Department of Physics

Vivekanand College, Kolhapur (Autonomous)

Notice for Internal Examination in Physics for B.Sc. III

It is hereby informed that; students of B.Sc. III should note that their Internal Examination in Physics will be conducted as per following time table.

Date	Time	Class	Subject
Tuesday, 22/11/2022	02.30 to 03.30 PM	B.Sc. III	Paper V section I (Classical Mechanics)
Wednesday, 23/11/2022	02.30 to 03.30 PM		Paper V section II (Quantum Mechanics)
Thursday, 24/11/2022	02.30 to 03.30 PM		Paper VI section I (Nuclear and Particle Physics)
Friday, 25/11/2022	02.30 to 03.30 PM		Paper VI section II (Mathematical Physics)

Nature of Question Paper

Q.1) Select correct alternative (5 Marks)
Q.2) Long answer type question (10 Marks, Attempt any One)
Q.3) Short answer type question (5 Marks, Attempt any One)
Total Marks: 20 Marks

VIVEKANAND COLLEGE ESTD JUNE 1964 KOLHAPUR - 416003

HOD, Physics
Head of the
Department of Physics
Vivekanand College, Kolhapur

"Dissemination of Education for Knowledge, Science and Culture"
- Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(Autonomous)

Department of Physics

Internal exam (2022-23)

B.Sc.III Sem V

Attendance Sheet

Roll No.	Name Of The Student	Signature			
		22/11/2022	23/11/2022	24/11/2022	25/11/2022
8201	Bhingardeve Dhiraj Prakash	Dheeraj	Dheeraj	Dheeraj	Dheeraj
8202	Dongare Prathamesh Abaji	PADongare	PADongare	PADongare	PADongare
8203	Dongare Suyash Sanjay	Dongare	Dongare	Dongare	Dongare
8204	Gaikwad Rajnandini Ganesh	ggaikwad	ggaikwad	ggaikwad	ggaikwad
8205	Jadhav Saee Sandeep	Saii	Saii	Saii	Saii
8206	Jamadar Mahek Shakilahmed	Mehek	Mehek	Mehek	Mehek
8207	Kalkutki Shubham Babasaheb	Kalkutki	Kalkutki	Kalkutki	Kalkutki
8208	Kamble Anjali Bhagwan	Anjali	Anjali	Anjali	Anjali
8209	Kothawale Tejas Vikas	Alonee	Alonee	Aloner	Aloner
8210	Maner Aman Imtiyaj	Amanee	Amanee	Amanee	Amanee
8211	Padmakar Alok Narayan	AVTejas	AVTejas	AVTejas	AVTejas
8212	Patil Aaryan Pramod	aaryan	aaryan	aaryan	aaryan
8213	Shinde Vivek Janardan	Shinde	Shinde	Shinde	Shinde
8214	Shingade Aishwarya Deepak	Singh	Singh	Singh	Singh
8215	Singh Sapana Raviranjan	Sarke	Sarke	Sarke	Sarke
8216	Warke Shriyash Keraba	Warke	Warke	Warke	Warke
8217	Yadav Vedaja Ajay	Y.A. Yadhav	Y.A. Yadhav	Y.A. Yadhav	Y.A. Yadhav

Internal Examinar ....

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964 (Autonomous)

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001E

B.Sc. – III, Sem – V Classical Mechanics

Time: 30 Minutes

Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

1) Derive Lagrange,s equation from D'alembert's principle.

OR

1) What do you mean by constraints. Explain its types.

Q. 2. SHORT Answer Questions **(10)**

1) Write a note on at Atwood's Machine.
2) Write a note on degrees of freedom.

Department :- Physics.

GOODLUCK Page No.
Date / /

Name :- Dhanashree Ananda Raval.
Class :- Bsc - III Div :- C Roll No :- 8208
Sem :- I.

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INTERNAL EXAM
VIVEKANDA COLLEGE, KOLHAPUR.

Q.1. Answer the following questions.

1. Explain analogy of rotational motion with transtational motion.

→ i) It is noticed that there is an anology between various physical quantities in rotational and transiational motion

ii) In the rotational motion about a fixed axis, the moment of a Inrtia (I) is the analogy the mass is the linear motion is the mesure of inttia of the body.

iii) Therfore moment of inrtia is also regateded as the ttansiatory motion.

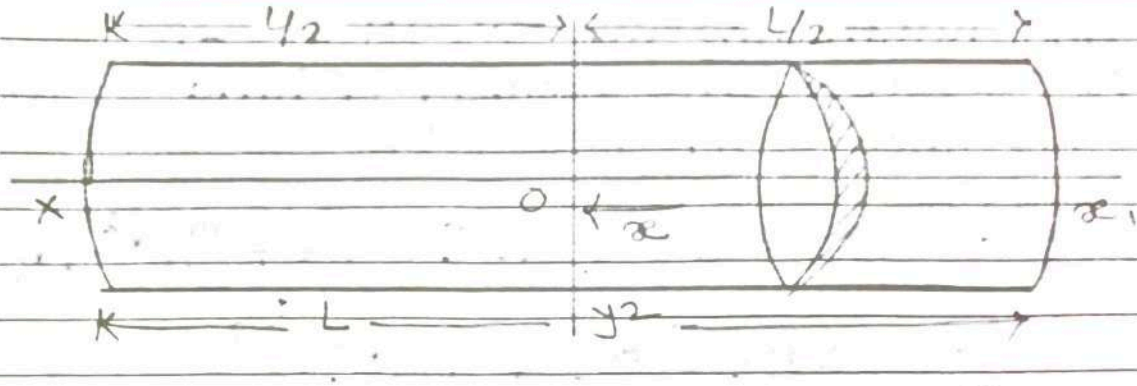
v) In case of translatory motion the inrtia of the body depends totally upon its upon mass but in case of rotational mostion the moment of inrtia of the body not only depends on the mass of the body but also on distribution of mass about the given axis of rotation.

vi) The anology between various Physical quantities in two types of motion.

Sr. No.	Translational Motion.	Rotional motion.
1.	Mass = m	Mament of inertia = I
2.	Displacement = s at x	Angular displace ment = θ
3.	velocity = v	Angular velocity
4.	Acceleration = a	Angular Accele -ration = α
5.	Force = F = ma	Torque = T = Iα
6.	linear momen tum	Angular momentum L = Iω
7.	Kinetic energy $\frac{1}{2} mv^2$	Rotational K.E = $\frac{1}{2}$ Iω
8.	Work done = F.s	Work done = I.θ

2) Derive an expression for M.I of a solid Cyilnder its axis of symmetry.

