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mock papers 1-foundation

1 Potassium sulfate and ammonium nitrate are both fertilisers.

Potassium sulfate has the formula K_2SO_4.

Ammonium nitrate has the formula NH_4NO_3.

Fertilisers contain one or more of the essential elements needed by plants.

(a) Ammonium nitrate contains the essential element nitrogen.

Potassium sulfate, K_2SO_4, contains another one of these essential elements.

Which one?

..... [1]

(b) What is the total number of atoms shown in the formula K_2SO_4?

..... [1]

(c) Ammonium nitrate has a relative formula mass (M_r) of 80.

What is the relative formula mass of potassium sulfate, K_2SO_4?

The relative atomic mass of O is 16, of S is 32 and of K is 39.

.....

.....

.....

relative formula mass = ... [1]

(d) Potassium sulfate dissolves in water.

A **neutral** solution is made.

(i) What is the pH of potassium sulfate solution?

Choose from the list.

5

7

8

14

answer ..... [1]

(ii) Why is it important that a fertiliser dissolves in water?

.....

..... [1]

(e) Clare makes ammonium nitrate.

She neutralises 25.0 cm^3 of an alkali called ammonia.

She slowly adds an acid until the alkali is just neutralised.

(i) What is the name of the acid she must use?

Choose from the list.

hydrochloric acid

nitric acid

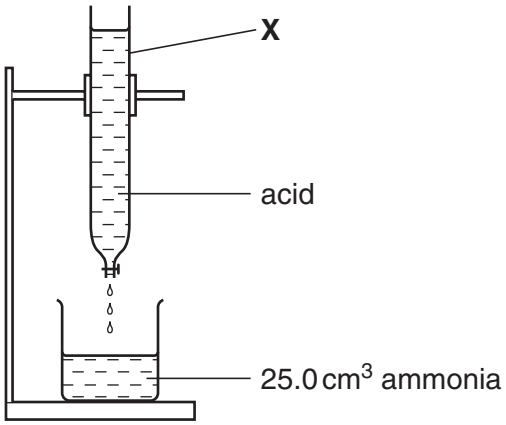
phosphoric acid

sulfuric acid

answer ..... [1]

[Turn over for remainder of question 1

(ii) Look at the apparatus she uses.



What is the name of the apparatus labelled **X**?

..... [1]

(iii) Clare makes 0.45 g of ammonium nitrate.

She predicts she should make 0.50 g.

What is her percentage yield?

.....

.....

.....

percentage yield = ... % [2]

[Total: 9]

2 This question is about the manufacture of chemicals.

(a) Lots of ammonia is manufactured each year in the United Kingdom.

Ammonia is made by the reaction of nitrogen and hydrogen in a continuous process.

The conditions used for this reaction are

- 450 °C
- high pressure
- iron catalyst.

One of the costs of making ammonia is buying the raw materials.

Write about **two** other costs of making ammonia.

.....

.....

..... [2]

(b) A new anti-cancer drug is made from a rare plant only found in South America.

Less than 100 kg of the drug is made each year.

It is made in a batch process.

(i) What is the difference between a continuous process and a batch process?

.....

..... [1]

(ii) The cost of manufacturing and developing the drug is very high.

Write about some of the reasons why this cost is very high.

.....

.....

..... [2]

[Total: 5]

3 In the year 2006 many areas of the United Kingdom suffered drought conditions.

Water companies take water from rivers and store it in reservoirs.

Unfortunately in the year 2006 many rivers were almost dry.

Reservoirs were often less than half full.

(a) Look at the table.

It shows the annual rainfall in 1998 and 2001 for some regions of the United Kingdom.

region	rainfall in 1998 in mm	rainfall in 2001 in mm
Anglia	713	731
Northumbria	1039	807
North West	1435	1081
Severn Trent	885	767
Southern	875	865
South West	1428	1008
Thames	812	779
Wales	1642	1250
Wessex	1005	825
Yorkshire	964	787

(i) Which region had the **most** rainfall in the year 2001?

..... [1]

(ii) One region had **more** rainfall in the year 2001 than in 1998.

Which one?

..... [1]

(b) Rivers and reservoirs are two sources of drinking water.

Write down the name of one **other** source of drinking water in the United Kingdom.

..... [1]

(c) Water from rivers sometimes contains dangerous microbes.

These must be killed before the water is safe to drink.

How are these microbes killed when water is purified?

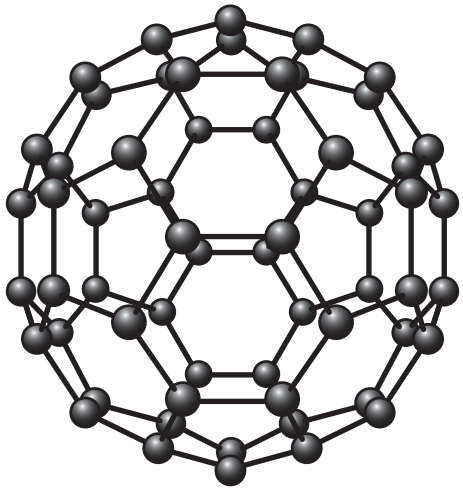
..... [1]

[Total: 4]

4 This question is about fullerenes and nanotubes.

(a) Look at the diagram of a fullerene.

It is called buckminster fullerene.



Buckminster fullerene is an element.

Which element?

..... [1]

(b) Fullerenes can be joined together to make nanotubes.

Nanotubes are used to make semiconductors and to reinforce graphite in sports equipment.

Put a tick (✓) in the box next to a correct property of nanotubes.

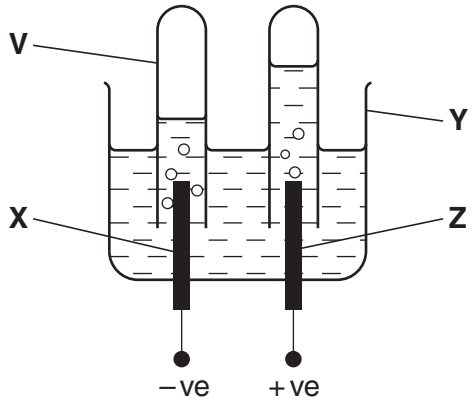
electrical insulator	☐
soluble in water	☐
strong	☐
very low melting point	☐

[1]

[Total: 2]

5 Hannah investigates the electrolysis of aqueous potassium sulfate.

Look at the apparatus she uses.



(a) Look at the table. It shows some of the names of the apparatus used.

Finish the table.

name of apparatus	letter
anode	
cathode	
test tube	

[3]

(b) There are bubbles of gas made at both electrodes.

What are the names of the **two** gases made during this electrolysis?

Choose from the list.

carbon dioxide

hydrogen

nitrogen

oxygen

sulfur dioxide

answer ..... and ..... [2]

[Total: 5]

[Turn over

6 Monty investigates the properties of two acids

- dilute ethanoic acid, CH_3COOH
- dilute hydrochloric acid, HCl.

(a) How many different **elements** are chemically bonded in ethanoic acid?

..... [1]

(b) Describe how Monty can measure the pH value of dilute ethanoic acid.

.....

..... [2]

(c) Monty adds a small piece of magnesium ribbon to a sample of dilute ethanoic acid.

Look at the word equation for this reaction.

magnesium + ethanoic acid $\longrightarrow$ magnesium ethanoate + hydrogen

A gas is made when magnesium reacts with ethanoic acid.

What is the name of this gas?

..... [1]

(d) Ethanoic acid and hydrochloric acid both react with calcium carbonate.

A gas is made when these acids react with calcium carbonate.

