Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

Date: 02/09/2024

Internal Examination Notice

The students of B.Sc. I, II and III are hereby informed that the internal examination of current semester is scheduled as per following time table:

Sr. No.	Class and Sem	Paper No.	Title of the paper	Date and time
1.	B.Sc. I, SEM I	I	Mechanics I	24/09/2024 10: 00 to 11:00 am
2.	B.Sc. I, SEM I	II	Electricity and Magnetism I	25/09/2024 10: 00 to 11:00 am
3.	B.Sc. II, SEM III	V	Thermal and statistical mechanics I	24/09/2024 10: 00 to 11:00 am
4.	B.Sc. II, SEM III	VI	Waves and Oscillations	25/09/2024 10: 00 to 11:00 am
5.	B.Sc. III, SEM V	IX	Mathematical Physics	24/09/2024 12:00 to 01:00 pm
6.	B.Sc. III, SEM V	X	Nuclear and Particle Physics	25/09/2024 12:00 to 01:00 pm
7.	B.Sc. III, SEM V	XI	Quantum physics	26/09/2024 12:00 to 01:00 pm
8.	B.Sc. III, SEM V	XII	Solid state physics I	27/09/2024 12:00 to 01:00 pm

Nature of question paper

- **For B.Sc. I and II**

Total Marks (for each paper) = 10

Q: 1) Select correct alternative (4 marks)

Q: 2) Short answer question (any two out of three) (08 marks)

- **For B.Sc. III**

Total Marks (for each paper) = 15

Q: 1) Select correct alternative (3 marks)

Q: 2) Short answer question (any three out of four) (12 marks)

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DEPARTMENT OF PHYSICS
VIVEKANAND COLLEGE, KOLHAPUR
(EMPOWERED AUTONOMOUS)

Shri Swami Vivekanand Shikshan Sanstha, Kolhapur's

Vivekanand College, Kolhapur

(Empowered Autonomous)

Department of Physics Date: 24/09/2024

B. Sc. / M.Sc. Part – I, **Semester** – I, **PHYSICS Paper** – I

Title of the Paper: Mechanics – I

Name of Teacher: Dr. Sumayya I. Inamdar.

Internal Examination Attendance Sheet

Sr. No.	Name of the Student	Paper I 24/9/2024		Paper II 25/09/2024			
1)	Shivali Shivaji Kumbhar	Shi		Shi			
2)	Amruta Vikrant Malawade	AMalawade		AMalawade.			
3)	Sanika Shivaji Chougule	Schougule.		Schougule.			
4)	Samruddhi Krushnat Powar.	Powar.		Powar.			
5)	Vaishnavi S. Chougale.	V.Chougale.		V.Chougale.			
6)	Mrunali I. Kotmire	MIK		MIK			
7)	Shreya. S. Patil	Patil		Patil			
8)	Grishma. S. Tiipankar	GST.		GST.			
9)	Megha. S. Patil	MPatil		MPatil			
10)	Shreya. P. Powar	Powar		Powar.			
11)	Anushka J. Patil.	APatil		APatil			
12)	PRANALI . R. GAIKWAD	Gaikwad		Gaikwad.			
13)	Vaishnavi S. Sawul.	Sawul.		Sawul.			
14)	Shrusthi . S. Chougule	S.S.C		S.S.C			
15)	Anuja M. Matkadkar	Anuja.		Anuja.			
16)	Nandini A. Chorage.	Nhorage		Nhorage			
17)	Purva . D. Chougale	Purva	Purva	Purva			
18)	Gungun . V. Dhanwani	Hemant Dhanwani		Hemant Dhanwani			
19)	Jayukta Gaikwad	[illegible]		[illegible]			
20)	Sakshi Chougule	Schougule		Schougule			

21)	Diksha. V. Sutar	Diksha	Diksha			
22)	Pratiksha. R. Mohite	RMohite.	RMohite.			
23)	Anushka B. Powar	Bpwar.	Bpwar			
24)	Sakshi. D. Sakhedkar	SDSakhedkar	SDSakhedkar			
25)	Sneha. P. Murgude	Sneha.	Sneha.			
26)	Trupti D. Chougale	Chougale	Chougale			
27)	Priti K. Maruda.	Kmaruda	Kmaruda			
28)	Sanika S Barade	Barade	Barade			
29)	Samruddhi. S Dixit	SDixit	SDixit			
30)	Aditi S kumbhar.	Akumbhar	Akumbhar			
31)	Shruti A. Sutar	S.A.Sutar.	S.A.Sutar			
32)	Arpita. B. Patil	A.B.Patil	A.B.Patil			
33)	Pratiksha. P. Patil	P.Patil	P.Patil			
34)	Sai Sarjerao Navale	SNavale.	SNavale			
35)	Jiya Salim Mulla	Jmulla	Jmulla			
36)	Swaleha pathan	Swaleha	Swaleha			
37)	Sahil S. kumbhar.	Sahil	Sahil			
38)	Shubham D. Davar	Savre	Savre			
39)	Harshvardhan. Kate	Hkate	Hkate			
40)	Rushi. Umesh. Pawar	Rushi	Rushi			
41)	Sahil Sachin Pachakatti	SSP	SSP			
42)	Abhay Nivas Patil	APatil	APatil			
43)	Pranav Dashrath Patil	Patil	Patil			
44)	Mayuresh A. Thunkikar					
45)	Ayan S. Shaikh	A.S.S	A.S.S			
46)	Tejas. P. Patil	TPatil	TPatil			
47)	Abhishek. S. Pardle					
48)	Yash. L. Dhotre	YDhotre	YDhotre			
49)	Mukund P. Mhetre					

