**Bachelor of Science (B.Sc.) Semester—II**

**(C.B.S.) Examination**

**PHYSICS**

**Compulsory Paper—I**

**(Oscillations, Kinetic Theory of Gases & Thermodynamics)**

Time—Three Hours] [Maximum Marks—50

**N.B. :—** (1) **ALL** questions are compulsory.

(2) Draw neat and labelled diagrams wherever necessary.

**EITHER**

1. (a) What are Lissajous' Figures ? Discuss analytically the composition of two perpendicular S.H.Ms of same frequencies but of different amplitudes and phases. State the equation for phase difference $3\pi/4$. 5

(b) (i) Deduce the energy equation of damped oscillations and show that the total energy decreases exponentially with time. 3

(ii) A body of mass 1 kg is suspended from a spring of stiffness constant 25 N/m. If undamped frequency is $\frac{2}{\sqrt{3}}$ times the damped frequency, calculate damping constant. 2

**OR**

(c) Derive a general differential equation of a Simple Harmonic Oscillator. 2½

(d) A man stands on a platform that vibrates simple harmonically in a vertical direction at a frequency of 5 Hz. Show that the man loses contact with the platform when the displacement exceeds 0.01 metres. 2½

(e) What is a damped oscillator ? Obtain the differential equation for it. 2½

(f) State and explain the condition for critically damped motion. 2½

**EITHER**

2. (a) Explain the terms (i) Collision cross section, and (ii) Mean free path of gas molecule.

Deduce an expression for the mean free path of a gas molecule on the basis of Kinetic theory of gas. 5

(b) (i) What is amplitude resonance ? Obtain the expression for amplitude at resonance in case of a forced harmonic oscillator. 3

(ii) The equation of motion is

$$2 \times 10^{-4} \frac{d^2x}{dt^2} + 4 \times 10^{-2} \frac{dx}{dt} + 5x = 0.124 \sin 100\, t$$

where all quantities are in S.I. units. Find Natural frequency of undamped oscillation. 2

**OR**

(c) Derive an expression for the power dissipated by the forced oscillator. 2½

(d) A harmonic oscillator consisting of 50 gm mass attached to a mass-less spring has a quality factor 200. If it oscillates with an amplitude 2 cm in resonance with a periodic force of frequency 20 Hz. Calculate (i) average energy stored in it and (ii) rate of dissipation of energy. 2½

(e) Using the law of equipartition of energy, derive an expression for the ratio of molar specific heats of gases. 2½

(f) Describe the effect of pressure, temperature and density on mean free path of gas molecules. 2½

**EITHER**

3. (a) Describe Carnot's cycle and obtain an expression for efficiency of Carnot's heat engine in terms of temperatures. 5

(b) (i) Explain First law of thermodynamics and give its physical significance. 3

(ii) Calculate change in internal energy when 0.004 kg of air is heated from 2°C to 10°C at constant volume.

(Given : Specific heat of air at constant volume, $C_v$ = 0.172 K-cal/kg°C.) 2

**OR**

(c) Derive an expression for the coefficient of thermal conductivity. 2½

(d) Explain reversible process and irreversible process with examples. 2½

(e) State van der Waals' equation of state. Obtain expression for the critical constants in terms of van der Waals' constants. 2½

(f) The van der Waal's constants for a gas a and b are 0.37 $Nm^4/mole^2$ and 43 $cm^2/mole$ respectively. Find its $V_c$, $P_c$ and $T_c$. 2½

**EITHER**

4. (a) State Joule-Thomson effect. Derive an expression for Joule-Thomson coefficient.

Discuss the results of Joule-Thomson porous-plug experiment. 5

(b) (i) Explain with neat diagram, the process of liquefaction of helium gas. 3

(ii) The van der Waal's constants of $CO_2$ gas are a = 172 atm. $cm^6$ $mole^{-2}$ and b = 0.002 $cm^3$ $mole^{-1}$. If R = 8.3 J $mol^{-1}$ $K^{-1}$, calculate its temperature of inversion. 2

**OR**

(c) Explain the term entropy and give its physical significance. 2½

(d) What is Boyle's temperature ? Obtain the relation between Boyle's temperature and the temperature of inversion. 2½

(e) State and prove the Law of increase of entropy in Thermodynamics. 2½

(f) Calculate the increase in entropy when 1 gm atom of solid mercury at its melting point is raised to a temperature of 40 °C.

(Given : For mercury, melting point = –39 °C,

Latent heat of fusion = 3.0 cal/gm,
Mean specific heat = 0.0335 cal/gm. K and

One gm atom of mercury = 200 gm.) 2½

5. Attempt any **TEN** questions :—

(i) Define angular Simple Harmonic Motion.

(ii) One kilogram mass of a body is attached to the spring of stiffness constant 16 N/m. Find the natural frequency of oscillation.

(iii) Define quality factor of oscillator.

(iv) Write any two assumptions of the kinetic theory of gases.

(v) State the law of equipartition of energy.

(vi) Compute the ratio of molar specific heats for polyatomic gas molecules.

(vii) State the Zeroth law of Thermodynamics.

(viii) Define coefficient of self diffusion.

(ix) Write any two limitations of van der Waals' equation.

(x) Entropy and electric charge belong to the category of extensive variables — true or false ?

(xi) Calculate increase in entropy when 1 gm of water at 100°C is converted into steam at 100°C.

(Given : Latent heat of steam = 540 cal/gm)

(xii) Name the gas used in the compressor of Air Conditioner. 1×10=10