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

Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Autonomous)

Department of Physics

M.Sc. Part- I

Classical Mechanics

Surprise Test

Date : 19/10/2018 **Total Marks: 20**

Day: - Saturday **Time :- 2pm to 3pm**

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 Choose the correct alternative **(05)**

1. Many different .... may correspond to the same microstate.

(a)microstates (b) phase points (c) phase densities (d) space point

2. The microstates which are allowed under given restriction are called ....

(a) allowed microstate (b) permitted microstates

c)accessible microstates (d) occupied microstates

3. For the distribution to be most probable......

(a) W = 0 b) ln W (InW)=0

(b) δ (ln W) = 0 (d) δW=0

4.The entropy has its maximum value for a thermodynamic assembly in... state.

a) an equilibrium (b) an inequillibrium

(c) a normal (d) an excited

5.Canonical in symbol is related to ---

(a) size to the system (b) number of particles in the system

(c) thermal equilibrium of the system (d) freedom of the system

Q.2 Attempt any one **(05)**

1. Verify Liouville's Theorem in classical presentation.
2. Derive an expression for the total probability of particular distribution.

Q3 Attempt any one **(10)**

I. Explain microstate and microstate with suitable examples.

2. Discuss concept of ensemble with its types.

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Department of Physics

M.Sc. I

Classical Mechanics

Surprise Test

Attendance Sheet

Date : 19/10/2018

Roll. No.	Name of Candidate	Sign
1331	Bagade Kiran Sharad	K.Bagade
1332	Chougule Shradha S.	Schougule
1333	Dayama Abhishek A.	Jayma
1334	Gaikwad Aishwaya Surykant	Aish
1335	Gawade Sayli Shantaram	Sayli
1340	Jamadar Wahida Sardar	Jwahida
1341	Kukde Seema Vishnu	Kukde
1353	Patil Akansha Bhimrao	Patil
1356	Patil Sanyogita Sanjay	Patil
1357	Patil Shrutika Jaysingh	Shruti
1363	Shelar Avinash Sanjay	Avinash
1364	Sonkamble Rohan R	Rohan
1346	Kondhare Adinath S.	AKondhare

Teacher Incharge....SundeAV....
(Mr. A.V. Shinde)

Head of the
Department of Physics
Vivekanand College, Kolhapur

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Department of Physics

M.Sc. I
Classical Mechanics
Surprise Test
Result

Date : 19/10/2018

Roll. No.	Marks	Roll. No.	Marks
1331	09	1355	–
1332	13	1356	12
1333	10	1357	11
1334	08	1358	–
1335	11	1359	–
1336	–	1360	–
1337	–	1361	–
1338	–	1362	–
1339	–	1363	09
1340	05	1364	09
1341	07		
1342	–		
1343	–		
1344	–		
1345	–		
1346	10		
1347	–		
1348	–		
1349	–		
1350	–		
1351	11		
1352	–		
1353	12		
1354	–		

Teacher Incharge........ Shinde AV
(Mr. A. V. Shinde)

Head of the
Department of Physics
Vivekanand College, Kolhapur.

Shraddha Sanjay chougule .

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VIVEKANAND COLLEGE (Autonomous), KOLHAPUR

13/20

Class M.SC-I Div – Roll No. 1332

Suppliment No. Subject Physics

Test / Tutorial No.

Q1

1) Microstates.

2) accessible microstate

3) $\delta(\ln W) = 0$

4) an equilibrium

5) thermal equilibrium of the system .

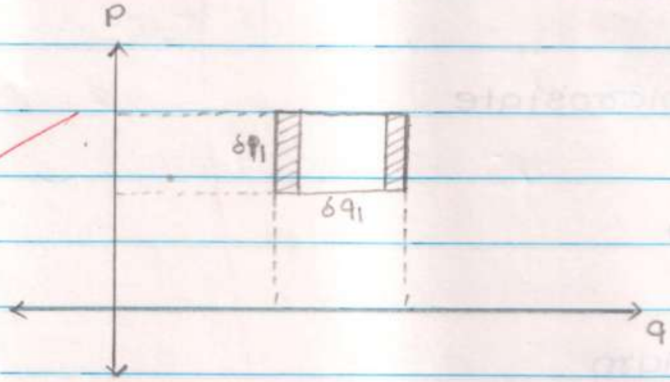
Q2. 2.

Infinitial hyper volume of phase point is certian density of the time.

$$\frac{dD}{dt} = 0$$

$$d\Gamma = dq_1, dq_2, \ldots dq_F . dp_1 . dp_2 \ldots dp_F$$

$$d\Gamma(q, p, t) = 0$$



The two dimestional ~~s~~ phase space.

$$\dot{D} \frac{\cancel{dp_1}}{\cancel{dp_1}} \cancel{dt} d$$

$$= \dot{D} \frac{q_1}{dq_1} dt dq_2 \, dq_3 \ldots dp_F$$

$$= \dot{D} \dot{q}_1 dt \, dq_2 . dq_3 \ldots dp_F \quad \text{—— (1)}$$

this is the enter phase space.

The leaving is,

$$= D \dot{q}_1 dt \, dq_2 . dq_3 \ldots dp_F + \frac{d}{dq_1} \left(D\dot{q}_1 \, dt \, dq_2 \ldots dp_F \right)$$

$$= D\dot{q}_1 dt \, dq_2 \ldots dp_F + \left[D \frac{d\dot{q}_1}{dt} dt + \frac{dD}{dt} d\dot{q}_1 dt \right] dq_2 \ldots dp_F \quad \text{—— (2)}$$

$$D\dot{q}_1\, dt\, dq_2 \cdot dq_3 \cdots\cdots dp_F - \left[\frac{d\dot{q}_1}{dt}\dot{D}\, dt + \frac{dD}{dt} d\dot{q}_1\, dt\right] dq_2 \cdots$$

$$+ D\dot{q}_1\, dt\, dq_2 \cdots\cdots dp_F.$$

$$D\dot{q}_1\, dt\, dq_2 \cdots\cdots dp_F - D\dot{q}_1\, dt\, dq_2 \cdots\cdots dp_F + \left[\dot{D}\frac{d\dot{q}_1}{dt} dt + \frac{dD}{dt} d\dot{q}_1\, dt\right] dq_2 \cdots$$

$$= -\left[D\frac{d\dot{q}_1}{dt} dt + \frac{dD}{dt} d\dot{q}_1\, dt\right] \tau$$

$$\therefore d\Gamma = (dq_1 \cdot dq_2 \cdots\cdots dp_F)$$

For p_1 co-ordinate

$$= -\left[D\frac{d\dot{p}_1}{dt} dt + \frac{dD}{dt} d\dot{p}_1\, dt\right] \Gamma$$

