GCE

Specimen Papers with Mark Schemes

Edexcel Advanced Subsidiary GCE in Chemistry (8080)

First Examination 2003

Edexcel Advanced GCE in Chemistry (9080)

First Examination 2003

December 2002

Contents

Question Papers

Mark Schemes

Centre No.					
Candidate No.					

Paper Reference (complete below)					
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Surname	Initial(s)
Signature	

Paper Reference(s)

6241.01

Edexcel GCE

Chemistry

Advanced Subsidiary

Unit Test C1

Specimen Paper

Time: 1 hour

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
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6	
Total	

Materials required for examination	Items included with question papers
None	None

Instructions to Candidates

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The paper reference is shown above.
Show all the steps in any calculations and state the units.
You may use a calculator.
Answer ALL the questions in the spaces provided in this question paper.

Information for Candidates

The total mark for this paper is 60. The marks for the various parts of questions are shown in round brackets, e.g. **(2)**.
A Periodic Table is printed on the back cover of this question paper.

Advice to Candidates

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1. (a) (i) Complete the electronic configuration of a sulphur atom.

$1s^2$ ....

(1)

(ii) Deduce the number of neutrons and protons in the nucleus of an atom of ^{34}**S**.

Neutrons ………………….. .Protons………………………

(2)

(b) (i) Define the term **first electron affinity**. .

....

....

....

(3)

(ii) The following equation represents the change occurring when the second electron affinity of sulphur is measured.

$$S^-(g) + e^- \longrightarrow S^{2-}(g)$$

Explain why the second electron affinity of an element is endothermic.

....

....

(2)

Total 8 marks

2. (a) Iron has several isotopes. One of them has the electronic configuration [Ar]$3d^6 4s^2$, an atomic number of 26 and a mass number of 56.

(i) Which of these pieces of information would be the most use in helping a chemist decide on the likely chemical reactions of iron?

....

(1)

(ii) What are isotopes?

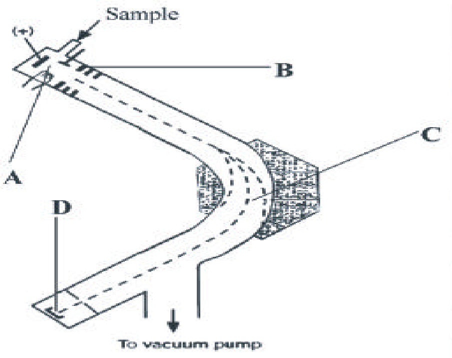
....

....

(2)

(b) The relative atomic mass of a sample of iron may be found by using a mass spectrometer to determine the isotopic composition.

(i) The diagram below represents a low-resolution mass spectrometer in which four areas have been identified. State what happens in each of these areas.



Area **A**..

Area **B**..

Area **C**..

Area **D**..

(4)

Leave blank

(ii) In such a determination the following isotopic composition was found.

Isotope	Percentage composition
^{54}Fe	5.80
^{56}Fe	91.6
^{57}Fe	2.20
^{58}Fe	0.40

Calculate the relative atomic mass of this sample of iron, giving your answer to two decimal places.

(2)

Total 9 marks

3. (a) When the Group 2 element calcium is added to water, calcium hydroxide and hydrogen are produced.

$$Ca(s) \ + \ 2H_2O(l) \longrightarrow Ca(OH)_2\,(aq) \ + \ H_2(g)$$

(i) Calculate the volume, in cm^3, of hydrogen that would be collected if 0.17 g of calcium were used.
(Assume that the molar volume of a gas is 24 000 cm^3 at the temperature and pressure of the experiment.)

(2)

(ii) How many molecules of hydrogen gas would this volume contain?
(Assume Avogadro's number, L, = 6.0×10^{23} mol^{-1})

(1)

(b) State the trend in solubility of the hydroxides of the Group 2 elements as the atomic mass of the metal increases.

....

(1)

(c) (i) Write an equation to represent the change occurring when the first ionisation energy of calcium is measured.

....

(2)

(ii) State and explain the trend in the first ionisation energy of the Group 2 elements.

....

....

....

....

(4)

Total 10 marks

4. (a) Boron forms the chloride BCl_3. Draw a dot-and-cross diagram for BCl_3.

(1)

(b) (i) Draw the shape of the BCl_3 molecule.

(1)

(ii) Explain why BCl_3 has this shape.

....

....

....

....

(2)

(c) (i) The B-Cl bond is polar due to the different electronegativity of the atoms. Explain what is meant by the term **electronegativity**.

....

(2)

(ii) The B-Cl bond is polar. Explain why BCl_3 is **not** a polar molecule.

....

....

(2)

Total 8 marks

5. (a) Hydrogen sulphide is produced when concentrated sulphuric acid is added to solid sodium iodide, but sulphur dioxide is produced when concentrated sulphuric acid is added to solid sodium bromide.

(i) Complete the following table:

Compound	Formula	Oxidation number of sulphur in compound
Sulphuric acid	H_2SO_4	
Hydrogen sulphide	H_2S	
Sulphur dioxide	SO_2	

(3)

(ii) Use your answers to part (a)(i) to suggest which of the ions, iodide or bromide, has the greater reducing power.

....

....

....

(2)

(b) (i) Write an ionic half-equation to show the oxidation of chloride ions, Cl^-, to chlorine, Cl_2.

....

(1)

(ii) Write an ionic half-equation to show the reduction of chlorate(I) ions, OCl^-, to chloride ions, in acidic conditions.

....

(2)

(iii) Bleach is a solution of chlorate(I) ions and chloride ions. Combine the two ionic half-equation above to produce an equation which shows the effect of adding acid to bleach. Include state symbols.

....

....

(2)

Total 10 marks

6. (a) The table below shows the melting temperatures of the elements of period 3.

	Na	Mg	Al	Si	P	S	Cl	Ar
m.p./ ^{o}C	98	650	660	1410	44	119	-101	-189

(i) Explain why the melting temperature of sodium is so much lower than that of magnesium or of aluminium.

....

....

....

....

(3)

(ii) Phosphorus exists as P_4, sulphur as S_8. Explain the difference in the melting temperature of these substances.

....

....

(2)

(b) State the structure of, and type of bonding in, the following substances. Draw labelled diagrams to illustrate your answers.

(i) Graphite

Structure ....

Bonding ....

Diagram:

(4)

(ii) Sodium chloride

Structure ....

Bonding ....

Diagram:

(3)

(c) (i) Explain why graphite is able to conduct electricity in the solid state.

....

....

....

(2)

(ii)Explain why sodium chloride conducts electricity in the liquid state.

....

....

(1)

Total 15 marks

TOTAL FOR PAPER: 60 MARKS

END

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Candidate No.									/			Signature	

Paper Reference(s)

6242.01

Edexcel GCE

Chemistry

Advanced Subsidiary

Unit Test C2

Specimen Paper

Time: 1 hour

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
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Total	

Materials required for examination	Items included with question papers
None	None

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Edexcel
Success through qualifications

1(a) (i) State one factor other than a change in temperature or use of a catalyst that can influence the rate of a chemical reaction.

....

....

(1)

(ii) For the factor you have chosen explain the effect on the rate.

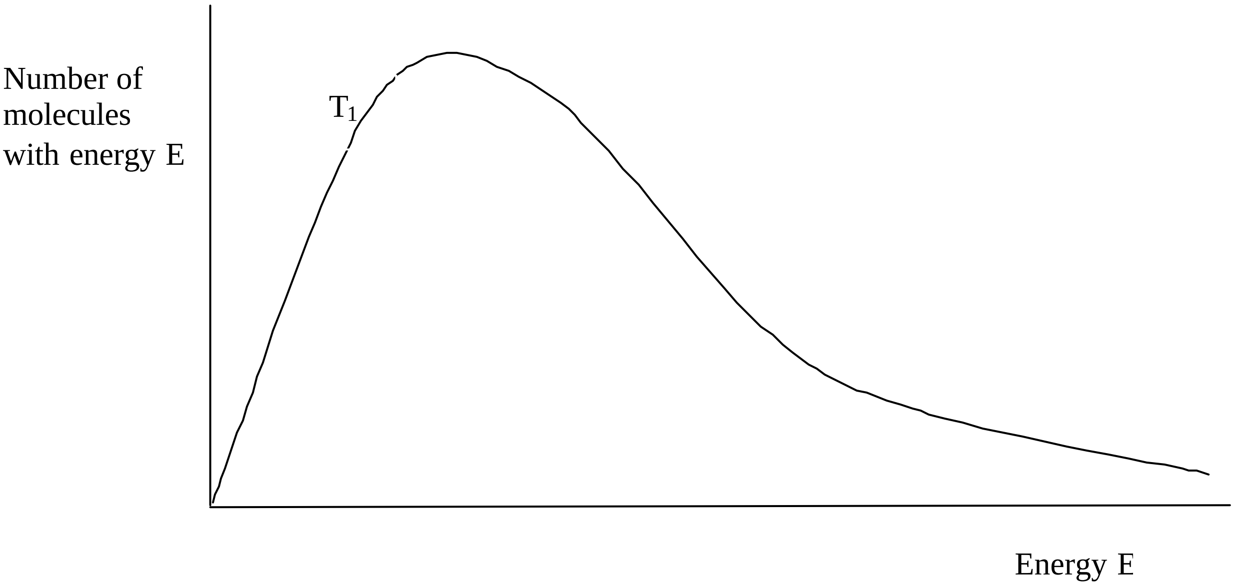
....

....

....

(2)

(b) The Maxwell-Boltzmann distribution of molecular energies at a given temperature T_1 is shown below.



(i) On the same axes draw a similar curve for a reaction mixture at a higher temperature T_2.

(2)

(ii) Place a vertical line E_a at a plausible value on the energy axis to represent the activation energy for a reaction.

(1)

(iii) Use your answers to parts (i) and (ii) to explain why an increase in temperature causes an increase in the reaction rate.

....

....

....

....

....

....

....

(3)

Total 9 marks

2. The reaction in the Haber Process that is used to produce ammonia is a homogeneous dynamic equilibrium:

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g) \quad \Delta H = -92\text{kJ mol}^{-1}$$

(a) State the meaning of the term **dynamic equilibrium.**

....

....

....

(2)

(b) Give, with a reason in each case , the effect of the following on the **position** of the equilibrium above:

(i) an increase in pressure;

....

....

....

(2)

(ii) an increase in temperature.

....

....

....

(2)

(c) (i) What temperature is used in the Haber Process?

....

(1)

(ii) Justify the temperature used in the Haber Process.

....

....

....

....

....

....

(3)

(d) (i) Name the catalyst used in the Haber Process.

....

(1)

(ii) How does a catalyst enable a reaction to occur more quickly?

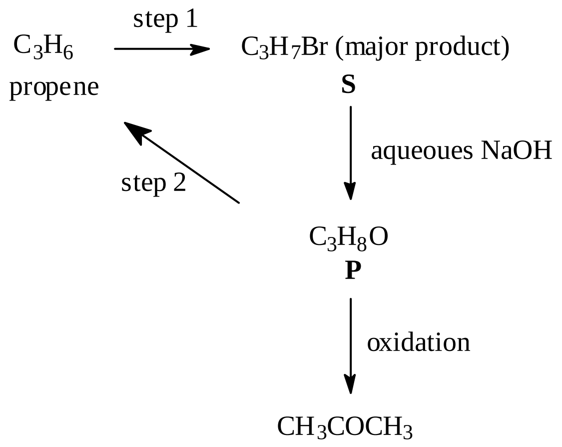
....

....

(2)

Total 13 marks

3. Consider the following reaction scheme:



(a) (i) Give the reagent and condition needed for step 1.

....

(2)

(ii) Give the structural formula of **S**.

(1)

(b) (i) Give the structural formula of **P**.

(1)

(ii) State the **type** of reaction in:

step 1..

the conversion of S to P..

(4)

(c) Give the reagent and the condition needed for step 2.

....

....

(2)

(d) If **S** is reacted with a solution of hydroxide ions in ethanol, **P** is not the product. Draw the structure of the compound that is produced in this reaction.

(1)

Total 11 marks

4. In the preparation of the alcohol butan-2-ol, 13.7 g of 2-bromobutane was hydrolysed with 9.0 g of potassium hydroxide in aqueous solution. The following reaction occurred.

$$CH_3CHBrCH_2CH_3 + KOH \longrightarrow CH_3CHOHCH_2CH_3 + KBr$$

(a) Give the amount (number of moles) of each **reactant** in the above experiment, and use your answers to state which reactant was present in excess.

(4)

(b) The reaction taking place can be classified as nucleophilic substitution. Explain the term **nucleophile** and identify the nucleophile in the reaction.

....

....

....

(2)

(c) The above experiment was repeated under identical conditions, except that 2-iodobutane was used in place of 2-bromobutane. State and explain the effect that this change would have on the rate of reaction.

....

....

....

....

(2)

Total 8 marks

5. (a) Ethene and propene are in the same homologous series. Explain the term **homologous series**.

....

....

....

....

(3)

(b) Draw a representative length of the polymer chain of poly(propene).

(1)

(c) Poly(propene) does not have a sharp melting temperature, but softens over a range of temperatures. Suggest why this is so.

....

(1)

(d) (i) Tetrafluoroethene, C_2F_4, also forms a polymer. Suggest why this polymer is very inert.

....

(1)

(ii) Give one use for poly(tetrafluoroethene).

....

(1)

(e) Ethane and ethene both react with bromine. Ethane does not react at room temperature in the dark, whereas ethene does so extremely quickly. Explain in terms of the bonding in each molecule why this is so.

....

....

....

....

....

(3)

Total 10 marks

Leave blank

6. (a) Define the term **standard enthalpy change of combustion**.

....

....

....

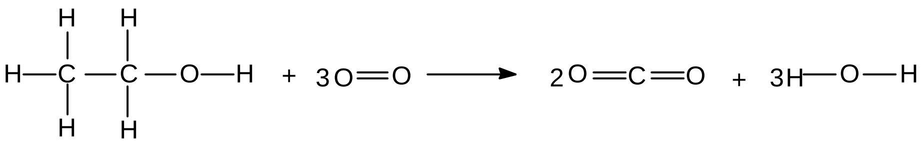
....

(3)

(b) The equation for the combustion of ethanol in air is:

$$C_2H_5OH\ (l) + 3O_2\ (g) \longrightarrow 2CO_2\ (g) + 3H_2O\ (l)$$

and the structural representation of this is:



(i) Calculate the enthalpy change for this reaction using the average bond enthalpy values given below.

Bond	Average bond enthalpy / kJ mol^{-1}	Bond	Average bond enthalpy / kJ mol^{-1}
C-H	+412	C-C	+348
C-O	+360	O-H	+463
O=O	+496	C=O	+743

(3)

Leave blank

(ii) Draw and label a reaction profile for this reaction.

Enthalpy

(3)

Total 9 marks

TOTAL FOR PAPER: 60 MARKS

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Paper Reference(s)

6243.02

Edexcel GCE

Chemistry

Advanced Subsidiary

Unit Test C3B

Specimen Paper

Time: 1 hour

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
Total	

Materials required for examination	**Items included with question papers**
Nil	Nil

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1. (a) The observations made when tests were carried out on a white solid compound **X** are shown in the table. **X** contains one metal ion and one anion.

Give the inferences, which follow the observations by completing the statements in the spaces in the table.

(i) A flame test was carried out on **X**.

Observation	Inference
A lilac flame.	The metal ion is ……………………………

(1)

(ii) A sample of **X** was heated and the gas evolved tested.

Observation	Inferences
A gas is given off which relights a glowing spill.	The gas is …………………………… **X** has the formula……………………

(2)

(b) The observations made when tests were carried out on an aqueous solution, **Y**, are shown in the tables below.

Give the inferences which follow the observations by completing the statements in the tables.

(i) Powdered sodium hydrogen carbonate was added to **Y** in test tube. Any gas evolved was tested.

Observations	Inferences
Bubbles of gas evolved. The gas turned limewater cloudy.	The gas is ……………………………
	Y contains ………………………… ions

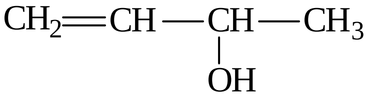
(2)

(ii) A few drops of aqueous barium chloride followed by dilute aqueous hydrochloric acid was added to **Y**.

Observations	Inferences
White precipitate which does not dissolve in dilute aqueous hydrochloric acid.	The precipitate is …………………………… **Y** is aqueous…………………………………

(2)

(c) The organic compound **Z** has the structure:



$$CH_2{=}CH{-}CH(OH){-}CH_3$$

Complete the table below by writing the observations you would expect to make when the tests described are carried out.

Tests	Observations
Shake a few drops of **Z** with bromine solution.	
Add phosphorus pentachloride to **Z**. Test any gas evolved with damp blue litmus.	
Add aqueous potassium dichromate acidified with aqueous sulphuric acid to **Z** and heat the solution.	

(6)

Total 13 marks

2. A student was required to determine the enthalpy change for the reaction between iron and copper sulphate solution.

The student produced the following account of their experiment.

