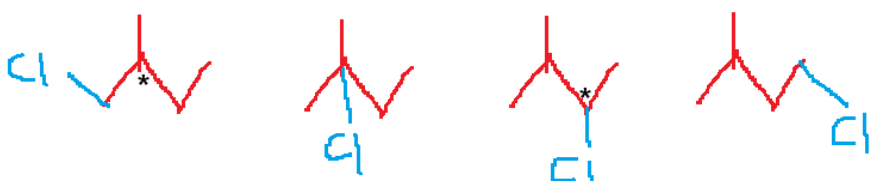**2026 H2 Chem Sample P3 Ans**

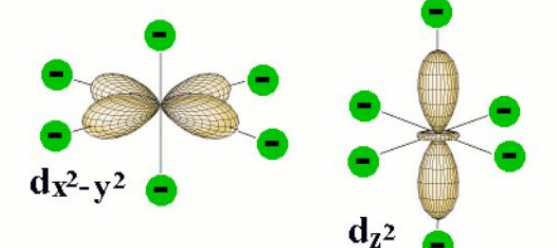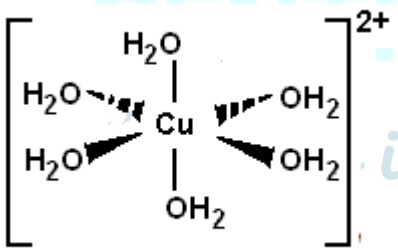| Qn	Ans
1 a)	Rate of forward reaction = Rate of backward reaction Concentration of reactants and products remain unchanged over time
bi)	$K_p = \dfrac{P_{H2}\,P_{CO}}{P_{H2O}}$ Unit of Kp = atm
ii)	Start state $\quad\quad\quad H_2O + C\,(s) \rightleftharpoons H_2 + CO$ Initial/atm 2.00 0 0 Chem/atm Equ/atm +1.40 Equilibrium $\quad\quad\quad H_2O + C\,(s) \rightleftharpoons H_2 + CO$ Initial/atm 2.00 0 0 Chem/atm -1.40 +1.40 +1.40 Equ/atm 0.60 +1.40 +1.40 Total pressure = 3.40 atm
iii)	$K_p = \dfrac{P_{H2}\,P_{CO}}{P_{H2O}} = \dfrac{1.40 \times 1.40}{0.60} = 3.27$ atm
ci)	Faster reaction rate due to larger surface area of the carbon resulting in higher rate of collision and effective collision Time taken is shorter
ii)	Kp remains the same → Affected only by temperature changes Position of equilibrium does not change as amt of carbon used is not featured in Kp expression
d)	CO forms dative bonds with Fe2+ in haemoglobin instead of with oxygen molecule which is non polar CO is polar and forms a stronger ligand bond with Fe^{2+} denying its ability to bind with oxygen molecule and hence transporting them to cells in the human body
ei)	$(CH_3)_2C{=}CH_2 + CO + H_2O \rightarrow (CH_3)_2CHCH_2CO_2H$ / Type 2 $C_6H_5CHO + CO + H_2O \rightarrow C_6H_5CH(OH)CO_2H$ / Type 3 $(CH_3)_3COH + CO \rightarrow (CH_3)_3CCO_2H$ / Type 1 [unable to use Type 2 for C=C]
ii)	Step 1: dilute aq H_2SO_4, $K_2Cr_2O_7$, heat Step 2: HCN with trace amount of KCN/KOH, 10^oC Step 3: dilute aq HCl/HNO_3, heat/reflux D: $C_6H_5COCO_2H$ E: $C_6H_5C(OH)(CN)CO_2H$
2 ai)	Pt(s)
ii)	$1.0\,moldm^{-3}$ for each cation/anion
iii)	Ecell = 1.33 – 0.34 = 0.99V
iv)	$Cr_2O_7^{2-} + 14H^+ + 3Cu \rightleftharpoons 2Cr^{3+} + 7H_2O + 3Cu^{2+}$
v)	ΔG = - nFEcell = - (6 x 96500 x 0.99) = -573,210 J = -573 kJ/mol
b)	PV = nRT → $1.00 \times 10^5 \times 126 \times 10^{-6}$ = n (8.31)(300)

