

**U.G. 3rd Semester Examination 2021**

**CHEMISTRY (Honours)**

**Paper Code : DC-6**

**[ Inorganic Chemistry ]**

**(CBCS)**

Full Marks : 25

Time : Two Hours

1. Answer any *five* questions from the following:

1 × 5 = 5

(a) According to molecular orbital theory for atomic species  $C_2$

- (i) Bond order is zero and it is paramagnetic
- (ii) Bond order is zero and it is diamagnetic
- (iii) Bond order is two and it is diamagnetic
- (iv) Bond order is two and it is paramagnetic

(b) The coordination number of  $Ba^{2+}$  ions in barium fluoride is 8. The coordination number of the fluoride ions is

- (i) 8
- (ii) 4
- (iii) 1
- (iv) 2

(c) How many  $\alpha$ - and  $\beta$ - particles would be emitted during the disintegration of  $^{232}Th$  to  $^{208}Pb$ ?

- (i)  $6\alpha$  and  $4\beta$
- (ii)  $4\alpha$  and  $8\beta$
- (iii)  $4\alpha$  and  $6\beta$
- (iv)  $8\alpha$  and  $6\beta$

(d) The boiling points of noble gases are illustrative of the operation of forces of the type –

- (i) ion-dipole
- (ii) dipole-induced dipole
- (iii) ion-induced dipole
- (iv) London dispersion forces

(e) Which of the following sequences represent the correct increasing order of the polarizing power of the cations?

- (i)  $\text{Ca}^{2+} < \text{Mg}^{2+} < \text{Be}^{2+} < \text{K}^+$
- (ii)  $\text{K}^+ < \text{Ca}^{2+} < \text{Mg}^{2+} < \text{Be}^{2+}$
- (iii)  $\text{Mg}^{2+} < \text{Be}^{2+} < \text{K}^+ < \text{Ca}^{2+}$
- (iv)  $\text{Be}^{2+} < \text{K}^+ < \text{Ca}^{2+} < \text{Mg}^{2+}$

(f) Band theory predicts that magnesium is an insulator. However, in practice it acts as a conductor due to

- (i) presence of filled  $3s$ - orbital
- (ii) Overlap of filled  $2p$ - and filled  $3s$ - orbital
- (iii) presence of unfilled  $3p$ - orbital
- (iv) Overlap of filled  $3s$ - and empty  $3p$  orbital

(g) Elements of which of the following radioactive disintegration series do not occur in nature?

- (i) Thorium series or  $4n$  series
- (ii) Neptunium series or  $(4n+1)$  series
- (iii) Uranium series or  $(4n+2)$  series
- (iv) Actinium series or  $(4n+3)$  series

(h) According to VSEPR theory, the shapes of  $[\text{SFCl}_2]^+$  and  $[\text{S}_2\text{O}_4]^{2-}$  should be

- (i) trigonal planar for  $[\text{S}_2\text{O}_4]^{2-}$  and trigonal pyramidal for  $[\text{SFCl}_2]^+$
- (ii) both trigonal planar
- (iii) trigonal pyramidal for  $[\text{S}_2\text{O}_4]^{2-}$  and trigonal planar for  $[\text{SFCl}_2]^+$
- (iv) both trigonal pyramidal

2. Answer any *four* questions :

$2 \times 4 = 8$

- (a) Draw the schematic band models for insulator and intrinsic semiconductor.
- (b) What are extrinsic semiconductors? Give examples
- (c) A cancer patient undergoing radiotherapy is given a dose of  $3.42 \mu\text{g } ^{60}\text{Co}$ . How much isotope will remain in his body after 30 years? The half-life of  $^{60}\text{Co}$  is 5.27 years.
- (d) Do you expect the structures of  $\text{PCl}_3\text{F}_2$  and  $\text{PF}_3\text{Cl}_2$  to be different? If so why?
- (e) Differentiate between Schottky defect and Frenkel defect.
- (f) Based on MO theory explain the chemical reactivity of  $\text{N}_2$  molecule.
- (g) What do you mean by nuclear spallation reaction? Give example.
- (h) Use Fajan's polarization rules to predict which is likely to be ionic or covalent:  $\text{RbCl}$  and  $\text{CsCl}$

3. Answer any *two* questions:

$6 \times 2 = 12$

- (a)
  - (i) Calculate the limiting radius ratio value for coordination number 6 (octahedral geometry).
  - (ii) Discuss the valence bond theory to explain the nature of metallic bond.
  - (iii)  $^9\text{Be}$  is stable but  $^9\text{B}$  is not. Why?  $2\frac{1}{2} + 2\frac{1}{2} + 1$
- (b)
  - (i) What are the significant differences observed in neptunium disintegration series from other disintegration series?
  - (ii) What information do we obtained from the plot of binding energy per nucleon vs. mass number?
  - (iii) What thermodynamic considerations are involved in creation of stoichiometric defects?

$2 + 2 + 2$

- (c) (i) Using Born – Haber Cycle, calculate the electron affinity of chlorine from the following data:

$$\text{Bond enthalpy of Cl}_2 = +240.0 \text{ kJ mol}^{-1}$$

$$\text{Enthalpy of formation of NaCl (s)} = -440.0 \text{ kJ mol}^{-1}$$

$$\text{Enthalpy of sublimation of Na (s)} = +110.0 \text{ kJ mol}^{-1}$$

$$\text{Enthalpy of ionization of Na (g)} = +480.0 \text{ kJ mol}^{-1}$$

$$\text{Enthalpy of lattice formation of NaCl (s)} = -810.0 \text{ kJ mol}^{-1}$$

- (ii) State Sody-Fajan group displacement law with suitable example.

- (iii) Write down the limitations of radius ratio concepts. 2 + 2 + 2

- (d) (i) On analysis, an ore of uranium shows the mass ratio for  $^{238}\text{U}$  to  $^{206}\text{Pb} = 6.08$ . All  $^{206}\text{Pb}$  are supposed to appear from the disintegration of  $^{238}\text{U}$ . Find the age of the ore. (Given,  $t_{1/2}$  for  $^{238}\text{U} = 4.5 \times 10^9$  year, the next longest lived nuclide  $^{234}\text{U}$  in the series shows  $t_{1/2} = 2.5 \times 10^5$  year)

- (ii) Draw and explain the MO diagram for  $\text{CO}_2$  molecule.

- (iii) What is the significance of Madelung constant? 2½ + 2½ + 1
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