IGCSE

London Examinations IGCSE

Chemistry (4335)

Exemplar candidate responses from the May 2005 examination session

March 2006

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Exemplar candidate responses

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Chemistry

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Paper 2H
Script 1

Leave blank

SECTION A

1. This question is about the properties and uses of some everyday materials.

Here is a list of possible uses for different materials, and a list of properties.

Use
coins
injection moulding of bottles
insulation on electrical wires
overhead electricity cables
railway tracks
window frames

Property
brittle
does not conduct electricity
good conductor of electricity
low melting point
resists corrosion
strong

Write **one** use for each material in the table. For each use, give a related property.

Each use and property may be used once, more than once or not at all.

Material	Use	Property
aluminium	Window frames	resists corrosion. ✓
copper	overhead electricity cables	good conductor of electricity ✓
poly(chloroethene)	insulation on electrical wires	does not conduct electricity ✓
poly(ethene)	injection ~~on~~ moulding of bottles	Low melting point ✓
steel (contains iron)	railway tracks	strong ✓

Q1 5

(Total 5 marks)

Leave blank

2. A mixture contains an insoluble compound and a soluble compound.
The mixture is separated by adding hot water and then filtering.
This produces a **white** solid, **A**, and a **green** solution, **B**.

The white solid and the green solution were tested to find out what they were. The tables show the tests used and the results.

Tests on white solid A	
Test	**Result**
Carry out flame test	The flame was coloured brick red
Add dilute hydrochloric acid Test the gas produced	Bubbles seen Found to be carbon dioxide

(a) (i) **Name** the cation in solid **A**.

Calcium ✓

(1) 1

(ii) The gas produced is carbon dioxide.

Give the test for carbon dioxide.

Bubble through clear lime/water

Give the result of this test.

Solution will turn turbid

(2) 2

(iii) **Name** the anion in solid **A**.

Carbonate ✓

(1) 1

Tests on green solution B	
Test	**Result**
Add sodium hydroxide solution	Green precipitate
Add dilute nitric acid Then add silver nitrate solution	No change No change
Add barium chloride solution Then add dilute hydrochloric acid	White precipitate No change

Leave blank

(b) (i) Give the **formula** of the cation in solution **B**.

~~Iron~~ Fe^{2+} ✓

(1) 1

(ii) Give the **name** of the green precipitate.

Iron (II) ~~Sulphate~~ Hydroxide ✓

(1) 1

(iii) **Name** the anion in solution **B**.

Sulphate ✓

(1) 1

(iv) Give the **formula** of the white precipitate.

$BaSO_4$ ✓

(1) 1

(c) There are three anions that give a precipitate when dilute nitric acid and silver nitrate solution are added. Name **two** of these anions.

Chlorine and Iodine

(2) 0

(d) (i) Give the **formula** of solid **A**.

~~Calcium Carbonate~~ $CaCO_3$ ✓

(1) 1

(ii) Give the **formula** of the compound in solution **B**.

~~$Fe(OH)_2$~~ $FeSO_4$ ✓

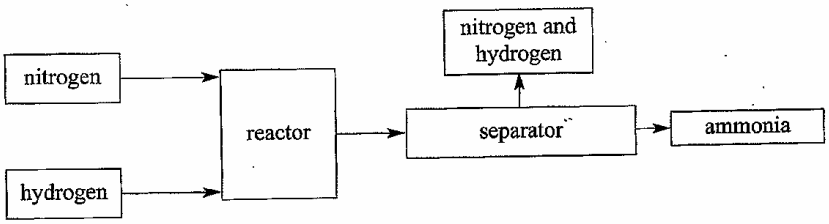
(1) 1

Q2

(Total 12 marks) 10

Leave blank

3. (a) Ammonia is made industrially by the Haber process. In this process nitrogen is reacted with hydrogen. The flow diagram shows what happens in the Haber process.



(i) Give the names of the raw materials from which the nitrogen and hydrogen are obtained.

Raw material from which nitrogen is obtained ..... Air ✓

Raw material from which hydrogen is obtained ..... h

(2) 1

(ii) State the conditions used in the reactor.

A pressure of 200 atm and a temperature of over 200°C ✓ with a catalyst of finely divided iron ✓

(3) 2

(iii) How is the ammonia separated from the unreacted nitrogen and hydrogen?

By use of a separator h

(1) 0

(iv) What is done with the unreacted nitrogen and hydrogen?

The are recycled into the process. ✓

(1) 1

(b) Ammonium nitrate can be used as a fertiliser to increase plant growth. It is made by reacting ammonia solution with nitric acid. Write a chemical equation for this reaction.

$NH_3 + HNO_3$ ✓ $\rightarrow (NH_4)_2NO_3$ ✗

(2) 1

Q3 5

(Total 9 marks)

Leave blank

4. Crude oil is a mixture of hydrocarbons. The mixture can be separated into fractions by the process of fractional distillation.

(a) Fractional distillation of crude oil produces the fractions bitumen, diesel, fuel oil, gasoline, kerosene and refinery gases.

State **one** use of bitumen and **one** use of kerosene.

Use of bitumen For road surfacing ✓

Use of kerosene Used as Jet Feul. ✓

(2) 2

(b) Gasoline is used as a fuel for cars. When gasoline undergoes complete combustion the products are carbon dioxide and water.

(i) Write a word equation for the complete combustion of gasoline.

Gasoline + Oxygen → Carbon dioxide & water **(1)** 1

(ii) In car engines, incomplete combustion takes place.
Why is the combustion incomplete?

Because of the lack of oxygen ✓

(1) 1

(iii) Explain why the incomplete combustion of gasoline can be harmful to humans.

when there is a lack of oxygen in the combustion, Carbon monoxide is formed rather than Carbon dioxide, this gas is very ✓ posious to all living creatures. **(3)** 2

(c) Fractional distillation works because each fraction has a different boiling range.

Describe how you could obtain a fraction with a boiling range of 80 °C to 120 °C **in the laboratory** from a sample of crude oil. Name the items of apparatus you would need.

- Boil ✓ crude oil in a boiling tube over a bunsen burner
- At 120°c collect gas and condense by running cold water into the condenser. This cools the vapour back into a liquid. ½
- Finally collect liquid into a beaker. Now You have a fraction with boiling range 80-120°c 1

(3) Q4

(Total 10 marks) 7

Leave blank

5. This question is about the synthetic polymer nylon.

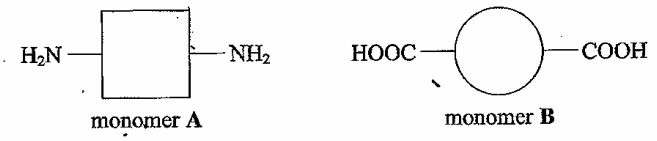
(a) Poly(ethene) is an addition polymer. What type of polymer is nylon?

Condensation polymer ✓

(1)

1

(b) Nylon can be made using the monomers **A** and **B** represented in the diagrams.



monomer **A** monomer **B**

(i) What type of compound is monomer **A**?

Organic ✗

(1)

0

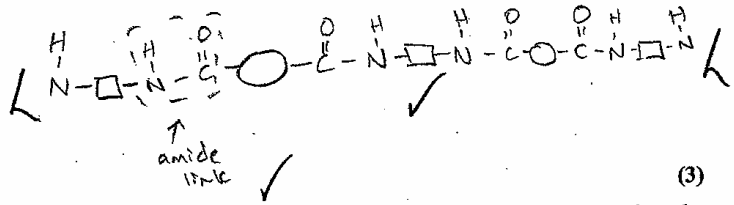
(ii) What type of compound is monomer **B**?

Acid ✗

(1)

0

(iii) Draw a diagram to show the structure of the polymer formed from **A** and **B**. You must draw enough of the structure to make the repeat unit clear.



(3)

2

(c) Nylon has a simple molecular structure. Use words from the box to complete the sentences.

Each word may be used once, more than once or not at all.

ions	**high**	**low**
molecules	**strong**	**weak**

Nylon has a high ✗ melting point. This is because there are strong ✗ forces between the molecules ✓ that make up the structure.

(3)

1

Q5

4

(Total 9 marks)

TOTAL FOR SECTION A: 45 MARKS

Leave blank

SECTION B

6. A sample of the element rubidium, Rb, contains two isotopes.

(a) Explain what isotopes are.

Isotopes are substances with same atomic number of the same element but different mass number

(2)

(b) (i) Complete the table for the isotopes of rubidium.

Atomic number of isotope	Mass number of isotope	Number of protons	Number of neutrons	Percentage of each isotope in sample
37	85	37	48	72
37	87	37	50	28

(3)

(ii) Use the table to calculate the relative atomic mass of the sample of rubidium. Give your answer to one decimal place.

$R.A.M. = \frac{(72 \times 85) + (28 \times 87)}{100} = \frac{6180 + 2436}{100}$

$= \frac{8556}{100} = 85.6$ a.m.

(2)

(c) Why do the two isotopes of rubidium have the same chemical properties?

Because they have the same atomic number

(1)

Leave blank

(d) Rubidium reacts with oxygen, chlorine and water in a similar way to other Group 1 elements.

(i) Suggest the formula of the compound formed when rubidium reacts with:

oxygen Rb_2O ✓

chlorine RbCl ✓

(2)

(ii) A small piece of rubidium is added to a trough of water.

Suggest two observations you could make ✓ during the reaction.

1 The metal melts ✓ and the metal darts

2 The solution becomes hotter as the reaction is exothermic. ✗

(2)

(iii) Complete and balance the equation for the reaction of rubidium with water.

$2\ Rb + 2\ H_2O \rightarrow 2RbOH + H_2$ ✓✓

(2)

Q6 1 1 ✓

(Total 14 marks)

Leave blank

7. (a) Chlorine gas can be prepared in the laboratory using concentrated hydrochloric acid and $KMnO_4(s)$.

State the name of $KMnO_4(s)$ and describe its function in the preparation.

Name Potassium manganate(VII) oxide

Function Speeds it the acts as a reducing agent ✗

(2)

(b) Some chlorine gas is bubbled into a solution containing potassium iodide.
A displacement reaction occurs.

(i) Write an ionic equation for the reaction.

$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ ✓

(1)

(ii) What colour is the solution at the end of the reaction? ✓

Red

(1)

(iii) Explain why no displacement reaction occurs when iodine is added to a solution of potassium chloride.

Because chloride is more reactive than iodine and so can displace it but iodine cannot

(1)

(c) Hydrogen chloride can be made using the reaction

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

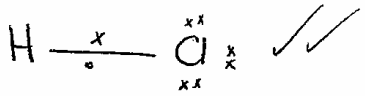
Describe the colour change seen during this reaction.

The green gas turns colourless ✓

(2)

Leave blank

(d) Draw a dot-and-cross diagram to show all the outer electrons in a molecule of hydrogen chloride.



(2)

(e) (i) Some hydrogen chloride gas was dissolved in water.
A piece of blue litmus paper was placed in the solution.

State, with a reason, the final colour of the litmus paper.

The litmus paper turns red as hydrogen the hydrogen dissolved hydrogen chloride gives hydrochloric acid.

(2)

(ii) Some hydrogen chloride gas was dissolved in methylbenzene.
A piece of blue litmus paper was placed in the solution.

