OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

INTERNATIONAL A-LEVEL

CHEMISTRY (9620)

Unit 5 Practical and synoptic

Thursday 24 January 2019 07:00 GMT Time allowed: 1 hour 25 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an Insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.

For Examiner's Use	
Question	Mark
1	
2	
3	
4–33	
TOTAL	

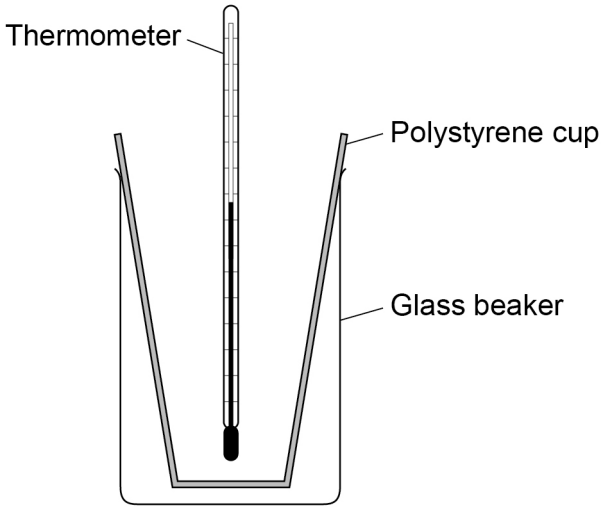
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Section A

Answer **all** questions in the spaces provided.

0 1 A student investigates the energy changes in reactions between metals and aqueous solutions of metal salts. **Figure 1** shows the apparatus used.

Figure 1



In one experiment using this apparatus, the student added magnesium powder to zinc nitrate solution.

Table 1 shows the information recorded about the reactants.

Table 1

Volume of zinc nitrate solution	30.0 cm^3
Concentration of zinc nitrate solution	1.58 mol dm^{-3}
Mass of magnesium powder	3.72 g

0 1 . 1 State why the student stirs the reaction mixture after adding the magnesium powder.

[1 mark]

Do not write outside the box

0 1 . 2 The equation for the reaction in this experiment is shown.

$$Mg(s) + Zn(NO_3)_2(aq) \rightarrow Zn(s) + Mg(NO_3)_2(aq)$$

Use the information in **Table 1** to identify the reagent in excess.
Show your working.

[2 marks]

Reagent in excess _____

Question 1 continues on the next page

Do not write outside the box

The student repeats the experiment using the same apparatus, but using zinc and copper(II) sulfate solution. The equation for the reaction is

$$Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$$

In this experiment, the zinc is in excess.
Table 2 shows the information about the reactants.