A piece of iron, mass 3 g, was placed in a glass beaker. 50 cm^3 of 0.5 mol dm^{-3} aqueous copper sulphate solution was measured using a measuring cylinder and added to the beaker. The temperature of the mixture was measured immediately before the addition and every minute afterwards until no further change took place.

$$Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$$

Timing	Before addition	1 min	2 min	3 min	4 min	5 min
Temperature / °C	22	27	29	26	24	22

(a) Suggest **two** improvements you would make to this experiment. Give a reason for each of the improvements suggested.

Improvement 1 ....

....

Reason 1 ....

....

Improvement 2 ....

....

Reason 2 ....

....

(4)

(b) In an improved version of the **same experiment** maximum temperature rise of 15.2°C occurred when reacting excess iron with 50.0 cm^3 of 0.500 mol dm^{-3} aqueous copper sulphate solution.

(i) Using this data and taking the specific heat capacity of all aqueous solutions as 4.18 J g^{-1} deg^{-1} calculate the heat change.

(2)

(ii) Calculate the number of moles of copper sulphate used.

(1)

(iii) Calculate the enthalpy change of this reaction in kJ mol^{-1}.

(2)

Total 9 marks

3 1-bromobutane (boiling temperature 102 °C) may be prepared by the reaction shown in the equation below.

$$C_4H_9OH + NaBr + + H_2SO_4 \longrightarrow C_4H_9Br + NaHSO_4 + H_2O$$

The preparation is in three stages.

- Stage I: The reagents are heated for about 45 minutes in the apparatus shown in **Diagram 1.**
- Stage II: Impure 1-bromobutane is extracted from the reaction mixture and transferred to the round-bottomed flask in the apparatus shown in **Diagram 2**.
- Stage III: A sample of pure 1-bromobutane is obtained using the apparatus shown in **Diagram 2**. The sample is weighed and the yield calculated.

(a) Give the names of the practical techniques carried out in the apparatus shown in Diagrams 1 and 2.

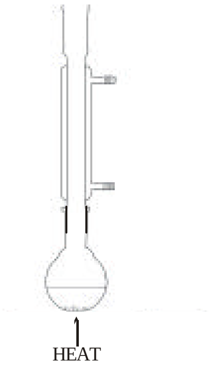


Diagram 1

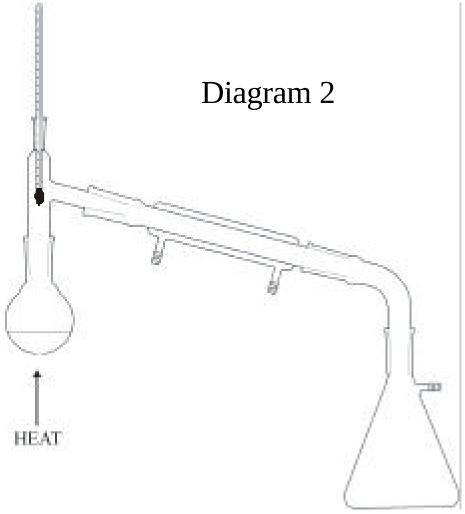


Diagram 2

Diagram 1:..

Diagram 2:..

(2)

(b) (i) Explain why, in Stage I, the reactants are heated for such a long time.

....

....

(1)

(ii) Explain the purpose and arrangement of the condenser in diagram 1.

....

....

....

....

(2)

(c) Briefly describe how you would use the apparatus shown in diagram 2 to give a sample of pure 1-bromobutane.

....

....

....

....

....

....

(3)

(d) A student preparing 1-bromobutane by this method calculated that the maximum yield in this preparation was 7.2 g. His actual yield was 3.1 g.

(i) Calculate the percentage yield.

(2)

(ii) Suggest **two** reasons why the actual yield was much lower than the maximum yield.

Reason 1:..

....

Reason 2: ....

....

(2)

(e) A few drops of 1-bromobutane were added to 2 cm^3 of ethanol in a test tube followed by 5 cm^3 of aqueous silver nitrate. The mixture was warmed in a water bath for a few minutes. The 1-bromobutane was hydrolysed and a cream precipitate formed.

(i) Give the formula of the precipitate.

....

(1)

(ii) Suggest why ethanol was used in the experiment.

....

(1)

(iii) Suggest a reason for the use of a water bath.

....

....

(1)

Total 15 marks

4.(a) In an experiment to standardise an aqueous solution of sodium hydroxide 0.25 g of solid sulphamic acid, NH_2SO_3H, was dissolved in distilled water in a conical flask. When the aqueous sodium hydroxide was run into the flask from a burette 23.45 cm^3 was required to exactly react with the sulphuric acid solution. The equation for the reaction is:

$$NH_2SO_3H(aq) + NaOH(aq) \longrightarrow NH_2SO_3Na(aq) + H_2O(l)$$

(i) Calculate the amount (number of moles) of sulphuric acid in 0.25 g.
M_r $(NH_2SO_3H) = 97.0$

(1)

(ii) State the amount (number of moles) of sodium hydroxide in 23.45 cm^3 of solution and hence calculate the concentration of the solution in mol dm^{-3}.

(3)

(b) The balance used to weigh the sulphamic acid is accurate to ± 0.01 g. Calculate the percentage error in the mass of the sulphamic acid weighed.

(1)

Leave blank

(c) An alternative method to that described in (a) involves making an aqueous solution of sulphamic acid of **accurately known concentration.**

Describe a procedure by which you would prepare 250 cm^3 of aqueous sulphamic acid of accurately known concentration. Assume that you are provided with a weighing bottle containing between 2.40 g and 2.50 g of sulphamic acid and that this is a suitable mass to use.

In your answer give full practical details including the name of each piece of apparatus used, how each would be prepared for the procedure and how you would calculate the concentration (in mol dm^{-3}) of the sulphamic acid solution. State, with a reason, one appropriate safety precaution that should be taken.

(8)

Total 13 marks

TOTAL FOR PAPER: 50 MARKS

END

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Candidate No.					

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6244.01

Edexcel GCE

Chemistry

Advanced Level

Unit Test C4

Specimen Paper

Examiner's use only

Team Leader's use only

Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
None	None

Question Number	Leave Blank
1	
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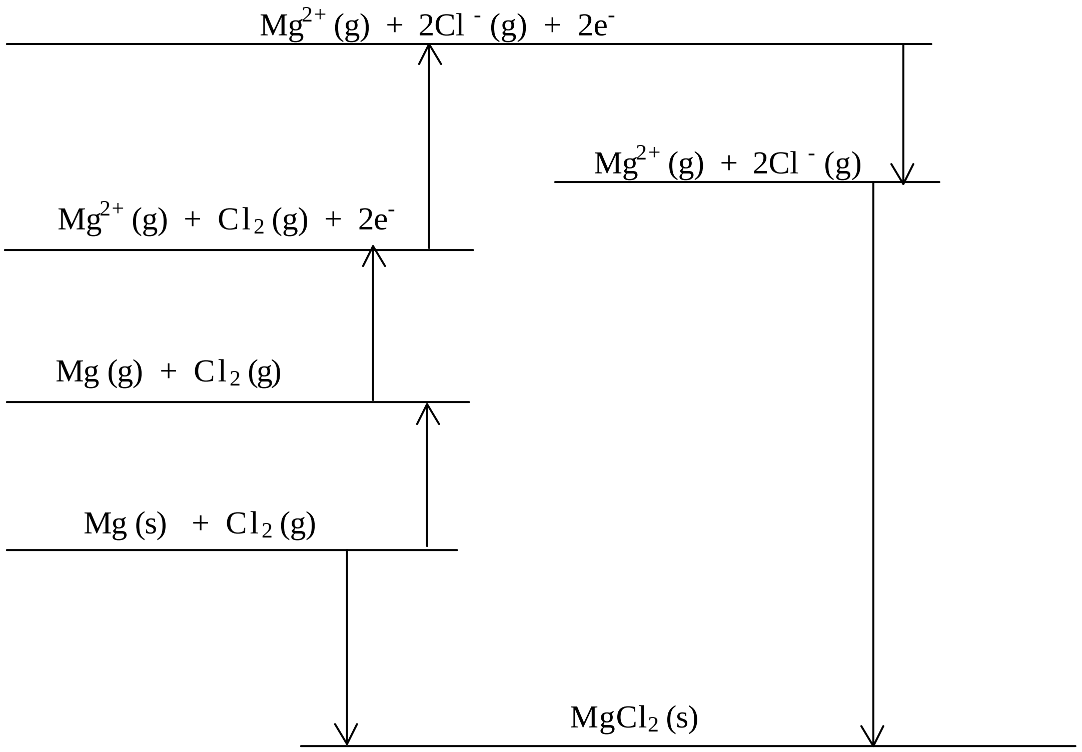
Success through qualifications

1. The formation of magnesium chloride from magnesium and chlorine may be represented by the following Born-Haber cycle:



(a) Define the terms:

(i) Lattice energy.

....

....

....

....

(3)

(ii) Enthalpy of atomisation.

....

....

....

....

(2)

(b) (i) Identify on the diagram the changes representing the enthalpy of atomisation of magnesium.

(1)

(ii) Use the data below to calculate the first electron affinity of chlorine.

Enthalpy change	Value of the enthalpy change / kJ mol^{-1}
Enthalpy of atomisation of magnesium	+150
1st ionisation energy of magnesium	+736
2nd ionisation energy of magnesium	+1450
Enthalpy of formation of magnesium chloride	-642
Enthalpy of atomisation of chlorine	+121
Lattice energy of magnesium chloride	-2493

(2)

(c) Hydrogen gas reacts with sodium metal to form an ionic solid, NaH, which contains sodium cations. Draw a Born–Haber cycle which could be used to determine the electron affinity of hydrogen.

(3)

Total 11 marks

2. (a) (i) Give the structural formula of a nitrile, C_4H_7N, that has an unbranched chain.

(1)

(ii) Primary amines can be made by reducing nitriles. Suggest a reagent that could be used for this purpose.

....

(1)

(iii) Draw the full structural formula of the amine produced by reducing the nitrile given in (a)(i).

(1)

(b) Draw the structure of an isomer of $C_4H_{11}N$, which has a chiral centre in the molecule, and identify the chiral centre.

(2)

(c) (i) What feature of an amine molecule make it both a base and a nucleophile?

....

(1)

(ii) Give, by writing an equation, an example of an amine acting as a base.

....

(1)

(d) Ethanoyl chloride, CH_3COCl, reacts with both amines and alcohols.

(i) Give the name of the **type** of compound produced when ethanoyl chloride reacts with ethylamine, $C_2H_5NH_2$.

....

(1)

(ii) State one of the advantages of reacting ethanoyl chloride with ethanol to make an ester rather than reacting ethanoic acid with ethanol.

....

....

(1)

(e) Ethanoyl chloride can be made from ethanoic acid. Suggest a reagent suitable for this conversion.

....

(1)

(f) Suggest how chloromethane can be converted into ethanoic acid via a Grignard reagent. (Details of the experimental apparatus are not required.)

....

....

....

....

....

....

....

(4)

Total 14 marks

3. (a) From the compounds of the elements in Group 4 of the Periodic Table, carbon to lead, give the formula of:

(i) an acidic oxide; ....

(ii) an oxide which can behave as a base..

(2)

(b) Aluminium hydroxide is an amphoteric hydroxide.

(i) What is meant by the term **amphoteric?**

....

....

(1)

(ii) Write ionic equations which show the amphoteric behaviour of aluminium hydroxide.

....

....

(3)

(c) Sodium chloride dissolves in water to give a neutral solution; phosphorus pentachloride reacts with water to give an acidic solution. Interpret this information in terms of the bonding in the compounds, giving equations where appropriate.

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(4)

(d) (i) State what happens when carbon tetrachloride is added to water.

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(1)

(ii) State what happens when silicon tetrachloride is added to water.

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(2)

(iii) Explain why carbon tetrachloride and silicon tetrachloride behave in different ways when added to water.

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(4)

Total 17 marks

4. (a) Methane reacts with steam in a reversible reaction. In industry this reaction, carried out at a pressure of 30 atm, is used to produce hydrogen for the manufacture of ammonia.

$$CH_4(g) + H_2O(g) \rightleftharpoons O(g) + 3H_2(g) \quad \Delta H = +210 \text{ kJ mol}^{-1}$$

(i) Define the term **partial pressure** as applied to a gas.

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(1)

(ii) Write an expression for the equilibrium constant, K_p, for this reaction.

(1)

(iii) State and explain the effect of increasing the total pressure on the position of this equilibrium.

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(2)

(b) State the effect on the value of K_p for this equilibrium of the following.

(i) Increasing the total pressure.

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(1)

(ii) Increasing the temperature.

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(1)

(iii) Adding a catalyst.

....

(1)

(c) There is a theory that methane, CH_4, constantly leaks from the earth's crust. This is not noticeable on land but at the bottom of a cold sea, such as off the Canadian coast, the methane is trapped in a solid cage of water molecules.

$$\underset{}{CH_4\,(g) + 6H_2O\,(s)} \rightleftharpoons \underset{\text{methane hydrate}}{[CH_4(H_2O)_6]\,(s)}$$

At –29 °C the equilibrium pressure of the methane is 101.3 kPa.

(i) Write an expression for K_p for this equilibrium.

(1)

(ii) Calculate the value of K_p at –29 °C stating its units.

(1)

(iii) At 0 °C the equilibrium pressure of methane rises to 2600 kPa. What does this tell you about the effect of temperature change on position of equilibrium and about the enthalpy change for this reaction?

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(2)

Total 11 marks

5 Ethanoic acid, CH_3COOH, is a weak acid which can be used, with its salts, to make buffer solutions.

(a) Explain what is meant by the terms **weak** and **acid**, in this context.

....

....

(2)

(b) Explain what is meant by the term **buffer solution**.

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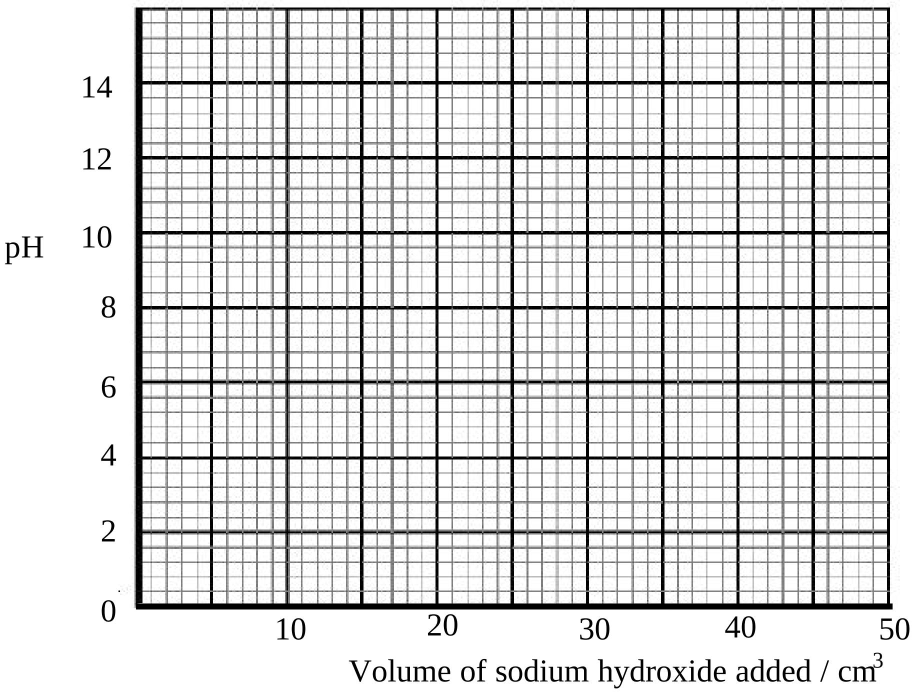
(2)

(c) An aqueous solution of ethanoic acid of concentration 1.00 mol dm^{-3} has a pH of 2.8. Sketch, with care, how the pH changes during the titration of 25.0 cm^3 of 1.00 mol dm^{-3} aqueous ethanoic acid with aqueous sodium hydroxide of the same concentration.



(4)

(d) Indicate on your sketch the portion of the curve where the mixture is behaving as a buffer.

(1)

(e) (i) Write an expression for the dissociation constant, K_a, for ethanoic acid.

(1)

(ii) Explain how the pK_a of ethanoic could be found from the graph.

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(2)

(f) Suggest, with reasoning, whether methyl orange or phenolphthalein would be the better indicator for this titration.

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(3)

(g) Explain why, as the titration proceeds, the flask becomes warm but not as warm as it would in similar titration using 1.00 mol dm^{-3} solutions of hydrochloric acid and sodium hydroxide.

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(3)

(h) A different monobasic weak acid has a dissociation constant of 1.8×10^{-5} mol dm^{-3}.

(i) Define pH.

....

(1)

(ii) Calculate the pH of a 1.00 mol dm^{-3} aqueous solution of this acid.

(3)

Total 22 marks

TOTAL FOR PAPER: 75 MARKS

END

Centre No.					
Candidate No.					