1) Let M be the mass, R be the radius and L be length of solid cylider.



2) The mas per unit length of the solid cylinder M/L. Let YY' be the axix passing through is O. and perpendicular to its awn axix XX' as

Fig.

3) To find its moment of inertia imagine that the Cylirutc to the made up of large number thin discs i.et thickness of the disc in let us casnisder one of such disc at a distance x Ftam O the thikness of the disc is dx ahvousty mass of the disc is $(M/L)\,dx$.

4) Therefor, moment of inrtia of the disc about is diameter mass dine $x = \frac{(\text{radius})^2}{4}$

$$= \frac{m}{L}\,dx \cdot \frac{R^2}{4}$$

5) According to the principle of parallel axix a moment of intriti of the disc about the axis $YY' = \frac{m}{L}\,dx\,\frac{R^2}{4} + \frac{m}{L}\,dx \cdot x^2$

6) The moment of inertia of the whole cylide about ut the axis yy' Can be abtained by integmeting the above equati between the limits $x = 0$ $a = 1/2$

and multiplying the result by 2.

7) Therefore the moment of intia of the cylinder about the axis YY' is.

$$I = \int dI = 2\int_0^{l/2}\left(\frac{m}{L}\frac{R}{4}^4 dx + \frac{m}{L}x^2 dx\right)$$

$$= \frac{2m}{L}\left[\frac{R^4}{4}x + \frac{x^3}{3}\right]_0^{L/2}$$

$$= \frac{2m}{L}\left[\frac{R^4}{4}\cdot\frac{1}{2} + \frac{L^3}{8\times 3}\right]$$

$$= \frac{2m}{L}\left[\frac{R^4 . L}{8} + \frac{L^3}{24}\right]$$

$$I = m\left[\frac{R^4}{4} + \frac{L^2}{12}\right]$$

This is the required expression.

Name - Yogita Vasant Sutar
Class - BSC III
Sem - 1 ROLL NO - 8206

INTERNAL EXAM
VIVEKANAND COLLOEGE, KOLAPUR.

Answer the following question.

1) Explan anology of ratational motion with transtional motion.

→ i) It is noticed that there is an anology between various physical quantities in ratational and translinal motion

ii) In ration motion about a fixed axis the moment of Inertia (I) is analogy to the mass (m) in linear motion But mass is the Inetia of the body.

iii) therfore moment of linear is also regrded as the hationan inerta.

iv) The moment of inecla of the body in case of ratational motion plays the same role as the mass of the body in traslatory motion

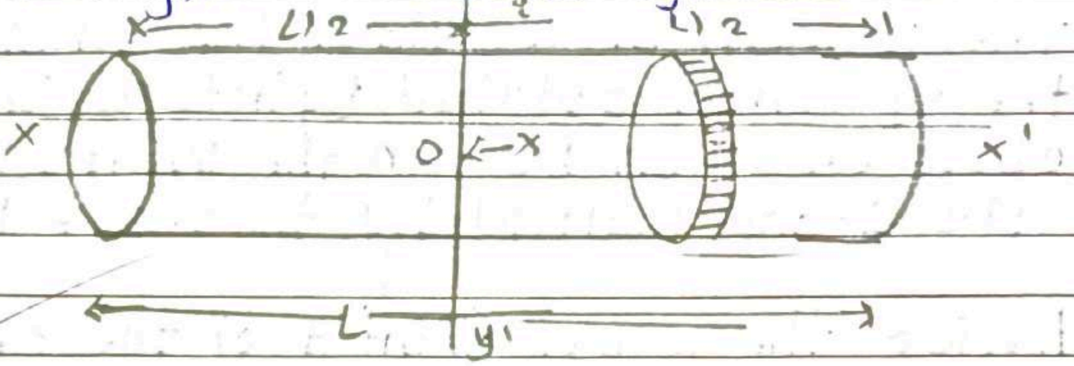
v) In case of translatory motion motion the inecta of the body depend totally upon its mass but in case of ratational motion the moment of only depend on the mass of the mass of the body but also on distribution of mass about the given axis of rotation

vi) The analogy between various physical quantities in two type of motion.

Sr. No	Translational Motion.	Rotational Motion.
1.	Mass = m	moment of Inertia = I
2.	Displacement = S. or x	Angular displacement
3.	velocity = v	Angular Velocity = ω
4.	Acceleration = a	Angular Accertion = α
5.	Force = F = ma	Torque = τ = $I\alpha$
6	linear momentum = p = mv	Angular momentum = L = $I\omega$
7	Kinetic energy $\frac{1}{2} mv^2$	Rotation K.E = $\frac{1}{2} I\omega$
8	Work done = F.S.	Work done = $I.\theta$

2) Decive an expression for M.I of a Said Cyllinder about its axis symmetry

→ i) let M be the mass R. be the radius and L be the length of the soild cylineder.



2) the mass of per unit length of the Soild cylinder is M/L let YY' be the azeis passing througth its centre aand perpendiculae in ts own azeis XX' as shown in Fig

3) To find its moment of inectia imagin that the cylinder to be mode up of large number of thin discs let us consider on of such disc at distance x from a the thickness of the disc is is dxcs is $(M/L)\ dx$

4) theefrove moment of inectia of the disc about its dismeter = mass of disc × $\frac{(\text{radius})^2}{4}$

$$= \frac{m}{l} \cdot dx \cdot \frac{R^2}{4}$$

5) According to the priciple of parallel axis a.

momet of inertia of the disc about the axis $YY' = \frac{m}{l} dx \cdot \frac{R^2}{4} + \frac{m}{l} dx \cdot x^2$

6) The moment of inertia of the whole cylinder the yy' can be obtained by integration the and above equation between the limits x= 0 to l/2 & and multiplying the result by 2.

7) therefore the momet of intria of the cyllinder about the axis yy' is

$$I = \int dI = 2\int_0^{l/2} \left(m/l \, R^4/4 \, dx + m/l \, x^2 dx \right)$$

$$= 2\frac{m}{l} \left[\frac{R^4}{4} x + \frac{x^3}{3} \right]^{l/2}$$

$$= 2\frac{m}{l} \left[\frac{R^4}{4} \cdot \frac{l}{2} + \frac{l^3}{3\times 3} \right]$$

$$= 2\frac{m}{l} \left[\frac{R^4 \cdot l}{8} + \frac{l^3}{24} \right]$$

$$I = m \left[\frac{R^4}{4} + \frac{l^2}{12} \right]$$

This is the required expression

Name - Madhavi Dhondiram Shingare. Department - Physics.
Class - BSC.III Div - B. Roll No - ~~7859~~ 8203
Sem - V

INTERNAL EXAM

VIVEKANAND COLLOEGE, KOLAPUR

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Q.1. Write the correct alternatives.

