

3/CHE-200 Syllabus-2023

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(Nov-Dec)

FYUP : 3rd Semester Examination

MAJOR

CHEMISTRY

(**Chemistry-III**)

CHE-200

Marks : 75

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

PART—A

(**Inorganic**)

(*Marks : 38*)

1. (a) Explain why the first ionization enthalpy of an alkaline earth metal is higher than that of an alkali metal in the same period, but its second ionization enthalpy is lower than that of the alkali metal.

2

(2)

- (b) State the type of oxides formed by lithium and potassium when they are burnt in excess air or oxygen. Write balanced chemical equations for the reaction of these oxides with water. 3
- (c) Write one method of preparation and one use for each of the following compounds : $2 \times 2 = 4$
- (i) Diborane
- (ii) Lead tetraacetate
- (d) What are the common oxidation states exhibited by group-14 elements? Give a reason why, on moving down the group, the lower oxidation state becomes more stable. 2
- (e) Explain why the atomic radius of gallium is smaller than that of aluminium. 1
- (f) For the molecule IF_7
- (i) draw the structure of the molecule;
- (ii) state the hybridization of the central atom;
- (iii) state the geometry of the molecule. 3
- (g) What are interhalogen compounds? How are they named? Give one example. 2

(3)

- (h) Write one method of preparation of cyanogen. How does cyanogen react with potassium? Write balanced chemical equations for both reactions. 2

OR

2. (a) Explain why the electron gain enthalpy of oxygen is less negative than that of sulphur. 2
- (b) Name two oxyacids of chlorine in which the oxidation states of chlorine are +5 and +7. Which of the two is more acidic and why? 3
- (c) Write one method of preparation and one use of each of the following compounds : $2 + 2 = 4$
- (i) Sodium thiosulphate
- (ii) Quick lime
- (d) What happens when potassium iodide react with copper (II) sulphate? Write the balanced chemical equations. 2
- (e) Explain why phosphorus forms pentahalides but nitrogen does not. 1
- (f) What are polyhalides? Give two examples. 2

(4)

- (g) Write one method of preparation of ClF_3 , draw its structure and mention its shape. 3
- (h) What are pseudohalogens and pseudohalides? Give one example of each. 2
3. (a) Give a reason why the second and third row transition elements resemble each other more closely than they resemble the first row transition elements. 2
- (b) Explain why transition metals exhibit variable oxidation states, unlike most other elements. 2
- (c) Write one method of preparation of potassium ferrocyanide and its reaction with copper sulphate solution. 2
- (d) Give reasons why lanthanides exhibit +3 as the most common oxidation state, whereas some lanthanides also show +2 and +4 oxidation states. 3
- (e) Identify which of the following metal ions does not form coloured compounds and explain their magnetic behaviour when placed in a magnetic field : 3
 Cu^{2+} , Cr^{3+} , Zn^{2+}

(5)

- (f) Draw the molecular orbital energy level diagrams of N_2 and NO molecules. Calculate their bond orders, and mention their magnetic properties. 3
- (g) Considering the z-axis as the molecular axis, which of the following atomic orbitals can combine to form molecular orbitals and which cannot? 2
- (i) $2s$ and $2p_x$
(ii) $2s$ and $2p_z$
(iii) $2p_y$ and $2p_y$
- (h) Arrange the following species in the increasing order of bond length : 2
 O_2 , O_2^+ , O_2^-
- OR**
4. (a) Explain why the second ionization energies of Cu and Cr are notably higher than those of their neighbouring elements. 2
- (b) Describe the preparations of potassium dichromate starting from chromite ore, giving balanced chemical equations. Draw the structure of the dichromates ion. 3

(6)

- (c) What are *trans*-uranic elements? Write the synthesis of plutonium. 3
- (d) Write down one point of similarity between lanthanides and actinides. 1
- (e) Explain the separation of lanthanides based on the ion-exchange method. 3
- (f) State the three conditions that must be satisfied for the combination of atomic orbitals to form molecular orbitals. 3
- (g) A chlorine molecule is ionized to form Cl_2^+ : 2+1=3
- (i) Write the molecular orbital electronic configuration of Cl_2 and Cl_2^+ .
- (ii) Which one will have shorter bond length? Give a reason.
- (h) What is the change in magnetic behaviour in the following transformation : 1
- $$\text{O}_2^+ \longrightarrow \text{O}_2^{2+}$$

