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

USPHT05 : Physics Paper-I : Thermal Physics

P. Pages : 3 **GUG/W/22/11616**

Time : Three Hours * 3 7 5 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. **1**

ii) Derive an expression for mean free path of gas molecules on the basis of kinetic theory of gasses and discuss the effect of temperature and pressure on mean free path. **5**

iii) Explain collision cross-section. **2**

iv) Calculate the mean free path and collision cross-section at 0ºC and 1 atmospheric pressure if the number of molecules per unit volume is 3×10^{25} m^{-3} effective diameter of molecules is 2×10^{-8} cm and the average speed of molecules at the given temperature and pressure is 10^3 m/s. **2**

OR

b) a) Write the assumptions of kinetic theory of gases. **2½**

b) what is Degree of Freedom? Write Degree of Freedom for Mono, Di and Polyatomic gases. **2½**

c) Derive an expression for the coefficient of viscosity of a gas on the basis of kinetic theory of gases. **2½**

d) The average kinetic energy of a gas molecule at a certain temperature is 6.21 X 10^{-21} joule. Find the temperature. **2½**
(Boltzmann's constant K = 1.38 X 10^{-23} joule K^{-1})

Either:-

2. a) i) What is an adiabatic Process? **1**

ii) Derive an expression for work done in adiabatic process. **3**

iii) Show that for an adiabatic change in a perfect gas PV^{γ} = Constant. **3**

iv) A gas occupying one litre at 80 cm pressure is expanded adiabatically to 1190 c.c. If pressure falls to 60 cm. in the process, deduce the value of γ. **3**

OR

b) a) What are intensive and extensive variables? **2½**

b) State First law of thermodynamics. Discuss its physical Significance and limitations. **2½**

c) Write a note on: **2½**
i) Isothermal process ii) Isochoric Process.

d) Calculate the work done by one mole of an ideal gas when it is expanded to double its volume at constant temperature at 0ºC. Given, R = 8.31 J/Mole ºC. **2½**

Either:-

3. a) i) What is Heat Engine? Define its efficiency. **2**

ii) Describe Carnot's reversible cycle. Deduce an expression for efficiency of Carnot's Heat Engine. **4**

iii) What are the effective ways to increase the efficiency of Carnot's Heat Engine. **2**

iv) In a Carnot's engine the temperature of the source and sink are 227ºC and 102ºC respectively. If the engine consumes 600×10^5 cals. Per cycle, find (i) efficiency of the engine (ii) work done per cycle. **2**

OR

b) a) Write Plank's and Clausius statements of second law of thermodynamics. **2½**

b) State Carnot's theorem. **2½**

c) Explain Carnot's reversible cycle on the basis of T-S diagram and find the efficiency of Carnot's heat engine. **2½**

d) Calculate the change in entropy of a system containing 1 kg ice at 0ºC which melts at the same temperature. Latent heat of ice 79.6 k cal/kg. **2½**

Either:-

4. a) i) What is Joule-Thomson effect? **1**

ii) Explain Joule-Thomson Porous-Plug experiment. **3**

iii) Apply Joule-Thomson effect to show that enthalpy is constant and obtain an expression for Joule-Thomson coefficient. **4**

iv) Calculate the change in temperature when carbon dioxide gas suffers Joule-Thomson expansion at 300 K. The pressure difference on the two sides of the plug being 5×10^5 Nm^{-2}. **2**

Given : $a = 0.303\ Nm^4\ mole^{-2}, b = 4.27x10^{-3} m^3 mole^{-1} R = 8.31\ J\ mole^{-1}K^{-1}$,

$C_p = 8.75\ cal\ mole^{-1}K^{-1}$, $J = 4.18\ J/cal.$

OR

b) a) Explain following thermodynamic potentials: **2½**
i) Gibb's function ii) Helmholtz function.

b) Derive general equation of Maxwell's Thermodynamics relation using first and second law of thermodynamics. **2½**

c) Derive Clausius – Clapeyron's latent equation. **2½**

d) Calculate the change in melting point of wax when pressure is increased by 50 atmospheric pressure, using the following data: **2½**
Melting point of was = 64ºC, volume of solid wax at its melting point = 1.161 cm^3, volume of liquid was at its melting point = 1.166 cm^3, density of solid wax at 64ºC = 0.96 g/cm^3, latent heat of wax = 97 kilo-cal/kg, 1 atmospheric pressure = 10^5 N/m^2, J = 4.2 joule/calorie.

5. Attempt **any ten** questions from the following.

a) Define degree of freedom. **1**

b) Write an equation of pressure exerted by the gas. **1**

c) Find the coefficient of viscosity of nitrogen gas at N.T.P. from the following given data. **1**
Mean free path, $\lambda = 9.98x10^{-8}$ m, average velocity, c = 455 m/s, Density $\rho = 1.25\ kg/m^3$.

d) What is an extensive variable? Give its example. **1**

e) State Zeroth law of thermodynamics. **1**

f) What is specific heat at constant pressure (C_p). **1**

g) Write second law of thermodynamics in terms of entropy. **1**

h) What is reversible and irreversible process? **1**

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

j) What is laten heat? Write its SI unit. **1**

k) Write first and second TdS equations. **1**

l) Write second latent heat equation (Clausius equation). **1**

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