

B.Sc. S.Y. CBCS Pattern Semester-III
USPHT05 - Physics Paper-I : Thermal Physics

P. Pages : 3

Time : Three Hours



GUG/W/23/11616

Max. Marks : 50

- Notes : 1. All questions are compulsory.
2. Draw neat and well labeled diagrams wherever necessary.

Either:-

1. a) i) Discuss the transport phenomena in gases? 2
ii) Deduce an expression for the coefficient of thermal conductivity of a gas in terms of mean free path. 6
iii) The average velocity of molecules of a gas is 4.5×10^2 m/s. The density of the gas is 1.25 kg/m^3 . The coefficient of viscosity of the gas is $1.66 \times 10^{-5} \text{ Ns/m}^2$. Calculate 2
a) the mean free path and b) The frequency of collision.

OR

- b) a) Define most probable speed of molecule of gas. Obtain an expression for most probable speed of a molecule of gas using Maxwell's law of distribution of speed. 2½
b) State and prove the law of equipartition of energy. 2½
c) Obtain an expression for mean free path of gas molecules. 2½
d) If the molecular diameter of nitrogen is 3.5 AU., then calculate the mean free path of molecules of nitrogen gas at 1 atmospheric pressure and temperature 37°C . Given that the Boltzmann's constant $k=1.38 \times 10^{-23} \text{ J/K}$, $1 \text{ atm} = 10^5 \text{ N/m}^2$ 2½

Either:-

2. a) i) Derive an expression for the work done during adiabatic process in terms of initial and final pressure. 3
ii) State and explain the first law of thermodynamics. Give its physical significance. 3
iii) What are the extensive and intensive variables? Give their examples. 2
iv) A perfect gas at initial pressure of 20 atm expands from 2 litre to 20 litres at a constant temperature of 27°C . Calculate the work done. 2
Given $1 \text{ atm} = 1.013 \times 10^5 \text{ N/m}^2$

OR

- b) a) State and explain Zeroth law of thermodynamics. Discuss its importance. 2½

- b) Prove that for an adiabatic process, $\frac{P^{\gamma-1}}{T} = \text{constant}$. 2½
- c) Distinguish between the isothermal process and adiabatic process. 2½
- d) A quantity of air at 27°C and atmospheric pressure is suddenly compressed to half its original volume. Find (i) the final pressure and (ii) the final temperature. 2½
Given $\gamma = 1.4$.

Either:-

3. a) i) What is the heat engine? Describe the construction of Carnot's ideal heat engine. Describe Carnot's reversible cycle and obtain an expression for its efficiency. 8
- ii) Calculate the efficiency of the Carnot's engine working between 100°C and 0 °C. 2

OR

- b) a) Define entropy of a system. Discuss its physical significance. 2½
- b) Discuss the reversible and irreversible processes. 2½
- c) State the various statements of the second law of thermodynamics. 2½
- d) Find the change in entropy when 10kg of ice at 273 K is converted into water at the same temperature. Given : Latent heat of fusion of ice 80 Kcal/kg 2½

Either:-

4. a) i) What is Joule Thomson effect? Describe Porous Plug experiment and show that $U+PV = \text{constant}$. 6
- ii) Deduce the second latent heat equation (Clausius equation). 2
- iii) Obtain second T.dS equation $TdS = C_P dT + T \left(\frac{\partial V}{\partial T} \right)_P dP$ 2

OR

- b) a) Derive Maxwell's general thermodynamic equation connecting the thermodynamic quantities. 2½
- b) Show that $TdS = C_V dT + T \left(\frac{\partial P}{\partial T} \right)_V dV$ 2½
- c) Derive Clausius – Clapeyron latent heat equation. 2½
- d) Calculate the pressure at which water will boil at 120°C, if change in the specific volume is 1.676 m³/kg, L = 540 Kcal/kg, J = 4200 J/Kcal, B.P. of water = 100°C and 1 atm = 10⁵ N/m². 2½

5. Attempt **any ten** questions from the followings.
- a) Draw the Maxwell's speed distribution curve at different temperatures. **1**
 - b) Define rms speed and average speed. **1**
 - c) What is meant by the degree of freedom? **1**
 - d) What is the isochoric process? Give its examples. **1**
 - e) Define specific heat of gases. **1**
 - f) State the limitations of first law of thermodynamics. **1**
 - g) Which is more effective way to increase the efficiency of Carnot's heat engine? **1**
 - h) State Carnot's theorem. **1**
 - i) Draw T-S diagram? **1**
 - j) What is the effect of change of pressure on the boiling point of liquid? **1**
 - k) Draw the experimental set up for the porous – Plug experiment. **1**
 - l) Define Gibbs function. **1**