The total time in phase point is,

$$\frac{\partial(dm)}{dt} = -\left[D\frac{d\dot{q}_1}{dt} dt + \frac{dD}{dt} d\dot{q}_1\, dt\right] + \left[D\frac{d\dot{p}_1}{dt} dt + \frac{dD}{dt} d\dot{p}_1\, dt\right] dt$$

$$= D\left[\frac{d\dot{q}_1}{dt} + \frac{d\dot{p}_1}{dt}\right] + \left[\frac{dD}{dt} d\dot{q}_1 + \frac{dD}{dt} d\dot{p}_1\right] dt\, d\Gamma$$

$$\therefore = \sum_{l=\infty}^{F} D\left[\frac{d\dot{q}_1}{dt} + \frac{d\dot{p}_1}{dt}\right] + \left[\frac{dD}{dt} d\dot{q}_1 + \frac{dD}{dt} d\dot{p}_1\right] dt\, d\Gamma$$

4 Hamilton's eq^n is,

$$\partial\dot{q}_1 = \frac{\partial H}{\partial q_1}, \quad \partial\dot{p}_1 = \frac{\partial H}{\partial p_1}$$

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VIVEKANAND COLLEGE (Autonomous), KOLHAPUR

Class M.SC - I Div. Roll No. 1332

Suppliment No. Subject

Test / Tutorial No.

Q3 1. Macrostate →

The particles are distrubuted in the macrostate in compartmently. The 4 particles are distrubuted in the two equal space compartment. In this compartment particles randomely distriuted. the way of the particles distriubated in compartment is as follow.

compartment	arrangment.				
	Distrubution 1	Distrubtion 2	Distrubution 3	Distrubution 4	Distrubution 5
compartment 1	0	1	2	3	4
compartment 2	4	3	2	1	0

The arrangment of the particles in two compartments is.

(0,4), (1,3), (2,2), (3,1), (4,0)

This is for 4 particles is distrubuted in two compartments.

i.e for n particles are distrubuted in two compartment is.

(0,n) (n,n-1) ------- (n-1,n), (0,n)

∴ The number of particles distrubuted in compartment is known as macrostate.

Microstates →

The distinct arrangment of the particles is known as microstates.

Macrostate	arrangment I	arrangment II	Microstate
(0,4)	0	abcd	1
(1,3)	a	bcd	4
	b	acd	
	c	abd	
	d	abc	
(2,2)	ab	cd	6
	ac	bd	
	ad	cb	
	bc	ad	
	bd	ac	
	cd	ab	
(3,1)	bcd	a	4
	acd	b	
	abd	c	
	abc	d	

The arrangment of particles is the (0,4) Macrostate is 1 microstate, (~~0~~1,3) Macrostate is 4 microstate, (2,2) macrostate is 6 microstate, (3,1) macrostate is 4 microstate, (4,0) macrostate is 1 microstate.

each macrostate have same microstate. The example of microstate is the particle having $2^4 = 16$, then for n particle is 2^n.

The total no. of microstate is 2^n.

84

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10/20 July

Class M.Sc-I Div Roll No. 1333

Suppliment No. Subject Physics

Test / Tutorial No.

Q. 1

1) a) microstates

2) b) accessible microstate.

3) c) $\delta(\ln W) = 0$

4) a) An equillibrium

5) c) thermal equillibrium system.

5

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Aishwarya Suryakant Gaikwad

$\frac{11}{20}$

Class M.Sc I. Div ______ Roll No. 1334

Suppliment No. ______ Subject Statictical Mech.

Test / Tutorial No. Internal Exameination-2.

Que.1.

1) Microstate.

2) accessible microstates.

3) $\ln W = 0$.

4) An equillibrium.

5) Thermal equillibrium of the system.

4

Que.2. Liouville's Theorum→
initemal ~~super~~ hypervolume points

$$\frac{dD}{dt} = 0.$$

Where, $d\Gamma = dq_1 dq_2 \cdots dq_F$. which is position co-ordinate.
$dp_1 dp_2 \cdots dp_F$ which is momentum co-ordinat

No. of density point are $D(p.q.t)$.

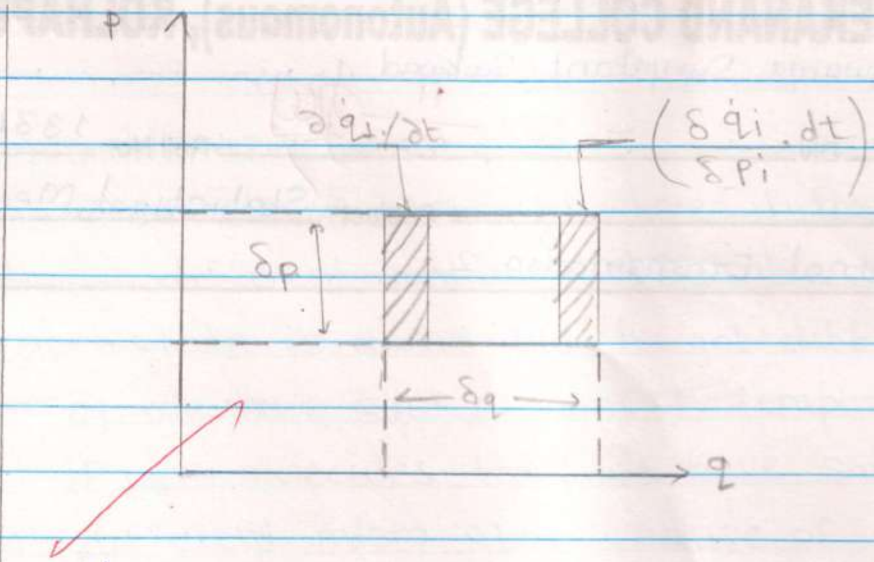
No. of phase point between insmation of 1st Face

$\therefore dV = dq_1 \cdot dq_2 \cdot dq_3 \cdots dq_F$.

$dT = dp_1 \cdot dp_2 \cdot dp_3 \cdots dp_F$.

Then, $d\Gamma = dq_1 \cdot dq_2 \cdot dq_3 \cdots dq_F \cdot dp_1 \cdot dp_2 \cdot dp_3 \cdots dp_F$.