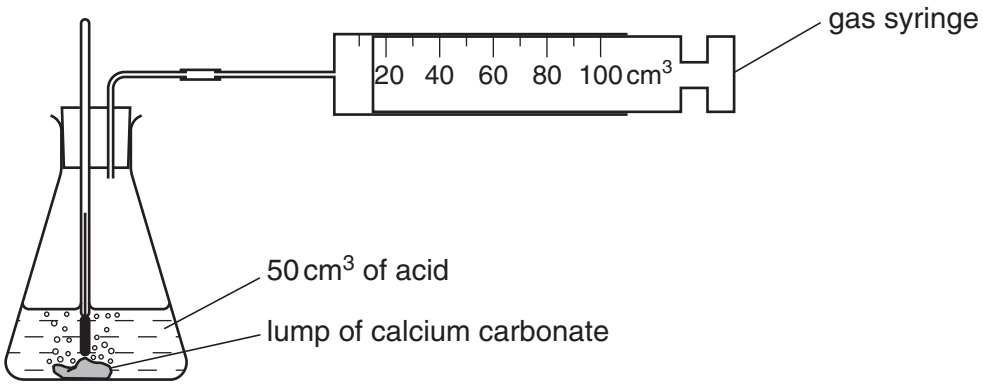
What is the name of this gas?

..... [1]

(e) Monty investigates the reaction of both acids with a lump of calcium carbonate.

He wants to find out the volume of gas made every 10 seconds.

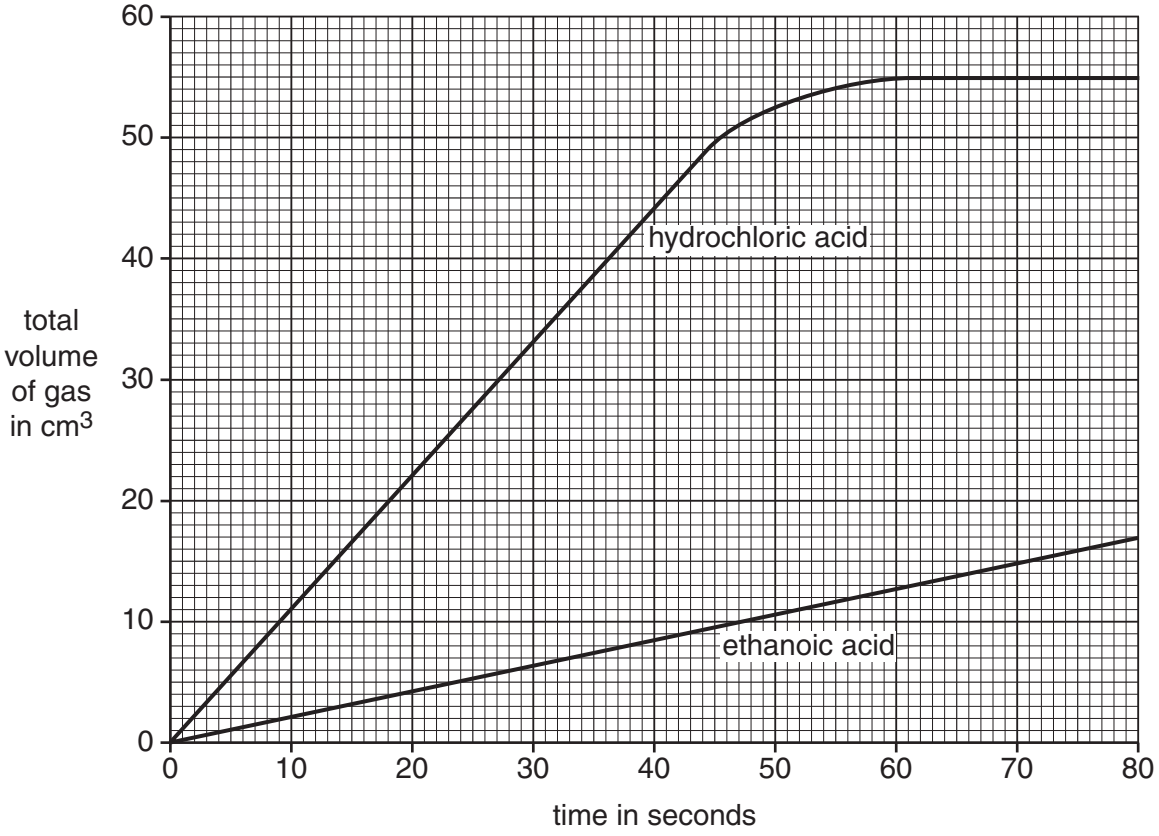
Look at the apparatus he uses.



He does two experiments, one with dilute ethanoic acid and one with dilute hydrochloric acid.

He makes sure he does a fair test.

Look at the graph of his results.



(i) Which acid reacts faster?

.....

Use the graph to explain your answer.

.....

..... [1]

(ii) How long does it take for the reaction with hydrochloric acid to stop?

..... seconds [1]

(iii) The reaction between calcium carbonate and ethanoic acid is still happening after 80 seconds.

What will be the total volume of gas collected at the **end** of this reaction?

..... cm^3 [1]

[Total: 8]

[Turn over

7 Zoe tests an unknown solution.

(a) She uses barium ions in solution to test for sulfate ions.

Look at the ionic equation.

It shows the reaction between barium ions and sulfate ions.

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

(i) What is the meaning of (s) in $BaSO_4(s)$?

..... [1]

(ii) What is the meaning of (aq) in $Ba^{2+}(aq)$?

..... [1]

(b) Zoe tests the unknown solution again.

This time she adds silver nitrate solution.

She sees a pale yellow precipitate.

Which ion is in the solution?

Choose from the list.

chloride, Cl^-

bromide, Br^-

iodide, I^-

answer ..... [1]

[Total: 3]

8 This question is about equilibrium and reversible reactions.

Ethene reacts with steam in a reversible reaction to make ethanol.

$$\text{ethene} + \text{water} \rightleftharpoons \text{ethanol}$$

This reversible reaction can reach equilibrium if it is in a sealed container.

(a) At equilibrium there is a connection between the rate of the forward reaction and the rate of the backward reaction.

What is this connection?

..... [1]

(b) What happens to the concentration of ethene and of water at equilibrium?

..... [1]

(c) Look at the table.

It shows how the percentage of ethene at equilibrium changes as the **temperature** changes and as the **pressure** changes.

	temperature		
pressure	200 °C	260 °C	320 °C
30 atmospheres	37%	26%	21%
40 atmospheres	40%	30%	25%
50 atmospheres	44%	35%	30%
60 atmospheres	48%	40%	34%

(i) Look at the row at 30 atmospheres.

What happens to the percentage of ethene as the temperature increases?

..... [1]

(ii) What happens to the percentage of ethene as the pressure increases but the temperature stays the same?

..... [1]

[Total: 4]

[Turn over

9 People living in hard water areas find they use more soap when washing.

The hardness of water can be measured by adding soap to the water until it makes permanent bubbles.

Look at the table.

It shows the results for some samples of water.

The volume of water in each sample was the same.

	sample of water			
	distilled water	**A**	**B**	**C**
volume of soap added to cold water in cm^3	3	3	15	14
volume of soap added to boiled water in cm^3	3	3	15	3

(a) (i) Which sample of water shows **permanent** hardness?

Choose from **A**, **B** or **C**.

answer ..... [1]

(ii) Which sample of water shows **temporary** hardness?

Choose from **A**, **B** or **C**.

answer ..... [1]

(b) Look at the list.

calcium hydrogencarbonate

calcium sulfate

ethanoic acid

sodium chloride

sodium hydroxide

(i) Write down the name of a substance that causes **permanent** hardness.

Choose from the list.

answer ..... [1]

(ii) Write down the name of a substance that causes **temporary** hardness.

Choose from the list.

answer ..... [1]

(iii) Hard water causes limescale to form on the heating element of a kettle.

Write down the name of a substance that could be used as a limescale remover.

Choose from the list.

answer ..... [1]

[Total: 5]

10 Chlorofluorocarbons, CFCs, are substances that damage the ozone layer.

$CFCl_3$ is the formula for a chlorofluorocarbon.

(a) Write down the **names** of the three elements found in $CFCl_3$.

element 1 .....

element 2 .....

element 3 .....

[2]

(b) What is the main use of CFCs?

Choose from the list.

cooking oil

disinfectants

refrigerants

rocket fuel

answer ..... [1]

(c) Damage to the ozone layer causes increased levels of ultraviolet light.