State, with a reason, the final colour of the litmus paper.

There is no change as the hydrogen chloride does not work as an acid in organic solvents

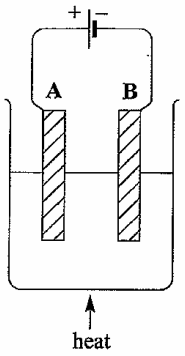
(2)

(Total 13 marks)

Q7
1 0

Leave blank

8. The diagram shows the apparatus used to electrolyse lead(II) bromide.



(a) The wires connected to the electrodes are made of copper.

Explain why copper conducts electricity.

Because it has free moving electrons ✓

.....

(1)

(b) Explain why electrolysis does not occur unless the lead(II) bromide is molten.

Because lead(II) bromide is insoluble ✗ compound

(2)

(c) The reactions occurring at the electrodes can be represented by the equations shown in the table.

Complete the table to show the electrode (**A** or **B**) at which each reaction occurs, and the type of reaction occurring (oxidation or reduction).

Electrode reaction	Electrode	Type of reaction
$Pb^{2+} + 2e^- \rightarrow Pb$	Cathode	reduction
$2Br^- \rightarrow Br_2 + 2e^-$	Anode ✗	oxidation ✓

(2)

Leave blank

(d) In an experiment using the same apparatus, the amount of charge passed was 0.10 faraday.

(i) Calculate the maximum amount, in moles, of each substance formed.

Amount of Pb $\frac{0.10}{2} \times 1 = 0.05$ moles

Amount of Br_2 $\frac{0.10}{2} \times 1 = 0.05$ moles

(2)

(ii) Calculate the mass of bromine formed.

Mass = Moles x Mr = 0.05 x 160

= 8 grams

(2)

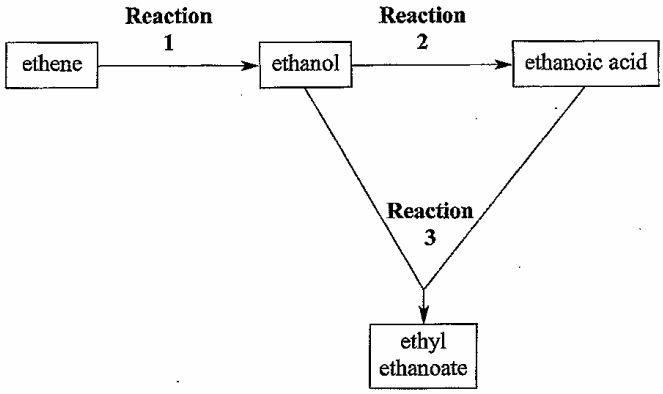
Q8

6

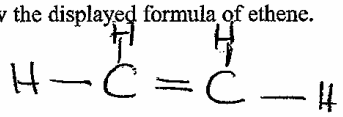
(Total 9 marks)

Leave blank

9. This question refers to the following reaction scheme.



(a) Draw the displayed formula of ethene.



(1)

(b) State the other reagent, and the conditions needed, for **Reaction 1.**

Yeast is used water is needed with high temperature and a catalyst X

(3)

(c) Ethanol can also be made from $C_{12}H_{22}O_{11}(s)$.

(i) What type of substance is $C_{12}H_{22}O_{11}(s)$?

Alkane Sugar

(1)

(ii) What type of reaction is used to make ethanol from this substance?

Fermentation

(1)

Leave blank

(d) State the type of reaction occurring in **Reaction 2** and suggest suitable reagents.

Oxidation as the reaction is of ethanol and Oxygen. The ethanol is easily oxidised by oxygen in air. $C_2H_5OH + O_2 \rightarrow CH_3COOH$

ethanol + Oxygen → ethanoic acid

(3)

(e) The organic product of **Reaction 3** is a member of a homologous series.

(i) State the name of the homologous series to which this substance belongs.

Ester

(1)

(ii) Explain what is meant by a homologous series.

They are substances ~~with~~ have ~~same~~ the same properties but different chemical and structural formulae.

(2)

(Total 12 marks)

Q9

7

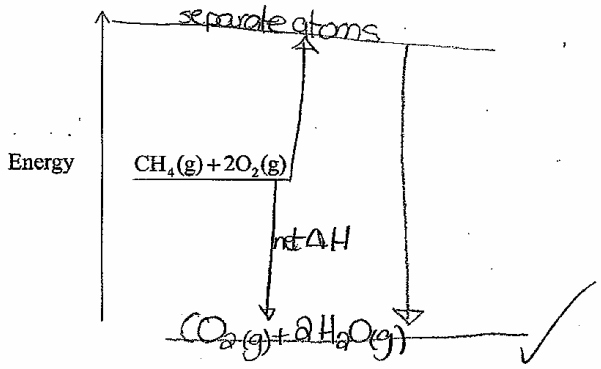
Leave blank

10. A common example of an exothermic reaction is the complete combustion of methane, as shown in the equation.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

(a) This reaction can be represented by an energy level diagram.

Complete the diagram by showing the products of the reaction.



(1)

(b) The table shows the values of some average bond dissociation energies.

Bond	C—H	O—H	O=O	C=O
Dissociation energy (kJ/mol)	412	463	496	743

Methane and water contain only single bonds. Oxygen and carbon dioxide contain only double bonds.

Use the values in the table to calculate the energy change occurring during the complete combustion of methane.

Energy lost = 4(412) + 2(2x496) = 1648+1984
= 3632

Energy gained = 2(743) + 2(2x463) = 1486+1852
= 3338

Energy change = 3338 − 3632 ×
= −294 ΔH ×

(3)

Leave blank

(c) At room temperature the reaction between methane and oxygen is very slow.

State **three** different changes in conditions that would increase the rate of this reaction.

1 Hight ~~pressure~~ pressure ✓

2 High temprature (and volume) of the gas ✓

3 ~~Use of~~ Use of catalyst (and its type) ✓

(3)

(d) Another reaction of methane, used in industry, is shown by the equation

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +210 \text{ kJ/mol}$$

(i) What do the symbols $\rightleftharpoons$ and ΔH represent?

$\rightleftharpoons$ ~~the~~ reaction is equilibrium ✗

ΔH heat value ✓

(2)

(ii) The reaction is carried out at 2 atm pressure and 1000 °C.

Predict what would happen to the amounts of carbon monoxide and hydrogen formed if these conditions were changed as follows.

Pressure increased The reaction moves towards the less number of moles which is left (backwards) ✓

Temperature decreased The reaction goes to the ~~endothermic~~ exothermic ~~direction~~ direction ~~of~~ which is right and the yes ✓ left (backwards)

(2)

(Total 11 marks)

Q10 5 ✓

Leave blank

11. (a) A student made a solution of potassium hydroxide by dissolving 14.0 g of solid potassium hydroxide in distilled water to make 250 cm^3 of solution.

(i) Calculate the relative formula mass of potassium hydroxide, KOH.

Relative Formula mass = 39 + 16 + 1 = 56 (atm) ✓

(1)

(ii) Calculate the amount, in moles, of potassium hydroxide in 14.0 g.

Moles = $\frac{\text{Mass}}{\text{Mr}} = \frac{14}{56} = 0.25$ moles

(1)

(iii) Calculate the concentration, in mol dm^{-3}, of this solution of potassium hydroxide. Show your working.

Moles = Conc. Concentration = $\frac{\text{moles}}{\text{Volume}}$ = ~~0.25~~

$= \frac{0.25}{0.25} = 1 \text{ mol/dm}^3$ ✓

(2)

Volume = $\frac{250}{1000} = 0.25 \text{ dm}^3$

Leave blank

(b) A different solution of potassium hydroxide, of concentration 2.0 mol dm^{-3}, was used in an experiment to react with carbon dioxide gas.

The equation for this reaction is

$$2KOH(aq) + CO_2(g) \rightarrow K_2CO_3(aq) + H_2O(l)$$
2 : 1 : 1 : 1

(i) Calculate the amount, in moles, of potassium hydroxide in 200 cm^3 of this solution.

Moles = Concentration x Volume ✓

= 2.0 x 0.2 = 0.4 moles

(1)

(ii) Calculate the amount, in moles, of carbon dioxide that reacts with 200 cm^3 of this solution of potassium hydroxide.

Moles of CO_2 = $\frac{0.4 \times 1}{2}$ = 0.2 moles ✓

(1)

(iii) Calculate the volume that this amount of carbon dioxide occupies at room temperature and pressure (rtp).
(molar volume of any gas = 24 dm^3 at rtp)

Volume = Moles x Molar volume

= 0.2 x 24 = 4.8 dm^3 ✓

(1)

(Total 7 marks)

Q11 7 ✓

Leave blank

12. Diamond and graphite are different forms of carbon.

(a) State the term used to describe different forms of the same element in the same physical state.

Allotropes ✓

(1)

(b) Name and describe the type of **bonding** in diamond.

It is regular arrangement of closely packed atoms bonded together by strong covalent bond

(3)

(c) State one industrial use of diamond.

Used in digging equipments ✗

(1)

(d) Graphite has a hexagonal layer structure. Draw a diagram, showing three hexagons, to show the atoms and bonding in graphite.

✗

(2)

(e) Diamond and graphite both have high sublimation points. Explain why.

Because they both have carbon atoms bonded together by strong covalent bond.

(2)

Leave blank

Q12

3

(Total 9 marks)

TOTAL FOR SECTION B: 75 MARKS

END

Script 1: Commentary

This candidate was awarded grade A for this paper.

Question 1: 5 marks out of 5

This is the first question in the section of the paper that is targeted at grades D and C, so it is expected that a grade A candidate will achieve a high score. Although all the information needed in the answer is provided in the question, careful selection is needed to score full marks. This candidate made a completely correct selection.

Question 2: 10 marks out of 12

This question was well answered, and the candidate followed the instructions about how to identify the substances. The only marks lost by the candidate in this question were for using the names of the halogens instead of the halide ions in part (c), a common error.
A general point to note is that when a name is asked for, a formula will not be accepted, and vice versa. Even though the instructions to give the name and formula are in bold in this question, many candidates lost marks through giving the one not asked for.

Question 3: 5 marks out of 9

(a) The candidate showed some knowledge of the Haber process, although 3 of the available marks were lost.
A general point to note is that when a temperature condition is asked for, and a specific value is quoted in the specification, then this is the answer expected. Although some variation is acceptable, candidates should be advised to quote a single value rather than a range. For example, in this question the value should be 450 °C, although a single value in the range 400-500 °C was accepted. An answer giving a wide range, such as 300-500 °C, was not accepted.

(b) A chemical equation is often allocated 2 marks. These marks can be awarded in different ways, one way being a mark for all the formulae being correct and a second mark for balancing. In this example, because no balancing is needed, and none of the formulae are given in the question, then the first mark is for the formulae of both reactants and the second for the formula of the product.

Question 4: 7 marks out of 10

(a) Correct.

(b) The only mark lost was for the last point in the explanation of carbon monoxide's harmful nature in part (iii) – some reference to the effect on the ability of blood to carry oxygen was expected.

