Set 5

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Q 1.A. Select the correct option and complete the following statements**(Any twelve)**

i. c) 10^{-7}.

ii. a) 1

iii. b) 8.5

iv. b) orderly arrangement

v. a) $a = b = c$, $\alpha = \beta = \gamma \neq 90°$

vi. c) with and without medium

vii. c) trigonal bipyramidal

viii. b) ionic bonds

ix. a) shared equally by both the atoms.

x. b) 90°

xi. a) KI

xii. b) F_2

xiii. b) aromatic

xiv. b) Sulfuric acid

xv. c) $-NO_2$

xvi. b) boat form

xvii. b) more stable

xviii. b) antiaromatic

Q.1.B. State whether the following statements are True or False (Any three)

i. False

ii. True

iii. True

iv. False.

v. True vi) False

Q.1.C. Match the following columns **(Any Five).**

i. g) 7.3

ii. e) Interfacial angle

iii. h) Reduction

iv. f) Free iodine solution

v. c) staggered form

vi. d) less stable

Q. No.		Marks
2. A.	$HA \rightleftharpoons H^+ + A^-$ ..... 1 mark $Ka = [H^+][A^-]/[HA]$ ..... 1 mark $[H^+] = Ka\,[HA] / [A^-]$ Where [HA] = [acid] and $[A^-]$ = [salt] $[H^+] = Ka\,[acid] / [salt]$ Taking logarithm $\log[H^+] = \log Ka + \log [acid]/[salt]$ $-\log[H^+] = -\log Ka + \log [salt]/[acid]$ $pH = pKa + \log [salt]/[acid]$ ..... 1 mark	2 marks
2. B.	$[OH^-] = \sqrt{K_b \times C}$ .... 1 mark $[OH^-] = \sqrt{1.77 \times 10^{-5} \times 0.1} = \sqrt{1.77 \times 10^{-6}}$ $[OH^-] = 1.33 \times 10^{-3}$ ..... 1 mark $pOH = -\log [OH^-]$ ..... ½ mark $= -\log[1.33 \times 10^{-3}] = 2.8761$ ..... ½ mark $pH + pOH = 14$ .....1 mark $pH = 14 - pOH = 14 - 2.8761 = 11.1239$ .....1 mark	
2. C.	Definition of Degree of Ionization ..... 1 mark Factors affecting Degree of Ionization ..... 4 marks	

Q.2.D.

Frequency (υ) $= c / \lambda$ (½ mark)

a) Wavelength (λ) $= c / \upsilon$ (½ mark)

$= 3 \times 10^{8} / (2.45 \times 10^{9})$

$= 0.122$ m (1 mark)

Energy $E = h \upsilon$ (½ mark)

$= 6.626 \times 10^{-34} \times 2.45 \times 10^{9}$

$= 1.623 \times 10^{-24}$ J (½ mark)

b) Wavelength (λ) $= c / \upsilon$

$= 3 \times 10^{8} / (5.8 \times 10^{9})$

$= 0.0517$ m (1 mark)

Energy $E = h \upsilon$

$= 6.626 \times 10^{-34} \times 5.8 \times 10^{9}$

$= 3.843 \times 10^{-24}$ J (1 mark)

Q.2.E.

Different types of interaction of radiation with matter
Absorption, Emission and Scattering (5 marks)

Q.2.F.

Definition of Unit cell (1 marks)

Statement of three laws of crystallography … (3 marks)

S.V) Attempt any four of the following

A- What is iso electronic principle? Explain it with suitable example.

Ans: The concept that molecules having the same number of electrons and the same number of atoms whose atomic masses are greater than that of hydrogen tend to have similar electronic structures, similar chemical properties and heavy-atoms geometries. — [1 M.]

e.g CH_4 and SiH_4 (5 atom + 8 valence electrons)

Isoelectronic species are isostructural for example [1]
AB_2 type with 16 valence electrons or and three heavy atoms. CO_2, CS_2 NO_2 are linear AB_2 type with more than 16 valence $\bar{e}^s$ are angular. for e.g. NO_2 (17), NO_2^- (18 valence [1 M]

The molecule O_3 + SO_2 are isoelectronic on the basis of number of valence $\bar{e}^s$ (18 valence e^-) — [1 M]

AB_3 type of molecule (i) with 24 $\bar{e}^s$ and 4 heavy atoms have trigonal planar st. eg. BF_3, NO_3^- + CO_3^{2-} ion

(ii) with 26 of valence $\bar{e}$ + 4 heavy atom have pyramidal st. NX_3, PX_3 etc.. (Any four point 4 M) [1 M]

(B) is in the next page

(C) What is steric number? calculate SN of the following molecule

Ans: Definition — [1 M].

