

B.Sc. Second Year (CBCS Pattern) Sem-III  
**USPHT05 - Physics Paper-I (Thermal Physics)**

P. Pages : 3

Time : Three Hours



**GUG/W/23/11616 (S)**

Max. Marks : 50

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

**Either :**

1. A) i) What are the transport phenomena in gases? 2
- ii) Deduce an expression for the coefficient of viscosity of gas on the basis of mean free path concept. Explain the effect of pressure and temperature of a gas on it. 6
- iii) The average velocity of molecules of a gas is  $4.5 \times 10^2 \text{ m/s}$ . The density of the gas is  $1.25 \text{ kg/m}^3$ . The coefficient of viscosity of the gas is  $1.66 \text{ N s/m}^2$ . Calculate (a) the mean free path and (b) the frequency of collision. 2

**OR**

- B) a) What is rms speed of molecule of gas. Obtain an expression for rms 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) What is mean free path of gas molecule. Derive an expression for mean free path of gas molecules. 2½
- d) Calculate the mean free path of a molecule of benzene if the number of molecules per unit volume is  $2.79 \times 10^{19} \text{ cm}^{-3}$  and the diameter is  $6 \times 10^{-8} \text{ cm}$ . 2½

**Either :**

2. A) i) Derive an expression for the work done during isothermal process in terms of pressure. 3
- ii) Prove that for an adiabatic process,  $PV^\gamma = \text{constant}$ . 3
- iii) Distinguish between the isothermal process and adiabatic process. 2
- iv) A quantity of dry air at  $27^\circ\text{C}$  is compressed suddenly to  $\frac{1}{4}$  of its volume. Calculate the final temperature. Given  $\gamma = 1.4$ . 2

**OR**

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

- b) State and explain the first law of thermodynamics. Give its physical significance. 2½
- c) What are the extensive and intensive variables? Give their examples. 2½
- d) If the ideal gas expands isothermally from initial volume of 3 litres at 20 atm to a final volume of 30 litres, calculate the work done by the gas. 2½
- Given  $1 \text{ atm} = 1.013 \times 10^5 \text{ N/m}^2$ .

**Either :**

3. A) i) Discuss the reversible and irreversible process with example. 2
- ii) Describe Carnot's reversible cycle. Obtain an expression for its efficiency. Which is more effective way to increase the efficiency of Carnot's heat engine? 6
- iii) A Carnot's engine whose heat sink is at  $27^\circ\text{C}$  has its efficiency 40%. What is the temperature of the heat source? 2

**OR**

- B) a) Define entropy of a system. Discuss its physical significance. 2½
- b) Prove that the area on T-S diagram represent the work done in the Carnot's cycle. 2½
- c) State the various statements of the second law of thermodynamics. 2½
- d) Calculate the change in entropy when  $5 \times 10^3 \text{ gm}$  of water of  $100^\circ\text{C}$  is converted into steam at the same temperature. Given latent heat of water is 540 Kcal/kg. 2½

**Either :**

4. A) i) What is Joule Thomson effect? Describe Porous Plug experiment and show that  $U + PV = \text{Contant}$ . 6
- ii) Derive Clausius – Clapeyron latent heat equation. 2
- iii) Show that  $TdS = C_V dT + T \left( \frac{\partial P}{\partial T} \right)_V dV$ . 2

**OR**

- B) a) Derive Maxwell's general thermodynamic equation connecting the thermodynamic quantities. 2½
- b) Obtain second T.dS equation  $TdS = C_P dT + T \left( \frac{\partial V}{\partial T} \right)_P dP$ . 2½
- c) Deduce the second latent heat equation. 2½

- d) Calculate the increase in boiling point of water when pressure of steam on its surface is increased from 1 atm to 1.10 atm. Given latent heat of water at 100°C is 540 cal/g, volume of 1 gm of steam is  $1676\text{ cm}^3$ ,  $1\text{ atm} = 1.013 \times 10^6\text{ dyne/cm}^2$ ,  $1\text{ cal} = 4.2 \times 10^7\text{ erg/g}$ . 2½

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

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|-----------------------------------------------------------------------------|---|
| a) Draw the Maxwell's speed distribution curve at different temperatures.   | 1 |
| b) Define most probable 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) What is heat engine? Define its efficiency.                              | 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) State the enthalpy function.                                             | 1 |
| l) State Clausius equation.                                                 | 1 |

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