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**B. TECH**  
**BSCC 2101**

**2ND SEMESTER EXAMINATION – 2006**

**CHEMISTRY-I**

**Full Marks – 70**

**Time – 3 Hours**

*The figures in the right hand margin indicate full marks for the questions.*

*Questions No. 1 is compulsory and any five from the rest.*

*Answer to all parts of a question must be written at one place only.*

(Standard data :  $h=6.626 \times 10^{-34} \text{Js}$ ,  $R=8.314 \text{JK}^{-1} \text{mol}^{-1}$ ,  
 $c=3 \times 10^8 \text{ms}^{-1}$ ,  $m_e = 9.1 \times 10^{-31} \text{kg}$ )

1. Answers the following in brief : 2×10
- (a) What is the uncertainty in velocity of an electron if the uncertainty of its position is 100 pm ?

**P.T.O.**

- (b) What conditions must be fulfilled for LCAO ?
- (c) What is triple point ? What are the values of temperature and pressure at this point for water system ?
- (d) The rate constant for the reaction,  
 $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$  is  $3.0 \times 10^{-5} \text{sec}^{-1}$ .  
If the rate is  $2.40 \times 10^{-5} \text{mol lit}^{-1} \text{sec}^{-1}$ , what is the concentration of  $\text{N}_2\text{O}_5(\text{g})$  in  $\text{mol lit}^{-1}$  ?
- (e) If the rate of the reaction is equal to the rate constant, what is the order of the reaction ?
- (f) For the electrochemical cell,  $\text{M} | \text{M}^+ || \text{X}^- | \text{X}$ ,  
 $E_{\text{M}^+/\text{M}}^\circ = 0.44\text{V}$  and  $E_{\text{X}^-/\text{X}}^\circ = 0.33\text{V}$  ;  
predict whether the reaction,  $\text{M}^+ + \text{X}^- \rightarrow \text{M} + \text{X}$   
is spontaneous ?
- (g) What is the overall reaction taking place during the charging of a lead storage battery ?

- (h) A substance  $A_xB_y$  crystallizes in FCC lattice in which atoms 'A' occupy each corner of the cube and atoms 'B' occupy the centres of each face of the cube. Identify the correct composition of  $A_xB_y$ .
- (i) For a reaction,  $\Delta H$  and  $\Delta S$  both are positive. Under what condition will the reaction be spontaneous ?
- (j) How is standard free energy change related to the equilibrium constant ?
- 2/ (a) Calculate the kinetic energy of a moving electron which has a wavelength of 4.8 nm. 3
- (b) What do you mean by eigen value and eigen function ? 3
- (c) Explain why the dissociation energy of  $N_2$  is higher than  $N_2^+$ , while that of  $O_2$  is lower than  $O_2^+$ . 4

3. (a) Define degree of freedom. How many degrees of freedom are present in the following systems ? 3



(b) For Sulphur system, what are the phases in equilibrium at the three triple points ? 3

(c) Draw the phase diagram of bismuth-cadmium system and explain the eutectic point. 4

4. ✓ (a) Differentiate between order of a reaction and its molecularity. 2

(b) The following reaction takes place in one step :  $2A(g) + B(g) \rightleftharpoons 2C(g)$

How will the rate of the above reaction change if the volume of the reaction vessel is diminished to half of its original volume ?

Will there be any change in the order of the reaction with the reduced volume ? 3.

(c) What are the characteristics of a first order reaction ? 3

(d) The specific rate constant of a reaction increases by a factor 4 if the temperature is changed from  $27^\circ$  to  $47^\circ$ . Find the activation energy for the reaction. 2

5. (a) Calculate the equilibrium constant K for the following reaction of 298K.



Given,  $E^\circ_{\text{Sn}^{4+}/\text{Sn}^{2+}} = +0.15\text{V}$ ,  $E^\circ_{\text{Cr}^{3+}/\text{Cr}} = -0.74\text{V}$ . 2

(b) How is pH of a solution measured using quinhydrone electrode ? What are the merits and demerits of this method ? 4

(c) Calculate the maximum work that can be accomplished by the operation of the following cell at  $25^\circ\text{C}$ .



Given,  $E_{\text{Ni}^{2+}/\text{Ni}}^{\circ} = -0.25\text{V}$ ,  $E_{\text{Cu}^{2+}/\text{Cu}}^{\circ} = +0.34\text{V}$ .

4

6. (a) In the compound AX, the radius of  $\text{A}^{+}$  ion is 95 pm and that of  $\text{X}^{-}$  ion is 181 pm. Predict the crystal structure of AX and write the coordination number of each of the ions.

3

- (b) Lithium metal crystal has body centred cubic structure. Its density is  $0.53\text{g cm}^{-3}$  and its molar mass is  $6.94\text{g mol}^{-1}$ . Calculate the volume of a unit cell of lithium metal.

2

- (c) What is Schottky defect in crystals ?

2

- (d) The reaction  $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$  is a first order reaction with half life  $3.15 \times 10^4\text{s}$  at  $320^{\circ}\text{C}$ . What percentage of  $\text{SO}_2\text{Cl}_2$  would be decomposed on heating at  $320^{\circ}\text{C}$  for 90 minutes.

3

7. (a) Show that  $\left(\frac{\partial G}{\partial T}\right)_P = -S$  4

(b) Calculate the free energy change which occurs when one mole of an ideal gas expands reversibly and isothermally at 300 K from an initial volume of 5 litres to 50 litres. 3

(c) Predict whether it is possible to reduce MgO using carbon at 25°C from the following data. For the reaction,



$$\Delta H^\circ = +491.18 \text{ kJ mol}^{-1} \text{ and}$$

$$\Delta S^\circ = +197.67 \text{ JK}^{-1} \text{ mol}^{-1}. \quad 3$$

8. (a) If the dissociation constant of acetic acid is  $1.74 \times 10^{-5}$  at 25°C, calculate the % of dissociation of the acid in 0.01M solution. 2

- (b) Find the pH of a solution obtained by mixing equal volume of 0.1N ammonium nitrate and 0.02N ammonium hydroxide, if the dissociation constant of ammonium hydroxide is  $1.8 \times 10^{-5}$  at  $25^\circ\text{C}$ . 4
- (c) A mixture containing 8.07 moles of hydrogen and 9.08 moles of iodine was heated at  $448^\circ\text{C}$  till equilibrium was attained when 13.38 moles of hydrogen iodide was obtained. Calculate the degree of dissociation of hydrogen iodide at  $448^\circ\text{C}$ . 4

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