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Department of Physics

B. Sc. / M.Sc. Part – I **, Semester –** I **, PHYSICS Paper -** I

Title of the Paper: Mechanics I

Name of Teacher: Dr. Sumayya. I. Inamdar

Attendance Sheet

Sr. No.	Name of the Student	Paper I 24/09/2024	Paper II 25/09/2024		
1)	SHREYASH. S SHINGATE	S.S.Shingate	S.S.Shingate		
2)	Samarth . B. Koli	S.B.Koli	S.B.Koli		
3)	Harshavardhan B. Chavan	[illegible]	[illegible]		
4)	Mahesh Gawari	MAG	[illegible]		
5)	Suyash . D . Ghugare	Ghugare			
6)	Shivtej. V. Patil	SVPatil.	[illegible]		
7)	Atharva R. Patil	ARPatil	ARPatil		
8)	Shivam P. Bodake	[illegible]	[illegible]		
9)	Adarsh . R. Jha	[illegible]	[illegible]		
10)	Parth . P. Gavali.	P.P.G	P.P.G		
11)	Prajwal S. Lokhande	[illegible]	[illegible]		
12)	Atharv . M. Salokhe	[illegible]	[illegible]		
13)	Pramod . P. Khot	PPK	PPK		
14)	Nikhil . S. Salokhe	NS	NS		
15)	Parth . V. Patil	P.V.P	P.V.Patil		
16)	Amit . S. Patil	Aspatil	Aspatil		
17)	Pandurang Rupnar	P.M. Rupnar	P.M. Rupnar		
18)	Vinit N. Magdum	Vinit	Vinit		
19)	Suras . D. Yelpale	S.D.Y.	S.D.Y.		
20)	Alfaz R. Patel	ARPatel	ARPatel		

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21)	Mahamadsaad G. Pendhari	Pendhari		Pendhari			
22)	Parth yashwant mali.	Pmali.		Pmali.			
23)	Harsh V. Pawar	Harsh		Harsh			
24)	Shubham S. Devpuje	SSP.		SSP.			
25)	Paras . P. Thakare	PThakare					
26)	Dinesh . D. Mane	Dmane		Dmane,			
27)	~~Jiya Salim Mulla~~	Jmulla		Jmulla			
28)	Prathamesh S. kumbhar	Pkumbhar		Pkumbhar			
29)							
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"Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe
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Department of Physics

B.Sc. Part-I SEM I Examination (2024-25)
Electricity and Magnetism I
Paper II (Paper code: DSC03PHY12)

Date : Total Marks: 10
Day : Time :-

Instructions:-

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q.1) Select correct alternative **(2)**

1. The gradient of scalar function $(\nabla . \emptyset)$ is -----
   (a) a vector (b) a scalar
   (c) used to represent equipotential surface (d) always zero
2. If magnitude of $\vec{A} \times \vec{B} = AB$, then the two vectors must be -----
   a) parallel to each other b) antiparallel to each other
   c) inclined at an angle 45° with each other d) always antiparallel

Q.2 Attempt any TWO **(08)**

1. Define scalar product of two vectors. State its characteristics.
2. Explain the physical significance of gradient of scalar function $(\nabla . \emptyset)$.
3. Write a short note divergence of vector field $\vec{\nabla} . \vec{V}$.

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Name - Sai Sarjerao Navale

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– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

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Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Date - 25-09-2024

Suppliment No. :

Roll No. : 7253

Class : BSc (I)

Signature of Supervisor

Subject : Physics (Electricity & magnetism) (Internal)

Test / Tutorial No. :

Div. :

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Q1)

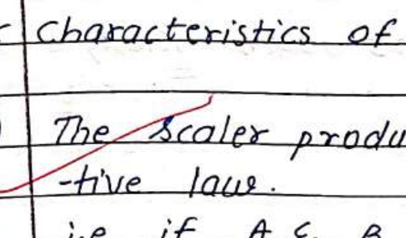
1) (a) a vector.

2) If magnitude of $\bar{A}\times\bar{B} = AB$, then two vectors must be perpendicular. * (All options are different).

Q2)

1) Scaler product -

The scaler product is also called as dot product is a product of two vectors & cosine angle between them.



If A & B are two vectors then their scaler product is given as,

$\bar{A}.\bar{B} = AB\cos\theta$

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* Characteristics of scaler product.

1) The scaler product or dot product obeys commutative law.

i.e if A & B are ~~are~~ two vectors then,

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$A.B = B.A.$

[2] Scaler product also obeys distributive law
i.e $A.(B+C) = A.B + A.C$

[3] Scaler product obeys associative law,
$A+(B+C) = (A+B)+C.$

[4] The scaler product of A & B depends upon an
made by two vectors.
(1) If $\theta = 0.$
$A.B = AB\cos 0 = AB.$
(Hence, Scaler product is maximum)

(2) If $\theta = 90.$
$A.B = AB\cos 90 = 0$
(Scaler product is 0)

(3) If $\theta = 180.$
$A.B = AB\cos 180 = -AB$
(Scaler Product is minimum

[5] If two vectors are parallel then,
$\hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1$
And, if two vectors are perpendicular then,
$\hat{i}\hat{j} = \hat{j}\hat{k} = \hat{i}.\hat{k} = 0$

[6] If A & B are two vectors such that,
$A = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$
$B = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

Then.

$A.B = (Ax\hat{i} + Ay\hat{j} + Az\hat{k}).(Bx\hat{i} + By\hat{j} + Bz\hat{k})$.

