H2 Chemistry 9647

1	Molecular formula of glucose = $C_6H_{12}O_6$ (from the diagram given, you should be able to observe that there are 4 hydroxyl groups, which will be replaced by chlorine atoms) $C_6H_8O_2(\mathbf{OH})_4 \longrightarrow C_6H_8O_2\mathbf{Cl}_4$ (hence, empirical formula = $C_3H_4OCl_2$)				С
2	initial moles change in moles moles left	Fe - 1 -1 0	+ 2Fe ³⁺ 2 -2 0	→ 3Fe ²⁺ 0 +3 3	С
	Given that reaction table using each of n(Fe) A 0 B 0 C 0 D 0.5 <u>Alternatively</u> , for $n(Fe^{2+})$ formed = initial $n(Fe)$:	goes to con the options $n(Fe^{3+})$ 0 1 3 0 = 3 (start with $n(Fe^{3+})$ 2 + 3	mpletion, you to come up n(Fe ²⁺) 3 3 4.5 th the smalle	t may complete the above with the values below. st whole no.) = n(Fe ³⁺) left	
	1	5	(option C)		
3	Cr [Ar] 3d ⁵ 4s ¹ Ge [Ar] 3d ¹⁰ 4s ² 4 S [Ne] 3s ² 3p ⁴ Sc [Ar] 3d ¹ 4s ²	lp² S⁻	[Ne] 3s² 3p ⁵		D
4	From the large incr	<u>ease in IE</u> v	when the 3 rd	electron is removed, it can	В

- From the <u>large increase in IE</u> when the 3rd electron is removed, it can ^B be deduced that there are only <u>2 valence electrons present</u> in X. Hence it is in <u>Group II</u> of the Periodic Table.
- ⁵ Factors affecting strength of hydrogen bonds
 - extensiveness of HB
 - <u>magnitude of polarity</u> (i.e. difference in electronegativity between F/O/N–H bond)

Each <u>water molecule</u> can form, on average, **2 hydrogen bonds** as compared with **1 hydrogen bond** per <u>HF molecule</u>.

- 6 Due to the formation of hydrogen bonds between CO₂ and H₂O molecules, <u>heat is evolved and Δ*H* is < 0</u>. As the forward reaction results in a decrease in no. of gaseous molecules, there will be less ways of arranging the particles and Δ<u>S</u> is < 0.
- 7 Electrolysis of molten $CuCl_2$ Anode: $2Cl^- \longrightarrow Cl_2 + 2e$

Electrolysis of aq. H_2SO_4 Anode: $2H_2O \longrightarrow O_2 + 4H^+ + 4e$ (preferentially discharged over SO_4^{2-})

Since $\frac{V_{Cl_2}}{V_{O_2}} = \frac{1}{2}$ for the same duration, $\frac{n_{e \text{ passed for } Cl_2}}{n_{e \text{ passed for } O_2}} = \frac{2}{8}$ (4H₂O \longrightarrow 2O₂ + 8H⁺ + 8e) and

hence the current used in electrolysis 2 will be 4I (n α I as nF = It).

- 8 $2H_2(g) + CO(g) \rightarrow CH_3OH(g)$ C initial moles 2.0 1.0 0 change in moles -x $-\frac{1}{2}x$ $+\frac{1}{2}x$ moles left 2.0 - x $1.0 - \frac{1}{2}x$ $\frac{1}{2}x$
- 9 Pyruvic acid is a <u>weak acid</u> while NaOH is a <u>strong alkali</u>. The A equivalence point of the titration will be <u>above pH 7</u> because the salt formed CH₃COCO₂⁻ <u>hydrolyses in water</u> to give a basic solution.

 $CH_3COCO_2^- + H_2O \implies CH_3COCO_2H + OH^-$

- ¹⁰ When aspirin (HA) enters the stomach where $[H^+]$ is very high $(10^{-1} \text{ mol } \text{dm}^{-3})$, it will <u>remain effectively as HA</u> due to the <u>suppression of its ionisation</u> in the presence of high $[H^+]$. Hence, **[HA] > [A^-]**. HA == H^+ + A^-
- ¹¹ no. of moles of excess HC*l* = 0.0040 0.0025 = 0.0015 mol $[H^+] = [HC$ *l* $] = \frac{0.0015}{1} = 0.00150 \text{ mol dm}^{-3}$ pH = **2.82**
- When molar proportion of uranium to lead is 1 : 3, it can be deduced c that the [uranium] has <u>decreased to ¼ of its initial concentration</u>. Hence **2 half–lives** have occurred.