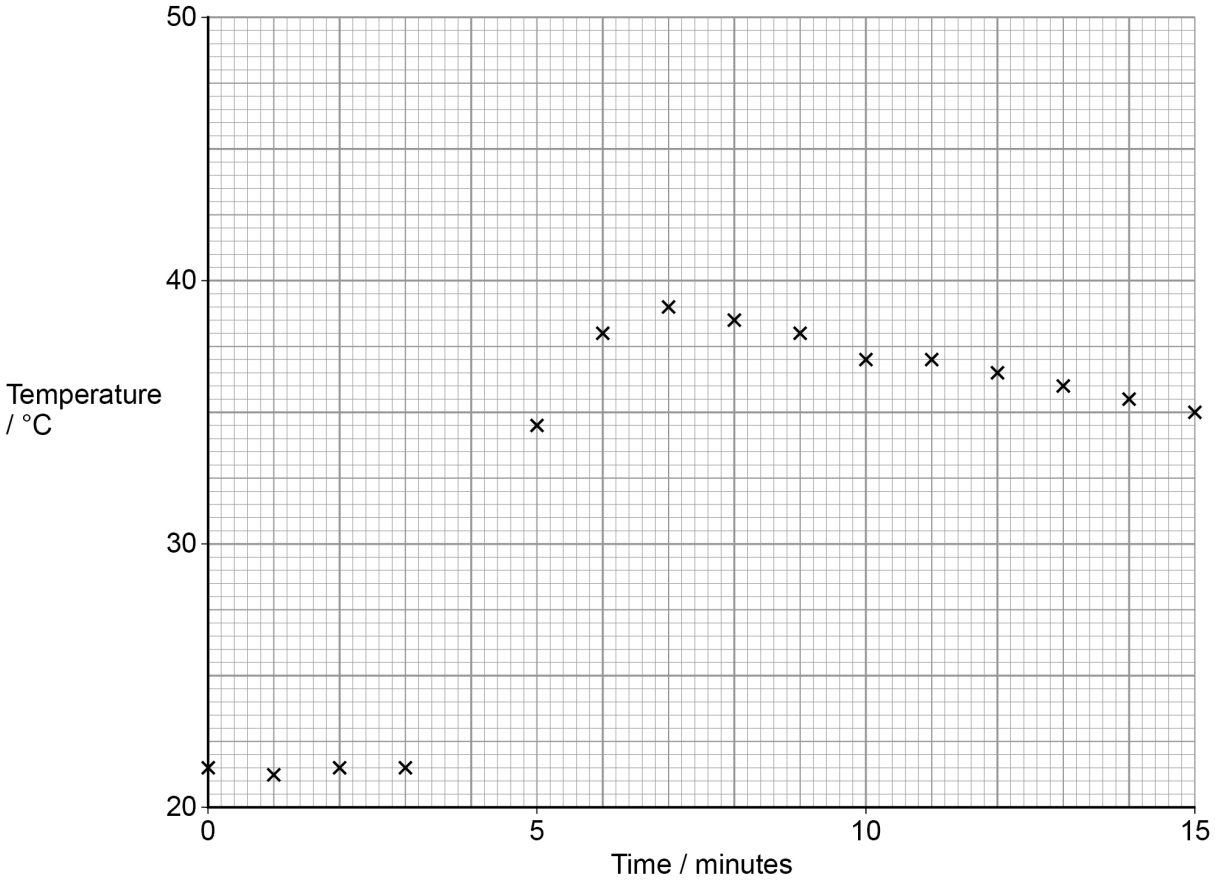
Table 2

Volume of copper(II) sulfate solution	50.0 cm^3
Concentration of copper(II) sulfate solution	0.500 mol dm^{-3}
Mass of zinc powder	5.46 g

- The temperature of the copper(II) sulfate solution is measured at one-minute intervals before adding the zinc.
- At the fourth minute the zinc is added, the mixture is stirred, but the temperature is not measured.
- The temperature of the mixture is measured every minute for 11 more minutes, stirring occasionally.

Figure 2 shows the results.

Figure 2



Do not write outside the box

0 1 . 3 Draw **two** lines of best fit on **Figure 2**.
Use your lines to determine an accurate value for the temperature change, ΔT, at t = 4.0 minutes.

[3 marks]

ΔT _____ °C

0 1 . 4 The student repeats the experiment using the same quantities as in **Table 2**, and obtains a temperature rise of 19.5 °C

Calculate the enthalpy change, ΔH, for the reaction.

The density of the solution is 1.00 g cm^{-3}
The specific heat capacity of the solution, c = 4.18 J K^{-1} g^{-1}

[3 marks]

ΔH _____ kJ mol^{-1}

9

Turn over for the next question

Do not write outside the box

0 2 A student prepares a sample of a carboxylic acid (**X**) from an ester. These are the five stages in the preparation.

Stage 1 Hydrolyse the ester by refluxing with an excess of sodium hydroxide solution.
Stage 2 Add dilute hydrochloric acid so that **X** precipitates.
Stage 3 Filter off the impure **X**.
Stage 4 Purify **X** by recrystallisation.
Stage 5 Test the purity of **X** by determining its melting point.

0 2 . 1 The formula of the ester is $(CH_3)C_6H_4COOCH_2CH_2CH_3$

State why this is **not** a structural formula.

