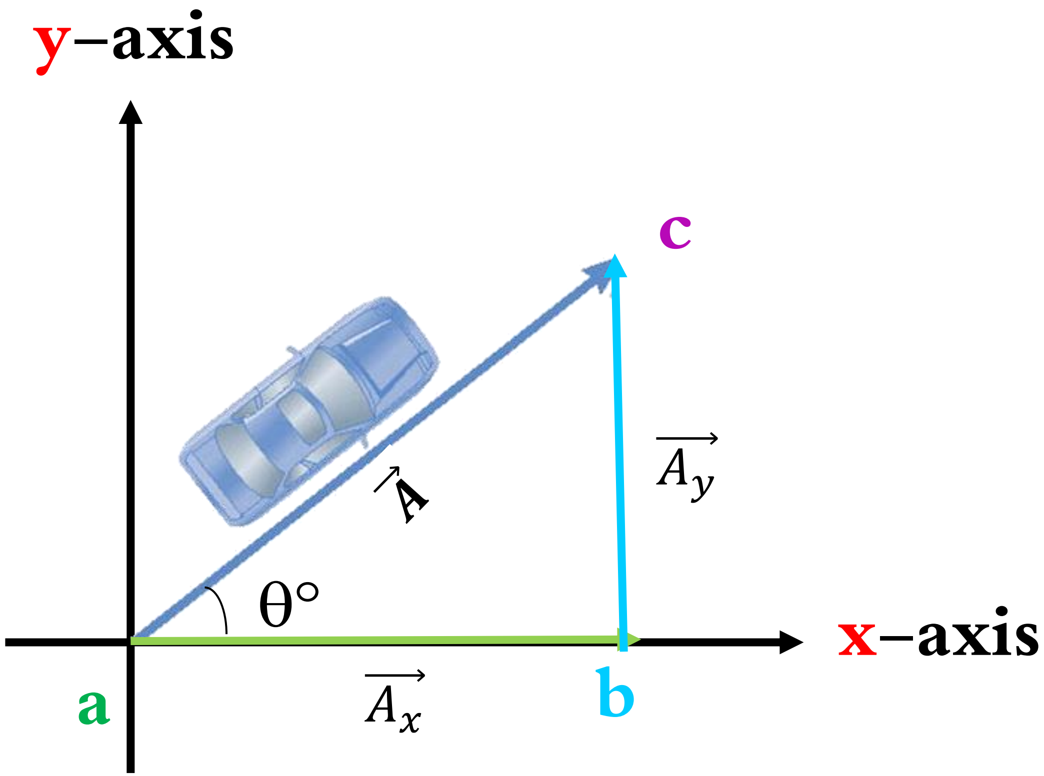
Trigonometric Functions :

$$\sin \theta° = opp / hyp$$
$$\cos \theta° = adj / hyp$$
$$\tan \theta° = opp / adj$$

Suppose a car moves along a straight line from a to c. The displacement vector is shown by $\vec{A}$.

However, the car could also arrive at the c by first moving from a due b ($\vec{A_x}$), then turning 90^o, and then moving from b due c ($\vec{A_y}$).

The vectors $\vec{A_x}$ and $\vec{A_y}$ are called the x and y vector components of $\vec{A}$.



