B.Sc.(Honours)Examination, 2018

Semester–III (CBCS)
Physics (Core)
Core Course: CC-6
(ThermalPhysics)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.
Answer***anyfour*** questions

1. a) Find out the expression of Clapeyron's equation from the pressure equation $p=(1/3)mnC^2$ where 'n' numbers of molecules per unit volume and other terms have usual meaning. 2
   b) The energy distribution law of a system of ideal gas molecules at a temperature T K is given by
   $$n(\varepsilon)d\varepsilon = AN\,exp(-\varepsilon/KT)\varepsilon\sqrt{\varepsilon}d\varepsilon$$
   where 'A' is a constant and 'N' is the total number of molecules. Find out the (i) value of the constant 'A', (ii) Hence find the most probable energy and (iii) the average energy of the molecules. 2+1+1
   c) Show graphically how the distribution of velocities of Maxwell's gas changes with absolute temperature and the mass of the gas molecules. 2
   d) Find the ratio of the molar specific heats for diatomic gas. Is this value match with experimental value Cl_2 gas at room temperature? 2

2. a) Find out an approximate expression of the numbers of collisions per unit time of gas molecules having diameter 'σ', density of particles 'n' and average velocity 'c'. 2
   b) If the molecular diameter of hydrogen is 1.9×10^{-8} cm, find the number of collisions by a hydrogen molecules per unit time, if $T=300K$, $p=76$ cm of mercury pressure. $K=1.38\times10^{-16}$ ergs/Kelvin, density of mercury 13.6 gm/c.c, $g=980$ cm/sec^2. 3.5
   c) Prove the expression for van der Waals gas, where γ is the ratio of the molar specific heats at constant pressure and volume respectively and the terms have their usual meaning.
   $$\gamma = 1+\frac{R}{C_V}\left(1+\frac{2a}{RTV}\right)$$ 3
   d) What do you mean by quasistatic process? Is quasistatic process always reversible? 1.5

3. a) Neatly draw the theoretical curves of van der Waals equation for real gases for different temperatures 'T'. On the curves show the locus of maxima and minima points and locus of the three different real roots of the equation for a particular 'p'. Properly mark the collapsible state of the on particular isothermal. 3
   b) Find out the expression of locus of the maxima and minima points for a set of isothermals of van der Waals gas in terms of 'p-V'. 2
   c) Assuming the critical state corresponds to a point of inflexion of an isothermal, find out the critical volume, temperature and pressure for a gas obeying the equation $p=(RT/V\text{-}b)\times e^{-(a/RTV)}$, where '$e$' is the exponential, '$a$', '$b$', '$R$' are constants and all other symbols have their usual meaning. 3.5
   d) Describe the phenomena of critical opalescence at critical temperature and characteristics of critical state. 1.5

4. a) What do you mean by thermal diffusivity of a material? Is the term meaningful at steady state? 1.5

P.T.O.

b) Set the Fourier equation of one dimensional heat flow. Find out the solution of the equation at steady state. 2+2

c) What will be temperature at a distance '*l*' from the hot end of lagged bar. 1.5

d) Calculate the time for the formation of '3 *cm*' thick ice on the surface of a lake when the surrounding air temperature drops to '–20° C'. Given, density of ice 0.917 g/c.c, latent heat 80 cal/gm, thermal conductivity 0.005 cal $cm^{-1}Sec^{-1o}C^{-1}$. 3

5. a) State the 'Zeroth law' of thermodynamics. What is the importance of this law? 1.5

b) What do you mean by first order phase change? Derive the second latent heat equation (Clausias equation) $\frac{dL}{dT}-\frac{L}{T}=c_{S2}-c_{S1}$ for the first order phase change, where c_{S2} and c_{S1} are the specific heat of saturated vapour and saturated liquid, L latent heat of vapourisation, T absolute temperature in Kelvin scale. 4.5

c) Why specific heat of saturated vapour pressure is negative? 1.5

d) What do you mean by 'heat', work and internal energy? Distinguish among them. 2.5

6. a) Derive the Maxwell's thermodynamic relations. 3.5

b) Prove that $C_P-C_V=-T\left(\frac{\partial V}{\partial T}\right)_P^2\left(\frac{\partial P}{\partial V}\right)_T$, where the terms are of usual meaning. Is C_P-C_V a negative quantity? Explain properly. For water, mention the temperature with proper reason at which C_P-C_V is zero. 3

c) Find out the change in entropy when two gases diffuse into one another. Show that this change is always positive for two different gases. In this context explain the Gibb's paradox. 3.5

7. a) Show that heat change '*dQ*' and change in entropy '*dS*' are inexact and exact differential respectively. 3

b) Plot the Carnot's cycle in '*S*-*T*' indicator diagram and state the name of the different operations in a complete cyclic operation. 1.5

c) Prove the equivalence of Kelvin-Planck and Clausius statements of second law of thermodynamics. 3

d) Two Carnot engines work in series between the sources and sink at temperatures 500 K and 300 K, respectively. If both the engines produce equal amount of work in equal time, determine the intermediate source temperature. 2.5

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