6301

[This question paper contains 2 printed pages]

Unique Paper Code : **2222301**

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Name of the Paper : **Thermal Physics**

Name of the Course : **B. Tech. (Polymer Science) (FYUP Scheme)**

Semester : **III- semester**

Duration : **3 hours** Maximum Marks : **75**

Attempt *five* questions in all including Question no. **1** which is compulsory.

All questions carry equal marks.

Q1. Attempt any five of the following: (5x3=15)

(a) Derive an expression for work done during an isothermal expansion of an ideal gas.

(b) State zeroth law of thermodynamics. Hence define temperature.

(c) Calculate the change in entropy when 1 mole of an ideal gas expands isothermally to three times its original volume. [$R = 8.31\, J\, mol^{-1}K^{-1}$]

(d) A refrigerator is to maintain eatables kept inside at 9 $^{\circ}C$. If room temperature is 36 $^{\circ}C$, calculate coefficient of performance.

(e) State second law of thermodynamics in terms of entropy.

(f) The mean free path λ of the molecules of a gas at pressure P and temperature T is $2x10^{-5}$ cm. Calculate λ under considerations: (i) P, 2T and (ii) 2P, T.

(g) State law of equipartition of energy.

Q2. (a) Applying first law of thermodynamics, obtain relation between pressure and volume for an ideal gas undergoing adiabatic process. Hence, write relation between pressure & temperature and also volume & temperature. (8)

(b) Using first law of thermodynamics, prove: (7)

i. $C_P - C_V = R$; for 1 mole of an ideal gas.

ii. $\frac{E_S}{E_T} = \frac{C_P}{C_V} = \gamma$; where E_S & E_T are adiabatic and isothermal elasticity respectively.

Q3. (a) Describe construction and working of Carnot's reversible heat engine. Derive expression for its efficiency. (10)

(b) A Carnot's engine has the same efficiency, (i) between $100K$ & $500K$ and (ii) between T K & $900K$. Calculate the temperature T of the sink. (5)

Q4. (a) Define four thermodynamic potentials. Using these, derive Maxwell's four (8)

thermodynamic relations.

(b) With the help of suitable thermodynamic relation, deduce Clausius-Clapeyron's latent heat equation. Hence explain the effect of pressure on (7)

i. Boiling point of a liquid

ii. Melting point of a solid

Q5. a) Define entropy and discuss its physical significance. Show that entropy' does not change during a cyclic reversible process and always increases during an irreversible process. (9)

b) Derive the two TdS equations. (6)

Q6. a) Define mean free path λ of the molecules of a gas. If d is the diameter of each molecule and n is the no. of molecules per unit volume, derive expression for λ assuming that all the molecules except the one under consideration are at rest. (7)

b) On the basis of kinetic theory of gases, derive an expression for the coefficient of viscosity η of a gas in terms of mean free path. Show that η is independent of pressure at a given temperature. (8)

Q7. Derive Maxwell-Boltzmann's law for the distribution of molecular velocities in an ideal gas. Hence derive the expressions for most probable velocity, average velocity and root mean square velocity. ~~Discuss it graphically.~~ (15)

Q8. a) Draw curves for the distribution of energy in the spectrum of black body for temperatures T_1 and T_2 where $T_1<T_2$. Discuss the important conclusions drawn from these curves. (7)

b) Derive Planck's radiation formula for a black body. Show that Planck's radiation law reduces to Wein's law for shorter wavelengths and Rayleigh-Jean's law for longer wavelengths. (8)