



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 **17** 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

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

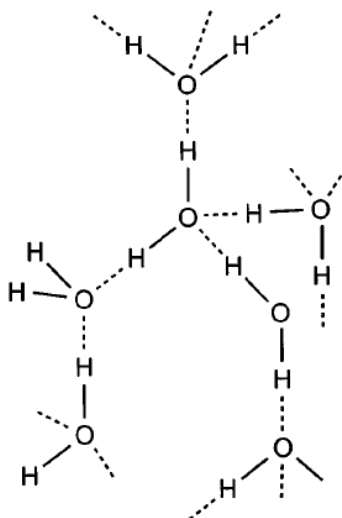
	1st	2nd	3rd	4th	5th	6th	7 th
Ionisation energy / kJ mol^{-1}	1010	1900	2900	5000	6300	21300	25400

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

- 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.
- 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

- 5** Y is an element in Period 3. In each reaction, Y forms a product in its highest oxidation state.

Reaction 1: Chlorine + Y $\rightarrow$ Y_aCl_b

Reaction 2: Oxygen + Y $\rightarrow$ 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 $\frac{p}{q}$
- 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

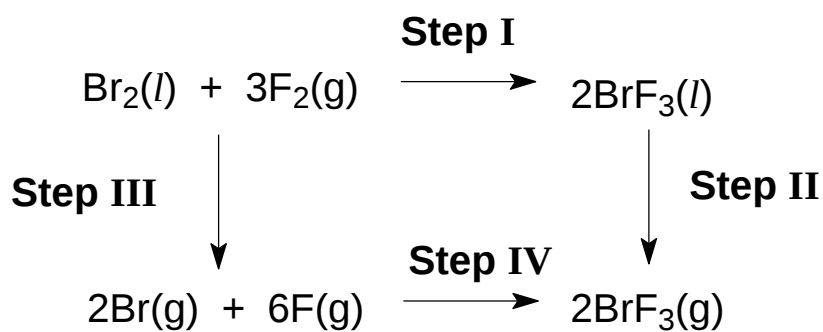
- 7 Use of the Data Booklet is relevant to this question.

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

- 8 An energy cycle is given below.

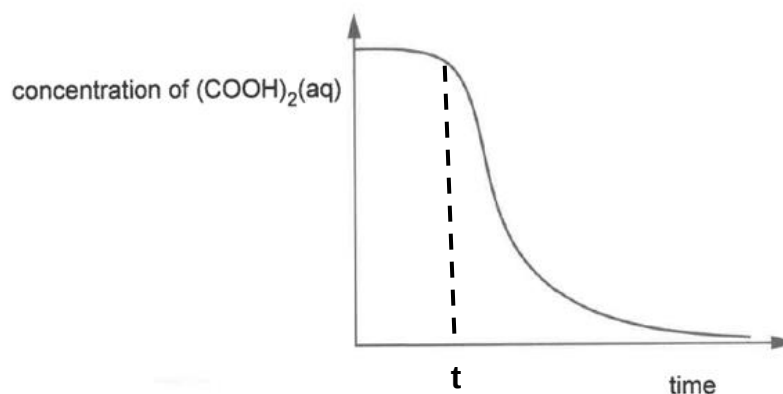


Which statements are correct?

- 1 Step I represents the enthalpy change of formation of $\text{BrF}_3(l)$.
- 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 $\text{F-F}(g)$ and 2 x enthalpy change of atomisation of $\text{Br}_2(l)$.

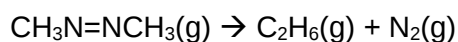
- A 1, 2 and 3
- B 1 and 2 only
- C 2 and 3 only
- D 3 only

- 9 The reaction between aqueous ethanedioic acid, $(\text{COOH})_2$, and acidified potassium manganate(VII) produces the following graph. This reaction is carried out in a thermostatically controlled water bath at 60°C . 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 $(\text{COOH})_2$.
 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.
- 10 Azomethane, $\text{CH}_3\text{N}=\text{NCH}_3$, undergoes thermal decomposition according to the following equation. This reaction is first order with respect to the concentration of azomethane.

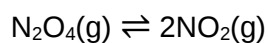


In an experiment, the initial pressure of azomethane was 300 Pa. After 20 minutes of thermal decomposition at 600 K, the pressure of azomethane was 150 Pa.

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

- 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.



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

- 12** 10 cm^3 of a $0.0100 \text{ mol dm}^{-3}$ solution of sulfuric acid is diluted with 90 cm^3 of water. What is the pH of the resulting solution?