Paper Reference (complete below)					
				/	

Surname	Initial(s)
Signature	

Paper Reference(s)

6245.01

Edexcel GCE

Chemistry

Advanced Level

Unit Test C5

Specimen Paper

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	

Materials required for examination	Items included with question papers
None	None

Instructions to Candidates

In the boxes above, write your Centre Number and Candidate Number, your surname, initial(s), signature and the paper reference..

Answer **ALL** questions in the spaces provided in this question paper

Show all the steps in any calculations and state the units.

You may use a calculator.

Information for Candidates

The total mark for this paper is 75. The marks for the various parts of questions are shown in round brackets, e.g. **(2)**.

A Periodic Table is printed on the back cover of this booklet.

Advice to Candidates

You are reminded of the importance of clear English and careful presentation in your answers.

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Edexcel
Success through qualifications

1. In an experiment to determine the rate of the reaction between persulphate ions and iodide ions in aqueous solution.

$$S_2O^{2-}_8 + 2I \longrightarrow 2SO^{2-}_4 + I_2$$

The following data were obtained:

Concentration / mol dm^{-3}		Initial rate/ mol dm^{-3} s^{-1}
$S_2O_8^{2-}$	I^-	
0.100	0.100	0.36
0.200	0.100	0.72
0.200	0.200	1.44

(a) (i) Deduce the order of reaction with respect to each of the reagents and hence write the equation for the reaction.

....

....

....

(3)

(ii) With reference to this reaction state what is meant by the **overall order** of a reaction.

....

....

(1)

(iii) Calculate the rate constant including units.

(2)

(iv) Explain why the rate equation cannot be written directly from the stoichiometric equation for the reaction.

....

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(1)

(b) (i) Suggest a suitable experimental technique that would enable you to determine the rate of the reaction given opposite.

....

....

(1)

(ii) Suggest a necessary condition that would help to ensure accurate results.

....

(1)

(iii) Suggest one advantage or disadvantage of your chosen experimental method.

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(1)

Total 10 marks

2. Alkenes undergo electrophilic addition whereas arenes, such as benzene, undergo electrophilic substitution.

(a) What is an electrophile?

....

(1)

(b) Propene, $CH_3CH{=}CH_2$, reacts with HBr to give $CH_3CHBrCH_3$ as the major product.

(i) What is the name of the compound $CH_3CHBrCH_3$?

....

(1)

(ii) Give the mechanism for the reaction.

(3)

(iii) Explain why the major product is $CH_3CHBrCH_3$ rather than $CH_3CH_2CH_2Br$.

....

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(2)

(c) Benzene C_6H_6 reacts with CH_3Br to give $C_6H_5CH_3$.

(i) What catalyst may be used in this reaction?

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(1)

(ii) Give the mechanism for the reaction. You should include the step that forms the electrophile.

(4)

(d) Explain in terms of structure and bonding why benzene and propene react differently with electrophiles.

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(4)

Total 16 marks

3. The following standard electrode potentials will be required in answering this question.

	E^o /V
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	-0.76
$V^{3+} + e^- \rightleftharpoons V^{2+}$	-0.26
$SO_4^{2-} + 2e^- + 2H^+ \rightleftharpoons SO_3^{2-} + H_2O$	+0.17
$VO^{2+} + 2H^+ + e^- \rightleftharpoons V^{3+} + H_2O$	+0.34
$VO_2^+ + 2H^+ + e^- \rightleftharpoons VO^{2+} + H_2O$	+1.00

(a) Give the colours of the following ions:

VO_2^+		VO^{2+}	
V^{3+}		V^{2+}	

(2)

(b) (i) Derive the overall equation for the reduction of VO_2^+ to VO^{2+} by zinc in acidic solution.

....

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(2)

(ii) Give the formula of the vanadium species that would result if VO_2^+ ions were to be reduced by sulphite ions, SO_3^{2-}. Explain your answer using suitable E^o values.

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(3)

(c) Disproportionation requires an element to have at least three oxidation states.

(i) Explain why this is so.

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(1)

(ii) Derive an equation for the disproportionation of VO^{2+} into VO_2^+ and V^{3+}.

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(2)

Total 10 marks

4. (a) Complete the electronic structure of a scandium atom, a copper atom and a Cu^{2+} ion.

		3d					4s
Sc	[Ar]						
Cu	[Ar]						
Cu^{2+}	[Ar]						

(3)

(b) Both scandium and copper are **d-block elements**, but only copper is a **transition element**. Explain the meaning of these two terms.

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....

(2)

(c) Cu^{2+} exists in aqueous solution as the ion $[Cu\ (H_2O_6)]^{2+}$.

(i) Give the name of the $[Cu\ (H_2O_6)]^{2+}$ ion.

....

(1)

(ii) Draw the $[Cu\ (H_2O)_6]^{2+}$ ion so as to clearly show its shape.

(1)

(iii) Explain the origin of the colour in [Cu $(H_2O)_6]^{2+}$.

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(3)

(d) (i) State what you would see if aqueous sodium hydroxide was added drop by drop to a solution of [Cu $(H_2O)_6]^{2+}$ until the sodium hydroxide was in excess.

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(2)

(ii) What type of reaction is occurring in (i)?

....

....

(1)

(e) Pure copper is needed for electrical purposes. The purity of a sample of copper can be found by reacting it with concentrated nitric acid, neutralising the resulting solution and treating it with excess potassium iodide. Iodine is liberated and this can be titrated with standard sodium thiosulphate solution. The reactions are:

$$Cu(s) + 4HNO_3(l) \longrightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

$$2Cu^{2+}(aq) + 4I^-(aq) \longrightarrow 2CuI(s) + I_2(aq)$$

A copper foil electrode from an electric cell weighs 1.74 g. It was made into 250 cm^3 of a solution of copper(II) ions. To 25.0 cm^3 of this solution excess iodide ions were added, and the mixture titrated with 0.100 mol dm^{-3} sodium thiosulphate solution. On average 26.8 cm^3 was required. Calculate the percentage purity of the copper foil.

(6)

Total 19 marks

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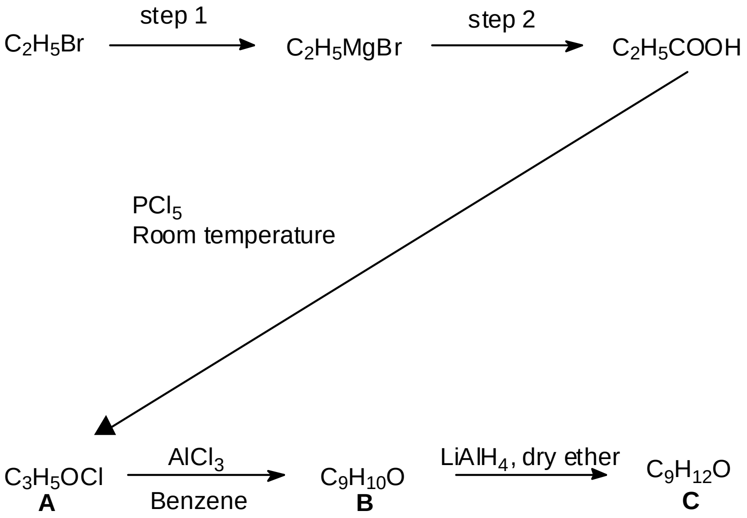
5. Consider the following reaction scheme:



(a) Give the reagents and conditions necessary for:

(i) step 1..

(ii) step 2..

(4)

(b) (i) State and explain one specific safety precaution necessary in performing **step1**.

....

....

(2)

(ii) Draw the apparatus that you would use for performing **step 1**.

(4)

(c) Give the equation for the reaction between propanoic acid and phosphorus pentachloride, making clear the structure of compound **A**.

(2)

(d) Compound **B** reacts with 2,4-dinitrophenylhydrazine but not with ammoniacal silver nitrate solution. Give the structural formula for compound **B** and explain why **B** reacts with 2,4- dinitrophenylhydrazine but not with ammoniacal silver nitrate.

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(3)

(e) (i) Give the structural formula for **C.**

(1)

(ii) State why the ether solvent must be dry in the conversion of **B** to **C**.

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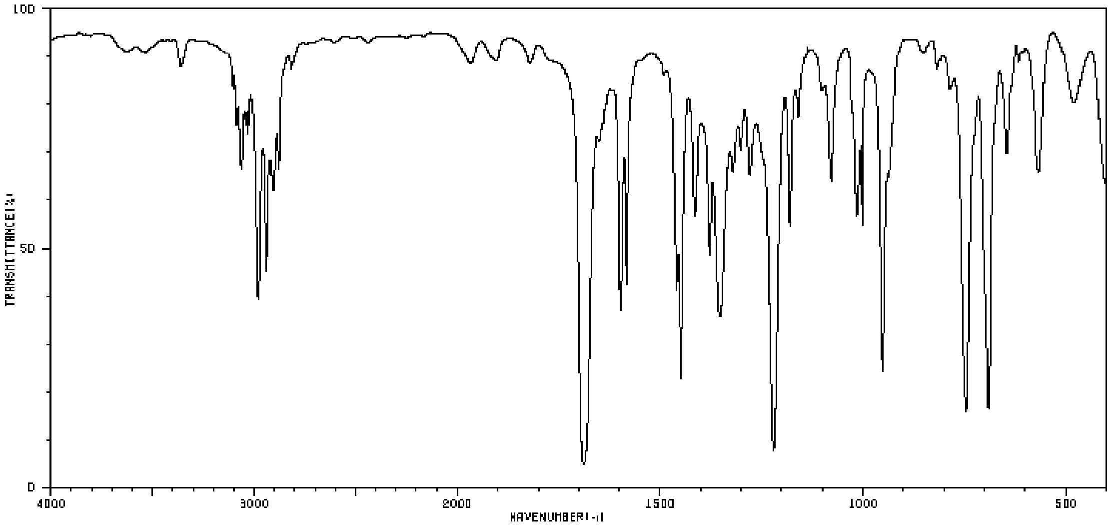
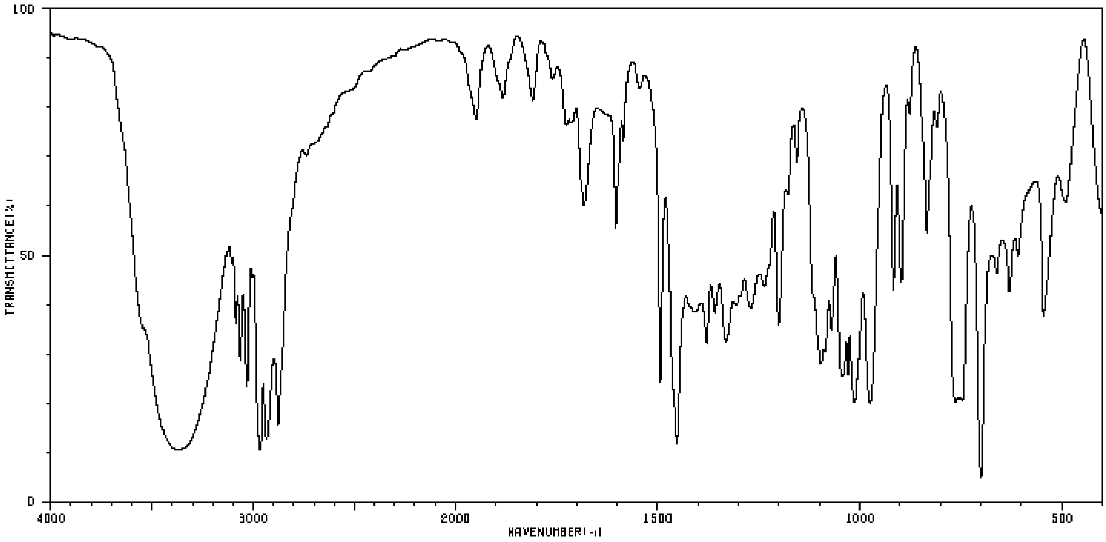
(1)

(f) The infra red spectra of **B** and of **C** are given below, together with a table of infrared absorbencies.

Compound **B:**



Compound **C**:



Infrared absorbencies.

Bond	Assignment	Wavenumbers / cm^{-1}
C-H	Alkanes Alkenes, arenes	2850-2950 3000-3100
C=C	Alkenes	1610-1680
Benzene Ring	Arenes	1450-1650
C=O	Aldehydes, ketones, amides Esters, carboxylic acids	1680-1750
O-H	Free Hydrogen bonded in alcohols or phenols Hydrogen bonded in carboxylic acids	3580-3670 3230-3550 2500-3300

What is the evidence from these spectra for the conversion of the functional group in **B** to that in **C**?

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....

(3)

Total 20 marks

TOTAL FOR PAPER: 75 MARKS

END

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Centre No.						Paper Reference (complete below)						Surname	Initial(s)
Candidate No.										/		Signature	

Paper Reference(s)

6246 B.02

Edexcel GCE

Chemistry

Advanced Level

Unit Test C6B (Synoptic)

Specimen Paper

Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
Answer Book (AB8) Additional Answer Sheet (ASLi) Graph Paper (ASG2)	None

Instructions to Candidates

Answer Section A plus any TWO questions from Section B in the answer book provided.
Complete the front cover of the answer book.
Show all the steps in any calculations and state the units. You may use a calculator

Information for Candidates

The total mark for this paper is 50. The marks for the various parts of questions are shown in round brackets, e.g. **(2)**.
A Periodic Table is printed on the back cover of this booklet.

Advice to Candidates

You must ensure that the answers to parts of questions are clearly numbered.
You are reminded of the importance of clear English and careful presentation in your answers.

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SECTION A

1. (a) One method of preparing ethyl ethanoate (boiling temperature 77 °C) includes the following steps:

- ethanoic acid and ethanol are heated under reflux for about 40 minutes in the presence of a little concentrated sulphuric acid;
- the reaction mixture is then distilled, everything boiling below 85°C being collected;
- the distillate is shaken with 30% aqueous sodium carbonate solution;
- the organic product is treated with anhydrous sodium sulphate or calcium chloride;
- the organic product is redistilled, the liquid boiling between 76°C and 80°C being collected.

Give the reasons for each of these procedures. Include in your answer a diagram of the apparatus for heating under reflux.

(8)

(b) Ethyl ethanoate can also be prepared using the reaction of ethanol with ethanoyl chloride. Suggest with reasons **two** advantages and **one** disadvantage of using this method compared to the method in (a).

(3)

(c) Propylmethanoate, $HCOOC_3H_7$, is an isomer of ethyl ethanoate.
Suggest with reasoning, whether it is possible to distinguish between these two compounds using low resolution n.m.r.

(3)

TOTAL FOR SECTION A: 14 MARKS

Section B

Answer TWO questions from this section.

2. (a) The covalent compound urea, $(NH_2)_2C{=}O$, is commonly used as fertiliser in most of the European Union whereas in the UK the most popular fertiliser is ionic ammonium nitrate, NH_4NO_3. Apart from the nitrogen content, suggest **two** advantages of using urea as a fertiliser compared with using ammonium nitrate.

(2)

(b) The ammonium ion in water has an acid dissociation constant, $K_a = 5.62 \times 10^{-10}$ mol dm^{-3}. The conjugate acid of urea has $K_a = 0.66$ mol dm^{-3}. Use this data to explain which of ammonia or urea is the stronger base.

(2)

(c) Ethanamide, CH_3CONH_2, can be converted into methylamine, CH_3NH_2.

(i) State the reagents and conditions for carrying out the conversion.

(3)

(ii) Suggest the formula of the likely product if urea were used instead of ethanamide in this conversion.

(1)

(d) With gentle heating ammonium nitrate volatilises reversibly.

$$NH_4NO_3(s) \rightleftharpoons NH_3(g) + NHO_3(g) \qquad \Delta H = +171 \text{kJ mol}^{-1}$$

(i) State why the expression for K_p for the reversible change does not include ammonium nitrate.

(1)

(ii) 8.00 g of ammonium nitrate was gently heated in a sealed vessel until equilibrium was reached. The equilibrium constant was found to be 15.7 atm^2 under these conditions. Calculate the partial pressure of ammonia present at equilibrium and, hence, the percentage of the ammonium nitrate which has dissociated.
(One mole of gas under these conditions exerts a pressure of 50 atm).

(5)

(e) Ammonium nitrate can explode when heated strongly.

$$NH_4NO_3(l) \longrightarrow N_2O(g) + 2H_2O(g) \qquad \Delta H = -23 \text{ kJ mol}^{-1}$$

Explain the concepts of thermodynamic and kinetic stability with reference to this reaction.

(4)

Total 18 marks

Turn over

3.(a) (i) Use the idea of electronegativity to explain the nature of the bonding in sodium chloride.

(3)

(ii) Aluminium ions have a radius of 0.053 nm compared with that for the sodium ion of 0.102nm. Suggest why, as a result of this difference, aluminium chloride is covalent rather than ionic.

(2)

(b) Argon does not have a chloride; explain in terms of the energy changes that would be needed to form an ionic chloride why this is so.