(c) This part was generally not well answered. One mark was for heating the crude oil – this candidate scored the mark with "boil". Another mark was for naming the items of apparatus; three were considered essential – a container for the crude oil, a condenser and a thermometer. This candidate gave the first two but not the third, so the mark was not awarded. The most difficult mark to score was to indicate clearly that the distillate would be collected only when the thermometer indicated a temperature in the range 80-120 °C. Although the candidate quoted this range, the use of the phrases "At 120 °C collect gas" and "Finally collect liquid" showed some confusion, and the mark was not awarded.

Question 5: 4 marks out of 9

(a) Correct.

(b) "Organic" is too vague to score, and "acid" was not accepted without the specific inclusion of "carboxylic". Part (iii) was well attempted, and the only mark not awarded was through failing to include the continuation bonds on the end nitrogen atoms.

(c) Only one mark was awarded in this part. At this level candidates should appreciate that compounds with intermolecular forces have low melting points.

(c) The candidate was aware of the link between low melting point and weak forces, but the choice of ions, given the mention of "molecular" in the question, was puzzling.

Question 6: 11 marks out of 14

(a) 1 mark was scored for recognising the difference between isotopes but the other mark was lost through lack of precision in identifying an atom, referring instead to element and substance.

(b) Full marks were scored for completing the table in part (i), and for the A_r calculation in part (ii).

(c) The candidate did not score here through failing to mention electrons.

(d) The only mark lost in this part was the second mark in part (ii). Although it is true that the reaction is exothermic, the addition of a small piece of rubidium to a large amount of water would produce a negligible temperature rise.
A general point to note is that the candidate wrote two answers on one line. This should be discouraged because if the extra answer had been incorrect (not just irrelevant) then there might have been a contradiction and the mark would not be awarded.

Question 7: 10 marks out of 13

(a) The first mark was lost through omitting the oxidation number (VII) for the compound. Although the inclusion of oxidation numbers is not expected in the names of many simple compounds, they should appear in compounds containing a transition metal, eg copper(II) sulphate.
The second mark was lost, as the candidate confused oxidation and reduction.

(b) Parts (i) and (ii) were correctly answered, but in (iii) there was confusion between halogen and halide ion. Candidates need to be precise in answers of this type – chlorine and chloride are not the same species.

(c) The candidate scored both marks here.
A general point to note is that when a colour change is asked for, it is good practice to give both the starting and finishing colours.

(d) This answer scored both available marks, although strictly speaking the bond line between H and Cl should not have been drawn. The dot and cross represents a shared pair of electrons and therefore also a covalent bond, so drawing a line as well might suggest the presence of two bonds.

(e) Well answered and awarded full marks.

Question 8: 6 marks out of 9

(a) Although the candidate came close to scoring the mark, the crucial point about the electrons moving was only implied and not clearly stated.

(b) Well answered and awarded full marks.

(c) Well answered and awarded full marks.

(d) In part (i), although the candidate did a mole calculation correctly, the presence of two electrons in the equations in (c) was not appreciated, so both answers were double the correct ones.
Part (ii) illustrates a common situation in calculations, whereby an incorrect answer can be awarded full marks if a correct method has been used, but an incorrect value (already penalised) from an earlier part has been used.
In part (ii) the candidate's answer was double the correct one, but it was obtained by correctly using the incorrect value of 0.1 from part (i). The examiner indicated what had been done by the abbreviation "t e" (transferred error).

Question 9: 7 marks out of 12

(a) Correct.

(b) The reagent "water" and the condition "high temperature" scored, but the catalyst's name was needed for the third mark.

(c) Correct.

(d) 1 mark was awarded for correctly recognising the reaction type, but an incorrect reagent was given.

(e) Part (i) was correct, but the candidate was confused about the meaning of the term "homologous series" and scored no marks in part (ii).

Question 10: 5 marks out of 11

(a) Correct.

(b) 1 mark was awarded for correctly calculating the value of 3338, although describing it as "energy gained" was not helpful. The value of 3632 did not score because the value for the O=O bond was multiplied by 4 instead of by 2.
A third mark might have been scored if the working had been shown as 3632 – 3338 instead of 3338 – 3632.

(c) Full marks were awarded, with the words in brackets being ignored.

(d) Many candidates do not distinguish between a reversible reaction (i.e. one that can occur in both directions) and a reaction at equilibrium (i.e. a reversible reaction in which the rates of the forward and reverse reactions are equal), so the first mark in part (i) was not awarded.
"Heat value" is not close enough to "enthalpy change" to score.
In part (ii) the candidate has correctly applied Le Chatelier's principle to predict the direction in which the equilibrium will shift, but has not answered the question, which asked for the effect on the amounts of two named substances, so neither mark was awarded.

Question 11: 7 marks out of 7	
	Every part of this question was answered using the method expected and all the answers were correct.
Question 12: 3 marks out of 9	
(a)	Correct
(b)	This was a difficult question which few candidates answered fully. A mark was awarded for the type of bonding, but neither mark for the description.
(c)	Not a correct use
(d)	Although hexagons appear, they are incorrectly linked, showing four C–C bonds instead of the three found in graphite.
(e)	The idea of the covalent bonds being strong was worth 1 mark, but the second point was missing – the idea that a lot of heat energy is needed to break them.

Paper 2H

Script2

Leave blank

SECTION A

1. This question is about the properties and uses of some everyday materials.

Here is a list of possible uses for different materials, and a list of properties.

Use
coins
injection moulding of bottles
insulation on electrical wires
overhead electricity cables
railway tracks
window frames

Property
brittle
does not conduct electricity
good conductor of electricity
low melting point
resists corrosion
strong

Write **one** use for each material in the table. For each use, give a related property.

Each use and property may be used once, more than once or not at all.

Material	Use	Property
aluminium	window frames	resists corrosion ✓
copper	coins (insulation on electrical wires)	resists corrosion ✓
poly(chloroethene)	overhead electricity cables ✗	does not conduct electricity
poly(ethene)	injection moulding of bottles	brittle.
steel (contains iron)	railway tracks	strong ✓

Q1

3 ✓

(Total 5 marks)

Leave blank

2. A mixture contains an insoluble compound and a soluble compound.
The mixture is separated by adding hot water and then filtering.
This produces a **white** solid, **A**, and a **green** solution, **B**.

The white solid and the green solution were tested to find out what they were. The tables show the tests used and the results.

Tests on white solid A	
Test	**Result**
Carry out flame test	The flame was coloured brick red
Add dilute hydrochloric acid Test the gas produced	Bubbles seen Found to be carbon dioxide

(a) (i) **Name** the cation in solid **A**.

Ca^{+}

(1)

(ii) The gas produced is carbon dioxide.

Give the test for carbon dioxide.

Turns limewater milky. Add limewater

Give the result of this test.

If present it will turn limewater milky.

(2)

(iii) **Name** the anion in solid **A**.

CO_3^{-}

(1)

Tests on green solution B	
Test	**Result**
Add sodium hydroxide solution	Green precipitate
Add dilute nitric acid Then add silver nitrate solution	No change No change
Add barium chloride solution Then add dilute hydrochloric acid	White precipitate No change

Leave blank

(b) (i) Give the **formula** of the cation in solution **B**.

Cu^+

(1)

(ii) Give the **name** of the green precipitate.

Copper Hydroxide ✓ Cq

(1)

(iii) **Name** the anion in solution **B**.

OH^- ✗

(1)

(iv) Give the **formula** of the white precipitate.

CuCl ✗

(1)

(c) There are three anions that give a precipitate when dilute nitric acid and silver nitrate solution are added. Name **two** of these anions.

(2)

(d) (i) Give the **formula** of solid **A**.

$CaCO_3$ ✓

(1)

(ii) Give the **formula** of the compound in solution **B**.

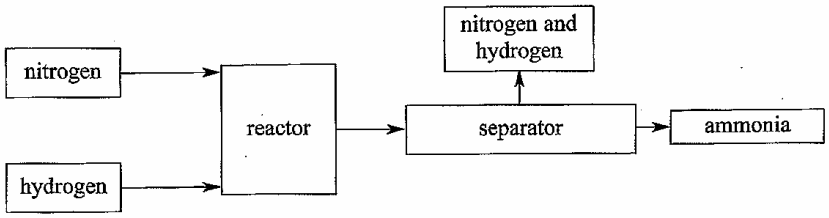
(1)

(Total 12 marks)

Q2 4 ✓

Leave blank

3. (a) Ammonia is made industrially by the Haber process. In this process nitrogen is reacted with hydrogen. The flow diagram shows what happens in the Haber process.



(i) Give the names of the raw materials from which the nitrogen and hydrogen are obtained.

Raw material from which nitrogen is obtained air ✓

Raw material from which hydrogen is obtained air ✗

(2)

(ii) State the conditions used in the reactor.

Temperature of 450°C ✓

Pressure of 200 atms. ✓

Catalyst is iron ✓

(3)

(iii) How is the ammonia separated from the unreacted nitrogen and hydrogen?

by pressure ✗

(1)

(iv) What is done with the unreacted nitrogen and hydrogen?

put back to form ammonia again ✓

(1)

(b) Ammonium nitrate can be used as a fertiliser to increase plant growth. It is made by reacting ammonia solution with nitric acid. Write a chemical equation for this reaction.

$NH_3 + NO_3 \rightarrow NH_3O_3$ ✗

(2)

Q3 5 ✓

(Total 9 marks)

Leave blank

4. Crude oil is a mixture of hydrocarbons. The mixture can be separated into fractions by the process of fractional distillation.

(a) Fractional distillation of crude oil produces the fractions bitumen, diesel, fuel oil, gasoline, kerosene and refinery gases.

State **one** use of bitumen and **one** use of kerosene.

Use of bitumen ..... fuel ✗ .....

Use of kerosene ..... candles ✗ .....

(2)

(b) Gasoline is used as a fuel for cars. When gasoline undergoes complete combustion the products are carbon dioxide and water.

(i) Write a word equation for the complete combustion of gasoline.

gasoline + oxygen → carbon dioxide + water ✓

(1)

(ii) In car engines, incomplete combustion takes place.
Why is the combustion incomplete?

Not enough oxygen is supplied ✓

(1)

(iii) Explain why the incomplete combustion of gasoline can be harmful to humans.

If the combustion is incomplete, harmful gases will be produced, such as CO_2 ✓ If this gas is inhaled by humans, you could die.

(3)

(c) Fractional distillation works because each fraction has a different boiling range.

Describe how you could obtain a fraction with a boiling range of 80 °C to 120 °C **in the laboratory** from a sample of crude oil. Name the items of apparatus you would need.

You would need a Bunsen burner. Above this you would have a tripod, with a beaker of crude oil. You would need a thermometer to measure the temperature of the oil. You would need to have a beaker of some sort on top to catch what is boiled off. ✓

(3)

Q4 2

(Total 10 marks)

Leave blank

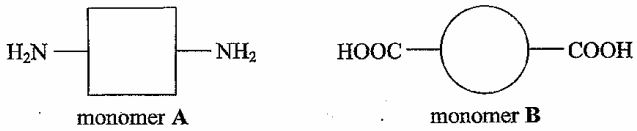
5. This question is about the synthetic polymer nylon.

