



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: 2×3 = 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 ($\text{X} = \text{Cl}, \text{Br}, \text{I}$). 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 2
 $[e = 1.60 \times 10^{-19} \text{ coulomb}]$.
- (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) = $146.4 \text{ kJ mol}^{-1}$.
 Dissociation of F_2 (D) = $158.9 \text{ kJ mol}^{-1}$.
 Ionisation energy of Mg(g) , $I(\text{Mg}^{2+}) = 2184.0 \text{ kJ mol}^{-1}$.
 Electron affinity for $\text{F(g)} = -334.7 \text{ kJ mol}^{-1}$.
 Lattice energy of MgF_2 (U_0) = $-2922.5 \text{ kJ mol}^{-1}$.
- (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 .

- (b) Calculate the lattice energy of $\text{Mg}(\text{ClO}_4)_2$ using Kapustinskii equation. Radii of Mg^{2+} and ClO_4^- ions are 86 pm and 226 pm respectively. 3

$$K = 1.214 \times 10^5 \text{ pm.mol}^{-1}.$$
- (c) $(\text{SiH}_3)_3\text{N}$ and $(\text{CH}_3)_3\text{N}$ react with HCl to give different products — Explain. 3
- (d) Solubility trend of fluorides of alkali metals in water are 3

$$\text{CsF} > \text{RbF} > \text{KF} > \text{NaF} > \text{LiF}.$$

 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.

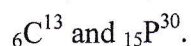
UNIT-II

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) $\text{N}_2 \longrightarrow \text{N}_2^+ + \text{e}^-$
 (ii) $\text{NO} + \text{e}^- \longrightarrow \text{NO}^-$
- (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 ${}_8\text{O}^{16}$ isotope chemically identical with the ${}_8\text{O}^{18}$ isotope? Discuss. 2

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



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

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



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

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

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

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