(3)

(c) (i) Phosphorus pentachloride is made by the action of excess chlorine gas on white phosphorus, P_4. Give an equation to represent this reaction.

(2)

(ii) Phosphorus pentachloride decomposes on heating just above its sublimation temperature

$$PCl_5(g) \longrightarrow PCl_3(g) + Cl_2(g)$$

Explain whether or not this is a redox reaction.

(3)

(d) Some organic chlorine compounds are used in the manufacture of polyesters by condensation polymerisation.

(i) Give an example of a polyester structure and the structures of suitable reagents that could give rise to the polyester shown.

(3)

(ii) Use the examples given in (i) to explain the term condensation polymerisation.

(2)

Total 18 marks

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Turn over

4. (a) One of the early rocket fuels was hydrazine, H_2NNH_2.

(i) Draw a ‘dot-and-cross’ diagram to show the electronic structure of a hydrazine molecule.

(1)

(ii) Deduce the value for the HNH bond angle in a hydrazine molecule. Explain your reasoning.

(3)

(b) Hydrazine burns in oxygen as follows:

$$H_2N\text{-}NH_2 + (g) + O_2 \longrightarrow N_2\,(g) + 2H_2O\,(g)$$

When 1.00 kg of hydrazine is burnt in excess oxygen 1.83×10^4 kJ of heat energy is released.

Use this and the average bond enthalpies below to calculate the N-N bond enthalpy.

Bond	Bond enthalpy/ kJ mol^{-1}	Bond	Bond enthalpy/ kJ mol^{-1}
N-H	+388	O=O	+496
N=N	+944	H-O	+463

(4)

(c) Hydrazine is a powerful reducing agent in alkaline solution. It is oxidised to nitrogen gas and water.

Vanadium exists in several oxidation states and some of its reduction potentials are listed below.

$VO^{2+}\,(aq) + H_2O(l) + e^- \rightleftharpoons V^{3+}\,(aq) + 2OH^-(aq)$ $E^o = -1.32$ V

$VO^{2+}\,(aq) + H_2O(l) + e^- \rightleftharpoons VO^{2+}\,(aq) + 2OH^-(aq)$ $E^o = -0.66$ V

(i) Deduce the ionic half equation for the oxidation of hydrazine in alkaline solution.

(2)

(ii) Hydrazine will reduce vanadium (V) but not vanadium (IV). What does this tell you about the value of the electrode potential for the reaction that you have written in (c)(i)?

(1)

(iii) Write the overall ionic equation for the reduction of vanadium(V) ions by hydrazine in alkaline solution.

(2)

(d) Hydrazine reacts with carbonyl compounds in a similar way to 2, 4- dinitrophenylhydrazine.

(i) Write an equation for the reaction of hydrazine with propanol showing clearly the structure of the organic product.

(2)

(ii) The organic product in (i) can exist as stereoisomers. Identify the type of stereoisomerism shown and explain why it arises in this compound.

(3)

Total 18 marks

TOTAL FOR SECTION B: 36 MARKS

END

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Centre No.	Paper Reference (complete below)	Surname	Initial(s)
Candidate No.	/	Signature	

Paper Reference(s)

6243.01A

Examiner's use only

Team Leader's use only

Edexcel GCE

Chemistry

Advanced Subsidiary

Unit Test C3A

Specimen Paper

Time: 1 hour 45 minutes

Question Number	Leave Blank
1	
2	
3	
4	
Total	

Materials required for examination
See the Confidential Instructions already issued to centres, relating to this practical test.

Items included with question papers
None

Calculators and any notes or textbooks may be used during this test.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, surname and initials, the paper reference and your signature. The paper reference is shown above.
Answer ALL questions in the spaces provided in this book.

Information for Candidates

The total mark for this paper is 50. The marks for the various questions are shown in round brackets: e.g. **(2)**.

Advice to Candidates

You are reminded that you should take all the usual safety precautions when working in a chemistry laboratory.

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This test is divided into four questions.

Leave blank

In **Question 1** you are required to carry out a series of **qualitative** reactions to identify a Group 1 salt. (9 marks)

In **Question 2** you are required to carry out a **quantitative** exercise to identify a Group 1 metal, **M**, in its hydrocarbonate, $MHCO_3$. (21 marks)

In **Question 3** you are required to carry out a **quantitative** exercise to find the enthalpy change when a Group 1 compound, **Z**, dissolves in water. (13 marks)

In **Question 4** you are required to **plan** an experiment investigating a reaction involving a Group 1 hydrocarbonate, $MHCO_3$. (7 marks)

Question 1

Identification of a Group 1 salt.

You are provided with about 1 g of a Group 1 salt, **W**, which contains one cation and one anion.

Carry out the following tests on, **W**, recording your observations and inferences in the spaces provided.

(a) Add a few drops of dilute, aqueous hydrochloric acid to about half of the sample of **W**, on a watch glass. Carry out a flame test on the solution. In your inference identify the cation.

Observation	Inference

(2)

(b) Dissolve the remaining sample of **W** in about 6 cm^3 of distilled water. Use half of this solution for each of the following tests.

(i) Add 3 drops of aqueous silver nitrate followed by about 3 cm^3 of dilute, aqueous ammonia.

Observations	Inferences

(3)

(ii) Add 6 drops of dilute, aqueous hydrochloric acid followed by 6 drops of aqueous chlorine. Include in your inferences a suggested formula for **W**.

Observations	Inferences

(2)

(iii) Give the name and reagent that reacts with solid **W** and would confirm the identity of the anion in **W**. Describe the observation you would expect to make.

Reagent ....

Observation...

....

(2)

(Total 9 marks)

Question 2

Quantitative exercise to identify a Group 1 metal in its hydrocarbonate.

You are provided with:

- Solution **X**, aqueous $MHCO_3$ of concentration 8.00 g dm^{-3}; where **M** is a group 1 metal;
- Solution **Y**, aqueous sulphuric acid of concentration 0.050 mol dm^{-3}.
- Methyl orange indicator.

You are required to titrate portions of the solution, **X**, with solution **Y**.

$$2MHCO_3(aq) + H_2SO_4(aq) \longrightarrow M_2SO_4(aq) \quad + \quad 2CO_2(g) + 2H_2O(l)$$

PROCEDURE

1. Rinse out, then fill, the burette with solution **Y**.
2. Rinse out the pipette with solution **X**. Transfer 25.0 cm^3 of solution **X** to a conical flask. Add 4 drops of methyl orange to the conical flask.
3. Titrate solution **X** with solution **Y** until the solution in the end-point is reached.
4. Record your burette readings in **Table 1.**
5. Repeat the procedure and attempt to obtain two titres that differ by no more than 0.20 cm^3. Record all your burette readings in **Table 1**.

Table 1

	1	2	3	4	5
Burette reading (final)					
Burette reading (initial)					
Titre / cm^3					

List the numbers of the titrations that you will use to calculate the mean (or average) titre.

Calculate a mean titre.

Write the value of your mean titre in the space below.

……………..cm^3 of solution **Y** reacts with 25.0 cm^3 of solution **X**.

(14)

Calculations and questions.

(a) Calculate the amount (number of moles) of sulphuric acid in the mean titre.

(1)

(b) Calculate the amount (number of moles) of $MHCO_3$ in 25.0 cm^3 of solution **X**.

(1)

(c) Calculate the concentration of $MHCO_3$ in solution **X** in mol dm^{-3}. Use this value to calculate the relative molecular mass of $MHCO_3$ and then identify **M**.

(Relative atomic mass: H=1, Li=7, C=12, O=16, Na=23, K=39, Rb=85, Cs=133.)

(3)

(d) When properly used, the pipette used in the experiment will deliver a volume of solution **X** within 0.5 % of 25.0 cm^3. Suggest two techniques which a student should follow when using the pipette to ensure that the volume delivered is within 0.5 % of 25 cm^3.

Technique 1 ....

....

Technique 2 ....

....

(2)

(Total 21 marks)

Question 3

Leave blank

Quantitative exercise to find the enthalpy change when a Group 1 compound dissolves in water.

You are provided with:

- a sample of a Group 1 compound, **Z**, in a specimen tube.

You are required to find the molar enthalpy change when **Z** dissolves in water.

$$Z(s) + aq \longrightarrow Z(aq)$$

PROCEDURE

1. Rinse out a 50 cm^3 measuring cylinder with distilled water, then use the measuring cylinder to measure 50 cm^3 of distilled water into a dry plastic cup held firmly in a beaker. Place the thermometer in the distilled water in the cup.
2. Weigh the specimen tube containing **Z**. Record the mass of the tube and **Z** in **Table 2.**
3. Measure the temperature of the distilled water in the cup to the nearest 0.2 °C. Record the temperature in **Table 3**.
4. Empty the sample of **Z** from the specimen tube into the plastic cup, stirring gently with the thermometer. (The accuracy of your results will not be affected if a small amount of **X** is left in the tube.) Continue stirring until all of the solid has been dissolved then record the steady temperature of the solution to the nearest 0.2 °C. Record the temperature in **Table 3**.
5. Weigh the emptied tube and record the mass in **Table 2**.

Table 2

Mass of specimen tube + **Z**	g
Mass of emptied specimen tube	g
Mass of **Z** used	g

(2)

Table 3

Temperature of distilled water before adding **Z**, T_1	°C
Steady temperature of solution, T_2	°C

Calculate the change in temperature, ΔT, by subtracting T_1 from T_2.

$\Delta T = T_2 - T_1 =$ …………………………….. =……………… °C

(6)

Calculations and questions

(a) Calculate the molar enthalpy change when **Z** dissolves in water using the formula.

$$\Delta H = - \frac{21.1 \times \Delta T}{\text{Mass of } \mathbf{Z} \text{ used}} \text{ kJ mol}^{-1}$$

Include a sign and units with your value of ΔH which should be expressed to an appropriate number of significant figures.

ΔH=

(3)

(b) Suggest a change to the procedure, using the same apparatus that may lead to a more accurate value of the molar enthalpy change. Explain the reason for your suggestion.

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(2)

(Total 13 marks)

Question 4

Planning an experiment to find the relative molecular mass of a Group 1 hydrogencarbonate.

When a solid group 1 hydrogencarbonate reacts with dilute, aqueous sulphuric acid carbon dioxide is evolved.

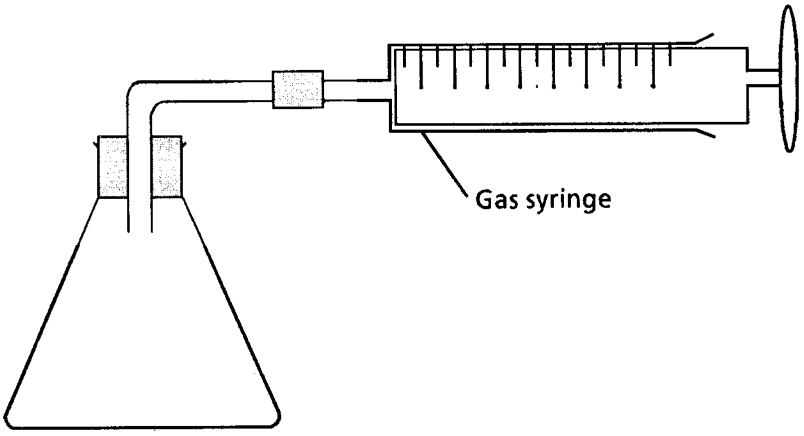
$$2MHCO_3(s) + H_2SO_4 \longrightarrow M_2SO_4(aq) + 2CO_2(g) + 2H_2O(l)$$

You are required to plan an experiment **using the apparatus shown below,** the results of which may be used to calculate the relative molecular mass of the hydrogencarbonate and identify **M**. Assume that you are provided with a sample of the hydrogencarbonate and a volume of acid (an excess); these will react to give a volume of carbon dioxide slighty less than the capacity of the gas syringe.

You must include in your plan:

- The procedure and measurements you would take;
- Details of how the results would be used to calculate the relative molecular mass of the hydrogencarbonate and identify **M** (but do not invent actual results);
- A discussion of the likely errors and the significance of these in identifying **M**;
- One safety measure and the reason for it.

You will need to make use of the fact that at the temperature of the experiment 1 mole of carbon dioxide occupies a volume of 24.0 dm^3.
(Relative atomic mass: H=1, Li=7, C=12, O=16, Na=23, K=39, Rb=85, Cs=133.)



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(7)

(Total 7 marks)

TOTAL FOR PAPER: 50 MARKS

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Centre No.					
Candidate No.					

Paper Reference (complete below)						
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Surname	Initial(s)
Signature	

Paper Reference(s)

6246.01A

Edexcel GCE

Chemistry

Advanced Level

Unit Test C6A

Specimen Paper

Time: 1 hour 45 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
Total	

Materials required for examination

See Confidential Instructions already issued to centres relating to this practical test.

Calculators and any notes or textbooks may be used during this test

Items included with question papers

Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature and the paper reference number.

Answer **ALL** the questions in the spaces provided in this question paper.

Show all the steps in any calculations and state the units.

Information for Candidates

The total mark for this paper is 50. The marks for the various parts of questions are shown in round brackets, e.g. **(2)**.

You may use a calculator

Advice to Candidates

You are reminded that you should take all usual safety precautions when working in a chemistry laboratory.

Turn over

Printer's Log No.

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This test is in four questions. You are required to:

In **question 1** to carry out a series of tests on compound **A** in order to identify the two cations and one anion in **A.** (16 marks)

In **question 2** to carry out a series of tests on an organic compound **B**, C_9H_8O, in order to suggest possible identities for **B.** (13 marks)

In **question 3** to plan an exercise to confirm the identity of **B.** (8 marks)

In **question 4** to measure the boiling temperature of the liquid product, **C**, of the reduction of **B**. (13 marks)

Question 1

Tests on A

(a) (i) Add 3 cm^3 of aqueous sodium hydroxide to a spatula measure of **A** in a test tube. Gently warm the test tube. After removing the test tube from the Bunsen flame, carefully smell any gas evolved. Carry out a simple test to confirm the identity of the gas.

Observations	Inferences

(3)

Dissolve the remaining sample of **A** in 10 cm^3 of distilled water. Use this solution for the tests which follow.

(ii) To 2 cm^3 of aqueous **A,** add 6 drops of aqueous barium chloride followed by 10 drops of dilute hydrochloric acid.

Observations	Inferences

(3)

(iii) To 2 cm^3 of aqueous **A**, add dilute aqueous ammonia drop by drop until the test tube is about half full. The ammonia will then be in excess.

Observations	Inferences

(3)

(iv) To 2 cm^3 of aqueous **A,** add 10 drops of aqueous potassium iodide followed by 6 drops of aqueous starch.

Observations	Inferences

(3)

(v) Suggest the formulae of the two cations and one anion in **A**.

Cations .... and ....

Anion ....

(2)

(vi) Give the name of the type of reaction which occurs in (iv) when aqueous potassium iodide is added to **A**. Write an **ionic** equation to represent the reaction.

Type of reaction ....……………………………………

Ionic equation ....…………..

(2)

(Total 16 marks)

Question 2

Tests on B

(b) Carry out the tests listed below on the organic compound **B**, C_9H_8O. **B** has two functional groups. Record the results of your tests in the 'Observations' spaces. Under 'Inferences' record the functional group, by name or formula, the presence of which may be suggested by your observations. You are not expected to attempt to identify **B** in your inferences.

(i) Using a dropping pipette, transfer 10 drops of **B** to a crucible. Carefully ignite **B**.

Observations	Inferences

(2)

(ii) To 1 cm^3 of **B,** add 8 drops of an aqueous solution of potassium manganate(VII) acidified with dilute sulphuric acid. Stopper and gently shake the test tube.

Observations	Inferences

(3)

(iii) To 2 cm^3 of **B,** add 8 drops of aqueous bromine. Stopper and gently shake the test tube.

Observations	Inferences

(2)

(iv) To 4 drops of **B,** add 2 cm^3 of aqueous 2, 4–dinitrophenylhydrazine. Stopper and shake the test tube gently.

Observations	Inferences

(2)

(v) Mix 2 cm^3 of each of Fehling's solutions 1 and 2. Add 6 drops of **B**. Heat the Test tube in a water bath at about 80 ºC.

Observations	Inferences

(2)

(vi) On the evidence of the tests carried out write structures for **two** isomers of **B**.

Structure 1 Structure 2

(2)

(Total 13 marks)

Question 3

If the product of the reaction that takes place in question 2 (b) (iv) is purified it may be used to obtain information that would allow you to decide if **B** has either one of the structures which you have drawn in (vi).

Devise an experimental procedure by which you could obtain this information. In your answer, give the names of any practical techniques and materials that you plan to use. Outline your planned procedure including any references to safety considerations involved in the technique and the materials you will use. Explain how you would use the information you obtain in an attempt to identify **B**.

You are not expected to carry out your planned procedure.