$d\Gamma = dV dT$.



Now, moment of system eneter̶ing in co-ordinate. in.
~~in~~ 1st Face.

$$= D \cdot \frac{\partial \dot{q}_1}{\partial q_1} \cdot dt \cdot dq_2 \cdots dq_F \cdot dP_1 \cdot dP_2 \cdots dP_F$$

$$= D \cdot \frac{\partial \dot{q}_1}{\partial q_1} \cdot dt \cdot dq_2 \cdots dq_F + \left[D\left(\frac{\partial \dot{P}_1}{\partial P_1} \cdot dt \cdot dP_2 \cdot dP_3 \cdots dP_F\right)\right]$$

Now, there, in ~~Ao~~ leaving co-ordinate.

$$= D q_1 \cdot dt \cdot dq_2 \cdots dq_F + (\cancel{Dq_1 \cdot dt\ DP_i}\ D\dot{q}_1\, dt \cdot dq_2 \cdots dq_t).$$

$$= \left(D \cdot \frac{\dot{q}_1}{q_1} dt\, dq_2 \cdots dP_1\right) + \left(D \cdot \frac{\partial \dot{P}_1}{\partial P_1} \cdot dt \cdot dP_2 \cdots dP_F\right) \delta t.$$

There is leaving and eneter̶ing state so we have.

= enter - leave.

$$\therefore = D \cdot \frac{\partial \dot{q}_1}{\partial q_1} dt \cdot dq_2 \cdots dq_F - D \frac{\partial \dot{P}_1}{\partial P_1} dt \cdot dP_2 \cdots dP_F.$$

$$= \left(D \cdot \frac{\partial \dot{q}_1}{\partial q_1} \cdot dt - D \cdot \frac{\partial \dot{P}_i}{\partial P_1} dt \cdot\right) dq_2 \cdot dq_3 \cdots dq_F \cdot dP_1 \cdot dP_2 \cdots dP_F.$$

$$\left(\frac{dD}{dt}\right) d\Gamma dt = D \left(\frac{\partial \dot{q}_1}{\partial q_1} \cdot dt - \frac{\partial \dot{P}_i}{\partial P_1} \cdot dt\right) d\Gamma \cdot \delta t.$$

$$\therefore \frac{dD}{dt} = D\left(\frac{\partial \dot{q}_1}{\partial q_1} \cdot dt\, dq_2 \cdots dq_F \cdot \frac{\partial \dot{P}_1}{\partial P_1} \cdot dt \cdot dP_2 \cdots dP_F\right).$$

by Hamiltonian's eq^n

$$\frac{\partial \dot{q}_i}{\partial p_i} = \frac{\partial \dot{p}_i}{\partial q_i}$$

but, $$\frac{\partial \dot{q}_i}{\partial \dot{p}_i q_i} - \frac{\partial \dot{p}_i}{\partial \dot{p}_i q_i} = 0.$$

Now, we know that

$D(p, q, t)$

$$\therefore \left(\frac{\partial D}{\partial t}\right)_{p.q} + \left(\frac{\partial D}{\partial t}\right)_{p.t} + \left(\frac{\partial D}{\partial t}\right)_{q.t} = 0.$$

$$\therefore \partial \frac{dD}{dt} = 0.$$

03

Que.3.

2. Ensemble →

Ensemble is a concept where, if there are system with ~~distigu different contain~~ distiguisable particle then the macrostate is same but he got different microstates. For eg. we have system ~~consist~~ temparature, volume and no. of ~~part~~ molecules then we have same macro-state but different micro state cause of various nature of system compounts.

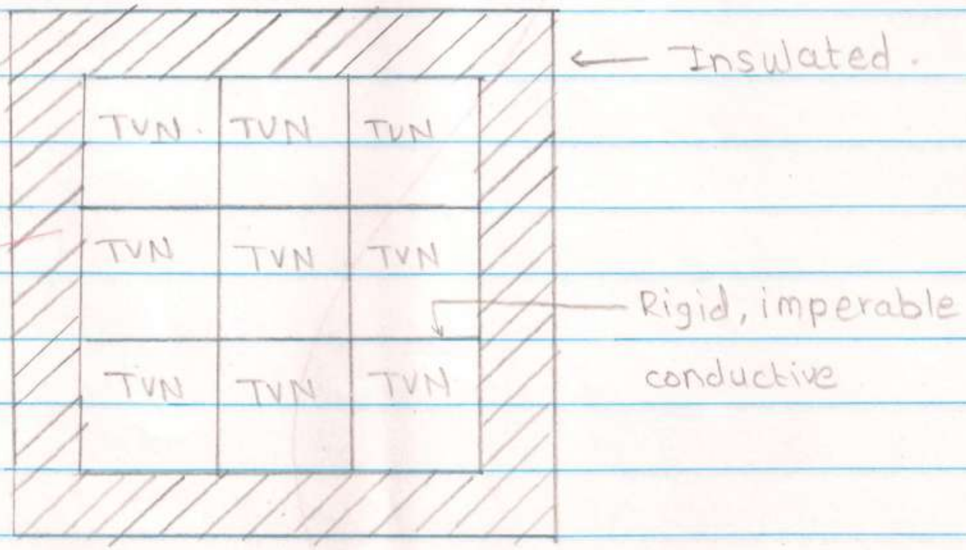
There are three types of Ensmeble.

1) Micro-canonical ensmeble.
2) Canonical ensmeble.
3) Grand Canonical ensmeble.

1) Micro-Canonical Ensmeble → In this system we consider a system having temparature, volume and no. of molecules. where we denote temparature as T, volume as V and no. of molecules with N. we distribute them int system ~~ta~~ having a compartment. with walls where all compartment are separte with each other by rigid, impermable and insulated wall. where no. change in or tranfer of any kind of things. this system we called as micro-canonical Ensmeble.

Rigid, impermable insulted walls.

2) Canonical Ensemble → In this system we ~~a~~ again conside ~~th~~ a system having some kind of temparature, volum and no. of molecules. where we again denote them a temperature as T, volume as V and no of molecules with N. we distribut them in 9 compartment but now in canonical Ensemble there are walls ~~wit~~ which are rigid, imperamable but this time middel walls are conductive. which means teamparature is able to transfer this system know as Canonical Ensemble



3) Grand Canonical Ensemble → In this system we consider system with a temparature, volume and No. of molecules. were, ~~distance~~ it separated by walls. this walls are rigid but permable and conductive.