(a) Poly(ethene) is an addition polymer. What type of polymer is nylon?

addition ✓

(1)

(b) Nylon can be made using the monomers **A** and **B** represented in the diagrams.



monomer **A** monomer **B**

(i) What type of compound is monomer **A**?

covalent ✗

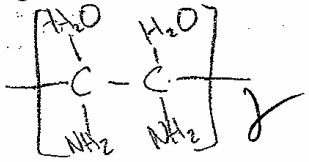
(1)

(ii) What type of compound is monomer **B**?

covalent ✓

(1)

(iii) Draw a diagram to show the structure of the polymer formed from **A** and **B**. You must draw enough of the structure to make the repeat unit clear.



✓

(3)

(c) Nylon has a simple molecular structure. Use words from the box to complete the sentences.

Each word may be used once, more than once or not at all.

ions	**high**	**low**
molecules	**strong**	**weak**

Nylon has a low ✓ melting point. This is because there are

weak ✓ forces between the ions ✓ that make up

the structure.

(3)

(Total 9 marks)

Q5 2 ✓

TOTAL FOR SECTION A: 45 MARKS

Leave blank

SECTION B

6. A sample of the element rubidium, Rb, contains two isotopes.

(a) Explain what isotopes are.

The same element or compound with the same proton number, but a different mass number. molecular structure, ~~physical properties~~

(2)

(b) (i) Complete the table for the isotopes of rubidium.

Atomic number of isotope	Mass number of isotope	Number of protons	Number of neutrons	Percentage of each isotope in sample
37	85	37	48	72
37	87	37	50	28

(3)

(ii) Use the table to calculate the relative atomic mass of the sample of rubidium. Give your answer to one decimal place.

RAM = 37 + 48 = 85 87/85 = 1.02

37 + 50 = 87 85 + 1.02 = 86.02

∴ RAM = 86.1

(2)

(c) Why do the two isotopes of rubidium have the same chemical properties?

It is still the same element in the same group on the Periodic Table, just with a different structure.

(1)

2

Leave blank

(d) Rubidium reacts with oxygen, chlorine and water in a similar way to other Group 1 elements.

(i) Suggest the formula of the compound formed when rubidium reacts with:

oxygen RbO ✓

chlorine $RbCl_2$ ✗

(2)

(ii) A small piece of rubidium is added to a trough of water.

Suggest two observations you could make during the reaction.

1 It would react violently and fizz along the surface.

2 It would burst into flame on the surface.

(2)

(iii) Complete and balance the equation for the reaction of rubidium with water.

$2\,Rb + 2\,H_2O \rightarrow 2RbOH + 2H_2$

(2)

Q6

(Total 14 marks) 7 ✓

Leave blank

7. (a) Chlorine gas can be prepared in the laboratory using concentrated hydrochloric acid and $KMnO_4(s)$.

State the name of $KMnO_4(s)$ and describe its function in the preparation.

Name ....Potassium Manganese hexate X.....

Function .....X.....

(2)

(b) Some chlorine gas is bubbled into a solution containing potassium iodide. A displacement reaction occurs.

(i) Write an ionic equation for the reaction.

$Cl_2^- + KIO_2^+ \rightarrow K^+ + OO_2^+$ ✓

.....

(1)

(ii) What colour is the solution at the end of the reaction?

yellow/green ✓

(1)

(iii) Explain why no displacement reaction occurs when iodine is added to a solution of potassium chloride.

.....

.....

(1)

(c) Hydrogen chloride can be made using the reaction

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

Describe the colour change seen during this reaction.

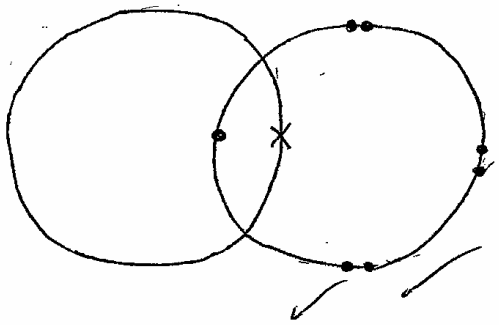
The chlorine combines with the Hydrogen gas.....

and goes from yellow/green ✓ to colorless ✓.....

(2)

Leave blank

(d) Draw a dot-and-cross diagram to show all the outer electrons in a molecule of hydrogen chloride.



(2)

(e) (i) Some hydrogen chloride gas was dissolved in water.
A piece of blue litmus paper was placed in the solution.

State, with a reason, the final colour of the litmus paper.

Because the solution is acidic, the litmus paper will turn from blue to red.

(2)

(ii) Some hydrogen chloride gas was dissolved in methylbenzene.
A piece of blue litmus paper was placed in the solution.

State, with a reason, the final colour of the litmus paper.

The litmus paper ~~went from~~ stayed a blue grey color, because the solution is not acidic.

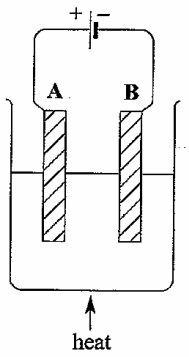
(2)

Q7

(Total 13 marks)

Leave blank

8. The diagram shows the apparatus used to electrolyse lead(II) bromide.



(a) The wires connected to the electrodes are made of copper.

Explain why copper conducts electricity.

because it contains flowing electrons

(1)

(b) Explain why electrolysis does not occur unless the lead(II) bromide is molten.

because when its solid the particles don't move and when its molten it has charged ions

(2)

(c) The reactions occurring at the electrodes can be represented by the equations shown in the table.

Complete the table to show the electrode (**A** or **B**) at which each reaction occurs, and the type of reaction occurring (oxidation or reduction).

Electrode reaction	Electrode	Type of reaction
$Pb^{2+} + 2e^- \rightarrow Pb$	cathode	oxidation
$2Br^- \rightarrow Br_2 + 2e^-$	anode	reduction

(2)

OIL RIG

Leave blank

(d) In an experiment using the same apparatus, the amount of charge passed was 0.10 faraday.

# of moles = mass / RAM

(i) Calculate the maximum amount, in moles, of each substance formed.

Amount of Pb @ 0.10 / 2 = 0.05

Amount of Br_2 .....

(2)

(ii) Calculate the mass of bromine formed.

mass = # of moles × RAM

= 0.10 × 80

= 8 g

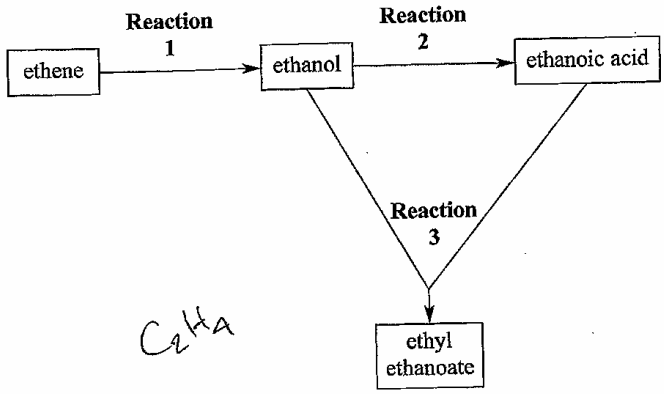
(2)

Q8

(Total 9 marks)

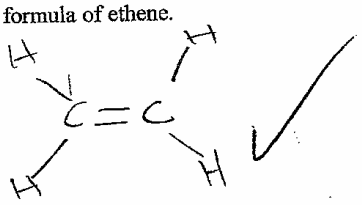
Leave blank

9. This question refers to the following reaction scheme.



C_2H_4

(a) Draw the displayed formula of ethene.



(1)

(b) State the other reagent, and the conditions needed, for **Reaction 1**.

ethene is added with water to for ethanol the catalyst is phosphoric acid in 78°c with pressure of 60-70 atms.

(3)

(c) Ethanol can also be made from $C_{12}H_{22}O_{11}(s)$.

(i) What type of substance is $C_{12}H_{22}O_{11}(s)$?

glucose so its sugar

(1)

(ii) What type of reaction is used to make ethanol from this substance?

fermentation

(1)

Leave blank

(d) State the type of reaction occurring in **Reaction 2** and suggest suitable reagents.

oxygen is added to it ✓

.....

.....

.....

(3)

(e) The organic product of **Reaction 3** is a member of a homologous series.

(i) State the name of the homologous series to which this substance belongs.

polymers ✗

(1)

(ii) Explain what is meant by a homologous series.

the series of which the elements are kept in order of reactivity. ✗

(2)

Q9

(Total 12 marks)

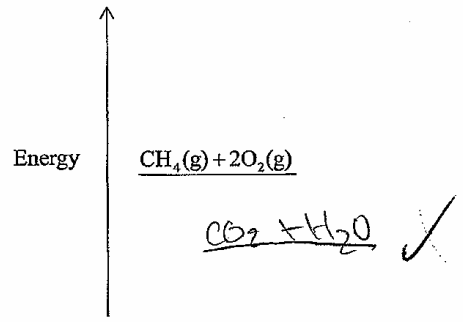
Leave blank

10. A common example of an exothermic reaction is the complete combustion of methane, as shown in the equation.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

(a) This reaction can be represented by an energy level diagram.

Complete the diagram by showing the products of the reaction.



(1)

(b) The table shows the values of some average bond dissociation energies.

Bond	C—H	O—H	O=O	C=O
Dissociation energy (kJ/mol)	412	463	496	743

CH_4 $2O_2$

Methane and water contain only single bonds. Oxygen and carbon dioxide contain only double bonds.

Use the values in the table to calculate the energy change occurring during the complete combustion of methane.

$412 + 496 \rightarrow 743 + 463$

$908 \rightarrow 1206$

$1206 - 908 = 298\ kJ/mol$

(3)

Leave blank

(c) At room temperature the reaction between methane and oxygen is very slow.

State **three** different changes in conditions that would increase the rate of this reaction.

1 pressure ✓

2 concentration ✓

3 catalyst ✓

(3)

(d) Another reaction of methane, used in industry, is shown by the equation

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +210 \text{ kJ/mol}$$

(i) What do the symbols $\rightleftharpoons$ and ΔH represent?

$\rightleftharpoons$ reversible ✓

ΔH energy change ✗

(2)

(ii) The reaction is carried out at 2 atm pressure and 1000 °C.

Predict what would happen to the amounts of carbon monoxide and hydrogen formed if these conditions were changed as follows.

Pressure increased if its a lot more than 2 atm the reaction will be reversed ✓

Temperature decreased if its a lot more than 1000°C the reaction will be reversed. ✓

(2)

(Total 11 marks)

Q10 3 ✓

Leave blank

11. (a) A student made a solution of potassium hydroxide by dissolving 14.0 g of solid potassium hydroxide in distilled water to make 250 cm^3 of solution.

(i) Calculate the relative formula mass of potassium hydroxide, KOH.

K = 39 O = 16 H = 1

39 + 16 + 1 = 56 ✓

(1)

(ii) Calculate the amount, in moles, of potassium hydroxide in 14.0 g.

$\frac{14}{56}$ = 0.25 moles ✓

(1)

(iii) Calculate the concentration, in mol dm^{-3}, of this solution of potassium hydroxide. Show your working.