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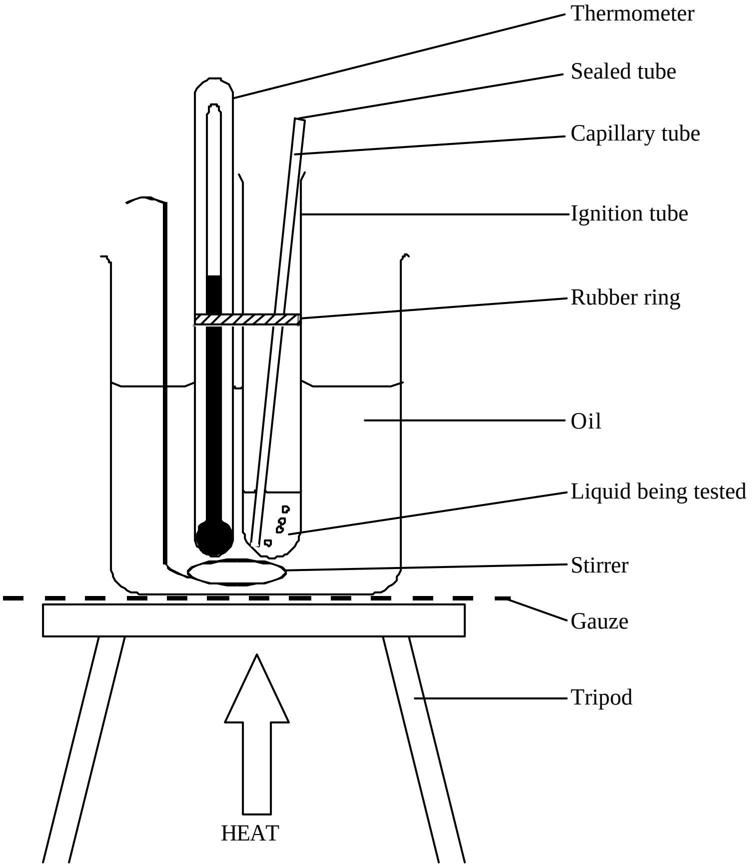
(8)

(Total 8 marks)

Question 4

In this part of the exercise you are to measure the boiling temperature of a liquid **C** and use the data to identify **C**.

Procedure for measuring the boiling temperature of liquid C.



Place liquid **C** in one of the clean dry ignition tubes to a depth of between 0.5 and 1.0 cm. Fix the tube to the side of the thermometer, with the liquid next to the bulb, using one of the rubber rings. Clamp the thermometer with the bulb in the oil as shown in the diagram above. Add a new capillary tube, sealed at one end, to the liquid in the ignition tube with the **open end** below the surface.

As the oil is heated and the temperature of the liquid is raised, air in the capillary tube expands and small bubbles **slowly** issue from the open end of the capillary tube: when the liquid boils the stream of bubbles is rapid and continuous.

Heat the oil bath to about 70 ºC, then, whilst stirring, raise the temperature of the oil by about 3 ºC per minute until the liquid in the ignition tube starts to boil. Stop heating **immediately** and record the temperature of the oil in the results table below. Continue to stir the oil as it cools and, as soon as bubbles cease to issue from the capillary tube, record the temperature in the results table. The second temperature is usually a more reliable figure for the boiling temperature than the first one.

Results table

	Temperature rising / °C	**Temperature falling / °C**
Boiling temperature of liquid **C**		

Use the table of boiling temperatures below to decide the identity of compound **C.**

Name	Structure	Boiling Temp / °C
Butan-1-ol	$CH_3CH_2CH_2CH_2OH$	117
Butan-2-ol	$CH_3CH_2CH(OH)CH_3$	99.5
2 methyl propan-1-ol	$CH_3CH(CH_3)CH_2OH$	108
2 methyl propan-2-ol	$CH_3C(OH)(CH_3)CH_3$	82.5

(i) Identify C……………………………………………………………….

(ii) Comment on the accuracy of the technique you used to find the boiling temperature of **C** and suggest how a more accurate value could be found.

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………………………………………………………………………………………

(13)

(Total 13 marks)

TOTAL FOR PAPER: 50 MARKS

END

Mark Scheme for Specimen Paper

Unit Test C1

1 (a) (i) $2s^22p^63s^23p^4$ **(1)** **[1]**

(ii) Protons = 16 **(1)** Neutrons = 18**(1)** **[2]**

(b) (i)
- Energy change when 1 mole**(1)**
- Of gaseous atoms**(1)**
- Gains 1 electron per atom**(1)** **[3]**

(ii)
- Electron and anion both negative**(1)**
- Repulsion occurs**(1)** **[2]**

Total 8 marks

2. (a) (i) electron configuration or $3d^64s^2$ or $4s^2$ or number of **outer** electrons **(1)** **[1]**

(ii) atoms of the same element **(1)** that have different numbers of neutrons**(1)**

or

atoms with the same number of protons **(1)** but different numbers of neutrons**(1)** **[2]**

(b) (i)
A ionisation (not vaporisation)**(1)**
B acceleration**(1)**
C deflection**(1)**
D detection**(1)** **[4]**

(ii) $\frac{(5.80 \times 54) + (91.6 \times 56) + (2.20 \times 57) + (0.40 \times 58)}{100}$ **(1)**

= 55.91**(1)** **[2]**

Total 9 marks

3 (a) (i) Mol of Ca used = 0.17/40 **(1)**
$= 4.25 \times 10^{-3}$
Volume of hydrogen produced =
$4.25 \times 10^{-3} \times 24000$ **[2]**
$= 102\ cm^3$ **(1)**

(ii) $4.25 \times 10^{-3} \times 6.0 \times 10^{23}$ molecules **[1]**
$= 2.55 \times 10^{21}$ **(1)**

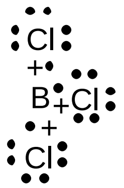
(b) Increases as group is descended**(1)** **[1]**

(c) (i) $Ca_{(g)} \longrightarrow Ca_{(g)}^{+} + e^{-}$
1 mark for formulae and charges
1 mark for state symbols **[2]**

(ii)
- Decreases as group is descended**(1)**
- Because although there is an increase in nuclear charge**(1)**
- The electron being removed is further from the nucleus**(1)**
- And more shielded from the nuclear charge**(1)** **[4]**

Total 10 marks

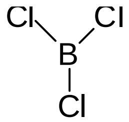
4 (a)



(1)

Must show all the outer electrons around the chlorine
Do not have to be · and + **[1]**

(b) (i)



(1) **[1]**

(ii) The (three) bonding (electron) pairs **(1)**
repel as far apart as possible / position of minimum repulsion **(1)** **[2]**

(c) (i) Power (of an atom) to attract (the pair of) electrons **(1)**
in a covalent bond / bonding pair **(1)**
n.b. could answer question by comparing the electronegativities of the B and Cl **[2]**

(ii) Bonds arranged symmetrically / molecule symmetrical / bond polarities directional / are vectors **(1)**
Bond polarities cancel **(1)** **[2]**

Could be shown as a diagram

Total 8 marks

5 (a) (i) H_2SO_4: +6 / VI **(1)**
H_2S: -2 **(1)**
SO_2: +4 / IV **(1)** **[3]**

(ii) Iodide has greater reducing power **(1)**
reduces sulphur by more oxidation numbers / or correctly uses their numbers from part (i) / or an 'electron gain' type argument **(1)** **[2]**

(b) (i) $2Cl^- \rightarrow Cl_2 + 2e^-$ or $Cl^- \rightarrow \frac{1}{2}Cl_2 + e^-$
or
$2Cl^- - 2e^- \rightarrow Cl_2$ **(1)** **[1]**

(ii) $OCl^- + 2H^+ + 2e^- \rightarrow Cl^- + H_2O$ **(2)**
Or $OCl^- + 2H^+ \rightarrow Cl^- + H_2O - 2e^-$
all species **1 mark**, balancing **1 mark** **[2]**

(iii) $OCl^- + 2H^+ + Cl^- \rightarrow Cl_2 + H_2O$ **(1)**
State symbols **(1)** **[2]**

Total 10 marks

6	(a)	(i)	Sodium has one outer electron that is delocalised into a sea of electrons others have more **(1)**. Na^+ smallest charge/ ion comparison of the charges on the three ions **(1)** Therefore weaker attraction between sodium cation and delocalised electrons hence lower melting temperature **(1)**	**[3]**
		(ii)	Both held by van der Waals forces that depends on the number of electrons **(1)** P_4 has less than S_8 hence S_8 has a higher melting temperature. **(1)**	**[2]**
	(b)	(i)	*Structure* - giant or macro + atomic / molecular/ covalent **(1)** *Bonding* - covalent **(1)** (ignore reference to vdW) *Diagram* - layers **(1)** of flat hexagons **(1)** (min of 2 hexagons correctly joined for the 'hexagon' mark)	**[4]**
		(ii)	*Structure* – lattice / giant ionic / cubic (allow face centred cubic) **(1)** *Bonding* - Ionic **(1)** *Diagram* – lattice of alternate clearly identified / Na^+ and Cl^- ions, must imply 3-D. **(1)**	**[3]**
	(c)	(i)	Delocalised or sea of electrons between layers**(1)** Which can flow/move **(1)**	**[2]**
		(ii)	Ions (free to) move / mobile (in liquid state) **(1)**	**[1]**

Total 15 marks

Paper total 60 marks

Mark Scheme for Specimen Paper

Unit Test C2

1 (a) (i) any **one** from
concentration
pressure
surface area / particle size **[1]**

(ii) Pressure/ concentration:
Increase of pressure / concentration increases rate **(1)**
The particles are closer together therefore more collisions / more collisions per unit volume per unit of time **(1)**
Allow more 'frequent' collision

Or
Surface area:
Increase in surface area increase the rate **(1)**
More collisions on surface of solid /more surface available for collisions **(1)** **[2]**

(b) (i) Similar curve with peak further **to the right (1)**
and **lower** maximum**(1)** **[2]**
Max 1 mark if second line crosses the first more than once or crosses axis

(ii) vertical line placed **to the right** of both of the peaks **(1)** **[1]**

(iii) (At higher temperature average kinetic) energy of molecules is greater **(1)**
More molecules / collisions have energy greater than / equal to the activation energy **(1)**
∴ more collisions are effective/ result in reactions **(1)** **[3]**

Total 9 marks

2 (a) *Dynamic:*
reaction occurring in both directions **/** rate of forward reaction and reverse reactions equal **(1)**

Equilibrium:
constant concentrations **/** no change in macroscopic properties **(1)** **[2]**

(b) (i) Higher yield of ammonia / (equilibrium position) moves to. r.h.s **(1)**
Fewer product molecules **(1)** **[2]**

(ii) Lower yield of ammonia / (equilibrium position) moves to l.h.s. **(1)**
since this absorbs heat/ shift in endothermic direction / the reaction is exothermic **(1)** **[2]**

(c) (i) 350 - 500°C / 623 – 773K **[1]**

(ii) High temp favours high rate **(1)** } Or reverse argument
Low temp favours good yield **(1)** }
Temperature used of 350-500°C compromise / balance between yield and rate **(1)** **[3]**
consequential on first two points correct

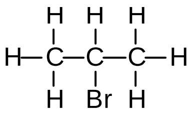
(d) (i) Iron (not Fe) **(1)** **[1]**
ignore references to oxides

(ii) Provides **alternative pathway** / route
or
Explanation of what happens at the surface**(1)**
of lower activation energy **(1)** **[2]**
Second mark consequential on the first

Total 13 marks

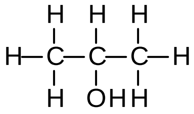
3 (a) (i) HBr (name or formula) **(1)**
gas phase or inert / organic solvent **(1)** **[2]**

(ii)



Or $CH_3CHBrCH_3$ **(1)** **[1]**

(b) (i)

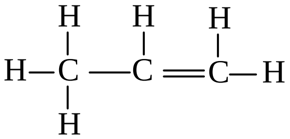


Or $CH_3CH(OH)CH_3$ **(1)**
This mark is **not** consequential on (a)(ii) i.e. this is the only acceptable answer **[1]**

(ii) electrophilic**(1)** addition **(1)**
nucleophilic **(1)** substitution/ hydrolysis **(1)** **[4]**
All marks stand alone in this part of the question

(c) Concentrated sulphuric acid / phosphoric acid / aluminium oxide **(1)**
Heat/ 170°C for sulphuric acid / 70 °C for phosphoric acid **(1)** **[2]**

(d)



(1) **[1]**

Total 11 marks

4 (a) M_r 2-bromobutane = 137 **(1)**
moles = 13.7/137 = 0.10 **(1)** allow 0.1
moles KOH = 9.0/56 = 0.16 (0.1607 or 0.161) **(1)**
KOH present in excess consequential **(1)** **[4]**

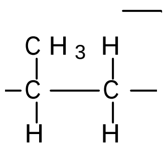
(b) lone pair donor / electron pair donor / lone or electron pair can form co-ordinate / dative bond **(1)**
hydroxide ion / OH^- **(1)** **[2]**

(c) rate increased **(1)**
C-I bond weaker (than C-Br bond) / lower bond energy **(1)** **[2]**

Total 8 marks

5 (a) Group of compounds with the same general formula **(1)** that differ by $-CH_2-$ **(1)**
Same or similar **chemical** properties / same functional group **(1)** **[3]**

(b)



$$\left[-\overset{CH_3}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}- \right]$$

At least one repeat unit and evidence of extension of chain **(1)** **[1]**

(c) Different chain lengths / areas of crystalline and amorphous structure **(1)** **[1]**

(d) (i) C-F bond strong/ high bond enthalpy/ bond not easily broken/ steric hindrance by fluorines around carbon **(1)** **[1]**

(ii) Non-stick coatings e.g. in saucepans, in pipes, on skis, stain-proofing of fabrics, waterproof clothing. **(1)** **[1]**

(e) **Only** single/ sigma bonds in ethane **(1)**
Allow saturated as an alternative to 'only', but types of bonds must also be mentioned
Ethene **also** has π bond **(1)**
π bond weaker (and breaks) / electrons in π bond more accessible **(1)** **[3]**

Total 10 marks

6 (a) Enthalpy or heat change per mole **(1)**
For complete combustion **(1)**
At 1atm pressure and specified temperature **(1)** **[3]**

(b) (i) *Bonds broken:*
5C-H+C-O+O-H+3O=O = +4371 **(1)**
Bonds made:
4C=O + 6O-H = -5750 **(1)**
ΔH = +4371-5750 = -1379 kJ mol^{-1} **(1)**
[3]

(ii) Exothermic **(1)**
Energy barrier **(1)** **[3]**
Fully labelled **(1)**

Total 9 marks

Paper total 60 marks

Mark Scheme for Specimen Paper

Unit Test C3B

1 (a) (i) Potassium / K^+ **(1)**
not K **[1]**

(ii) oxygen / O_2 **(1)**
KNO_3 / $KClO_3$ / KO_2 **(1)**
Do not allow K_2O **[2]**

(b) (i) carbon dioxide / CO_2 **(1)**
hydrogen / H^+ / H_3O^+ **(1)** **[2]**

(ii) barium sulphate / $BaSO_4$ **(1)**
sulphuric acid / H_2SO_4 **(1)** **[2]**

(c) Yellow / orange / brown *(not red alone)* **(1)**
to colourless / decolourised **(1)**

steamy fumes / steamy vapour / misty fumes **(1)**
litmus turns red **(1)** *if candidates then go on to say the litmus is bleached score zero for litmus test*

orange **(1)** to green **(1)** **[6]**

Total 13 marks

2 (a) *Note* ***1 mark*** *for improvement* ***1 mark*** *for related reason in each case to* ***max 4 marks.*** *Reason must relate to improvement. Max 2 for improvement max. 2 for reason.*

Improvement Insulate beaker/polystyrene cup/plastic cup/use lid **(1)**

Reason Prevents/ reduces heat loss or absorbs less heat **(1)**

Improvement Use pipette/ burette **(1)**

Reason More accurate (than measuring cylinder) **(1)**

Improvement Measure temperature for several minutes before the addition **(1)**

Reason Allows more accurate value for the initial temperature **(1)**

Improvement Measure temperature more often **(1)**

Reason Allows for better extrapolation/ more accurate temperature change from graph **(1)**

Improvement	Read thermometer to 1dp **/**use more precise thermometer/digital thermometer **(1)**
Reason	Gives more accurate temperature change**(1)**
Improvement	Stir mixture**(1)**
Reason	Ensure even temperature/reaction faster less heat loss with time**(1)**
Improvement	Use finely divided iron/smaller pieces **(1)**
Reason	Reaction faster less heat loss with time **(1)** not speeds up alone

[4]

(b) (i) Heat change = 50.0 x 4.18 x 15.2J**(1)**
= 50.0 x 4.18 x 15.2 / 1000kJ
= 3.18kJ or 3180J **(1)**
Ignore sig. fig. Allow 1 mark for correct answer with no working **[2]**

(ii) Number of mols of copper sulphate =
50.0 x 0.500 / 1000
= 0.025 **(1)** **[1]**

(iii) Enthalpy change per mol = 3.18/.025 = -127kJ**(1)**
negative sign **(1)***stand alone*
consequential on (i) and (ii)
max. 4 sig. fig and answer must be in kJ mol^{-1} *even if units omitted.* **[2]**

Total 9 marks

3 (a) diagram 1 (heating under) reflux **(1)**
diagram 2 distillation **(1)** *allow fractional distillation* **[2]**

(b) (i) reaction is slow / time needed for reaction to reach completion **(1)** **[1]**

(ii) condenses vapours and returns liquid to flask / vapour turns to liquid and returns to flask**(1)**
(it allows reaction at boiling point of reactants) without loss / escape of material/reactants
prevents loss/escape of materials/reactants/products **(1)** **[2]**

(c) heat the mixture (slowly) **(1)**
collect **only** fraction/distillate **(1)**
produced at 102 °C / around 102 °C **/** between 100 -104°C **(1)**
Need to make clear that only distillate at this temperature is collected e.g. rest discarded for second mark **[3]**

(d) (i) $\frac{3.1}{7.2}$ **(1)** x 100 = 43.1% **(1)** Allow 2-4 significant figures **[2]**

(ii) **two** reasons from:
side reactions **(1)**
reaction incomplete **(1)** **max [2]**
product lost in purification / transfers **(1)**

(e) (i) AgBr **(1)** **[1]**

(ii) $CH_4H_9Br + H_2O \rightarrow C_4H_9OH + H^+ + Br^-$

$CH_3CH_2CH_2CH_2Br + H_2O \rightarrow CH_3CH_2CH_2CH_2OH + H^+ + Br^-$
OH^- $+ Br^-$ **(1)** **[1]**

(iii) Reaction very slow at room temperature / heat speeds up the reaction /increases rate / flammable **(1)** **[1]**
Do not allow constant temp.

