Registration No. :

Total number of printed pages – 3

B. Tech
BS 1103

First Semester Examination – 2012-13

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.

Answer all parts of a question at one place only.

(Standard data : $h = 6.626 \times 10^{-34}$ Js, $c = 3 \times 10^8$ ms^{-1}, $m_e = 9.1 \times 10^{-31}$ kg,
$N = 6.023 \times 10^{23}$ mol^{-1}, $R = 8.314$ JK^{-1}mol^{-1}, $k = 1.38 \times 10^{-23}$ JK^{-1} molecule^{-1})

1. Answer the following questions :   2×10

    (a) What is the de-Broglie wavelength of an electron travelling at 1% of the speed of light ?

    (b) Give the unit of rate constant of a second order reaction with example.

    (c) Identify the catalyst and promoter in the following reaction

    $$CO_2(g) + H_2(g) \quad \xrightarrow[250^\circ C]{ZnO, Cr_2O_3} \quad CH_3OH(l)$$
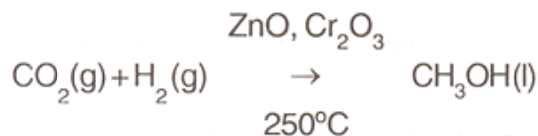
    (d) Write the decreasing order of stability for the following :

    H_2, H_2^+, H_2^- and justify

    (e) Write the Nernst equation for the electrode reaction,

    $M^{n+}(aq) + ne \rightarrow M(s)$

    (f) Calculate the number of components and degree of freedom for

    $N_2(g) + O_2(g) \rightarrow 2NO(g)$.

P.T.O.

(g) Calculate the activation energy of a chemical reaction which doubles the rate when the temperature is raised from 300 K to 310 K.

(h) NaCl has FCC structure. How many Na^+ and Cl^- ions are there in the unit cell ?

(i) What is the significance of writing + or – (minus) sign before the rate of reaction ?

(j) State and explain Hess's law.

2. (a) Write down the molecular orbital configuration for O_2, O_2^- and O_2'. Compare their bond lengths and magnetic characteristics.   4

   (b) The unit cell of nickel is a face-centered cube of volume 0.0438 mm^3. Find the atomic radius of nickel.   3

   (c) Write the cell reactions of lead-acid storage cell during charging and discharging process.   3

3. (a) With the help of the Phase rule, draw and describe the phase diagram of Sulphur system.   5

   (b) What do you mean by atomic packing factor ? Calculate atomic packing factor of Face centered cubic lattice and simple cubic lattice.   5

4. (a) The standard electrode potentials of the electrodes, $Ag^+(aq)/Ag(s)$, and $Fe^{3+}(aq)/Fe^{2+}(aq)$, are 0.799 V and 0.771 V at 298 K, respectively. Write down the electrode reactions and designate the cell. Calculate the equilibrium constant for the cell reaction at 298 K.   5

   (b) How pH is measured by a glass electrode ?   3

   (c) What are the Miller indices, if the plane intersects the crystal lattice at 2a, b, 2c ?   2

5. (a) Silver has an atomic radius of 0.144 nm. Calculate the densities of silver if it crystallizes in (i) simple cube, and (ii) FCC structure (At. mass of Ag = 108 amu).   4

   (b) The rate constant of a reaction is found to be tripled when the temperature increased from 25°C to 60°C. Calculate the activation energy.   4

   (c) Explain why the order of a reaction cannot be predicted from overall stoichiometry ?   2

6. (a) Show that : 2.5+2.5

   (i) $(\delta S/\delta P)_T = -(\delta V/\delta T)_P$

   (ii) $(\delta V/\delta S)_P = (\delta T/\delta P)_S$

   (b) For the reaction,

   $Ag_2O(s) \rightarrow 2Ag(s) + 1/2\ O_2(g)$ at 1 atm,

   $\Delta H = +30.6$ kJ mol^{-1} and $\Delta S = 0.66$ kJ K^{-1}.

   Calculate the temperature at which the reaction would be in equilibrium. 2

   (c) A second order reaction, when two reactants are same, is 30% completed in 500 seconds. How long will it take to go to 90% completion ? 3

7. Write notes on : 3+4+3

   (a) Born-Haber cycle

   (b) Enzyme catalysis

   (c) Application of Schrödinger equation.

8. (a) Calculate the uncertainty in velocity for a particle with mass 7×10^{-18} kg, if the uncertainty in position is 0.1 nm. 3

   (b) Zinc granules are added in excess to a 500 ml solution of 1 M nickel nitrate at 298 K until equilibrium is reached. Find out the concentration of Ni^{2+} ion in solution at equilibrium ($E°$ of $Ni^{2+}(aq)/Ni(s) = -0.24$ V and $E°$ of $Zn^{2+}(aq)/Zn(s) = -0.76$ V, at 298 K). 4

   (c) How is fuel cell different from battery ? What are the advantages of fuel cells ? 3

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