1) Mass is the measure of inertia in linear motion.

2) Acceleration of a body rolling down in an inclined plane is independent of mass of the body.

3) Force in rotational motion is analogus to torque in translational motion.

4) Moment of inertia of a spherical shell about its diameter is $\frac{2}{3} mR^2$

Q.2. Answer the following questions.

1) Explain analogy of rotational motion with translational motion.

→ i) It is noticed that there is an analogy between various physical quantities in rotational and translational motion.
ii) In rotational motion about a fixed axis, the moment of inertia (I) is analogus to the mass (m) in linear motion. But mass is the linear motion is the measure of inertia of the body.
iii) Therefore moment of inertia is also regarded as the rotational inertia.
iv) The moment of inertia of the body in case of rotational motion plays the same role as the mass of the body in translatory motion.
v) In case of translatory motion motion, the inertia of the body depends totally upon its mass, but in case of rotational motion the moment of Inertia of the body ~~not onto~~ only depends on the mass of the body but also on distribution of mass about the given axis

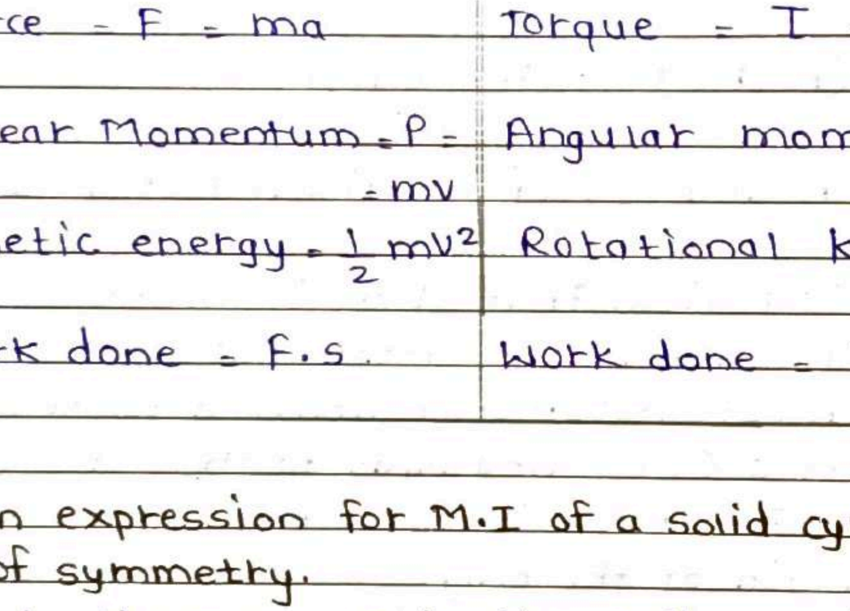
of rotation.

vi) The analogy between various physical quantities in two types of motion

Sr. No.	Translational Motion.	Rotational Motion.
1.	Mass = m	Moment of Inertia = I
2.	Displacement = S or x	Angular displacement = θ
3.	Velocity = V	Angular velocity = ω
4.	Accelaration = a	Angular Accelaration = α
5.	Force = F = ma	Torque = τ = $I\alpha$
6.	Linear Momentum = P = mv	Angular momentum = L = $I\omega$
7.	Kinetic energy = $\frac{1}{2}mv^2$	Rotational K.E = $\frac{1}{2}I\omega^2$
8.	Work done = F.S	Work done = $\tau \cdot \theta$

2) Derive an expression for M.I of a solid cylinder about its axis of symmetry.

1) Let M be the mass, R be the radius and L be the length of the solid cylinder.



2) The mass per unit length of the solid cylinder is M/L. Let YY' be the axis passing through its centre O and perpendicular to its own axis XX' as shown in

fig.

3) To find its moment of inertia, imagine that the cylinder to be made up of large number of thin discs. Let us consider one of such disc at a distance x from o. The thickness of the disc is dx. obviously, mass of the disc is $(M/L)\,dx$.

4) Therefore, moment of inertia of the disc about its diameter $=$ mass of disc $\times \frac{(\text{radius})^2}{4}$

$$= \frac{m}{L}\,dx \cdot \frac{R^2}{4}$$

4) According to the principle of parallel axis, a moment of inertia of the disc about the axis $YY' = \frac{m}{L}\,dx\,\frac{R^2}{4} + \frac{m}{L}\,dx \cdot x^2$

5) The moment of inertia of the whole cylinder about the axis yy' can be obtained by integrating the above equation between the limits $x = 0$ to $L/2$ and multiplying the result by 2

6) Therefore, the moment of inertia of the cylinder about the axis yy' is,

$$I = \int dI = 2\int_0^{l/2} \left(m/_L\, R^4/_4\, dx + m/_L\, x^2\, dx \right)$$

$$= 2\,\frac{m}{L}\left[\frac{R^4}{4}x + \frac{x^3}{3}\right]_0^{L/2}$$

$$= 2\,\frac{m}{L}\left[\frac{R^4}{4}\cdot\frac{L}{2} + \frac{L^3}{8\times 3}\right]$$

$$= 2\,\frac{m}{L}\left[\frac{R^4 \cdot L}{8} + \frac{L^3}{24}\right]$$

$$I = m\left[\frac{R^4}{4} + \frac{L^2}{12}\right]$$

This is the required expression.

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001E

B.Sc. – III, Sem – V Quantum Mechanics

Time: 30 Minutes Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

i) Obtain Schrodinger , s time independent equation and time dependent equation

ii) Using cartesian components of operators L_x , L_y & L_z prove that $[L_x, L_y] = i\hbar L_z$ &

$[L^2, L_x] = 0$

Q. 2. SHORT Answer Questions (any two) **(10)**

i) Show that $[x, P_x] = i\hbar$ give its physical significance

ii) Give physical significance of wave function

iii) Obtain Schrodingers equation in spherical polar coordinate system for hydrogen atom

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

34605

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

16/20

Signature of Supervisor

Suppliment No. :

Subject : Quantum Mechanics

Roll No. : 8214

Test / Tutorial No. :

Class : B.Sc III, Sem-V

Div. :

Q.2)

1) $[x, P_x]\psi = [x, -i\hbar \frac{\partial}{\partial x}]\psi$

$= -i\hbar\ [x, \partial/\partial x]\psi$

$= -i\hbar \left(x \cdot \frac{\partial}{\partial x} - \frac{\partial}{\partial x} \cdot x\right)\psi$