This can lead to medical problems.

Write about **two** of these medical problems.

.....

.....

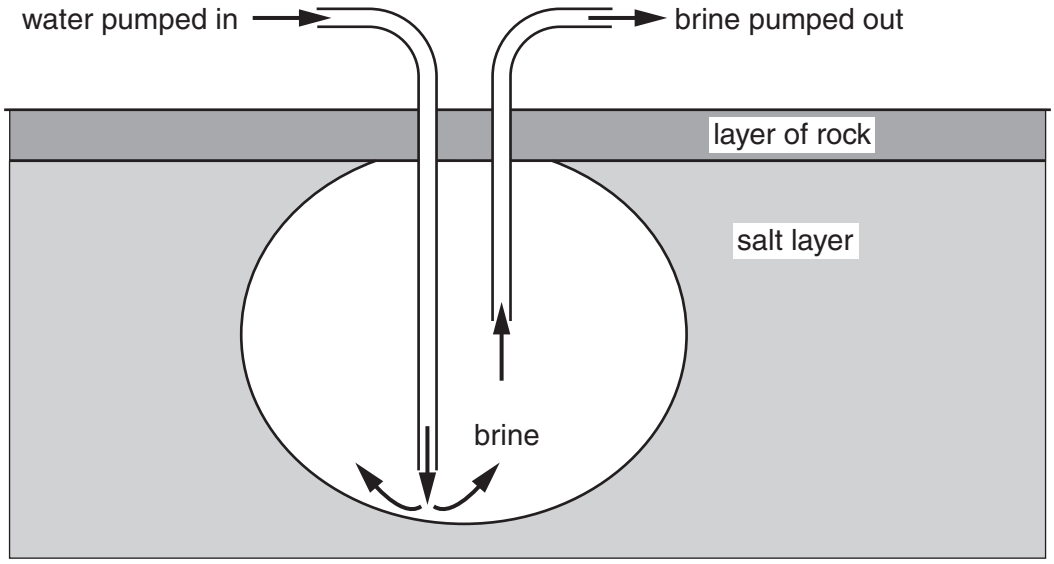
..... [2]

[Total: 5]

11 Brine is a solution of sodium chloride.

Solution mining is used to get brine out of the ground.

Look at the diagram of solution mining.



(a) Write about one major environmental problem caused by solution mining.

..... [1]

(b) Hydrogen and chlorine can be obtained by the electrolysis of brine.

(i) Describe a chemical test for hydrogen gas.

test .....

result .....

..... [2]

(ii) Describe a chemical test for chlorine gas.

test .....

result .....

..... [2]

[Total: 5]

[Turn over

12 Ethanol is made by the fermentation of glucose.

Carbon dioxide is also made in the process.

(a) Complete the **word** equation for fermentation.

glucose → ..... + ... [1]

(b) What is the best temperature for fermentation to happen?

Choose from the list.

0 °C

40 °C

100 °C

400 °C

answer ..... [1]

(c) Fermentation makes a dilute solution of ethanol.

What method of separation could be used to get almost pure ethanol?

Choose from the list.

crystallisation

electrolysis

evaporation

filtration

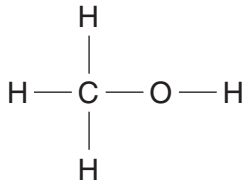
fractional distillation

answer ..... [1]

(d) Write down **one** of the uses of ethanol.

..... [1]

(e) Look at the displayed formula for methanol, CH_3OH.



Draw the displayed formula of ethanol, C_2H_5OH.

[1]

[Total: 5]

END OF QUESTION PAPER

mock papers 2-higher

1 Ammonium sulfate and ammonium nitrate are both fertilisers.

Ammonium sulfate has the formula $(NH_4)_2SO_4$.

Ammonium nitrate has the formula NH_4NO_3.

(a) What is the total number of **atoms** shown in the formula $(NH_4)_2SO_4$?

..... [1]

(b) Ammonium nitrate has a relative formula mass (M_r) of 80.

What is the relative formula mass of ammonium sulfate?

The relative atomic mass of H is 1, of N is 14, of O is 16, and of S is 32.

.....

.....

.....

relative formula mass = ... [1]

Ammonium nitrate contains 35% by mass of nitrogen.

What is the percentage by mass of nitrogen in ammonium sulfate?

.....

.....

percentage by mass = ... [1]

(c) Ammonium sulfate dissolves in water.

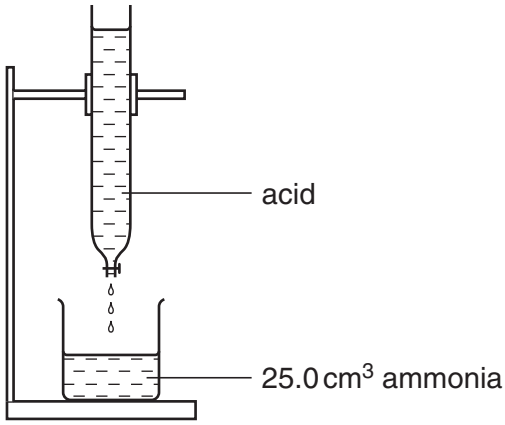
Why is it important that a fertiliser dissolves in water?

.....

..... [1]

(d) Clare makes ammonium nitrate.

Look at the apparatus she uses.



She uses 25.0 cm^3 of an alkali called ammonia.

She slowly adds an acid until the alkali is just neutralised.

(i) What is the name of the acid she must use?

Choose from the list.

hydrochloric acid

nitric acid

phosphoric acid

sulfuric acid

answer ..... [1]

(ii) The pH value in the beaker changes as the acid is added.

Describe how the pH value changes.

.....

Explain why.

.....

.....

..... [2]

[Turn over for remainder of question 1

(iii) Clare makes 0.45 g of ammonium nitrate.

She predicts she should make 0.50 g.

What is her percentage yield?

.....

.....

.....

percentage yield = ... % [2]

[Total: 9]

2 This question is about the manufacture of chemicals.

(a) Many millions of tonnes of ammonia are manufactured each year in the United Kingdom.

Ammonia is made by the reaction of nitrogen and hydrogen in a continuous process.

The conditions used for this reaction are

- 450 °C
- high pressure
- iron catalyst.

Explain why these conditions are chosen.

Use ideas about rate of reaction and percentage yield in your answer.

.....

.....

.....

.....

..... [3]

(b) A new anti-cancer drug is made from a rare plant only found in South America.

Less than 100 kg of the drug is made each year.

It is made in a batch process.

The cost of manufacturing and developing the drug is very high.

Write about some of the reasons why this cost is very high.

.....

.....

..... [2]

(c) The anti-cancer drug is made in a batch process rather than a continuous one.

Suggest one reason why.

.....

..... [1]

[Total: 6]

[Turn over

3 Washing up liquids contain a detergent.

Washing up liquid will clean plates covered in fat.

(a) Look at the diagram of a detergent molecule.

Label the diagram to show

- the hydrophilic part of the molecule
- the hydrophobic part of the molecule.

[1]

(b) Detergent molecules help to remove fat from a dirty plate.

Explain how.

A labelled diagram will help you to answer this question.

.....

.....

.....

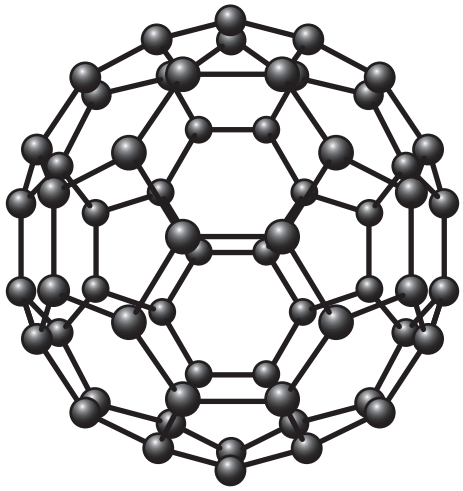
..... [2]

[Total: 3]

4 This question is about fullerenes and nanotubes.

(a) Look at the diagram of a fullerene.