(a) CO_2 - SN = No. of atoms bonded to the central atom + No. of lone pairs (e's in the valence shell of central atom)

$= \frac{2}{2} + 0 = 2$. [2 M]

b) NH_3 - Same steps followed.

$= 3 + 1 = 4$. [2 M]

D) Draw Lewis dot st. of the following

(a) BCl_3 b) H_2O. [4 M]

Ans. Step I arrange the atoms Cl B Cl — [1 M]
Cl

Q. No.		Marks
	Step-2 count up total No. of valence e^-. $3(7)+3 = 24\ \bar{e}$	
	Step 3 Draw single bonds betn central atom + surrounding atoms - B	1M
	Cl - B(Cl) - Cl	1M
	Step 4 place remaining electron in pairs, around appropriate atom, start with outer atoms $24 - 6 = 18\ e^-$ ∴ 9 lone pairs.	
	:Cl(:)–B(–:Cl:)–Cl:	
	Step 5 Make sure that all atom have octect. $Cl^{'s}$ have octect; B is special element that can have an incomplete octect, so B only needs 6.	1M
	b) H_2O - follow the same steps as above H - Ö - H 1M each for each step	$2\frac{1}{2}$ M
B]	Explain the effect of lone pair of $\bar{e}^s$ in the geometry of molecule by giving suitable example.	
Ans	* The shape of molecule and also the approximate bond angle can be predicted from the Number and type of $\bar{e}^s$ pairs in the valence shell of central atom.	1M
	* electron pairs in the valence shell around the central atom of a molecule repel each other, so as to orient in space so as to minimize the repulsions	1M
	* Lone pair - Lone pair repulsion > Lone pair - bond pair > bP-bP	1M
	* Effect on bond angle + shape: the bond angle decreases due to the presence of LP. lonepairs	
	* methane, NH_3, H_2O can give examples for these and each have 4 $\bar{e}$ pair. CH_4 has 4 bP, NH_3 has 3 bP + 1 LP and H_2O has 2 bP + 2 LP. ∴ CH_4 has tetrahedral geometry, bond angle 109°28', NH_3 has pyramidal shape bond angle 107°28'. and H_2O molecule has V-shape and bond angle 104°27'.	1M

Q3 (E) Balance the equation

Marks

$CrO_4^{2-} + SO_3^{2-} \rightarrow Cr(OH)_4^- + SO_4^{2-}$ (in basic medium)

Step 1 (01)

$Cr^{+6} \rightarrow Cr^{+3}$ (reduction)

$S^{+4} \rightarrow S^{+6}$ (oxidation)

Step 2 (01)

$Cr^{+6} + 3e^- \longrightarrow Cr^{+3}$ — (1)

$S^{+4} \longrightarrow S^{+6} + 2e^-$ — (2)

Step 3. multiply (1) by 2 & (2) by 3. (01)

$2Cr^{+6} + 3S^{+4} \rightarrow 2Cr^{+3} + 3S^{+6}$

Step 4. $2CrO_4^{2-} + 2SO_3^{2-} \rightarrow 2Cr(OH)_4^- + 3SO_4^{2-}$ (01)

In basic medium add $3H_2O$ on RHS and $6OH^-$ on LHS (01)

$2CrO_4^{2-} + 3SO_3^{2-} + 6OH^- \rightarrow 2Cr(OH)_4^- + 3SO_4^- + 3H_2O$

Q3 (F) Redox Stability in Water : (01)

Strong oxidizing agents will oxidise water to O_2 while strong reducing agents will reduce water to H_2. Water may be oxidized or reduced depending upon the nature of ions or molecules present.