1.2 An introduction to vectors : The Components of a Vector

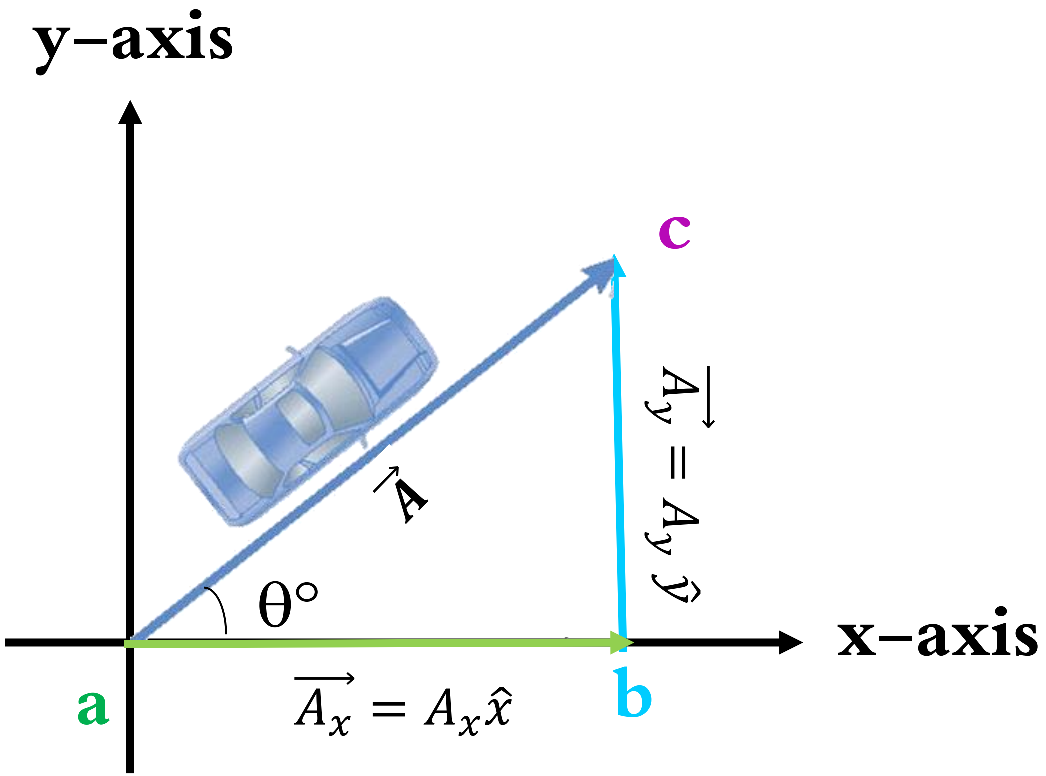
A vector $\vec{A}$ with components A_x and A_y can written as:

$$\vec{A} = \vec{A_x} + \vec{A_y}$$

or

$$\vec{A} = A_x\hat{x} + A_y\hat{y}$$

Where $\hat{x}$ and $\hat{y}$ are the unite vectors:



$\hat{x}$ a vector of length one in the +x direction

$\hat{y}$ a vector of length one in the +y direction

1.2 An introduction to vectors : The Components of a Vector

The x–component of a vector is the projection along the x axis

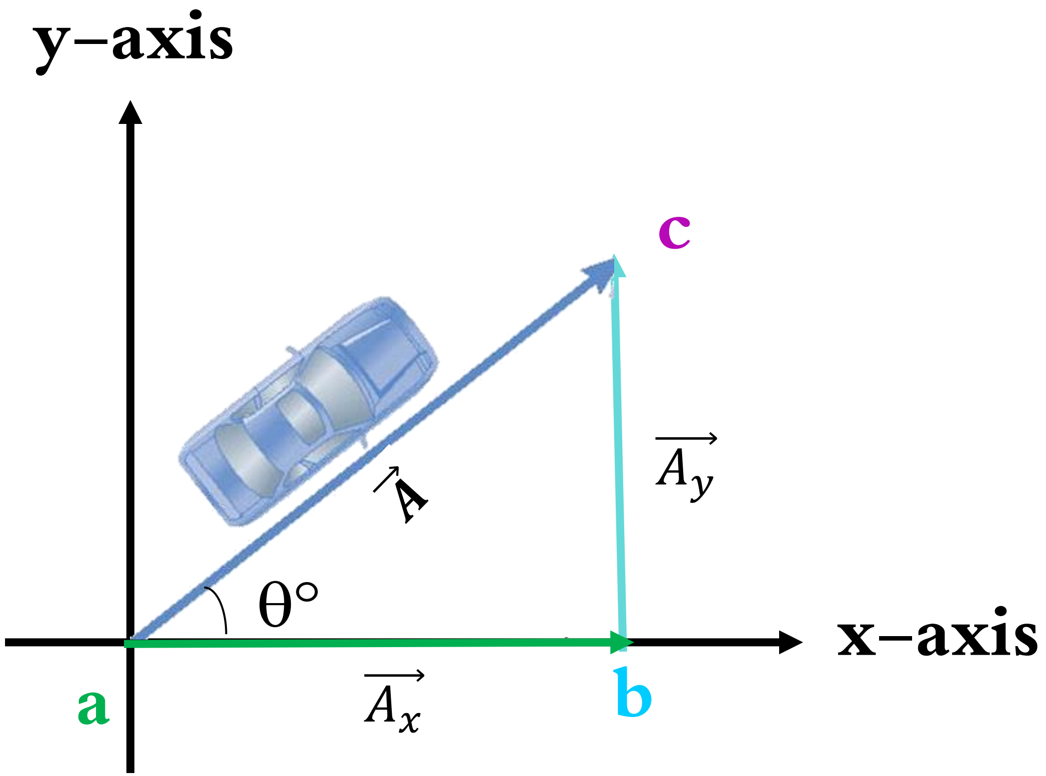
$$A_x = A\cos\theta$$

The y–component of a vector is the projection along the y–axis

$$A_y = A\sin\theta$$

Then,

$$A = \sqrt{A_x^2 + A_y^2}\,,\ \theta = \tan^{-1}\frac{A_y}{A_x}$$

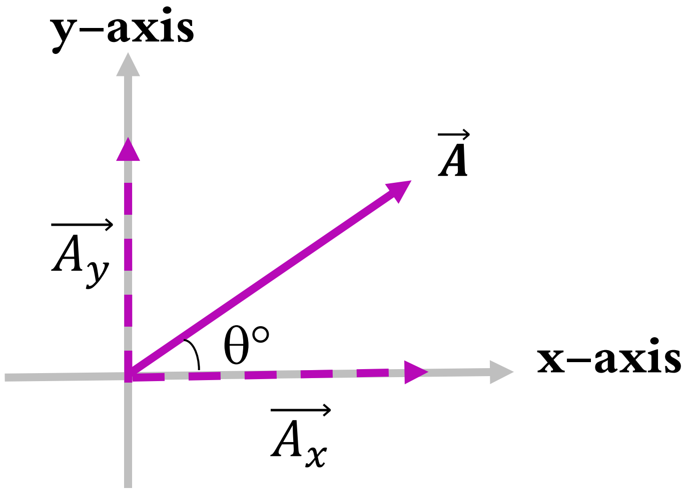


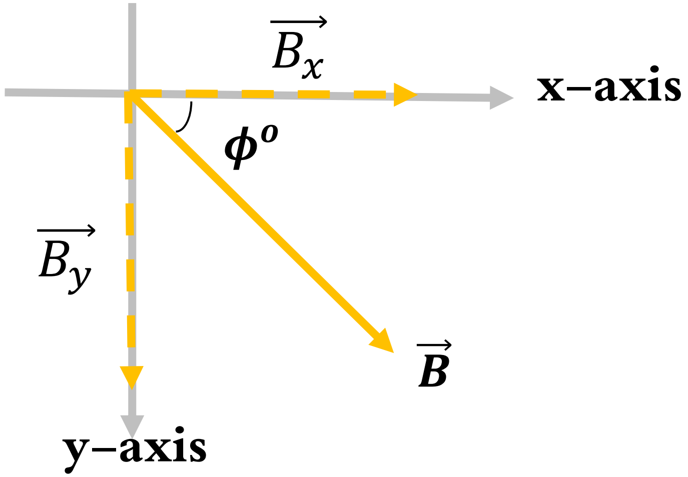
1.2 An introduction to vectors : The Components of a Vector

Example 2.1 page 30: A person walks 1 km due east. If the person then walks a second kilometer, what is the final displacement from the starting point if the second kilometer is walked : (a) due east (Ans: 2 km); (b) due west (Ans: 0); (c) due south? (Ans: $\sqrt{2}$ km)

Example 2.2 page 32: Find the components of the vectors $\vec{A}$ and $\vec{B}$ in Figs., if $A = 2, \theta = 30^o$ and $B = 3, \phi = 45^o$.

