ST ANDREW'S JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
HIGHER 2

CANDIDATE NAME	
CLASS	**2 3 S**

CHEMISTRY **9729/01**

Paper 1 Multiple Choice **11 September 2024**

Candidate answer on the Optical Answer Sheet **1 hour**

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **XX** printed pages (including this cover page).

1 *Use of Data Booklet is relevant to this question.*

Sodium azide, NaN_3, is an ionic salt which is used to inflate airbags inside a car during a crash.

How many electrons are there in a sodium ion and an azide ion respectively?

	sodium ion	azide ion
A	10	22
B	11	21
C	22	42
D	22	43

Ans: A

Total number of electrons in Na^+ = 11 – 1 = 10

Total number of electrons in N_3^- = (7 x 3) + 1 = 22

2 The first seven successive ionisation energies for element **Y** are as shown. **Y** is found in Period 3.

	1st	2nd	3rd	4th	5th	6th	7th
Ionisation energy / kJ mol^{-1}	1010	1900	2900	5000	6300	21300	25400

Which statements are correct?

1	The valence shell of **Y** contains only s and p orbitals.
2	The element after **Y** in the same period has a lower first ionisation energy than **Y**.
3	**Y** can react with magnesium metal to form the compound Mg_3Y_2.

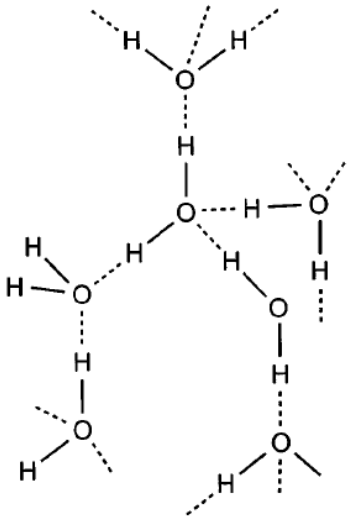
A	1, 2 and 3
B	1 and 3 only
C	2 and 3 only
D	2 only

Ans: C

Option 1 is wrong as the valence shell is n = 3, which consists of s, p and d orbitals. The d orbitals are empty though.

	Option 2 is correct as the valence electronic configuration of the element after Y is $3s^2 3p^4$, where there is interelectronic repulsion between the paired electrons and this outweighs the increase in nuclear charge across the period. Hence, the 1st ionisation energy will be lower than that of **Y**. Option 3 is correct as **Y** is P which has a valency of 3. Mg has a valency of 2.

3 The structure of ice is as shown.



Which statement is **incorrect**?

	A	The open structure causes ice to be less dense than liquid water.
	B	The open structure gives ice a smaller mass than liquid water.
	C	Four electrons from each oxygen are involved in forming hydrogen bonds.
	D	Each oxygen atom in a water molecule is tetrahedrally bonded to 4 hydrogen atoms.

Ans: B

Option A is correct as the open structure (owing to the hydrogen bonds between water molecules) results in a larger volume occupied than liquid water and hence, density of ice is smaller than water.

Option B is incorrect as the open structure does not change the mass.

Option C is correct as each O atom will use its 2 lone pairs of electrons to form 2 hydrogen bonds in ice.

Option D is correct as around each O atom, there are 2 covalent bonds to H atoms and 2 hydrogen bonds to H atoms, resulting in a tetrahedral arrangement.

4	A sample of pure gas is put into a gas syringe at 27.0 °C and 16 kPa. The plunger of the syringe is pushed in to compress the gas, until the volume occupied is halved. After compression, the pressure of the gas is 40 kPa. What is the new temperature of the gas?	
	A	33.8 °C
	B	67.5 °C
	C	102.0 °C
	D	375.0 °C
	Ans: C Given that n and R are constant (n is constant because the gas did not react), $p_1V_1 / T_1 = p_2V_2 / T_2$. Temperature must be in K when using this formula. $16V / 300 = 40(0.5V) / T_2$ ➔ $T_2 = 375K$ = **102 °C**	
5	**Y** is an element in Period 3. In each reaction, **Y** forms a product in its highest oxidation state. Reaction 1: Chlorine + **Y** → $\mathbf{Y}_aCl_b$ Reaction 2: Oxygen + **Y** → $\mathbf{Y}_pO_q$ Which fractions show an increase from sodium to phosphorus?	
	A	Both $\frac{a}{b}$ and $\frac{p}{q}$
	B	$\frac{a}{b}$ only
	C	$\frac{p}{q}$ only
	D	Neither $\frac{a}{b}$ and $\frac{p}{q}$
	Ans: D	

	Na	Mg	Al	Si	P
Chlorides of Period 3	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_5
Fraction	1/1 = 1	½ = 0.5	1/3 = 0.33	¼ = 0.25	1/5 = 0.2
Oxides of Period 3	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10}
Fraction	2/1 = 2	1/1 = 1	2/3 = 0.66	½ = 0.5	4/10 = 0.4

6 When dilute sulfuric acid is added to copper(I) oxide, the products formed are copper metal, copper(II) ions and water.