[1 mark]

0 2 . 2 When dilute hydrochloric acid is added to the reaction mixture in **Stage 2**, these two reactions occur.

$$(CH_3)C_6H_4COONa + HCl \rightarrow (CH_3)C_6H_4COOH + NaCl$$

$$NaOH + HCl \rightarrow NaCl + H_2O$$

After adding dilute hydrochloric acid, the student tests a sample of the reaction mixture with blue litmus paper. The litmus paper turned red.

State how the result of the litmus test shows that the reactions in **Stage 2** are complete.

[1 mark]

Do not write outside the box

0 2 . 3 The student uses these four steps in the recrystallisation in **Stage 4**.

- Dissolve the solid carboxylic acid in the **minimum volume of hot solvent**.
- **Filter the hot solution**.
- Cool the filtrate **in an ice bath**.
- Filter off the crystals and **wash with cold solvent**.

Explain the importance of the words **in bold** in each step of the recrystallisation.

[4 marks]

Minimum volume of hot solvent _____

Filter the hot solution _____

In an ice bath _____

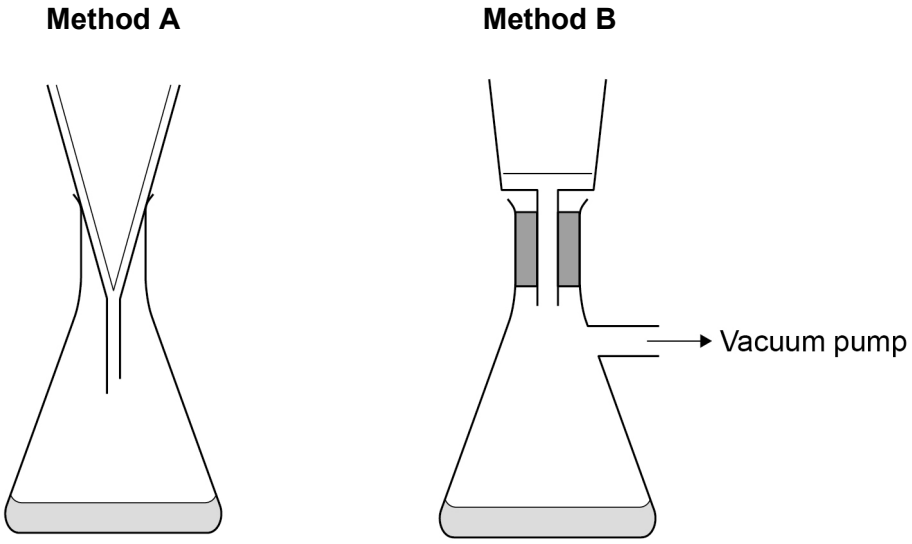
Wash with cold solvent _____

Question 2 continues on the next page

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0 2 . 4 **Figure 3** shows two different methods to filter off the purified carboxylic acid in **Stage 4**.

Figure 3



Give **two** advantages of using method **B** rather than method **A**.

[2 marks]

Advantage 1 _____

_____

Advantage 2 _____

_____

0 2 . 5 In a data book, the value for the melting point of carboxylic acid **X** is 181 °C

The student measures the melting point of the sample of **X** in **Stage 5**.
The student makes these observations:

- The solid starts to melt at about 173 °C
- All of the solid melts when the temperature reaches 179 °C

Give **two** reasons why these observations show that the sample of **X** is **not** pure.

[2 marks]

Reason 1 _____

_____

Reason 2 _____

_____

10

Do not write outside the box

0 3 Ammonium chloride can act as a weak acid when dissolved in water.
The ionic equation for the dissociation is shown.

$$NH_4^+(aq) \rightleftharpoons NH_3(aq) + H^+(aq)$$

A student:
- adds 25.0 cm^3 of ammonium chloride solution to a conical flask
- titrates the solution with sodium hydroxide solution
- uses a pH meter to measure the pH of the mixture during the titration.