It is called buckminster fullerene.



What is the chemical formula of buckminster fullerene?

..... [1]

(b) Fullerenes can be joined together to make nanotubes.

Nanotubes are used to make very effective industrial catalysts.

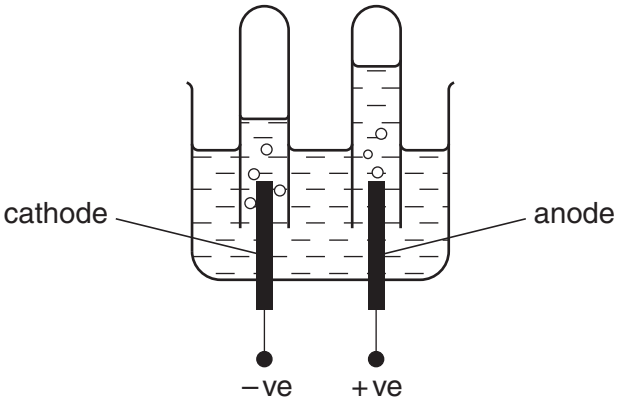
Give **one** reason why.

..... [1]

[Total: 2]

5 Hannah investigates the electrolysis of aqueous potassium sulfate.

Look at the apparatus she uses.



(a) There are bubbles of gas made at both electrodes.

What are the names of the **two** gases made during this electrolysis?

Choose from the list.

carbon dioxide

hydrogen

nitrogen

oxygen

sulfur dioxide

answer ..... and ..... [2]

(b) Write down **two** factors that affect the amount of gas made when aqueous potassium sulfate is electrolysed.

1 .....

2 ..... [2]

[Total: 4]

[Turn over

6 Monty investigates the properties of two acids

- dilute ethanoic acid, CH_3COOH
- dilute hydrochloric acid, HCl.

(a) Monty adds a small piece of magnesium ribbon to dilute ethanoic acid.

Monty sees bubbles of a gas. At the end of the reaction a colourless solution is left.

The colourless solution contains magnesium ethanoate, $Mg(CH_3COO)_2$.

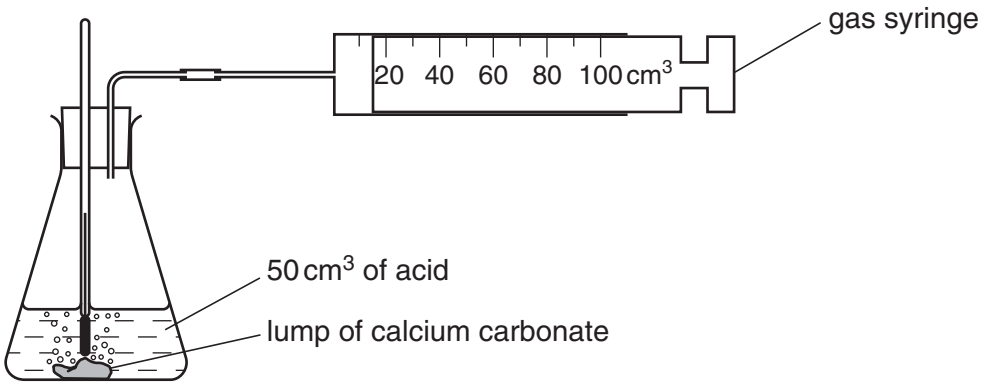
Write down the balanced **symbol** equation for the reaction between magnesium and ethanoic acid.

..... [2]

(b) Monty investigates the reaction of both acids with a lump of calcium carbonate.

He wants to find out the volume of gas made every 10 seconds.

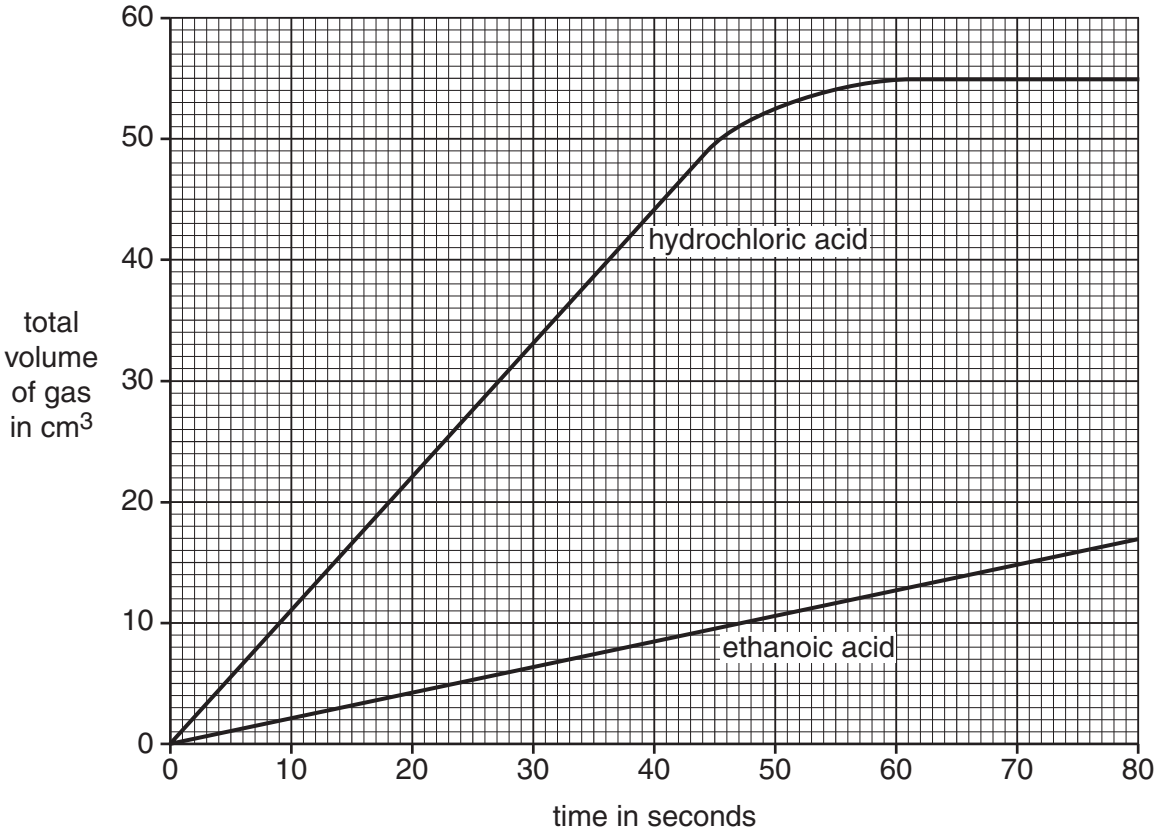
Look at the apparatus he uses.



He does two experiments, one with dilute ethanoic acid and one with dilute hydrochloric acid.

He makes sure he does a fair test.

Look at the graph of his results.



(i) The reaction between calcium carbonate and ethanoic acid is still happening after 80 seconds.

What will be the total volume of gas collected at the **end** of this reaction?

..... cm^3 [1]

(ii) Dilute hydrochloric acid reacts much faster than dilute ethanoic acid.

Explain why.

Use ideas about

- hydrogen ions
- collisions between particles.

.....

.....

.....

..... [3]

[Total: 6]

[Turn over

7 This question is about equilibrium and reversible reactions.

Ethene reacts with steam in a reversible reaction to make ethanol.

$$C_2H_4 + H_2O \rightleftharpoons C_2H_5OH$$

This reversible reaction can reach equilibrium if it is in a sealed container.

(a) At equilibrium there is a connection between the rate of the forward reaction and the rate of the backward reaction.

What is this connection?

..... [1]

(b) What happens to the concentration of ethene and of water at equilibrium?

..... [1]

(c) Look at the table.