Α

D

¹³ rate = $k [H_2O_2]$ (1st order reaction) If [H₂O₂] is doubled, <u>rate is doubled</u>.

Hence,

for 0.1M H ₂ O ₂	0.01 mol dm ⁻³ decomposed in 5 min (given that
	10% decomposed)

for 0.2M H₂O₂ 0.02 mol dm⁻³ decomposed in 5 min (as rate doubled) i.e. $\frac{0.02}{0.2}$ x 100% = **10%** decomposed

Alternatively,

Using the concept that "half–life is independent of the initial concentration", you should be able to conclude that the time taken for H_2O_2 to decrease to the same extent (i.e. 10% in this case) will be the same regardless $[H_2O_2]$ is 0.1 mol dm⁻³ or 0.2 mol dm⁻³.

- 14 From the mechanism proposed, the catalysed reaction should be a A 2–step reaction (Option **A** or **B**). And since catalyst does not alter ΔH of reaction, option **A** is the answer.
- ¹⁵ $[Cu(H_2O)_6]^{2+} + 4Cl^- \implies CuCl_4^{2-} + 6H_2O$ This is a <u>ligand exchange reaction</u>. Hence the <u>no. of d-electrons</u> around copper **remains the same** but the energy gap between the d-orbitals changes as H₂O and Cl⁻ ligands give **different extent** of the <u>d-orbital splitting</u>.
- MgO dissolves in water to give a <u>white suspension</u> not aqueous solution, hence the reaction giving Mg(OH)₂(aq) <u>does not take place</u> readily.
- 17 Since there is <u>no large increase in IE</u> when the 2nd or 3rd electron is removed, the element cannot be from Group I or II. The <u>high melting</u> <u>point</u> suggests the presence of giant lattice structure, hence the element is not likely to be from Group VII too. <u>All the above</u> and the <u>high density</u> confirms that the element is likely to be a **transition element**.
- ¹⁸ Under hot conditions, compound X is **sodium chlorate(V)**. C Recall: $3Cl_2$ + hot $6OH^- \longrightarrow ClO_3^- + 5Cl^- + 3H_2O$

19



20 This is another way of asking how many different monochlorinated C products will be obtained.

The 3 are: $CH_2CH_2C(CH_3)_3$ $CH_3CHC(CH_3)_3$ $CH_3CH_2C(CH_3)_2CH_2$

- ²¹ PGE₂ is converted to PGE_{2α} when the <u>ketone</u> in PGE₂ is <u>reduced</u> to the <u>2° alcohol</u> in PGE_{2α}. However, not all reducing agents are suitable for use as there are <u>other functional groups that can be</u> <u>reduced</u> (e.g. alkenes and acids). Hence only reducing agent <u>specific</u> for reduction of aldehyde and ketone (**NaBH**₄) can be used.
- ²² When cholesterol reacts with cold, dilute KMnO₄, the likely product is ^B



- Y: Wrong
- Z: Correct
- ²³ In this case, the transition state will have an <u>overall negative charge</u> (*RX is neutral while nucleophile is anionic*). Hence the charges on
 - Presence of C–C¹ or C–Br bonds in compound will result in formation D of halogen radical which destroy the ozone and are not suitable replacement. C–H and C–F are <u>relatively inert</u>!

both N and L should be δ - while that on the reactive carbon is δ +.

В

²⁵ Hydrolysis of rosmarinic acid will give



- 26 Addition Α Α of Br₂(aq) produce either $(CH_3)_2C(OH)CH(Br)CH_2CH_2COCH_3$ (major) or $(CH_3)_2C(Br)CH(Br)CH_2CH_2COCH_3.$ Both contain a chiral centre.
 - **B** Prolonged heating with conc. KMnO₄/H⁺ produces (CH₃)₂CO and HO₂CCH₂CH₂COCH₃, NOT HO₂CCH₂CO₂H.
 - **C** Reduction by NaBH₄/methanol produces (CH₃)₂C=CHCH₂CH₂CH(OH)CH₃ (C₈H₁₆O), NOT C₈H₁₈O.
 - D Warming with I₂/OH⁻ produces (CH₃)₂C=CHCH₂CH₂CO₂⁻, NOT CH₃CO₂H.
- 27 α-helix is a type of <u>secondary structure protein</u> and is stabilised by intramolecular hydrogen bonding between C=O and N-H of the peptide bonds.