(7)

PART—B

(Physical)

(Marks : 37)

5. (a) Find $P(0)$ and $P(\frac{3}{2})$ for the following polynomials : $2 \times 2 = 4$
- (i) $P(x) = x^3$
- (ii) $P(y) = y^2 - y + 1$
- (b) Differentiate $x^{\sin x}$ w.r.t. x . 2
- (c) Draw the graph of $2x - 3y + 3 = 0$ and find the three solutions of the equation. 3
- (d) Find the value of k for which the equation $3x^2 - 6x + k = 0$, has integer and real root. 3
- (e) Express the matrix
- $$A = \begin{bmatrix} 2 & 4 & -6 \\ 7 & 3 & 5 \\ 1 & -2 & 4 \end{bmatrix}$$
- as the sum of a symmetric and a skew-symmetric matrix. 3
- (f) In a single throw of two dice, what is the probability of obtaining 'a total of 9'? 3

OR

6. (a) Integrate the following : $2 \times 2 = 4$

(i) $\frac{x}{e^{x^2}}$

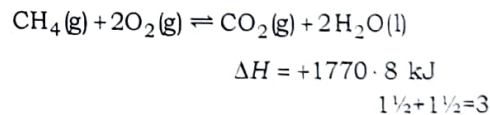
(ii) $x e^x$

(b) Solve for x if

$$\log_2(x-1) + \log_2(x+1) = \log_2 1 \quad 2$$

(c) (i) Find the units of the equilibrium constants k_c and k_p for the reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$.(ii) Convert an acceleration of 2 kmh^{-2} into cms^{-2} . $1\frac{1}{2} + 1\frac{1}{2} = 3$ (d) If $\vec{a} = 5\hat{i} - \hat{j} - 3\hat{k}$ and $\vec{b} = \hat{i} + 3\hat{j} - 5\hat{k}$, then show that the vectors $\vec{a} + \vec{b}$ and $\vec{a} - \vec{b}$ are orthogonal. 3 (e) Find the value of n such that ${}^n P_5 = 4 {}^n P_3$, $n > 4$. If ${}^n C_9 = {}^n C_8$, find ${}^n C_{17}$. $2+2=4$ (f) Approximate $\frac{7!}{5!}$ using Stirling approximation. 2 7. (a) Starting from the law of mass action, derive the mathematical formulations of the law of chemical equilibrium. State the law of chemical equilibrium. $3+1=4$ (b) The value of K_p at 20°C for the reaction $2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{NOCl}(\text{g})$ is $1.9 \times 10^3 \text{ atm}^{-1}$. Calculate the value of K_c at the same temperature. 2

(c) Define Le-Chatelier's principle. Discuss the effect of temperature on the reaction

(d) For a salt of weak acid and weak base, derive $k_h = \frac{k_w}{k_a k_b}$. Also obtain the relation between hydrolysis constant and degree of hydrolysis. $2+2=4$ (e) Write short notes on the following : $1\frac{1}{2} \times 2 = 3$

(i) Common-ion effect

(ii) Buffer activity

(10)

- (f) The solubility of PbSO_4 in water is 0.038 kg m^{-3} at 298 K. Calculate its solubility product at 298 K. (Molar mass of $\text{PbSO}_4 = 303 \text{ g}$) 3

OR

8. (a) Discuss the temperature dependence of equilibrium constant in terms of pressure. 3
- (b) Derive the relation between free energy change and equilibrium constant. 3
- (c) Which of the following equilibria are not affected by pressure changes and why? 1+1+1=3
- (i) $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$
- (ii) $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$
- (iii) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
- (d) A buffer solution contains 0.015 mol of ammonium hydroxide and 0.025 mol of ammonium chloride. Calculate the pH value of the solution. Dissociation constant of NH_4OH at room temperature is 1.80×10^{-5} . 3

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- (e) What is meant by ionic product of water? Does it vary with temperature? 1+1=2
- (f) Write short notes on the following : 1½×2=3
- (i) Cationic hydrolysis
- (ii) Anionic hydrolysis
- (g) Define pH of a solution. What happens to pH of water when it is completely vaporised or freed? 1+1=2