$= AxBx(\hat{i}.\hat{i}) + AxBy(\hat{i}.\hat{j}) + AxBz(\hat{i}.\hat{k})$
$+ AyBx(\hat{j}\hat{i}) + AyBy(\hat{j}.\hat{j}) + AyBz(\hat{j}.\hat{k})$
$+ AzBx(\hat{k}\hat{i}) + AzBy(\hat{k}\hat{j}) + AzBz(\hat{k}\hat{k})$

$= AxBx + 0 + 0 + 0 + AyBy + 0 + 0 + 0 + AzBz$

$\because (\hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}\hat{k} = 1)$

$A.B = AxBx + AyBy + AzBz \quad (\hat{i}\hat{j} = \hat{j}\hat{k} = \hat{i}.\hat{k} = 0)$

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3) [1] The divergance of vector field $\bar{\nabla}\times\bar{V}$ is a scaler quantity which can be expressed in the form of.

$$\bar{\nabla}\times\bar{V} = \left(\frac{\partial Vx}{\partial x} + \frac{\partial Vy}{\partial y} + \frac{\partial Vz}{\partial z}\right)$$

[2] Here, Vx, Vy & Vz are vectors & $\bar{\nabla}$ is a del operator or differential operator.

$$\bar{\nabla} = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)$$

$\& V = (Vx\hat{i} + Vy\hat{j} + Vz\hat{k})$.

[3] $\therefore \bar{\nabla}.V = \left(\frac{\partial Vx}{\partial x} + \frac{\partial Vy}{\partial y} + \frac{\partial Vz}{\partial z}\right)$.

[4] Also, $\bar{\nabla}.V$ is a scaler function.

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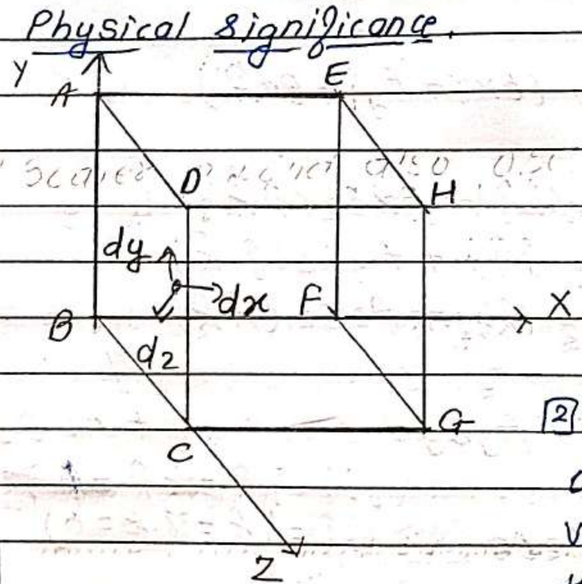
* Physical significance.



[1] Consider a rectangular parallelopiped ABCD-EFGH on co-ordinate system x, y & z

[2] Let dx, dy & dz be lengths of parallelopiped & V_x, V_y & V_z be a vector & $\vec{V} = V_x + V_y + V_z$ entering th^r ABCD

[3] When a vector enters through ABCD, then

$$= V_x \, dy \, dz \quad \text{——} (1)$$

When it leaves from EFGH, then

$$- V_x \, dy \, dz - \frac{\partial V_x}{\partial x} dx \, dy \, dz \quad \text{——} (2)$$

$\therefore$ Net flux from parallelopiped through X-axis

(2) − (1)

$$= V_x \partial y \, dz - V_x dy dz + \frac{\partial V_x}{\partial x} dx \, dy \, dz$$

$$= \frac{\partial V_x}{\partial x} dx \, dy \, dz \quad \text{——} (3)$$

[4] Similarly the net vector form Y axis is

$$= \frac{\partial V_y}{\partial y} dx \, dy \, dz \text{——} (4)$$

And from z,

$$- \frac{\partial V_z}{\partial z} dx dy dz \quad -(5)$$

[5] $\therefore$ from (3) (4) (5).

$$\nabla . \vec{V} = \left(\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} \right) dx . dy dz$$

;Sai S. Navale

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 1

Roll No. : 7253

Class : BSc (I)

Subject : Physics

Test / Tutorial No. :

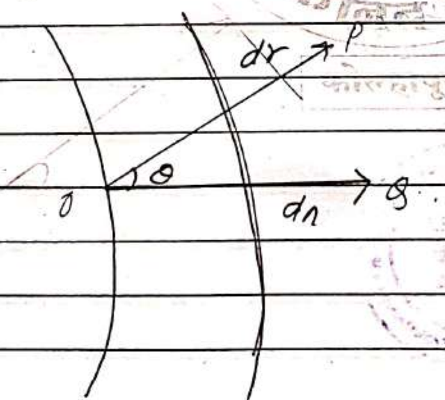
Div. :

6 Therefore, divergence per unit volume is,

$$\nabla \cdot \bar{V} = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z}$$

2) Physical significance of gradient of scaler function

1 Let



$\cos\theta = \frac{dn}{dr}$, $dn = dr\cos\theta$

1 consider a del operator $\bar{\nabla}$ & scaler function ϕ such that,

$$\bar{\nabla} = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial x}\hat{k} \quad \& \quad \phi = \phi x\hat{i} + \phi y\hat{j} + \phi z\hat{k}.$$

2 Therefore their dot product is taken as

$$\bar{\nabla}\cdot\phi = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial x}\hat{k}\right)\cdot\left(\phi x\hat{i} + \phi y\hat{j} + \phi z\hat{k}\right) \cdot dn.$$

$\bar{\nabla}.\phi = \left(\frac{\partial\phi x}{\partial x}\hat{i} + \frac{\partial\phi y}{\partial y}\hat{j} + \frac{\partial\phi z}{\partial z}\hat{k}\right)$ (This is called gra[dient] of scaler field).

[2] Also, if $dr = dx\hat{i} + dy\hat{j} + dz\hat{k}$ & $\cos\theta = \cos 0 = 1$

Then it becomes,

$\bar{\nabla}.\phi = \left(\frac{\partial\phi x}{\partial x}\hat{i} + \frac{\partial\phi y}{\partial y}\hat{j} + \frac{\partial\phi z}{\partial z}\hat{k}\right)(\phi x\hat{i} + \phi y\hat{j} + \phi z\hat{k})$

$\bar{\nabla}.\phi = \left(\frac{\partial\phi x}{\partial x}dx + \frac{\partial\phi y}{\partial y}dy + \frac{\partial\phi z}{\partial z}dz\right)$

There-fore this is called gradient of scaler field which can also be written as

3

$$\boxed{\bar{\nabla}.\phi = \frac{\partial\phi x}{\partial x} + \frac{\partial\phi y}{\partial y} + \frac{\partial\phi z}{\partial z}}$$

It is a vector function.