It shows how the percentage of ethene at equilibrium changes as the **temperature** changes and as the **pressure** changes.

	temperature		
pressure	200 °C	260 °C	320 °C
30 atmospheres	37%	26%	21%
40 atmospheres	40%	30%	25%
50 atmospheres	44%	35%	30%
60 atmospheres	48%	40%	34%

What happens to the percentage of ethene as the pressure increases but the temperature stays the same?

..... [1]

(d) Calculate the maximum mass of ethanol that can be made from 5.6 tonnes of ethene.

The relative atomic mass for H is 1, for C is 12 and for O is 16.

.....

.....

.....

.....

maximum mass of ethanol = ... [3]

[Total: 6]

8 Zoe tests copper(II) sulfate solution.

(a) Zoe adds barium chloride solution to copper(II) sulfate solution.

A white precipitate appears.

Write down the **word** equation for this reaction.

..... [1]

(b) Zoe adds sodium hydroxide solution to copper(II) sulfate solution.

This time she gets a blue precipitate of copper(II) hydroxide, $Cu(OH)_2$.

Write down the **ionic** equation for the reaction between aqueous Cu^{2+} and aqueous OH^-.

Include **state** symbols.

..... [3]

[Total: 4]

9 This question is about the hardness of water.

(a) Look at the list.

calcium hydrogencarbonate

calcium sulfate

ethanoic acid

sodium chloride

sodium hydroxide

(i) Write the name of a substance that causes **permanent** hardness.

Choose from the list.

answer ..... [1]

(ii) Write the name of a substance that causes **temporary** hardness.

Choose from the list.

answer ..... [1]

(b) Calcium carbonate, $CaCO_3$, reacts with water and carbon dioxide to make calcium hydrogencarbonate, $Ca(HCO_3)_2$.

Write a balanced **symbol** equation for this reaction.

..... [1]

(c) Ion exchange resins can be used to soften water.

Explain how ion exchange resins soften water.

.....

.....

.....

..... [2]

[Total: 5]

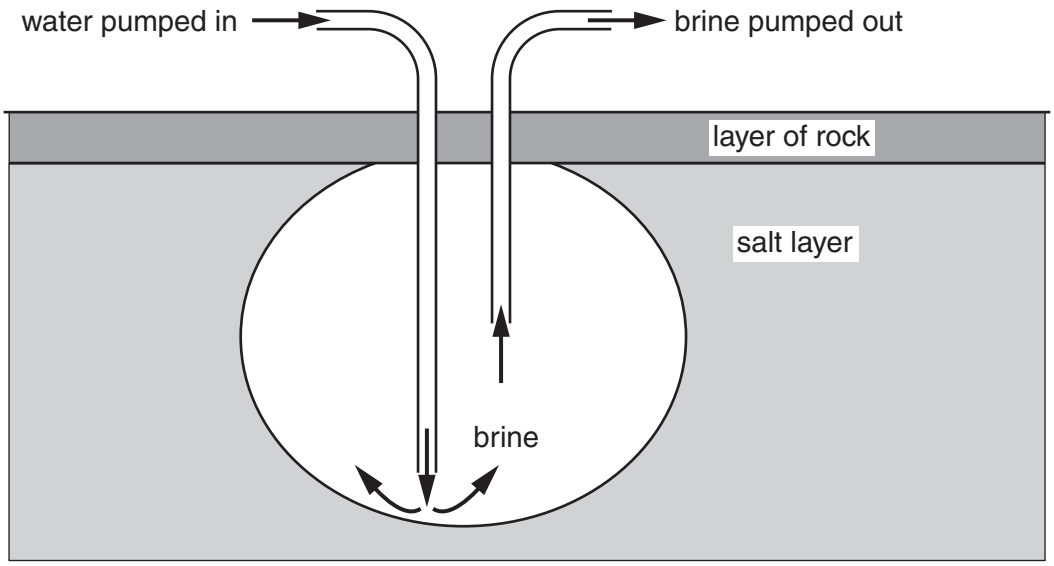
[Turn over

10 This question is about sodium chloride.

Brine is a solution of sodium chloride.

Solution mining is used to get brine out of the ground.

Look at the diagram of solution mining.



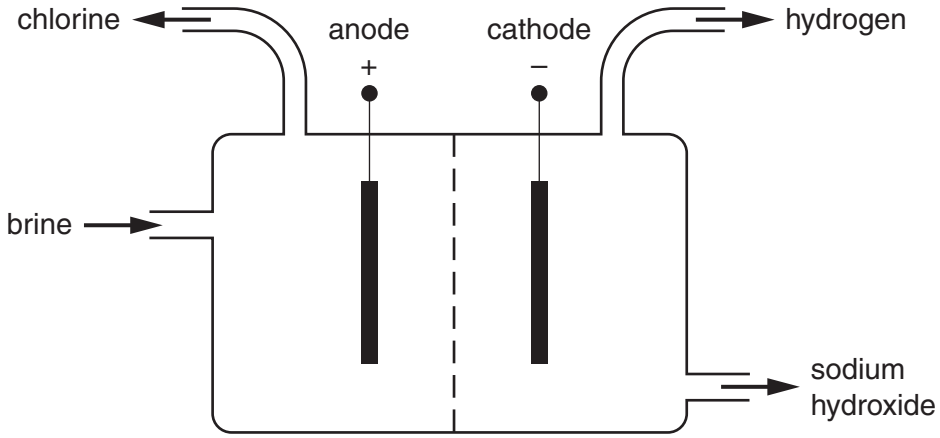
(a) Write about one major environmental problem caused by solution mining.

..... [1]

(b) Look at the diagram.

It shows the apparatus used for the electrolysis of sodium chloride solution (brine).

Chlorine, hydrogen and sodium hydroxide are made.



(i) Hydrogen ions, H^+, react to make hydrogen gas, H_2.

Write an equation for this reaction.

Use e^- to show an electron.

..... [1]

(ii) Chloride ions, Cl^-, react to form chlorine gas.

Write an equation for this reaction.

Use e^- to show an electron.

..... [1]

(iii) Sodium hydroxide is also made in this electrolysis.

Explain why.

..... [1]

[Total: 4]

[Turn over

11 Ethanol is made by the fermentation of glucose.

Carbon dioxide is also made in the process.

(a) Complete the **word** equation for fermentation.

glucose → ..... + ... [1]

(b) Fermentation makes a dilute solution of ethanol.

What method of separation could be used to get almost pure ethanol?

Choose from the list.

crystallisation

electrolysis

evaporation

filtration

fractional distillation

answer ..... [1]

(c) A fermentation reaction takes place at 40 °C.

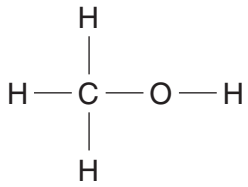
When the temperature is raised to 80 °C, fermentation stops.

Explain why.

.....

..... [1]

(d) Look at the displayed formula for methanol, CH_3OH.



Draw the displayed formula of ethanol, C_2H_5OH.

[1]

(e) Look at this table.

It shows the formulae of some alcohols.

alcohol	**formula**
methanol	CH_3OH
ethanol	C_2H_5OH
propanol	
butanol	C_4H_9OH

(i) Complete the table by writing the formula for propanol. [1]

(ii) The general formula for an **alkene** is C_nH_{2n}.

Write down the general formula for an **alcohol**.

..... [1]

[Total: 6]

[Turn over

12 This question is about fats and oils.

(a) In a saturated fat all the bonds between carbon atoms are single bonds.

How is an unsaturated fat different?

..... [1]

(b) Describe a chemical test for unsaturation in a fat.

test..... [1]

result ..... [1]

(c) Fats and oils can be heated with sodium hydroxide to make soap.

Look at the list.

displacement

neutralisation

oxidation

reduction

saponification

Put a (ring) around the word that best describes the process. [1]

(d) How is margarine manufactured from vegetable oils?

..... [1]

[Total: 5]

END OF QUESTION PAPER

1 This question is based on the article 'The bioethanol dilemma'.

(a) (i) The article suggests that most bioethanol produced in the UK would be made from wheat.

Name two **other** fuel crops mentioned in the article that are used to make bioethanol.

