



WEST BENGAL STATE UNIVERSITY  
B.Sc. Honours 3rd Semester Examination, 2022-23

CEMACOR06T-CHEMISTRY (CC6)

Full Marks: 40

Time Allotted: 2 Hours

*The figures in the margin indicate full marks.*

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

UNIT-I

2×3 = 6

1. (a) Justify or criticise the following statements:

- (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,  $\text{NH}_4\text{F}$  is expected to crystallise in the NaCl structures like other  $\text{NH}_4\text{X}$  ( $\text{X} = \text{Cl}, \text{Br}, \text{I}$ ). 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  $3.336 \times 10^{-29}$  cm. The distance between  $\text{K}^+$  and  $\text{Cl}^-$  ion is  $2.6 \times 10^{-10}$  m. Calculate the % of ionic character of KCl [ $e = 1.60 \times 10^{-19}$  coulomb]. 2

(c) The dipole moment of  $\text{NH}_3$  is 1.49 D but that of  $\text{BF}_3$  is zero — Why? 2

(d) Calculate the heat of formation ( $\Delta H_f$ ) of  $\text{MgF}_2$  from its elements using Born-Haber cycle. 2

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

Dissociation of  $\text{F}_2$  (D) =  $158.9 \text{ kJ mol}^{-1}$ .

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

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

Lattice energy of  $\text{MgF}_2$  ( $U_0$ ) =  $-2922.5 \text{ kJ mol}^{-1}$ .

(e) Write down the resonating structure of  $\text{SCN}^-$  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  $\text{SOF}_4$ . 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)  $\text{XeOF}_4$

(ii)  $\text{I}_5^-$

(iii)  $\text{PCl}_3\text{Br}_2$ .

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

$$K = 1.214 \times 10^5 \text{ pm} \cdot \text{mol}^{-1}$$
- (c)  $(\text{SiH}_3)_3\text{N}$  and  $(\text{CH}_3)_3\text{N}$  react with  $\text{HCl}$  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)  $\text{K}^+$  and  $\text{F}^-$  have comparable sizes. Which one has the greater hydration energy and why? 2
- (f) Give reasons why: 2  
 (i)  $\text{BaSO}_4$  is insoluble in water.  
 (ii) Melting point of  $\text{BaO}$  is high.

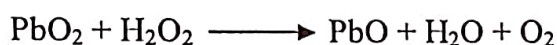
### UNIT-II

3. (a) Rationalize the bond lengths of  $\text{CO}$  (1.128 Å) and  $\text{CO}^+$  (1.115 Å) with the help of MO diagram. Explain the ligating behaviour of  $\text{CO}$ . Explain why the dipole moment of  $\text{CO}$  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)  $\text{N}_2 \longrightarrow \text{N}_2^+ + e^-$   
 (ii)  $\text{NO} + e \longrightarrow \text{NO}^-$
- (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  $\text{NiO}$  is heated at 1500 K with excess of  $\text{O}_2$  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  $\text{CO}_2$ . Calculate the bond order from it. 4+1
- (b) Between  $\text{H}_2\text{O}$  and  $\text{H}_2\text{O}_2$  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)  $\text{NO}$                       (B)  $\text{C}_2$                       (C)  $\text{CN}$  and                      (D)  $\text{O}_2$
- (d) Explain the following variation of colour in the diatomic halogens from the view point of HOMO/LUMO concept. 3  
 $\text{F}_2$  (pale yellow),  $\text{Cl}_2$  (greenish yellow),  $\text{Br}_2$  (reddish brown) and  $\text{I}_2$  (violet)
- (e) Explain the fact that in  $\text{B}_2\text{H}_6$ , 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
- ${}_6\text{C}^{13}$  and  ${}_{15}\text{P}^{30}$ .
- (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

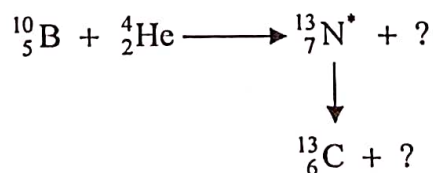
6. (a) Considering the following reaction profile how you would establish that entire oxygen is evolved from either  $\text{PbO}_2$  or from  $\text{H}_2\text{O}_2$ ? 2



- (b)  ${}_4^9\text{Be}$  is stable but  ${}_5^9\text{B}$  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



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