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Motion [CLASS 9th]
Short - Notes

Physical Quantity

The property of material or a system that can be measured is called Physical Quantity. It can be expressed by a value, which is the product of a numerical value and a unit of measurement.

Basic Physical Quantities

S.No.	Name of Physical Quantity	SI Unit	
		Name	Symbol
1.	Length	Metre	m
2.	Time	Second	s
3.	Mass	Kilogram	kg
4.	Absolute Temperature	Kelvin	K
5.	Amount of Substance	Mole	mol.
6.	Electric Current	Ampere	A
7.	Luminous Intensity	Candela	Cd.

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Types of Physical Quantity

1) Scalar Quantity - Those quantities which only have magnitude but no direction.

Example :- Speed, distance, mass, etc.

2) Vector Quantity - Those quantities which have both magnitude and direction.

Example :- Velocity, displacement, momentum, etc.

Motion

A body is said to be in motion if it changes its position continuously with respect to time and reference point.

Rest

A body is said to be at rest if it does not changes its position with respect to time and reference point.

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Reference Point

A fixed point used to specify the position of object.

Distance [Unit = metre (m)] [Denoted by d/r]

The actual length of path covered by a body during its journey (irrespective of direction).

Ex- A body moves from point A to B and then to C and back to A. Distance here equal to AB + BC + CA.

Displacement [Unit = metre (m)] [Denoted by s]

It is defined as the shortest distance between initial and final point of a journey.

Difference between Distance and Displacement

	Distance	Displacement
1.	Actual length of path covered by a body.	1. Shortest distance between initial and final point.
2.	Scalar Quantity.	2. Vector Quantity.

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3. Always positive, never zero.	3. Can be positive, negative or zero.
4. Dependent on path followed by the body.	4. Independent on path followed by the body.
5. Always greater or equal to displacement.	5. Always lesser or equal to distance.

Speed [Unit = m/s]

The rate of change of distance with respect to time. It shows how fast or slow an object moves.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Instantaneous Speed

The speed of an object at any instant/point.

Average Speed

Ratio of total distance covered by an object and total time taken to do so.

$$\text{Average Speed} = \frac{\text{Total distance travelled}}{\text{Total Time Taken}}$$

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Uniform and Non-uniform Speed

An object is said to be moving with a uniform speed, if it covers equal distance in equal interval of time.

An object is said to be moving with non-uniform speed, if it covers unequal distance in equal interval of time.

Velocity [Unit = m/s]

Speed in a particular direction

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

Uniform Velocity and Non-Uniform Velocity

An object is said to be in/moving with uniform velocity if it covers equal distance in equal interval of time along a particular direction.

An object is said to be moving with non-uniform velocity if it covers unequal distance in equal interval of time along a particular direction.

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Average Velocity

Ratio of Total displacement of object to the total Time taken during the journey.

$$\text{Avg. velocity} = \frac{\text{Total Displacement}}{\text{Total Time Taken}}$$

When velocity is changing at a uniform rate:-

$$\text{Avg. velocity} = \frac{u+v}{2}$$

[$\because u$ = initial velocity, v = final velocity]

Difference between Speed and Velocity

	Speed	Velocity
1.	Distance per unit time.	Displacement per unit time.
2.	Scalar Quantity.	Vector Quantity.
3.	Never zero, always positive.	May be zero, positive or negative.

Accelaration [Unit = m/s^2]

Rate of change of velocity of a moving object.

$$a = \frac{v-u}{t}$$

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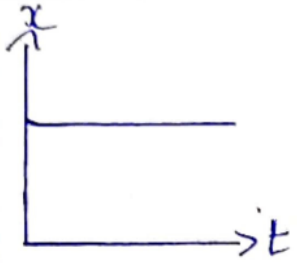
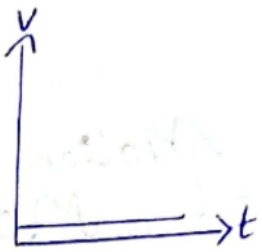
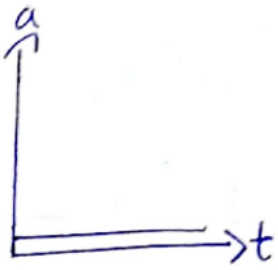
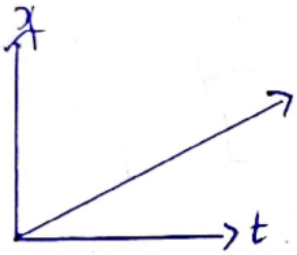
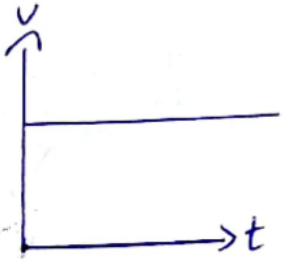
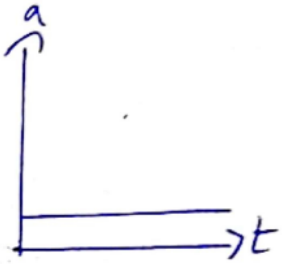
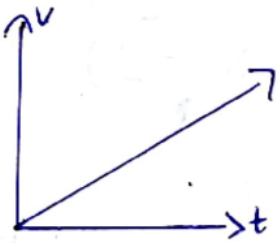
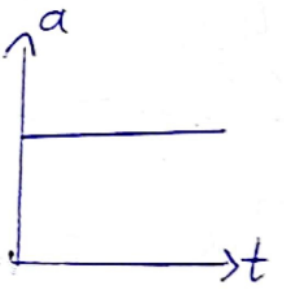
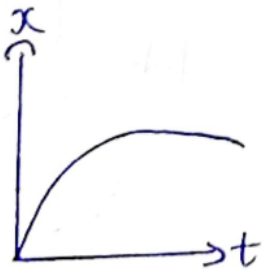
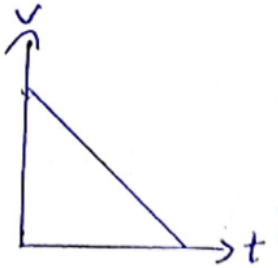
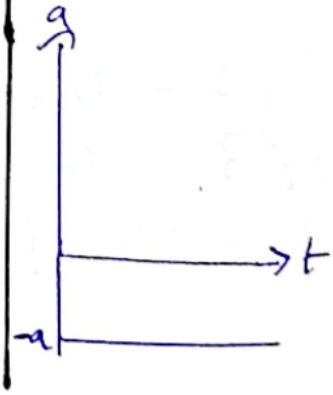
Graphs [motion]