1 .....

2 ..... **[1]**

(ii) The table in the article shows how bioethanol consumption increased in a number of European countries from 2005 to 2006.

In which country did bioethanol consumption have the biggest increase?

..... **[1]**

(b) Describe **two** of the environmental benefits of burning bioethanol, compared to petrol, that are mentioned in the article.

.....

.....

.....

..... **[2]**

(c) (i) The European Union expects biofuels to meet 5.75% of transport fuel needs by 2010.

Soon most petrol sold in the UK will contain some bioethanol.

It is not likely that petrol will contain more than 5% bioethanol in the near future.

Suggest why.

.....

..... **[1]**

(ii) In the more distant future, cars may be fuelled by 100% bioethanol.

A typical driver in the UK drives 600 000 miles in their lifetime.

How many hectares of wheat would need to be grown to produce bioethanol to fuel a car for the total mileage driven by this typical driver?

.....hectares of wheat **[1]**

(d) (i) The article suggests that as demand for bioethanol increases, food prices will rise.

Suggest why.

.....

.....

..... **[1]**

(ii) The article also suggests that as demand for bioethanol increases, there will be a decline in soil fertility.

This will result in farmers using more fertilizers.

Suggest why using more fertilizers might harm the environment.

.....

.....

.....

..... **[2]**

(e) (i) List **two** factors mentioned in the article that are involved in the Life Cycle Assessment for bioethanol that do not apply to petrol.

1 .....

.....

2 .....

..... **[2]**

(ii) Explain how bioethanol may be a more sustainable fuel than petrol.

.....

.....

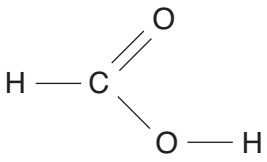
.....

..... **[2]**

[Total: 13]

2 Methanoic acid is a carboxylic acid that is released in bee stings.

(a) The diagram shows the structural formula of methanoic acid.



On the diagram, draw a circle around the functional group that is responsible for the characteristic properties of carboxylic acids. **[1]**

(b) Methanoic acid is used to remove the limescale that can build up in kettles.
Limescale is made of calcium carbonate, which is insoluble in water.

Carboxylic acids react with carbonates in a similar way to other acids, such as hydrochloric acid.

calcium carbonate + hydrochloric acid → calcium chloride + carbon dioxide + water

(i) Complete this word equation for the reaction between methanoic acid and calcium carbonate.

[ ] + [ ] → calcium methanoate + [ ] + [ ] **[2]**

(ii) Suggest a property of calcium methanoate that explains how this reaction removes limescale.

.....

..... **[1]**

(iii) Some kettles have metal bodies, and all have metal heating elements.

Hydrochloric acid is not used to remove limescale from kettles.

Explain why methanoic acid is used to remove limescale but hydrochloric acid is not.

Use ideas about strong and weak acids in your answer.

One mark is for correct spelling.

.....

.....

.....

..... **[3+1]**

(c) Ethanoic acid, CH_3COOH, is another carboxylic acid, present in vinegar.

Draw a diagram to show the structural formula for ethanoic acid.

[2]

[Total: 10]

3 Vegetable oils are commonly used in cooking. Examples are rape seed oil and sunflower seed oil.

(a) These oils are found in the seeds produced by plants.

What is the job of the oil in these seeds?

..... **[1]**

(b) **(i)** When an ester is hydrolysed it forms an alcohol and a carboxylic acid. This reaction is the reverse of that used to make the ester.

Oils and fats are esters. Write the **name** of the alcohol and of the **type** of carboxylic acid to complete this word equation for the hydrolysis of an oil.

oil + water $\rightleftharpoons$ ..... + ... **[2]**

(ii) What **two** things does the $\rightleftharpoons$ sign tell you about this reaction?

.....

.....

..... **[2]**

(c) In addition to vegetable oil, a food product may contain other esters.

Suggest **two** reasons why other esters may be added to food products.

.....

..... **[2]**

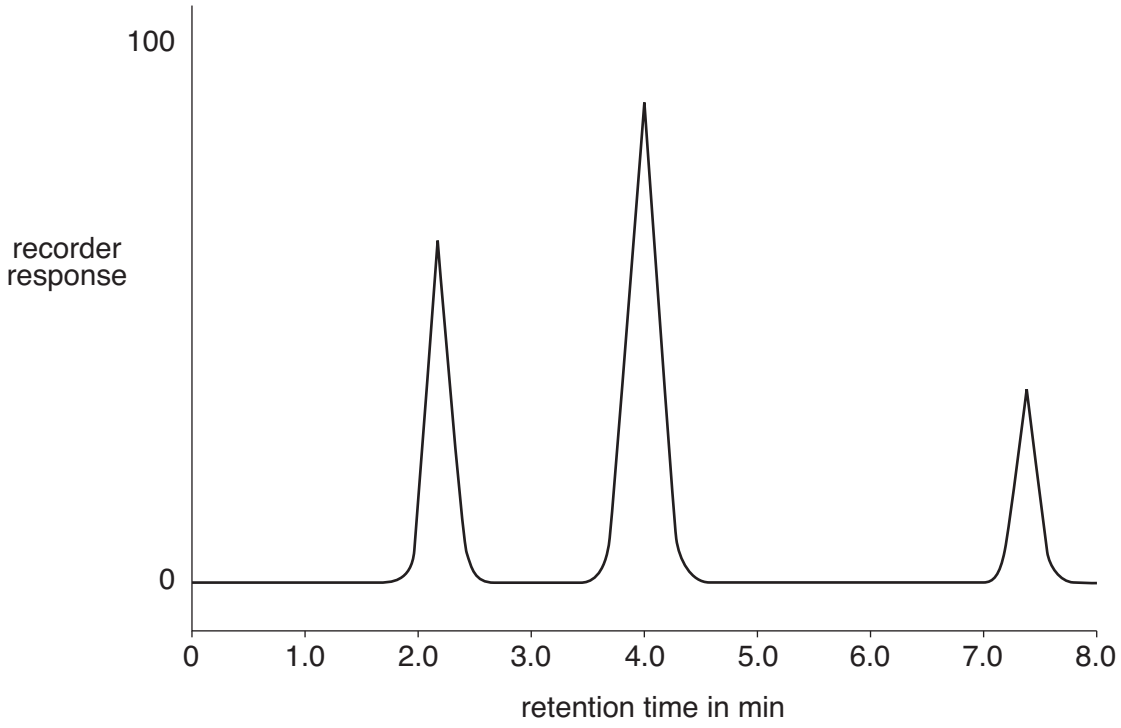
[Total: 7]

4 A technician carries out an analysis of a mixture of hydrocarbons using gas chromatography.

She first calibrates the equipment using standard hydrocarbons. The retention times for these hydrocarbons are shown in the table.

hydrocarbon	retention time in min
methane	1.7
ethane	2.2
propane	3.5
propene	4.0
butane	7.4

The technician then analyses the mixture of hydrocarbons. The recorder print-out from this analysis is shown below.



(a) Explain what is meant by the term *retention time*.

.....

..... **[2]**

(b) (i) Which **three** hydrocarbons are present in the mixture?

1 .....

2 .....

3 ..... **[2]**

(ii) Name the hydrocarbon that has the highest concentration in the mixture.

..... **[1]**

(iii) One of the gases in the mixture is not an alkane.

What is the name of this gas?

..... **[1]**

(c) Two of the hydrocarbons in the mixture are alkanes.

Alkanes burn but they do not react with solutions of other chemicals, for example bromine water.

(i) Explain why alkanes do not react with bromine water.

Use ideas about the bonds in alkanes in your answer.

.....

.....

..... **[2]**

(ii) The burning of alkanes gives out energy.

Use ideas about bond making and breaking to explain why.

.....

.....

..... **[2]**

[Total: 10]

5 Some indigestion tablets contain the active ingredient, magnesium hydroxide. This reacts with excess stomach acid to relieve the symptoms of acid indigestion.

$$Mg(OH)_2 + 2HCl \longrightarrow MgCl_2 + 2H_2O$$

The tablets also contain starch.