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$\frac{11}{20}$

Class MSc I Div. ________ Roll No. 1335

Suppliment No. 1 Subject Statistical Mechanic

Test / Tutorial No. ________

Q1)

1)

→ microstates

2)

→ accesible microstates

3)

→ $\delta(\ln W) = 0$

4)

→ en equilibrium

5)

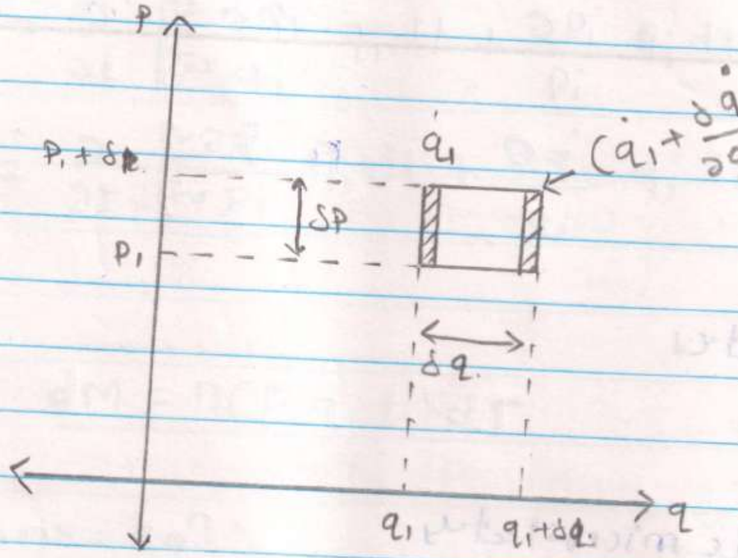
→ thermal equilibrium of the system.

5

Q2.

1)

→ Liouville's Theorem in classical presentation.



$\overline{F}$ → degree of freedom

$p_1 p_2 \dots p_f$ → movementum.

$q_1 q_2 \dots q_n$ → possition.

$dM = p_1 p_2 p_3 \dots p_f$
$q_1 q_2 q_3 \dots q_f$.

$dM = p_i q_i$

Liouville's theorem:-

liouville's theorem saidu that the position of movement does not change with respact to time.

Density of phases movement does not change in to time.

$$\frac{dD}{dt} \left[\frac{\partial \dot{p}_i q_i}{\partial p_i} p_i + \frac{\partial \dot{q}_i}{\partial \dot{q}_1} \partial q \right] dt$$

$$= \left[\frac{\partial \dot{q}_i}{\partial q_i} \partial q_1 + \frac{\partial \dot{p}_i}{\partial p_1} \partial p_i \right] dt \; (q_1 q_2 \dots q_f)$$

Density ~~Diff~~ Distribution.

$D = D(p\,q\,d)$.

$$\frac{dD}{dt} = \left[\frac{\partial \dot{p}}{\partial p_i} p_i + \frac{\partial \dot{q}}{\partial q} dq_i\right]_{pq} dt \, (q_1 p_1 \ldots \phi_f)$$

$$\frac{dD}{dt} = \left(\frac{\partial \dot{p}}{\partial p_i} p_i dt\right)_{pq} + \left(\frac{\partial \dot{q}}{\partial q} q_i dt\right)_{pq} (q_1 q_2 \ldots q_f)$$

$$\frac{dM}{dt} = \left[\frac{\partial \dot{p}}{\partial p_i} p_i dt + \frac{\partial \dot{q}}{\partial q} q_i dt\right]_{pq} - D \frac{\partial \dot{p}}{\partial p_i} p_i dt + \frac{\partial \dot{q}}{\partial q} \dot{q}_i dt.$$

leving point of phase is.

$$= \left[~~\dot{q}_1 + \delta q~~ \frac{\partial \dot{q}_1}{\partial q_1} d\dot{q}_1\right] dt + \left[\frac{\partial \dot{q}_1}{\partial q_1} q_1 - \frac{\partial \dot{p}_1}{\partial p_1} p_1\right]$$

$$= D\left[\frac{dD}{\partial q_1} \dot{q}_1 + \frac{d\dot{q}}{dq_1} q_1\right] + \left[\frac{dD}{dp_1} \dot{p}_1 + \frac{d\dot{p}}{dp_1} p_1\right].$$

$$[q_1 p_1 \, q_2 p_2 \ldots q_f p_f]$$

Net phase point = enter - leaving.

$$\frac{dM}{dt} = \left(\frac{\partial \dot{p}_1}{\partial p_1} \dot{p}_1 dt + \frac{\partial \dot{q}}{\partial q_1} q_1 dt\right) - \left[\frac{\partial \dot{q}_1}{\partial q_1} q_1 dt + \frac{\partial \dot{q}}{\partial q_1} q_1 dt\right]$$

$$= \sum_{i=0}^{\infty}\left[\frac{dD}{\partial q_1} \dot{q}_1 + \frac{d\dot{q}}{dq_1} q_1\right] + \left[\frac{dD}{dp_1} \dot{p}_1 + \frac{d\dot{p}}{dp_1} p_1\right].$$

$$= \sum_{i=0}^{\infty}\left[\frac{\partial \dot{p}_1}{\partial p_1} \dot{p}_1 dt + \frac{\partial \dot{q}}{\partial q_1} q_1 dt - \frac{\partial \dot{q}_1}{\partial q_1} q_1 dt + \frac{\partial P}{\partial p_1} p_1 + \frac{d\dot{p}}{dp_1} \dot{p}_1\right].$$

p_i the co-ordinate.