Which is correct?

	number of moles of Cu^+ reacted	number of moles of Cu formed	number of moles of Cu^{2+} formed
A	1	1	1
B	1	2	1
C	2	1	1
D	2	2	1

Ans: C

$Cu_2O + H_2SO_4 \rightarrow H_2O + SO_4^{2-} + Cu + Cu^{2+}$

To get 1 mol of Cu and 1 mol of Cu^{2+},

$Cu^+ + e^- \rightarrow Cu$ --- (1)

$Cu^+ \rightarrow Cu^{2+} + e^-$ -- (2)

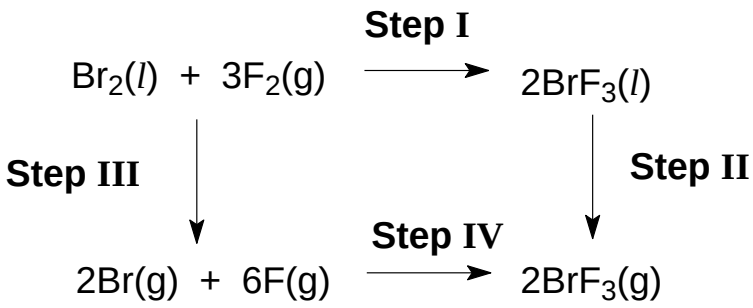
(1) + (2): $2Cu^+ \rightarrow Cu + Cu^{2+}$ ($2Cu^+$ came from 1 mol of Cu_2O)

7 *Use of the Data Booklet is relevant to this question.*

In an experiment, 2 g of a fuel is completely burnt. 55% of the energy released is absorbed by 200 g of water and the temperature rose from 18 °C to 66 °C.

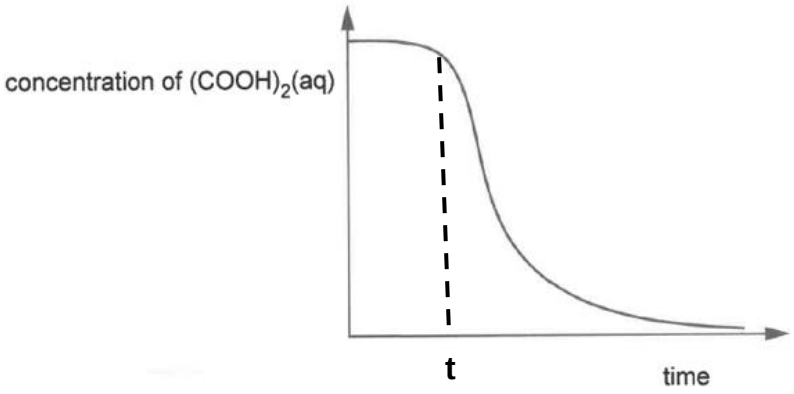
What is the energy released per gram of fuel burnt?

A	20 064 J
B	36 480 J
C	36 845 J
D	72 960 J

	Ans: B q = 200 x 4.18 x (66 – 18) = 40 128 J q (100%) = (100 x 40 128) / 55 = 72 960 J Total energy released per gram of fuel burnt = 72 960 / 2 = 36 480 J
8	An energy cycle is given below.  Which statements are correct?

	1	Step I represents the enthalpy change of formation of $BrF_3(l)$.
	2	Step II involves the breaking of intermolecular instantaneous dipole-induced dipole interactions only.
	3	Step III involves the sum of 3 x bond energy of F-F(g) and 2 x enthalpy change of atomisation of $Br_2(l)$.
	A	1, 2 and 3
	B	1 and 2 only
	C	2 and 3 only
	D	3 only

