21/1/20 **PHYSICS - I** **CLASS - 1**

MECHANIC AND PROPERTIES OF MATTER

In physics-I we study about mechanic and properties of matter.

In physics-II we study about Electronics and electromagnetism.

ORIGIN:-

It is a reference point.
e.g, I locate the table w.r.t chair. so, chair is the origin.

QUANTITIES:-

It has two types.

•) Countable quantities (the quantities which is equally divided). (for this we use submission. Σ).

•) Measurable quantities (the quantities which cannot be equally divided).
(for this we use integration).

DERIVATIVE:-

Small change in any very large thing.

Small part of any big thing.

INTEGRATE:-

Small sample of any thing on which tested many experiments and apply the results on it big part.

FORCE:-

An agent which begin, stop or change the direction of motion is called force.

BOOKS:-

- Physics (Resnick, Halliday, Krane)
  (H.R.K)

- Physics for engineers and scientist
  (Serway and Jewett)

Class = 2

28/1/20

Mechanics And Properties Of Matter

Topics:-

- Scalar and Vector
- Motion in 1 dimension
- Motion in 2 dimension
- Circular motion.

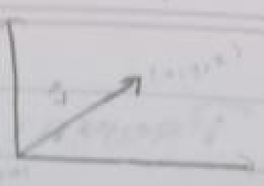
Scalar And Vector

Null Vector:-

The vector whose magnitude is zero and has no direction is called null vector.

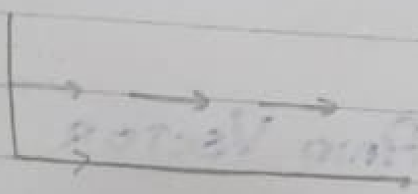
Position Vector:-

The vector whose one end is fixed with origin and other end attached to the moving point, which is used to describe the position of point. As the point moves, the position vector will change in length or direction or in both. It has different velocities.



FREE VECTOR:-

The vector which moves parallel to its axis and maintains the same magnitude and direction is called null vecter.



UNIT VECTOR:-

The vector which have magnitude of 1.

$$\vec{a} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\hat{a} = \frac{\vec{a}}{|\vec{a}|} = \frac{x\hat{i} + y\hat{j} + z\hat{k}}{\sqrt{x^2 + y^2 + z^2}}$$

•) $\vec{A} \times \vec{B} = \vec{C}$ ($\vec{C}$ is perpendicular $\perp$ to $\vec{A}$ and $\vec{B}$)

•) $\frac{d}{dt}\vec{B}$ $\perp$ to $\vec{B}$

VECTOR CALCULUS:-

DEL $\vec{\nabla}$ OPERATION:-

It is a directional derivative.

$$\vec{\nabla} = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$$

∂ = dava

$r = x\hat{i} + y\hat{j} + z\hat{k}$ $\qquad \frac{\partial r}{\partial x}$

•) Dava apply on single variable or on that variable that depend on single variable.

e.g) Temperature depends on sunshine, wind, humidity. But dava apply on sunshine.

FIELD:-

Field is a region where we get different value at every point.

GRADIENT:-

It is a scalar multiplication of del operation $\vec{\nabla}$ and scalar potential ϕ (it is a dumy variable mean we take whatever we want). It provide maximum change in field.

$$\vec{\nabla} \phi = \vec{A} \quad \text{(gradient)}$$

•) $\vec{\nabla}$ (electric potential) = $\vec{E}$

Q)

DATA:-

$$\phi = 3x^2y + 2yz$$

$$\vec{\nabla} = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$$

REQUIRE:-

Gradient = $\vec{\nabla}\phi$

point = $(1, 1, -1) = (x, y, z)$

SOLUTION:-

$$\vec{\nabla}\phi = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\left(3x^2y + 2yz\right)$$

$$\Rightarrow \frac{\partial}{\partial x}(3x^2y + 2yz) = 6xy + 0 = 6xy$$

$$\Rightarrow \frac{\partial}{\partial y}(3x^2y + 2yz) = 3x^2 + 2z$$

$$\Rightarrow \frac{\partial}{\partial z}(3x^2y + 2yz) = 0 + 2y = 2y$$

$$\vec{\nabla}\phi = 6xy\,\hat{i} + (3x^2 + 2z)\,\hat{j} + 2y\,\hat{k}$$

$$= 6(1)(1)\hat{i} + (3(1)^2 + 2(-1))\,\hat{j} + 2(1)\,\hat{k}$$

$$\vec{\nabla}\phi = 6\hat{i} + \hat{j} + 2\hat{k}$$ ans

Q)

DATA:-

$$\phi = 4x^2 + 2yz^2$$

$$\vec{\nabla} = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$$

REQUIRE:-

Gradient $= \vec{\nabla}\phi$

Point $= (1, -1, 1) = (x, y, z)$

SOLUTION:-

$$\vec{\nabla}\phi = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\left(4x^2 + 2yz^2\right)$$