A chemist uses quantitative analysis to find the mass of active ingredient in each tablet.

(a) The statements describe the main stages of this analysis, but they are in the wrong order.

A Crush the tablet and stir it into approximately 25 cm^3 distilled water.

B Use the average titration result to calculate the mass of magnesium hydroxide in each tablet.

C Titrate the mixture against hydrochloric acid of known concentration.

D Measure accurately the mass of one indigestion tablet.

E Estimate the degree of uncertainty in the result.

F Repeat the procedure using several more tablets.

Write letters in the boxes to show the correct order of the stages. The correct letter has already been written in the first box.

D					

[3]

(b) What apparatus should the chemist use to measure each of the following?

(i) The 25 cm^3 distilled water.

..... **[1]**

(ii) The volume of hydrochloric acid used in each titration.

..... **[1]**

(c) The chemist finds that the average volume of hydrochloric acid used to react with the magnesium chloride in a tablet is 23.5 cm^3.

(i) The relative formula mass of hydrochloric acid is 36.5.

Work out the relative formula mass (RFM) of magnesium hydroxide, $Mg(OH)_2$.

You should show your working.

(relative atomic masses: H = 1, Mg = 24, O = 16)

relative formula mass (RFM) of magnesium hydroxide = ... **[2]**

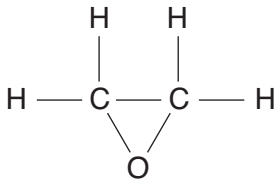
(ii) Use this formula to work out the mass of magnesium hydroxide in each indigestion tablet.

$$\text{mass of magnesium hydroxide} = \frac{\text{volume HC}l \times 40 \times \text{RFM Mg(OH)}_2}{2000 \times 36.5}$$

mass of magnesium hydroxide in each tablet = ... g **[1]**

[Total: 8]

6 Epoxyethane, $(CH_2)_2O$, is an intermediate in the production of car anti-freeze, and is used to sterilize medical supplies.



epoxyethane

Epoxyethane is poisonous, carcinogenic and highly flammable.

The raw material used to make epoxyethane is ethene. This is obtained by the cracking of hydrocarbons from petroleum.

(a) (i) Epoxyethane is a bulk chemical.

Explain what is meant by the term 'bulk'.

.....

..... **[1]**

(ii) The manufacture of epoxyethane may not be sustainable to the end of this century.

Use information about the raw material used in its manufacture to suggest why.

.....

.....

..... **[2]**

(b) Two methods have been used to make epoxyethane.

- original method – from ethene, chlorine and calcium hydroxide
- modern method – ethene and oxygen are passed over a silver catalyst at 250-350 °C

(i) The original method produces solid calcium chloride as a by-product, but the modern method does not.

There is little use for this calcium chloride.

Explain why this makes the original method less sustainable than the modern method.

.....

..... **[1]**

(ii) The catalyst in the modern method consists of very fine particles.

Explain why.

.....

.....

..... **[2]**

(c) The government has strict regulations that control the way that epoxyethane is made, stored and transported.

What is the purpose of these regulations?

.....

..... **[1]**

[Total: 7]

END OF QUESTION PAPER

The bioethanol dilemma

Life on Earth depends on energy from the Sun, which warms our atmosphere. But if too much energy is trapped by gases in the atmosphere, our globe warms up, and this can cause violent changes in the weather. Carbon dioxide from road vehicles is believed to add to this global warming.

28% of all carbon dioxide emissions in the United Kingdom come from the petrol and diesel burned by road traffic. The government is committed to a 20% reduction in these emissions by 2010. If the government is going to consider alternative fuels they need to carry out a whole Life Cycle Assessment for each fuel.

What is bioethanol?

Bioethanol is a fuel produced by fermentation of sugar. It is made from corn, maize, wheat or sugar beet. The plants absorb carbon dioxide from the air as they grow.

Most modern cars can use petrol with up to 5% of bioethanol added. Higher concentrations can only be used if car engines are modified.

The European Union (EU) recently issued a directive calling for biofuels to meet 5.75% of transport fuel needs by 2010. This table shows how use of bioethanol increased in some European countries during the years from 2005 to 2006.

	bioethanol consumption (energy units)	
	2005	**2006**
Austria	0	920
France	870	1750
Poland	330	610
Spain	1310	1330
Sweden	1680	1900
United Kingdom	500	560

Burning bioethanol

Burning pure bioethanol produces 70% less carbon dioxide than burning the same volume of petrol. Even putting just 5% bioethanol into petrol reduces the carbon dioxide released by 3.5%.

Using bioethanol can help reduce the amount of carbon monoxide and particulate carbon produced by vehicles, thus improving air quality.

Can we make enough bioethanol?

The UK grows a surplus of about 3.5 million tons of wheat each year. This could be used to make bioethanol without affecting the production of food. This wheat surplus could produce about 1 million tons of fuel, which is equivalent to 5% of the UK petrol market.

Most UK wheat crops are high starch varieties which give the highest bioethanol yield. One hectare of wheat would produce enough bioethanol to run an average car for about 30 000 miles and one lorry load of wheat will produce enough bioethanol for 100 000 miles of motoring.

Environmental benefits of using bioethanol as transport fuel

The UK Central Science Laboratory says that bioethanol requires 61% less energy to produce than petrol. Also less energy is used, and less pollution caused, when transporting it to the filling station.

Bioethanol is considered to be a sustainable material because it uses the Earth's resources in a way that can continue in the future. Photosynthesis absorbs carbon dioxide from the air as the fuel crops grow. The sugar produced is later processed into bioethanol. The carbon dioxide that was absorbed by the crops as they were grown is returned to the air as the bioethanol is burned. This cycle can be continued indefinitely.

Blending bioethanol with petrol will help extend the life of the UK's own oil supplies and reduce our dependence on other oil producing nations. Bioethanol is also biodegradable and far less toxic than fossil fuels.

What are the disadvantages of using bioethanol?

Growing crops to produce bioethanol would use a large area of cultivated land. It has been estimated that meeting the 5.75% EU target would use a quarter of the EU's arable land. Other concerns are a possible decline in soil fertility, a decrease in water availability and quality, and an increase in the use of fertilizers.

To obtain a large enough supply, the UK may need to import bioethanol. If bioethanol is imported from the USA, it will likely come from maize, which uses fossil fuels at every stage of production. Fossil fuels are used in cultivation, production of fertilizers, harvesting, processing and transportation. Growing maize appears to use 30% more energy than the bioethanol produces when used as a fuel.

As demand for bioethanol increases, food crops are replaced by fuel crops, driving food prices up. This leads to higher prices for animal products like chicken, beef, and cheese. Food prices are already increasing. With just 10% of the world's sugar harvest being converted to bioethanol, the price of sugar has doubled.

As more wheat is used to make bioethanol, the price of bread will rise.

The amount of grain required to make enough bioethanol to run one large car would feed the population of an African village.

1 This question is based on the article 'The bioethanol dilemma'.

(a) Burning bioethanol gives a 70% carbon dioxide reduction compared to petrol.

However, some scientists think that the overall effect of using bioethanol instead of petrol would reduce total carbon dioxide emissions by only about 13%.

Use information from the article to explain why a figure of 13% for overall reduction in carbon dioxide emissions may be more realistic than 70%.

.....

.....

.....

..... **[2]**

(b) It is technically feasible to produce enough bioethanol from crops grown in the UK to satisfy all of our transport needs.

Suggest **two** disadvantages of this.

.....

.....

..... **[2]**

(c) In the UK it is reasonable to suggest that enough bioethanol can be made from crops to use as a 5% blend with petrol.

It is less reasonable to suggest that developing countries in Africa should do the same.

Explain why.

.....

.....

..... **[2]**

(d) The combustion of bioethanol can be represented by this equation.

$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$

Octane, C_8H_{18}, is one of the hydrocarbons in petrol. The combustion of octane can be represented by this equation.