	Ans: D Option 1 is wrong as step I should be 2 x enthalpy change of formation of $BrF_3(l)$. Option 2 is wrong as both intermolecular permanent dipole-permanent dipole interactions and instantaneous dipole-induced dipole interactions are broken. Option 3 is correct.
9	The reaction between aqueous ethanedioic acid, $(COOH)_2$, and acidified potassium manganate(VII) produces the following graph. This reaction is carried out in a

	thermostatically controlled water bath at 60 ºC. The products formed are Mn^{2+}, CO_2 and H_2O.  Which statement is correct?	
	A	Before time t, the reaction rate is slow because of the high concentration of $(COOH)_2$.
	B	The temperature used is sufficient to cause the reaction rate to increase after time t.
	C	The presence of more Mn^{2+} causes the reaction rate to increase after time t.
	D	The reaction rate decreases eventually as the temperature decreases.
	Ans: C This question is an example of autocatalysis. The rate increases after time t because sufficient concentration of Mn^{2+} is produced to catalyse the reaction.	
10	Azomethane, $CH_3N=NCH_3$, undergoes thermal decomposition according to the following equation. This reaction is first order with respect to the concentration of azomethane. $CH_3N=NCH_3(g) \rightarrow C_2H_6(g) + N_2(g)$ In an experiment, the initial pressure of azomethane was 300 Pa. After 20 minutes of thermal decomposition at 600 K, the pressure of azomethane was 150 Pa. In another experiment, the initial pressure of azomethane was 600 Pa. What would be the final pressure of azomethane after 20 minutes of thermal decomposition at 600 K?	
	A	150 Pa
	B	300 Pa
	C	450 Pa

	D	900 Pa

Ans: B

Half-life of a first order reaction is constant and therefore, independent of the [reactant] or initial pressure of azomethane. In the first experiment, 20 min is actually the half-life of reaction. For the second experiment, even though the initial pressure doubled, 20 min is still the half-life which means that pressure of azomethane will be halved (ie. ½ x 600 = 300 Pa).

11 1 mol of N_2O_4 and 0.2 mol of NO_2 were added to a 2 dm^3 sealed vessel of fixed volume at 298 K. When the system reached equilibrium, 0.68 mol of NO_2 was present in the vessel.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

Which statements are correct?

	1	0.76 mol of N_2O_4 was present at equilibrium.
	2	The value of the equilibrium constant, K_c, is 0.608.
	3	The pressure in the vessel at equilibrium is lower than the pressure in the vessel before the reaction started.
	A	1, 2 and 3
	B	1 and 2 only
	C	2 and 3 only
	D	1 only

Ans: D

	$N_2O_4(g)$	$\rightleftharpoons$	$2NO_2(g)$
Initial amount / mol	1		0.2
Change in amount / mol	-0.24		+0.48
Equilibrium amount / mol	0.76		0.68

$K_c = (0.68/2)^2 / (0.76/2) = 0.304$

Statement 1 is correct.

Statement 2 is wrong.

Since n_{total} is greater at equilibrium, pressure should be higher. Statement 3 is wrong.

12	10 cm^3 of a 0.0100 mol dm^{-3} solution of sulfuric acid is diluted with 90 cm^3 of water. What is the pH of the resulting solution?	
	A	2.65
	B	2.70
	C	2.95
	D	3.00
	Ans: B $[H^+]$ = 2 x 10/1000 x 0.01 ÷ 100/1000 = 0.00200 $moldm^{-3}$ pH = -lg $[H^+]$ = 2.698 ≈ 2.70	
13	Equal volumes of two solutions are mixed. Which mixtures will result in buffer solutions?	
	1	0.1 mol dm^{-3} NaOH with 0.2 mol dm^{-3} $(COOH)_2$
	2	0.2 mol dm^{-3} CH_3NH_2 with 0.1 mol dm^{-3} HBr
	3	0.2 mol dm^{-3} NaOH with 0.1 mol dm^{-3} H_2SO_4
	A	1, 2 and 3
	B	1 and 2 only
	C	2 and 3 only
	D	1 only
	Ans: B Mixture 1 consists of 0.0025 mol HOOC-COOH and 0.0025 mol $HOOC\text{-}COO^-$ – Acidic buffer Mixture 2 consists of 0.0025 mol CH_3NH_2 and 0.0025 mol $CH_3NH_3^+$ – Basic buffer Mixture 3 consist of 0.0025 mol Na_2SO_4 – Neutral salt	
14	ZnS is a sparingly soluble salt. $ZnS(s) \rightleftharpoons Zn^{2+}(aq) + S^{2-}(aq)$ A sample of ZnS is added to H_2S solution, which is a weak dibasic acid.	