~~moles = $\frac{14}{240}$ = 0.058 n = 0.25 × 24 dm^3 = 6 m.~~

0.058 moles/dm^3

(2)

Leave blank

(b) A different solution of potassium hydroxide, of concentration 2.0 mol dm^{-3}, was used in an experiment to react with carbon dioxide gas.

The equation for this reaction is

$$2KOH(aq) + CO_2(g) \rightarrow K_2CO_3(aq) + H_2O(l)$$

(i) Calculate the amount, in moles, of potassium hydroxide in 200 cm^3 of this solution.

2x(39+16+1) = 112

$\frac{112}{200}$ = 0.56 x 2 = 1.12 ✗

(1)

(ii) Calculate the amount, in moles, of carbon dioxide that reacts with 200 cm^3 of this solution of potassium hydroxide.

200 - 112 = 88

$\frac{88}{200}$ = 0.44 x 2 = 088 ✗

(1)

(iii) Calculate the volume that this amount of carbon dioxide occupies at room temperature and pressure (rtp).
(molar volume of any gas = 24 dm^3 at rtp)

$0.88 = \frac{n}{24 dm^3}$ so $n = 0.88 \times 24 = 21.12 dm^3$ ✓

(1)

Q11 3 ✓

(Total 7 marks)

Leave blank

12. Diamond and graphite are different forms of carbon.

(a) State the term used to describe different forms of the same element in the same physical state.

allotropys ✓

(1)

(b) Name and describe the type of **bonding** in diamond.

The molecules in a diamond structure are held together by strong bonds, which makes it hard. Each Carbon molecule is bonded with four other Carbon molecules. ✓

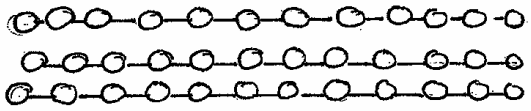
(3)

(c) State one industrial use of diamond.

jewelry ✓

(1)

(d) Graphite has a hexagonal layer structure. Draw a diagram, showing three hexagons, to show the atoms and bonding in graphite.



✓ **(2)**

2

(e) Diamond and graphite both have high sublimation points. Explain why.

This is because

.....

.....

.....

(2)

Leave blank

Q12

1

(Total 9 marks)

TOTAL FOR SECTION B: 75 MARKS

END

Script 2: Commentary

This candidate was awarded grade C for this paper.

Question 1: 3 marks out of 5

The choice of poly(ethene) is understandable, although incorrect, but giving "brittle" as the related property indicates that the candidate does not know the meaning of the term or how injection moulding is carried out. The choice of poly(chloroethene) for overhead electricity cables and the related property of not conducting electricity is baffling.

Question 2: 4 marks out of 12

The candidate did not always follow the instructions about how to identify the substances, in terms of choosing either a name or a formula, although the difference between cations and anions was understood. In parts (a)(i) and (iii), as well as not giving the required names, the charges on the ions were incorrect. Although the answer to part (b)(ii) was incorrect, the mark was awarded consequentially, based on the choice of an incorrect metal in (b)(i) – this is indicated by the symbol "cq". The only parts of the question answered correctly concerned the limewater test for carbon dioxide.

Question 3: 5 marks out of 9

(a) The candidate showed some knowledge of the Haber process, although 2 of the available marks were lost.

(b) A chemical equation is often allocated 2 marks. These marks can be awarded in different ways, one way being a mark for all the formulae being correct and a second mark for balancing. In this example, because no balancing is needed, and none of the formulae are given in the question, then the first mark is for the formulae of both reactants and the second for the formula of the product. Although this candidate's equation was not balanced, the marks were actually lost for incorrect formulae. Writing "NO_3" for nitric acid is a serious error at this level.

Question 4: 2 marks out of 10

(a) Both uses given were incorrect.
A general point to note in questions about uses of fractions is that as many are used as fuels, the answer "fuel" would not score without extra information. For example, for kerosene, "fuel for aircraft" would score, but not just "fuel".

(b) No marks were awarded in part (iii) – the wrong gas was identified, and "harmful" could not score because it was given in the question.

(c) This part was generally not well answered. One mark was for heating the crude oil – this candidate did not score the mark with "bunsen burner". Another mark was for naming the items of apparatus; three were considered essential – a container for the crude oil, a condenser and a thermometer. This candidate gave a beaker (not suitable) and a thermometer, but not a condenser, so the mark was not awarded. The most difficult mark to score was to clearly indicate that the distillate would be collected only when the thermometer indicated a temperature in the range 80-120 °C. The candidate's answer contained no reference to this.

Question 5: 2 marks out of 9

(a) The candidate seemed to be unfamiliar with other types of polymer.

(b) The only positive aspect of this candidate's answer was the use of continuation bonds and brackets to indicate the repeat unit. However, as the structure was completely wrong, no mark could be awarded.

(c) The candidate was aware of the link between low melting point and weak forces, but the choice of ions, given the mention of "molecular" in the question was puzzling.

Question 6: 9 marks out of 14

(a) 1 mark was scored for recognising the difference between isotopes but the other mark was lost through lack of precision in identifying an atom, referring instead to element.

(b) Full marks were scored for completing the table in part (i), and for the A_r calculation in part (ii).

(c) A clear answer that scored the mark.

(d) Neither mark was scored in part(i) through giving incorrect formulae. Equations were written that were not asked for, although this would not have been penalised if the final formulae had been correct.
In part (iii), although the equation is balanced, neither mark could be scored because the formula of one of the products is incorrect.

Question 7: 8 marks out of 13

(a) The candidate did not seem to be familiar with the name of this compound and did not recognise the redox nature of the reaction.

(b) Weaker candidates who attempt the writing of an ionic equation often write ionic formulae for all species, even for those that do not exist as ions. In this example, Cl^- appears instead of Cl_2.

(c) The candidate scored both marks here.
A general point to note is that when a colour change is asked for, it is good practice to give both the starting and finishing colours.

(d) This answer scored both available marks, although ideally each atom should have been identified by writing H or Cl in the centres of the circles.

(e) Well answered and awarded full marks.

Question 8: 2 marks out of 9

(a) The mark was awarded because the idea of electrons moving was clearly conveyed by the use of the word "flowing".

(b) Neither mark was awarded. Instead of "ions" the less precise word "particles" was used, and the answer implies that ions are only present when the compound is molten.

(c) The first mark was not awarded because the candidate did not use the required letters **A** and **B** to identify the electrodes. The second mark was lost because the answers were the wrong way round, in spite of the correctly remembered mnemonic OIL RIG being

written down by the candidate.

(d) No answers were given in part (i).
The candidate was fortunate to score 1 mark in part (ii), because although a correct method was used, both numerical values used were incorrect. It just happened that one value was double the correct one and the other value was half the correct one, so that the two errors cancelled to give the correct final answer.

Question 9: 4 marks out of 12

(a) Correct.

(b) Well answered and awarded full marks.

(c) The candidate was unlucky in part (i). The expected answer for the type of substance was "sugar". Although the name of the compound is sucrose, this correct name would have been accepted, but not "glucose". There were thus two answers given – one incorrect and one correct. On some occasions this situation is considered a contradiction and no mark is awarded, while on other occasions the incorrect answer might be ignored and the mark awarded.

(d) No mark was awarded for the incorrect reagent.

(e) No marks awarded for completely wrong answers.

Question 10: 3 marks out of 11

(a) Correct.

(b) No marks were awarded. Although the correct values from the table were used, no account was taken of the numbers of each bond involved.
The third mark might have been scored if some working had been shown.
A general point to note is that in calculations it is good practice to include a few words to indicate what is being done, because with an incorrect final answer it may be possible to award one or more marks if it is clear that a correct method has been used.

(c) Only the catalyst mark was awarded here.
Candidates should understand that the word "pressure" by itself does not imply that the pressure is being increased. A similar situation often arises with the word "temperature".

(d) In part (i) "energy change" was not close enough to "enthalpy change" or "heat change" to be awarded the mark.
In part (ii) it is clear that Le Chatelier's principle has not been used, even though the effect on the direction of the reaction in both cases has been correctly predicted. However, the question has not been answered – it asked for the effect on the amounts of two named substances, so neither mark was awarded.

Question 11: 3 marks out of 7

(a) Both marks were awarded in parts (i) and (ii), but in part (iii) the (incorrect) working has been crossed out and the final answer is incorrect, so no marks were awarded.

(b) Incorrect methods have been used in parts (i) and (ii), so no marks were awarded. Although the answer in part (iii) is incorrect, the mark was awarded for correctly multiplying the (incorrect) answer in part (ii) by 24.

Question 12: 1 mark out of 9

(a) Correct.

(b) The type of bonding (covalent) was not named, and the answer implies that molecules, rather than atoms, are joined together.

(c) Although diamond is certainly used in jewellery this was not accepted as an industrial use.

(d) The diagram shows no understanding of the structure of graphite.

(e) Not answered.

Paper 3

Script 1

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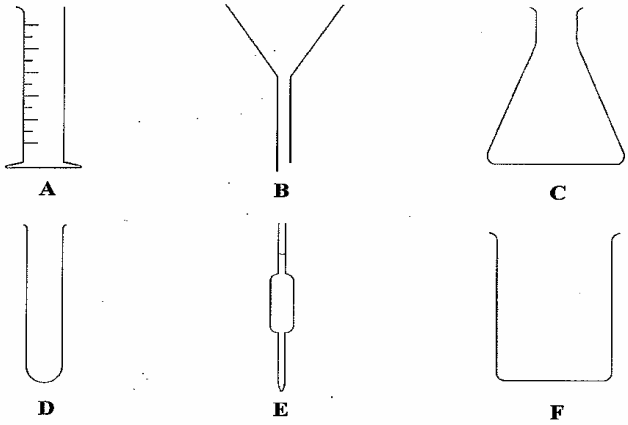
1. The diagrams show a selection of apparatus you can find in a chemistry laboratory.



(a) Complete the table by adding the name of each piece of apparatus.

Letter	Name
A	measuring cylinder
B	filter funnel
C	conical flask
D	test tube
E	pipette
F	beaker

(3) 3

(b) Select the **letters** of two pieces of apparatus that you would normally use to measure accurately the volume of a liquid.

1 E.

2 A.

(2) 2

(c) Which piece of apparatus is needed to separate particles of a solid from a liquid?

B.

(1) 1

Q1

(Total 6 marks) 6

Leave blank

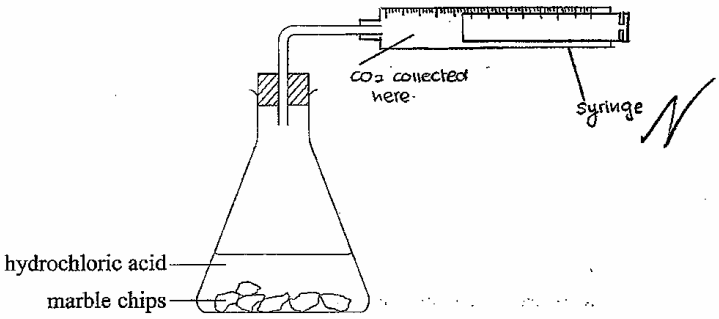
2. Marble chips (calcium carbonate) react with hydrochloric acid.

The equation for the reaction is

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Some students investigated the rate at which carbon dioxide gas is given off at 25 °C. In separate experiments they used different masses of the same sized marble chips with the same volume of hydrochloric acid (an excess).