0 3 . 1 Identify the most suitable piece of apparatus to use when adding the reactant solutions to the conical flask.

[1 mark]

Ammonium chloride solution _____

Sodium hydroxide solution _____

0 3 . 2 Near the end point, the student rinses the inside walls of the conical flask with deionised water.

State why this rinsing improves the accuracy of the titre, but does not change the volume of sodium hydroxide solution needed in the titration.

[2 marks]

Improving accuracy of titre _____

_____

_____

No change in volume of sodium hydroxide solution needed _____

_____

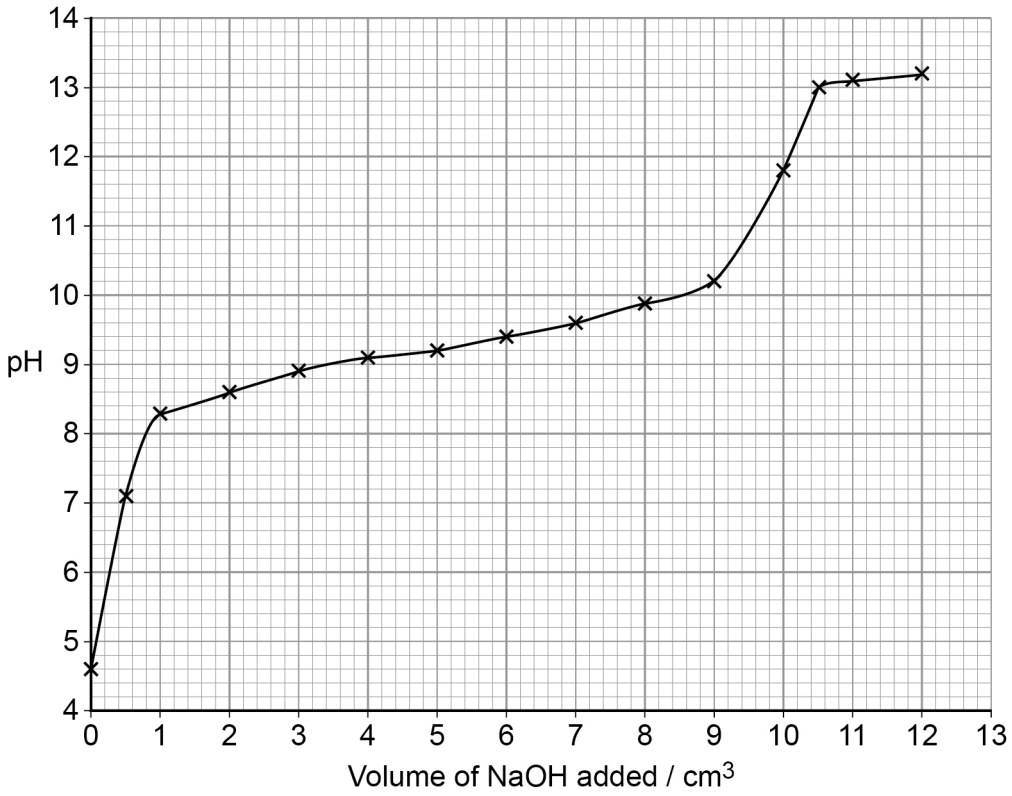
_____

Question 3 continues on the next page

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Figure 4 shows the results.

Figure 4



0 3 . 3 The end point of this titration is difficult to judge accurately with an indicator.

Explain how the graph in **Figure 4** shows this.

[2 marks]

Do not write outside the box

The end point in this titration is reached when 10.00 cm^3 of sodium hydroxide solution is added.

0 3 . 4 Use **Figure 4** to determine the pH of the reaction mixture at the end point.
Calculate the concentration of hydroxide ions at the end point.

$K_w = 1.0 \times 10^{-14}$ mol^2 dm^{-6} at the temperature of the experiment.