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Shri Swami Vivekanand Shikshan Sanstha Kolhapur's' 51474

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT	Signature of Supervisor
Name : Megha Sambhaji Patil	
Suppliment No. : 01	Subject : Physics
Roll No. : 7223	Test / Tutorial No. :
Class : B.S.C I	Div. :

$\frac{10}{10}$

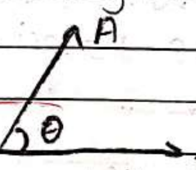
Q1) 1) The gradient of scalar function $(\nabla \cdot \phi)$ is vector

2) If magnitude of $\vec{A} \times \vec{B} = AB$, then two vectors must be antiparallel to each other.

Q2) Scalar product :- If two vectors, inclined at some angle θ, then there ~~cross~~ scalar product will be product of their magnitudes and cosine angle between them

$\vec{V} = A \cdot B$

$= |A| \cdot |B| \cos\theta$

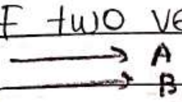


* characteristics.

(1) Scalar product holds commutative law
i.e $A \cdot B = B \cdot A$

(2) Scalar product holds distributive law
$A \cdot (B + C) = A \cdot B + A \cdot C$

(3) If two vectors are parallel to each other



angle, $\theta = 0^{\circ}$
$\cos 0^{\circ} = 1$

(4) If two vectors are perpendicular to each other then the angle; $\theta = 90^{\circ}$

$\cos(90^{\circ}) = 0$

(5) If two vectors are antiparallel then,

$\theta = 180^\circ$

$\cos(180^\circ) = -1$

we get negative sign here

(6) one of the well known example of scalar product is work done

Work done = Force $\cdot$ displacement

$$W = F \cdot ds$$

Q2) Let ϕ be the scalar function, then the quantity $\left(i \frac{\partial \phi}{\partial x} i + \frac{\partial \phi}{\partial y} J + \frac{\partial \phi}{\partial z} k \right)$ is a gradient of scalar function ϕ is called as grad ϕ.

Denoted by the symbol $\vec{\nabla} \cdot \phi$ or grad ϕ.

here ϕ is continously differentiable function.

$$\text{grad } \phi = \frac{\partial \phi}{\partial x} i + \frac{\partial \phi}{\partial y} J + \frac{\partial \phi}{\partial z} k$$

let $\phi = \phi(x, y, z)$

$= \phi(r)$

$=$ here $r = xi + yJ + z\hat{k}$

If $d\phi$

$dr = dx i + dy \hat{J} + dz \hat{k}$ then total differential function $d\phi = \frac{\partial \phi}{\partial x} dx + \frac{\partial \phi}{\partial y} dy + \frac{\partial \phi}{\partial z} dz$.

here $\vec{\nabla}$ = del operator, which is vector differential operator.

denoted by $\vec{\nabla} = \hat{i} \frac{\partial}{\partial x} + J \frac{\partial}{\partial y} + \hat{k} \frac{\partial}{\partial z}$.

which is used, ~~in~~ gr

It gives total variation of field (scalar or ector) and give maximum rate of change of that field. It act as simple differentiator, which operates on scalar function ϕ.

$\vec{\nabla}\phi$:- here $\vec{\nabla}$ operates on scalar function ϕ.

$\vec{\nabla}\cdot v$ & $\vec{\nabla}\times v$ is a formal vector.

here scalar field define as :- when we give scalar quantity to every point in space, It is called as scalar field.

eg of scalar field :- electric potential, magnetic potential, gravitational potential.

3) Vector field :- when vector quantity is given to every point in space, it is called as vector field.

Let $\vec{V}(x,y,z)$ be the continuous differentiable function, then the quantity

$$\left[\hat{i}\frac{\partial \vec{V}_x}{\partial x} + \hat{j}\frac{\partial \vec{V}}{\partial y} + \hat{k}\frac{\partial \vec{V}}{\partial z}\right]$$ is a divergence

of vector field, denoted by $\vec{\nabla}\cdot\vec{V}$.

let $\vec{V} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$

then

divergence of vector field can be written as :

$$\vec{\nabla}\cdot\vec{V} = \left(\hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}\right)\cdot\left(v_x\hat{i} + v_y\hat{j} + v_z\hat{k}\right)$$

$$= \left(\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z}\right)$$ = Divergence of vector field.

This is scalar quantity.

Divergence can also defined as
(ii) Total Flux diverging per unit volume of a vector element of a vector Field.

Total Flux of vector element,

$$\left(\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z}\right) \cdot dx\,dy\,dz$$

here $dx \cdot dy \cdot dz$ is volume,

So, Total flux per unit volume,

$$\frac{\left(\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z}\right) \cdot dx \cdot \cancel{dy} \cdot dz}{dx \cdot dy \cdot \cancel{dz}}$$

4

here, above terms get cancel out, we get the divergence.

Divergence used in hydrodynamics, it represent the rate at which Fluid is flowing.

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Megha Sambhaji patil

Suppliment No. : 02

Roll No. : 7223

Class : B·S·C I

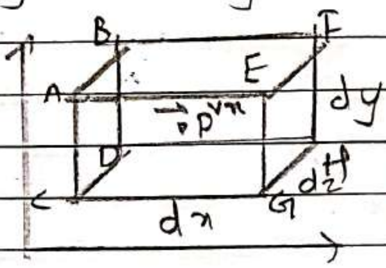
Signature of Supervisor

Subject : physics

Test / Tutorial No. :

Div. :

3) physical significance:



consider a rectangular parallelopiped ABCDEFGH having sides dx, dy, dz parallel to the axes.