$= -i\hbar \left\{x \cdot \frac{\partial \psi}{\partial x} - \frac{\partial}{\partial x}(x\psi)\right\}$

$= -i\hbar \left\{x \cdot \frac{\partial \psi}{\partial x} - x\frac{\partial \psi}{\partial x} - \psi\right\}$

$= -i\hbar(-\psi)$

$[x, P_x]\psi = i\hbar\psi$

$[x, P_x] = i\hbar$

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ESTD JUNE 1964 VIVEKANAND COLLEGE KOLHAPUR (Autonomous)

2> Physical Significance of wave function-

i> ψ must be finite for all values of x, y & z.

ii> ψ must be single valued i.e for each set of values of x, y & z ψ must have only one value.

iii> ψ must be continuous in all regions exept in those regions where the potential energy $V(x,y,z) = \infty$

iv> ψ must vanish at infinity i.e. $\psi = 0$ as $x \to \pm\infty$ $y \to \pm\infty$ or $z \to \pm\infty$.

v> The potential derivatives of ψ i.e. $\frac{\partial\psi}{\partial x}, \frac{\partial\psi}{\partial y}, \frac{\partial\psi}{\partial z}$ must also be finite, single-valued and Continuous at all points except at points where the potential $V(x)$ is infinite.

Q. 1) 2)

(i) The orbital angular momentum is defined as,

$$L = r \times p$$

where, p represents momentum of body and r is the position vector of a body from the axis of rotation.

The components of momentum x, y, z in cartesian co-ordinates will be

$$\left.\begin{aligned} L_x &= -i\hbar\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right) \\ L_y &= -i\hbar\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right) \\ L_z &= -i\hbar\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right) \end{aligned}\right\} \quad (1)$$

Let us write the communication relation $[L_x L_y]$ as,

$$[L_x, L_y] = L_x L_y - L_y L_x$$

Substituting operator values we get,

$$L_x L_y = -i\hbar\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)(-i\hbar)\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)$$

$$= -\hbar^2\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)$$

$$= -\hbar^2\left[y\frac{\partial}{\partial z}\left(z\frac{\partial}{\partial x}\right) - y\frac{\partial}{\partial z}\left(x\frac{\partial}{\partial z}\right) - z\frac{\partial}{\partial y}\left(z\frac{\partial}{\partial x}\right) + z\frac{\partial}{\partial y}\left(x\frac{\partial}{\partial z}\right)\right]$$

$$= -\hbar^2\left[yz\frac{\partial^2}{\partial z\partial x} + 0 + y\frac{\partial}{\partial x} - yx\frac{\partial^2}{\partial z^2} - 0 - z^2\frac{\partial^2}{\partial y\partial x} - 0 + zx\frac{\partial^2}{\partial y\partial z} + 0\right]$$

$$= -\hbar^2\left\{\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)\right\}$$

$$= -\hbar^2 \left\{ z\frac{\partial}{\partial x}\left(y\frac{\partial}{\partial z}\right) - z\frac{\partial}{\partial x}\left(z\frac{\partial}{\partial y}\right) - x\frac{\partial}{\partial z}\left(y\frac{\partial}{\partial z}\right) + x\frac{\partial}{\partial z}\left(z\frac{\partial}{\partial y}\right)\right\}$$

$$= -\hbar^2 \left\{ zy\frac{\partial z}{\partial x\partial z} + 0 - \frac{z^2\partial 2}{\partial x\partial y} - 0 - xy\frac{\partial^2}{\partial z^2} - 0 + xz\frac{\partial^2}{\partial z\partial y} + x\frac{\partial}{\partial y}\right\}$$

$$= -\hbar^2 \left\{ zy\frac{\partial^2}{\partial x\partial z} - z^2\frac{\partial^2}{\partial x\partial y} - xy\frac{\partial^2}{\partial z^2} + xz\frac{\partial^2}{\partial z\partial y} + x\frac{\partial}{\partial y}\right\}$$

On substracting above two relations we get,

$$[L_x L_y] = \hbar^2 \left\{\left(yz\frac{\partial^2}{\partial z\partial x} + y\frac{\partial}{\partial x} - yx\frac{\partial^2}{\partial z^2} - z^2\frac{\partial^2}{\partial y\partial x} + zx\frac{\partial^2}{\partial y\partial z}\right) - \left(zy\frac{\partial^2}{\partial x\partial z} - z^2\frac{\partial^2}{\partial x\partial y} xy\frac{\partial^2}{\partial z^2} + xz\frac{\partial^2}{\partial z\partial y} + x\frac{\partial}{\partial y}\right)\right\}$$

$$= -\hbar^2\left(y\frac{\partial}{\partial x} - x\frac{\partial}{\partial y}\right)$$

$$= -\hbar^2\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right)$$

$$= i\hbar(-i\hbar)\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right)$$

$$[L_x L_y] = i\hbar L_z$$

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

34602

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

$\frac{18}{20}$

Suppliment No. :

Subject : Quantum Mechanics

Roll No. : 8201

Test / Tutorial No. :

Class : BSc-III, Sem-V

Div. :

Q.1)

2) (1) The orbital angular momentum is defined as,

$$L = r \times p$$

where p represents momentum of body and r is the position vector of a body from the axis of rotation.

The components of momentum x, y, z in cartesian co-ordinates will be.

$$L_x = -i\hbar\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right) \quad \text{—— (1)}$$

$$L_y = -i\hbar\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)$$

$$L_z = -i\hbar\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right)$$

Let us write the communication relation $[L_x L_y]$ as

$$[L_x L_y] = L_xL_y - L_yL_x$$

Substituting operator values we get

$$L_xL_y = -i\hbar\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)(-i\hbar)\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)$$

$$= -\hbar^2\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)$$

$$= -\hbar^2\left[y\frac{\partial}{\partial z}\left(z\frac{\partial}{\partial x}\right) - y\frac{\partial}{\partial z}\left(x\frac{\partial}{\partial z}\right) - z\frac{\partial}{\partial y}\left(z\frac{\partial}{\partial x}\right) + z\frac{\partial}{\partial y}\left(x\frac{\partial}{\partial z}\right)\right]$$

$$= -\hbar^2\left[yz\frac{\partial^2}{\partial z\partial x} + 0 + y\frac{\partial}{\partial x} - yx\frac{\partial^2}{\partial z^2} - 0 - z^2\frac{\partial^2}{\partial y\partial x} - 0 + zx\frac{\partial^2}{\partial y\partial z} + 0\right]$$

$$= -\hbar^2\left\{\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)\right\}$$

$$= -\hbar^2\left\{ z\frac{\partial}{\partial x}\left(y\frac{\partial}{\partial z}\right) - z\frac{\partial}{\partial x}\left(z\frac{\partial}{\partial y}\right) - x\frac{\partial}{\partial z}\left(y\frac{\partial}{\partial z}\right) + x\frac{\partial}{\partial z}\left(z\frac{\partial}{\partial y}\right)\right\}$$

$$= -\hbar^2\left\{ zy\frac{\partial^2}{\partial x\partial z} + 0 - z^2\frac{\partial^2}{\partial x\partial y} - 0 - xy\frac{\partial^2}{\partial z^2} - 0 + xz\frac{\partial^2}{\partial z\partial y} + x\frac{\partial}{\partial y}\right\}$$

$$= \hbar^2\left\{ zy\frac{\partial^2}{\partial x\partial z} - z^2\frac{\partial^2}{\partial x\partial y} - xy\frac{\partial^2}{\partial z^2} + \cancel{xy}\, xz\frac{\partial^2}{\partial z\partial y} + x\frac{\partial}{\partial y}\right]$$