$\Rightarrow \dfrac{\partial}{\partial x}(4x^2 + 2yz^2) = 8x + 0 = 8x$

$\Rightarrow \dfrac{\partial}{\partial y}(4x^2 + 2yz^2) = 0 + 2z^2 = 2z^2$

$\Rightarrow \dfrac{\partial}{\partial z}(4x^2 + 2yz^2) = 0 + 4yz = 4yz$

$\vec{\nabla}\phi = 8x\hat{i} + 2z^2\hat{j} + 4yz\hat{k}$

$= 8(1)\hat{i} + 2(1)^2\hat{j} + 4(-1)(1)\hat{k}$

$\vec{\nabla}\phi = 8\hat{i} + 2\hat{j} - 4\hat{k}$ ans

Q)

<u>DATA:-</u>

$\phi = \ln|r|$

$|r| = (x^2 + y^2 + z^2)^{1/2}$

<u>REQUIRE:-</u>

Gradient $= \vec{\nabla}\phi = \vec{\nabla}(\ln|r|)$

point $= (x, y, z) = (1, 1, 1)$

<u>SOLUTION:-</u>

$\vec{\nabla}\phi = \left(\dfrac{\partial}{\partial x}\hat{i} + \dfrac{\partial}{\partial y}\hat{j} + \dfrac{\partial}{\partial z}\hat{k}\right)\left(\ln(x^2+y^2+z^2)^{1/2}\right)$

$\Rightarrow \dfrac{\partial}{\partial x}(\ln(x^2+y$

$\Rightarrow \dfrac{\partial}{\partial y}(\ln(x^2+y^2+z^2)^{1/2}$

$\Rightarrow \dfrac{\partial}{\partial z}(\ln(x^2+y^2+z^2)^{1/2}$

$\vec{\nabla}\phi =$

$$\Rightarrow \frac{\partial}{\partial x}\left(\ln(x^2+y^2+z^2)^{1/2}\right) = \left(\frac{1}{(x^2+y^2+z^2)^{1/2}}\right)\left(\frac{1}{2}(x^2+y^2+z^2)^{1/2-1}\right)(2x+0+0)$$

$$= \frac{\cancel{2}x}{\cancel{2}(x^2+y^2+z^2)^{1/2}(x^2+y^2+z^2)^{1/2}}$$

$$= \frac{x}{x^2+y^2+z^2}$$

$$\Rightarrow \frac{\partial}{\partial y}\left(\ln(x^2+y^2+z^2)^{1/2}\right) = \left(\frac{1}{(x^2+y^2+z^2)^{1/2}}\right)\left(\frac{1}{2}(x^2+y^2+z^2)^{1/2-1}\right)(0+2y+0)$$

$$= \frac{\cancel{2}y}{\cancel{2}(x^2+y^2+z^2)^{1/2}(x^2+y^2+z^2)^{1/2}}$$

$$= \frac{y}{x^2+y^2+z^2}$$

$$\Rightarrow \frac{\partial}{\partial z}\left(\ln(x^2+y^2+z^2)^{1/2}\right) = \left(\frac{1}{(x^2+y^2+z^2)^{1/2}}\right)\left(\frac{1}{2}(x^2+y^2+z^2)^{1/2-1}\right)(0+0+2z)$$

$$= \frac{\cancel{2}z}{\cancel{2}(x^2+y^2+z^2)^{1/2}(x^2+y^2+z^2)^{1/2}}$$

$$= \frac{z}{x^2+y^2+z^2}$$

$$\vec{\nabla}\phi = \frac{x}{x^2+y^2+z^2}\hat{i} + \frac{y}{x^2+y^2+z^2}\hat{j} + \frac{z}{x^2+y^2+z^2}\hat{k}$$

$$= \frac{x\hat{i} + y\hat{j} + z\hat{k}}{x^2+y^2+z^2} = \frac{\vec{r}}{|\vec{r}|^2}$$

$$= \frac{(1)\hat{i} + (1)\hat{j} + (1)\hat{k}}{(1)^2 + (1)^2 + (1)^2}$$

$$\vec{\nabla}\phi = \frac{\hat{i} + \hat{j} + \hat{k}}{3} \quad \text{ans}$$

Q)

Data:-

$$\phi = \frac{1}{|\vec{r}|}$$

$$|\vec{r}| = (x^2 + y^2 + z^2)^{1/2}$$

Require:-

$$\vec{\nabla}\phi = \vec{\nabla}\left(\frac{1}{|\vec{r}|}\right) = \text{Gradient}$$

$$\text{point} = (x, y, z) = (1, 1, 1)$$

Solution:-

$$\nabla\phi = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\left(\frac{1}{|\vec{r}|}\right)$$

$$= \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\left(\frac{1}{(x^2+y^2+z^2)^{1/2}}\right)$$

$$= \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)(x^2+y^2+z^2)^{-1/2}$$

