VECTORS & CALCULUS

1. SCALAR :

In physics we deal with two type of physical quantity one is scalar and other is vector. Each scalar quantity has a magnitude and a unit.

For example mass = 4kg

Magnitude of mass = 4

and unit of mass = kg

Example of scalar quantities : mass, speed, distance etc.

Scalar quantities can be added, subtracted and multiplied by simple laws of algebra.

2. VECTOR :

Vector are the physical quantites having magnitude as well as specified direction.

For example :

Speed = 4 m/s (is a scalar)

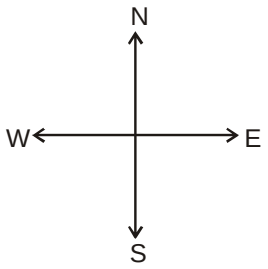
Velocity = 4 m/s toward north (is a vector)

If someone wants to reach some location then it is not sufficient to provide information about the distance of that location it is also essential to tell him about the proper direction from the initial location to the destination.

The magnitude of a vector ($\vec{A}$) is the absolute value of a vector and is indicated by $|\vec{A}|$ or A.

Example of vector quantity : Displacement, velocity, acceleration, force etc.

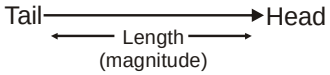
Knowledge of direction



3. GENERAL POINTS REGARDING VECTORS :

3.1 Representation of vector :

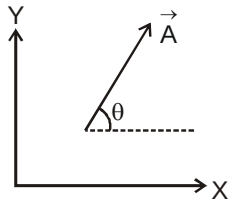
Geometrically, the vector is represented by a line with an arrow indicating the direction of vector as



Mathematically, vector is represented by $\vec{A}$.

Sometimes it is represented by bold letter A.

Thus, the arrow in abow figure represents a vector $\vec{A}$ in xy-plane making an angle θ with x-axis.



A representation of vector will be complete if it gives us direction and magnitude.

Symbolic form : $\vec{v}, \vec{a}, \vec{F}, \vec{s}$ used to separate a vector quantity from scalar quantities (u, i, m)

Graphical form : A vector is represented by a directed straight line, having the magnitude and direction of the quantity represented by it.

e.g. if we want to represent a force of 5 N acting 45° N of E

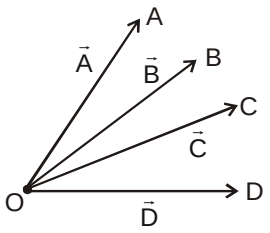
3.5 Collinear vectors :

Any two vectors are co-linear then one can be express in the term of other.

$\vec{a} = \lambda\vec{b}$ (where λ is a constant)

3.6 Co-initial vector : If two or more vector start from same point then they called co-initial vector.

e.g.



here A, B, C, D are co-initial.

3.7 Multiplication and division of a vector by a scalar

Multiplying a vector $\vec{A}$ with a positive number λ gives a vector $(\vec{B} = \lambda\vec{A})$ whose magnitude become λ times but the direction is the same as that of $\vec{A}$. Multiplying a vector $\vec{A}$ by a negative number λ gives a vector $\vec{B}$ whose direction is opposite to the direction of $\vec{A}$ and whose magnitude is $-\lambda$ times $|\vec{A}|$.

The division of vector $\vec{A}$ by a non-zero scalar m is defined as multiplication of $\vec{A}$ by $\frac{1}{m}$.

At here $\vec{A}$ and $\vec{B}$ are co-linear vector

Ex.2 A physical quantity (m = 3kg) is multiplied by a vector $\vec{a}$ such that $\vec{F} = m\vec{a}$. Find the magnitude and direction of $\vec{F}$ if

(i) $\vec{a}$ = 3m/s^2 East wards

(ii) $\vec{a}$ = –4 m/s^2 North wards

Sol. (i) $\vec{F} = m\vec{a} = 3 \times 3ms^{-2}$ East wards

= 9 N East wards

(ii) $\vec{F} = m\vec{a} = 3 \times (-4)N$ North wards

= –12 N North wards

= 12 N South wards

4. LAWS OF ADDITION AND SUBTRACTION OF VECTORS :

4.1 Triangle rule of addition : Steps for additing two vector representing same physical quantity by triangle law.

(i) Keep vectors s.t. tail of one vector coincides with head of other.