On subtracting above two relations we get,

$$[L_x, L_y] = \hbar^2\left\{\left(yz\frac{\partial^2}{\partial z\partial x} + y\frac{\partial}{\partial x} - yx\frac{\partial^2}{\partial z^2} - z^2\frac{\partial^2}{\partial y\partial x} + zx\frac{\partial^2}{\partial y\partial z}\right) - \left(zy\frac{\partial^2}{\partial x\partial z} - z^2\frac{\partial^2}{\partial x\partial y} - xy\frac{\partial^2}{\partial z^2} + xz\frac{\partial^2}{\partial z\partial y} + x\frac{\partial}{\partial y}\right)\right\}$$

$$= -\hbar^2 \left(y \frac{\partial}{\partial x} - x \frac{\partial}{\partial y} \right)$$

10

$$= \hbar^2 \left(x \frac{\partial}{\partial y} - y \frac{\partial}{\partial x} \right)$$

$$= i\hbar(-i\hbar) \left(x \frac{\partial}{\partial y} - y \frac{\partial}{\partial x} \right)$$

$$[L_x, L_y] = i\hbar L_z$$

(iii) The total angular momentum is defined by the relation

$$L^2 = L_x^2 + L_y^2 + L_z^2$$

Let us take,

$$[L^2, L_x] = [L_x^2 + L_y^2 + L_z^2, L_x]$$

$$= [L_x^2 + L_y^2 + L_z^2] L_x - L_x [L_x^2 + L_y^2 + L_z^2]$$

$$= L_x^2 L_x + L_y^2 L_x + L_z^2 L_x - (L_x L_x^2 + L_x L_y^2 + L_x L_z^2)$$

$$= (L_y^2 L_x - L_x L_y^2) + (L_z^2 L_x - L_x L_z^2)$$

$$= [L_y^2, L_x] + [L_z^2, L_x]$$

we know that,

$$[ab, c] = a[b, c] + [a, c] b$$

$$[L^2, L_x] = [L_y L_y, L_x] + [L_z L_z, L_x]$$

$$= L_y [L_y, L_x] + [L_y, L_x] L_y + L_z [L_z, L_x] + [L_z, L_x] L_z$$

$$= (-i\hbar L_z) L_y - (i\hbar L_z) L_y + i\hbar L_y L_z + i\hbar L_y L_z$$

$$[L^2 L_x] = 0$$

Q.2) i) $[x, P_x]\psi = [x, -i\hbar\, \partial/\partial x]\psi$

$= -i\hbar\, [x, \partial/\partial x]\psi$

$= -i\hbar \left(x \frac{\partial}{\partial x} - \frac{\partial}{\partial x} x\right)\psi$

$= -i\hbar \left\{ x \frac{\partial \psi}{\partial x} - \frac{\partial}{\partial x}(x\psi) \right\}$

$= -i\hbar \left\{ x \frac{\partial \psi}{\partial x} - x \frac{\partial \psi}{\partial x} - \psi \right\}$

$= -i\hbar(-\psi)$

$[x, P_x]\psi = i\hbar\psi$

$[x, P_x] = i\hbar$

4

Q.2) ii) Physical significance of wave function-

1) Ψ must be finite for all values of x, y & z

2) Ψ must be single valued i.e. for each set of values of x, y & z. ψ must have only one value.

3) ψ must be continuous in all regions, except in those regions where the potential energy $V(x, y, z) = \infty$

4) ψ must vanish at infinity i.e. $\Psi = 0$ as $x \to \pm\infty$ $y \to \pm\infty$ or $z \to \pm\infty$.

4

5) The partial derivatives of ψ. i.e. $\frac{\partial \psi}{\partial x}, \frac{\partial \psi}{\partial y}, \frac{\partial \psi}{\partial z}$ must also be finite, single-valued and continuous at all point except at points where the potential $V(x)$ is infinite

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001F

B.Sc. – III, Sem – V Nuclear and particle Physics

Time: 30 Minutes | Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

1. Define specific heat at constant volume and specific heat at constant pressure. Obtain an expression for CP – CV. Apply that for perfect gas and for van-derwaal's gas.

2. Derive Planck's law of radiation in terms of frequency and wavelength.

Q. 2. SHORT Answer Questions (any two) **(10)**

1. Write a note on perfect black body?
2. What is electron gas? Obtain expression for fermi energy of electrons.
3. Explain concept of energy density.

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- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

34607

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	
Suppliment No. : 20	Subject : Nucleae and paeticle physics
Roll No. : 8210	Test / Tutorial No. :
Class : B.Sc III, Sem V	Div. :

Q2.

1 Perfect black body

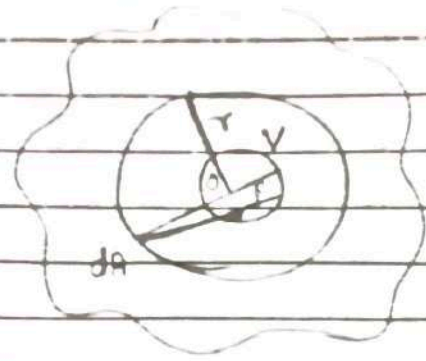
→ A very good experimental approximation of black body is provided by Cavity the interior walls of which are maintained at uniform tempreture and which communicates with outside through a hole having very small diameter in Comparison with dimensions of the Cavity. Any radiation entering the hole is partly absorbed and partly diffused reflected with only negligible fraction eventually finding its way out of the hole. This is true regardless of matrial of which interior walls are compared. Such black body is called Fery's black body.

