2024/FYUG/ODD/SEM/
PHYDSC–202T/058

FYUG Odd Semester Exam., 2024

PHYSICS

(3rd Semester)

Course No. : PHYDSC–202T

(Thermal Physics)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* from the following : 2×2=4

(a) Why is C_P greater than C_V ?

(b) What are the limitations of the first law of thermodynamics?

(c) Distinguish between isothermal and adiabatic processes.

2. *(a)* Using the first law of thermodynamics, derive an expression for the difference between the two specific heats of gases. 5

(b) Calculate the amount of work done during isothermal expansion of a gas. 5

OR

3. *(a)* Describe Carnot's cycle. Explain the term 'efficiency' of a heat engine and deduce an expression for the efficiency of a Carnot's reversible heat engine. 1+4=5

(b) State and explain Carnot's theorem. 5

UNIT—II

4. Answer any *two* from the following : 2×2=4

(a) Discuss the concept of entropy.

(b) Show that entropy remains constant in a reversible process.

(c) Explain Helmholtz free energy and Gibbs free energy.

5. *(a)* Show that entropy always increases in an irreversible process. 5

(b) Represent the Carnot's cycle on a temperature-entropy diagram. Show in it the areas representing *(i)* heat absorbed from the source and *(ii)* heat rejected to the sink. 5

OR

6. *(a)* Explain what happens to Helmholtz free energy during isothermal isochoric process.

Prove that in an isobaric process, change in enthalpy is equal to the heat transferred during the process. 3+3=6

(b) Write down the expressions for Helmholtz free energy, enthalpy, Gibbs' function and internal energy. 4

UNIT—III

7. Answer any *two* from the following : 2×2=4

(a) Deduce the *Tds* equation

$$Tds = C_V dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$$

(b) What are first- and second-order phase transitions?

(c) Derive the value of Joule-Kelvin coefficient for ideal gases.

8. Deduce the following Maxwell's thermodynamical relations : 5+5=10

(i) $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$

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

OR

9. *(a)* Use Maxwell's relations to obtain $C_P - C_V = R$ for an ideal gas, where C_P and C_V are molar specific heats at constant pressure and constant volume respectively. 5

(b) Show by mathematical analysis using Maxwell's equations that adiabatic expansion produces cooling. 5

UNIT—IV

10. Answer any *two* from the following : 2×2=4

(a) State the law of equipartition of energy.

(b) What do you mean by transport phenomena of gases? Which phenomenon arises due to transport of mass?

(c) Give the concept of degrees of freedom.

11. *(a)* Using Maxwell-Boltzmann distribution law of molecular speeds, show that r.m.s. velocity of the molecules is given by

$$v_{r.m.s.} = \sqrt{\frac{3kT}{m}}$$

where the symbols have their usual meanings. 5

(b) Assuming Maxwell-Boltzmann distribution of molecular speeds, show that the most probable velocity is given by

$$v_{mp} = \sqrt{\frac{2kT}{m}}$$

where the symbols have their usual meanings. 5

OR

12. *(a)* Discuss the phenomenon of transport of momentum. 2

(b) Show that the coefficient of viscosity is given by $\eta = \frac{1}{3}\rho \bar{c} \lambda$, where ρ is the density, $\bar{c}$ is the mean molecular velocity and λ is the mean free path. 8

UNIT—V

13. Answer any *two* from the following : 2×2=4

(a) Distinguish between vapour and gas.

(b) Discuss the law of corresponding states.

(c) What do you understand by regenerative cooling?

14. *(a)* What are the deviations in behaviour of real gases from ideal gas? 2

(b) Deduce the van der Waals' gas equation

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

where a and b are constants and the other symbols have their usual meanings. 8

OR

15. (a) Define critical constants from van der Waals' equation of state and obtain expressions for the critical temperature, critical pressure and critical volume in terms of the constants of the van der Waals' equation. 8

(b) What is critical coefficient of a gas? 2

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