(ii) Join tail of first to head of the other by a line with arrow at head of the second.

(iii) This new vector is the sum of two vectors. (also called reultant)

EXERCISE

Q.1 Angular momentum is :
(A) Axial vector (B) Polar vector
(C) Scalar (D) None of these

Q.2 What happens, when we multiply a vector by (– 2) ?
(A) direction reverses and unit changes
(B) direction reverses and magnitude is doubled
(C) direction remains unchanged and unit changes
(D) none of these

Q.3 Which of the following is a vector quantity ?
(A) Temperature (B) Surface tension
(C) Calorie (D) Force

Q.4 Which of the following is a scalar quantity ?
(A) Displacement (B) Electric Field
(C) Acceleration (D) Work

Q.5 Which of the following vector identities is false
(A) $\vec{P}+\vec{Q}=\vec{Q}+\vec{P}$ (B) $\vec{P}+\vec{Q}=\vec{Q}\times\vec{P}$
(C) $\vec{P}.\vec{Q}=\vec{Q}.\vec{P}$ (D) $\vec{P}\times\vec{Q}\neq\vec{Q}\times\vec{P}$

Q.6 Which of the following is a scalar quantity ?
(A) current (B) velocity
(C) force (D) acceleration

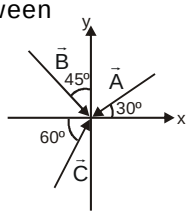
Q.7 The magnitude of a vector cannot be :
(A) positive (B) unity
(C) negative (D) zero

Q.8 Which one of the following statement is false :
(A) Mass, speed and energy are scalars
(B) Momentum, force and torque are vectors
(C) Distance is a scalar while displacement is a vector
(D) A vector has only magnitude where as a scalar has both magnitude and direction

Q.9 A physical quantity which has a direction :
(A) must be a vector (B) may be a vector
(C) must be a scalar (D) none of the above

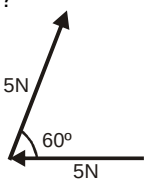
Q.10 A set of vectors taken in a given order gives a closed polygon. Then the resultant of these vectors is a
(A) scalar quantity (B) pseudo vector
(C) unit vector (D) null vector

Q.11 Vectors $\vec{A},\vec{B}$ and $\vec{C}$ are shown in figure. Find angle between



(i) $\vec{A}$ and $\vec{B}$ (ii) $\vec{A}$ and $\vec{C}$ (iii) $\vec{B}$ and $\vec{C}$

Q.12 The forces, each numerically equal to 5 N, are acting as shown in the Figure. Find the angle between forces?



Q.13 A man walks 40 m North, then 30 m East and then 40 m South. Find the displacement from the starting point?

Q.14 Two forces $\vec{F}_1$ and $\vec{F}_2$ are acting at right angles to each other, find their resultant ?

Q.15 A vector of magnitude 30 and direction eastwards is added with another vector of magnitude 40 and direction Northwards. Find the magnitude and direction of resultant with the east.

Q.16 Two force of $\vec{F}_1=500N$ due east and $\vec{F}_2=250N$ due north. Find $\vec{F}_2-\vec{F}_1$?

ANSWER KEY

1.	A	2.	B	3.	D	4.	D
5.	B	6.	A	7.	C	8.	D
9.	B	10.	D				

11. (i) 105°, (ii) 150°, (iii) 105° 12. 120°

13. 30 m East 14. $\sqrt{F_1^2+F_2^2}$

15. 50, 53° with East

16. $250\sqrt{5}N$, $\tan^{-1}(2)$ W of N