B.Tech-2 (All)
Chem
Set-2

Full Marks : 70

Time : 3 hours

Q. No. 1 is compulsory and answer any five from the rest

The figures in the right-hand margin indicate marks

1. Answer the following questions : 2×10

(*a*) Find the uncertainty in the velocity of an electron if the uncertainty in its position is 1pm.

(*b*) Between super oxide and peroxide, which one has larger bond length ?

(*c*) An object of mass 1.0 kg suspended from the end of a rubber band has a vibrational frequency of 2 Hz. Calculate the force constant of the rubber.

(*d*) For a reversible reaction, the value of standard free energy change is Zero. What is the value of its equilibrium constant ?

(*e*) If the dissociation constant of weak base is $1{\cdot}6\times10^{-5}$ at 25 °C, what is the percentage of dissociation of the base in a 0·1 M solution ?

(*f*) Considering one mole of an ideal gas, prove

$$\left(\partial P/\partial T\right)_V \left(\partial T/\partial V\right)_P \left(\partial V/\partial P\right)_T = -1$$

(*g*) What are the value of pressure and temperature at which all the three phases of water are coexist in equilibrium ?

(*h*) The Standard EMF of the Diniel cell involving the cell reaction

$$Zn + Cu^{+2}(aq) \rightleftharpoons Cu + Zn^{+2}(aq) \text{ is } 1{\cdot}10V.$$

Calculate the equilibrium constant of the cell reaction at 25 °C.

(*i*) Two particles *A* and *B* are in motion. The wavelength of *A* is 5×10^{-8} m. Calculate the wavelength of *B*, if its momentum is half of *A*.

(*j*) If the ionic radii of M^+ and X^- are 147 and 195 pm respectively, what is the most probable coordination number of M^+ ion in MX ?

2. (*a*) Compare the relative stability of O_2^- and N_2^+ and predict their magnetic behaviour. 5

(*b*) Derive the expression for the energy of a particle of mass *m* confined in an one dimensional box. 5

3. (*a*) Derive the relationship between moment of inertia and inter nuclear distance of a diatomic molecule consist of two atoms of mass M_1 and M_2. 5

(*b*) The spacing of the lines in a rotational spectrum of $C^{12}O$ molecule is 10·590 cm^{-1}. Calculate the energy (in cm^{-1}) of rotational state with $j = 2$ for $C^{13}O$ molecule. Assuming

the replacement of C^{12} by C^{13} leaves the bond length unchanged. 5

4. (*a*) Show that $C_p - C_v = R$ for a one mole of ideal gas. 5

(*b*) Show that

$$\mu_{JT} = -1/C_p \left[\left(\frac{\partial U}{\partial P} \right)_T + \left(\frac{\partial (PV)}{\partial P} \right)_T \right]$$ 5

5. (*a*) Derive the expression for the rate constant of a first order reaction. 5

(*b*) The rate constant of a certain reaction is found to be doubled when temperature is raised from 27 °C to 37 °C. What is the activation energy? 5

6. (*a*) Calculate the equilibrium constant of the cell reaction

$$Ag^{+2} + Zn \rightleftharpoons Ag^{+} + Zn^{+2}$$

occurring in the silver cell at 25 °C when

$[Zn^{+2}] = 0{\cdot}1\,M$ and $[Ag^{+}] = 10M$. The EMF of the cell is found to be 1·62 V. 5

(*b*) What are the difference between Frenkel defect and Schottky defect ? Which of the two defect changes the density of the solid ? 5

7. (*a*) The degree of dissociation of acetic acid in a 0·1 M solution is $1{\cdot}32 \times 10^{-2}$. Find out the dissociation constant of the acid and pK_a value. 5

(*b*) Derive Gibbs-Helmholtz equation for a process at constant volume and constant pressure. 5

8. (*a*) Draw and explain the phase diagram of sulphur system. 5

(*b*) NaCl is a face centered cubic lattice. Calculate its density if the edge of the cube is $5{\cdot}62 \times 10^{-10}$ m long. 5