Total 15 marks

4 (a) (i) $\frac{0.25}{97}$ = 0.00258 / 2.58 x 10^{-3} / 0.0026 / 0.002577 **(1)** **[1]**

(ii) 0.00258 / *same number of moles as calculated in (i)* **(1)**

0.00258 x $\frac{1000}{23.45}$ **(1)** = 0.110 (mol dm^{-3}) **(1)** *units not required*
consequential on (i) **[3]**

(b) $\frac{2 \times 0.01 \times 100}{0.25}$ = 8% **(1)** **[1]**

(c)

W	Weighing	must be evidence of two weightings at some point in the process **(1)**
P	Preparation	Rinsing out one piece of relevant apparatus correctly **(1)**
D	Dissolve	Dissolve in water in beaker / volumetric flask **(1)**
R	Rinse	Rinse beaker and add washing to volumetric flask / rinse funnel (if solid straight to volumetric flask) **(1)**
V	Volumetric flask	Volumetric / standard / graduated flask **(1)** DO NOT AWARD IF CANDIDATE USES VOLUMETRIC FLASK TO MEASURE OUT 250 cm^3
M	250 cm^3	Making up to mark / exactly 250 cm^3 of solution **(1)**

Max 5 marks

S Shake Shake / invert / mix final solution **(1)** *n.b. this is at end*

C concentration = $\frac{\text{mass of sulphamic acid}}{97 \text{ (or Mr)}} \times \frac{1000}{250}$ **(1)**

H Safety
(solution of) acid is corrosive wear gloves **(1)** **[8]**

Total 13 marks

Paper total 50 marks

Mark Scheme for Specimen Paper

Unit Test C4

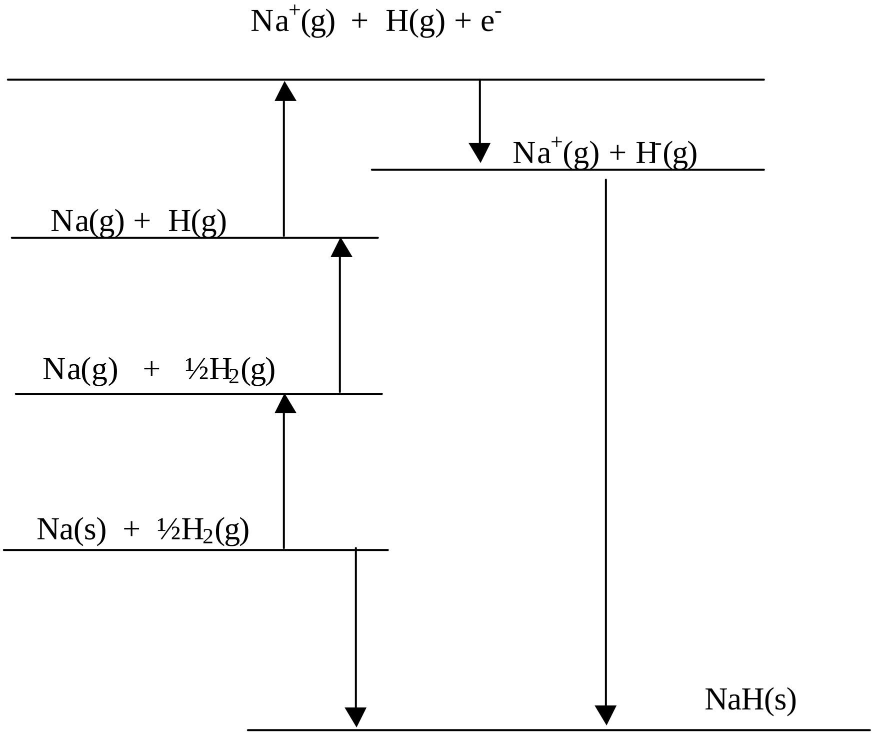
1 (a) (i) Lattice Energy –heat energy released **(1)**
when gaseous ions **(1)**
(come together to) form 1 mole solid / crystal / lattice **(1)** **[3]**

(ii) Enthalpy of Atomisation - heat energy change for the formation of one mole of gaseous atoms **(1)**
from an element in its standard state **(1)**
if state or imply exothermic max 1 **[2]**

(b) (i) correct step shown **(1)** *must identify* ***change*** **[1]**

(ii) +150 + 736 + 1450 + (2x121) + 642 = 3220
= 2493 + 2x **(1)**
2x = 727
x = -364 **(1)** sign vital **[2]**

(c)



Marking points on cycle

- all correct species and steps plus state symbols where crucial **(1 mark)**

n.b. crucial steps Na (s) to Na (g) + gaseous ions to solid NaH

- complete cycle **(1 mark)**
- ½H_2 to H **(1 mark)**

n.b. the whole cycle could be doubled to give 2 x electron affinity **[3]**

n.b. an energy diagram as above is not essential any correct cycle in any representation is equally acceptable

Total 11 marks

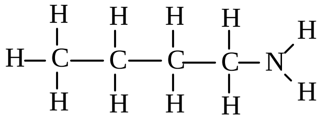
2 (a) (i) *n.b. if H omitted penalise only once in this question*

$CH_3CH_2CH_2CN$ **[1]**

(ii) $LiAlH_4$ / $NaBH_4$ / Na + C_2H_5OH / H_2 + Ni or Pt catalyst / zinc plus acid **(1)**

Name or correct formula **[1]**

(iii)

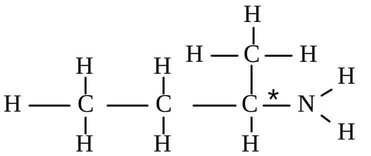


(1)

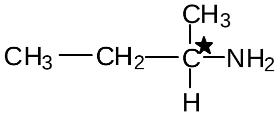
not $CH_3CH_2CH_2CH_2NH_2$

consequential on (i) **[1]**

(b)

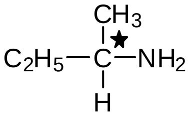


Allow



$CH_3-CH_2-\overset{CH_3}{\underset{H}{C^{\bigstar}}}-NH_2$

or



$C_2H_5-\overset{CH_3}{\underset{H}{C^{\bigstar}}}-NH_2$

(1+1) **[2]**

(c) (i) lone pair of electrons on the N atom **(1)** **[1]**

(ii) $C_4H_9NH_2 + H^+ \longrightarrow C_4H_9NH_3^+$ **(1)**

not consequential on (b)/ allow molecular equation **[1]**

allow RNH_2

[1]

(d) (i) amide **(1)**

(ii) faster / more control / better yield / not equilibrium / no need to heat **(1)** **[1]**

(e) PCl_5 / PCl_3 / $SOCl_2$ **(1)** *or name* **[1]**

(f) Make a Grignard reagent using magnesium **(1)**

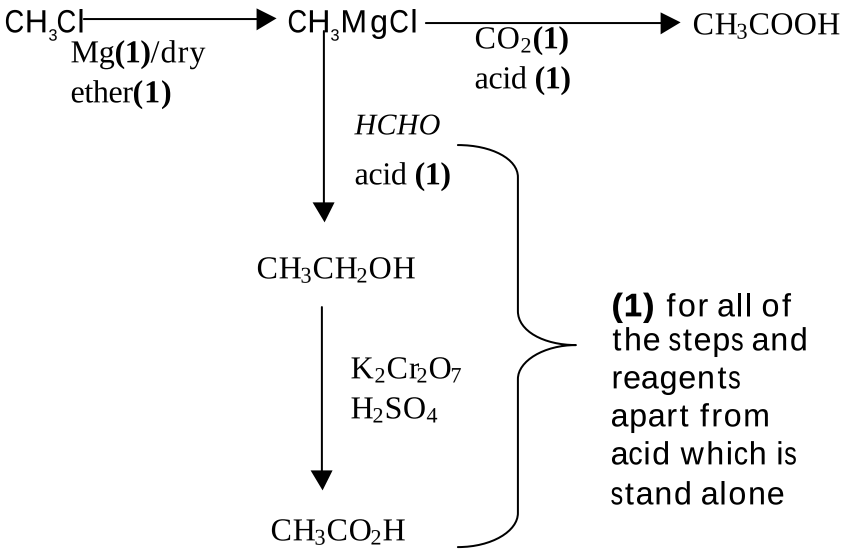
in dry ether **(1)** *not stand alone mark*

react this with (solid) CO_2 **(1)**

then hydrolyse with acid / + acid / + H^+ / + HCl **(1)** *not stand* *alone*

Alternative routes are possible

Or



(1) for all of the steps and reagents apart from acid which is stand alone

[4]

Total 14 marks

3 (a) (i) CO_2 / SiO_2 **(1)**

(ii) PbO / PbO_2 / SnO / SnO_2 **(1)** *allow GeO* **[2]**

(b) (i) Reacts with both acids and bases / can act as both an acid or a base / has both acidic and basic properties or characteristics **(1)** **[1]**

(ii) $Al_2O_3\,(s) + 6H^+\,(aq) \longrightarrow 2Al^{3+}\,(aq) + 3H_2O\,(l)$ **(1)**
Balanced and ionic
$Al_2O_3 + 6OH^- + 3H_2O \rightarrow 2Al(OH)_6^{3-}$ /
$Al_2O_3 + 2OH^- \rightarrow 2AlO_2^- + H_2O$ /
$Al_2O_3\,(s) + 2OH^-\,(aq) + 3H_2O\,(l) \longrightarrow 2Al(OH)_4^-\,(aq)$ **(1)**

Evidence of understanding of meaning of amphoteric **(1)**
i.e. two equations, one with H^+ *and one with* OH^- **[3]**

(c) $NaCl + H_2O \longrightarrow Na^+ + Cl^-$ **(1)**
do not penalise omission of water
Ionic chlorides dissolve without hydrolysis / no hydrolysis has occurred the bonding is ionic **(1)**
$PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl$ /
$PCl_5 + H_2O \longrightarrow POCl_3 + 2HCl$ **(1)**
The bonding is covalent in the chloride and hydrolysis occurs with water / covalent chlorides react with water to give an acidic solution. **(1)** **[4]**

(d) (i) Two layers formed / no reaction / nothing / immiscible **(1)** **[1]**

(ii) (Violent) reaction / hydrolysed **(1)**
Identification of one product / description of one product **(1)**
e.g. steamy fumes / white fumes / white solid / gas / named product **[2]**

(iii) The reaction takes place by the interaction of the **lone pair** of electrons on the water **(1)**

Bonding to central (silicon/carbon) atom / attaching to central atom **(1)**

In silicon the **3d** orbital is available to accept the pair of electrons **(1)**

In carbon no similar orbital is available / not enough energy available to utilise vacant carbon orbitals / carbon surrounded by chlorine atoms causing steric hindrance **(1)**

[4]

Total 17 marks

4 (a) (i) fraction of the total pressure generated by a gas **(1)** **[1]**

(ii) $K_P = \dfrac{p(CO) \times p(H_2)^3}{p(CH_4) \times p(H_2O)}$ **(1)** **[1]**

(iii) Increase in total pressure will result in less product molecules in the equilibrium mixture / equilibrium moves to left **(1)**
because more molecules on product side of the equilibrium than on left hand /reactant side **(1)** **[2]**

(b) (i) No change **(1)** **[1]**

(ii) K_p increase **(1)** **[1]**

(iii) No change **(1)** **[1]**

(c) (i) $K_P = \dfrac{1}{p(CH_4)}$ **(1)** **[1]**

(ii) 9.87×10^{-3} kPa^{-1} **(1)** **[1]**

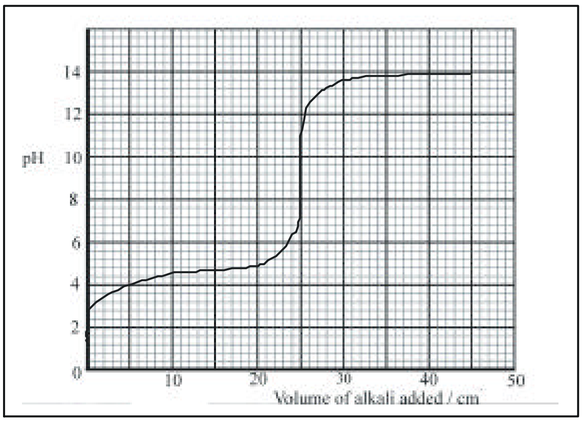
(iii) equilibrium has moved left **(1)**
exothermic as written /in the forward direction **(1)** **[2]**

Total 11 marks

5 (a) only partially dissociated / ionised **(1)**
into H^+ ions / H_3^+O / proton donor **(1)** **[2]**

(b) (a solution that) resists change in pH / retains an **almost constant** pH **(1)**
on addition of **small** quantities of acid or alkali **(1)** **[2]**

(c)



Marking points
General shape **(1)**
Vertical section at 25 cm^3 **(1)**
End point around pH 9 and vertical between about 7 to 11 **(1)**
Starting point at 2.8 **(1)**
[4]

(d) Horizontal portion of graph below pH 7 indicated on graph **(1)** **[1]**

(e) (i) $K\text{a} = \dfrac{[CH_3COO^-][H^+]}{[CH_3COOH]}$ **(1)** **[1]**

(ii) pH = pK_a at halfway to neutralisation point = 12.5 cm^3 **(1)**
Because pH = pK_a when $[CH_3COO^-] = [CH_3COOH]$ **(1)** **[2]**

(f) Phenolphthalein **(1)**
indictor changes colour between pH 7 and 10 this is vertical part of graph **(1)**
methyl orange would change in acid between pH4 and pH6 **(1)**
n.b. +ve statement about methyl orange **[3]**

(g) exothermic reaction / heat (energy) released during reaction **(1)**
HCl is strong acid fully ionised **(1)**
this is weak acid so some energy used for dissociation **(1)** **[3]**

(h) (i) pH = -$\log_{(10)}$ [H^+] or in words **[1]**

(ii) $1.8 \times 10^{-5} = \frac{[H^+]^2}{1}$ **(1)**

[H^+] = $\sqrt{1.8 \times 10^{-5}}$ = 4.24×10^{-3} **(1)**
pH = $-\log(4.24 \times 10^{-3})$
= 2.37/2.4 **(1)** 2 to 4 sig. figs. **[3]**

Total 22 marks

Paper total 75 marks

Mark Scheme for Specimen Paper

Unit Test C5

1 (a) (i) Working to show first order with respect to $[S_2O_8^{2}]$ **(1)**
Working to show first order with respect to $[I^-]$ **(1)**
overall equation**(1)** **[3]**
Consequential

(ii) Sum of power of the concentration terms (for thio and iodide) in rate equation / number of each species involved up to and including or, in, the rate-determining step in the reaction mechanism / Sum of the partial / individual orders / general equation of the form $[\text{thio}]^m[\text{iodide}]^n$
overall order = m + n **(1)** **[1]**

(iii) 36 **(1)** $dm^3mol^{-1}s^{-1}$ **(1)** **[2]**
Consequential on part (i)

(iv) Rate equation depends on mechanism / rate equation only involves those species in the rate determining step / slowest step**(1)** **[1]**

(b) (i) Colorimetry / conductivity / remove samples and titrate with (standard) sodium thiosulphate solution **(1)** **[1]**

(ii) Constant temperature **(1)** **[1]**

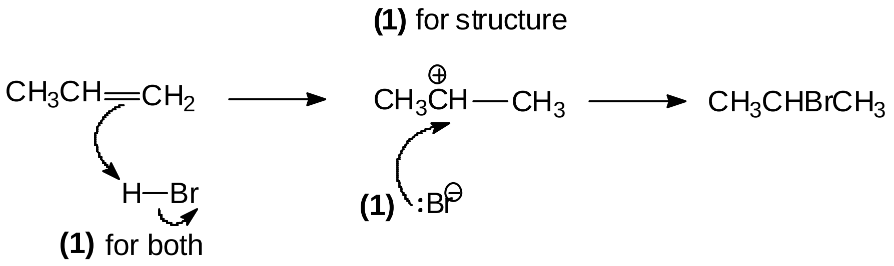
(iii) Colorimeter / conductivity **adv** that monitoring is continuous / does not need removal of samples
or
disadv of titration is problems with timing **(1)** **[1]**

Total 10 marks

2 (a) Species seeking negative charge / electron deficient / electron **pair** (lone pair) acceptor **(1)** **[1]**
*If say **must** be a positive ion then zero marks*

(b) (i) 2-bromopropane **(1)** **[1]**

(ii)



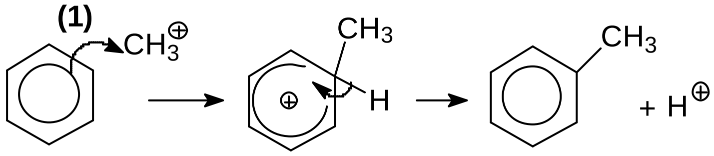
*The arrow for the attack of the bromide ion must **not** go from the negative charge* **[3]**
*Do **not** need lone pair of electrons on the bromide*
If mechanism gives 1-bromopropane can get first and third mark

(iii) (major product) involves 2° carbocation as intermediate **(1)** which is more stable / has a lower E_a of formation /more electron releasing groups around the carbon atom than the 1° carbocation **(1)** **[2]**

This could be shown as diagrams.
n.b. Markovnikov's Rule is not an explanation of why the major product is formed simply a means of remembering which is the major product.

