B.Sc. Semester-III (Honours) Examination 2020 (CBCS)

Subject: Physics

Paper: CC-VI

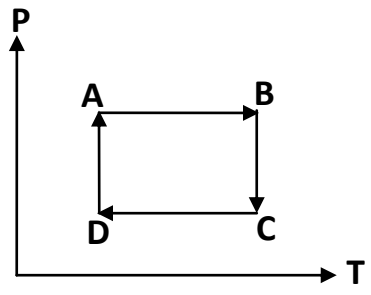
Time: 2 hours **Full Marks: 40**

Answer any eight of the following questions: 5 × 8 = 40

1. (i) Define intensive and extensive thermodynamic variable, giving one example of each.

(ii) A heat engine receives half of its heat supply at 1000 K and half at 500 K, while rejecting heat to a sink at 300 K. What is the maximum possible thermal efficiency of this heat engine? 5

2. (i) An ideal gas undergoes the cyclic process A - B – C – D. Indicator diagram P-T of this cyclic process is shown in the following figure. Represent the same process in the P-V and V-T indicator diagrams.



(ii) A substance has an isothermal compressibility $\beta_T = \frac{a}{V}$ and volume expansivity $\alpha = \frac{2bT}{V}$, where a and b are constants. Find out the equation of state of the substance. 5

3. (i) Show that the violation of Clausius statement of 2nd law of thermodynamics leads to violation of Kelvin-Planck statement.

(ii) Why is an isentropic process not necessarily an adiabatic process? 5

4. (i) Show that, during 1st order phase transition, the entropy of the entire system is a linear function of the total volume.

(ii) What is λ transition? Distinguish λ transition from 1st and 2nd order phase transitions with respect to variation of specific heat at constant pressure C_P with temperature T. 5

5. (i) What is Boyle temperature? Show that at the Boyle temperature the second virial coefficient is zero.

(ii) The critical temperature T_C and pressure P_C of Argon are -122 ^{O}C and 48 atmos. respectively. Calculate the radius of the Argon atom. 5

6. (i) Write down the Maxwell distribution of molecular velocities in an ideal gas. Why does the peak of the curve showing Maxwell velocity distribution move towards the higher speed at higher temperature?

(ii) Find out the probability with which speed of the oxygen molecule will lie in between 100 m/s to 100.1 m/s at 200 K temperature. [Given: Molecular weight of oxygen is 32, Avogadro no. = 6×10^{23} molecules/mol and Boltzmann constant=1.38×10^{-23} J/K.] 5

7. (i) State the principle of equipartition of energy. How one can estimate about the atomicity of the gas molecules from their ratio of specific heats?

(ii) If one gm mole of an ideal monoatomic gas at temperature T_1 is mixed with one gm mole of another ideal diatomic gas at temperature T_2 without loss of any energy, then find out the final temperature of the mixture. 5

8. (i) Define mean free path of a gas molecule. How does the collision frequency of the ideal gas molecules at absolute temperature T for an isochoric process depend upon the mean free path λ of it?

(ii) Prove that the number of particles striking per unit area per unit time on the surface of the wall of the container is equal to $\frac{n\langle c\rangle}{4}$, where n is the number of molecules per unit volume and $\langle c\rangle$ is the mean speed. 5

9. (i) What do you mean by Brownian motion? Give two examples of natural phenomena where Brownian motion is observed.

(ii) Show that near absolute zero temperature, an isothermal and an adiabatic process are identical. 5

10. (i) Differentiate between the cooling process through adiabatic expansion and Joule-Thomson effect.

(ii) State the principle of production of low temperature using adiabatic demagnetization. 5