(For Non-CBCS Students Only)

B.Sc.(Honours) Examination, 2019

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) State the Trouton's rule. How is it possible to exist such a rule? Based on your answer could you justify the rule qualitatively assuming that the molar volume of a liquid is 1 ml at normal boiling point? Is there any limitation of the rule? Could you modify it to be valid for wide range of temperature for non associative liquids? 0.5+1+1.5+1+1

   b) What are the assumptions taken for the Maxwell's speed distribution law? 1

   c) Derive the expression for the average root mean square velocity of a gas using the Maxwell's speed distribution law. 2

   d) Show that the mean kinetic energy of molecules at T K is $\bar{\epsilon}=\frac{3}{2}kT$ (Symbols have usual meaning). 2

2. a) Derive an expression to calculate the change of entropy due to change of temperature and pressure of a non reactive thermodynamics closed system. Using it calculate entropy change of an ideal gas for the change of state from T_1, P_1 to T_2, P_2. Show that it is zero for adiabatic reversible process. Also show that the entropy change is not zero for the adiabatic irreversible process. Explain these observations. 2+1+1+1

   b) Obtain the expression for frequency of binary collision between molecules of a gas. 3

   c) According to the equipartition principle find the average energy of CO_2 and H_2O molecules. 2

3. a) Calculate the efficiency of a Carnot engine with an ideal gas. Show that for this engine

   $$\oint \frac{đQ_{rev}}{T} = 0.$$ 1.5+1

   b) The solar energy flux is about $4J/\left(cm.^2 \min.\right)$. In a nonfocusing collector the temperature can reach a value of about 90°C. If we operate a heat engine using the collector as the heat source and a low temperature reservoir at 25°C, calculate the area of collector needed if the heat engine is to produce 1 horse power(=746 watt). Assume that the engine operating at maximum efficiency. 2.5

   c) Discuss the temperature dependence of the viscosity of gases. 2

   d) Calculate the number of molecules coming out from a pinhole of area 1mm present in a cylinder, provided with a piston, in a second containing He at constant pressure of 10 atm and 300 K. 3

4. a) State and prove the Clausius inequality. Give a justification of the relation. 1.5+1.5

   b) The second law of thermodynamics suggests that if a heat engine is working between the two heat reservoir and produces a positive amount of work then both Q_1 and Q_2 cannot have same sign. Symbols have the usual meaning. Comment on the statement. 2

   c) Derive the Poiseulle's equation for a fluid. 4

   d) If $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ show that $\alpha = \frac{1}{\rho}\left(\frac{\partial \rho}{\partial T}\right)_P$, where ρ is the density. 1

P.T.O.

5. a) State the Kelvin-Planck and the Clausius statements. Show that these two statements are equivalent to each other. 1+2

b) One mole of an ideal gas expands adiabatically against a constant external pressure of 1 atm. until the pressure balances. The initial temperature and volume are 200°C and 20 lit. respectively. Calculate the final temperature, work done and the change in entropy. 1+0.5+0.5

c) For a certain liquid, the plot of $\log\eta$ vs. $\frac{1}{T}$ gives a slope 600K. Calculate the value of the activation energy for the flow. 2

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