B.Sc. (Honours) Examination, 2017

Semester-II

Chemistry (Honours)

Course: BCHC-23

(Physical Chemistry)

Time: Three Hours **Full Marks: 30**

Questions are of value as indicated in the margin.

Answer ***any three*** questions.

1. a) Could you setup a criteria for spontaneous change of state of an isolated system from the microscopic point of view? Give answer with a suitable example. 2

   b) The second law of thermodynamics suggests that if a heat engine is working between the two heat reservoirs and produces a positive amount of work then both Q_1 and Q_2 can not have same sign. Symbols have usual meanings. Comment on the statement. 1.5

   c) Define coefficient of performance of the refrigerator working at your home. Prove that coefficient of performance of this refrigerator is less than that of the Carnot refrigerator. Given that the efficiency of the Carnot engine is greater than any irreversible engine if all of them are working between the same two reservoirs. 1.5

   d) Starting with the expression $P = \frac{1}{3}\rho\overline{c^2}$ for an ideal gas, show that the square of r.m.s velocity is proportional to the absolute temperature. Symbols have usual meaning. In which logic the temp of a gas may be considers as the manifestation of the Kinetic energy of its molecules? 1.5+0.5

   e) Obtain Dalton's partial pressure from the Kinetic theory of gas. 1

   f) Show that the mean Kinetic energy of molecules at T K is $\bar{\epsilon} = \frac{3}{2}k_B T$. 2

2. a) Give a general proof of the relations, $\oint \frac{dQ}{T} \leq 0$. Symbols have usual significance. Give two examples for each case to justify the above relations. 2+1.5+1.5

   b) Derive the distribution law of molecular Kinetic energy from the Maxwell's speed distribution law. Show a plot of the distribution curve of Kinetic energy with brief description. 1+1+3

3. a) The ideal gas scale of temperature is absolute like. Comment on the statement. 1

   b) Is there any correspondence between the temperatures in the ideal gas scale and the Kinetic theory, respectively? 1

   c) Define temperature based on the thermodynamics. Using the Carnot cycle one may develop thermodynamic scale of temperature. Comment on the statement. Why thermodynamical scale of temperature is named as the Kelvin scale of temperature. Prove that there is a correspondence between the ideal gas scale of temperature and the thermodynamical scale of temperature. 0.5+1+0.5+1

   d) Derive the expression for number of collision between gas molecules and the wall of a container in unit time per unit area 2

   e) Calculate the frequency of binary collision per c.c. of N_2 gas at 25^oC and 1 atm. pressure. 2

   f) Discuss the temperature dependence of viscosity of gases. 1

P.T.O.

4. a) Consider one mole of an ideal gas, $\bar{C}_V = \frac{3}{2}R$, in the initial state: 300 K, 1 atm. For each transformation, (i) and (ii), calculate Q, W, ΔU, ΔH and ΔS; compare ΔS to $\frac{Q}{T}$.

   i) The gas is expanded isothermally and reversibly until the pressure drops to $\frac{1}{2}$atm. 2.5

   ii) The gas is expanded isothermally against a constant external pressure equal to $\frac{1}{2}$atm. until the gas pressure reaches $\frac{1}{2}$atm. 2.5

   b) For most molecular substances, the heat of vaporisation is several times larger than the heat of fusion. What conclusion you can draw from this statement. 1

   c) If $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p$, show that $\alpha = -\left(\frac{1}{\rho}\right)\left(\frac{\partial \rho}{\partial T}\right)_p$, where 'ρ' is the density. 1

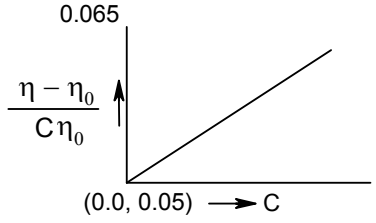
   d) Derive Poiseuille's formula for the fluid flow. 3

5. a) Under 1 atm. pressure, helium boils at 4.216 K. The heat of vaporization is 84 J/mole. What size motor (in horse power, 1 horse power = 746 Jule/sec) is needed to run a refrigerator that must condense 2 mole of gaseous helium at 4.216 K to liquid at 4.216 K in one minute? Assume that the ambient temperature is 300 K and that the coefficient of performance of the refrigerator is 50% of the maximum possible. 3

   b) For thermal and mechanical stability of a system having fixed composition and in a single state of aggregation, C_V and κ are always positive. Comment on the statement. 1+1

   c) From the general definition of α, we find $V = v_0 \exp\left(\int_0^t \alpha\, dt\right)$. If α has the form $\alpha = \alpha_0 + \alpha' t + \frac{1}{2}\alpha'' t^2$, where α_0, α', α'' constants, find the relation between α_0, α' and α'' and the constants a, b and c in the empirical equation $V = V_0\left(1 + at + bt^2 + ct^3\right)$. 2

   d) Using standard equation for intrinsic viscosity $[\eta] = K\bar{M}^a$, for solution of polymer and any information from the graph given below calculate the viscosity average molar mass $\bar{M}$ of the polymer. [Given that $a = 0.05$ and $k = 5 \times 10^{-5}\,Lg^{-1}$]. 1.5



   e) How much time a neurotransmitter (Diffusion coefficient $\sim 10^{-6}\,cm^2 s^{-1}$) would take to transmit a signal along a nerve cell of 100 cm long. What conclusion you can draw from this result. 1.5