WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 3rd Semester Examination, 2022-23

CEMACOR06T-CHEMISTRY (CC6)

Time Allotted: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks.

Answer any *three* questions taking *one* from each unit

UNIT-I

1. (a) Justify or criticise the following statements: $2\times3 = 6$

    (i) From the radius ratio $(r_+/r_- = 0.76)$, RbBr can adopt the CsCl structure but in practice it crystallises in the NaCl structure. A similar situation arises for KCl.

    (ii) From the radius ratio, NH_4F is expected to crystallise in the NaCl structures like other $NH_4X\,(X = Cl, Br, I)$. But it crystallizes in the ZnS structure.

    (iii) The lattice energies of silver halides are almost the same as that of alkali halides, yet they are insoluble in water.

    (b) The dipole moment of KCl is 3.336×10^{-29} cm. The distance between K^+ and Cl^- ion is 2.6×10^{-10} m. Calculate the % of ionic character of KCl $[e = 1.60\times10^{-19}$ coulomb]. 2

    (c) The dipole moment of NH_3 is 1.49 D but that of BF_3 is zero — Why? 2

    (d) Calculate the heat of formation (ΔH_f) of MgF_2 from its elements using Born-Haber cycle. 2

    Sublimation energy of Magnesium, $(S) = 146.4$ kJ mol^{-1}.

    Dissociation of $F_2(D) = 158.9$ kJ mol^{-1}.

    Ionisation energy of Mg(g), $I(Mg^{2+}) = 2184.0$ kJ mol^{-1}.

    Electron affinity for $F(g) = -334.7$ kJ mol^{-1}.

    Lattice energy of $MgF_2(U_0) = -2922.5$ kJ mol^{-1}.

    (e) Write down the resonating structure of SCN^- ion indicating the formal charges on each atom. Indicate which structure is most contributing and why? 2

    (f) Using VSEPR theory, predict the shape of SOF_4. Indicate the state of hybridisation of the central atom. 2

2. (a) Predict the shapes and indicate the state of hybridisation of the central atom for the following: 3

    (i) $XeOF_4$

    (ii) I_5^-

    (iii) PCl_3Br_2.

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Turn Over

(b) Calculate the lattice energy of $Mg(ClO_4)_2$ using Kapustinskii equation. Radii of Mg^{2+} and ClO^{4-} ions are 86 pm and 226 pm respectively.
$$K = 1.214 \times 10^5 \text{ pm.mol}^{-1}.$$ 3

(c) $(SiH_3)_3N$ and $(CH_3)_3N$ react with HCl to give different products — Explain. 3

(d) Solubility trend of fluorides of alkali metals in water are 3
$$CsF > RbF > KF > NaF > LiF.$$
But this trends is reverse for iodides. Explain.

(e) K^+ and F^- have comparable sizes. Which one has the greater hydration energy and why? 2

(f) Give reasons why: 2
 (i) $BaSO_4$ is insoluble in water.
 (ii) Melting point of BaO is high.

UNIT-II

3. (a) Rationalize the bond lengths of CO (1.128 Å) and CO^+ (1.115 Å) with the help of MO diagram. Explain the ligating behaviour of CO. Explain why the dipole moment of CO is exceedingly small with the help of MO diagram. 3+1+2

 (b) What are the expected changes in bond order and bond distance that accompany the following ionisation processes? 3
 (i) $N_2 \longrightarrow N_2^+ + e^-$
 (ii) $NO + e \longrightarrow NO^-$

 (c) Why are glass apparatus dried by cleaning with alcohol or acetone? Which one is more effective and why? 2+1

 (d) Which type of defects occurs when NiO is heated at 1500 K with excess of O_2 and the colour turns to black? 2

 (e) Explain the effect of temperature on the variation of conduction of metal and semiconductors. 2

4. (a) Construct the M.O energy level diagram for CO_2. Calculate the bond order from it. 4+1

 (b) Between H_2O and H_2O_2 which one has higher boiling point and why? 2

 (c) From the view point of qualitative M.O. description indicate which of the given molecules are expected to be stabilized by: 2+2
 (i) Addition of an electron, (ii) Removal of an electron.
 (A) NO (B) C_2 (C) CN and (D) O_2

 (d) Explain the following variation of colour in the diatomic halogens from the view point of HOMO/LUMO concept. 3
 F_2 (pale yellow), Cl_2 (greenish yellow), Br_2 (reddish brown) and I_2 (violet)

 (e) Explain the fact that in B_2H_6, all hydrogens are not identical. 2

UNIT-III

5. (a) Is the $_8O^{16}$ isotope chemically identical with the $_8O^{18}$ isotope? Discuss.   2

(b) Predict the mode of decay of the following nuclei: 3

$_6C^{13}$ and $_{15}P^{30}$.

(c) Calculate the binding energy per nucleon of the $_{18}Ar^{40}$ nucleus. The experimental   3
mass of $_{18}Ar^{40}$ is 39.962384 u. $M_H = 1.007825$ u; $M_n = 1.008665$ u.

6. (a) Considering the following reaction profile how you would establish that entire   2
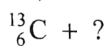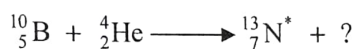oxygen is evolved from either PbO_2 or from H_2O_2?

$$PbO_2 + H_2O_2 \longrightarrow PbO + H_2O + O_2$$

(b) $_4^9Be$ is stable but $_5^9B$ is unstable — Why?   1

(c) An Uranium mineral contains 15 g of lead (^{206}Pb) for each 100 g of Uranium   3
(^{238}U) present. What is the age of the mineral?

$$[t_{1/2} \text{ of } ^{238}U = 4.2 \times 10^9 \text{ years}]$$

(d) Complete and then interpret the following nuclear reactions given below: 2

$$_5^{10}B + _2^4He \longrightarrow _7^{13}N^* + \text{ ?}$$
$$\downarrow$$
$$_6^{13}C + \text{ ?}$$

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