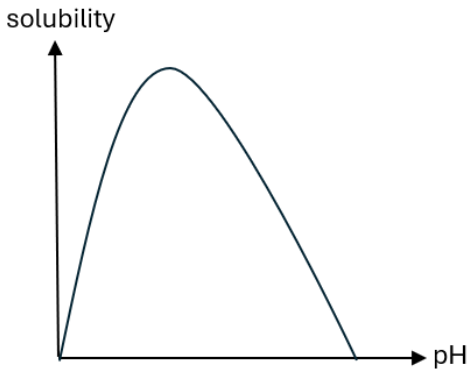
$H_2S(aq) \rightleftharpoons H^+(aq) + HS^-(aq)$

$HS^-(aq) \rightleftharpoons H^+(aq) + S^{2-}(aq)$

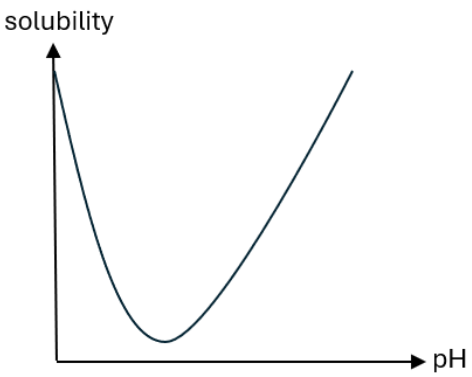
The pH of the solution is then increased by adding KOH.

Which diagram shows how the solubility of ZnS will change with the pH of the solution at a fixed temperature?

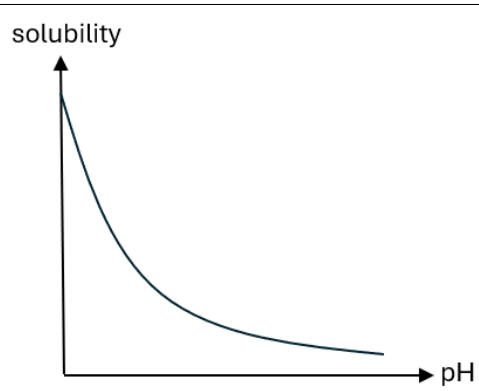
A



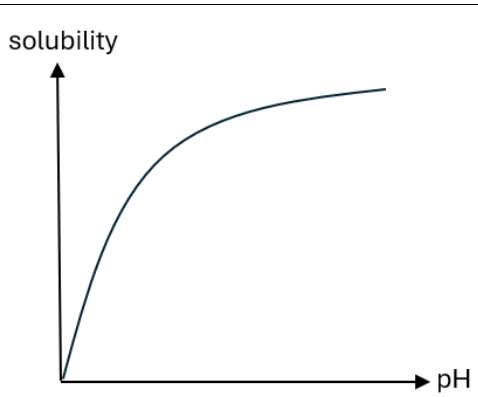
B



C



D



Ans: C

$H_2S \rightleftharpoons H^+ + HS^-$ -- (1)

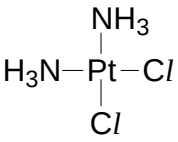
$HS^- \rightleftharpoons H^+ + S^{2-}$ -- (2)

When KOH is added, $[H^+]$ decreases. by Le Chatelier's Principle, position of equilibrium (2) shifts right to produce more S^{2-}.

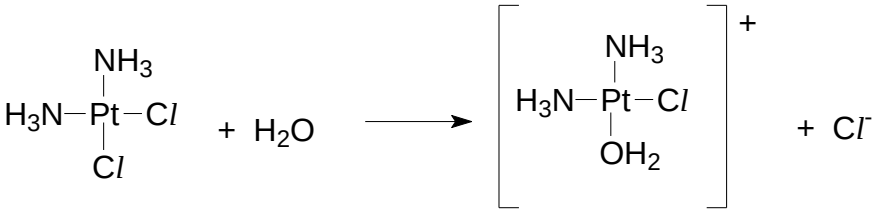
$ZnS \rightleftharpoons Zn^{2+} + S^{2-}$ -- (3)

As $[S^{2-}]$ increases, by Le Chatelier's Principle, position of equilibrium (3) shifts left to form more ZnS. Hence, solubility of ZnS decreases as pH is increased.

15 The structure of a famous anti-cancer drug is as shown. Around Pt, the shape is square planar.



Inside the human body, the following reaction takes place. $Pt(NH_3)_2Cl_2$ and $[Pt(NH_3)_2(H_2O)Cl]^+$ have different colours.



Which statements are correct?

	1	Pt has an oxidation state of +4.
	2	$Pt(NH_3)_2Cl_2$ can exist as cis-trans isomers.
	3	When the Pt complex reacts with H_2O, the energy gap between d-orbitals remains the same.
	A	1, 2 and 3
	B	1 and 3 only
	C	2 and 3 only
	D	2 only

Ans: D

Option 1 is wrong as the oxidation state of Pt should be +2. The complex is overall electrically neutral while the ligands exist as NH_3 (0 charge) and Cl^-.

