U.G. 3rd Semester Examination - 2022

PHYSICS

[HONOURS]

Course Code : PHY-H-CC-T-06

(Thermal Physics)

Full Marks : 40 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP-A

1. Answer any **five** questions: 2×5=10

   a) Explain the concept of quasi-static process in thermal physics.

   b) What are isothermal elasticity and adiabatic elasticity of a gas?

   c) What is r.m.s speed of a gas? At what temperature will r.m.s speed of oxygen molecule be double its value at N.T.P., while pressure remaining constant?

d) State and explain the 1st law of thermodynamics.

e) 'The reversibility is an ideal concept' — Explain.

f) 'Entropy is a measure of disorder' — Explain.

g) Define enthalpy and Gibbs free energy of a thermodynamic system.

h) State the law of equipartition of energy.

GROUP-B

Answer any **three** questions: 10×3=30

2. a) Calculate the probability that the speed of an oxygen molecule of mass 32 units will lie in the range of 200 m/s to 201 m/s at 27°C.

b) Show that the Kelvin-Planck statement and Clausius statement of the second law of thermodynamics are equivalent. 5+5

3. a) Prove the relation:

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$$

where the symbols have their usual meanings.

b) The Gibbs free energy of a certain thermodynamic system is given by $G(p,T) = RTln\left[\frac{ap}{(RT)^{\frac{5}{2}}}\right]$, where a and R are constants. Find the specific heat at constant pressure of the thermodynamic system.

c) What do you mean by phase transition? What is the order of the phase transition in ferromagnetic to paramagnetic transition?

3+5+(1+1)=10

4. a) Using the law of equipartion of energy, establish the relation between degrees of freedom and the ratio of the two specific heats of a gas.

b) What is Carnot's theorem? A Carnot engine operates between two tempeatures T_1 and T_2, where $T_1 > T_2$. Show that the efficiency of the cycle is $\left(1-\frac{T_2}{T_1}\right)$.

c) Consider two distinguishable particles X and Y. If the diameter of X is thrice that of Y while molecular weight is thrice, find the ratio of the co-efficient of viscosity of the two molecules. 3+(1+4)+2=10

5. a) Show that the probability of a gas molecule, traversing a distance x in a collision-free process, is $e^{-\frac{x}{\lambda}}$, where λ is the mean free path of the gas molecule.

b) Assuming linear combination, find the number of the degrees of freedom of a water molecule.

c) Using Maxwell's distribution for the speed of molecules in a gas, find the most probable speed v_p. Is the distribution symmetric about v_p?

3+2+(3+2)=10

6. a) Using Clausius' theorem, show that $S_f - S_i \geq \int_i^f \frac{\delta Q}{T}$, where the symbols have their usual meanings.

b) Establish the relation for the rate of change of temperature with pressure in a Joule- Thomson process: $\mu_{JT} = \left(\frac{\partial T}{\partial P}\right)_H = \frac{V}{C_P}(\alpha T - 1)$, where the symbols have their usual meanings. What is the value of μ_{JT} for an ideal gas?

5+(4+1)=10
