2023
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) Using the law of equipartition of energy, show that for a gas possessing degrees of freedom (f), the ratio of two specific heat at constant pressure and volume is $(1+2/f)$. Find the ratio for mono-atomic, dia-atomic and tri-atomic gases. 4+3=7
   (b) Explain Brownian motion? Derive Einstein's relation for Brownian motion. 3+4=7

2. (a) What is meant by free path? Derive an expression for the mean free path of gas molecules. 2+4=6
   (b) What is transport phenomenon? On the basis of kinetic theory, deduce an expression for the viscosity of a gas in terms of mean free path of its molecules. 3+5=8

UNIT–II

3. (a) Deduce van der Waal's equation of state. 3+4=7
   (b) With proper diagram give the description of Joule-Thomson porous plug experiment. 4
   (c) The van der Waal's constants for 1 gm molecule of hydrogen gas are 0.245 atms litre^2/mole^2 and 2.67 $\times 10^{-2}$ litre/mole. Calculate the critical temperature. 3

4. (a) Discuss mathematically the Joule-Thomson effect for a van der Waal's gas and show that the temperature of inversion is $\frac{2a}{bR}$, where symbols have their usual meanings. 8
   (b) In what respect an isotherm of real gases differs from an ideal gas. 3
   (c) The van der Waal's constant for dry air are 13.31×10^6 atm cm^6, 36.41 cm^3, 132 K and 82.07 cm^3 atm/K. Calculate the critical pressure. 3

UNIT–III

5. (a) Derive the expression for the work done during an isothermal expansion of a perfect gas. 4
   (b) Explain thermodynamic system and thermodynamic variables. 4
   (c) What are the basic requirement for thermodynamic equilibrium? 3
   (d) A diatomic gas at 27° C is compressed adiabatically. Find the final temperature of the gas. 3

6. (a) With proper diagram, explain the principle and working of a heat engine. 2+2+2=6
   (b) Write Kelvin-Planck and Clausius statement of second law of thermodynamics. 4
   (c) Find the efficiency of a Carnot's engine working between 127° C and 27° C. If it absorbs 80 calories of heat, how much heat is rejected? 4

UNIT–IV

7. (a) State and explain the third law of thermodynamics. Prove that it is impossible to obtain absolute zero temperature. 2+2+2=6
   (b) What is disorder in a system? Why does a natural system always tend to change in the direction of increasing disorder? 2+2=4
   (c) One gram molecule of a gas expands isothermally to four times of its volume. Calculate the change in its entropy in terms of the gas constant. 2+2=4

8. (a) What do you mean by entropy? Derive an expression for the change of entropy of a perfect gas in respect of temperature and pressure. 2+4=6

(b) Discuss the law of increase of entropy and give its importance in natural processes. 5

(c) Calculate the change in entropy when 5 kg of ice at 0° C is converted into water at the same temperature. The latent heat of steam is 540 cal/gm. 3

UNIT–V

9. (a) Derive the first energy equation and show that the internal energy of a real gas depends on volume. 6

(b) Explain why the temperature of a gas drops in adiabatic expansion and rises during adiabatic compression. 3+3=6

(c) Distinguish between first and second order phase transition. 2

10. (a) Derive first, second and third Tds equations. 3+3+3=9

(b) Discuss the production of cooling in a thin film when it is stretched adiabatically. 5