Let velocity of the fluid v at the centre, $v(v_x, v_y, v_z)$. The field strength of vector changes from point to point. ~~PA~~ Divergence is used to measure how vector is spread from point to point.

The component of x & its magnitude is

$\left(V_x - \frac{\partial V_x}{\partial x} \cdot \frac{dx}{2}\right)$ normally inwards

$\left(V_x + \frac{\partial V_x}{\partial x} \cdot \frac{dx}{2}\right)$ normally outwards

Total flux, $d\phi = \vec{V} \cdot ds$

$\vec{V} \cdot dydz$

$\left[\left(\frac{\partial V_x}{\partial x}\right) dydz \right.$ along x component

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Total flux along all the axes

$$\left(\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z}\right) dx\, dy \cdot dz$$

2

Trupti Dattatray Chougale

।। ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।।
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

51511

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. :

Roll No. : 7201

Class : BSc · I

Subject : PHYSICS

Test / Tutorial No. : Internal

Div. :

$\frac{9}{10}$

Q.1)

1) the gradient of scalar function ($\nabla.\phi$) is a scalar and used to represent equipotential surface.

0

2) If magnitude of $\vec{A}\times\vec{B} = AB$ then two vectors must be ~~parallel to each other~~ inclined at an angle 45° with each other

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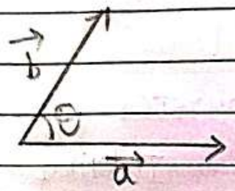
Q.2.

1) scalar product :



let $\vec{a}$ and $\vec{b}$ are two vectors incliened each other at an angle θ.

Then the scalar product of two vectors is product of magnitude of Given two vectors i.e $\vec{a}$ and $\vec{b}$ and cosine of the angle betn them.

$$\boxed{\vec{a}\cdot\vec{b} = |\vec{a}||\vec{b}|\cos\theta}$$

characterstics of scalar product :

1) The scalar product obey commutative law.
i.e $\vec{a}\cdot\vec{b} = \vec{b}\cdot\vec{a}$

2) The scalar product distributive over vector addition.
let $\vec{a}$, $\vec{b}$ and $\vec{c}$ are three vectors

$\vec{a}\cdot(\vec{b}+\vec{c}) = \vec{a}\cdot\vec{b} + \vec{a}\cdot\vec{c}$

4

3) when two vectors are parallel to each other Then thieir scalar product is maximum.
$\theta = 0$ or $\theta = 180^\circ$
$\vec{a}\cdot b = ab\,\cancel{\sin}\cos\theta$
$= ab\cos 0^\circ$

i.e $\cos 0^\circ = 1$

$\therefore \quad \vec{a}\cdot\vec{b} = |\vec{a}||\vec{b}|$

4) When the two vectors are perpendicular to each other, Then their scalar product becomes zero.

$$\cos 90^\circ = 0$$

$$\vec{a}\cdot\vec{b} = |\vec{a}||\vec{b}|\cos 90^\circ$$
$$= 0$$

5) In case of orthogonal vectors

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

where $\hat{i}, \hat{j}, \hat{k}$ are mutually parallel to each other.

6) let $\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$
$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

$\therefore \vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$

4

if $\vec{A} = \vec{B}$

$\vec{A}\cdot\vec{A} = A^2$

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

3)

divergenie of vector field: $(\bar{\nabla}\cdot\bar{V})$

$\cancel{\frac{\partial v_x}{\partial x}\hat{i} + \frac{\partial v_y}{\partial y}\hat{j} + \frac{\partial v_z}{\partial z}\hat{k}}$

The $v(x,y,z)$ is the contineous differential vector function and $\frac{\partial v_x}{\partial x}\hat{i} + \frac{\partial v_y}{\partial y}\hat{j} + \frac{\partial v_z}{\partial z}\hat{k}$ is called as divergenie of vector field

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

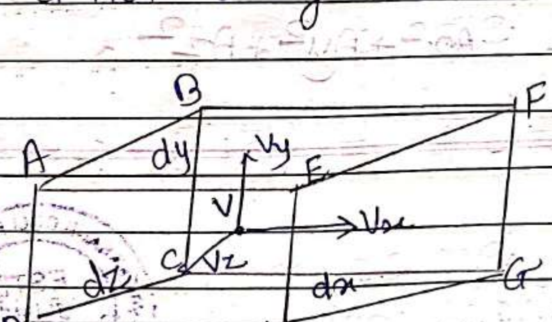
and $\bar{v}(x,y,z) = v(\bar{r})$

$= v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$

$\therefore \vec{\nabla}\cdot\vec{v} = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\cdot\left(v_x\hat{i} + v_y\hat{j} + v_z\hat{k}\right)$

$\therefore \vec{\nabla}\cdot\vec{v} = \frac{\partial v_x}{\partial x}\hat{i} + \frac{\partial v_y}{\partial y}\hat{j} + \frac{\partial v_z}{\partial z}\hat{k}$

Thus the divergen of vector field is a dot product of gradient and vector function denoted by $\vec{\nabla}\cdot\vec{V}$.



॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

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51490

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

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Signature of Supervisor

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Subject :

Roll No. : 7201

Test / Tutorial No. :

Class : BSc1

Div. :

physical significance of vector field.

consider a parallelopiped ABCD-EFGH. having length dx, dy, dz

let $\vec{v} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$ which is the point on centre of parallepiped.

The vector field changes from point to point.

vector field : The quantity assingned to every point in space is called vector field.

– The vector field is a scalar quantity.