(a) The diagram shows the apparatus used. Complete the diagram to show how the carbon dioxide could be collected and its volume measured.



(2) 2

Leave blank

(b) The students recorded these results.

(S) Using 2.34 g of marble chips, 83cm³ of carbon dioxide gas were collected in 60 seconds..

(E) We got 45 cm³ of gas in 1 minute when we used 1.05 g of marble chips.

(U) With 1.47 g of solid we made 98 cm³ of gas in 120 seconds.

(I) In 60 seconds 0.59 g of solid gave 29 cm³ of carbon dioxide.

(S) After 90 seconds, 1.21 g of calcium carbonate had made 54 cm³ of carbon dioxide.

Draw a suitable table and enter all of the results given and the units.

Mass of calcium carbonate (grams)	Time taken (seconds)	Amount of carbon dioxide collected (cm^3)
0.59 g	60 secs	29 cm^3
1.05 g	60 secs	45 cm^3
1.21 g	90 secs	54 cm^3
1.47 g	120 secs	98 cm^3
2.34g	60 secs	83 cm^3

(3)

3

QUESTION 2 CONTINUES ON PAGE 6

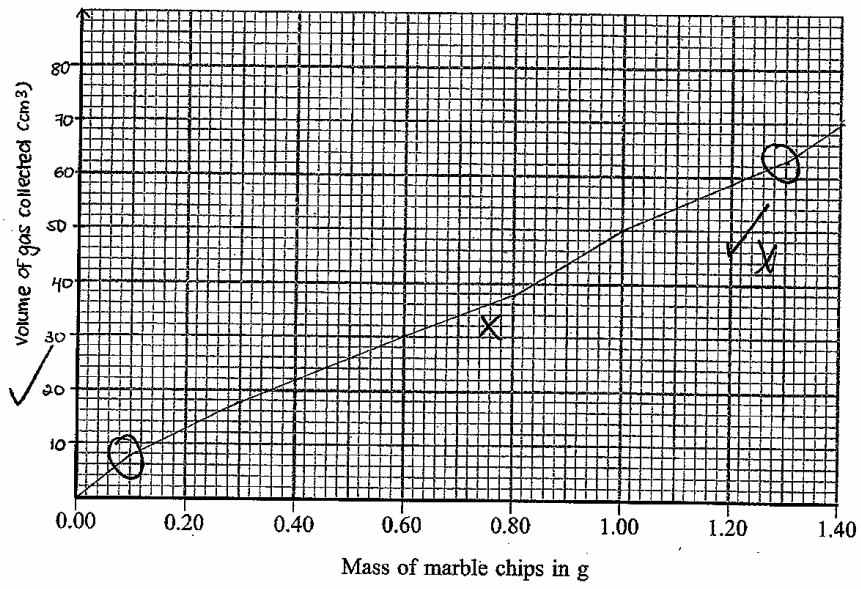
Leave blank

(c) The students' experiment was criticised for not being a **fair test**.
Some students repeated the experiment, making sure it was a fair test.
To do this they measured the volume of gas collected in the first 60 seconds of the reaction.

One student's results are shown in the table.

Mass of marble chips used (g)	Volume of gas collected in 60 seconds (cm^3)
0.15	7.5
0.30	17.5
0.60	30.0
0.80	37.5
1.00	50.0
1.25	62.5
1.40	70.0

(i) Draw a graph of these results on the grid. The scale for the *x*-axis has been done for you.



(4)

2

(ii) Describe how the **rate** of the reaction increases as the mass of marble chips changes.

As the mass of the marble chips increases, the rate of reaction also increases. ✓

(2)

Leave blank: 1

(iii) Give an explanation for this change in rate as the mass of marble chips increases.

The rate of reaction increases as mass increases because as the mass of the marble chips increases, the amount of matter or the composition of calcium carbonate in the reaction increases. When this happen more of calcium carbonate and hydrochloric acid would react togetner and therefore the rate of reaction in the experiment increases. ✗

(2)

Leave blank: 0

(d) Suggest a different way in which the original experiment could be improved to make it a fair test.

The number of marble chips placed in the reaction should be equal throughout the experiment regardless of their mass. ✗

(1)

Leave blank: 0

Q2

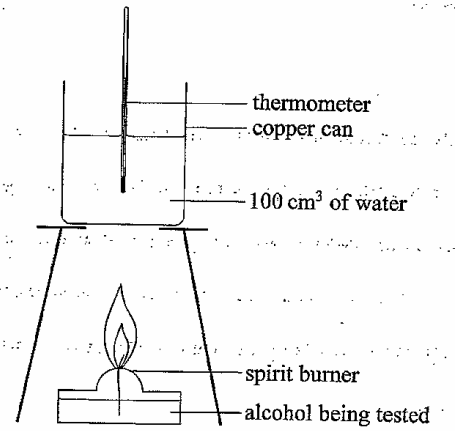
(Total 14 marks)

Leave blank: 8

Leave blank

3. Alcohols are flammable and can be used as fuels.
A student carried out an investigation to see if there was a relationship between the number of carbon atoms in an alcohol and how much energy it gave out when burned.

The diagram shows the apparatus used.



The student placed a spirit burner containing methanol under the can of water. She lit the spirit burner, heated the water for two minutes and put the spirit burner out. She repeated the experiment two more times. As the fuel was burned, the mass of the spirit burner became less. She repeated the experiment with three other alcohols.

(a) The table shows the results obtained.

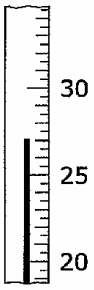
Name of alcohol	Formula of alcohol	Mass of fuel used (g)	Temperature change of water (°C)	Temperature change per gram of fuel (°C g^{-1})	Mean temperature change per gram of fuel (°C g^{-1})
methanol	CH_3OH	0.84	40·5	48.2	48·5
		0.79	38.5	48.7	
		0.76	37.0	48.7	
ethanol	C_2H_5OH	0.78	52.5	67·3	67·1
		0.64	43.0	67·2	
		0.68	45.5	66·9	
propanol	C_3H_7OH	0.54	37.0	68.5	70·4
		0.49	30.0	61.2	
		0.57	46.5	81.6	
butanol	C_4H_9OH	0.43	35.5	82.6	82·3
		0.47	38.5	81.9	
		0.51	42.0	82.4	

Leave blank

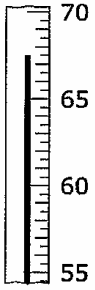
(i) The diagrams show the thermometer readings before and after heating the water in the first experiment for methanol.

Record the temperature shown on each thermometer.

Before



After



Temperature before ..... 27 ✓ °C

Temperature after ..... ✓ 67·5 ..... °C

Calculate the **temperature change** for this experiment.

Temperature change ..... 67·5° − 27° = 40·5° ✓ .....

(3)

3

(ii) Other than measuring the temperature of the water before **and** after heating, what measurements must have been taken to get the results shown in the table on page 8?

other than temperature of water, the mass of the fuel before and after the heating must be measured. ✓

(1)

1

(iii) The temperature change per gram of fuel used is calculated using the equation

$$\textbf{temperature change per gram of fuel} = \frac{\textbf{temperature change}}{\textbf{mass of fuel used}}$$

Complete the table on page 8 to show the temperature change per gram of fuel for each experiment using ethanol.

(3)

3

(iv) For each fuel, calculate the mean temperature change per gram of fuel. Record your answers in the table on page 8.

(2)

2

QUESTION 3 CONTINUES ON PAGE 11

Leave blank

(b) Use the information in the table on page 8 to help you answer this question.

(i) Are the results obtained for **methanol** reliable? Explain your answer.

No. The results obtained for methanol are not reliable because the difference in temperature change between methanol and ethanol are too great and therefore the results obtained are not very reliable.

(1)

0

(ii) The results for **propanol** are not reliable. Explain why not.

The results for propanol are not reliable because the difference in temperature change between propanol and butanol are too great.

(1)

0

(iii) What should the student have done about the results for **propanol**?

The student should have repeated the experiment over again and this time it would be advisable if she start the experiment using the minimum mass of the fuel instead of the one she had already performed.

(2)

1

(c) The student made the following conclusion.

As the number of carbon atoms in any fuel increases, the energy given out when one gram of the fuel is burned also increases.

Are the results obtained sufficient to support this conclusion? Explain your answer.

Yes. The results on the table on page 8 showed as the carbon atoms in the fuel increases, the temperature change in the water also increases. And this happens everytime the number of carbon atom increases. More energy is given out when there are more carbon atoms.

(2)

0

Q3

(Total 15 marks)

10

Leave blank

4. Solutions of lead(II) nitrate and potassium iodide react together to make the insoluble substance lead(II) iodide.

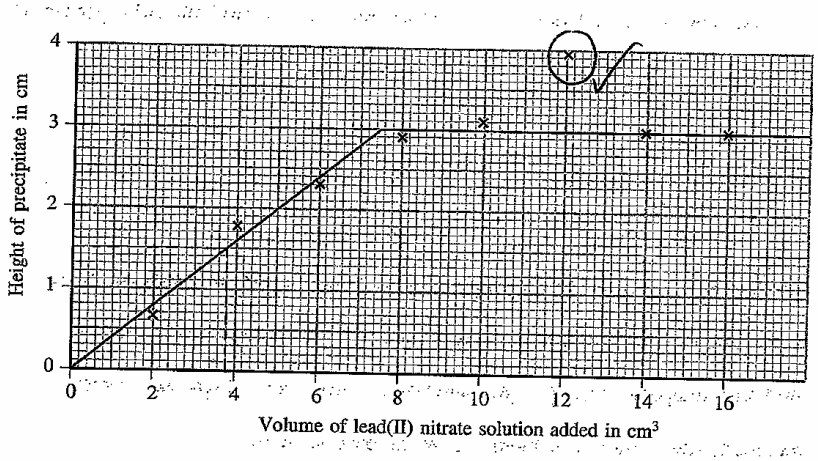
The equation for the reaction is

$$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow 2KNO_3(aq) + PbI_2(s)$$

An investigation was carried out to find how much precipitate formed with different volumes of lead(II) nitrate solution.

- A student measured out 15 cm^3 of potassium iodide solution using a measuring cylinder.
- He placed this solution in a clean boiling tube.
- Using a clean measuring cylinder, he measured out 2 cm^3 of lead(II) nitrate solution (of the same concentration, in mol dm^{-3}, as the potassium iodide solution). He added this to the potassium iodide solution.
- A cloudy yellow mixture formed and this was left to settle.
- The student then measured the height (in cm) of the precipitate using a ruler.

The student repeated the experiment using different volumes of lead(II) nitrate solution. The graph shows the results obtained.



(a) (i) On the graph, circle the point which seems to be anomalous.

(1)

Leave blank

(ii) Explain two things that the student may have done in the experiment to give this anomalous result.

1 The student might have added an access of lead (II) nitrate solution which would form more precipitate making it inaccurate. X

2 Another reason might be because he had placed an inaccurate amount of sodium iodide into the mixture. X

(4) 0

(iii) Why must the graph line go through (0,0)?