The radiant energy emitted within the Cavity whose walls are at tempreture θ is equal to radiant emittance of black body at the same tempreture. For this reason, the radiation within the Cavity is Called black body radiation.

black body radiation is homogeneous and isotropic The physical laws for perfect gas can, as they can be applied to the black body radiation.

5

3. Concept of Energy Density



Energy density of diffuse radiation.

The energy contained in unit volume of radiation is called energy density of radiation. Let us find the energy density of diffused radiation inside uniformly heated enclosure density inside enclosure at large distance from its walls. All the radiation contained in V may be assumed to come from sphere is very large as compared to the dimensions of volume V.

The amount of radiation energy contained in V due to this elementary cone is

5

$$k\ dA \cdot \frac{f}{r^2} \cdot t = k.\frac{dA}{r^2}\ \frac{f l}{c}$$

The total amount of radiation energy coming from dA and contained in V is found by summing over all

$$\Sigma\, k\, \frac{dA}{r^2} \cdot \frac{fl}{c} = \frac{k}{c}\ \frac{dA}{r^2}\ \Sigma fl = \frac{k}{c}\ \frac{dA}{r^2}\ V$$

Σfl = Volume element V

Q1.

1. plank applied quantum theory to the problem if black body radiation. The radiation from black body is supposed its consists of photons of energy, ranging from zero to practically infinite. They are supposed to moving in all possible directions with speed of light c. The wall of enclosure it can be replaced by emission of several photons of frequencies $\nu_1 \nu_2 \nu_3$ ---- So that total energy of the system is Constant.

$$h\nu = h\nu_1 + h\nu_2 + h\nu_3 + ---$$

The total number of eigen states between the momentum range P and P + dP is

$$\therefore \quad g(P)\,dP = \frac{4\pi P^2 dP}{h^3/V} = \frac{4\pi V P^3}{h^3} dP$$

photon, $P = \frac{h\nu}{c}$ and $dP = \frac{h\,d\nu}{c}$

put eq^n we have the number of given states between the Frequenty range ν & $\nu + d\nu$ is,

$$g(\nu)\,d\nu = \frac{4\pi V \nu^2}{c^3} d\nu$$

As there are two modes of Propagation for each photon. the total no. of eigen states available for the photons in the frequency range ν and $\nu + d\nu$ is,

$$g(\nu)\,d\nu = \frac{8\pi V \nu^2}{c^3} d\nu$$

Consider the Bose - Einstein distribution law

$$n_i = \frac{g_i}{e^{\alpha} e^{u_i/kT} - 1}$$

put $\alpha = 0$ and $u_i = h\nu$ we have number of photons with frequency between ν and $\nu + d\nu$ in volume V of radiation

$$N(\nu)\, d\nu = \frac{8\pi V \nu^2}{c^3 (e^{h\nu/KT} - 1)} d\nu$$

$$\therefore n(\nu)\, d\nu = \frac{N(\nu)\, d\nu}{V} = \frac{8\pi\, d\nu}{c^3 (e^{h\nu/KT} - 1)}$$

Hence the energy density $u(\nu)\, d\nu$ which is the energy per unit volume in frequency range ν + $\nu + d\nu$ is

$$u(\nu)\, d\nu = h\nu \times n(\nu)\, d\nu$$

$$\therefore u(\nu)\, d\nu = \frac{8\pi h \nu^3}{c^3} \cdot \frac{d\nu}{(e^{h\nu/KT} - 1)}$$

Eq^n represent plank - radiation formula in terms of the frequency of black - body rad^n

10

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34606

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

$\frac{17}{20}$

Signature of Supervisor	
Subject : Nuclear and Particle Physics.	
Test / Tutorial No. :	
Div. :	

Suppliment No. :

Roll No. : 8217

Class : B.Sc-III, Sem-V

Q.1)

2) Plank applied quantum theory to the problem of black body radiation. The radiation from a black body is supposed to consist of photons of energy, ranging from zero to practically infinite. They are supposed to be moving in all possible directions with the speed of light c. The wall of the enclosure, it can be replaced by the emission of several photons of frequencies ν_1, ν_2, ν_3 ... so that the total energy of the system is constant.

$$h\nu = h\nu_1 + h\nu_2 + h\nu_3 + \cdots$$

Thus in this case the principle of conservation of number of particles is not valid i.e. $\Sigma \delta n_i \neq 0$. It is equivalent to say that the undermined constant α is equal to zero. Moreover the photons are Bose particles with spin 1 having two modes of propogation. At any instant all photons having their momenta between $P + dP$ will lie within a spherical shell with radius P and thickness dP. The volume of this shell is $4\pi P^2 dP$. Therefore the total number of eigen states between the momentum range P and $P + dP$ is

$$g(P)\, dP = \frac{4\pi P^2 dP}{h^3/V} = \frac{4\pi V P^3}{h^3} dP$$

For a photon, $P = \frac{h\nu}{c}$ and $dP = \frac{h\,d\nu}{c}$

Substituting eqn we have the number of given states between the frequency range ν and $\nu+d\nu$ is

$$g(\nu)\,d\nu = \frac{4\pi V \nu^2}{c^3}\,d\nu$$

As there are two modes of propagation for each photon, the total number of eigen states available for the photons in the frequency range ν and $\nu+d\nu$ is

$$g(\nu)\,d\nu = \frac{8\pi V \nu^2}{c^3}\,d\nu$$

Now, consider the Bose-Einstein distribution law.

$$n_i = \frac{g_i}{e^{\alpha}e^{u_i/kT}-1}$$

Putting $\alpha=0$ and $u_i = h\nu$, we have the number of photons with frequency between ν and $\nu+d\nu$ in the volume V of the radiation.

$$N(\nu)\,d\nu = \frac{8\pi V \nu^2}{c^3(e^{h\nu/kT}-1)}\,d\nu.$$

Therefore, the number of photons with frequency in the range ν and $\nu+d\nu$ per unit volume of the radiation is,

$$n(\nu)\,d\nu = \frac{N(\nu)\,d\nu}{V} = \frac{8\pi\,d\nu}{c^3(e^{h\nu/kT}-1)}$$

Hence, the energy density $u(\nu)\,d\nu$, which is the energy per unit volume in the frequency range ν and $\nu+d\nu$ is,

$$u(\nu)\,d\nu = h\nu \times n(\nu)\,d\nu$$

$$\therefore\ u(\nu)\,d\nu = \frac{8\pi h\nu^3}{c^3}\cdot\frac{d\nu}{(e^{h\nu/kT}-1)}$$

Eqn represents Plank-radiation formula in terms of the frequency of black body radiation.