Option 2 is correct as the 2 NH_3 or 2 Cl^- can either be on the same side or opposite side in the complex.

Option 3 is wrong as the type of reaction is ligand exchange. With H_2O as the new ligand, it will affect the extent of d-splitting, thus affecting the energy gap.

16 Nitrogen monoxide, NO, is an air pollutant which is produced in the internal combustion engine of vehicles.

Which reaction occurs in a catalytic converter to decrease the emission of nitrogen monoxide?

	A	$NO(g) + CO(g) \rightarrow NO_2(g) + C(s)$
	B	$NO(g) + CO(g) \rightarrow \frac{1}{2}N_2(g) + CO_2(g)$
	C	$NO(g) + CO_2(g) \rightarrow NO_2(g) + CO(g)$
	D	$NO(g) \rightarrow \frac{1}{2}N_2(g) + \frac{1}{2}O_2(g)$

Ans: B

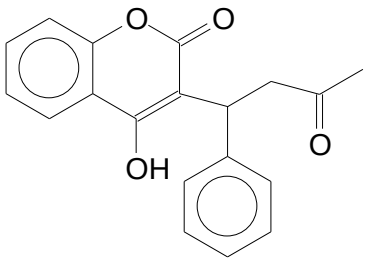
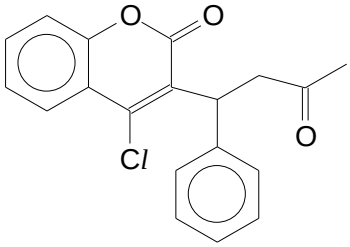
CO produced from the incomplete combustion of fuel will reduce NO to form N_2, while it itself is oxidised to form CO_2. N_2 and CO_2 are less harmful than NO and CO.

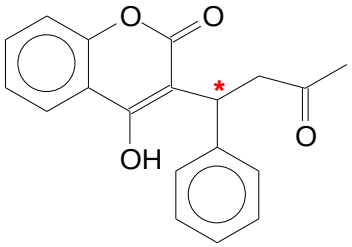
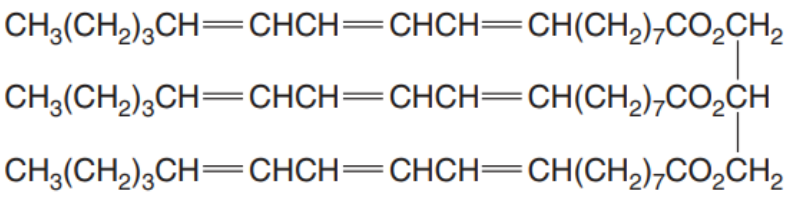
17 $CH_3CH_2CH(CH_3)CH_3$ undergoes free radical substitution with chlorine. During the reaction, primary, secondary and tertiary hydrogen atoms are replaced by chlorine atoms at different rates as shown below.

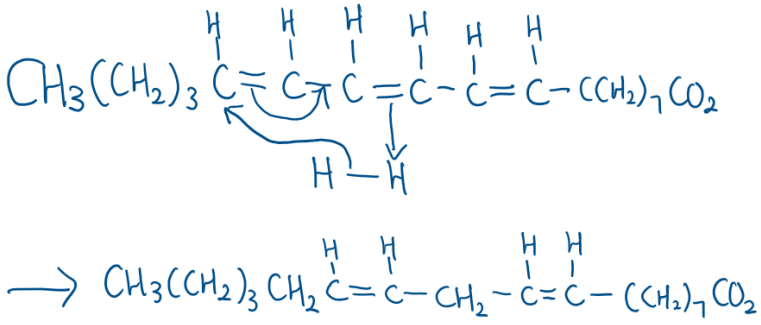
reaction	relative rate
$RCH_3 \rightarrow RCH_2Cl$	1
$R_2CH_2 \rightarrow R_2CHCl$	7
$R_3CH \rightarrow R_3CCl$	21

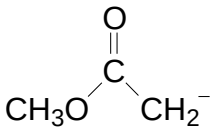
Which statements regarding the mono-substituted product $C_5H_{11}Cl$ are correct?