The graph must go through the (0,0) point because if 0cm³ of lead (II) nitrate solution is added then 0 cm precipitate would be formed. ✓

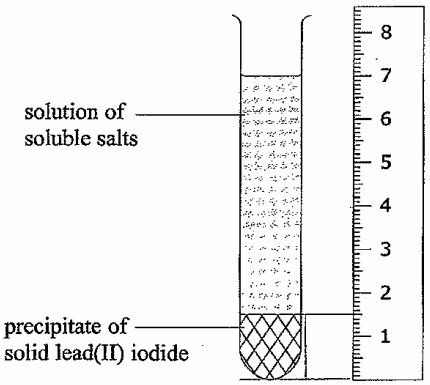
(1) 1

(b) Suggest a reason why the height of the precipitate stops increasing.

The height of the precipitate stopped increasing because there are no more particles left for them to react in order to make the precipitate. X

(1) 0

(c) (i) How much precipitate has been made in the tube?



1.5 ✓ cm

(1) 1

(ii) Use the graph to find the volume of lead(II) nitrate solution needed to make this amount of precipitate.

3.8 cm3. ✓

(1) 1

QUESTION 4 CONTINUES ON PAGE 15

Leave blank

(d) After he had plotted the graph, the student decided he should obtain some more results.

(i) Suggest what volumes of lead(II) nitrate solution he should use.

[redacted] The volumes that he should use are 10 cm^3 and 12 cm^3. X

(1)

0

(ii) Explain why he should use these volumes.

He should use these volumes because it would be easy to add onto the graph and he would be able to find out if he made any mistakes, and find the correct results. X

(1)

0

(e) Suggest a different method for measuring the amount of precipitate formed. This method **must not** be based on the height of the precipitate.

Another method of measuring the amount of precipitate would be by weighing it. To do this take the mixture of precipitate and solution of soluble salt that has been formed and filter it off. The solution would pass through the filter paper as a filtrate and the precipitate would remain on the filter paper as a residue. The residue (precipitate on filter paper) can then be dried in the oven. Once dried, the precipitate can be placed on the weighing scale and its mass can be determined. This is a different method of measuring the amount of precipitate formed.

(4)

3

Q4

4

(Total 15 marks)

TOTAL FOR PAPER: 50 MARKS

END

Paper 3, Script 1: Commentary

This candidate was awarded grade A for this paper.

Question 1

This candidate scored 6 out of 6 in this question.

Question 2

This candidate scored 8 out of 14 in this question, a poor performance for a grade A candidate.

(a) The diagram was carefully drawn and accurately labelled, so both marks were awarded.

(b) The table headings were correct and all the data was accurately entered, so full marks were awarded.

(c) In part (i), one mark was awarded for a correctly labelled and suitably chosen scale for the *y*-axis. Two of the points plotted are at incorrect mass values, so only one out of two marks for plotting was awarded. The line drawn was clearly not straight, so this mark was not awarded.
A general point to note in graph plotting is that the points should always be clearly shown (using a small dot, or dot-in-circle, or a cross). This candidate did not show the points, so the examiner had to check all the places where points should have appeared and assume that if the line went through them all, then the marks for plotting could be awarded. Also, candidates should expect that a line on a graph showing experimental data is likely to be a straight line or a smooth curve. If a decision is made that the line should be straight, then a ruler (required by the rubric on the cover) should be used to draw it.
In part (ii), one mark was awarded for recognising that the rate increased as the mass increased, but for the second mark the connection had to be recognised as one of direct proportion.
No marks were awarded in part (iii) – the candidate omitted to refer to the increase in surface area and there was no reference to collision theory.

(d) This was a difficult mark to score. An obvious suggestion would be to collect the same volume of gas in each experiment.

Question 3

This candidate scored 10 out of 15 in this question, not a good performance for a grade A candidate.

(a) This part was very well answered, with all nine marks being awarded.

(b) In part (i), the candidate compared results for two alcohols, rather than comparing all the results for methanol – as the temperature changes per gram of fuel are very close and much closer than for the other alcohols, the results are reliable.
Again in part (ii) the candidate compared results for two alcohols, rather than comparing all the results for propanol.
In part (iii) the easier mark was awarded, for suggesting repeats, but the candidate did

not include the more subtle point that the original results should not be used.

(c) No marks were awarded here. The results are not sufficient, partly because only a limited range of carbon atoms (only 1-4) was used, but more importantly because only alcohols were considered.

Question 4

This candidate scored 7 out of 15 in this question, not a good performance for a grade A candidate.

(a) The candidate correctly identified the obvious anomalous point in part (i). In part (ii), there were at least three ways in which the anomalous result might have been obtained. The candidate's first suggestion was an excess of lead(II) – as this is already in excess it would not have had an effect. The second suggestion referred to the amount of sodium iodide (this should have been potassium iodide), but the mark was not awarded, not for the slip in mentioning sodium instead of potassium, but for failing to mention that the amount of iodide would have been too great, rather than just inaccurate.

(b) To score the mark here, there had to be a reference to all the iodide being used up, not just the number of particles.

(c) Correct.

(d) Some reference to values in the range 6-10 cm^3 was expected, since these would help to identify the turning point in the graph more accurately.

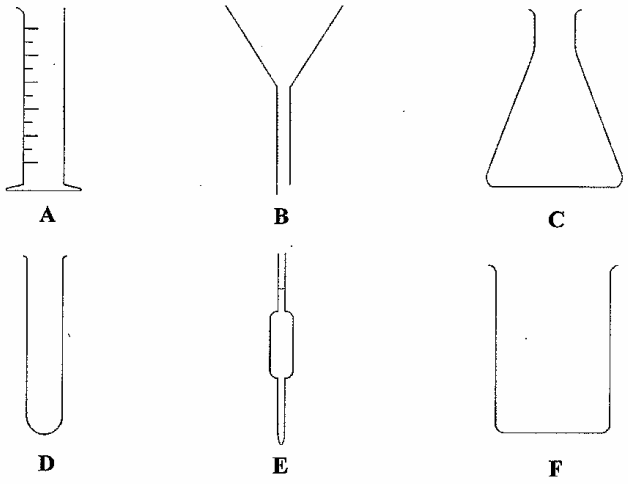
(e) This was well answered, with only the most difficult point (washing the precipitate) being omitted.

Paper 03

Script 2

Leave blank

1. The diagrams show a selection of apparatus you can find in a chemistry laboratory.



(a) Complete the table by adding the name of each piece of apparatus.

Letter	Name
A	measuring cylinder ✓
B	filter funnel
C	Conical flask ✓
D	test tube
E	pipette
F	Beaker ✓

(3)

(b) Select the **letters** of two pieces of apparatus that you would normally use to measure accurately the volume of a liquid.

1 E ✓

2 A ✓

(2)

(c) Which piece of apparatus is needed to separate particles of a solid from a liquid?

B ✓ (filter funnel)

(1)

(Total 6 marks)

Q1 6 ✓

Leave blank

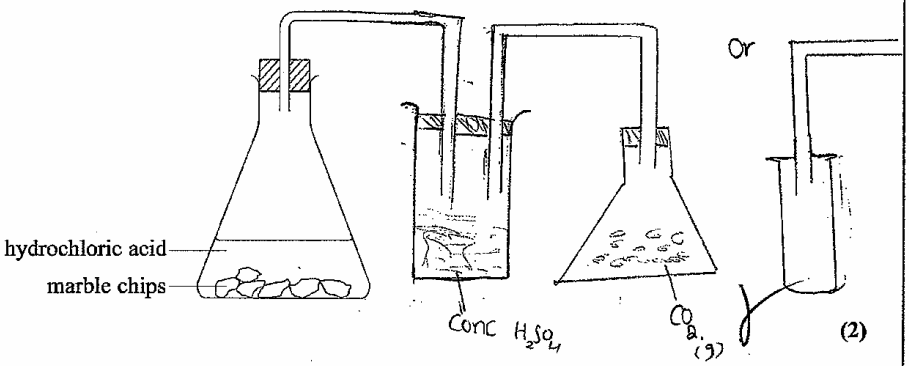
2. Marble chips (calcium carbonate) react with hydrochloric acid.

The equation for the reaction is

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Some students investigated the rate at which carbon dioxide gas is given off at 25 °C. In separate experiments they used different masses of the same sized marble chips with the same volume of hydrochloric acid (an excess).

(a) The diagram shows the apparatus used. Complete the diagram to show how the carbon dioxide could be collected and its volume measured.



(2)

Leave blank

(b) The students recorded these results.

Using 2.34 g of marble chips, 83cm^3 of carbon dioxide gas were collected in 60 seconds.

We got 45 cm^3 of gas in 1 minute when we used 1.05 g of marble chips.

With 1.47 g of solid we made 98 cm^3 of gas in 120 seconds.

In 60 seconds 0.59 g of solid gave 29 cm^3 of carbon dioxide.

After 90 seconds, 1.21 g of calcium carbonate had made 54 cm^3 of carbon dioxide.

Draw a suitable table and enter all of the results given and the units.

Marble Chips (in grams)	Co_2 gas (in cm^3)	CO_2 gas (Sec)
2.34	83	60
1.05	45	60
1.47	98	120
1.21	54	90

(3)

1

QUESTION 2 CONTINUES ON PAGE 6

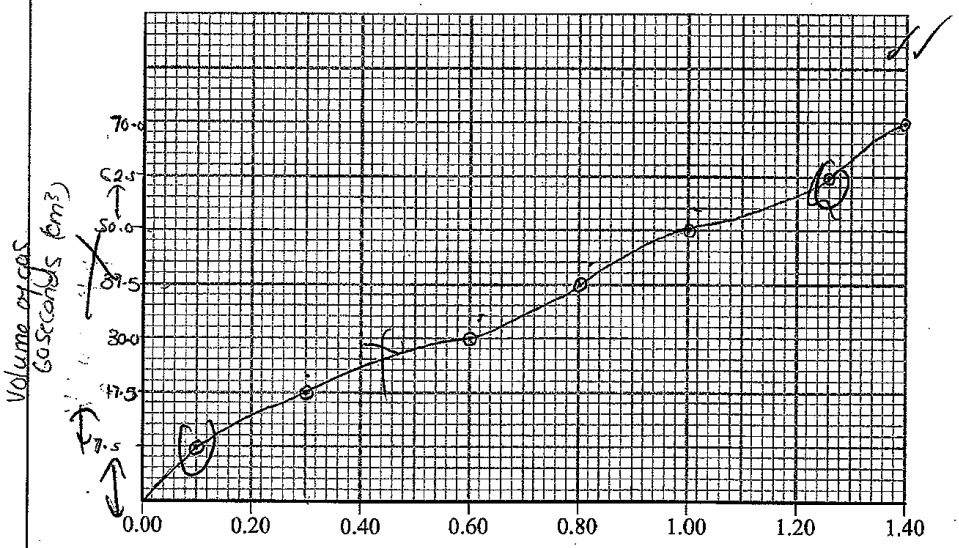
Leave blank

(c) The students' experiment was criticised for not being a **fair test.**
Some students repeated the experiment, making sure it was a fair test.
To do this they measured the volume of gas collected in the first 60 seconds of the reaction.

One student's results are shown in the table.