$$= (p_1 + \delta p)\left(\frac{\partial \dot{p}_1}{\partial p_1} p_1 dt\right).$$

rate charge of no of phase point

$$\frac{\partial(dm)}{\partial t}dt = \frac{\partial}{\partial t}\left[\cancel{\frac{\partial D}{\partial t}}\right] D\,(Pqd]$$

$$= \frac{\partial}{\partial t}\left[\sum_{i=0}^{\infty}\frac{\partial \dot{q}_i}{q_i}q_i dt + \frac{\partial \dot{p}_i}{p_i}q_i dt\right]_{pq} +$$

$$= \frac{\partial}{\partial t}\left[\sum_{i=0}^{\infty}\frac{\partial q_1}{p_i}q_i dt + \frac{\partial \dot{q}_i}{q_i}q_i dt\right](q_1+\partial q).$$

$$dM = D(P, q, t)\,d\Gamma$$

Hamiltons eq^n

$$\dot{p}_i = \frac{\partial H}{\partial q_i} \quad \& \quad q_i = \frac{\partial H}{\partial q^i}$$

$$\frac{\partial \dot{p}_i}{p_1} \neq \frac{\partial \dot{q}_i}{q_i} = \frac{\partial^2 H}{\partial p_i \partial q_i} + \frac{\partial^2 H}{\partial p_i \partial q_i}$$

$$\therefore \frac{\partial(dm)}{\partial t} = \frac{\partial}{\partial t}\left[\frac{\partial \dot{p}_1}{\partial p_1}p_1 dt + \frac{\partial \dot{q}_1}{\partial q}q_1 dt\right] \quad (4)$$

$$dM = D(P, q, t)\,d\Gamma$$

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Class MSc I Div Roll No. 1335

Suppliment No. Subject

Test / Tutorial No. 2

full dependance density $D(P, q, t)$

$$\frac{dD}{dt} = \frac{d}{dt}\left[\frac{d\dot{p}_i}{\partial p_i} p_i + \frac{\partial \dot{q}_i}{\partial q_i} \partial p\right] - \frac{\partial p_i}{\partial \partial p} \dot{p}_i + \frac{\partial q_i}{\partial q_i} \dot{q}_i \quad - (B)$$

than Adding eq^n (A) + (B)

$$\boxed{\frac{dD}{dt} = 0}$$

The liouville's theorm hus the value's 0 become the density of phase space value remains zero than the unltrrulent Rus cun be affect in zero spun phase

03

Q3

1) Macrostate :-

a, b, c, d are the 4 particle in microsstate which probality 1/2

the componentswise distrabution

Sr No	compounts	arrangement of paaticle				
		1	II	III	IV	V
1	1	0	1	2	3	4
2	2	4	3	2	1	0

their are compoundewise distribution has 5 arrangement particle

(0,4) (1,3) (2,2), (3,1) (4,0).

each compsitionwise distribution of particle is known as microstate.

In the general form is

(1, n+1) (2, n+2) - - - (n, n+1)

& total number has (n n-1)

2) microstate

macrostate	Arrangement wise distribution I	II	microstate
(0.4)	abcd	0	1
(1,3)	a	bcd	4
	b	acd	
	c	abd	
	d	abc	
(2,2)	ab	cd	6
	ac	bd	
	ad	cb	
	bc	ad	
	bd	ac	
	ba	cd	
(3,1)	abc	d	4
	abd	c	
	acd	b	
	bcd	a	
(4,0)	abcd	0	1

(0.4) has only one microstate.
(1,3) has 4 microstate
(2,2) has 6 microstate

Q3

1) Macrostate :-

a, b, c, d are the 4 particle in microsstate which probality 1/2

the componentswise distrabution

Sr No	compounts	arrangement of particle				
		1	II	III	IV	V
1	1	0	1	2	3	4
2	2	4	3	2	1	0

their are compoundewise distribution has 5 arrangement particle

(0, 4) (1, 3) (2, 2), (3, 1) (4, 0).

each compsitionwise distribation of particle is known as microstate.

In the general form is

(1, n+1) (2, n+2) - - - (n n+1)

& total number has (n n-1)

2) microstate

macrostate	Arrangement wise distribution I	II	microstate
(0.4)	abcd	0	1
(1,3)	a	bcd	4
	b	acd	
	c	abd	
	d	abc	
(2,2)	ab	cd	6
	ac	bd	
	ad	cb	
	bc	ad	
	bd	ac	
	ba	cd	
(3,1)	abc	d	4
	abd	c	
	acd	b	
	bcd	a	
(4,0)	abcd	0	1

(0.4) has only one microstate.
(1,3) has 4 microstate

each particle compoundwise distribution of macrostate is known as microstate.

for exampl 16 microstates on

$$16 = 2^4.$$

then 2^n

general form of microstate is 2^n.

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- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Signature of Supervisor

Shri Swami Vivekanand Shikshan Sanstha's

VIVEKANAND COLLEGE (Autonomous), KOLHAPUR

$\frac{12}{20}$

Class M.Sc-I Div. Roll No. 1336

Suppliment No. Subject physics

Test / Tutorial No. M.Sc-I, Sem-II Internal Examination

Q1. 1. a. microstate

2. b. accessible microstate

3. c. $\delta(\ln W) = 0$

4. d. an excited

5. b. number of particles in the system

3

Q2. 1. Liouvill'es Theorem

← f degree of freedom

Configuration of the system
position co-ordinate ⇒ $\partial q_1\ \partial q_2 \ldots \partial q_f$
momentum co-ordinate ⇒ $\partial p_1\ \partial p_2 \ldots \partial p_f$

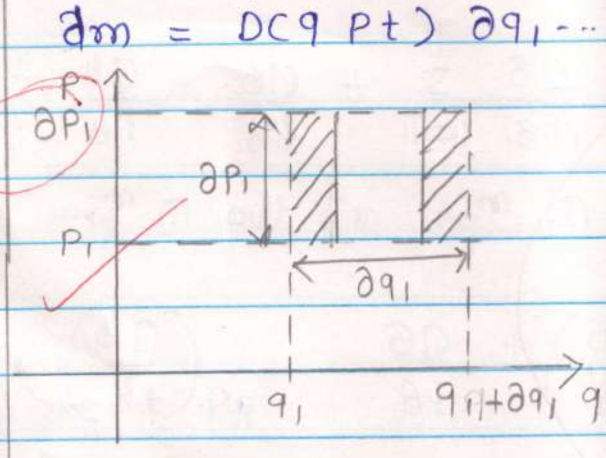
∴ consider the infinitesimal hypervolume the no. of phase point density doesn't change with time

$$\frac{dD}{dt} = 0$$

The volume $d\tau = \partial q_1\ \partial q_2 \ldots \partial q_f\ \partial p_1\ \partial p_2 \ldots \partial p_f$

∴ density distribution function is $D = D(q, p, t)$

∴ No of phase points
$\partial m = D(q\,p\,t)\ \partial q_1 \ldots \partial q_f\ \partial p_1 \ldots \partial p_f\ d\tau$



the no. of phase point entering in the 1^{st} face in time dt

∴ $D\ \partial q_1\ dt\ \partial q \ldots \partial q_f\ \partial p \ldots \partial p_f$

Q2.

