(b) Write the differences between the first order and second order phase transitions. 2

(c) Derive the relation 2

$$C_2 - C_1 = \frac{dL}{dT} - \frac{L}{T}$$

where L is the latent heat.

9. (a) Find the elctric field as a point inside a uniformly changed solid sphere of radius R and change density ρ using Gauss's law. 4

(b) Show that the solution of $\nabla^2 V = 0$ in spherical polar coordinate system is 6

$$V\,(r,\theta) = \sum_{l=A}^{\infty} \left(A_l\, r^l + \frac{B_l}{r^{l+1}}\right)\, p_l\,(\cos\theta)$$

where p_l (cos θ) is Legendre polynomial.

10. (a) Obtain the multipole expansion of V in powers of $\frac{1}{r}$ and identify the octopole term. 6

(b) Find the capacitance of a parallel plate capacitor filled with a dielectric medium of dielectric constant. 4

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UG (CBCS) EVEN SEMESTER EXAMINATION, 2023

EDUCATION (B.Sc. B.Ed.)

PHYSICS (HONOURS)

4th Semester

Course No. : BSPH - 401

(Heat, Thermodynamics & Electrostatics)

Full Marks : 50

Pass Marks : 20

Time : 2 hours

The figures in the margin indicate full marks for the questions

1. (a) Show that the man free path of a gas is $\lambda = \frac{1}{n\pi d^2}$ where the symbols have their usual meanings. 3

(b) Derive the relation for pressure exerted by a gas.

$$p = \frac{1}{3}\varrho\, c^2 \quad where \quad c^2 = \frac{c_1^2 + c_2^2 + \ldots\ldots c_n^2}{n}$$ 7

Or

2. (a) Derive Vander Waal's equation of state of gas.

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT$$ 5

(b) Show that the coefficient of diffusion of gas is 5

$$D = \frac{2}{3}\,\frac{1}{d^2 p\sqrt{m}}\left(\frac{KT}{\pi}\right)^{3/2}$$

3. (a) Derive the one dimensional heat conduction equation 5

$$\rho\,c\,\frac{dT}{dt} - K\frac{dT}{dx^2} = 0$$

(b) Define emissive power of black body. 1

(c) State and prove Kinchhoff's law of blackbody radiation. 4

Or

4. (a) Explain ultra-violet (uv) catastrophe of blackbody radiation. 2

(b) Deduce Rayleish-Jean's law of blackbody radiation from Planck's law. 2

(c) Derive Wein's displacement law of blackbody radiation from Planck's law. 6

5. (a) Derive the work done in the isothermal process. 5

(b) Show that the change in entropy in adiabatic process is 5

$$S_2 - S_1 = R\left(\frac{\gamma}{\gamma-1}\right)\log_e\left(\frac{V_2}{V_1}\right)$$

Or

6. (a) Derive the relation $C_P - C_V = nR$. Explain why $C_P > C_V$. 5

(b) Show that the entropy of perfect gas is 5

$S = C_P \log_e V + C_V \log_e P + \text{Const.}$

7. (a) Write the physical significance of thermodynamic potentials. 2

(b) Obtain the relation 2

$dA = - SdT - PdV$

where A = Helmhottz free energy. 2

(c) Derive Maxwell's thermodynamic relations 3+3=6

(i) $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial s}\right)_V$

(ii) $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$

Or

8. (a) Derive the following Tds equations. 3+3=6

(i) $Tds = C_p dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$

(ii) $Tds = C_v \left(\frac{\partial T}{\partial P}\right)_V dP + C_v \left(\frac{\partial T}{\partial V}\right)_P dV$