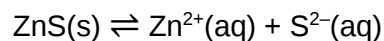
- A** 2.65
B 2.70
C 2.95
D 3.00

- 13** Equal volumes of two solutions are mixed.
Which mixtures will result in buffer solutions?

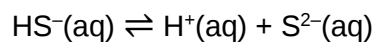
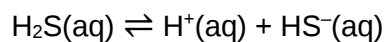
- 1 0.1 mol dm^{-3} NaOH with 0.2 mol dm^{-3} $(\text{COOH})_2$
- 2 0.2 mol dm^{-3} CH_3NH_2 with 0.1 mol dm^{-3} HBr
- 3 0.2 mol dm^{-3} NaOH with 0.1 mol dm^{-3} H_2SO_4

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

- 14 ZnS is a sparingly soluble salt.

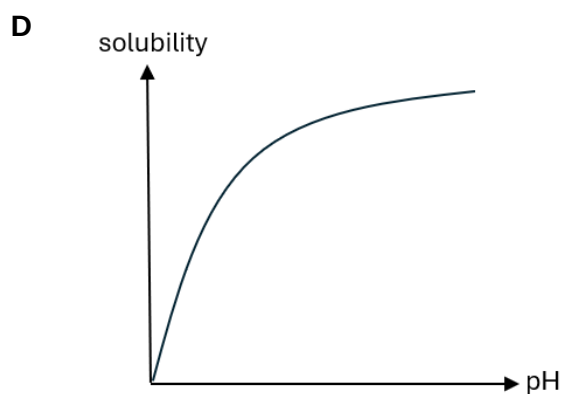
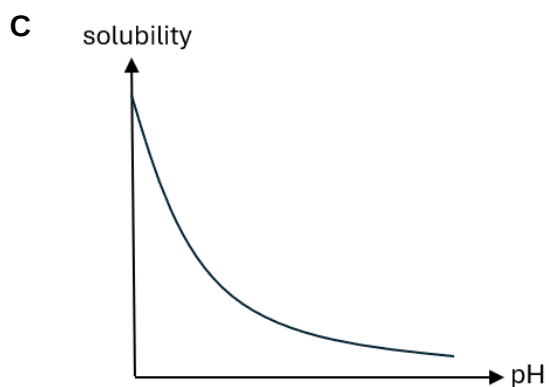
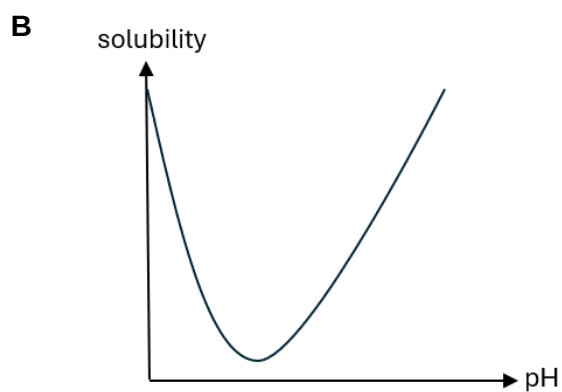
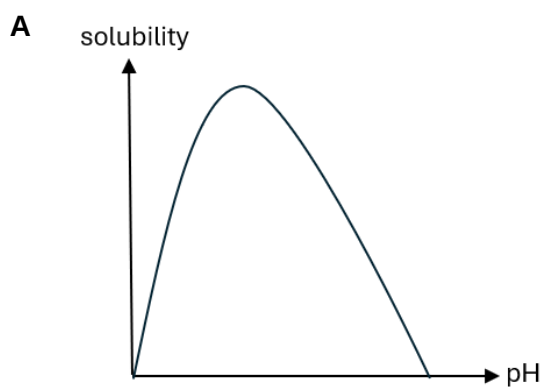


A sample of ZnS is added to H₂S solution, which is a weak dibasic acid.

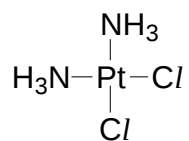


The pH of the solution is then increased by adding KOH.

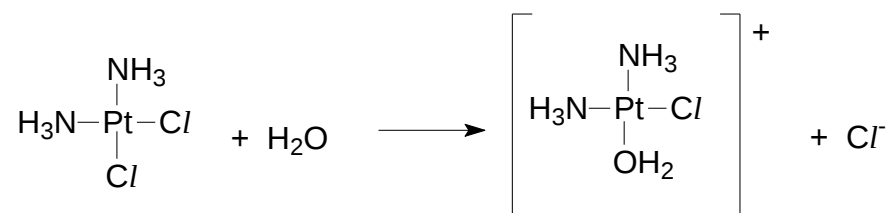
Which diagram shows how the solubility of ZnS will change with the pH of the solution at a fixed temperature?