1. the no. of phase point leaving

$\therefore D\dot{q}_1\, dt\, \partial q_1 \cdots \partial p_f + \frac{\partial}{\partial q_1}\left(D\dot{q}_1\, dt\, \partial q_1 \cdots \partial p_f\right)$

$\therefore D\dot{q}_1\, dt\, \partial q_1 \cdots \partial p_f + D\frac{\partial \dot{q}_1}{\partial q_1} dt + \frac{\partial D}{\partial q_1}\dot{q}_1\, dt\, \partial q_1 \cdots \partial p_f$

$\therefore$ the net no. of phase points entering
= enter - leave

$\therefore D\dot{q}_1 dt\, \partial q_1 \cdots \partial p_f - D\dot{q}_1 dt\, \partial q_1 \cdots \partial p_f$
$- D\frac{\partial \dot{q}_1}{\partial q_1} dt + \frac{\partial D}{\partial q_1}\dot{q}_1$

$= -\left[+D\frac{\partial \dot{q}_1}{\partial q_1} dt + \frac{\partial D}{\partial q_1}\dot{q}_1\right]\delta q_1$

$= -\left(+D\frac{\partial \dot{q}_1}{\partial q_1} + \frac{\partial D}{\partial q_1}\dot{q}_1\right) d\Gamma$

For p- co-ordinate

$= -\left[D\frac{\partial \dot{p}_1}{\partial p_1} + \frac{\partial D}{\partial p_1}\dot{p}_1\right] d\Gamma$

$\therefore$ the total rate of change of no. of phase point in time dt

$\therefore \frac{\partial}{\partial t}(dm)\,dt = -\left[D\left(\frac{\partial \dot{q}_1}{\partial q_1} + \frac{\partial \dot{p}_1}{\partial p_1}\right) + \left(\frac{\partial D}{\partial q_1}\dot{q}_1 + \frac{\partial D}{\partial p_1}\dot{p}_1\right)\right] dt$

Q2. 1. Acc. to Hamiltonian

$$\dot{p}_i = -\frac{\partial H}{\partial q_i} \quad \dot{q}_i = \frac{\partial H}{\partial p_i}$$

$$\therefore \frac{\partial \dot{q}_i}{\partial q_i} + \frac{\partial \dot{p}_i}{\partial p_i} = \frac{\partial^2 H}{\partial p_i \partial q_i} - \frac{\partial^2 H}{\partial p_i \partial q_i} = 0$$

consider

$$\frac{\partial}{\partial t}(dm)\,dt = -\left[\sum_{i=1}^{f} \frac{\partial D}{\partial q_i} \dot{q}_i + \frac{\partial D}{\partial p_i} \dot{p}_i\right] dt\, d\tau$$

$$\therefore D^{(pqt)} = (dm)\,dt\,d\tau$$

$$\therefore \frac{\partial D}{\partial t}\,dt\,d\tau = -\left[\sum_{i=1}^{f} \frac{\partial D}{\partial q_i} \dot{q}_i + \frac{\partial D}{\partial p_i} \dot{p}_i\right] dt\, d\tau$$

$$\therefore \frac{\partial D}{\partial t} = -\sum_{i=1}^{f} \frac{\partial D}{\partial q_i} \dot{q}_i + \frac{\partial D}{\partial p_i} \dot{p}_i \quad \text{---} (1)$$

$\therefore$ The full of probability density is given by

$$\therefore \frac{dD}{dt} = \frac{\partial D}{\partial t} + \sum_{i=1}^{f} \frac{\partial D}{\partial q_i} \frac{\partial q_i}{\partial t} + \sum_{i=1}^{f} \frac{\partial D}{\partial p_i} \frac{\partial p_i}{\partial t} \quad \text{---} (2)$$

eq^n (1) put in eq^n (2) we get

$$\therefore \left(\frac{dD}{dt}\right)_{pq} = \frac{\partial D}{\partial t} + \left(\frac{\partial D}{\partial q}\right)_{p,t} + \left(\frac{\partial D}{\partial p}\right)_{q,t}$$

5

$$\therefore \boxed{\frac{dD}{dt} = 0}$$

the Theorem states that the rate of cha

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Class M.Sc-I Div. Roll No. 1336

Suppliment No. 1 Subject physics

Test / Tutorial No. M.Sc-I, Sem-II Internal Examination

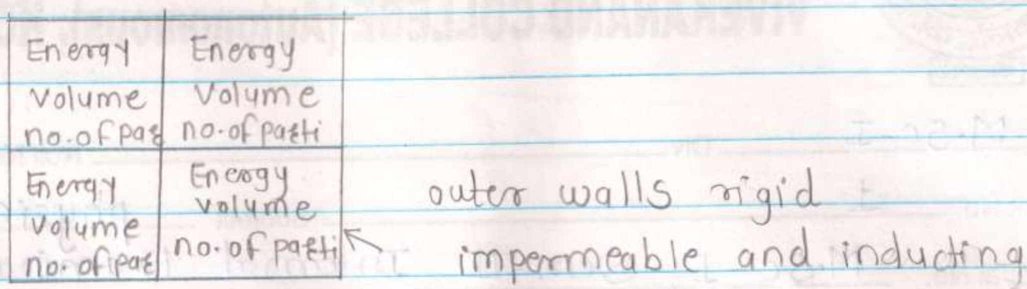
Q3. 2. Concept of ensemble with its types

Ensemble -
It is the collection of large number of macroscopically identical and essentially independent system.
macroscopically identical means it have same values of tempreture, pressure, volume, number of particles.
microscopically differ in parity, Symmetry and quantum states.

