2023

CHEMISTRY — HONOURS

Paper : CC-4

(Inorganic Chemistry - 2)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer *question no.* **1** and *any eight* questions from the rest.

1. Answer *any ten* questions : 1×10

   (a) Arrange the following in order of increasing thermal stability :

   $MgSO_4$, $CaSO_4$, $SrSO_4$, $BaSO_4$.

   (b) Predict the increasing bond angle sequence of the following :

   CH_4, CH_3^-, CH_3^+.

   (c) Categorize the compounds with respect to Schottky and Frenkel defects : AgBr, ZnS, NaCl, KCl.

   (d) Predict the structure of $XeOF_4$ indicating the hybridization of the central element.

   (e) Which of the following has greater melting point?

   RbCl and AgCl.

   (f) Find the total number of lone pairs of electrons on the central atom of SF_4.

   (g) Predict the unstable nucleii and write the mode of decay— $^{18}_9F$ and $^{18}_{10}Ne$.

   (h) Write the number of unpaired electrons in the HOMO of NO.

   (i) Find the O – O bond order in O_2^{2-}.

   (j) Predict the order of solubility in water of the following :
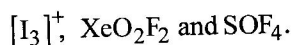
   AgF, AgCl, AgBr and AgI.

   (k) Give an example of an isotope which is used in the treatment of human cancer.

   (l) Write an example of an odd electron molecule.

Please Turn Over

2. (a) Predict the shapes of the following species and mention the type of hybrid orbitals on the central atom :

$$[I_3]^+, XeO_2F_2 \text{ and } SOF_4.$$

(b) How and under what condition can an insulator be converted to a semiconductor? 3+2

3. (a) Write the Kapustinskii equation and explain how it is helpful in finding the lattice energy of an ionic solid, where the crystal structure is not known.

(b) Find the minimum energy required to split an $^{16}_8O$ nucleus into ^4_2He and $^{12}_6C$ nucleus. The binding energies of $^{16}_8O$, $^{12}_6C$ and ^4_2He are 127.6, 92.1 and 28.3 MeV, respectively. 3+2

4. (a) Construct the MO energy level diagram of CO_2 and find the C–O bond order in the molecule.

(b) The C–Cl distance in CH_3Cl and CF_3Cl are 1.78 Å and 1.75 Å, respectively. Explain. 3+2

5. (a) Compare the σ-donor and π-acceptor property of CN^- and NO^+ through MO approach.

(b) Which hydrogen bond would you expect to be stronger and why?

S — H ······ O and S ······ H — O. 3+2

6. (a) Calculate the electron affinity of iodine from the following data :

Formation energy of $NaI(s) = -289$ kJ mol^{-1}

Sublimation energy of $Na(s) = 108.8$ kJ mol^{-1}

Dissociation energy of $I_2(g) = 214.2$ kJ mol^{-1}

Ionization energy of $Na(g) = 497.3$ kJ mol^{-1}

Lattice energy of $NaI(s) = -694.7$ kJ mol^{-1}

(b) What do you mean by 'Fissile nucleus'? Name one of such nucleii with atomic and mass numbers. 3+2

7. (a) BF_3, PF_3 and ClF_3 are AX_3 type of molecule, but their structures and bond angles are different. Explain.

(b) From the radius ratio (r_+ / r_-) values, CdS (0.52) and HgS (0.55) are expected to adopt the NaCl structure but they actually crystallize in the ZnS structure. Explain. 3+2

8. (a) Explain the following :

(i) Li_3N can be formed while Na_3N is not.

(ii) The iodine atom in IF_5 sits slightly below the plane of the base of the square pyramid.

(b) N_3^- is more resonance stabilized than HN_3. Explain. 3+2

9. (a) Justify the following :

   (i) Methanol, CH_3OH, has a much higher boiling point than methyl mercaptan, CH_3SH.

   (ii) Solubility of ortho-nitrophenol and para-nitrophenol in water are different.

   (b) The nucleus ^{23}Ne decays by β-emission. Write down the decay equation and determine the maximum kinetic energy of the electron emitted. (Ignore the mass of anti-neutrino)

   Mass of ^{23}Ne = 22.994466 u

   Mass of ^{23}Na = 22.989770 u   3+2

10. (a) ZnO and SnO_2 are white when cold but they look yellow when hot. Explain schematically the theory behind it.

    (b) $AlCl_3$ is covalent, but it behaves like an ionic compound on hydration. — Justify.   3+2

11. (a) Draw the Lewis structure of SO_2Cl_2 and find the formal charge on S and O.

    (b) Predict and justify the order of dipole moment of CH_3Cl and $CHCl_3$.   3+2

12. (a) Explain the structure of PCl_3F_2 in the light of Bent's rule.

    (b) $PbCl_2$ is white while PbI_2 is coloured. — Justify.   3+2

13. (a) CH_3NCS is angular while SiH_3NCS is linear. — Explain.

    (b) What is radiocarbon dating?   3+2

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