[3 marks]

pH at end point _____

Concentration _____ mol dm^{-3}

0 3 . 5 The initial concentration of the ammonium chloride solution was 1.00 mol dm^{-3}

The expression for the acid dissociation constant (K_a) for the ammonium ion is

$$K_a = \frac{[NH_3][H^+]}{[NH_4^+]}$$

Use **Figure 4** to determine the value of K_a for this dissociation.
Include units in your answer.

[3 marks]

K_a _____

Units _____

11

Turn over for the next section

Do not write outside the box

Section B

Each question is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is allowed.
For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD 

WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

You may do your working in the blank space around each question but this will not be marked.

0 4 What is the formula of rubidium nitride?

[1 mark]

A Rb_5N ⬭

B RbN ⬭

C Rb_3N ⬭

D RbN_3 ⬭

0 5 Which is a correct definition of relative atomic mass?

[1 mark]

A $\dfrac{\text{mean mass of an element} \times 12}{\text{mass of 1 atom of } {}^{12}C}$ ⬭

B mean mass of an atom of an element compared to $\frac{1}{12}$ mass of an atom of ^{12}C ⬭

C total number of protons and neutrons in the nucleus of an atom ⬭

D $\dfrac{\text{total mass of protons and neutrons}}{\frac{1}{12}\text{ mass of 1 atom of } {}^{12}C}$ ⬭

Do not write outside the box

0 6 Which atom contains the most neutrons?

[1 mark]

A ^{59}Co ⬭

B ^{64}Ni ⬭

C ^{63}Cu ⬭

D ^{64}Zn ⬭

0 7 The unbalanced equation for the decomposition of 4 mol of an organic compound is shown.

$$4C_3H_5N_3O_9 \rightarrow \quad CO_2 + \quad H_2O + \quad N_2 + \quad O_2$$

What is the simplest mole ratio of carbon dioxide to water when the equation is balanced?

[1 mark]

A 3:5 ⬭

B 5:6 ⬭

C 1:1 ⬭

D 6:5 ⬭

0 8 Which statement explains why barium has weaker metallic bonding than calcium?

[1 mark]

A The ionic radius of a barium ion is greater than that of a calcium ion. ⬭

B Barium ions have fewer delocalised electrons than calcium ions. ⬭

C Barium has a lower first ionisation energy than calcium. ⬭

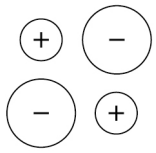
D One mole of barium has fewer protons than one mole of calcium. ⬭

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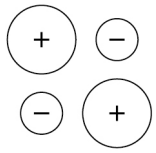
0 9 Which diagram best shows the positions and relative sizes of the ions in the crystal structure of sodium chloride?

[1 mark]

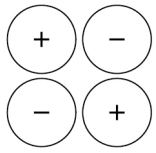
A



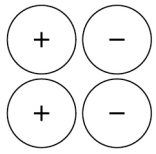
B



C



D



1 0 The highest oxidation state of an element is +4

What is the electron configuration of this element?

[1 mark]

A $1s^2\ 2s^2$

B $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$

Do not write outside the box

1 1 What are the trends in electronegativity and boiling point going down Group 7?

[1 mark]

	Electronegativity of the atoms	Boiling point of the elements	
A	decrease	increase	⬭
B	decrease	decrease	⬭
C	increase	decrease	⬭
D	increase	increase	⬭

1 2 The enthalpies of formation of some compounds are shown in the table.

	ZnO(s)	HCl(g)	$ZnCl_2(s)$	$H_2O(l)$
$\Delta_f H^{\ominus}$/kJ mol^{-1}	–348	–92	–416	–286

What is the enthalpy change, in kJ mol^{-1}, for this reaction?

$$ZnO(s) + 2HCl(g) \rightarrow ZnCl_2(s) + H_2O(l)$$

[1 mark]

A +262 ⬭

B +170 ⬭

C –170 ⬭

D –262 ⬭

1 3 Which statement describes the role of a catalyst in a reaction?

