2022
B.A./B.Sc.
Third Semester
CORE – 6
PHYSICS
Course Code: PHC 3.21
(Thermal Physics)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) Give any four postulates of kinetic theory of gases. 2
   (b) Starting from the Maxwell-Boltzmann law of distribution of velocities in an ideal gas, derive the expressions for the average velocity, mean square velocity, root mean square velocity and the most probable velocity. 3+3+3+3=12

2. (a) Derive an expression for the probability for molecule to travel a distance *x* without suffering a collision. 5
   (b) What are transport phenomena? Derive an expression for the coefficient of thermal conductivity of a gas. 1+6=7
   (c) Calculate the values of molar heat capacity C_p and C_v of a gas if ratio of heat capacities is 1.49. Given R = 8.3 J/mole/K 2

UNIT–II

3. (a) What are critical constants of a gas? Obtain the expressions for critical temperature, pressure and volume in terms of the constants of Van der Waals equation. 1+4+3+3=11
   (b) Calculate the Van der Waals constants for dry air, given that T_c = 132 K, P_c = 32.7 atmospheres and R per molecule = 82.07 cm^3 atmosphere/K. 3

4. (a) Explain Joule-Thomson porous plug experiment and derive the fundamental equation of the Joule-Thomson effect. Discuss the results obtained from the experiment. 4+4+2=10

   (b) Obtain the relation between Boyle temperature, critical temperature and temperature of inversion. 4

UNIT–III

5. (a) State the differential form of first law of thermodynamics and discuss its physical significance. 2+2=4

   (b) Explain why the specific heat of a gas at constant pressure is greater than at constant volume. Derive Mayer's relation for the difference between the two specific heats of a perfect gas. 2+4=6

   (c) Derive the expression for the work done during an adiabatic expansion of a perfect gas. 4

6. (a) Describe Carnot's reversible heat engine and obtain an expression for its efficiency. 4+4=8

   (b) Discuss the thermodynamical scale of temperature. Show that this scale of temperature is identical with the perfect gas scale of temperature. 3+3=6

UNIT–IV

7. (a) Explain how the concept of entropy leads to second law of thermodynamics. Draw the temperature entropy diagram for a Carnot's cycle and show that its area represents the available energy. 2+3=5

   (b) What is an isentropic process? Show that in irreversible processes entropy always increases. 1+3=4

   (c) State Clausius inequality and prove it for the case of reversible cycle. 1+2=3

   (d) Calculate the change in entropy when 20 gms of ice at 0°C is converted into water at the same temperature. The latent heat of ice is given by 80 cal/gm. 2

8. (a) Why does a natural system always tend to change in the direction of increasing disorder? Derive an expression for the change of entropy of a perfect gas in respect of pressure and volume. 2+3=5
   (b) State and explain the third law of thermodynamics. 3
   (c) Explain the four thermodynamic potentials. 4
   (d) 30 g of water at 0°C is mixed with an equal mass of water at 80°C. Calculate the change in entropy. 2

UNIT–V

9. (a) Starting from the four thermodynamic potentials, derive the Maxwell's thermodynamic relations. 2+2+2+2=8
   (b) Explain how low temperature can be achieved by adiabatic demagnetisation of paramagnetic substance. 4
   (c) Write two energy equation obtained from Maxwell's relations. 2

10. (a) What is a triple point? Derive the expression for Clausius-Clapeyron's latent heat equation from the first order phase transitions. 1+4=5
   (b) Using Maxwell's thermodynamic relation, explain the Joule-Thomson effect for Van der Waal's gas. 6
   (c) Write the three TdS equation obtained from Maxwell's relations. 3