$$\Rightarrow \frac{\partial}{\partial x}(x^2+y^2+z^2)^{-1/2} = ($$

$$=$$

$$=$$

$$\Rightarrow \frac{\partial}{\partial y}(x^2+y^2+z^2)$$

$$\Rightarrow \frac{\partial}{\partial z}(x^2+y^2+z^2)^{-1}$$

$$\vec{\nabla}\phi = \frac{-}{(x^2}$$

$$= -$$

$$\Rightarrow \frac{\partial}{\partial x}(x^2+y^2+z^2)^{-1/2} = \left(-\frac{1}{2}(x^2+y^2+z^2)^{-\frac{1}{2}-1}\right)(2x+0+0)$$

$$= -\frac{\cancel{2}x}{\cancel{2}(x^2+y^2+z^2)^{3/2}}$$

$$= -\frac{x}{(x^2+y^2+z^2)^{3/2}}$$

$$\Rightarrow \frac{\partial}{\partial y}(x^2+y^2+z^2)^{-1/2} = \left(-\frac{1}{2}(x^2+y^2+z^2)^{-1/2-1}\right)(0+2y+0)$$

$$= \frac{-(x^2+y^2+z^2)^{-3/2}(\cancel{2}y)}{\cancel{2}}$$

$$= \frac{-y}{(x^2+y^2+z^2)^{3/2}}$$

$$\Rightarrow \frac{\partial}{\partial z}(x^2+y^2+z^2)^{-1/2} = \left(-\frac{1}{2}(x^2+y^2+z^2)^{-1/2-1}\right)(0+0+2z)$$

$$= \frac{-(x^2+y^2+z^2)^{-3/2}(\cancel{2}z)}{\cancel{2}}$$

$$= \frac{-z}{(x^2+y^2+z^2)^{3/2}}$$

$$\vec{\nabla}\phi = \frac{-x}{(x^2+y^2+z^2)^{3/2}}\hat{i} - \frac{y}{(x^2+y^2+z^2)^{3/2}}\hat{j} - \frac{z}{(x^2+y^2+z^2)^{3/2}}\hat{k}$$

$$= -\left(\frac{x\hat{i}+y\hat{j}+z\hat{k}}{((x^2+y^2+z^2)^{1/2})^3}\right) = \frac{\vec{r}}{|\vec{r}|^3}$$

$$= -\left(\frac{(1)\hat{i} + (1)\hat{j} + (1)\hat{k}}{\left((1^2+1^2+1^2)^{1/2}\right)^3}\right)$$

$$\vec{\nabla}\phi = -\left(\frac{\hat{i}+\hat{j}+\hat{k}}{3^{3/2}}\right) \quad \text{ans}$$

14-2-20

Lecture-3

Divergence Of A Vector:-

dot product

- Div of a vector = $\vec{\nabla} \cdot \vec{A}$
- Its result is scalar.
- In divergence we study,
  - Physical significance
  - Examples
  - Numericals.

Physical Significance:-

- Divergence tells gives explanation that surface is working as source or sink or perfectly neutral.

- Divergence +ve = source
- Divergence -ve = sink

eg) •) If a lines are enter on ~~surface~~ surface and if lines are increases on coming out from surface, then divergence is positive

•) If a lines are enter in surface and if lines are decreases while coming out from surface, then divergence is negative.

Q) $\vec{E} = 3x\hat{i} + 4x^2y\hat{j} + 6z\hat{k}$

Divergence of $\vec{E}$ = $\vec{\nabla}\cdot\vec{E}$ = ? at $(\cancel{0}\,1, -1, 1)$ point

Solution:-

$$\vec{\nabla}\cdot\vec{E} = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\cdot\left(3x\hat{i} + 4x^2y\hat{j} + 6z\hat{k}\right)$$

$$\because \hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$$

$$\Rightarrow \frac{\partial}{\partial x}(3x) = 3$$

$$\Rightarrow \frac{\partial}{\partial y}(4x^2y) = 4x^2$$

$$\Rightarrow \frac{\partial}{\partial z}(6z) = 6$$

$$\vec{\nabla}\cdot\vec{E} = 3 + 4x^2 + 6$$

$$= 3 + 4(1)^2 + 6$$

$$\vec{\nabla}\cdot\vec{E} = +13$$

•) As div is +ve its mean it is source.

•) Divergence is of vector always

i.e) $E = 3x\hat{i} + 4x^2y\hat{j} + 6z\hat{k}$ $(\vec{\nabla}\cdot\vec{E})$

e.g Q) $\vec{V} = 3x^2yz\hat{i} + 6yz^2\hat{j} + xy^2z^2\hat{k}$

$\vec{\nabla}\cdot\vec{V} = ?$ at $(1,1,-1)$

Solution:-

$$\vec{\nabla}\cdot\vec{V} = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\cdot\left(3x^2yz\hat{i} + 6yz^2\hat{j} + xy^2z^2\hat{k}\right)$$

$$\Rightarrow \frac{\partial}{\partial x}(3x^2yz) = 6xyz$$

you may skip these steps

$$\Rightarrow \frac{\partial}{\partial y}(6yz^2) = 6z^2$$

$$\Rightarrow \frac{\partial}{\partial z}(xy^2z^2) = 2xy^2z$$

$$\vec{\nabla}\cdot\vec{V} = 6xyz + 6z^2 + 2xy^2z$$

$$= 6(1)(1)(-1) + 6(-1)^2 + 2(1)(1)^2(-1)$$

$$= -6 + 6 - 2$$

$$\vec{\nabla}\cdot\vec{V} = -2$$

(Div is sink)

