

2021

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** from the rest.1. Answer **any ten** questions :

1×10

- Which term accounts for the repulsion in the Born-Landé equation?
- Carbon monoxide has very low dipole moment. — Why?
- Write down the increasing order of bond angles (from lowest to the highest) in CH_2Cl_2 .
- What is the bond order of carbide (C_2^{2-}) ion?
- Unipositive helium (He^+) ion has non zero bond order, but no stable compound of it is found in nature. — Why?
- What is an F-Centre?
- What is the dimension of Madelung constant (A) in the Born-Landé equation?
- Which isotope of carbon and what activity is measured in radio carbon dating?
- For the reaction ${}_{15}\text{P}^{31}({}_0^n, x){}_{14}\text{Si}^{31}$, identify 'x'.
- What is the nature of LUMO in O_2 molecule?
- Although fluorine exerts one of the strongest hydrogen bond, yet boiling point of HF is less than water.— Explain.
- Indicate the formal charge of each atom in CO_3^{2-} .

2. (a) Explain which have the longer axial P-F distance : $\text{PF}_2(\text{CH}_3)_3$ or $\text{PF}_2(\text{CF}_3)_3$.

- Iodine-ammonia adduct is a liquid with somewhat metallic lustre. Comment on the bonding between iodine and ammonia.

3+2

Please Turn Over

3. (a) It is found that enthalpy of formation of CaF_2 is $-1220 \text{ KJ mol}^{-1}$. The thermochemical data (in KJ mol^{-1}) for the formation of CaF (*theoretical*) are :

Term	Compound CaF
Enthalpy of atomisation (Ca)	+178
First ionisation energy (Ca)	+590
Enthalpy of atomisation (F)	+79
Affinity energy (F)	-328
Lattice energy (U_0 of CaF)	-795

Explore the possible stability of CaF with respect to disproportionation into elementary calcium and CaF_2 .

- (b) What were the future modifications of Born-Landé equation? 3+2
4. (a) The observed trends of the boiling point of the Group 16 and Group 15 hydrides are in the order : $\text{H}_2\text{O} \gg \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$ and $\text{NH}_3 \gg \text{PH}_3 < \text{AsH}_3 < \text{SbH}_3$. — Justify.
- (b) Hydrofluoric acid is a monobasic acid, but forms acid salt. Explain with reason and appropriate illustrations. 3+2
5. (a) (i) 2-Nitrophenol and 4-nitrophenol may be separated by steam distillation. — Justify.
(ii) Boric acid has a greasy feeling. — Explain.
- (b) Work out the angle between the lone pairs of electrons on oxygen in water. The angle between two hydrogen atoms centring oxygen (H-O-H) is 104.5° . [$\text{Cos}(104.5) = -0.25$] 3+2
6. (a) State the limitations of VSEPR theory with necessary illustrations.
- (b) Explain the order of the bond angle :
 $\angle \text{F-O-F} < \angle \text{H-O-H} < \angle \text{Cl-O-Cl}$ 3+2
7. (a) Indicate the atoms which exhibit :
(i) sp^3 hybridisation in ClO_4^- ion
(ii) sp^2 hybridisation in ozone molecule.
- (b) Work out the formal charge on the constituent atoms of :
(i) SOCl_2 (ii) N_3^- ion. 3+2
8. (a) Work out the bond order of Be_2 and comment on its stability.
- (b) Indicate on the basis of either hybridisation of the central atom or VSEPR considerations the structures of :
(i) $[\text{IOF}_4]^-$ (ii) $[\text{PF}_4]^+$. 3+2

9. (a) Ionisation of molecular dinitrogen decreases the bond order and increases the bond distance but an opposite effect is observed in case of molecular dioxygen. — Explain.
- (b) Water has two lone pairs of electron on oxygen yet it acts as a monoacidic base. Explain in terms of MO consideration. 3+2
10. (a) (i) The melting points of lithium halides follow the order :
 $\text{LiF} \gg \text{LiCl} > \text{LiBr} > \text{LiI}$. — Explain.
- (ii) Electrical conduction in metals decrease with increase in temperature. — Justify.
- (b) What happens when stoichiometric Ni(II) oxide is doped with Li_2O ? 3+2
11. (a) What are magic numbers? On the basis of nuclear shell model, justify the concept of magic number.
- (b) Approximately how many grams of ^{14}C did an organism initially possess if there are 7g remaining after 17,830 years? [Given the half-life of ^{14}C is 5700 years.] 3+2
12. (a) What are mesons? How different meson exchange phenomena account for the nuclear stability?
- (b) Write a comparative note on hazards of α , β and γ radiations. 3+2
13. (a) Construct the MO diagram of BeH_2 mentioning the group orbitals constructed and showing the interaction with the appropriate orbitals of Be.
- (b) Outline the process of separation of the isotope of uranium that is required as fuel in a nuclear reactor. 3+2
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