Q2>

3) Energy Density of radiation →

The energy contained in unit volume of radiation is called the energy density of radiation. Let us find the energy density of diffused radiation inside a uniformly heated enclosure of any Shape. Consider a very small element of volume inside the enclosure at large distance from its walls. All the radiation contained in V may be assumed to come from a Sphere described about any point O inside V. The radius r of the sphere is very large as compared to the dimensions of volume V.

The amount of radiation energy contained in V due to this elementary cone is,

$$K\, dA \cdot \frac{f}{r^2}\, t = K \cdot \frac{dA}{r^2}\, \frac{fl}{c}$$

The total amount of radiation energy coming from dA and contained in V is found by summing over all elementary cones. as,

$$\Sigma K \frac{dA}{r^2} \cdot \frac{fl}{c} = \frac{K}{c}\, \frac{dA}{r^2}\, \Sigma fl = \frac{K}{c}\, \frac{dA}{r^2}\, V.$$

Where, Σfl = Volume element V.

1) Black body →

A very good experimental approximation of a black body is provided by a Cavity the interior walls of which are maintained at a uniform Temperature and which with the outside through a hole having very small diameter in comparision with the dimensions of the cavity. Any radiation entering the hole is partly absorbed and partly different reflected with only a negligible fraction eventually finding its way out of the hole.

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001F

B.Sc. – III, Sem – V Mathematical Physics

Time: 30 Minutes | Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

1. Obtain an expression for curl of vector field in orthogonal curvilinear co-ordinators.
2. What is mean by an ensemble. Discuss microcanonical and canonical ensemble.

Q. 2. SHORT Answer Questions (any two) **(10)**

1. Write a note on assessable microstate.
2. What is electron gas? Obtain expression for fermi energy of electrons.
3. Discuss cylindrical co-ordinate system.

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34604

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor:

15/20

Suppliment No. :

Roll No. : 8216

Class : B.Sc. III, Sem V

Subject : Mathematical physics

Test / Tutorial No. : Internal exam

Div. :

Q1

2. The collection of large number of assemblies is called as an ensemble. All the member of an ensemble. are referred as elements. These element differ in their microscopic states. Thus an ensemble is defined as collection of large number of assemblies which are essentially independent of one another but which have been made macroscopically as identical as possible.

a) Microcanonical Ensemble -

The microcanonical ensemble is collection of essentially independent assemblies having same Energy E, volume V, number N of system all the system are of same type. The individual assemblies are separated by rigid, impermeable and well insulated wall such that the values of E, V and N, are not affected by presence of other systems, we can't actually specify the macroscopic energy of an assembly exactly.

E, V, N	E, V, N	E, V, N
E, V, N	E, V, N	E, V, N
E, V, N	E, V, N	E, V, N

Due to complete isolation of system, thermodynamic can't be applied to this ensemble. Microcanonical ensemble can be made practical use if we can apply thermodynamics to it. This is possible only average energy $\bar{E}$ of the system is specified

b. Canonical ensemble -

The canonical ensemble is collection of essentially independent assemblies having same temprature T, volume V and the no. of identical particle N.

To assure that all the assemblies in thermal contact with each other. The individual assemblies are separated by rigid, impermeable but diathermic walls, since energy can be exchanged between the assemblies and reach common temprature, Thus in canonical ensemble, system can change but not particles.

T, V, N	T, V, N	T, V, N
T, V, N	T, V, N	T, V, N
T, V, N	T, V, N	T, V, N

Thermodynamics can be applied to such ensemble. In thermodynamics we do not know the exact value of energy as we usually deal with systems kept in thermal contact.

Q2.

1. Note On Microstates.

Consider an assembly consisting of large number of independent system / number of molecules in phase space. The state of individual / molecules may be separated in phase space by point known as phase point / representative point. The phase space may be divided into cells 1, 2, 3 --- i. A phase point for any of the system / molecules may reside in one of these cells.

Microstate is an arrangement of specified system / molecules with their representative point in particular cell. In other words, microstate of assembly may be defined by the specifications of individual position of phase point for each system or molecule of assemblies.

A phase point gives the state of motion of the molecule at that point. So to define the microstate of the assembly we should know the state of each and every molecule of assembly a given instant of time.

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- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

34603

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

15/20

Signature of Supervisor:

Suppliment No. :

Roll No. : 8212

Class : B.Sc III

Subject : Mathematical physics

Test / Tutorial No. : Internal exam

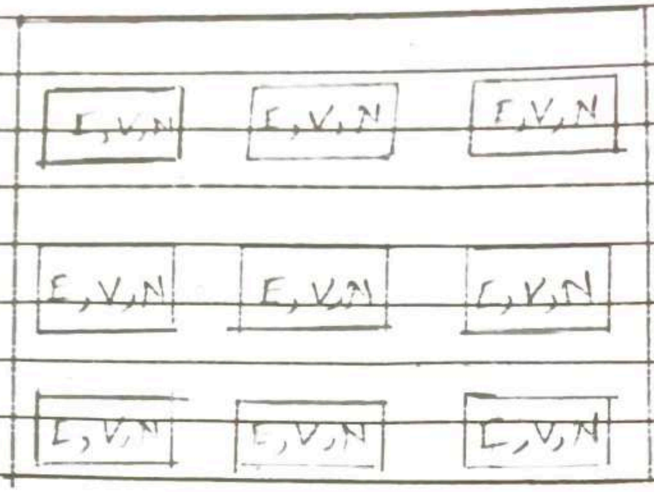
Div. :

Q.1

2. The collection of large number of assemblies is called as an ensemble. All the member of an ensemble are referred as elements. These elements differ in their microscopic states. Thus an ensemble is defined as a collection of a large number of assemblies which are essentially independent of one another but which have been made macroscopically as identical as possible.

a) Microcanonical ensemble :-

The microcanonical ensemble is a collection of essentially independent assemblies having the same energy E, volume V and number N of system, all the systems are of the same types. The individual assemblies are separated by rigid, impermeable and well insulated wall such that the values of E, V and N are not affected by the presence of other systems. We cannot actually specify the macroscopic energy of an assembly exactly.

