2019

CHEMISTRY

(Honours)

Paper : CHE-HC-1016

(Inorganic Chemistry—I)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following : 1×7=7

(a) Maximum number of electron possible in *N* shell of an atom of an element is

(i) 18 *(ii)* 8

(iii) 28 *(iv)* 32

(b) Physically meaningful quantity is given by

(i) only ψ

(ii) only ψ^2

(iii) both ψ and ψ^2

(iv) none of ψ and ψ^2

(c) In the long form of modern periodic table, element 49 has the position at

(i) group 12 of 4th period

(ii) group 13 of 5th period

(iii) group 13 of 4th period

(iv) group 15 of 4th period

(d) The radii of Mg^{2+} and O^{2-} ions are 0·66 Å and 1·40 Å, and that of B^{3+} and O^{2-} ions are 0·23 Å and 1·40 Å respectively. The crystals formed by MgO and B_2O_3 have shapes respectively

(i) octahedral and trigonal planar

(ii) tetrahedral and octahedral

(iii) octahedral and cubic

(iv) trigonal planar and octahedral

(e) The van der Waals' forces active in solid I_2 are

(i) ion-dipole forces

(ii) dipole-dipole interactions

(iii) induced dipole interactions

(iv) zero

(f) The half-cell reaction of two redox systems are as follows :

$$2Hg^{2+} + 2e^- \rightleftharpoons Hg_2^{2+}, \quad E^\circ_{el} = +0{\cdot}92$$

$$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}, \quad E^\circ_{el} = +0{\cdot}15$$

If the two half cells are linked to give a cell, then

(i) Hg_2^{2+} will be oxidized and Sn^{4+} will be reduced

(ii) Hg^{2+} will be reduced and Sn^{2+} will be oxidized

(iii) both Hg^{2+} and Sn^{2+} will be oxidized

(iv) both Hg^{2+} and Sn^{2+} will be reduced

(g) When you prepare $KMnO_4$ and $H_2C_2O_4 \cdot 2H_2O$ solution by transferring a measured amount of these from chemical balance, then it is necessary to standardize

(i) both $KMnO_4$ and $H_2C_2O_4 \cdot 2H_2O$ solution

(ii) only $H_2C_2O_4 \cdot 2H_2O$ solution, but not $KMnO_4$

(iii) only $KMnO_4$, but not $H_2C_2O_4 \cdot 2H_2O$ solution

(iv) none of $KMnO_4$ and $H_2C_2O_4 \cdot 2H_2O$ solution

2. Answer the following questions : 2×4=8

(a) Deduce de Broglie equation of wave-particle duality.

(b) Write Born-Landé equation with meaning of all the terms involved. From this equation, predict which of CaO and $Al_2(SO_4)_3$ has higher lattice energy.

(c) Define the terms 'bond moment' and 'dipole moment'. Taking an example, explain that bond moment in a molecule does not lead to a non-zero dipole moment in the molecule.

(d) Isolate the equation in acidic medium $MnO_4^- + I^- \rightarrow I_2 + Mn^{2+}$ into oxidized half reaction and reduced half reaction and balance the two parts separately and write down the overall balanced reaction.

3. Answer the following questions : 5×3=15

(a) Find an expression for energy of hydrogen atom. Write the Schrödinger's wave equation for the electron in hydrogen atom. 4+1=5

Or

Draw the proper diagram of *p*-orbitals and *d*-orbitals of an atom. Write the values of all the quantum numbers for an atom when $n = 3$. 3+2=5

(b) Define electronegativity and deduce the expression for Pauling electronegativity scale. Calculate the electronegativity of carbon atom following Allred-Rochow's approach. (Covalent radius of carbon atom is 0·77 Å) 1+2+2=5

(c) Discuss Heitler-London approach of valence bond theory. 5

Or

(i) What is solvation energy? Discuss the mechanism of dissolution of an ionic solute in a polar solvent. 3

(ii) Calculate the formal charge of P and H in PH_3. 2

4. Answer the following questions (any *three*) : 10×3=30

(a) *(i)* What are the factors that affect ionization energy? Discuss its periodic trend. Why does successive ionization enthalpy of atom of an element increase immensely? 1+2+2=5

(ii) State Slater's rule. Calculate the effective nuclear charge at the periphery of chromium atom. 3+2=5

(b) (i) Draw Lewis dot picture for NO and CO_3^{2-}. 2

(ii) Give a neat molecular orbital diagram of N_2. Identify HOMO and LUMO in this diagram. Is it possible to obtain an N_2^+ molecular ion? Justify it. 3+1+1=5

(iii) What is non-bonding molecular orbital? Explain it with appropriate example. 1+2=3

(c) (i) Explain the terms 'radial' and 'angular' wave functions for hydrogen atom. Draw radial probability distribution curve for hydrogen atom when $n = 2$. 3+2=5

(ii) What are the two basic postulates of VSEPR theory? Is it possible to give suitable explanation for the shape of PCl_3F_2 molecule by VSEPR theory? Elaborate your answer. 2+3=5

(d) (i) State and explain Hund's rule of maximum multiplicity. 2

(ii) How does electronegativity change in sp, sp^2 and sp^3 hybridization? 2

(iii) Apply molecular orbital theory to CO molecule. 3

(iv) Describe the theory involved in estimation of Fe^{2+} ion in a given solution of unknown strength. 3

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