NKT/KS/17/5080

Bachelor of Science (B.Sc.) Semester—II (C.B.S.) Examination
PHYSICS
Compulsory Paper—1
(Oscillations, Kinetic Theory of Gases and Thermodynamics)

Time : Three Hours] [Maximum Marks : 50

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

(2) Draw neat diagrams wherever necessary.

(3) Symbols have their usual meaning unless otherwise stated.

EITHER

1. (A) What are Lissajous figures ? Obtain an expression for resultant of two linear S.H.M. of frequencies 2 : 1 and of different amplitudes, different phases. 5

(B) (i) Show that for damped harmonic oscillator, total energy decreases exponentially with time. 3

(ii) A mass of 25 gm is suspended with a vertical spring of force constant 25 N/m. The mechanical resistance of the system is 1.5 Ns/m. The mass is set to vertical oscillation. State whether the motion is oscillatory. 2

OR

(C) What is Restoring force ? Obtain an expression for differential equation of linear simple harmonic oscillator. 2½

(D) Explain how Lissajous' figures can be demonstrated using CRO. 2½

(E) For a damped harmonic oscillator show that average power dissipation is given by $P_{diss} = 2bE$. 2½

(F) A particle executing a S.H.M. has a maximum displacement of 4 cm and its acceleration at a distance of 1 cm from its mean position is 3 cm/s^2. What will be its velocity, when it is at a distance of 2 cm from its mean position ? 2½

EITHER

2. (A) What is forced oscillator ? Establish the differential equation for a forced oscillator. Distinguish between free and forced oscillations. 5

(B) (i) Explain the variation of amplitude with driving force frequency in a forced oscillation. 3

(ii) Calculate the maximum amplitude of the forced harmonic oscillator at resonance with amplitude of driving force $F_o = 6N$, mass of damped oscillator is 0.2 kg, spring constant $k = 100$ Nm^{-1}, Damping constant $R = 5$ Nm^{-1}s. 2

OR

(C) What is quality factor ? Give the physical significance of quality factor of a forced oscillator. 2½

(D) What is amplitude resonance ? Show that resonance frequency at amplitude resonance is given by $p_r = \sqrt{w^2 - 2b^2}$. 2½

(E) Write the expression for displacement of a particle performing forced oscillations. Show that maximum displacement is given by $A_{max} = \frac{f}{2b\sqrt{w^2 - p^2}}$. 2½

(F) A harmonic oscillator consisting of 100 gm mass attached to a massless spring has a quality factor 300. If it oscillates with an amplitude of 2 cm in resonance with a periodic force of frequency 20 Hz, calculate (i) the average energy stored in it and (ii) the rate of dissipation of energy. 2½

EITHER

3. (A) Define viscosity. Obtain an expression for coefficient of viscosity in terms of mean free path of the molecules. 5

(B) (i) Obtain an expression for critical temperature, critical pressure and critical volume for a real gas. 3

(ii) Calculate the critical pressure of a gas having van der Waals' constants a = 0.37 Nm^4/mole and b = 43 cm^3/mole. 2

OR

(C) Define mean free path. Discuss the effect of temperature and pressure on mean free path. 2½

(D) State and prove the law of equipartition of energy. 2½

(E) State van der Waals' equation of State of a real gas. What are its limitations ? 2½

(F) Calculate the mean free path of a gas at T = 300 K, p = 10^6 dynes/cm^2 and the molecular diameter $\sigma = 2 \times 10^{-8}$ cm. (Given K = 1.38×10^{-16} erg/K) 2½

EITHER

4. (A) Derive Claussius-Clapeyron's latent heat equation $\frac{dP}{dT} = \frac{L}{T(V_2 - V_1)}$ using Maxwell's thermodynamic relations. Explain the effect of pressure on the melting point of solid. 5

(B) (i) What is a heat engine ? Describe Carnot's ideal heat engine with a neat diagram. 3

(ii) A Carnot's engine takes in 1000 Kcal of heat from a reservoir maintained at 900 K and exhausts it to a sink at 300 K. Calculate the maximum efficiency of heat engine. 2

OR

(C) Define 'entropy'. Give its physical significance. 2½

(D) Show that change in entropy of a reversible process is zero. 2½

(E) Show that enthalpy remains constant in Porous plug Experiment. Hence state the condition for cooling effect of the gas. 2½

(F) Calculate the change in entropy when a substance of Mass 0.5 gm is heated from 100 K to 300 K. (Specific heat of the substance = 0.1 cal/gm-K) 2½

5. Attempt any **TEN** questions :—

(i) What is the condition of frequency ratio of two S.H.M.s forming Lissajous' figure of the shape ∞.

(ii) The Q value of a spring loaded with 0.3 kg is 60. It vibrates with a frequency of 2 Hz. Calculate the force constant.

(iii) What is the unit of mechanical resistance (R) of a system ?

(iv) If the resonant frequency of an acoustic system is 280 Hz and half power frequencies are 240 Hz and 360 Hz respectively, calculate the quality factor.

(v) Define mechanical impedance.

(vi) What is meant by sharpness of resonance ?

(vii) Define self -diffusion.

(viii) Define critical temperature of a gas.

(ix) Find the coefficient of viscosity of N_2 gas at N.T.P. if $\lambda = 10$ Å, $\bar{C} = 300$ m/s, $\rho = 1.5$ kg/m^3.

(x) What will be the efficiency of Carnot's engine at absolute zero temperature of the sink ?

(xi) State the third law of thermodynamics.

(xii) Define Joule-Thomson coefficient. 10×1=10