CURL

•) Curl of

PHYSICAL

•) It fin

or tell

surfac

•) Curvat

•) Curvat

Q) $\vec{r} =$

$\vec{\nabla} \times$

Solution

$\vec{\nabla} \times$

$\vec{\nabla} \times \vec{r}$

CURL OF A VECTOR:-

cross product

-) Curl of a vector $= \vec{\nabla} \times \vec{V}$

PHYSICAL SIGNIFICANCE:-

-) It finds the curve of a surface or tells about the curve of a surface.

-) Curvature = +ve if

-) Curvature = -ve if parabola

Q) $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ (Position vector)

$\vec{\nabla} \times \vec{r} = ?$

Solution:-

$$\vec{\nabla} \times \vec{r} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x & y & z \end{vmatrix}$$

$$= \begin{vmatrix} \partial/\partial y & \partial/\partial z \\ y & z \end{vmatrix} \hat{i} - \hat{j} \begin{vmatrix} \partial/\partial x & \partial/\partial z \\ x & z \end{vmatrix} + \hat{k} \begin{vmatrix} \partial/\partial x & \partial/\partial y \\ x & y \end{vmatrix}$$

$$= (0-0)\hat{i} - (0-0)\hat{j} + (0-0)\hat{k}$$

$$\vec{\nabla} \times \vec{r} = 0$$

•) Position vector is always a straight line, so it curve = 0.
i.e) $\vec{\nabla} \times \vec{r} = 0$

Q) $\vec{V} = x^2 y \hat{i} + yz \hat{j} + xz^2 \hat{k}$

$\vec{\nabla} \times \vec{V} = ?$ at $(1, 1, -1)$

Solution:-

$$\vec{\nabla} \times \vec{V} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x^2 y & yz & xz^2 \end{vmatrix}$$

$$= \begin{vmatrix} \partial/\partial y & \partial/\partial z \\ yz & xz^2 \end{vmatrix} \hat{i} - \begin{vmatrix} \partial/\partial x & \partial/\partial z \\ x^2 y & xz^2 \end{vmatrix} \hat{j} + \begin{vmatrix} \partial/\partial x & \partial/\partial y \\ x^2 y & yz \end{vmatrix} \hat{k}$$

$$\Rightarrow \frac{\partial}{\partial y}(xz^2) - \frac{\partial}{\partial z}(yz) = 0 - y = -y\hat{i}$$

$$\Rightarrow \frac{\partial}{\partial x}(xz^2) - \frac{\partial}{\partial z}(x^2 y) = -(z^2 - 0) = -z^2\hat{j}$$

$$\Rightarrow \frac{\partial}{\partial x}(yz) - \frac{\partial}{\partial y}(x^2 y) = 0 - x^2 = -x^2\hat{k}$$

$$\vec{\nabla} \times \vec{V} = -y\hat{i} - z^2\hat{j} - x^2\hat{k}$$

$$= -(1)\hat{i} - (-1)^2\hat{j} - (1)^2\hat{k}$$

$$= -\hat{i} - \hat{j} - \hat{k}$$

$$= -(\hat{i} + \hat{j} + \hat{k})$$

$\vec{\nabla} \times \vec{v} = -(\vec{r})$

•) -ve sign shows that it has curve

Q) $\phi = 3x^2y - 2z^2$ at $(-1, 1, 1)$

Gradient of $\phi = \vec{\nabla}\phi = \vec{A} = ?$

$\vec{\nabla} \cdot \vec{A} = ?$

$\vec{\nabla} \times \vec{A} = ?$

<u>Solution</u>

$$\vec{\nabla}\phi = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)(3x^2y - 2z^2)$$

$$\Rightarrow \frac{\partial}{\partial x}(3x^2y - 2z^2) = 6xy - 0 = 6xy$$

$$\Rightarrow \frac{\partial}{\partial y}(3x^2y - 2z^2) = 3x^2 - 0 = 3x^2$$

$$\Rightarrow \frac{\partial}{\partial z}(3x^2y - 2z^2) = 0 - 4z = -4z$$

$$\vec{\nabla}\phi = 6xy\hat{i} + 3x^2\hat{j} - 4z\hat{k} = \vec{A}$$

$$= 6(-1)(1)\hat{i} + 3(-1)^2\hat{j} - 4(1)\hat{k}$$

$$\vec{\nabla}\phi = -6\hat{i} + 3\hat{j} - 4\hat{k}$$

•) Gradient always gives straight line so it curve is always zero.