	1	Ratio of $CH_2ClCH_2CH(CH_3)CH_3$: $CH_3CHClCH(CH_3)CH_3$: $CH_3CH_2CCl(CH_3)CH_3$: $CH_3CH_2CH(CH_3)CH_2Cl$ is 3 : 14 : 21 : 6.
	2	Excess $CH_3CH_2CH(CH_3)CH_3$ is used to ensure that the monosubstituted product is the major product.
	3	Amongst the organic products formed from the mono-substitution of $CH_3CH_2CH(CH_3)CH_3$, there is only one constitutional isomer which can exhibit stereoisomerism.
	A	1, 2 and 3
	B	1 and 2 only
	C	1 and 3 only

	D	2 only
	Ans: B Option 1 is correct. Ratio of $CH_2ClCH_2CH(CH_3)CH_3$: $CH_3CHClCH(CH_3)CH_3$: $CH_3CH_2CCl(CH_3)CH_3$: $CH_3CH_2CH(CH_3)CH_2Cl$ is (3 x 1) : (2 x 7) : (1 x 21) : (6 x 1). Option 2 is correct as the excess alkane means that it is less likely for multiple substituted products to be formed. Option 3 is wrong as there are 2 constitutional isomers that have a chiral carbon and therefore can exhibit enantiomerism - $CH_3C^*HClCH(CH_3)CH_3$ and $CH_3CH_2C^*H(CH_3)CH_2Cl$.	
18	Warfarin is used as a blood thinner to prevent blood clots. The structure of warfarin is as shown.  Which statements are correct?	
	1	Warfarin has 1 chiral carbon.
	2	Warfarin has 2 cis-trans isomers.
	3	Warfarin can react with PCl_5 to form the following product. 
	4	Warfarin has 2 functional groups that react with $NaBH_4$.
	A	1 only
	B	2 and 3 only
	C	1, 2 and 3 only

	D	All of the above
	Ans: A Option 1 is correct as shown.  Option 2 is wrong because C=C is within a ring and therefore, the trans isomer will experience ring strain. Hence, there is no cis-trans isomerism. Option 3 is wrong because the lone pair of electrons on O will delocalise towards C=C, resulting in C-OH to have partial double character, making it harder to break. As such, there is no nucleophilic substitution with PCl_5. Option 4 is wrong because 1 of the C=O belongs to ester functional group, which can only be reduced by $LiAlH_4$.	
19	To synthesise margarine, glyceryl trieleostearate is suitably reduced so that on average, one of its side-chains is converted into $CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7CO_2$ and two side-chains are converted into $CH_3(CH_2)_7CH{=}CH(CH_2)_7CO_2$.  Glyceryl trieleostearate How many moles of hydrogen gas are needed to convert one mole of glyceryl trieleostearate into margarine?	
	A	3
	B	5
	C	6
	D	9
	Ans: B	

	Each side chain has 3 double bonds initially. After hydrogenation, 1 side chain has 2 double bonds and 2 side chains have 1 double bond. (3 x 3) – (2 + 2) = 5 C=C which participated in hydrogenation OR For $CH_3(CH_2)_3CH=CH-CH=CH-CH=CH(CH_2)_7CO_2$ ➔ $CH_3(CH_2)_4CH=CH-CH_2-CH=CH(CH_2)_7CO_2$, the following must happen.  Hence, 1 mol of H_2 is needed. For $CH_3(CH_2)_3CH=CHCH=CHCH=CH(CH_2)_7CO_2$ ➔ $CH_3(CH_2)_7CH=CH(CH_2)_7CO_2$, this means that the C=C highlighted in yellow must undergo addition with H_2. Number of moles of H_2 required = 2 x 2 (for 2 side-chains) = 4 Total amount of H_2 = 1 + 4 = 5 mol
20	Which statement correctly describes the benzene molecule as a result of the delocalised electrons present within it?
	A Benzene can act as reducing agent.
	B Benzene is a conductor of electricity.
	C Benzene prefers to undergo addition reactions.
	D All the carbon-carbon bonds are of the same strength.
	Ans: D The delocalisation of pi electrons results in every carbon–carbon bonds to have partial double bond character and therefore, they will all have the same strength.
21	CH_3OCOCH_3 is reacted with a strong base to form the following nucleophile.



Which compound can be formed from the nucleophilic addition between a ketone and $CH_3OCOCH_2^-$, followed by protonation?

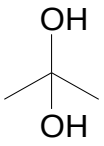
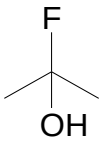
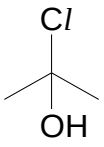
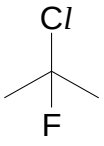
	A	$CH_3OCOCH_2CH(OH)CH_3$
	B	$CH_3COOCH_2C(OH)(CH_3)_2$
	C	$CH_3OCOCH_2CH(OH)CH_2CH_3$
	D	$CH_3OCOCH_2C(OH)(CH_3)_2$

Ans: D

Options A and C are wrong because aldehyde are used instead of ketone.

Option B is wrong because it should be the -H on C adjacent to C=O which is acidic, not the -H on C adjacent to O of ester.

