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

PHYSICS

(Oscillations, Kinetic Theory of Gases & Thermodynamics)

Compulsory Paper—I

Time—Three Hours] [Maximum Marks—50

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

(2) Draw neat and labelled diagrams wherever necessary.

EITHER

1. (A) (i) What are damped vibrations ?

(ii) Obtain the differential equation of motion for damped harmonic oscillator and obtain an equation for displacement. 5

(B) (i) Using the general solution of equation of damped harmonic motion discuss the case of :

(a) Dead beat motion

(b) Critically damped motion. 3

(ii) A particle of mass 5 kg lies in a potential field $V = 8x^2 + 200$ J/kg. Calculate its time period. 2

OR

(C) Show that the resultant of two SHMs at right angle to each other and having equal periods and amplitudes but phase difference is 90° is a circle. 2½

(D) Obtain an expression for the velocity and acceleration of the particle performing SHM. 2½

(E) A lift is ascending at acceleration of 3 m/s^2. What is the period of oscillation of simple pendulum of length one meter suspended in the lift ? 2½

(F) Define simple harmonic motion. Obtain differential equation for it. 2½

EITHER

2. (A) (i) What is meant by mean free path ? Derive an expression for mean free path of gas molecules. 3

(ii) Define the terms :

(a) Collision cross-section

(b) Frequency of collision. 2

(B) (i) Obtain the differential equation for forced harmonic oscillator. Solve the above differential equation to obtain steady state solution. 3

(ii) A mass of 25×10^{-2} kg is suspended from the lower end of the vertical spring having force constant 25 N/m. What should be the damping constant so that the motion is critically damped ? 2

OR

2. (C) Explain Amplitude Resonance in forced oscillations. 2½

(D) Derive an equation for power dissipated by forced oscillator. 2½

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

(F) The mean free path of N_2 molecules at 0°C at 1 atm. pressure is 8×10^{-8} m. If there are 2.7×10^{25} molecules/m^3 at this temperature and pressure, find the molecular diameter. 2½

EITHER

3. (A) Explain the Carnot's reversible cycle. Deduce an expression for its efficiency. 5

(B) (i) State and prove Carnot's theorem. 3

(ii) If efficiency of Carnot's engine with sink temp 27°C is 25% find the source temp. 2

OR

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

(D) Calculate the values of Van der Waal's constants 'a' and 'b' with following data :

$T_C = 132°K$, $P_C = 37.2$ atm.

$R = 8.314$ J/mol°K, 1 atm $= 1.013 \times 10^5$ N/m^2. 2½

(E) Explain the volume correction in Van der Waal's equation of state of gases. 2½

(F) State the Van der Waal's equation of state and give its limitations. 2½

EITHER

4. (A) (i) Describe the porous plug experiment with diagram. 2

(ii) What is Joule-Thomson effect ? Show that enthalpy remains constant in porous plug experiment. 3

(B) (i) Obtain an equation for Joule-Thomson coefficient. 3

(ii) Calculate change in temperature of gas when it suffers Joule-Thomson expansion at 300°K, the pressure difference on two sides of the plug being 5 atm.

$a = 0.303\ Nm^4/mole^2$, $b = 4.27 \times 10^{-3}\ m^3/mole$

$R = 8.31$ J/mole °K, $C_p = 8.75$ Cal/mole °K,

$J = 4.18$ J/Cal. 2

OR

(C) Derive Claussius Clapeyron's equation from Maxwell's thermodynamic relation. 2½

(D) Explain the process of liquefaction of helium gas with neat diagram. 2½

(E) What is entropy ? Explain the change in entropy in reversible and irreversible process. 2½

(F) Calculate the change in vapour pressure of water when its boiling point changes from 100°C to 110°C. Given : Volume of 1 gm of water = 1640 cm^3 and latent heat of vapourization = 540 Cal/gm and 1 Cal = 4.2 J. 2½

5. Attempt any **TEN** questions :

(i) What is Lissajous figures ?

(ii) Draw the resultant of two SHMs acting perpendicular to each other of same frequencies with diff. amplitude when $\phi = \pi/4$.

(iii) At what distance the kinetic energy and potential energy of Simple Harmonic Oscillator is equal ?

(iv) What is quality factor ?

(v) What is velocity resonance ?

(vi) Explain the term degrees of freedom.

(vii) Define intensive and extensive variables of the system.

(viii) State zeroth law of thermodynamics.

(ix) Find the coefficient of viscosity of Nitrogen at N.T.P. if $\lambda = 9.98 \times 10^{-8}$ m, $\tau = 455$ m/s and $\rho = 1.25$ kg/m^3.

(x) What is throttling process ?

(xi) Calculate the inversion temperature of gas if a = 0.0341 atm $lit^2/mole^2$, b = 0.0237 lit/mole, R = 8.31 J/mole °K.

(xii) Define the term Reversible Process. 1×10=10