[1 mark]

A A catalyst provides an alternative route with a lower activation energy. ⬭

B A catalyst increases the yield because it lowers the activation energy. ⬭

C A catalyst lowers the enthalpy change. ⬭

D A catalyst increases the energy of the intermediate. ⬭

Do not write outside the box

1 4 Which reaction has a negative value of entropy change, ΔS?

[1 mark]

A $CO_2(g) + C(s) \rightarrow 2CO(g)$ ⬭

B $2H_2S(g) + SO_2(g) \rightarrow 3S(s) + 2H_2O(l)$ ⬭

C $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$ ⬭

D $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$ ⬭

1 5 What does compromise temperature mean when referring to a reversible reaction used in an industrial process?

[1 mark]

A A high temperature in an endothermic process to increase the yield. ⬭

B A low temperature in an exothermic process to increase the yield. ⬭

C A temperature that achieves a reasonable rate at a reasonable pressure. ⬭

D A temperature that achieves a reasonable rate and a reasonable yield. ⬭

1 6 The half-equation for the reduction of $Fe^{2+}(aq)$ is shown.

$$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$$

Which is the conventional representation of the cell used to measure the standard electrode potential of the Fe^{2+}/Fe half-cell?

[1 mark]

A $Fe(s) \mid Fe^{2+}(aq) \parallel H^+(aq) \mid H_2(g) \mid Pt$ ⬭

B $Pt \mid Fe^{2+}(aq) \mid Fe(s) \parallel H_2(g) \mid H^+(aq) \mid Pt$ ⬭

C $Pt \mid H^+(aq) \mid H_2(g) \parallel Fe^{2+}(aq) \mid Fe(s)$ ⬭

D $Pt \mid H_2(g) \mid H^+(aq) \parallel Fe^{2+}(aq) \mid Fe(s)$ ⬭

Do not write outside the box

1 7 Nickel-cadmium cells are used in rechargeable electric drills.
The electrode reactions are shown.

$NiO(OH) + H_2O + e^- \rightarrow Ni(OH)_2 + OH^-$ $\quad E^\ominus = +0.52$ V

$Cd + 2OH^- \rightarrow Cd(OH)_2 + 2e^-$ $\quad E^\ominus = -0.88$ V

What is the EMF for the cell when the drill is working?

[1 mark]

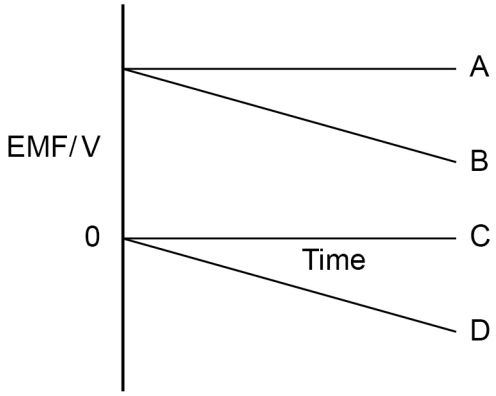
A –1.40 V ⬭

B –0.36 V ⬭

C +0.36 V ⬭

D +1.40 V ⬭

1 8 Which line shows the change in EMF with time for a hydrogen fuel cell used to power a car on a short journey?



[1 mark]

A ⬭

B ⬭

C ⬭

D ⬭

Turn over ►

Do not write outside the box

1 9 Two colourless aqueous solutions are mixed.
There is no visible change.

What are the solutions?

[1 mark]

A $BaSO_4$ and $Mg(OH)_2$ ⬭

B $Ba(OH)_2$ and $MgSO_4$ ⬭

C Na_2SO_4 and $Ba(OH)_2$ ⬭

D NaOH and $BaCl_2$ ⬭

2 0 A solution containing $EDTA^{4-}$ ions is added to a solution containing $[CuCl_4]^{2-}$ ions.
The $EDTA^{4-}$ ions replace the Cl^- ligands in the copper complex to form $[CuEDTA]^{2-}$ ions.

Why does this reaction occur?