- 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. $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ and $[\text{Pt}(\text{NH}_3)_2(\text{H}_2\text{O})\text{Cl}]^+$ have different colours.



Which statements are correct?

- 1 Pt has an oxidation state of +4.
 - 2 $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ 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

- 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** $\text{NO(g)} + \text{CO(g)} \rightarrow \text{NO}_2\text{(g)} + \text{C(s)}$
B $\text{NO(g)} + \text{CO(g)} \rightarrow \frac{1}{2}\text{N}_2\text{(g)} + \text{CO}_2\text{(g)}$
C $\text{NO(g)} + \text{CO}_2\text{(g)} \rightarrow \text{NO}_2\text{(g)} + \text{CO(g)}$
D $\text{NO(g)} \rightarrow \frac{1}{2}\text{N}_2\text{(g)} + \frac{1}{2}\text{O}_2\text{(g)}$

- 17** $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3$ 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.

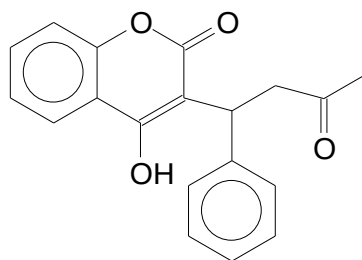
Reaction	relative rate
$\text{RCH}_3 \rightarrow \text{RCH}_2\text{Cl}$	1
$\text{R}_2\text{CH}_2 \rightarrow \text{R}_2\text{CHCl}$	7
$\text{R}_3\text{CH} \rightarrow \text{R}_3\text{CCl}$	21

Which statements regarding the mono-substituted product $\text{C}_5\text{H}_{11}\text{Cl}$ are correct?

- Ratio of $\text{CH}_2\text{Cl}/\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3$: $\text{CH}_3\text{CHCl}/\text{CH}(\text{CH}_3)\text{CH}_3$: $\text{CH}_3\text{CH}_2\text{CCl}/(\text{CH}_3)\text{CH}_3$: $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{Cl}$ is 3 : 14 : 21 : 6.
- Excess $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3$ is used to ensure that the monosubstituted product is the major product.
- Amongst the organic products formed from the mono-substitution of $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3$, there is only one constitutional isomer which can exhibit stereoisomerism.

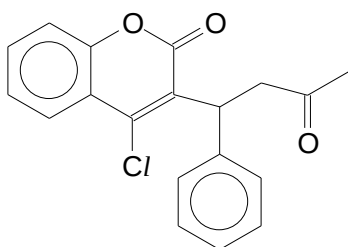
- A** 1, 2 and 3
B 1 and 2 only
C 1 and 3 only
D 2 only

- 18** Warfarin is used as a blood thinner to prevent blood clots. The structure of warfarin is as shown.



Which statements are correct?

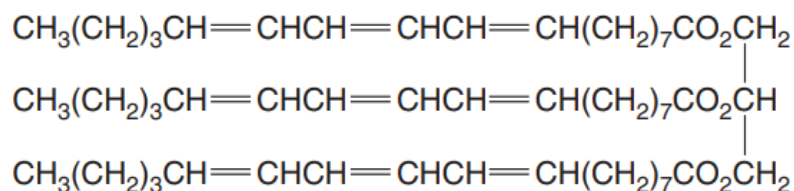
- 1 Warfarin has 1 chiral carbon.
- 2 Warfarin has 2 cis-trans isomers.
- 3 Warfarin can react with PCl_5 to form the following product.



- 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

- 19** To synthesise margarine, glyceryl trieleostearate is suitably reduced so that on average, one of its side-chains is converted into $\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{CO}_2$ and two side-chains are converted into $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{CO}_2$.

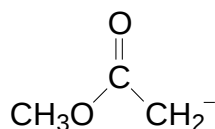


Glyceryl trieleostearate

How many moles of hydrogen gas are needed to convert one mole of glyceryl trieleostearate into margarine?

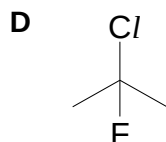
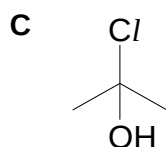
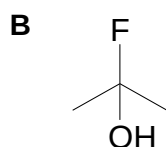
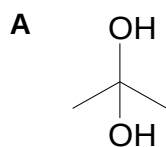
- A** 3
B 5
C 6
D 9
- 20** Which statement correctly describes the benzene molecule as a result of the delocalised electrons present within it?
- A** Benzene can act as reducing agent.
B Benzene is a conductor of electricity.
C Benzene prefers to undergo addition reactions.
D All the carbon-carbon bonds are of the same strength.

