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MS20040

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH MOHALI

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CHM202: ENERGETICS AND DYNAMICS OF CHEMICAL REACTIONS

FULL MARKS 60 **DURATION 3 HR**

Constants: $N = 6.023*10^{23}$ mol^{-1}; $k = 1.381*10^{-23}$ JK^{-1}; R = 8.314 J.K^{-1}/mol = 0.082 Lt-atm/K/mol.;

1. At 1000 °C, the pressure of I_2 gas is found to be 0.112 atm. However, the expected pressure is 0.074 atm. The difference in the pressure is due to dissociation of I_2 to 2I (g). Calculate the pressure at which I_2 will be 90% dissociated at 1000 °C. **6**

2. At 1000 K, the value of K_p for the reaction [$2SO_2 + O_2 = 2SO_3$] is 3.5. What would be the thermodynamic potential change if 2 moles of SO_3 at 1 atm are formed from SO_2 at 0.1 atm and O_2 at 0.2 atm at this temperature? [Use R is Lt-atm] **4**

3. At 127 °C, the equilibrium constant K_p for the dissociation of SO_2Cl_2 [$SO_2Cl_2 = SO_2 + Cl_2$] is 2.4 atm. 6.75 g of SO_2Cl_2 is stored in an empty sealed bulb at a pressure (P) of 1.64 atm and raise the temperature to 127 C . (a) Estimate the pressure of SO_2 gas in the bulb . (b) Estimate the pressure of SO_2 if a same amount of SO_2Cl_2 is introduced to the sealed bulb already containing Cl_2 at 1 atm. [Hint: $P_{SO2Cl2} = P - P_{SO2}$] **3 + 2**

4. Calulate the freezing temperature of water if the pressure be increased by 1 atm. [Latent heat of fusion = 80 cal/g; and If 1g of water freezes into ice the change in its specific volume is 0.091 cc; 1 atm = 1013961.6 dyn/cm^2]. **5**

5. The densities of α- and β- sulphur are 2.00 and 1.95 g/cc, respectively at their transition temperature, 96 °C. The transition temperature changes by 0.036 for every atm rise in pressure. Find out the heat of transition. [1 cc- atm =0.000024 Cal] **5**

6. In a gaseous reaction, $X + 2Y \Rightarrow XY_2$, $K_p = 2.5x10^{-4}$ atm^{-2} at 100 °C. 2 moles of Y and 1 mole of X are mixed. What total pressure would be required to convert 50% of X into XY_2. **5**

7. What would be the rise in temperature when 1 cc of water at 10 °C is reversibly and adiabatically compressed from 0 to 1000 atmospheres? [Hint: α = 1.5x10-5; Cp = 1.005; Rel. $dS = \frac{C_p}{T} dT - \alpha V \, dP$]. **5**

8. Prove that the free energy decrease is largest when equimolar quantities of the two components are mixed. **5**

cal/K/mol.

9. 1 mole of an ideal diatomic gas (Cv = 5.00) initially at 25 °C and 1 atm changes to 100 °C and 10 atm pressure. Find out the absolute entropy of the gas in the final state if the standard molar entropy of the gas at 25 °C and1 atm pressure is 45.80 e.u. **5**

10. Answer all the following questions.

(a) What would be the change in entropy when 1 kg water at 7 °C is mixed with 2 kg water at 37 °C in aninsulated vessel? 3

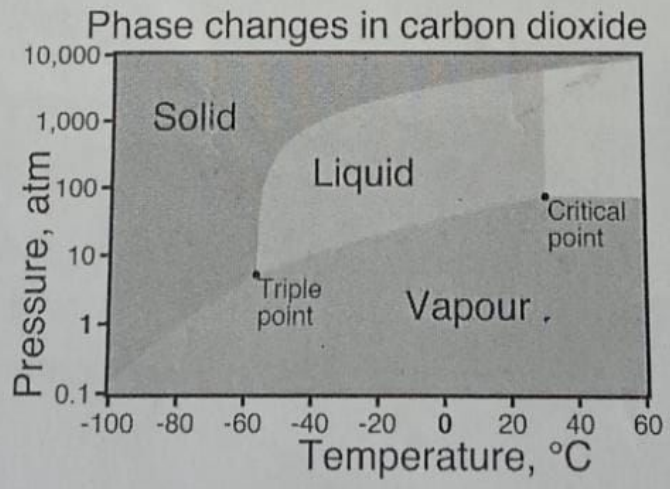
(b) In the reaction $H_2O_2(aq) \rightarrow H_2O(l) + \frac{1}{2} O_2(g)$, the initial concentration of H_2O_2 is 0.2546 M, and the initial rate of reaction is 9.32×10^{-4} M s^{-1}. What will be $[H_2O_2]$ at t = 35 s? 3

(c) The isomerization of cyclopropane to propene, following kinetic data has been recorded: 3

T, °C	477	523	577	623
$1/T$, $K^{-1} \times 10^3$	1.33	1.25	1.18	1.11
k, s^{-1}	0.00018	0.0027	0.030	0.26
ln k	–8.62	–5.92	–3.51	–1.35

Estimate Activation energy and pre-exponential factor.

(d) See the phase diagram of CO_2 carefully and answer the following. 3+3



(i) What phase carbon dioxide is normally in at standard temperature and pressure, 1 atm and 273.15 K?

(ii) Looking at the same diagram, we see that carbon dioxide does not have a normal melting point or a normal boiling point. Explain what kind of a change carbon dioxide makes at 1 atm and estimate the temperature of this point.