22 What is the organic product obtained when 2-chloro-2-fluoropropane is heated with excess NaOH(aq)?

	A	
	B	
	C	
	D	

Ans: B

C-F is too strong to be broken, unlike C-C*l*. Therefore, C*l* will be substituted to form OH.

23 1 mole of organic compound is placed in 1 dm^3 of water.

Which row correctly ranks the order of decreasing pH for the following compounds?

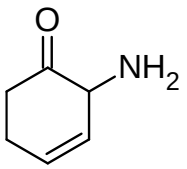
	Highest pH ⟶		Lowest pH
A	C_6H_5OH	CH_3COOH	CH_3COCl
B	CH_3COCl	C_6H_5OH	CH_3COOH
C	C_6H_5OH	CH_3COCl	CH_3COOH
D	CH_3COCl	CH_3COOH	C_6H_5OH

Ans: A

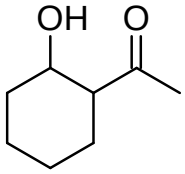
C_6H_5OH is less acidic than CH_3COOH because CH_3COO^- is resonance stabilised where the negative charge is delocalized over the O-C-O bond, making it more stable than $C_6H_5O^-$ where the negative charge is delocalised into the benzene ring.

CH_3COCl undergoes hydrolysis in water, forming CH_3COOH and HCl. Thus, an aqueous solution of CH_3COCl is the most acidic.

24 Which reagents and conditions can be used to distinguish between compounds **Y** and **Z**?



Y



Z

1	Acidified $KMnO_4$(aq), heat
2	Acidified $K_2Cr_2O_7$(aq), heat
3	Alkaline I_2(aq), warm

A	1, 2 and 3
B	1 and 2 only
C	1 and 3 only
D	2 and 3 only

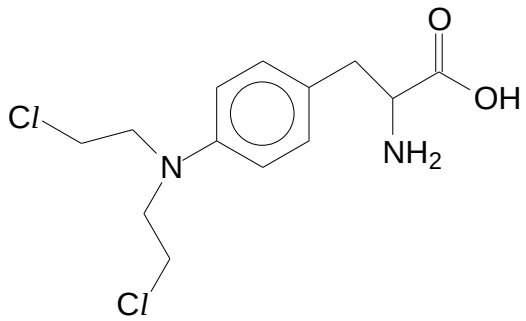
Ans: D

$KMnO_4$ will result in the strong oxidation of C=C in **Y** and oxidation of secondary alcohol in **Z**, thus giving the same observation of purple $KMnO_4$ being decolourised.

$K_2Cr_2O_7$ will only result in the oxidation of secondary alcohol in **Z**.

Z has $CH_3C(=O)$- which can undergo oxidation with alkaline I_2(aq).

25 Melphalan is a nitrogen mustard derivative of the α-amino acid phenylalanine.



Melphalan

The pK_a values of melphalan are 4.3, 6.5 and 12.3.

Which statement about Melphalan is correct?

	A	Melphalan exists predominantly as a zwitterion at pH 6.0.
	B	One mole of melphalan will react with 2 moles of Br_2(aq) at room temperature.
	C	White precipitate is observed when $AgNO_3$(aq) is added to an aqueous solution of melphalan.
	D	One mole of fully protonated melphalan will react with 5 moles of OH^-(aq) at room temperature.

Ans: B

A is wrong. While -COOH becomes -COO^-, the 2 -NH_3^+ remain and therefore, there is no zwitterion. Instead, the overall charge is 1+.

B is correct as the N directly bonded to benzene means that its lone pair of electrons will delocalise into the ring, making it more susceptible towards electrophilic substitution. Hence, Melphalan will undergo multiple substitution, with -Br replacing -H at -2 and -6 positions. This will require 2 moles of Br_2.

C is wrong as in the absence of heat, C-C*l* did not break to give Cl^-. Hence, no white precipitate can be observed.

D is wrong as only 3 moles of OH^- are needed for the neutralisation with fully protonated melphalan.

26 Lactic acid, $CH_3CH(OH)COOH$, is a common monomer used in the manufacture of polyesters. It can be synthesised from ethanol by the following reactions.

$$CH_3CH_2OH \xrightarrow[\text{Step 1}]{} CH_3CHO \xrightarrow[\text{Step 2}]{} CH_3CH(OH)CN \xrightarrow[\text{Step 3}]{} CH_3CH(OH)COOH$$

Which option shows the correct reagents and conditions for steps 1 to 3?