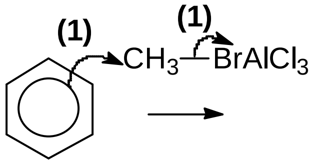
(c) (i) Aluminium chloride / iron(III) chloride / iron / or bromides / correct formulae **(1)** **[1]**

(ii) $CH_3Br + AlCl_3 \rightarrow CH_3^{\oplus} + BrAlCl_3^{\ominus}$ **(1)**



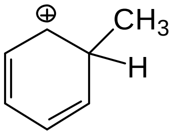
(1) for arrow
(1) for structure

alternative way
of showing part played by catalyst



[4]

Kekulé intermediate



(d) delocalised π electron / from p-orbitals system in benzene **(1)**

substitution enables delocalisation to be preserved **(1)**

π bond in propene weaker than π bond in benzene **(1)**

(π bond broken in) formation of two single bonds (on addition to propene) which is energetically more favourable than substitution **(1)** **[4]**

Total 16 marks

3 (a)

VO_2^+	yellow	VO^{2+}	blue
V^{3+}	green	V^{2+}	Lavender/mauve/lilac/purple/ violet

[2]

All four correct **2 marks -** any 2 correct **1 mark**

(b) (i) $2VO_2^+ + Zn + 4H^+ \rightarrow 2VO^{2+} + 2H_2O + Zn^{2+}$
species **(1)** balance **(1)** **[2]**

(ii) V^{3+}
or
V^{3+} and VO^{2+}**(1)** allow $[V(H_2O)_6]^{3+}$
E value for both reduction reactions positive so feasible **(1)**
(further) reduction (to V^{2+}) not feasible since E value negative**(1)** **[3]**

(c) (i) Disproportionation requires the original oxidation states to be able to both rise and fall **(1)**
or
In disproportionation a species must be able to be reduced and to be oxidised thus needs 3 oxidation states **(1)** **[1]**

(ii) $2VO^{2+} \rightarrow VO_2^+ + V^{3+}$
species **(1)** balance **(1)** **[2]**

Total 10 marks

4 (a)

Sc	[Ar]	↑					↑↓
Cu	[Ar]	↑↓	↑↓	↑↓	↑↓	↑↓	↑
Cu^{2+}	[Ar]	↑↓	↑↓	↑↓	↑↓	↑	

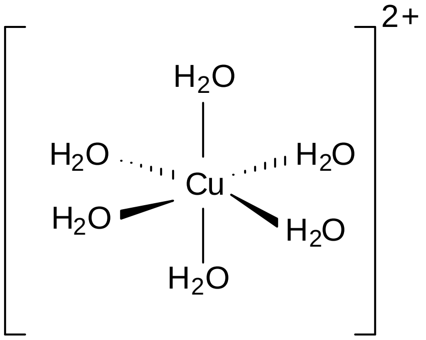
[3]

Cu^{2+} consequential on structure for Cu

(b) Electronic configuration differs from previous element by an electron in a d (sub) shell / electrons are filling the d-shell **(1)**
transition elements have at least one ion with partially-filled d-shell **(1)** **[2]**
Not ‘highest energy shell is the ‘d’-shell
outer electron in ‘d’ shell

(c) (i) Hexaaquacopper(II) **[1]**

(ii) **[1]**



(iii) d-orbitals split (in energy by ligands) / or diagram to illustrate **(1)**
electron transitions/ jumps from **lower** to **higher** energy level **(1)**
absorbs light in visible region **(1)** **[3]**

(d) (i) Blue **precipitate (1)**
Insoluble/ remains in excess sodium hydroxide **(1)** **[2]**

(ii) Deprotonation / acid base **(1)** **[1]**

(e) $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$ / or clearly stated **(1)**

amount of thio = 26.8 x 0.1 / 1000 = 2.68 x 10-3 mol**(1)**
ratio of copper to thio is 1:1 **(1)**
total amount of copper = 2.68 x 10^{-3} mol x 10 =2.68 x 10^{-2} mol **(1)**
mass of copper = 2.68 x 10^{-2} mol x 63.5 g mol^{-1} = 1.70g **(1)**
purity = 1.70x100 / 1.74 = 97.8 / 97.7 % **(1)**
allow 2 to 4 sig figs in final answer mark consequentially **[6]**

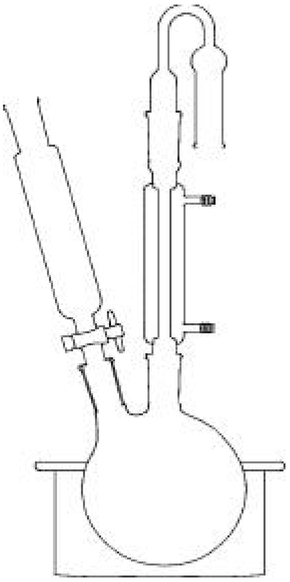
Total 19 marks

5 (a) (i) Magnesium **(1)**
Dry Ether**(1)** **[2]**

(ii) (Solid) carbon dioxide **(1)** then / followed by dilute HCl **(1)** **[2]**
Carbon dioxide <u>and</u> dil HCl scores 1 mark
Any named mineral acid can score
Ignore state of carbon dioxide

(b) (i) (ether) flammable **(1)**
No naked flames / use water bath / heating mantle**(1)** **[2]**

(ii)



This is a diagrammatic representation of a set up that could be used. The marks are for the particular elements not their orientation

Some means of adding bromoethane safely.
Or
Calcium chloride drying tube

Reflux condenser

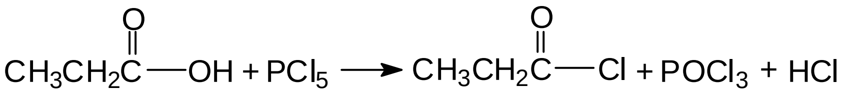
Magnesium
+
ether

Water bath / heating mantle
This mark lost if Bunsen present or heat ↑

Marking
Flask + Reflux condenser **(1)**
Water bath / heating mantle **(1)** *Consequential on first mark*
Some means of excluding water vapour e.g. calcium chloride guard tube **or** some means of adding reactants without danger **(1)**

Overall diagram **(1)** this must work and this must be safe i.e. not closed **[4]**

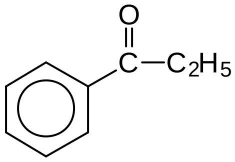
(c)



$$CH_3CH_2\overset{\overset{O}{\|}}{C}-OH + PCl_5 \longrightarrow CH_3CH_2\overset{\overset{O}{\|}}{C}-Cl + POCl_3 + HCl$$

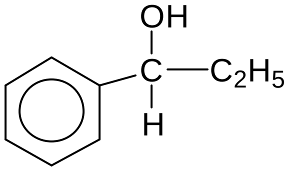
structure of acid chloride showing at least expansion of COCl **(1)** products **(1)** **[2]**

(d)



(1)
2,4-dinitrophenylhydrazine reacts with carbonyl group **(1)**
this carbonyl compound is a ketone and cannot be oxidised by/ cannot reduce ammoniacal silver nitrate **(1)**
*This is consequential on **B** being shown as a ketone* **[3]**

(e) (i)



[1]

(1)
This is consequential on a ketone being shown in (d)

(ii) The lithium aluminium hydride would react with any water **(1)** **[1]**

(f) B has absorption peak in region 1680 - 1750 showing carbonyl **(1)**
but peak in region of 3250 - 3550 is present (not present in B) showing alcohol group / allow broad peak if range omitted **(1)**
comparison between two spectra **(1)** **[3]**

Total 20 marks

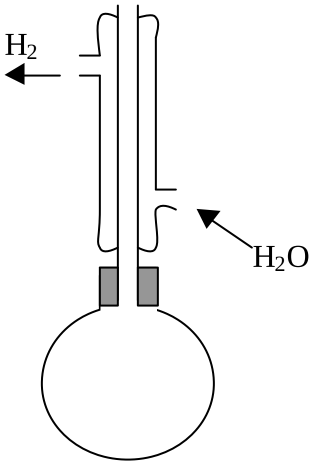
Paper total 75 marks

Mark Scheme for Specimen Paper

Unit Test C6B

1 (a) Conc. H_2SO_4 catalyst **(1)**
40 minutes since reaction slow **(1)**
ester boils below 85°C **(1)**
sodium carbonate removes acid **(1)**
Na_2SO_4 removes water **(1)**
76°C – 80°C fraction contains most of the ester **(1)**

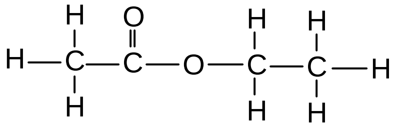
diagram **(2)** max **(1)** if closed or other silly error



[8]

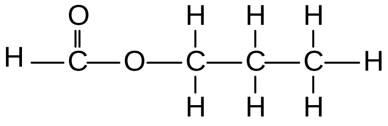
(b) Advantages:
Reaction much faster/ no need to heat / fast at room temperature **(1)**
Reaction goes to completion / reaction not equilibrium / better yield of ester **(1)**
Disadvantage:
Hydrogen chloride gas given off –toxic/ need to use fume cupboard **(1)** **[3]**

(c)



$$H-\underset{H}{\overset{H}{C}}-\overset{O}{\overset{\|}{C}}-O-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$$

Ethyl ethanoate



$$H-\overset{O}{\overset{\|}{C}}-O-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$$

Propyl methanoate

Ethyl ethanoate has three peaks: at 1.2ppm due to the methyl in the ethyl group, 2ppm due to the methylene group, and 4.1ppm due to the methyl adjacent to the carbonyl group. These are in ratio 3:2:3 **(1)**
Propyl methanoate has four peaks: 1ppm due to the methyl part of the propyl group; 1.7ppm due to the methylene group next to this; 4.1ppm due to the methylene group next to the oxygen atom; 8.1ppm due to the hydrogen next to the C=O group. These are in ratio 3:2:2:1. **(1)**

Therefore it will be possible to distinguish between the two **(1)** **[3]**

Total 14 marks

2 (a) Low(er) solubility or not easily leached
non-explosive
neutral
less osmotic pressure / less scorching
slow release **Any two for 1 mark each** **[2]**

(b) Ammonia is the stronger base because
ammonium ion is the weaker acid **(2)**
or
The weaker the acid, the stronger is its
conjugate base **(1)**
Therefore (NH_4^+ weaker acid / smaller K_a)
ammonia is stronger base **(1)**
or
K_a for NH_4^+ is less than K_a for conjugate acid of
urea**(1)**
therefore the ammonia is the stronger base**(1)** **[2]**

(c) (i) Bromine **(1)**
NaOH**(1)**
Order of adding/addition and heat **(1)** **[3]**

(ii) NH_2NH_2**(1)** **[1]**

(d) (i) Ammonium nitrate is a **solid** / not a gas **(1)** **[1]**

(ii) $K_P = P_{NH3}\ P_{HNO3}$**(1)**

$P_{NH3} = \sqrt{15.7} = 3.96$ atm **(1)**
3.96 atm = 3.96 x 1/50 moles of ammonia
= 0.079 moles **(1)**
Moles of NH_4NO_3 = 8.00/80 = 0.100 **(1)**

% dissoc = 0.079/0.1 x100 = 79% **(1)** **[5]**

(e) Energy level of ammonium nitrate is higher
than energy level of products **(1)**
therefore ammonium nitrate is
thermodynamically unstable with respect to
products (or the reverse argument) **(1)**
Ammonium nitrate is kinetically stable **(1)**
Strong heating needed to overcome high
activation energy **(1)** **[4]**

Total 18 marks

3 (a) (i) Electronegativity: tendency of an atom to draw electrons in a bond towards itself **(1)**
large electronegativity difference between sodium and chlorine **(1)**
Chlorine attracts electrons to form Cl^- ion hence ionic bond **(1)** **[3]**

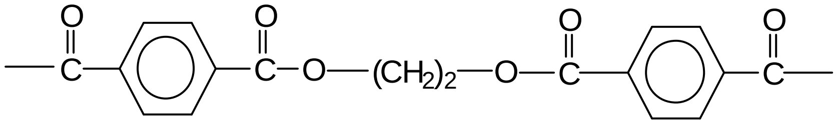
(ii) Al^{3+} much more charge dense than Na^+ **(1)**
so much more polarising tending to covalent bonding **(1)** **[2]**

(b) Ar ionisation energy so high **(1)**
that is not compensated by **(1)**
the lattice energy **(1)** **[3]**

(c) (i) $P_4 + 10Cl_2 \rightarrow 4PCl_5$
Allow
$P_4 \rightarrow PCl_3 \rightarrow PCl_5$
for species **(1)** for balancing **(1)** **[2]**

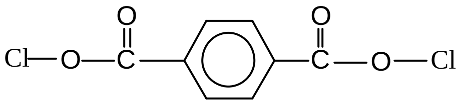
(ii) Oxidation number of phosphorus changes from 5 to 3 therefore reduction **(1)**
Oxidation number of chlorine changes from -1 to 0 therefore oxidation **(1)**
It is a redox reaction **(1)** **[3]**

(d) (i)



Reagents

$HO—(CH_2)_2—OH$ and



1 mark each **[3]**

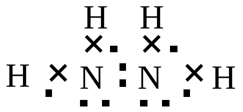
The polyester needs to show at least one ester link and some evidence for extension of the chain for the mark. The exact groups between the ester links are not important
The reagents are consequential on the ester drawn

(ii) A polymer is made by the elimination of a small molecule – in this case hydrogen chloride **(1)**

between two molecules each of which has a reactive group at each end of the molecule **(1)** **[2]**

Total 18 marks

4 (a) (i)



(1) **[1]**

(ii) Basic shape around each nitrogen – triangular pyramidal since 3 bonding and one lone pair of electron **(1)**
Pairs of electrons repel each other as far as possible / to position of minimum repulsion around each nitrogen **(1)**
Because lone pairs repel more than bond pairs giving angle of about 107°**(1)** **[3]**

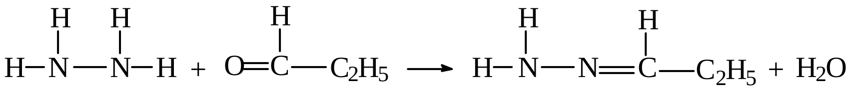
(b) Amount hydrazine = 1000g/32g mol^{-1} = 31.25 mol **(1)**
$DH_c^{O} = -1.83 \times 10^4 / 31.25 = -585.6$ kJ mol^{-1} **(1)**
Break N-N — Make N≡N - 944
4 x N-H + 388 x 4 — 4 x O-H - 463 x 4
O=O + 496
(Bond energy N-N + 2048) — - 2796 **(1)**
(Bond energy N-N + 2048) – 2796 = 586
∴ Bond energy N-N = + 162 kJ mol^{-1} **(1)** **[4]**

(c) (i) $N_2H_4 + 4OH^- \rightarrow N_2 + 4H_2O + 4e^-$ (state symbols not required) **[2]**
(1) for species and **(1)** for balance

(ii) E^Ovalues for (i) > +0.66V but < +1.32 / between +0.66 and +1.32 / reduction potential for N_2/N_2H_4
less negative than – 1.32V but more negative than – 0.66V **(1)** **[1]**

(iii) $4VO_2^+ + N_2H_4 \rightarrow 4VO^{2+} + N_2 + 4OH^-$
or
$4VO_2^+ + 4H_2O + N_2H_4 + 4OH^- \rightarrow 4VO^{2+} + 8OH^- + N_2 + 4H_2O$
species **(1)** balance **(1)** **[2]**

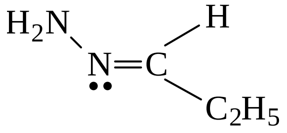
(d) (i)



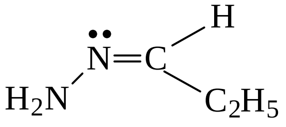
$$H\text{-}N(H)\text{—}N(H)\text{-}H + O{=}C(H)\text{—}C_2H_5 \longrightarrow H\text{-}N(H)\text{—}N{=}C(H)\text{—}C_2H_5 + H_2O$$

Equation**(1)** structure of product **(1)** **[2]**

(ii) The carbon nitrogen double bond restricts rotation**(1)** and this leads to geometric isomerism**(1)**
With the NH_2 and C_2H_5 on the same or different sides of the molecule / or structures drawn**(1)**



Trans



Cis

[3]
Total 18 marks
Paper Total 50 marks

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Mark Scheme for Specimen paper

Unit Test C3A

Question 1

(a)		Lilac / mauve / pinkish / purple **(1)**	Potassium / K /K^+ **(1)**	**[2]**
(b)	(i)	any yellow ppt **(1)** Insoluble**(1)**	AgI / I^- / iodide / KI / iodine anion **(1) or** AgBr / Br Br^- *Not iodine*	**[3]**
	(ii)	Brown or red solution / I_2 / black ppt or solid **(1)**	KI **(1)** only, *not bromide or chloride accept NaI if flame colour yellow*	**[2]**
	(iii)	Concentrated sulphuric acid **(1)** Purple gas / black solid / bad-egg smell / yellow solid **(1)**		**[2]**

Total 9 marks

Question 2

Table 1

Check subtractions and averaging arithmetic, correcting if necessary.