	No of mol of H_2 = 0.00505415 mol No of mol of Zn = No of mol of H_2 = 0.00505415 mol Mass of Zn = 0.3305 = 0.331g No of mol of Cu = No of mol of MnO_4^- x $^5/_2$ = 0.0122 mol Mass of Zn = 0.7747 = 0.775g
ci)	OH^- neutralises the H^+ $[H^+]$ decreases causing position of equilibrium to shift forward More chromate(VI) than dichromate(VI) hence colour changes from orange to yellow
ii)	Lowering temperature favours exothermic reaction Forward reaction is endothermic & enthalpy change of forward reaction > 0
iii)	CrO_4^{2-} forms ppt with Ba^{2+} $[CrO_4^{2-}]$ decreases causing position of equilibrium to shift forward $[H^+]$ increases & pH decreases
3 a)	Cl_2 + $AlCl_3$ → Cl^+ + $AlCl_4^-$ Lewis base/electron pair donor I_2 + I^- → ^-I→I-I Lewis acid/electron pair acceptor
bi)	HCl(g), rtp
ii)	Cl_2(g), rtp, absence of UV light
iii)	Anhydrous PCl_5/PCl_3/$SOCl_2$, heat/warm
iv)	Anhydrous PCl_5/PCl_3/$SOCl_2$, heat/warm
v)	Cl_2(g), $AlCl_3$, heat
vi)	Cl_2(g), rtp, UV light
ci)	C-H bond is not polarised Hydrogen atom is neither electrophilic or nucleophilic to react with acid/base BE(C-H) bond is high & carbon is unable to be oxidised
ii)	Free radical substitution
iii)	Initiation Cl_2 → $2\overset{\bullet}{Cl}$ (UV light) Propagation $\overset{\bullet}{Cl}$ + C_2H_6 → $\overset{\bullet}{CH_3CH_2}$ + HCl Cl_2 + $\overset{\bullet}{CH_3CH_2}$ → CH_3CH_2Cl + $\overset{\bullet}{Cl}$ Termination $\overset{\bullet}{Cl}$ + $\overset{\bullet}{CH_3CH_2}$ → CH_3CH_2Cl

d

Ratio of H: I = 21:9 = 7:3 |
e)	
fi)	Mr of repeat unit = 2x(12+2) = 28 Mr of polymer > 15000 28 x n > 15000 n > 535.7 minimum repeat units = 536
ii)	Unable to be biodegradable & hence need to be incinerate or bury Incinerate cause air pollution / toxic fumes / increase greenhouse gas Bury takes up land space & forms microplastic that may be passed into our drinking water or food chain
4 a)	An element that forms at least one stable ion with an incomplete/partially filled sub-shell of d electrons.
b)	Conc HCl
ci)	
ii)	
iii)	highest energy level: ligand bonds formed between ligands and central atom in the direction x, y and z axes coincide with the orbital space of $3d_{xy}$ or $3d_{x2-y2}$ resulting in the largest repulsion forces between the electrons residing in the ligand bond and these orbitals

	lowest energy level: ligand bonds formed between ligands and central atom in the direction x, y, z axes is the furthest away from electrons that reside in the $3d_{xy}$ $3d_{yz}$ $3d_{xz}$ plane resulting in minimum repulsion forces between the electrons residing in the ligand bond and these orbitals
di)	Cu^+ ($1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^{10}$)
ii)	For coordination complexes of the transition metals, the 5 d orbitals are split into 2 sets of energy levels. The d electron thus undergoes d-d transitions when white light is directed on the complex (vacancies required in d orbitals) During the d – d transition/promotion of electron from lower to higher energy level, the d electron absorbs certain wavelength of light from the visible region of the electromagnetic spectrum and reflects the remaining wavelength, which appears as the colour observed. The colour observed is thus the complement of the colour absorbed. Cu^+ has a fully filled 3d subshell and no d electron is able to absorb wavelength of light and promote from lower to higher energy level
iii)	Strength of ligand bond formed Mn^{3+}/Cu^{2+} with water molecules are varied, resulting in different energy gap between the separated sets of d orbitals. Different wavelength of light from visible region would be absorbed.
iv)	
ei)	ΔH = **sum of enthalpies of formation of products - reactants** ΔH = -168.6 + (2 x 33.2) + (0/elements) – (-302.9) = 200.7 = 200 kJ/mol
ii)	$CuO \leftrightarrow \frac{1}{2} Cu_2O + \frac{1}{4} O_2$ (g) Reaction 4.1 would have a higher entropy change per mole of CuO since it releases 2.5 mol of gases as compared to 4.2 which releases 0.5 mol
fi)	

