

**"Education for Knowledge, Science and Culture"**  
-Shikshanmaharshi Dr. Babuji Salunkhe  
Shri Swami Vivekanand Shikshan Sanstha, Kolhapur  
**Vivekanand College, Kolhapur (Empowered Autonomous)**  
**Department of Physics**

B.Sc. Part-II SEM II Internal Examination (2023-24)  
Paper-Thermodynamic and Statical Mechanics-II  
Topic-Thermodynamic potentials

Day: -  
Date: -

Time: - 10.00 am- 11.00 am  
Total Marks: 10

**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:**

**(02)**

1. Thermodynamic potentials are also known as .....  
(a) thermodynamic variables                      (b) thermodynamic constants  
(c) thermodynamic functions                      (d) thermodynamic relations
2. For an ideal gas, Joule-Thomson effect is .....  
(a) zero    (b) positive  
(c) negative    (d) infinite

**Q.2 Attempt any two**

**(08)**

1. State and explain thermodynamic potentials: a) Internal energy b) Enthalpy.
2. State and explain Joule-Thomson effect.
3. Derive Clausius-Clapeyron's equations from Maxwell's thermodynamic relations.



Internal Attendance  
Thermal & Statistical Mechanics - II  
B.Sc. II  
2023-24.

Ser. No.	Name of student	Seat No.	Sign.
1)	Sakshi Raju Biranje	7726	<u>SR Biranje</u>
2)	Ritu R. Nishad	7731	<u>Rutishad</u>
3)	Tanishq Anil Mude	7730	<u>th</u>
4)	Prasad P. Gurav	7729	<u>P Gurav</u>
5)	Vedant M. Mangaonkar	7718	<u>Vm</u>
6)	Shivaji R. Jadhav	7939	<u>Shah</u>
7)	Noushabh R. Chougale	7727	<u>Chougale</u>
8)	Sahil C. Patnekar	7733	<u>Shil</u>
9)	Sanika J. Kalamkar	7708	<u>Shnikar</u>
10)	Aparita J. Patil	7714	<u>A Patil</u>
11)	Riya D. Patil	7732	<u>R Patil</u>
12)	Shridhar S. Jadhav	7706	<u>Shu</u>



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- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

06889

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

# VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

## SUPLIMENT

Signature  
of  
Supervisor

Subject : Thermodynamic & statical  
Mechanics.

Test / Tutorial No. :  $\frac{07}{10}$

Div. :

Suppliment No. :

Roll No. : 7731

Class : B.Sc. Sy

Q.1 1)  $\rightarrow$  Thermodynamic function.

$\rightarrow$   $\rightarrow$  zero.

Q.2 1) Internal energy:

The sum of kinetic energy & potential energy of every element of in thermodynamic system is called internal energy. The infinitely heat energy supplied to the thermodynamic system. The internal energy is change by thermodynamic first law.

$$dQ = dU + dW.$$

but  $dW = PdV.$

$$\therefore dQ = dU + PdV.$$



Enthalpy: It is denoted by H. It is the total heat content of thermodynamic system is in termal energy & pressure.

of volume.

$$H = U + PV.$$

differentiating

$$dH = dU + PdV + VdP$$

$$dH = Tds + PdV + VdP.$$

Q

$$dH - PdV = Tds + VdP.$$

Q.2) When a gas in region constant pressure, passes through a porous plug, to a region of lower constant pressure, its temperature reduces is called as Joule-Thomson effect.



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06890

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## SUPPLIMENT

Signature  
of  
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Roll No.

: 7732

Class

: B.Sc. Syg

Subject :

Test / Tutorial No. :

Internal Exam.

Div. :

08  
10

Q-1 1) c) Thermodynamic functions.

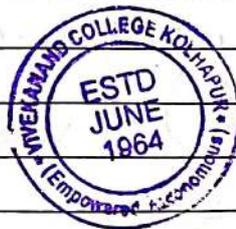
2) a) u.s.o.

Q-2 1) d) Internal energy. The sum of kinetic & potential energy of all the molecules in a thermodynamic system is called as internal energy. It is denoted by  $U$ .

i.e.  $dU = Tds - PdV$  from  $dQ = dU + dW$ .

b) Enthalpy - Enthalpy is a thermodynamic potential equal to the internal energy plus product of pressure & volume. It is denoted by  $H$ .

i.e.  $H = U + PV$ .



2.2

6) Clausius-clapeyron's equations!