Types of ensemble
i Micro-canonical ensemble
ii. Canonical ensemble
iii Grand-canonical ensemble

i Micro-canonical ensemble -
It is the collection of large no. of essentially independent system having same Energy, volume, and no. of particle
In this ensemble the system is seperated

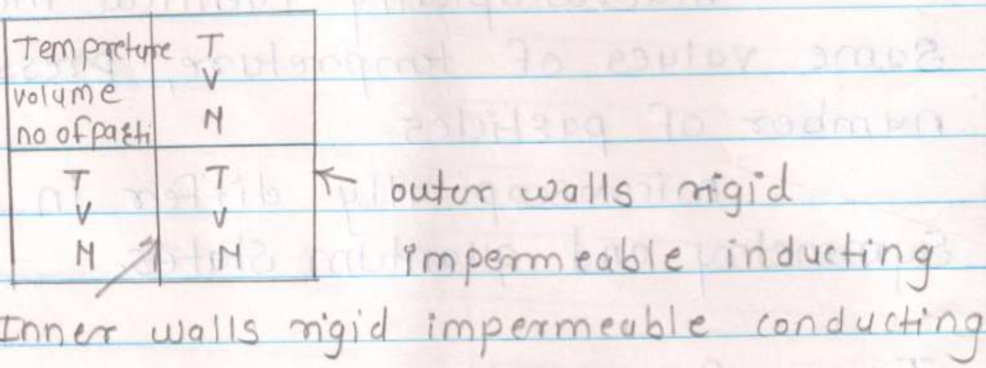
Q3. 2.



ii Canonical ensemble -

It is the collection of large number of essentially independent system having Same Tempreture, volume, No. of pa&ticle

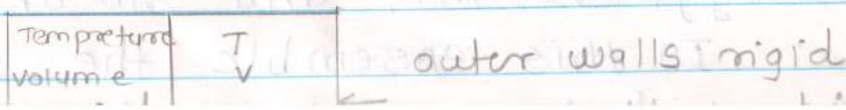
In this ensemble the System is Separated by rigid impearmeable and conducting walls



iii Grand- canonical ensemble

It is the collection of large number of essentially independent system having same Tempreture, volume and chemical potential

In this ensemble system is Separated by the permeable and conducting walls.



Q.3

→2] Ensembles can be defined as It is the collection of no. of macroscopically identical but esentially independent System.

Here the term macroscopically identical means constituent system of ensembles having same microscopic condition like pressure, volume, temperacture, no. of particles etc. Here again the term esentially independent means constituent system of ensembles having different microscopic condition like quantum stat etc.

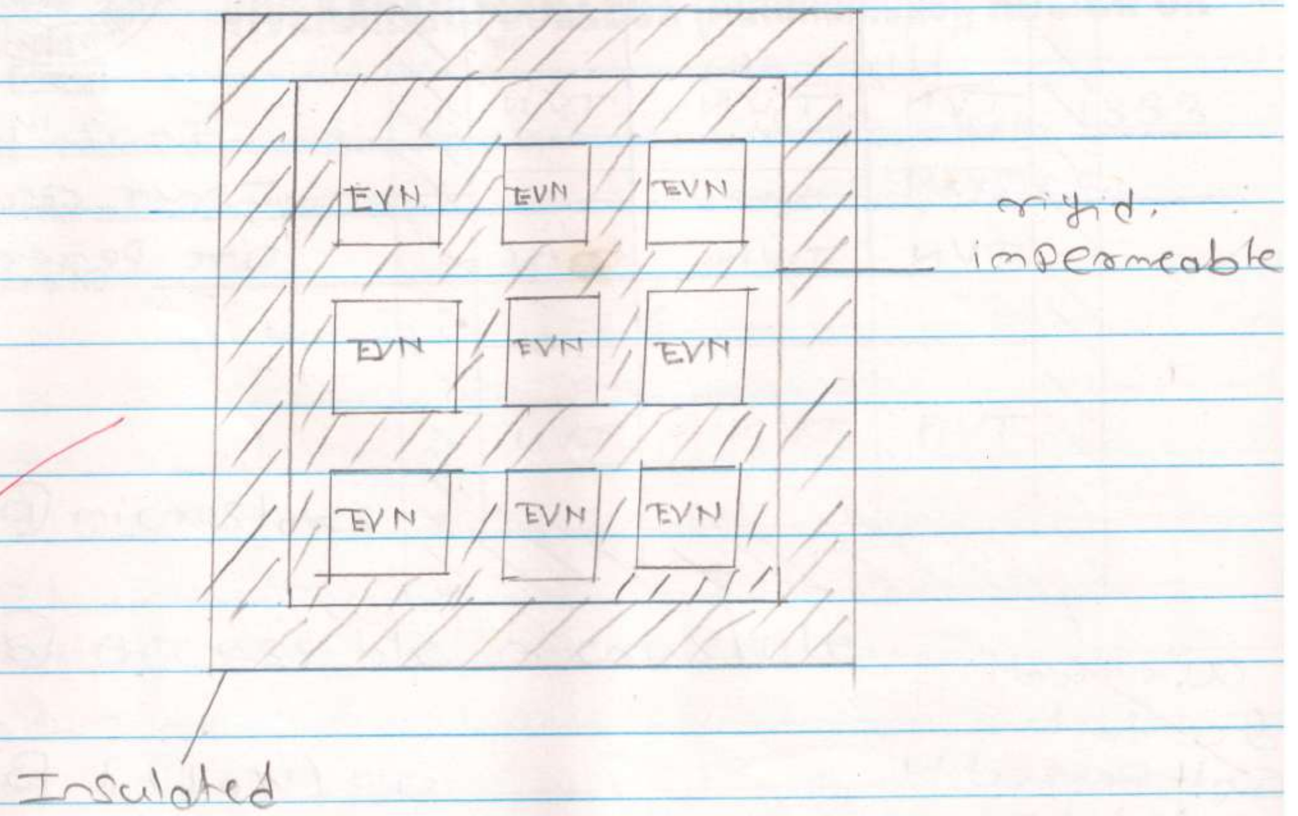
There are 3 type of ensembles.

1) Microcanonical ensemble.
2) Canonical ensemble.
3) Grand canonical ensemble.

1) Microcanonical ensemble.

It is the large no. of microscopi condition but esentially independent syst having same energy E, volume V, No of particle N