$$\vec{\nabla}\cdot\vec{A} = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\cdot\left(6xy\hat{i} + 3x^2\hat{j} - 4z\hat{k}\right)$$

$$= 6y + 0 - 4$$

$$= 6(1) - 4$$

$\vec{\nabla}\cdot\vec{A} = 2$ (Div is source) +ve

$$\vec{\nabla}\times\vec{A} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ 6xy & 3x^2 & -4z \end{vmatrix}$$

$$= \begin{vmatrix} \partial/\partial y & \partial/\partial z \\ 3x^2 & -4z \end{vmatrix}\hat{i} - \begin{vmatrix} \partial/\partial x & \partial/\partial z \\ 6xy & -4z \end{vmatrix}\hat{j} + \begin{vmatrix} \partial/\partial x & \partial/\partial y \\ 6xy & 3x^2 \end{vmatrix}\hat{k}$$

$$\Rightarrow \cancel{\frac{\partial}{\partial y}(-4z) - \frac{\partial}{\partial z}(3x^2) = 0 - 0}$$

$$= (0-0)\hat{i} - (0-0)\hat{j} + (6x - 6x)\hat{k}$$

$$= (0)\hat{i} - (0)\hat{j} + (0)\hat{k}$$

$\vec{\nabla}\times\vec{A} = 0$ (It has no curve)

MECH

Kinemati

(discuss motio

vector d/

•) $\vec{r}$ —

•) $\vec{r}$ ⟵

•) Graph
one

MECHANICS:-

Mechanics

kinematic mechanics (discuss motion without force)

Dynamic mechanics (motion with force)

•) vector $\vec{r} \xrightarrow{d/dr}$ velocity V (dr/dt) $\xrightarrow{d/dr}$ acceleration a (d^2r/dt^2)

•) $\vec{r} \xleftarrow[\int]{} V \xleftarrow[\int]{} a$

•) Graphical representation of one dimension motion (in exams).

21-2-20 **Class: 4**

Mechanics

Ch: Motion In One Dimension

Kinematics:-

In kinematic we describe the motion of an object while ignoring the interaction with external agents that might be affecting or modifying that motion. This portion of classical mechanics is called kinematics.

Graphical Representation Of Motion,

Pg # 22, Book: S and J 9th E, Table 2.1.

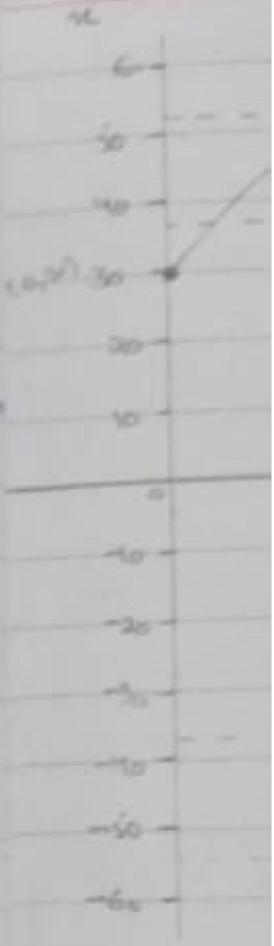
Position	t (s)	displacement x (m)	
A	0	30	
B	10	52	22
C	20	38	14
D	30	0	38
E	40	-37	37
F	50	-53	+16 127 =

•) These 'x' are displacement because every point is w.r.t origin.