The clausius-clapeyron's equation is derived from Maxwell's eq<sup>n</sup> of first thermodynamic potential

$$\text{i.e. } \left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V \quad \text{--- (1)}$$

Multiplying both sides by T.

$$T \left(\frac{\partial S}{\partial V}\right)_T = T \left(\frac{\partial P}{\partial T}\right)_V \quad \text{--- (2)}$$

We know  $dQ = Tds$  from first law of thermodynamics.

eq<sup>n</sup> (2) becomes.

$$\left(\frac{\partial Q}{\partial V}\right)_T = T \left(\frac{\partial P}{\partial T}\right)_V \quad \text{--- (3)}$$

Here  $\left(\frac{\partial Q}{\partial V}\right)_T$  represents heat absorbed or

emitted by the thermodynamic system. This heat must be latent heat. This also corresponds to change in volume. Let, L be the change in heat,  $dQ = L$  &  $dV = V_2 - V_1$ ,

$$\left(\frac{dQ}{dV}\right)_T = \frac{L}{V_2 - V_1}$$

Putting eq<sup>n</sup> (4) in (3)

$$T \left(\frac{\partial P}{\partial T}\right)_V = \frac{L}{V_2 - V_1}$$

$$\therefore \frac{\partial P}{\partial T} = \frac{L}{T(V_2 - V_1)}$$

This is clausius-clapeyron's equations



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**Vivekanand College, Kolhapur (Empowered Autonomous).**  
**Department of Physics**  
B.Sc. Part-II SEM III Examination (2023-24)  
Waves and Oscillations

Date :

Total Marks: 10

Day :

Time :- 30 min

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**

**(3)**

- 1) What is the frequency of SHM?
  - a) Number of oscillations per unit time
  - b) Time for one oscillation
  - c) Time taken for motion to reverse direction
  - d) Same as angular frequency
- 2) The waves, in which the particles of the medium vibrate in a direction perpendicular to the direction of wave motion, is known as \_\_\_\_\_
  - a) Transverse waves
  - b) Longitudinal waves
  - c) Propagated waves
  - d) Magnetic waves
- 3) Principle of superposition is obeyed by \_\_\_\_\_
  - a) Homogeneous equation
  - b) Linear equation
  - c) non linear equation
  - d) homogeneous and linear

**Q.2 Attempt any One**

**(12)**

1. Discuss in detail , analytically , the resultant motion of two simple harmonic motions having same frequency and acting along the same line
2. Discuss in detail , analytically , the resultant motion of two simple harmonic motions having same frequency and acting at right angles to each other.



Internal Attendance  
Waves & Oscillations  
B.Sc II  
2023-24.

Sr. No.	Name of student	Seat No.	Sign.
1)	Sakshi Raju Bronje	7726	<u>SPB Bronje</u>
2)	Ritu R. Nishad	7731	<u>Relishad</u>
3)	Tanishq Anil Mude	7730	<u>Tanishq</u>
4)	Prasad P. Gurav	7729	<u>Prasad</u>
5)	Vedant M. Mangaonkar	7718	<u>Vedant</u>
6)	Shivaji R. Jadhav	7939	<u>Shivaji</u>
7)	Vrushabh R. Chougule	7727	<u>VChougule</u>
8)	Sahil C. Patnekar	7733	<u>Sahil</u>
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06885

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

# VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

**SUPPLIMENT**  
wave & oscillations

Suppliment No. :

Roll No. : 7732

Class : B.Sc. II.

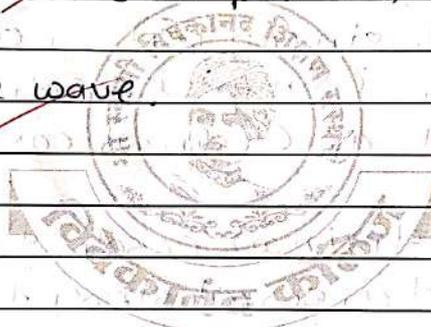
Signature  
of  
Supervisor

Subject : Physics  $\frac{06}{10}$   
Test / Tutorial No. : Internal Examination

Div. :

Q.1 1) a) Number of oscillation per unit time

2) ~~b)~~ a) Transverse wave



चार लाखां



Q2 1) Consider a simple harmonic motion having same frequency but different amplitude  $a_1$  &  $a_2$  so the phase difference are  $\alpha_1$  &  $\alpha_2$