[1 mark]

A $EDTA^{4-}$ is more highly charged than Cl^- ⬭

B $EDTA^{4-}$ is larger than Cl^- ⬭

C The enthalpy change is positive. ⬭

D The entropy change is positive. ⬭

2 1 In acid solution, manganate(VII) ions react with ethanedioate ions ($C_2O_4^{2-}$)
to form carbon dioxide.

What is the mole ratio of MnO_4^- : $C_2O_4^{2-}$ in this reaction?

[1 mark]

A 1:5 ⬭

B 2:5 ⬭

C 4:5 ⬭

D 5:2 ⬭

Do not write outside the box

2 2 Which species contains the metal ion in oxidation state +3?

[1 mark]

A $[CuCl_4]^{2-}$ ⬭

B $[Pt(NH_3)_2Cl_2]$ ⬭

C $[V(C_2O_4)_3]^{3-}$ ⬭

D $[Co(C_2H_8N_2)_2(OH)_2]$ ⬭

2 3 Which row shows the reactants and products in a reaction with **no** changes in oxidation state?

[1 mark]

	Reactants	Products	
A	MnO_4^- and H^+	Mn^{2+} and H_2O	⬭
B	MnO_4^{2-} and H^+	MnO_4^- and H_2O	⬭
C	CrO_4^{2-} and H^+	$Cr_2O_7^{2-}$ and H_2O	⬭
D	$Cr_2O_7^{2-}$ and H_2	Cr^{3+} and H_2O	⬭

2 4 Iron(II) hydroxide can be oxidised to iron(III) hydroxide in alkaline conditions. The half-equations for the two reactions are shown.

$$Fe(OH)_2 + OH^- \rightarrow Fe(OH)_3 + e^-$$
$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

What is the equation for the overall redox reaction?

[1 mark]

A $2Fe(OH)_2 + OH^- + H_2O \rightarrow 2Fe(OH)_3$ ⬭

B $2Fe(OH)_2 + O_2 + H_2O \rightarrow 2Fe(OH)_3$ ⬭

C $4Fe(OH)_3 + O_2 + 2H_2O \rightarrow 4Fe(OH)_2$ ⬭

D $4Fe(OH)_2 + O_2 + 2H_2O \rightarrow 4Fe(OH)_3$ ⬭

Turn over ►

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2 5 Alkenes are obtained from crude oil by fractional distillation and cracking.

Which is a correct statement about these processes?

[1 mark]

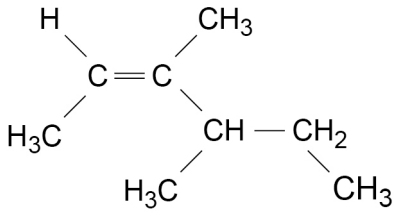
A The boiling points of alkane isomers increase as the carbon chains become more branched. ⬭

B Thermal cracking produces a high percentage of ethene and propene. ⬭

C Compounds with longer chains have higher boiling points and rise to the top of a fractionating column. ⬭

D Catalytic cracking happens at high temperature and high pressure. ⬭

2 6 Which is a correct statement about this compound?



[1 mark]

A It has the empirical formula C_8H_{16} ⬭

B It is a functional group isomer of 1,4-dimethylbenzene. ⬭

C Its mirror image isomers are superimposable. ⬭

D It is a *Z*-isomer. ⬭

2 7 Which reaction does **not** involve substitution?

[1 mark]

A The reaction of butanone with hydrogen cyanide. ⬭

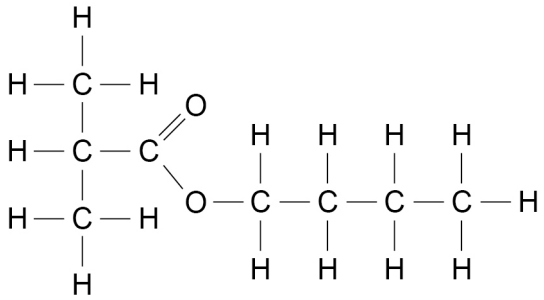
B The reaction of methylbenzene with chlorine in the presence of ultraviolet light. ⬭

C The reaction of methylbenzene with chlorine in the presence of aluminium chloride. ⬭

D The reaction of chloroethane with aqueous sodium hydroxide. ⬭

Do not write outside the box

2 8 How many peaks are there in the ^{13}C NMR spectrum of this compound?