	Step 1	Step 2	Step 3
A	Acidified $K_2Cr_2O_7$(aq), heat	Hot ethanolic KCN	Hot H_2SO_4(aq)
B	Acidified $K_2Cr_2O_7$(aq), distill	Hot ethanolic KCN	Hot NaOH(aq)
C	Acidified $K_2Cr_2O_7$(aq), heat	Cold HCN with KCN	Hot NaOH(aq)
D	Acidified $K_2Cr_2O_7$(aq), distill	Cold HCN with KCN	Hot H_2SO_4(aq)

Ans: D

Step 1: Must distill with $K_2Cr_2O_7$ to isolate the aldehyde product.

Step 2: Nucleophilic addition requires the use of cold HCN with trace KCN.

Step 3: Acidic hydrolysis is needed to form the hydroxy acid (Lactic acid) as alkaline hydrolysis will result in the -COOH to be neutralized to $-COO^-$.

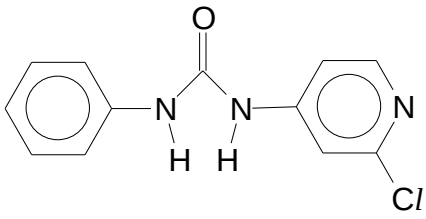
27 Which is the dominant species formed when equal volumes of 0.1 mol dm^{-3} H_2SO_4(aq), 0.1 mol dm^{-3} KOH(aq) and 0.1 mol dm^{-3} $H_2NCH(CH_2C_6H_5)CO_2H$ are mixed?

A	$H_2NCH(CH_2C_6H_5)COO^-$
B	$H_2NCH(CH_2C_6H_5)CO_2H$
C	$H_3N^+CH(CH_2C_6H_5)CO_2H$
D	$H_3N^+CH(CH_2C_6H_5)COO^-$

Ans: C

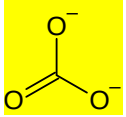
When mixed together, H_2SO_4 and KOH will undergo neutralisation. Since H^+ is in excess, it will be used to protonate the amino group of amino acid, thus forming $-NH_3^+$. -COOH remains intact as it is a weaker acid than H_2SO_4 and therefore, does not react with KOH first.

28 Forchlorfenuron is a chemical commonly used to accelerate plant growth. The structure of forchlorfenuron is as shown.

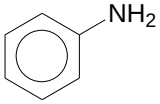


When forchlorfenuron is heated with NaOH(aq), a mixture of products are obtained. Which product is most water soluble?

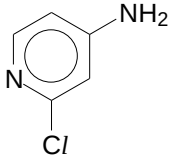
A



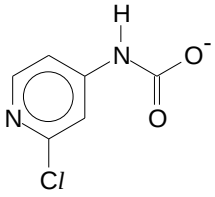
B



C



D



Ans: A

CO_3^{2-} is able to form more extensive ion-dipole interactions with water molecules, thus releasing the most energy and is the most soluble as a result.

29 *Use of the Data Booklet is relevant to this question.*

Brine is concentrated sodium chloride. During the electrolysis of brine using inert electrodes, hydrogen gas, sodium hydroxide and an unknown gas are produced.

What is the molar ratio of these products?

	hydrogen gas	sodium hydroxide	unknown gas
A	1 mol	0 mol	1 mol of O_2
B	1 mol	2 mol	1 mol of Cl_2
C	1 mol	1 mol	1 mol of Cl_2

	D	2 mol	4 mol	1 mol of O_2	

Ans: B

In concentrated NaC*l* solution, the high [Cl^-] will shift the following equilibrium position left.

$$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$$

Its electrode potential (E) will become less positive than +1.23V and hence, Cl^- will be oxidised.

At the cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

At the anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Overall equation: $2H_2O + 2Cl^- \rightarrow Cl_2 + H_2 + 2OH^-$

30 There are two electrolytic cells. The first one contains **X**SO_4(aq) and the second one contains $\mathbf{Y}_2SO_4$(aq). The same current is passed through both cells for the same amount of time to obtain **X** and **Y**. The relative atomic masses of **X** and **Y** are in the ratio 1 : 2.

What is the ratio of the mass of **X** produced to the mass of **Y** produced?

	A	1 : 1
	B	1 : 2
	C	1 : 4
	D	2 : 1

Ans: C

$X^{2+} + 2e^- \rightarrow X$

$Y^- + e^- \rightarrow Y$

$Q = It$

For It C of electricity, It/96500 mol of e^- are transferred

Amount of X formed = It/2(96500) mol

Mass of X = It/2(96500) x 1 g

Amount of Y formed = It/(96500) mol

Mass of Y = It/(96500) x 2 g

Mass ratio of X : Y = (1/2) : 2 = 1 : 4

END OF PAPER