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Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

B.Sc. Part-I SEM I Examination (2024-25)
Mechanics I
Paper I (Paper code: DSC03PHY11)

Date :
Day :

Total Marks: 10
Time :-

Instructions:-

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q.1) Select correct alternative **(2)**

1. Angular momentum is conserved when there is ------- net torque applied to a system.
   (a) zero (b) infinity
   (c) one (d) none of above
2. The energy conservation theorem states that the total energy of a particle in a conservative force field is --------.
   a) zero b) constant
   c) infinity d) one

Q.2 Attempt any TWO **(08)**

1. State and explain conservation theorem of angular momentum for a particle.
2. Define and explain the physical significance of Center of mass.
3. State and explain conservation theorem of linear momentum for system particles.

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Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

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Class : B.S.C I

Signature of Supervisor

Subject : Physics

Test / Tutorial No. :

Div. :

$\frac{10}{10}$

Q1)

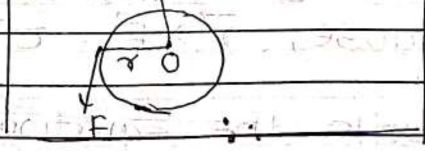
1] Angular momentum is conserved when there is zero net torque applied to a system.

2) The energy conservation theorem states that the total energy of a particle in a conservative Force Field is constant.

Q2. ①

Statement:- when the torque applied to a particle is zero then, angular momentum is conserved.

Diagram



Let consider a particle of mass m, moving about point O.

② Let r be the position vector about point O

③ Let L be the angular momentum about point O i.e $L = \vec{r} \times \vec{p}$ —— (1)

p is here linear momentum of that particle. If we take rate of change of equation on both side w.r.t time.

i.e $\frac{dL}{dt} = \frac{d}{dt}(\vec{r} \times \vec{p})$

$= \frac{d(\vec{r} \times \vec{p})}{dt}$

$= r \times \frac{dp}{dt} + \frac{dr}{dt} \times p.$

$= r \times \frac{dp}{dt} + \frac{dr}{dt} \times mv$ — [Linear momentum is product of mass and velocity]

$= r \times \frac{dp}{dt} + v \times mv$ [rate of change of r w.r.t time is v. i.e $\frac{dr}{dt}$]

$= r \times \frac{dp}{dt} + v \times mv$

Here $v \times mv = 0$, because cross product of vector to itself is zero

$= r \times \frac{dp}{dt}$

$= r \times \frac{dp}{dt}$ is written as

$= \vec{r} \times \vec{F}$ [According to 2nd Law of motion]

$= \tau$

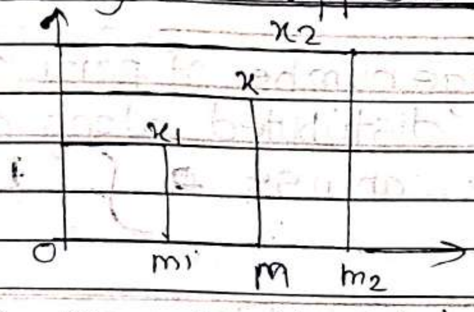
= because, $\vec{r} \times \vec{F} = \tau$ (defination of torque)

So, we can write the equation as

$\frac{dL}{dt} = \tau$

if $\tau = 0$, then $\frac{dL}{dt} = 0$, i.e L = constant hence, angular momentum is conserved.

2] centre of mass:- COM is the point, where whole mass of body is supposed to be concentrated.



Let m_1, m_2 are the point masses w.r.t origin at a distance x_1, x_2, here total mass M is at a distance x.

By equating mass-moment about origin, we can write

$$(m_1+m_2)x_{cm} = m_1x_1 + m_2x_2$$

$$\therefore x_{cm} = \frac{m_1x_1 + m_2x_2}{m_1+m_2} \quad \text{--- (1)}$$

If there are 'n' number of particles present along the centre of mass, then eqn (1) become,

$$x_{cm} = \frac{m_1x_1 + m_2x_2 + \cdots + m_nx_n}{m_1+m_2+\cdots+m_n} = \frac{\sum_{i=1}^{N} m_ix_i}{M}$$

If we want to describe the above equation in 3-d space, then centre of mass about origin can be denoted with the help of coordinate (x, y, z)

i.e. $x_{cm} = \sum_{i=1}^{N} \frac{m_ix_i}{M}$

$y_{cm} = \sum_{i=1}^{N} \frac{m_iy_i}{M}$

$z_{cm} = \sum_{i=1}^{N} \frac{m_iz_i}{M}$

All these 3 equation can be combine using vector notation r,

i.e $r_{cm} = x_{cm}\hat{i} + y_{cm}\hat{j} + z_{cm}\hat{k}$

If there are large number of particles present, which are uniformly distibuted along centre of mass, then we can use $\int$ for the Σ.

$$\boxed{r_{cm} = \frac{\int m_i r_i}{\int dm} = \frac{\int m_i r_i}{M} \quad \text{--- (iii)}}$$

So, Let consider 'n' no. of particles present having mass $m_1, m_2, m_3 \ldots m_n$, here no particle can leave the system, i.e Mass is constant here.

From (ii) we can write,

$$\therefore M r_{cm} = m_1 r_1 + m_2 r_2 + m_3 r_3 \ldots + m_n r_n$$

From eqn (ii)

~~but~~ if we differentiate the above equation we get

$$M \cdot \frac{dr}{dt} = m_1 \frac{dr_1}{dt} + \ldots + m_n \frac{dr_n}{dt}$$

but $\frac{dr}{dt} = v$

$$M \cdot v_{cm} = m_1 v_1 + \ldots + m_n v_n$$

again if we differentiate we get

$$M \cdot \frac{dv}{dt} = m_1 \frac{dv_1}{dt} + m_2 \frac{dv_2}{dt} \ldots + m_n \frac{dv_n}{dt}$$

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Roll No. : 7223	Test / Tutorial No. :
Class : BSC I	Div. :

Q2. $\frac{dv}{dt} = a$

So we can write equation of

$m \cdot a = m_1 a_1 + m_2 a_2 + \cdots m_n a_n$

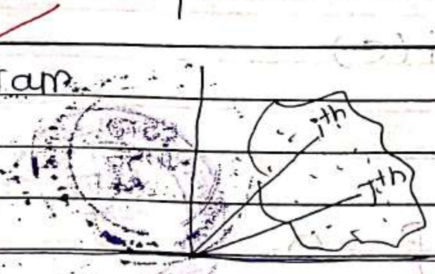
From using Newton second equation

$m \cdot a = F$

But here force is external because, internal force is cancel, because they are equal and opposite in the direction.