[1 mark]

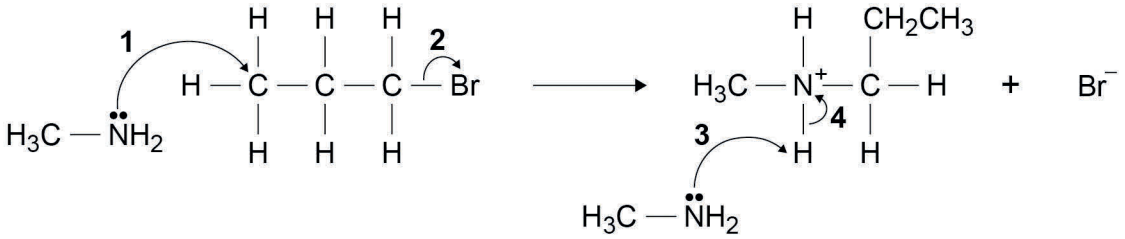
A 5 ⬭

B 6 ⬭

C 7 ⬭

D 8 ⬭

2 9 Which curly arrow is **not** correct in the mechanism for the reaction of methylamine with 1-bromopropane?



[1 mark]

A 1 ⬭

B 2 ⬭

C 3 ⬭

D 4 ⬭

Do not write outside the box

3 0 Which is a correct statement about this reaction scheme?

$$CH_3CH_2Cl \xrightarrow{\text{step 1}} CH_3CH_2CN \xrightarrow{\text{step 2}} CH_3CH_2CH_2NH_2$$

[1 mark]

A Ammonia is a suitable reagent for step 1. ⬭

B Step 1 involves a nucleophilic substitution mechanism. ⬭

C Step 2 is an oxidation reaction. ⬭

D Step 2 produces a secondary amine. ⬭

3 1 Which of the following is an advantage of using ethanoic anhydride instead of ethanoyl chloride during the manufacture of aspirin?

[1 mark]

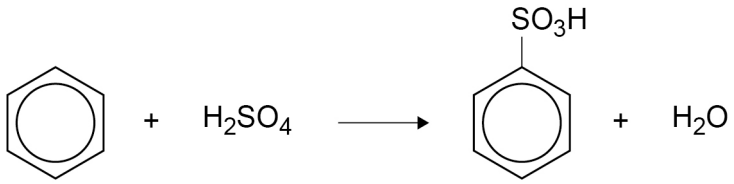
A Ethanoic anhydride has a higher boiling point. ⬭

B Ethanoic anhydride has a higher M_r. ⬭

C Ethanoic anhydride is less corrosive. ⬭

D Ethanoic anhydride reacts faster. ⬭

3 2 Benzenesulfonic acid can be prepared from benzene as shown.



In one preparation, 15.6 g of benzene (M_r = 78.0) is used.
The yield is 33.5 %

What mass, in grams, of benzenesulfonic acid is formed in this preparation?

[1 mark]

A 5.2 ⬭

B 10.6 ⬭

C 31.6 ⬭

D 35.2 ⬭

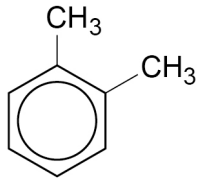
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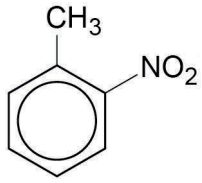
3 3 Which compound can be made from methylbenzene by a free-radical substitution reaction?

[1 mark]

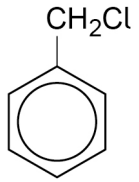
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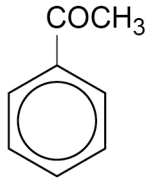
B



C



D



END OF QUESTIONS

30

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