INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR
CHEMISTRY DEPARTMENT

Date of Examination: 17.02.11	Time: 2 Hrs.	Full Marks: 40	No. of Students: 15
Semester: Spring 2010-11	Department: Chemistry		2nd Year Int. MSc.
Session: Midterm Exam	Subject Name: Physical Chemistry II		Subject No. CY20102

[k = 1.38 x 10^{-23} J K^{-1}; R = 8.314 J K^{-1} mol^{-1}; 1 bar = 1 x 10^5 Pa; g= 9.81 ms^{-2}; 1F = 96500 C/mol]

Answer All Questions

Q1. State whether the following statements are True / False and justify your answers in one or two lines. ....(1×6 =6)

a). According to Maxwell distribution function, the *range* of speed (*c*) and the *range* of the *x*-component of velocity (v_x) is _____ and _____ for ideal gas molecules.

b). The distribution function, *f(c)*, and the probability density, *f(c)dc*, both are dimensionless expressions.

c). Thermal conductivity of gases is dependent on pressure only when the pressure is such that λ is much larger than the molecular diameter of gas molecules and the distance of separation between the heat-reservoirs between which the heat flows.

d). The thermal conductivity of a phase is an intensive property.

e). In ordinary incandescent lamps the bulb needs to be completely evacuated to prevent oxidation and immediate burnout of the tungsten filament and hence to increase its life.

f). In Maxwell Distribution in speed, the value of speed of a molecule and the x, y and z components of velocity are all positive quantities.

Q2. Fill the blanks or complete the following statements. ....(1×6 =6)

a). In the expression: $dN_c /N = f (c)dc$; dN_c is _____

b). According to Maxwell distribution function, the *range* of speed (*c*) and the *range of* the *x*-component of velocity (v_x) is _____ and _____ for ideal gas molecules.

c). The expression for the distance of closest approach between two colliding molecules in terms of coefficient of viscosity of gases can be given by _____.

d). From kinetic theory of gases it has been proven and also experimentally verified that the ratio of the coefficients of viscosity (η) and thermal conductivity (κ_T) of a gas at given temperature is equal to the ratio of _____.

e). According to kinetic theory, if the average kinetic energy of He (g) at 300K and 1 bar is [$\Delta\varepsilon_{tr}$] then the value of average kinetic energy of N_2 (g) at same temperature and pressure would be _____.

f). If the $\lambda_m°$ values of NaI, CH_3COONa and $Mg(CH_3CO_2)_2$ are known then experimentally the limiting molar conductivity value of MgI_2 can be determined using the expression: _____

Q3. Give the expressions of Maxwell speed and energy distribution and Illustrate how the plots differ. ....(1×3 =3)

Q4. Consider a 1.0 L container of neon gas at STP which is subjected to the following conditions.
(a) The temperature is increased to 100°C; (b) The volume is decreased to 0.5 L at constant temp.;
(c) The number of moles of neon is doubled at constant temperature.
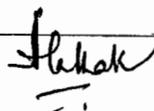
(d) The neon gas is replaced by Krypton

Predict whether the (i) root mean square speed, (ii) average kinetic energy, (iii) mean free path, (iv) frequency of molecular collision, and (v) frequency of collision with the walls of the container, increases/decreases/ remains the same*for the gas molecules when subjected to each of the conditions. [Tabulate your answers for each condition]   ....(5)

Q5. Calculate the value of η of nitrogen gas at 300 K when the η of the gas at 293 K is given to be 176×10^{-7} kgm^{-1} s^{-1}.   ....(5)

Q6. A solid surface with the dimensions (3.5 mm × 4.0 cm) is exposed to helium gas at 111 Pa and 1500K. How many collisions do the helium atom makes with this surface in 10 sec?   .   ...(5)

Q7. Two sheets of copper of area 1.50 m^2 are separated by 10.0 cm. What is the rate of transfer of heat by conduction from the warm sheet (at 50 °C) to the cold sheet (at −10 °C) when the space between the two plates is filled with air. What is the rate of loss of heat (**in J sec^{-1}**)? [Given the thermal conductivity coefficient of air is 0.241×10^{-3} J K^{-1}cm^{-1}sec^{-1}]   ....(5)

Q8. Calculate the ratios of thermal conductivities of gaseous hydrogen at 300 K to gaseous hydrogen at 10K. Be circumspect, and think about the modes of motion that are thermally active at the two temperatures. Take into account that there is a critical temperature at which each degree of freedom gets activated. For any real gas translational degrees of freedom may be considered to be always activated. The rotational degrees of freedom are the next to get activated while the vibrational degrees of freedom are generally the last to get activated. In a light diatomic gas, the critical temperature for the activation of rotational modes is usually a few hundreds of kelvins while the activation of vibrational modes usually requires a few thousands of kelvins.   ....(5)

Signature of the paper setter

AMITA (PATHAK) MAHANTY
Name in Capital Letters