Q3) Statement : If force acting on system of particles is zero, then linear momentum of system of particles is conserved.

Diagram



Let consider, there are N number of particles consider the ith particle of the system

Force acting on i^{th} particle can be written as

$$F_i = F_i(e) + \sum_{J=1}^{N} F_{ij} \quad \text{---} (1)$$

$F_i(e)$ external force, $\sum F_{ij}$ internal force. F_{ij} which acts on the i^{th} particle.

$$\boxed{F_i = \frac{dp_i}{dt}} \text{ — [Newtons second law of motion.]}$$

eqn (1) becomes

$$\frac{dp_i}{dt} = F_i(e) + \sum_{J=1}^{N} F_{iJ} \longrightarrow \text{For } i^{th} \text{ particle}$$

For whole system take summation on the both side.

$$\sum \frac{dp_i}{dt} = \sum_{i=1}^{N} F_i(e) + \sum_{i=1}^{N} \sum_{J=1}^{N} F_{ij}$$

$$= \sum_{i=1}^{N} \frac{dp_i}{dt} = \sum_{i=1}^{N} F_i(e) + \sum_{i,J}^{N} F_{iJ}$$

here F_{iJ} become zero because, if force act on i^{th} then i^{th} particle also act on the other particle i.e they all are equal and opposite, so all internal force get cancel.

$$\sum_{i=1}^{N} \frac{dp_i}{dt} = \sum_{i=1}^{N} F_i(e)$$

$$= \frac{dP}{dt} = F_i(e)$$

if $F_i(e) = 0$ then $\frac{dP}{dt} = 0$

hence $P =$ constant.

4

hence linear momentum is conserved for system of Particles.

Name :- Harshvardhan. M. Kate

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Signature of Supervisor	
Subject : Physics	
Test / Tutorial No. :	
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Suppliment No. :

Roll No. : 7206

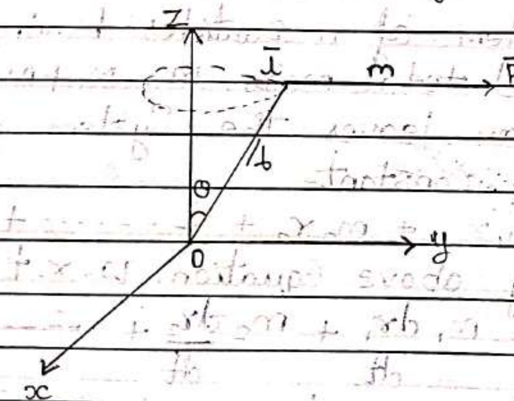
Class :

$\frac{10}{10}$

Q1] 1] Angular momentum is conserved when there is Zero net torque applied to a System.

2] The energy conservation theorem States that total energy of a particle in a Conservative force feild is constant.

Q2] 1]



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Consider a particle moving with mass 'm' with torque τ. let $\bar{P}$ be the linear momentum of the particle and $\bar{r}$ be its position vector.

$\therefore$ ~~The~~ $\bar{L} = \bar{r} \times \bar{p}$ —— ①

But τ is perpendicular to a plane $\bar{r}$ and $\bar{p}$

$|\bar{L}| = rp \sin\theta$ —— where $r \sin\theta$ is component $\bar{r}$ which

$= pr \sin\theta$ is $\perp^{ar}$ to $\bar{P}$

$\therefore$ For Single particle $\therefore \bar{F} = \frac{d\bar{P}}{dt}$ —— ②

Differeniating eq^n (1) with respect to time.

$$\frac{d\bar{L}}{dt} = \bar{r} \times \frac{d\bar{p}}{dt} + \bar{p} \times \frac{d\bar{r}}{dt}$$

$$= \bar{r} \times \frac{d\bar{p}}{dt} + m\bar{v} \times \bar{v}$$

$$= \bar{r} \times \frac{d\bar{p}}{dt} + 0$$

$$= \bar{r} \times \frac{d\bar{p}}{dt} \quad \text{--- (3)}$$

$\therefore$ After comparing eq^n (2) & (3)

$$\frac{d\bar{L}}{dt} = 0$$

The rate of change of momentum is equal to the torque acting on it.

If net torque acting on a particle is zero then $\frac{d\bar{L}}{dt} = 0$

$\therefore$ The angular momentum of a particle is conserved.

2] $\rightarrow$ Consider a system of n particles having masses $m_1, m_2, \ldots, m_n$ and total mass $M = M_1 + M_2 + \ldots + M_n$

No particle enters or leaves the system as the total mass of system is constant.

$$\therefore r_{cm} = m_1 r_1 + m_2 r_2 + \ldots + m_n r_n$$

Differeniating above equation w.r.t time

$$\frac{dr_{cm}}{dt} = m_1 \frac{dr_1}{dt} + m_2 \frac{dr_2}{dt} + \ldots + m_n \frac{dr_n}{dt}$$

But $v_{cm} = \frac{dr_{cm}}{dt}$ = velocity of centre of mass

$$v_{cm} = m_1 v_1 + m_2 v_2 + \ldots + m_n v_n$$

Again differeniating with respect to time

$$\frac{dv_{cm}}{dt} = m_1 \frac{dv_1}{dt} + m_2 \frac{dv_2}{dt} + \ldots + m_n \frac{dv_n}{dt}$$

But $a_{cm} = \frac{dv_{cm}}{dt}$

$\therefore a_{cm} = m_1 a_1 + m_2 a_2 + \ldots + m_n a_n$

There are two internal forces acting on a particle internal as well as external. But internal forces are equal and opposite so they cancel. There exists only external force on a particle.