- 21 $\text{CH}_3\text{OCOCH}_3$ is reacted with a strong base to form the following nucleophile.



Which compound can be formed from the nucleophilic addition between a ketone and $\text{CH}_3\text{OCOCH}_2^-$, followed by protonation?

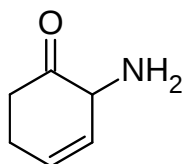
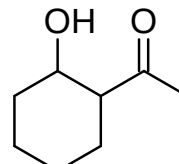
- A $\text{CH}_3\text{OCOCH}_2\text{CH}(\text{OH})\text{CH}_3$
 B $\text{CH}_3\text{COOCH}_2\text{C}(\text{OH})(\text{CH}_3)_2$
 C $\text{CH}_3\text{OCOCH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
 D $\text{CH}_3\text{OCOCH}_2\text{C}(\text{OH})(\text{CH}_3)_2$
- 22 What is the organic product obtained when 2-chloro-2-fluoropropane is heated with excess $\text{NaOH}(\text{aq})$?



- 23** 1 mole of organic compound is placed in 1 dm³ of water.
Which row correctly ranks the order of decreasing pH for the following compounds?

	Highest pH	—————→	Lowest pH
A	C ₆ H ₅ OH	CH ₃ COOH	CH ₃ COC <i>l</i>
B	CH ₃ COC <i>l</i>	C ₆ H ₅ OH	CH ₃ COOH
C	C ₆ H ₅ OH	CH ₃ COC <i>l</i>	CH ₃ COOH
D	CH ₃ COC <i>l</i>	CH ₃ COOH	C ₆ H ₅ OH

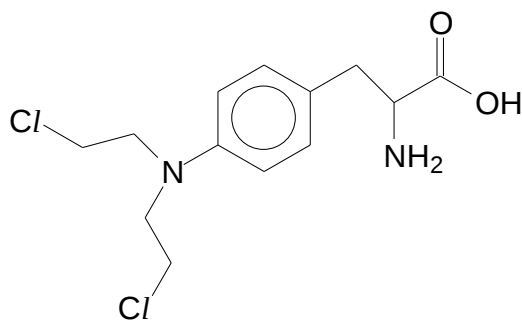
- 24** Which reagents and conditions can be used to distinguish between compounds **Y** and **Z**?

**Y****Z**

- 1 Acidified KMnO₄(aq), heat
- 2 Acidified K₂Cr₂O₇(aq), heat
- 3 Alkaline I₂(aq), warm

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

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

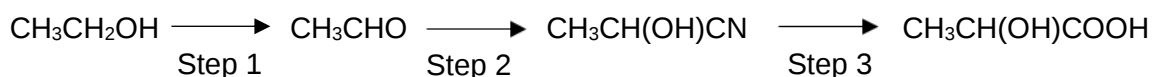


Melphalan

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.
- 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.



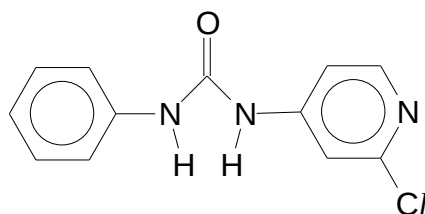
Which option shows the correct reagents and conditions for steps 1 to 3?

	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 $H_2SO_4(aq)$

- 27 Which is the dominant species formed when equal volumes of $0.1 \text{ mol dm}^{-3} \text{H}_2\text{SO}_4(\text{aq})$, $0.1 \text{ mol dm}^{-3} \text{KOH}(\text{aq})$ and $0.1 \text{ mol dm}^{-3} \text{H}_2\text{NCH}(\text{CH}_2\text{C}_6\text{H}_5)\text{CO}_2\text{H}$ are mixed?

- A $\text{H}_2\text{NCH}(\text{CH}_2\text{C}_6\text{H}_5)\text{COO}^-$
- B $\text{H}_2\text{NCH}(\text{CH}_2\text{C}_6\text{H}_5)\text{CO}_2\text{H}$
- C $\text{H}_3\text{N}^+\text{CH}(\text{CH}_2\text{C}_6\text{H}_5)\text{CO}_2\text{H}$
- D $\text{H}_3\text{N}^+\text{CH}(\text{CH}_2\text{C}_6\text{H}_5)\text{COO}^-$

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



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

- A
- B
- C
- D

- 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

- 30** There are two electrolytic cells. The first one contains $XSO_4(aq)$ and the second one contains $Y_2SO_4(aq)$. 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

END OF PAPER