

SECOND SEMESTER EXAMINATION -2007

CHEMISTRY – I

Full Marks – 70

Time – 3 Hours

*Answer Question No. 1 which is compulsory  
and any five from the rest.*

*The figures in the right-hand margin indicate marks.*

(Reference data :  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ,  $1 \text{ amu} = 1.6605 \times 10^{-27} \text{ kg}$ , Atomic weight of silver = 107.88)

1. Answer the following questions in brief :  $2 \times 10$ 
  - (a) Mention two significant causes for the failure of classical mechanics.
  - (b) What is meant by time independent wave function,  $\Psi$  of a particle ? Mention its unit, if any.

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- (c) On the basis of MO theory, what would be the bond orders  $N_2$  and  $O_2^{2-}$  ?
- (d) Give one example of a zero order reaction. What is the unit of a zero order rate constant ?
- (e) Distinguish between the triple point of ice-water-water vapour system and the normal freezing point of water.
- (f) An electrochemical cell is discharged irreversibly at a finite rate. If  $\Delta G$  is the free energy change for the discharge reaction, and  $w_{el}$  is the total electrical work output of the cell during the discharge process, which of following relations will be true ?
- (i)  $w_{el} = - \Delta G$
- (ii)  $w_{el} < - \Delta G$
- (iii)  $w_{el} > - \Delta G$

- (g) What is meant by Schottky defect ? In which type of crystals, this is encountered ?
- (h) A monobasic weak acid has an ionization constant of  $1 \times 10^{-5}$  at the room temperature. 20 mL of a 0.1 M solution of the acid is mixed with 10 mL of a 0.1 M solution of sodium hydroxide. What would be the pH of the resultant solution?
- (i) Predict the effect of increased pressure and temperature on the following reaction equilibria stating only whether the product formation will be favoured, inhibited or unchanged ?
- (i)  $2SO_2(g) + O_2(g) = 2SO_3(g) \Delta H^\circ = -194.0 \text{ kJ}$
- (ii)  $N_2(g) + O_2(g) = 2NO(g) \Delta H^\circ = +361.0 \text{ kJ}$
- (j) State the criteria of spontaneity and equilibrium for a chemical reaction under

- (i) Constant pressure and temperature
- (ii) Constant volume and temperature.

2. Explain the following :

- (a) Hydrogen forms a diatomic molecule while helium does not. 3
- (b) Molecular oxygen is a paramagnetic substance. 3
- (c) Metals are good conductors of electricity. 4

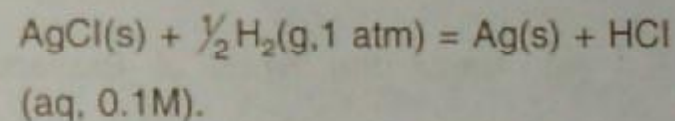
3. (a) Sketch the phase diagram of Bi-Cd system labelling all the phases, curves, and points. 6

(b) If Bi-Cd eutectic mixture has 40% of Cd by mass, then what would happen if a molten mixture of Bi and Cd containing 15% of Cd is gradually cooled to the eutectic temperature of the system. 4

4. (a) Explain how  $\Delta G$  of a cell process occurring in an electrochemical cell is related to the EMF of the cell. 3

(b) What would be the EMF of the cell,  
 $Zn|Zn^{2+}(0.05M)||H^+(0.1M)|H_2(1atm)|Pt$   
 at 298K given that  $E^0_{Zn^{2+}/Zn} = -0.76 V$ ? 4

(c) The overall cell process of an electrochemical cell is



Design and represent the cell schematically and write down the anodic and cathodic reactions at the electrodes. 3

5. (a) Distinguish between the order and molecularity of a reaction. Give examples to show where they may be the same and where they may be different. 4

(b) Write the equation that relates the rate constant of a reaction with its activation energy explaining all the symbols used.

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(c) A first order reaction is 50% complete in 20 min. at 300 K and the reaction occurs to the same extent at 10 min. when the temperature is raised to 310 K. Calculate the activation energy of the reaction.

4

6. (a) Name the types of Bravais lattices encountered in the cubic system. Also assuming that the lattice points are occupied by atoms, find –

6

(i) the no. of atoms in the unit cell of each lattice type

(ii) the coordination no. of each atom in such lattices.

(b) Silver crystallizes with FCC lattice with a unit cell length of  $4.085 \text{ \AA}$ . Calculate the density and the atomic radius of silver.

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7. (a) The  $pK_a$  of a weak monobasic acid is 4.74 at 298K. What will be the pH of its 0.01 M solution at this temperature?

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(b) Two moles of a perfect gas are expanded from a pressure of  $20 \text{ Nm}^{-2}$  to  $1 \text{ Nm}^{-2}$  at 300K. What will be the free energy change of the gas ?

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(c) The degree of dissociation of steam into hydrogen and oxygen at 1273K and 1 atm pressure is  $2.4 \times 10^{-5}$ . Calculate,  $K_p$  for the reaction at this temperature and pressure.

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8. Write short notes on any two of the following :

5×2

- (a) Fuel cells and their applications
- (b) Common ion effect, and its use in chemical analysis
- (c) Homogeneous and heterogeneous catalysis.