•) Distance is never in -ve so these are displacement

Position-

•) Graph



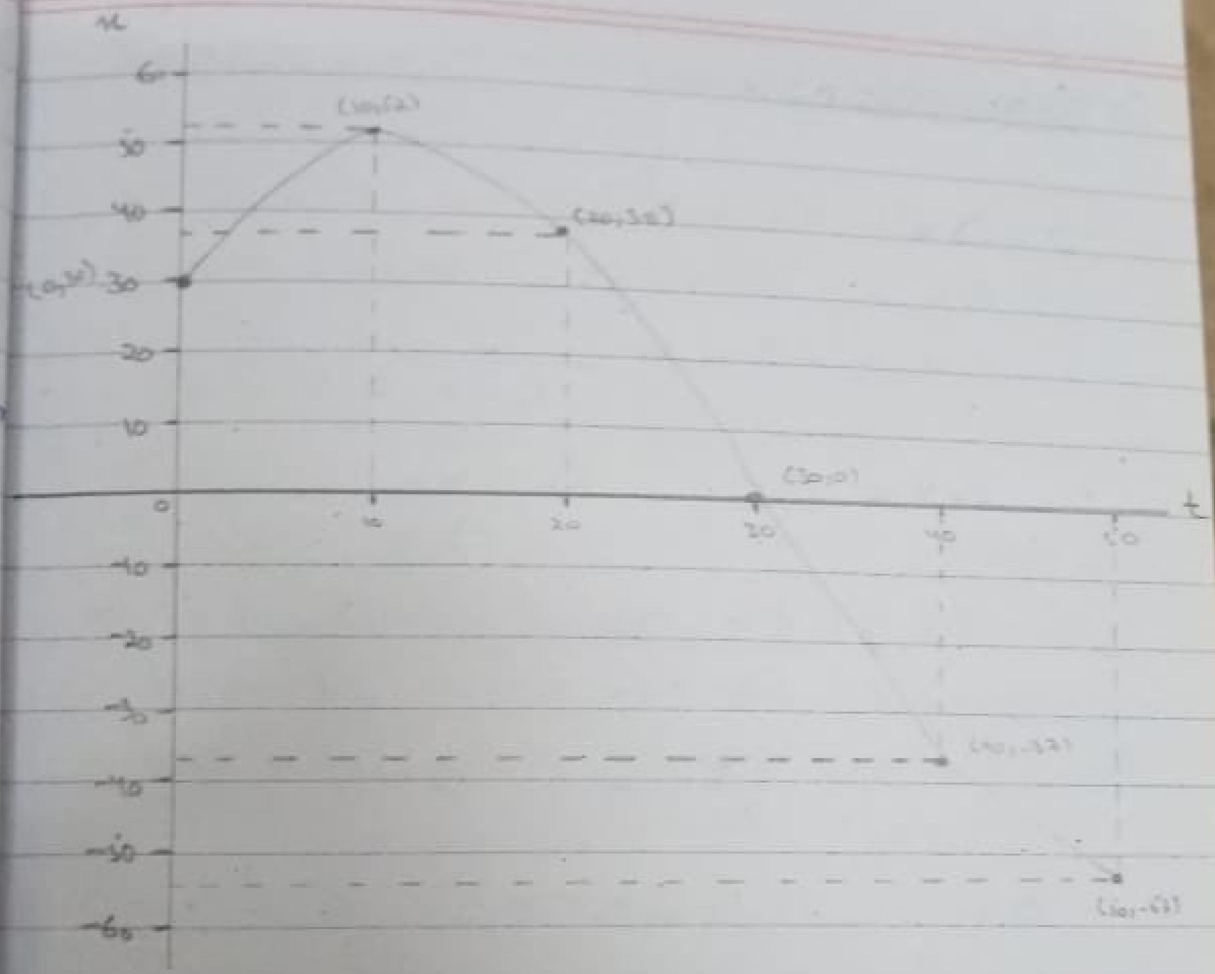
•) Join (...

Ex = 2.

Find velocit... betwe... (F).

Position-time

•) Graph:



•) Join these points by free hand (without scale).

$Ex = 2 \cdot 1$ (Pg-24) =

Find the displacement, Δx average velocity Δv and average speed of car between position (A) and position (F).

Solution:-

$\because \Delta x = x_f - x_A$

$\Delta x = -53 - 30$

$\Delta x = -83 \text{ m}$

$$\because \Delta V = \frac{\Delta x}{\Delta t} = \frac{x_f - x_A}{t_f - t_A}$$

$$= \frac{-53 - 30}{50 - 0}$$

$$= \frac{-83}{50} = -1.66 \text{ m/s}$$

$$\Delta V = -1.7 \text{ m/s}$$

$$\because \text{average speed} = V_{avg} = \frac{\text{distance (d)}}{\Delta t}$$

$$V_{avg} = \frac{127}{50}$$

$$V_{avg} = 2.54 \text{ m/s}$$

•) Notice that it is only one motion but it has different speed, velocity, displacement and distance.

INSTANTANEOUS VELOCITY:

Velocity of a body at a particular instant.

$$<V> = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

•) We apply limit at particular instant because the distance travel and time is so small.

<u>Ex. 2.3 (Pg # 27)</u>:

<u>DATA:-</u>

$x(t) = -4t + 2t^2$

<u>REQUIRED:</u>

a) $\Delta x_{0-1} = ?$

$\Delta x_{1-3} = ?$

b) $\Delta V_{0-1} = ?$

$\Delta V_{1-3} = ?$

c) $<V_{2.5}> = ?$

ce (d)

one

t

nd

FORMULA:-

$$\Delta x_{0-1} = x_1 - x_0$$

$$\Delta x_{1-3} = x_3 - x_1$$

$$\Delta v_{0-1} = \frac{x_1 - x_0}{t_1 - t_0} = \frac{\Delta x_{0-1}}{\Delta t_{0-1}}$$