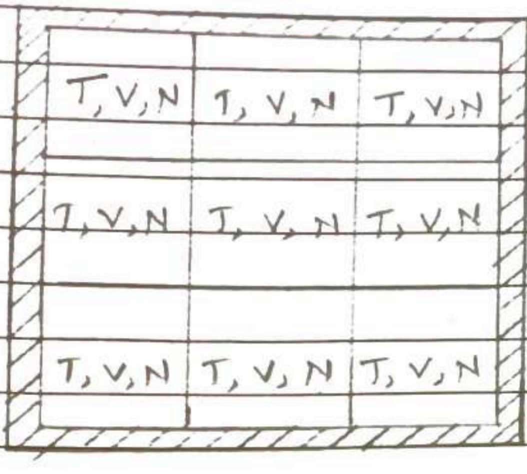


Due to the complete isolation of the system, thermodynam. cannot be applied to this ensemble. Microcanonical ensemble can be made of practical use if we can apply thermodynamics to it. This is possible only the average energy $\bar{E}$ of the system is specified.

b) Canonical ensemble :-

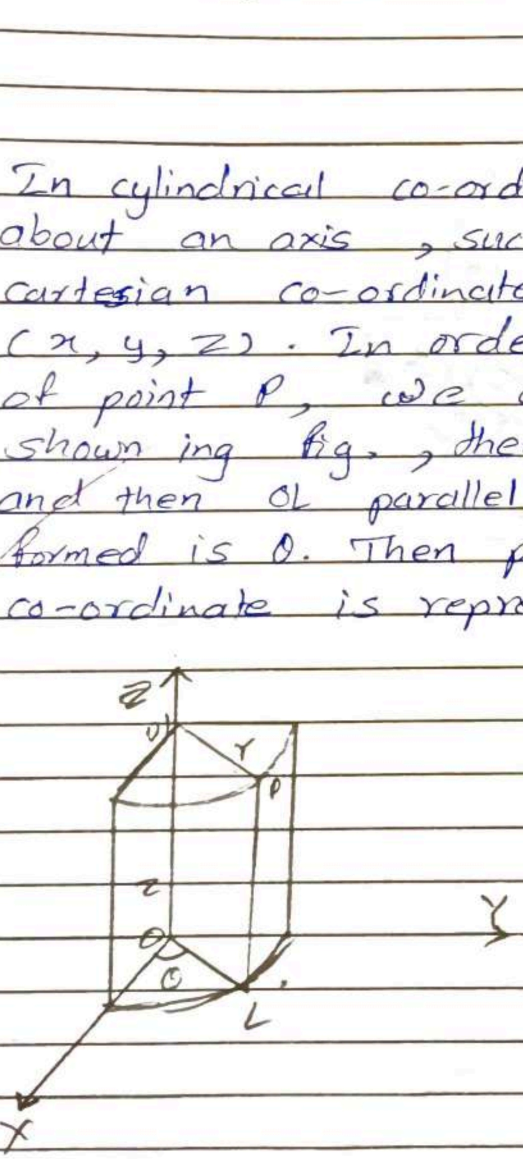
The canonical ensemble is collection of essentially independent assemblies having the same temperature T, Volume V and the number of identical particles N.

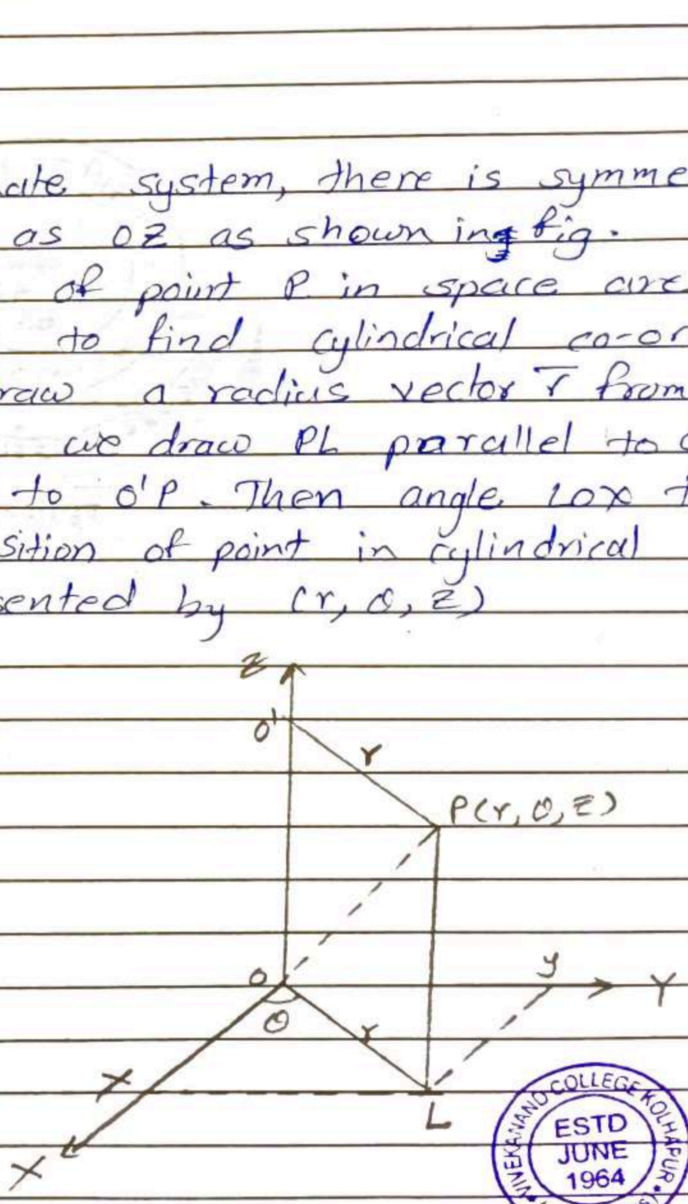
To assure that all the assemblies have the same temperature we could simply bring all the assemblies in thermal contact with each other. Fig. represents symbolically a canonical ensemble. The individual assemblies are separated by rigid, impermeable but diathermic walls, since energy can be exchanged betwen the assemblies and will reach a common temperature. Thus in canonical ensemble, system can exchange energy but not particles.



Q.2

3. In cylindrical co-ordinate system, there is symmetry about an axis , such as OZ as shown ing fig. cartesian co-ordinates of point P in space are (x, y, z). In order to find cylindrical co-ordinates of point P, we draw a radius vector r from O' as shown ing fig., then we draw PL parallel to OZ and then OL parallel to O'P. Then angle LOX thus formed is θ. Then position of point in cylindrical co-ordinate is represented by (r, θ, z)





So from fig. we have

$$\left.\begin{aligned} x &= r\cos\theta \\ y &= r\sin\theta \\ z &= z \end{aligned}\right\}$$

Differentiating we get

$$dx = dr\cos\theta - r\sin\theta\, d\theta$$

$$dy = dr\sin\theta + r\cos\theta\, d\theta$$

$$dz = dz$$

Then expression for line segment in cartesian co-ordinate is

$$ds^2 = dx^2 + dy^2 + dz^2$$

substituting values of dx, dy and dz, we get

$$ds^2 = dr^2 + r^2 d\theta^2 + dz^2$$

05