(Ans: A_x=1.73, A_y=1.00, B_x=2.12 and B_y=−2.12)





1.2 An introduction to vectors : The Components of a Vector

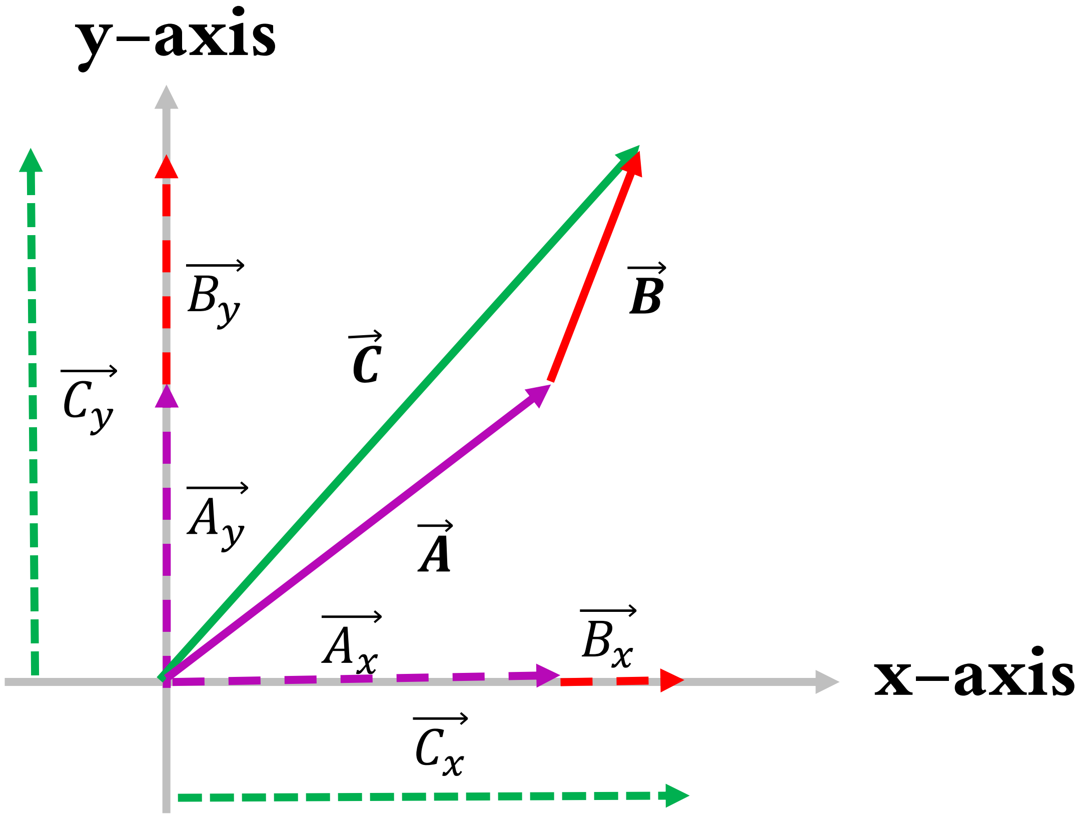
Suppose we wish to add vector $\vec{B}$ to vector $\vec{A}$, where vector $\vec{B}$ has components B_x and B_y. The resultant vector $\vec{C} = \vec{A} + \vec{B}$

$$\vec{C} = (A_x\hat{x} + A_y\hat{y}) + (B_x\hat{x} + B_y\hat{y})$$

$$\vec{C} = (A_x + B_x)\hat{x} + (A_y + B_y)\,\hat{y}$$

Because $\vec{C} = C_x\hat{x} + C_y\hat{y}$ we see that the components of the resultant vector are :