$$\Delta v_{1-3} = \frac{x_3 - x_1}{t_3 - t_1}$$

$$\langle v \rangle_{2.5} = \frac{d}{dt}(x)$$

SOLUTION:-

$$x(t) = -4t + 2t^2$$

$$x(0) = -4(0) + 2(0)^2$$

$$x(0) = 0$$

$$x(1) = -4(1) + 2(1)^2$$

$$= -4 + 2$$

$$x(1) = -2$$

$$x(2) = -4(2) + 2(2)^2$$

$$= -8 + 2(4)$$

$$= -8 + 8$$

$$x(2) = 0$$

$\cancel{d})\ x(3) = -4(3) + 2(3)^2$

$= -12 + 2(9)$

$= -12 + 18$

$x(3) = 6$

a) $\Delta x_{0-1} = x_1 - x_0$

$= -2 - 0$

$\Delta x_{0-1} = -2 \text{ m}$

$\Delta x_{1-3} = x_3 - x_1$

$= 6 - (-2)$

$\Delta x_{1-3} = 8$

b) $\Delta V_{0-1} = \dfrac{x_1 - x_0}{t_1 - t_0}$

$= \dfrac{-2 - 0}{1 - 0}$

$\Delta V_{0-1} = -2 \text{ m/s}$

$\Delta V_{1-3} = \dfrac{x_3 - x_1}{t_3 - t_1}$

$= \dfrac{6 - (-2)}{3 - 1}$

$= \dfrac{8}{2}$

$\Delta V_{1-3} = 4 \ m/s$

c) $\langle V \rangle_{2.5} = \dfrac{dx}{dt}$

$= \dfrac{d}{dt}(-4t + 2t^2)$

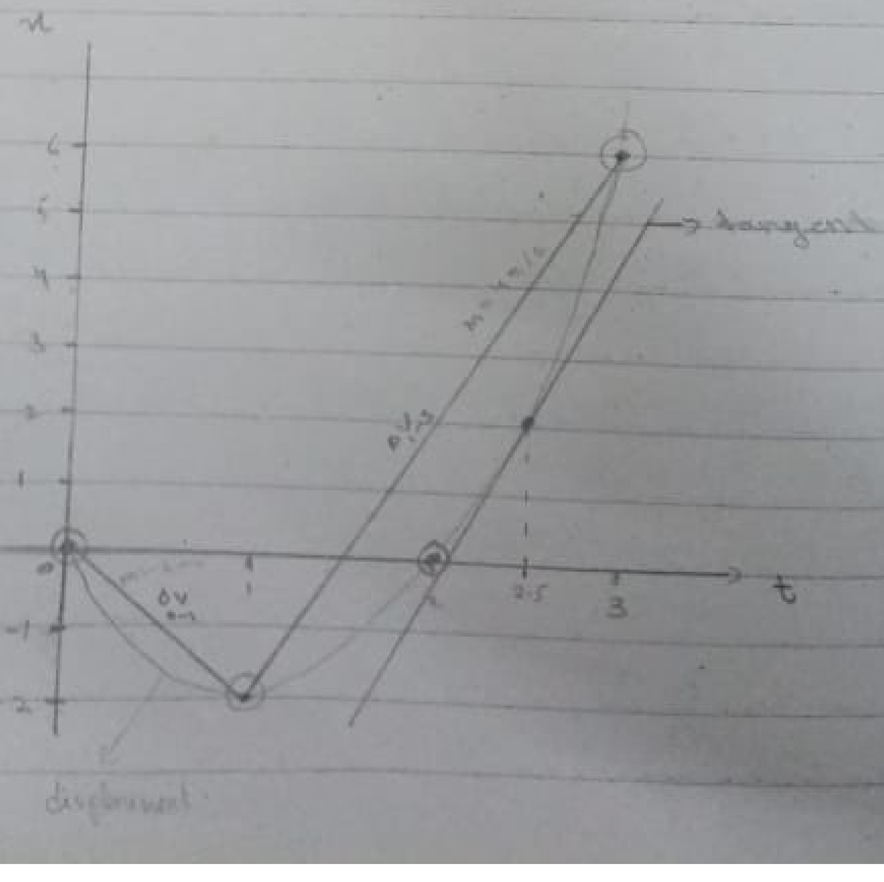
$\langle V \rangle_{2.5} = -4 + 4t$

put $t = 2.5$

$\langle V \rangle_{2.5} = -4 + 4(2.5)$

$= -4 + 10$

$\langle V \rangle_{2.5} = 6 \ m/s$



•) Tangent is the line that touch only one point on (displacement) curve.