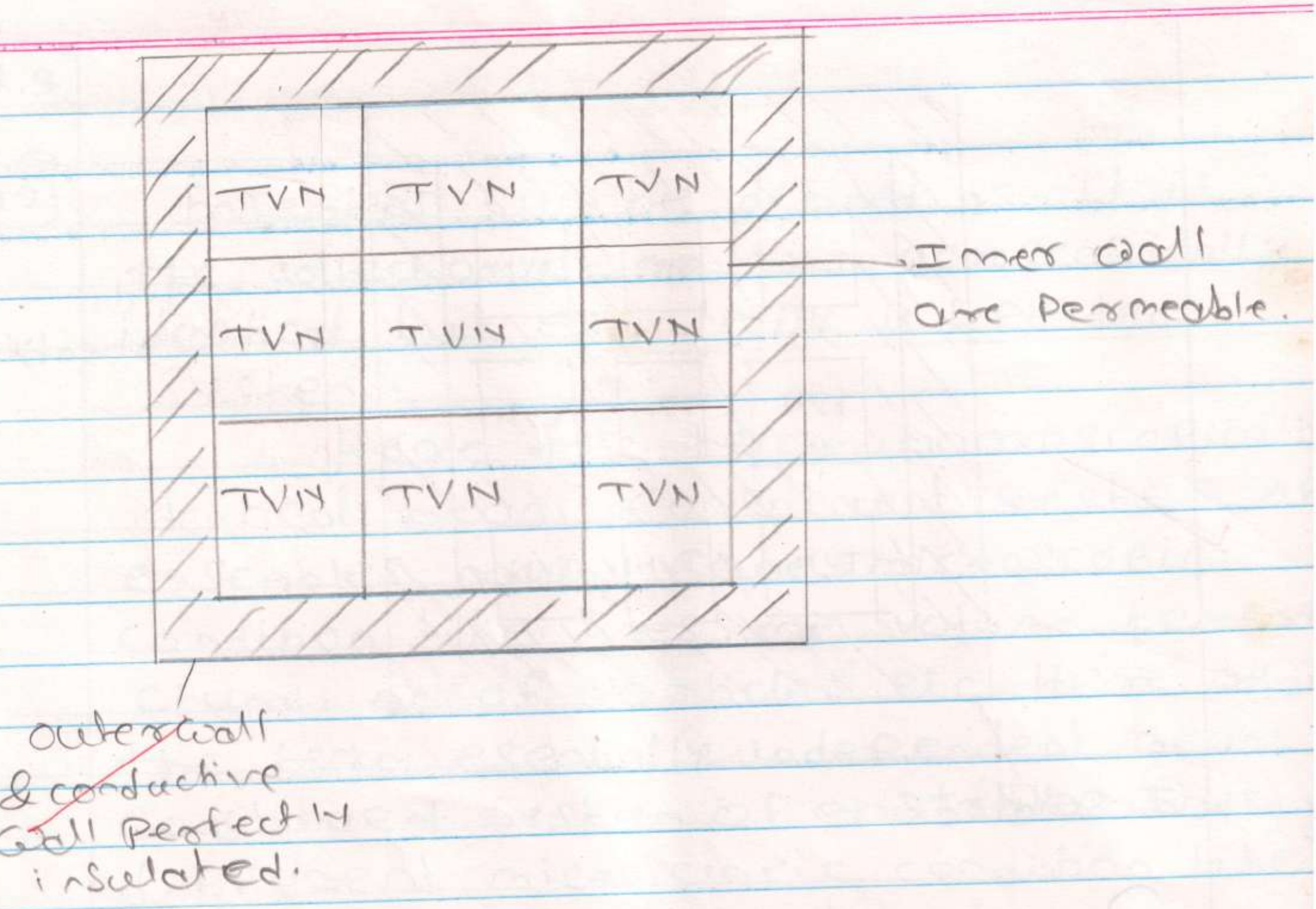
Microcanonical ensemble are
... impermeable &



2) canonical ensemble

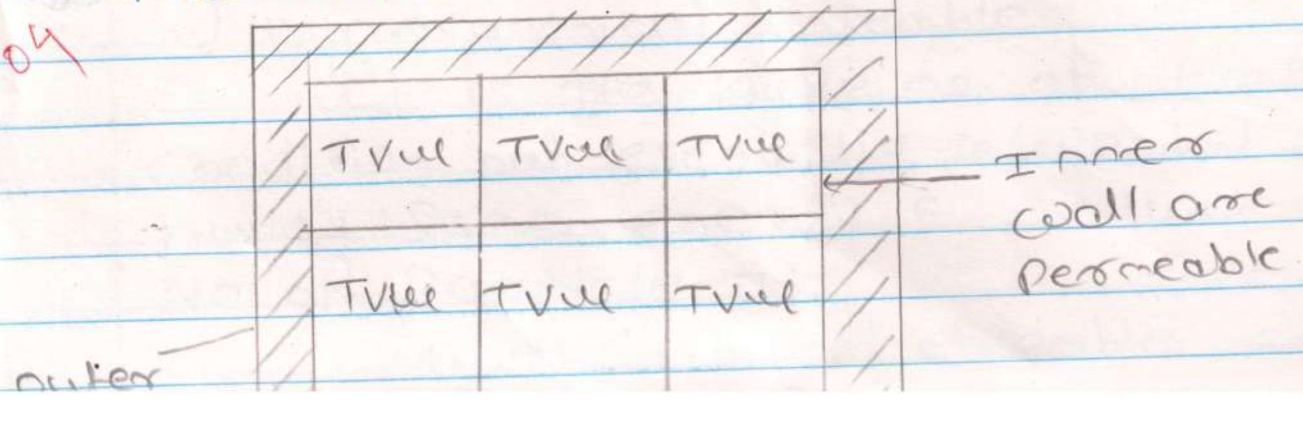
It is the large no. of microscopical condition but essentially independent system having same ~~energy~~ temperature T volume v & no of particle N.

canonical ensemble are separate by rigid, impermeable & ~~perfectly insulated~~ but conductive walls & outer wall are perfectly insulated.



3) Grand canonical system:-
It is the large no. of microscopical condition but essentially independent system. having same temprerture T volume v & Chemical potential μ.
Grand canonical ensembles are Separated by rigid permeable & insulated walls.

04



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In this grand canonical system inner wall are rigid & permeable. but outer wall as-well as inner wall are insulated.

~~Canoni~~

Ensemble avarage:-

$$\overline{R_i} = \frac{\int_{-\infty}^{\infty} R(x)\, N(x)\, dx}{\int_{-\infty}^{\infty} N(x)\, dx}.$$

Q.2

1) Liouville's Therem.

Infinitimal hyper volume no. of Phase Posint density does not change with time

$$\frac{dD}{dt} = 0$$

where volume

$dq_1, dq_2 \dots dq_f \quad dp_1, dp_2, \dots dp$

$d\tau = dq \cdot dp$

density distribution function $D = D(p, q, t)$

No of Phase Point $dy = D(D, q, T)$

For instant phase space two domential the no. of phase Point entering the ~~Phase Space~~ 1^{st} face in time dt.

$$= D \frac{dq_1}{dq_t} dt\, q_2 \dots dq_3 \dots dp_f \dots dp_I \dots dp_f$$

$$= D\, q_1 dt \dots q_2 dt \dots dp_f$$

0

~~The no. of Phase Point~~