Any Two recorded titres within 0.2 **(3)** 0.3 **(2)** 0.5 **(1)**

All volumes, including mean titre, recorded to 2 dp–allow one slip but withhold this mark if any readings are in the wrong boxes. **(1)**
Allow initial reading of 0 or 0.0

All subtractions correct **(1)**

Record these marks on the script below table

Mean titre

For correct averaging of chosen values or for choosing identical values and for recording the average correct to 2 or 3 dp or to nearest 0.05 cm^3**(1)**

Accuracy

Award marks for accuracy as follows using the titre supplied by the centre supervisor. If you suspect that this value is inaccurate and that using it will be unfair to the candidates you may have to use a different titre. A number of possibilities exist.

- Ignore the supervisor's titre and average all or most of the candidate's titres.
- assume that the centre made up solutions exactly as specified and use a theoretical value of 23.8 cm^3
- Use an average of the titres gained by the candidates who perform well in the other part s of the paper. Ignore the candidates who are clearly weak.

	Marks awarded for accuracy if average titre difference is **less than or equal to difference given**							
Difference d =	± 0.20	± 0.30	± 0.40	± 0.50	± 0.60	± 0.70	± 0.80	± 1.00
Mark	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**

e.g. a difference of 0.45 would score 5 marks

Penalty If the candidate has averaged titres which differ by more than $0.2 cm^3$ then, using the outermost titres, the examiner must subtract marks from the accuracy mark. The examiner must also subtract marks if the mean has been corrected because of incorrect subtraction and new titres outside $0.2 cm^3$ have been used.

Range between titres averaged / cm^3	0.00 to 0.20	0.21 to 0.30	0.31 to 0.40	0.41 to 0.50	0.51 to 0.60	0.61 to 0.70	0.71 to 0.80	0.81 to 0.90	0.91 to 1.00
Subtract from accuracy mark	0	1	2	3	4	5	6	7	8

(a) $\frac{\text{Titre} \times 0.05}{1000}$ **(1)** **[1]**

(b) 2 x answer to (a) **(1)** **[1]**

(c) Answer to (b) x $\frac{1000}{25}$ **(1)**

$M_r = \frac{8.0}{\text{conc in mol dm}^{-3}}$ **(1)**

M = Na **(1)** **[3]**

(d) **Two** techniques from:

- avoiding air bubbles
- reading pipette at eye-level / correct reference to meniscus
- touching side of flask with tip of pipette / touching solution with **[2]**
- tip of pipette
- leaving drop in tip of pipette
- rinsing out with solution **X** before use

Total 21 marks

Question 3

Table 2 All weighings recorded in correct spaces to at least 2 dp **(1)**

Correct subtraction **(1)** **[2]**

Table 3 Both temperatures recorded in correct spaces to at least 1dp. **(1)**

Correct subtraction including sign **(1)**

Accuracy Multiply the candidate's - corrected if necessary - mass by **1.55** and record this figure to 1 dp close to the candidates T value (corrected if necessary) on page 7.
Record the difference between the two values on the script.
Award accuracy marks as follows

Difference	± 0.5	± 0.8	± 1.0	± 1.5
Mark	**4**	**3**	**2**	**1**

[6]

If assumed mass of 3.1g subtract 1 mark from accuracy mark (no negatives.

(a) Correct arithmetic **(1)**
Positive sign **(1)**
Value to 3sf and units **(1)** **[3]**

(b) The principle is general change **(1)** reason for change **(1)**

Note ; If a candidate changes the apparatus give 1 mark for reasoning **[2]**
Examples might include:

- Take a series of temperature readings / repeat experiment (and average results) **(1)**
- To allow for odd / erratic temperatures / heat gain from surroundings **(1)**
- Use more solid **(1)** larger T value**(1)**
- Put a lid on apparatus**(0)** to prevent heat losses **(1)**
- Use the same thermometer / different thermometer **(0)** reading to an accuracy of 0.1 °C **(1)**

Total 13 marks

Question 4

Planning

- General Procedure
  Procedure used **(1)** and measurements taken **(1) ✓p ✓p**
  Procedure:
  Add $MHCO_3$ + acid and stopper flask **/** use suspended test tube in large flask **(1)**
  Measurements:
  Mass of $MHCO_3$ **and** (final) volume of carbon dioxide **/** when effervescence stops record volume of gas in syringe **(1)**

- Calculation **✓c ✓c**
  Explain how to convert volume of CO_2 to moles by correct use of 24.0 **(1)**
  Use of moles $MHCO_3$ = mass $MHCO_3 \div M_r$ $MHCO_3$ to find M_r **(1)**
  Hence find identity of M **(1)**

- Errors **✓e ✓e**
  One likely error eg escape of gas before bung replaced / solid did not all react / carbon dioxide soluble in acid **(1)**
  Should not affect identification since even if M_r is slightly wrong it will still correspond to nearest Group 1 metal atomic mass **(1)**

- Safety **✓s**
  Sensible safety precaution and reason eg eye protection–acid hazard **(1)** **[7]**

Total 7 marks
Paper Total 50 marks

Mark Scheme for Specimen Paper

Unit Test C6A

The mark scheme is written into the questions.

Question 1

Tests on A

(a) (i) Add 3 cm^3 of aqueous sodium hydroxide to a spatula measure of **A** in a test tube. Gently warm the test tube. After removing the test tube from the Bunsen flame, carefully smell any gas evolved. Carry out a simple test to confirm the identity of the gas.

Observations	Inferences
description of ammonia smell ***(1)***	
red litmus turns blue ***(1)***	*ammonia* ***(1)***

[3]

Dissolve the remaining sample of **A** in 10 cm^3 of distilled water. Use this solution for the tests which follow.

(ii) To 2 cm^3 of aqueous A add 6 drops of aqueous barium chloride followed by 10 drops of dilute hydrochloric acid.

Observations	Inferences
white precipitate ***(1)***	
insoluble in acid ***(1)***	$BaSO_4$/SO_4^{2-}/*sulphate* ***(1)***

[3]

(iii) To 2 cm^3 of aqueous **A** add dilute aqueous ammonia drop by drop until the test tube is about half full. The ammonia will then be in excess.

Observations	Inferences
brown precipitate ***(1)*** *insoluble in excess* ***(1)***	$Fe(OH)_3$ ***(1)***

[3]

(iv) To 2 cm^3 of aqueous **A** add 10 drops of aqueous potassium iodide followed by 6 drops of aqueous starch.

Observations	Inferences
brown solution ***(1)*** *blue-black colour* ***(1)***	*iodine* ***(1)***

[3]

(v) Suggest the formulae of the two cations and one anion in **A**.

Cations Fe^{3+} *and* NH_4^+

Anion SO_4^{2-} **(3 correct score 2 marks, 2 correct scores 1 mark)**

[2]

(vi) Give the name of the type of reaction which occurs in (iv) when aqueous potassium iodide is added to **A**. Write an ionic equation to represent the reaction.

Type of reaction *oxidation / redox* **(1)**

Equation $2Fe^{3+} + 2I^{-} \rightarrow 2Fe^{2+} + I_2$ ***(1)***

[2]

Total 16 marks

Question 2

Tests on B

(b) Carry out the tests listed below on the organic compound **B**, C_9H_8O. **B** has two functional groups.

Record the results of your tests in the Observations spaces. Under Inferences record the functional group, by name or formula, the presence of which may be suggested by your observations. You are not expected to attempt to identify **B** in your Inferences.

(i) Using a dropping pipette transfer 10 drops of **B** to a crucible. Carefully ignite the **B**.

Observations	Inferences
smoky flame ***(1)***	*benzene / aromatic* ***(1)***

[2]

(ii) To 1 cm^3 of **B,** add 8 drops of an aqueous solution of potassium manganate(VII) acidified with dilute sulphuric acid. Stopper and gently shake the test tube.

Observations	Inferences
Mauve / purple colour of potassium manganate(VII) discharged / decolourised ***(1)***	*reducing agent present**(1)*** *alcohol or aldehyde* ***(1)*** *unsaturated carbon double bond* ***(1)*** ***Any two***

[Max 3]

(iii) To 2 cm^3 of **B** add 8 drops of aqueous bromine. Stopper and gently shake the test tube.

Observations	Inferences
Orange / yellow to colourless ***(1)***	*unsaturated / alkene* ***(1)***

[2]

(iv) To 4 drops of **B** add 2 cm^3 of aqueous 2, 4-dinitrophenylhydrazine. Stopper and shake the test tube gently.

Observations	Inferences
yellow / orange precipitate ***(1)***	*carbonyl group**(1)***

[2]

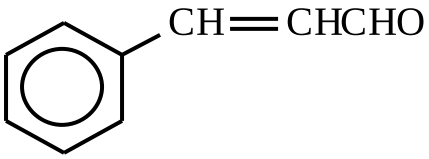
(v) Mix 2 cm^3 of each of Fehling's solutions 1 and 2. Add 6 drops of **B**. Heat the test tube in a water bath at about 80 °C.

Observations	Inferences
red precipitate ***(1)***	*aldehyde* ***(1)***

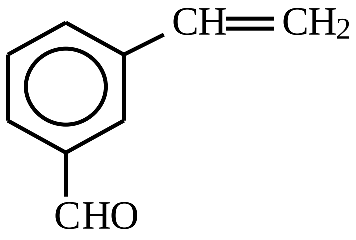
[2]

(vi) On the evidence of the tests carried out write structures for **two** isomers of **B**.

Structure 1



Structure 2



[2]

Total 13 marks

Question 3

(1 mark is to be awarded for a proposed method that (i) works and is (ii) logical. Candidates cannot score full marks on this section of the question without this mark)

Method to include:

filter off 2, 4–DNP derivative **(1)**

dissolve in hot **(1)**

minimum / filter hot **(1)**

cool / crystallise **(1)**

filter off crystals **(1)**

dry crystals **(1)**

measure melting point **(1)**

check mp with listed mp's of derivatives **(1)**

safety **(1)**

[Max 8]

Total 8 marks

Question 4

For a pair of results in which the rising and falling temperatures do not differ by more than 5°C **(1)**

For an actual falling temperature differing from the ideal by:

not more than 2°C **(5)**
not more than 3°C **(4)**
not more than 4°C **(3)**
not more than 5°C **(2)**
not more than 6°C **(1)**

[6]

(i) Product must be $C_9H_{10}O$ **(1)**

Structure of product based on the structure drawn in part (b)(vi) showing saturation of the double bond only.**(1)**

[2]

(ii) Very difficult to judge the exact temperature

Poor conduction between the liquid and the oil
Difficult to control temperature rise and fall
Repeat experiment with (fresh) sample till reproducible results obtained
Use a distillation procedure

[5]
Total 13 marks

Paper total 50 marks

General Guidance on Marking

Examiners should look for qualities to reward rather than faults to penalise. This does **not** mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge, and for critical and imaginative thinking. Examiners should therefore read carefully and consider every response; even if it is not what is expected it may be worthy of credit.

Using the Mark Scheme

1. The mark scheme gives you:
   - an idea of the types of response expected
   - how individual marks are to be awarded
   - the total mark for each question
   - examples of responses that should not receive credit.
2. ; separates points for the award of each mark.
3. / means that the responses are **alternatives** and either answer should receive full credit.
4. ( ) means that a phrase/word is not essential for the award of the mark but helps the examiner to get the sense of the expected answer.
5. Phrases/words in **bold** indicate that the meaning of the phrase/word is **essential** to the answer.
6. ecf (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Marking

1. You must give a tick (in red) for every mark awarded. The tick must be placed on the script close to the answer. The mark awarded for part of a question should be written in the margin close to the sub-total.
2. The sub-total marks for a question should be added together and the total written and ringed at the end of the question then transferred to the front of the script.
3. Suggestion/explanation questions should be marked correct even when the suggestion is contained within the explanation.
4. **Do not** award marks for repetition of the stem of the question.
5. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. (Quality of written Communication). Answers must be in the correct context.

THE PERIODIC TABLE

Group

key

Atomic Number
Symbol
Name
Molar mass in g mol^{-1}

Period	**1**	**2**											**3**	**4**	**5**	**6**	**7**	**8**
1	1 H Hydrogen 1																	2 He Helium 4
2	3 Li Lithium 7	4 Be Berylium 9											5 B Boron 11	6 C Carbon 12	7 N Nitrogen 14	8 O Oxygen 16	9 F Fluorine 19	10 Ne Neon 20
3	11 Na Sodium 23	12 Mg Magnesium 24											13 Al Aluminium 27	14 Si Silicon 28	15 P Phosphorus 31	16 S Sulphur 32	17 Cl Chlorine 35.5	18 Ar Argon 40
4	19 K Potassium 39	20 Ca Calcium 40	21 Sc Scandium 45	22 Ti Titanium 48	23 V Vanadium 51	24 Cr Chromium 52	25 Mn Manganese 55	26 Fe Iron 56	27 Co Cobalt 59	28 Ni Nickel 59	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 70	32 Ge Germanium 73	33 As Arsenic 75	34 Se Selenium 79	35 Br Bromine 80	36 Kr Krypton 84
5	37 Rb Rubidium 85	38 Sr Strontium 88	39 Y Yttrium 89	40 Zr Zirconium 91	41 Nb Niobium 93	42 Mo Molybdenum 96	43 Tc Technetium (99)	44 Ru Ruthenium 101	45 Rh Rhodium 103	46 Pd Palladium 106	47 Ag Silver 108	48 Cd Cadmium 112	49 In Indium 115	50 Sn Tin 119	51 Sb Antimony 122	52 Te Tellurium 128	53 I Iodine 127	54 Xe Xenon 131
6	55 Cs Caesium 133	56 Ba Barium 137	57 ▶ La Lanthanum 139	72 Hf Hafnium 178	73 Ta Tantalum 181	74 W Tungsten 184	75 Re Rhenium 186	76 Os Osmium 190	77 Ir Iridium 192	78 Pt Platinum 195	79 Au Gold 197	80 Hg Mercury 201	81 Tl Thallium 204	82 Pb Lead 207	83 Bi Bismuth 209	84 Po Polonium (210)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 ▶▶ Ac Actinium (227)	104 Unq Unnilquadium (261)	105 Unp Unnilpentium (262)	106 Unh Unnilhexium (263)												

58 Ce Cerium 140	59 Pr Praseo-dymium 141	60 Nd Neodymium 144	61 Pm Promethium (147)	62 Sm Samarium 150	63 Eu Europium 152	64 Gd Gadolinium 157	65 Tb Terbium 159	66 Dy Dysprosium 163	67 Ho Holmium 165	68 Er Erbium 167	69 Tm Thulium 169	70 Yb Ytterbium 173	71 Lu Lutetium 175
90 Th Thorium 232	91 Pa Protactinium (231)	92 U Uranium 238	93 Np Neptunium (237)	94 Pu Plutonium (242)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (245)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (253)	101 Md Mendelevium (256)	102 No Nobelium (254)	103 Lr Lawrencium (257)

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