The lone pair of e on the N B atom is <u>delocalised</u> into the carbonyl group and hence it is <u>less available</u> in accepting a H⁺ (less basic)

(Option **C** is a correct statement but it does not explain why amide is less basic.) В



The substitution occurs at 2^{nd} and 4^{th} position with respect to $-NH_2$ group rather than $-CH_3$ group because $-NH_2$ group is strongly activating and more reactive.

- ³¹ Each carbon atom in the graphite lattice is bonded to <u>3 other carbon</u> ^B <u>atoms</u>. The <u>unpaired electron</u> present in each of the unhybridised p orbital of the carbon atoms allows the <u>delocalisation of electrons</u> in the lattice (along the plane). The <u>3 σ and 1 π bond</u> formed by each carbon atom in the lattice give it a *valency* of 4.
- 32 Factors affecting mass of copper deposited
 - time
 - magnitude of current
- ³³ By observation comparing expt 1 and 2, order of reaction wrt A 1-bromoethane can be deduced to be <u>1</u>. (when [1-bromoethane] is doubled, rate of reaction doubles).

By observation comparing expt 1 and 4, order of reaction wrt HS⁻ can be deduced to be $\underline{1}$. (when [HS⁻] is doubled, rate of reaction doubles).

Hence both 1-bromoethane and HS⁻ will be involved in the ratedetermining step in a 1 : 1 ratio. rate = k [1-bromoethane] [HS⁻]

Using data for expt 1 (or any of the other 4),

$$k = \frac{1.5 \times 10^{-5}}{(0.1)(0.1)} = 1.5 \times 10^{-3} \text{ mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$$

 $X \qquad Y$ $1 \qquad Mg + Cl_2 \longrightarrow MgCl_2 \qquad Na + \frac{1}{2}Cl_2 \longrightarrow NaCl$ $2 \qquad H_2 + Cl_2 \longrightarrow 2HCl \qquad KBr + \frac{1}{2}Cl_2 \longrightarrow KCl + \frac{1}{2}Br_2$ $3 \qquad 2OH^- + Cl_2 \longrightarrow ClO^- + Cl^- + H_2O \qquad 6OH^- + 3Cl_2 \longrightarrow ClO^- + 5Cl^- + 3H_2O$

В

Α

D

- ³⁵ 1 brine is a solution containing concentrated NaC*l*. $2Cl^{-} \longrightarrow Cl_{2} + 2e$ (oxidation state changes from -1 to 0)
 - 2 $H_2 + Cl_2 \longrightarrow 2HCl$ (oxidation state changes from 0 to -1)
 - **3** $Cl^- + H_2SO_4 \longrightarrow HCl + HSO_4^-$ (**no change** in oxidation state)
- 36 1 s-block elements have fixed oxidation states (identical to B their Group no.)
 - 2 s-block elements are <u>good reducing agents</u> and hence their ions are **poor oxidising agent**. e.g. Ca²⁺ + 2e \implies Ca $E^{\circ} = -2.87V$ However, ions of transition element can act as oxidising agent. e.g. $E_{\text{Fe}^{3+}/\text{Fe}^{2+}} = +0.77V$; $E_{\text{Co}^{3+}/\text{Co}^{2+}} = +1.82V$; $E_{\text{Mn}^{3+}/\text{Mn}^{2+}} = +1.49V$
 - 3 lons formed from both transition elements and s-block elements have a smaller ionic radius than their respective atomic radius due to increase in effective nuclear charge as the valence electrons are removed.
- **37 1** CH₃CH=CH₂ is formed by <u>elimination of HBr</u> from **D** 1–bromopropane.
 - 2 CH₃CH₂CH₂OH is <u>neutral</u> and will not react with NaOH to give CH₃CH₂CH₂ONa.
 - **3** The reaction condition does not allow the CH₃CH=CH₂ formed to undergo electrophilic addition to give CH₃CH(OH)CH₃.

38 1 free radical substitution occurs

- 2 substitution of –OH group
- **3 reduction** of ketone (C=O)
- ³⁹ Reaction with bromoethene will involve <u>substitution of Br bonded to</u> <u>sp² hybridised C</u> where the C–Br bond is <u>stronger</u> due to **interaction between the unhybridised p orbitals** (lone pair of e on Br delocalised into C–C π bond.

The C atom is also less electron–deficient and there is a possibility of the π e repelling the electron–rich nucleophile.

Α

7



В