Condition	Distance-time	Velocity-Time	Acceleration-Time
At rest			
At constant velocity			
↑velocity			
↓velocity			

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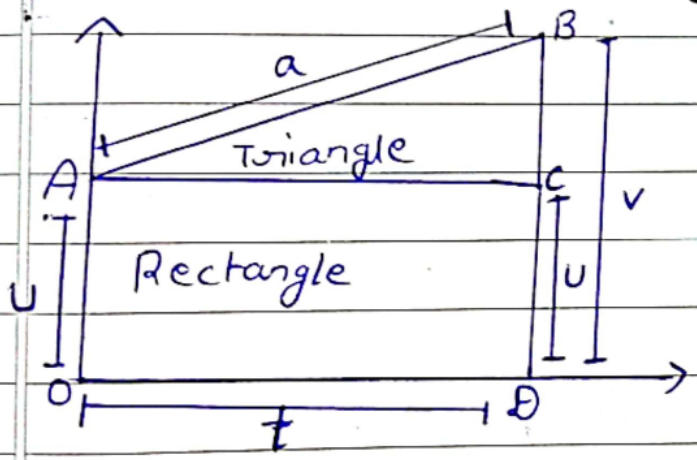
Uniform and non-uniform accelaration

If velocity of an object changes by equal amount in equal interval of time, then the object is said to be in uniform accelaration.

If velocity of an object changes by unequal amount in equal interval of time, then the object is said to be in non-uniform accelaration.

Equation of motion [By graphical Method]



Consider the linear motion of an object with initial velocity 'u'. The object accelarates uniformly with accelaration 'a' and aquires the final velocity 'v' in time 't'.

① First equation of motion [velocity-time relation] (v=u+at):-

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accelaration = Slope AB

$$\text{accelaration} = \frac{BC}{AC}$$

$$\text{accelaration} = \frac{v-u}{t}$$

$$a(t) = v-u$$

$$\boxed{v = u + at}$$

② IInd equation of motion [Position-time relation] $(s = ut + \frac{1}{2}at^2)$:-

Displacement = area occupied by vel-time graph.

Displacement = Area of rectangle + area of triangle

$$s = (L \times B) + (\tfrac{1}{2} \times \text{Base} \times \text{Height})$$

$$s = (OD \times OA) + (\tfrac{1}{2} \times AC \times BC)$$

$$s = (t \times u) + (\tfrac{1}{2} \times t \times v-u)$$

$$s = ut + \tfrac{1}{2}(t)(v-u) \quad -(I)$$

As we know, $v = u + at$

$$v - u = at \quad -(II)$$

Put (II) in (I)

$$s = ut + \tfrac{1}{2}(t)(at)$$

$$\boxed{s = ut + \tfrac{1}{2}at^2}$$

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③ IIIrd equation of motion [Position-vel. relation] ($v^2-u^2=2as$) :-

Displacement = area occupied by vel-time graph

s = area of trapezium $OABD = \frac{1}{2} \times$ (sum of parallel side)(height)

$s = \frac{1}{2}(OA+BD) \times OD/AC$

$2s = (u+v) \times t$ — (I)

We know, $v = u+at$

$\boxed{\frac{v-u}{a} = t}$ — (II)

Put (II) in (I)

$2s = (u+v)\left(\frac{v-u}{a}\right)$

$\boxed{2as = v^2-u^2 \;/\; v^2-u^2 = 2as}$

Uniform Circular Motion

- When an object moves in circular path, its motion is called circular motion.
- When an object moves in a circular path with constant speed, its direction of motion changes continuously.
- Accelaration of body moving uniformly in circular path is called centripetal accelaration.

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