B.Sc. S. Y. (CBCS Pattern) Semester-III

USPHT05 - Physics Paper-I : Thermal Physics

P. Pages : 3 **GUG/S/25/11616**

Time : Three Hours * 1 5 6 6 * Max. Marks : 50

Notes : 1. All questions are compulsory.
2. Draw neat labelled diagram wherever necessary.

Either:

1. A) i) Define mean free path. Derive the Maxwell's expression for mean free path (λ) on the basis of kinetic theory of gases. **5**

ii) Explain the variation of mean free path (λ) with temperature and pressure. **3**

iii) The diameter of nitrogen molecule is 3.2×10^{-10} m. The number of molecules at 0°C and 1 atm. Pressure is 2.69×10^{25} per m^3. Calculate the mean free path for nitrogen molecule. **2**

OR

B) a) Describe the basic postulates of kinetic theory of gases. **2½**

b) State and prove Maxwell's law of equipartition of energy. **2½**

c) Find the coefficient of viscosity of nitrogen at N.T.P. from the following data: **2½**
$\rho = 1.25\,kg/m^3$, $c = 454.4\,m/sec$, $\lambda = 9.44\times10^{-8}\,m$

d) Discuss the effect of temperature and pressure on coefficient of thermal conductivity. **2½**

Either:

2. A) i) Derive an expression for work done during an adiabatic process. **4**

ii) Prove that PV^r = constant in an adiabatic transformation. **4**

iii) Air at N.T.P. is compressed adiabatically to half its volume. Calculate the change in its temperature. (Given : r for air = 1.4). **2**

OR

B) a) Explain the term thermodynamic system and thermodynamic variables. **2½**

b) State first law of thermodynamics. Give its physical significance. **2½**

c) What is internal energy of a system? Show that internal energy is a state function. **2½**

d) Calculate the work done when a gram molecule of an ideal gas expands isothermally at 27°C to double its original volume. $\left[R = 8.3 J / deg.mole\right]$. **2½**

Either:

3. a) i) Describe Carnot's cycle and obtain the expression for the efficiency of an ideal heat engine in terms of temperatures. **7**

ii) Find the efficiency of the Carnot's engine working between the steam point and the ice point. **3**

OR

B) a) Explain the concept of reversible and irreversible process. **2½**

b) Define entropy. Discuss the physical meaning of entropy. **2½**

c) Calculate the change in entropy when 10 gms of ice at 0°C is converted into water at the same temperature. (Latent heat of ice = 80 cal/gram) **2½**

d) Explain how concept of entropy leads to second law of thermodynamics. **2½**

Either:

4. A) i) state and deduce Clausius-Clapeyron's equation. Explain the effect of pressure on boiling point of liquid and melting point of solid. **7**

ii) Calculate under what pressure ice freezes at 272k if the change in specific volume when 1 kg of water freezes is $91\times10^{-6} m^3$. Given latent heat of ice = $3.36\times10^5 J / kg^{-1}$. **3**

OR

B) a) Prove the first T.ds equation i.e. **2½**

$$Tds = C_v dT + T\left(\frac{\partial P}{\partial T}\right)_V dV.$$

b) Using Maxwell's thermodynamical relations show that **2½**

$$\left(\frac{\partial C_v}{\partial V}\right) = T\left(\frac{\partial^2 S}{\partial V.\partial T}\right) = T\left(\frac{\partial^2 P}{\partial T^2}\right) V.$$

c) Define the Helmholtz function for an isochoric process and establish the relation: **2½**

$$U = F - T\left(\frac{\partial F}{\partial T}\right)_V.$$

d) Obtain the first Maxwell's thermodynamical relation. **2½**

5. Attempt **any ten** of the following.

a) What is degree of freedom. **1**

b) Define coefficient of thermal conductivity. **1**

c) Write the relation between η and K. **1**

d) What is isothermal process? **1**

e) State the zeroth law of thermodynamics. **1**

f) What is the relation between C_p and C_v? **1**

g) State Carnot's theorem. **1**

h) What is heat engine? **1**

i) State third law of thermodynamics. **1**

j) Define Latent heat. **1**

k) What is Gibb's function? **1**

l) What is Joule-Thomson effect? **1**

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