Acc to newton's second law

$$F = F_{ext}$$
$$= F_1 + F_2 + \ldots + F_n$$

3 ~~Thus the total energy of mass centre of mass is the mass of~~

3] Consider a system of n particles having masses $m_1, m_2, \ldots m_n$ & velocity $v_1, v_2, \ldots v_n$. Assume that no. of particles enters and leaves the system so that total part of the system is constant.

The total mass of a system is vector sum of individual particle. ~~ie~~

$$F = F_{ext}$$
$$= F_1 + F_2 + \ldots + F_n$$

Let $\bar{P}_1, \bar{P}_2, \ldots \bar{P}_n$ be the linear momentum of a system of particle where $P = mV$

The total momentum of ~~parti~~ system particle is given as

$$\bar{P} = \bar{P}_1 + \bar{P}_2 + \ldots + \bar{P}_n$$
$$mV = m_1 V_1 + m_2 V_2 + \ldots + m_n V_n$$

According to newton's second law

4

$$F = ma$$
$$= m \frac{dv}{dt}$$
$$F = \frac{d\bar{P}}{dt}$$

$\therefore$ If the net force acting on the system of particle is zero then $\frac{d\bar{P}}{dt} = 0$

$$\therefore P = \text{constant}$$

∴ The vector sum of moment of all particles in a System remains constant if the resultant force acting on System is Zero.

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Roll No. : 7218	Test / Tutorial No. :
Class : BSc. FY	Div. :

09/10

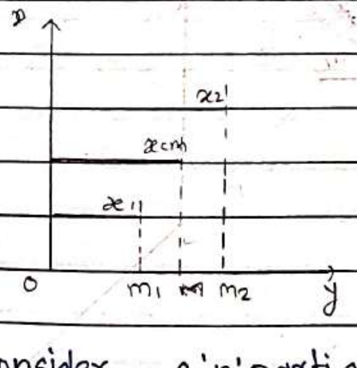
Q.1.

1) a) zero.

2) b) constant.

Q.2.

2) a)



We have, in fig.

$(m_1+m_2)x_{cm} = m_1x_1 + \cancel{x_2} m_2x_2$

$x_{cm} = \frac{m_1x_1 + \cancel{x_2}\, m_2x_2}{m_1+m_2}$

Consider, a 'n' particles of masses $m_1, m_2, m_3 \ldots m_n$ having total mass $M = m_1+m_2+m_3 \ldots + m_n$

Def^n:-

"Centre of mass is a point where the ~~wei~~ mass of whole body is concentrated."

$\therefore M = m_1 + m_2 + m_3 \dots m_n$ with r

$\therefore$ ~~the vector~~

$M = m_1\bar{r}_1 + m_2\bar{r}_2 + m_3\bar{r}_3 + \dots + m_n\bar{r}_n$

differentiating with time

$M = m_1 \frac{d\vec{r}_1}{dt} + m_2 \frac{d\bar{r}_2}{dt} + m_3 \frac{d\bar{r}_3}{dt} \dots + m_n \frac{d\bar{r}_n}{dt}$

$\therefore M = \frac{\sum m_i r_i}{\sum m_i}$

3

$\int r_{cm}$

3)
→ Consider 'n' no. of particles in a system with linear moment $\bar{P}$.

$\therefore \bar{P} = \bar{P}_1 + P_2, P_3$

m is the mass & v be the velocity of those particles.

We have,

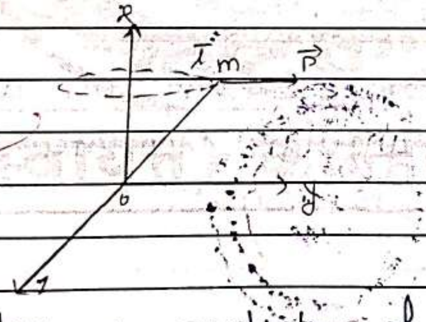
$$\bar{P} = \bar{m} \times \bar{v}$$

- If the external force acting on a system is zero, then the linear momentum said to be conserved.

- If external force is zero,

$$\therefore \vec{p} \quad \frac{d\vec{P}}{dt} = 0$$

$$\therefore \bar{p} = \text{constant.}$$

1)
→ 

Consider a particle of mass 'm' rotating about it's axis with Torque 'T'.

$\vec{P}$ be the linear momentum & $\vec{r}$ be the radius of its rotation.

We know,

$$\vec{P} = m\vec{v}$$

$\vec{L}$ is the angular momentum of the particle

$$\therefore \vec{L} = \vec{P} \times \vec{r} \quad \text{—(1)}$$

$\vec{L} = pr \sin\theta$

where, ~~p~~ $r\sin\theta$ is a component of r.

~~We take~~ ~~force~~ torque ~~of one~~ particle,

Diff. eqn ① with t

$$\frac{d\vec{L}}{dt} = r\left(\frac{d\vec{P}}{dt}\right) + \left(\frac{d\vec{r}}{dt}\right)\vec{p}$$

$$\frac{d\vec{l}}{dt} = \vec{r} \times \frac{d\bar{P}}{dt} + \vec{p} \times \overline{m}\vec{v}$$

$$\frac{d\vec{l}}{dt} = \bar{r} \times \frac{d\bar{P}}{dt} \qquad [\because \overline{m}\bar{v} = 0]$$

Therefore, i) angular momentum of a particle in a system is equal to the torque.

ii) If the torque acting on particle is zero, then $\frac{d\bar{l}}{dt} = 0$

$\therefore$ $\bar{l}$ = constanst.

iii) If the torque acting on a particle is zero, then the angular momentum of a particle inof a system is conserved.

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