Now the linear SHM  $y_1$  &  $y_2$  it is

$$y_1 = a_1 \sin(\omega t + \alpha_1) \quad \text{--- (1)}$$

$$y_2 = a_2 \sin(\omega t + \alpha_2) \quad \text{--- (2)}$$

Here

$$y = y_1 + y_2$$

$$\begin{aligned} y &= a_1 \sin(\omega t + \alpha_1) + a_2 \sin(\omega t + \alpha_2) \\ &= a_1 (\sin \omega t \cos \alpha_1 + \cos \omega t \sin \alpha_1) \\ &\quad + a_2 (\sin \omega t \cos \alpha_2 + \cos \omega t \sin \alpha_2) \\ &= a_1 \sin \omega t \cos \alpha_1 + a_2 \sin \omega t \cos \alpha_2 \\ &\quad + a_1 \cos \omega t \sin \alpha_1 + a_2 \cos \omega t \sin \alpha_2 \\ &= \sin \omega t (a_1 \cos \alpha_1 + a_2 \cos \alpha_2) \\ &\quad + \cos \omega t (a_1 \sin \alpha_1 + a_2 \sin \alpha_2). \end{aligned}$$

Now,

$$(a_1 \cos \alpha_1 + a_2 \cos \alpha_2) = R \cos \alpha$$

$$(a_1 \sin \alpha_1 + a_2 \sin \alpha_2) = R \sin \alpha$$

$$\sin \omega t (R \cos \alpha) + \cos \omega t (R \sin \alpha)$$

$$= R (\sin(\omega t + \alpha)). \quad \text{(3)}$$



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Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

# VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

## SUPPLIMENT

Suppliment No. :

Roll No. : 7731

Class : B.Sc. '57

Signature  
of  
Supervisor

Subject : physics

Test / Tutorial No. :

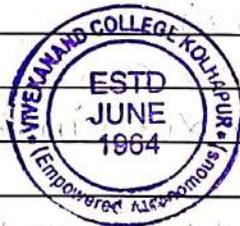
Div. :

09  
10

a.1

1) a) Number of oscillations per unit time.

2) b) transverse waves.



Q.2

17

Consider two Simple Harmonic oscillations having same frequencies but different amplitudes & phase acting on a particle in  $\gamma$ -direction, let  $\gamma_1$  &  $\gamma_2$  be the displacement of two SHM's. Therefore, according to the principle of superposition of waves the resultant displacement is given by

$$\gamma = \gamma_1 + \gamma_2$$

Here

$$\gamma_1 = a_1 \sin(\omega t + \alpha_1)$$

$$\gamma_2 = a_2 \sin(\omega t + \alpha_2)$$

where  $a_1$  &  $a_2$  are the amplitudes &  
 $\alpha_1$  &  $\alpha_2$  are phases.

$$\begin{aligned}\gamma &= a_1 \sin(\omega t + \alpha_1) + a_2 \sin(\omega t + \alpha_2) \\ &= a_1 (\sin \omega t \cos \alpha_1 + \cos \omega t \sin \alpha_1) + \\ &\quad a_2 (\sin \omega t \cos \alpha_2 + \cos \omega t \sin \alpha_2) \\ &\therefore \sin(A+B) = \sin A \cos B + \cos A \sin B\end{aligned}$$

$$= a_1 \sin \omega t (\cos \alpha_1 + \cos \alpha_2) + a_2 \cos \omega t (\sin \alpha_1 + \sin \alpha_2)$$

$$\text{put } a_1 (\cos \alpha_1 + \cos \alpha_2) = R \cos \theta \quad (1)$$

$$\text{& } a_2 (\sin \alpha_1 + \sin \alpha_2) = R \sin \theta \quad (2)$$

$$\gamma = \sin \omega t + R \cos \theta + \cos \omega t R \sin \theta \\ \sin(\omega t + \theta)$$

$$\therefore \sin(A+B) = \sin A \cos B + \cos A \sin B,$$

$$\gamma = \sin(\omega t + \theta)$$

This is the resultant displacement of two SHM's having same angular frequency but different,



amplitude & phase.

Squaring & adding eq<sup>n</sup> (1) & (2).

$$R \cos^2 \theta + R \sin^2 \theta = a_1^2 (\cos \alpha_1 + \cos \alpha_2) + a_2^2 (\sin \alpha_1 + \sin \alpha_2)^2.$$

$$= a_1^2 \cos^2 \alpha_1 + 2 \cos \alpha_1 \cos \alpha_2 + a_2^2 \cos^2 \alpha_2 + a_2^2 \sin^2 \alpha_1 + 2 \sin \alpha_1 \sin \alpha_2 + \sin^2 \alpha_2.$$

$$R (\cos^2 \theta + \sin^2 \theta) = a_1^2 (\cos^2 \alpha_1 + 2 \cos \alpha_1 \cos \alpha_2 + \cos^2 \alpha_2) + a_2^2 (\sin^2 \alpha_1 + 2 \sin \alpha_1 \sin \alpha_2 + \sin^2 \alpha_2).$$

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