$2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$

Water as reducing agent :- (02)

$O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O(aq)$

applying Nernst equation

$E_{O_2, H^+/H_2O} = E^\circ_{O_2, H^+/H_2O} - \frac{2.303RT}{4F} \log\left[\frac{1}{[H^+]^4}\right]$

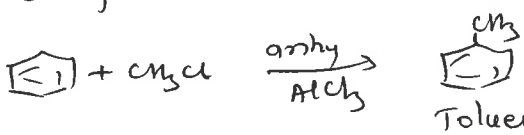
Water as oxidising agent :- (02)

$2H^+ + 2e^- \longrightarrow H_2(g)$ $E^\circ_{H^+/H_2} = 0.0\,V$

(aq)

$E = -0.05916\,pH$

potential is dependent on pH, overvoltage

Q. No.		Marks
	4 A Sulphonation of Benzene Reaction – 1M Mechanism – 4 steps ≡ 4M	
B	Criteria for aromatic compounds 5 criteria ≡ 5M	
C	Draw conformations of cyclohexane Structure of all four conformations = 2M Relative stabilities = 2M Potential Energy diagram = 1M	
D	(i) 4πe⁻s Antiaromatic more energy than the alicyclic compound	1½
	 6πe⁻s → 4π + 2π (C, N) Satisfies Huckel's Rule ∴ Aromatic	1½
	 6πe⁻s satisfies Huckel's Rule ∴ Aromatic	2M
E	 angle = θ = 60°C Baeyer's strain calculation (2M)  θ = 108 Baeyer's strain calculation (2M) comparison between the two ≡ 1M	
R	 Friedel Crafts Alkylation Reaction ≡ 1M Mechanism – 3 steps – 1M each	

Q. No.		Marks
5. A.	pH = pKa + log [salt] / [acid] ..... 1mark pKa = -log Ka = -log (1.8×10^{-5}) = 4.7447 .....1 mark pH = 4.74 + log 0.2/ 0.1 ..... 1 mark pH = 4.74 + 0.3010 .....1 mark pH = 5.0457 ..... 1 mark	
Q-5 B)	Definition of axis of Symmetry and explanation of.. (2 marks). Diagram of different axis of Symmetry and explanation (3 marks)	

Q5(c)

(i) Oxidation Number of Cr in (02)

$K_2Cr_2O_7$ $\quad 2\times(+1) + 2\times Cr + 7\times(-2) = 0$

$Cr = +6$

K_2CrO_4 $\quad 2\times(+1) + Cr + 4\times(-2) = 0$

$Cr = +6$

(ii) Self oxidation and reduction is called disproportionation (01)

Disproportionation of Cu^+ to Cu^{2+} and Cu^0 (02)

$2\,Cu^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + Cu^0_{(s)}$

Cu^{2+}/Cu^+ couple undergoes oxidation

Cu^+/Cu couple undergoes reduction

E^0 cell is +ve, where ΔG° = -ve.

Q5 (D) Titration curve for Fe(II) against Ce(IV)

Acid solution of Fe (II) is titrated with standard solution of Ce (IV) (01)

$Fe^{2+} + Ce^{4+} \rightleftharpoons Fe^{3+} + Ce^{3+}$

① Fe^{2+} and Fe^{3+} has tendency to hydrolyse. (02)

② Two redox system present, potential is given by Nernst equation

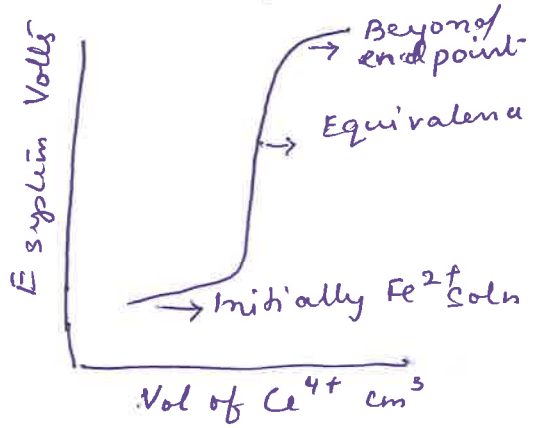
③ Titration curve is plotted in terms of cell potential Vs concentration of the standard. (02)

④ The E cell value with respect to volume of titrant are monitored specially in three distinct region

(a) before equivalence point

(b) at equivalence point

(c) after the equivalence point.



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Q. No.	5	Marks
E	i) flipping of cyclohexane explanation 2M structure 1M	
	ii) Steric strain — explanation 1M example 1M.	
F	state Hammond's postulate = 2M Three cases ≡ 1M each exoergic, endoergic, etc	