Mass of marble chips used (g)	Volume of gas collected in 60 seconds (cm^3)
0.15	7.5
0.30	17.5
0.60	30.0
0.80	37.5
1.00	50.0
1.25	62.5
1.40	70.0

(i) Draw a graph of these results on the grid. The scale for the *x*-axis has been done for you.



(4)

Leave blank

(ii) Describe how the **rate** of the reaction increases as the mass of marble chips changes.

The rate of reaction increases when marble chips are increased in mass. ✓ 1

(2)

(iii) Give an explanation for this change in rate as the mass of marble chips increases.

The particle size of the marble chips are more increasing the mass and therefore the rate of X reaction could be faster. 0

(2)

(d) Suggest a different way in which the original experiment could be improved to make it a fair test.

By placing the correct readings on the table. 0

(1)

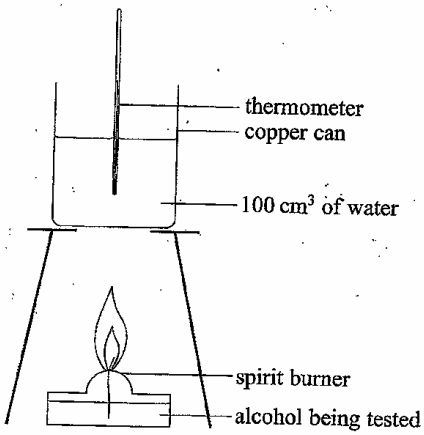
Q2 0 ✓

(Total 14 marks)

Leave blank

3. Alcohols are flammable and can be used as fuels.
A student carried out an investigation to see if there was a relationship between the number of carbon atoms in an alcohol and how much energy it gave out when burned.

The diagram shows the apparatus used.



The student placed a spirit burner containing methanol under the can of water. She lit the spirit burner, heated the water for two minutes and put the spirit burner out. She repeated the experiment two more times. As the fuel was burned, the mass of the spirit burner became less. She repeated the experiment with three other alcohols.

(a) The table shows the results obtained.

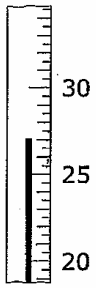
Name of alcohol	Formula of alcohol	Mass of fuel used (g)	Temperature change of water (°C)	Temperature change per gram of fuel (°C g^{-1})	Mean temperature change per gram of fuel (°C g^{-1})
methanol	CH_3OH	0.84	40.5	48.2	24.3
		0.79	38.5	48.7	
		0.76	37.0	48.7	
ethanol	C_2H_5OH	0.78	52.5	67.3	67.13
		0.64	43.0	67.2	
		0.68	45.5	66.9	
propanol	C_3H_7OH	0.54	37.0	68.5	70.43
		0.49	30.0	61.2	
		0.57	46.5	81.6	
butanol	C_4H_9OH	0.43	35.5	82.6	82.3
		0.47	38.5	81.9	
		0.51	42.0	82.4	

Leave blank

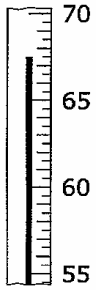
(i) The diagrams show the thermometer readings before and after heating the water in the first experiment for methanol.

Record the temperature shown on each thermometer.

Before



After



Temperature before ~~22~~ 27 °C

Temperature after 67.5 °C

Calculate the **temperature change** for this experiment.

Temperature change ~~45.5~~ 40.5 °C

(3)

3

(ii) Other than measuring the temperature of the water before **and** after heating, what measurements must have been taken to get the results shown in the table on page 8?

The Initial temperature

(1)

0

(iii) The temperature change per gram of fuel used is calculated using the equation

$$\textbf{temperature change per gram of fuel} = \frac{\textbf{temperature change}}{\textbf{mass of fuel used}}$$

Complete the table on page 8 to show the temperature change per gram of fuel for each experiment using ethanol.

(3)

3

(iv) For each fuel, calculate the mean temperature change per gram of fuel. Record your answers in the table on page 8.

(2)

1

QUESTION 3 CONTINUES ON PAGE 11

Leave blank

(b) Use the information in the table on page 8 to help you answer this question.

(i) Are the results obtained for **methanol** reliable? Explain your answer.

The results for methanol are not reliable because the Carbon atoms decreases.

(1)

0

(ii) The results for **propanol** are not reliable. Explain why not.

They have Propanol has less Carbon atoms and that decreases energy given out.

(1)

0

(iii) What should the student have done about the results for **propanol**?

The Student Should have Increased the temperature so as to make Propanol have good results

(2)

0

(c) The student made the following conclusion.

As the number of carbon atoms in any fuel increases, the energy given out when one gram of the fuel is burned also increases.

Are the results obtained sufficient to support this conclusion? Explain your answer.

The results are Sufficient because the fuel in table burned increases and that Carbon atom increase.

(2)

0

Q3

(Total 15 marks)

7 ✓

Leave blank

4. Solutions of lead(II) nitrate and potassium iodide react together to make the insoluble substance lead(II) iodide.

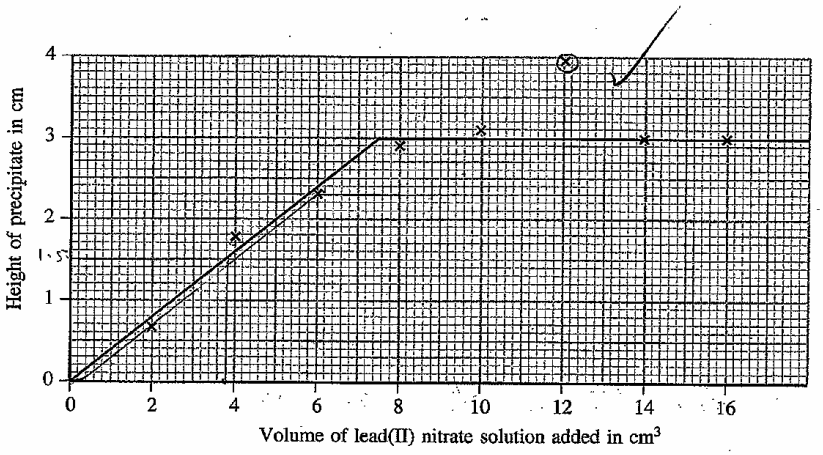
The equation for the reaction is

$$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow 2KNO_3(aq) + PbI_2(s)$$

An investigation was carried out to find how much precipitate formed with different volumes of lead(II) nitrate solution.

- A student measured out 15 cm^3 of potassium iodide solution using a measuring cylinder.
- He placed this solution in a clean boiling tube.
- Using a clean measuring cylinder, he measured out 2 cm^3 of lead(II) nitrate solution (of the same concentration, in mol dm^{-3}, as the potassium iodide solution). He added this to the potassium iodide solution.
- A cloudy yellow mixture formed and this was left to settle.
- The student then measured the height (in cm) of the precipitate using a ruler.

The student repeated the experiment using different volumes of lead(II) nitrate solution. The graph shows the results obtained.



(a) (i) On the graph, circle the point which seems to be anomalous.

(1)

(ii) Explain two things that the student may have done in the experiment to give this anomalous result.

1 Addition of lead (II) nitrate - will speed up the rate of reaction. ✓

2 Measure the initial readings of the Solution. ✓

(4)

Leave blank

0

(iii) Why must the graph line go through (0,0)?

The graph line must go through (0,0) so as to be accurate.

(1)

0

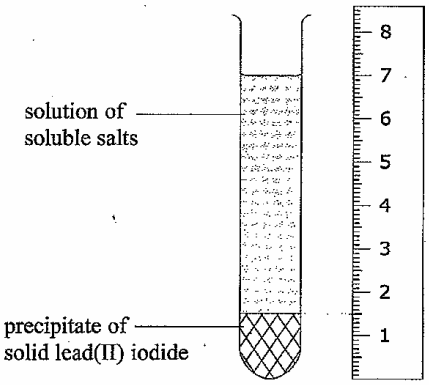
(b) Suggest a reason why the height of the precipitate stops increasing.

The height stops to increase because of the concentration of the lead (II) nitrate. ✓

(1)

0

(c) (i) How much precipitate has been made in the tube?



1.5 ✓ cm

(1)

1

(ii) Use the graph to find the volume of lead(II) nitrate solution needed to make this amount of precipitate.

3.8cm³ ✓

(1)

1

QUESTION 4 CONTINUES ON PAGE 15

Leave blank

(d) After he had plotted the graph, the student decided he should obtain some more results.

(i) Suggest what volumes of lead(II) nitrate solution he should use.

2 cm^3 and 6 cm^3. ✓

0

(1)

(ii) Explain why he should use these volumes.

Because the volumes are accurate. ✓

0

(1)

(e) Suggest a different method for measuring the amount of precipitate formed. This method **must not** be based on the height of the precipitate.

By using graduated Syringe, the Solid lead(II) nitrate is passed through the tube and then the Syringe reads the volume of the lead (II) nitrate and it is also used to Separate mixtures Such as lead (II) nitrate.

0

(4)

Q4

3 ✓

(Total 15 marks)

TOTAL FOR PAPER: 50 MARKS

END

Question 1

This candidate was awarded a grade C for this paper.

6 out of 6 in this question is a good performance for a grade C candidate.

Question 2

This candidate scored 4 out of 14 in this question, a poor performance for a grade C candidate.

(a) The diagram showed apparatus for drying the gas (which was not required, but which would not have been penalised), but no correct method of gas collection was shown (this could have been over water or in a syringe).

(b) One mark was awarded for the correct units appearing. However, the table headings did not contain references to mass, volume or time, and one of the values was copied incorrectly.

(c) In part (i), the candidate was fortunate to score both marks for plotting the points (there was one error, which was not penalised), as the scale chosen for the *y*-axis was not linear. The line drawn was clearly not straight, so the final mark was not awarded.
In part (ii), one mark was awarded for recognising that the rate increased as the mass increased, but for the second mark the connection had to be recognised as one of direct proportion.
No marks were awarded in part (iii) – the candidate omitted to refer to the increase in surface area and there was no reference to collision theory.

(d) This was a difficult mark to score. An obvious suggestion would be to collect the same volume of gas in each experiment.

Question 3

This candidate scored 7 out of 15 in this question, a reasonable performance for a grade C candidate.

(a) This part was quite well answered, with seven out of nine marks being awarded. The mean temperature change per gram of fuel for methanol was incorrectly calculated, probably by dividing the total of the temperature changes by 6 instead of by 3

(b) No marks were awarded here. The candidate showed no understanding of reliability, and in addition none of the answers contained any chemical sense.

(c) No marks were awarded here. The results are not sufficient, partly because only a limited range of carbon atoms (only 1-4) was used, but more importantly because only alcohols were considered.

Question 4

This candidate scored 3 out of 15 in this question, a poor performance for a grade C candidate.

(a) The candidate correctly identified the obvious anomalous point in part (i). Neither suggestion in part (ii) made any chemical sense.

(b) To score the mark here, there had to be a reference to all the iodide being used up. The candidate's reference to the concentration of lead(II) nitrate is irrelevant.

(c) Correct.

(d) Some reference to values in the range 6-10 cm^3 was expected, since these would help to identify the turning point in the graph more accurately.

(e) It is hard to imagine what might have been in the candidate's mind from this answer.

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