

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

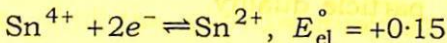
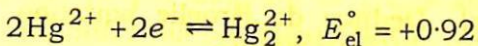
(d) The radii of Mg^{2+} and O^{2-} ions are 0.66 Å and 1.40 Å, and that of B^{3+} and O^{2-} ions are 0.23 Å and 1.40 Å respectively. The crystals formed by MgO and B_2O_3 have shapes respectively

- (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 :



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 $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution by transferring a measured amount of these from chemical balance, then it is necessary to standardize

(i) both KMnO_4 and $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution

(ii) only $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution, but not KMnO_4

(iii) only KMnO_4 , but not $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution

(iv) none of KMnO_4 and $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ 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 $\text{Al}_2(\text{SO}_4)_3$ 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 $\text{MnO}_4^- + \text{I}^- \rightarrow \text{I}_2 + \text{Mn}^{2+}$ 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 \AA) 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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