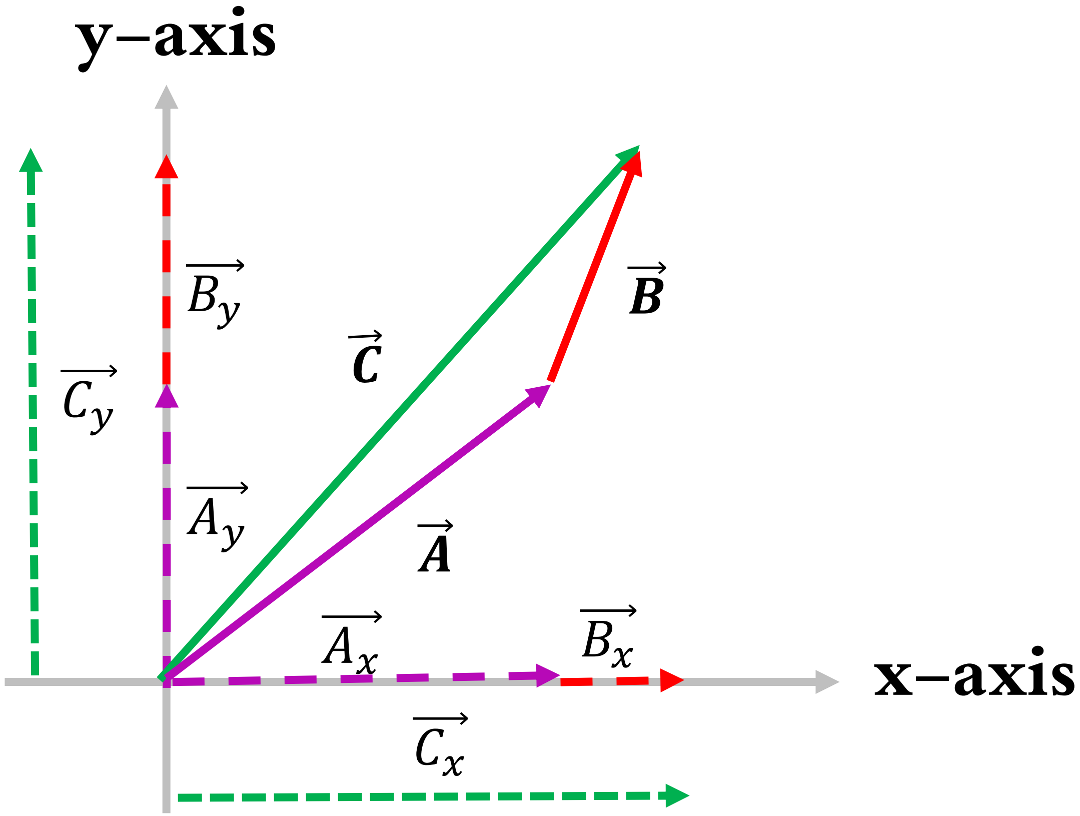
$$C_x = A_x + B_x \qquad C_y = A_y + B_y$$



1.2 An introduction to vectors : The Components of a Vector

In the component method of adding vectors, we add all the x–components together to find the x–component of the resultant vector and use the same process for the y–components.

The magnitude of $\vec{C}$ and the angle it makes with the x axis are obtained from its components using the relationships



$$C = \sqrt{{C_x}^2 + {C_y}^2} = \sqrt{(A_x + B_x)^2 + (A_y + B_y)^2}$$

And

$$\theta = \tan^{-1}\frac{C_y}{C_x} \quad \theta = \tan^{-1}\frac{A_y + B_y}{A_x + B_x}$$

Example 2.3 page 32:

$$\vec{A} = 2\hat{x} + \hat{y}, \vec{B} = 4\hat{x} + 7\hat{y}$$

(a) Find the components of $\vec{C} = \vec{A} + \vec{B}$ (Ans: C_x=6 and C_y=8)

(b) Find the magnitude of $\vec{C}$ and its angle θ with respect to the positive x axis (Ans: C=10 and θ=53.1)

Name: **Section**

- ## Homework 2

Ch2: [2.1, 2.3, 2.4, 2.5,2.14]

Final Answers: 2.4 [a(7.07), b(3.16), c(8.25)], 2.14 [a(5.91, 35.5 above + x), b(19.30, below + x)]