test on L	observations / results	type of reaction	functional groups identified in L
addition of Na_2CO_3(aq)	effervescence	acid-base	carboxylic acid
addition of 2,4-DNPH	orange precipitate formed	condensation	ketone
addition of alkaline aqueous iodine, followed by acid	yellow precipitate and organic compound formed, $HO_2CCH_2CH(CH_3)CH_2CO_2H$	Oxidation & neutralisation	ketone

|	
ii)	
5 ai)	• Acids are substances which produce hydrogen ions in **aqueous solution**. • Bases are substances which produce hydroxide ions in **aqueous solution**.
ii)	$SO_3 + H_2O \rightarrow H_2SO_4$ / completely dissociates in water to form H+ ions; pH is low $Na_2O + H_2O \rightarrow 2\ NaOH$ / completely dissociates in water to form OH- ions; pH is high $MgO + H_2O \leftrightarrow Mg(OH)_2$ / partially dissociates in water to form OH- ions; pH is lower than Na_2O but higher than SO_3
bi)	 1 x double bond and 1 x dative bond
ii)	Valence Electron pairs: 2 bond pairs (bp) and 1 lone pair (lp) Lp-bp exert greater repulsion forces than bp-bp, hence angle is <120° Answer: 110-120 °; suggested 118°
c)	F is period 2 element unable to have expanded octet electronic configuration as there is 2s and 2p orbital available for sharing of electrons Cl is period 3 element which has low lying energetically accessible d orbitals for forming of covalent bonds to have expanded octet electronic configuration
di)	Minimise change in pH when small amt of acid/base is added
ii)	Added H⁺ is being neutralised and removed by CH_3COO^- $CH_3COO^- + H^+ \rightarrow CH_3COOH$ Added OH⁻ is being neutralised and removed by CH_3COOH $CH_3COOH + H_3O^+ \rightarrow CH_3COO^- + H_2O$
iii)	Salt completely hydrolyses/dissolves to release CH_3COO^- which acts as a base to remove added H+
di)	No of mole of $Na_2S_2O_3$ = 15.0/1000 x 0.100 mol No of mole of iodine = ½ x 15.0/1000 x 0.100 = 0.00075mol
ii)	No of mole of O_3 = ½ x 15.0/1000 x 0.100 = 0.000750mol $[O_3] = \dfrac{\text{no of mole}}{\text{Total volume}} = \dfrac{0.000750mol}{0.500\ dm^3} = 0.00150moldm^{-3}$
ei)	Compound M and N: $C_6H_5 – C_3H_5$ $C_nH_{2n+1} \rightarrow$ **n = 3 & 2n+1=7** $\rightarrow$ short of 2 H **(C=C, cyclo, C=O)**
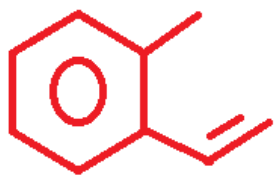
C=C decolourises bromine
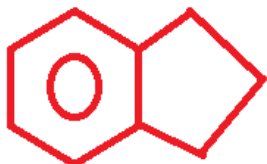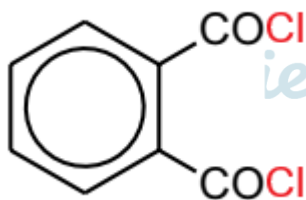

saturated

Compound P: $C_6H_5 - C_3H_7O$
C_nH_{2n+1} → **n = 3 & 2n+1=7** → saturated, OH is alcohol which can undertake positive iodoform reaction
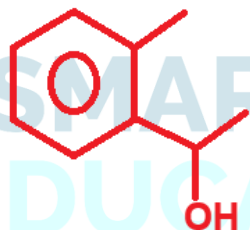
ii)	Step 1: Anhydrous PCl_5, PCl_3, $SOCl_2$, heat/warm Step 2: $H_2N-CH_2-NH_2$, heat/warm
f)	