Q) Same question ~~on this~~ except $x(t) = -2t + 3t^2 - 2$

DATA:-

$x(t) = -2t + 3t^2 - 2$

REQUIRED:-

a) $\Delta x_{0-1} = ?$

$\Delta x_{1-3} = ?$

b) $\Delta v_{0-1} = ?$

$\Delta v_{1-3} = ?$

c) $\langle v \rangle_{2.5} = ?$

& FORMULA:-

$\Delta x_{0-1} = x_1 - x_0$

$\Delta x_{1-3} = x_3 - x_1$

$$\Delta v_{0-1} = \frac{x_1 - x_0}{t_1 - t_0}$$

$$\Delta v_{1-3} = \frac{x_3 - x_1}{t_3 - t_1}$$

$$\langle v \rangle_{2.5} = \frac{d}{dt} x$$

Scanned with CamScanner

Solution:-

$x(t) = -2t + 3t^2 - 2$

$x(0) = -2(0) + 3(0)^2 - 2$

$x(0) = -2$

$x(1) = -2(1) + 3(1)^2 - 2$

$= -2 + 3 - 2$

$x(1) = -1$

$x(2) = -2(2) + 3(2)^2 - 2$

$= -4 + 12 - 2$

$x(2) = 6$

$x(3) = -2(3) + 3(3)^2 - 2$

$= -6 + 27 - 2$

$x(3) = 19$

a) $\Delta x_{0-1} = x_1 - x_0$

$= -1 - (-2)$

$\Delta x_{0-1} = 1\ m$

$\Delta x_{1-3} = x_3 - x_1$

$\Delta x_{1-3} = 19 - (-1) = 20\ m$

b) Δ

Δ

Δ

Δv_{1-3}

c) <

<

<

<

b) $\Delta V_{0-1} = \dfrac{x_1 - x_0}{t_1 - t_0}$

$= \dfrac{-1 - (-2)}{1 - 0}$

$\Delta V_{0-1} = 1 \text{ m/s}$

$\Delta V_{1-3} = \dfrac{x_3 - x_1}{t_3 - t_1}$

$= \dfrac{19 - (-1)}{3 - 1}$

$= \dfrac{20}{2}$

$\Delta V_{1-3} = 10 \text{ m/s}$

c) $\langle V \rangle_{2.5} = \dfrac{d}{dt} x$

$= \dfrac{d}{dt}(-2t + 3t^2 - 2)$

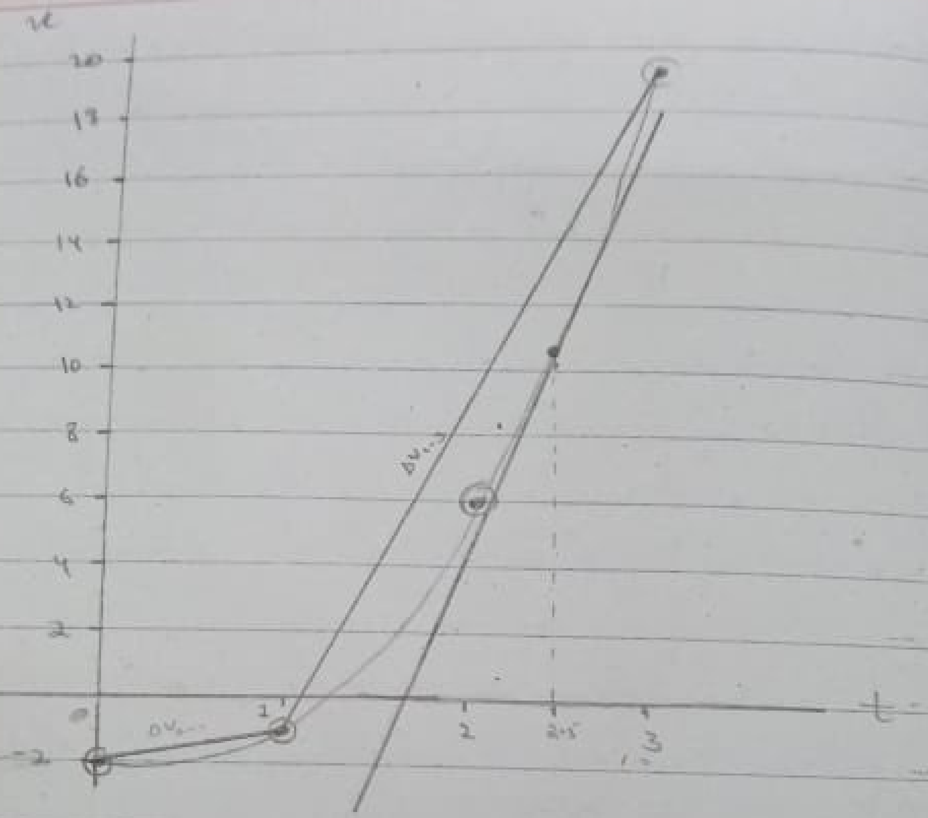
$\langle V \rangle_{2.5} = -2 + 6t$

put $t = 2.5$

$\langle V \rangle_{2.5} = -2 + 6(2.5)$

$= -2 + 15$

$\langle V \rangle_{2.5} = 13$



Q) See graph on pg = 33.

a) position x vs time

- Velocity increases uniformly between O and t_A
- Between t_A and t_B velocity is constant.
- Between t_B and t_D velocity decreases and at t_D velocity is zero.
- Between t_D and t_E velocity is negative and decreasing

uniformly.

•) Between t_E and t_F velocity increases in negative and at t_F velocity is zero means body is at rest.

b) Velocity vs time.

•) B/w $t_0 - t_A$ ~~velocity~~ increase uniformly

•) B/w $t_A - t_B$ // constant

•) B/w t_B and t_D same as in x vs t.

•) B/w t_D and t_E same as in x vs t.

Mean object is moving backward.

•) B/w t_E and t_F same as in x vs t

c) acceleration vs time.

•) B/w $t_0 - t_A$, as velocity increases uniformly acceleration is constant and positive

•) B/w $t_A - t_B$, as velocity is constant acceleration is zero.

•) B/w $t_B - t_E$, acceleration is negative.

•) B/w $t_E - t_F$, accleration is positive.