$C_8H_{18} + 12½O_2 \longrightarrow 8CO_2 + 9H_2O$

Burning 1.0 g of bioethanol produces 1.9 g of carbon dioxide.

Burning octane produces about 60% more carbon dioxide than the same mass of bioethanol.

Show that this is true by calculating the mass of carbon dioxide produced when 1.0 g of octane burns, and the percentage increase in carbon dioxide produced compared to bioethanol.

(relative atomic masses: C = 12, H = 1, O = 16)

mass of carbon dioxide = ... g

percentage increase = ... **[3]**

(e) **(i)** List **two** factors mentioned in the article that are involved in the Life Cycle Assessment for bioethanol that do not apply to petrol.

1 .....

.....

2 .....

..... **[2]**

(ii) Explain how bioethanol may be a more sustainable fuel than petrol.

.....

.....

.....

..... **[2]**

[Total: 13]

2 Methanoic acid, HCOOH, is a carboxylic acid that is released in bee stings.

(a) What is the formula of the functional group that is responsible for the characteristic properties of carboxylic acids?

..... **[1]**

(b) Methanoic acid is used to remove the limescale that can build up in kettles.
Limescale is made of calcium carbonate, which is insoluble in water.

Carboxylic acids react with carbonates in a similar way to other acids, such as hydrochloric acid.

calcium carbonate + hydrochloric acid → calcium chloride + carbon dioxide + water

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

(i) Complete and balance this symbol equation for the reaction between calcium carbonate and methanoic acid.

..... + ... → $Ca(HCOO)_2$ + ... + ... **[2]**

(ii) Suggest a property of $Ca(HCOO)_2$ (calcium methanoate) that explains how this reaction removes limescale.

.....

..... **[1]**

(iii) Hydrochloric acid is not used to remove limescale from kettles because it is a strong acid.

Methanoic acid is used to remove limescale from kettles because it is a weak acid.

Explain the difference between a strong acid and a weak acid in terms of dynamic equilibrium.

One mark is for correct spelling.

.....

.....

.....

.....

..... **[3+1]**

(c) Butanoic acid, $C_4H_8O_2$, is responsible for the unpleasant taste in rancid butter.

Draw a diagram to show the structural formula for butanoic acid.

[1]

[Total: 9]

3 Vegetable oils are commonly used in cooking. Examples are rape seed oil and sunflower seed oil.

(a) **(i)** When an ester is hydrolysed it forms an alcohol and a carboxylic acid. This reaction is the reverse of that used to make the ester.

Oils and fats are esters. Write the **name** of the alcohol and of the **type** of carboxylic acid to complete this word equation for the hydrolysis of an oil.

oil + water $\rightleftharpoons$ ..... + ... **[2]**

(ii) What **two** things does the $\rightleftharpoons$ sign tell you about this reaction?

.....

.....

..... **[2]**

(b) An ester can be made by reacting an alcohol with a carboxylic acid. The technique used involves four stages: **reflux**, **distillation**, **purification** and **drying**.

In the **reflux** stage the alcohol and ester are heated with a little concentrated sulfuric acid in a flask with a condenser attached. The condenser prevents evaporation of the mixture.

In the **distillation** stage the mixture is heated, and the product collected at its boiling point. This separates the product from most of the impurities.

Describe and explain the other two stages.

purification .....

.....

drying .....

..... **[4]**

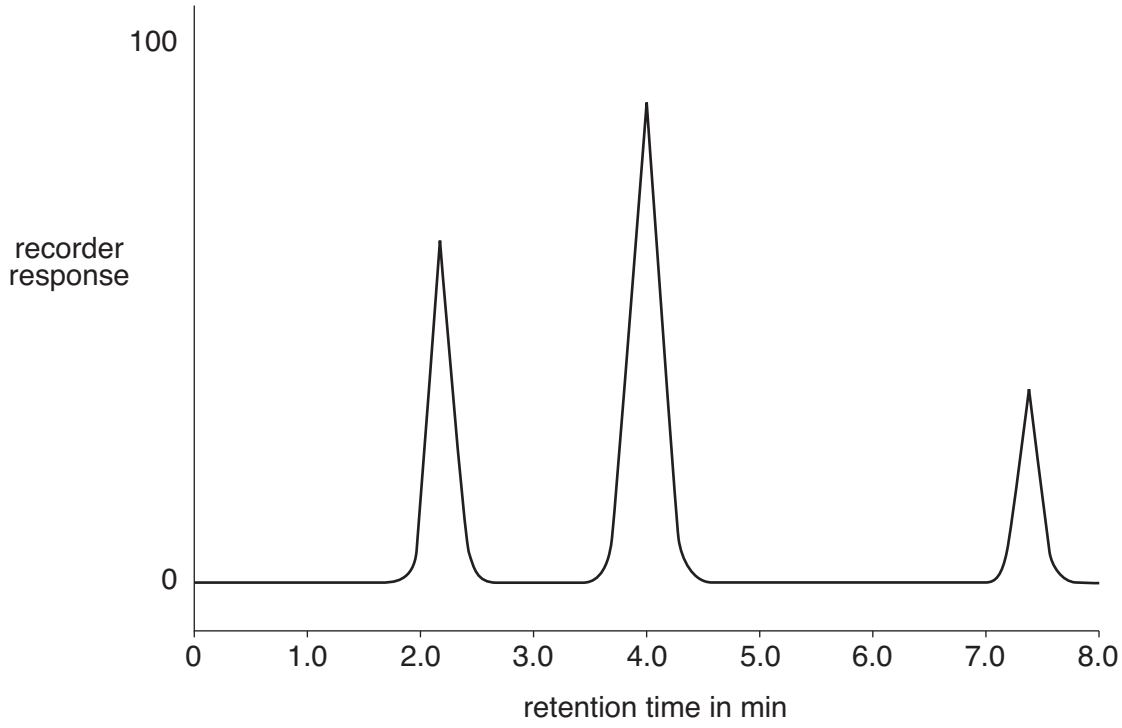
[Total: 8]

4 A technician carries out an analysis of a mixture of hydrocarbons using gas chromatography.

She first calibrates the equipment using standard hydrocarbons. The retention times for these hydrocarbons are shown in the table.

hydrocarbon	retention time in min
methane	1.7
ethane	2.2
propane	3.5
propene	4.0
butane	7.4

The technician then analyses the mixture of hydrocarbons. The recorder print-out from this analysis is shown below.



(a) The mixture contained ethane, propene and butane

(i) Name the hydrocarbon that has the highest concentration in the mixture.

..... **[1]**

(ii) Explain how the recorder print-out shows that this gas has the highest concentration.

.....

..... **[1]**

(b) Explain how this gas chromatography separated the components of the mixture.

Use ideas about the following in your answer:

- stationary phase
- mobile phase
- dynamic equilibrium.

.....

.....

.....

.....

.....

..... **[4]**

(c) Two of the hydrocarbons in the mixture are alkanes.

Alkanes burn but they do not react with solutions of other chemicals, for example bromine water.

(i) Explain why alkanes do not react with bromine water.

Use ideas about the bonds in alkanes in your answer.

.....

.....

..... **[2]**

(ii) The burning of alkanes gives out energy.

Use ideas about bond making and breaking to explain why.

.....

.....

..... **[2]**

[Total: 10]

5 Some indigestion tablets contain the active ingredient, magnesium hydroxide. This neutralises excess stomach acid to relieve the symptoms of acid indigestion. The tablets also contain starch.

A chemist uses quantitative analysis to find the mass of active ingredient in each tablet. He makes a suspension of each of five tablets and titrates these with a solution containing hydrochloric acid. The concentration of this acid is 40.0 g/dm^3.

His results are shown in the table.

tablet number	1	2	3	4	5	average
volume of hydrochloric acid in cm^3	23.6	23.5	23.4	23.5	23.5	23.5

(a) Use the average of his results to work out the average mass of magnesium hydroxide in each tablet in the following way.

(i) The relative formula mass of hydrochloric acid is 36.5.

Work out the relative formula mass (RFM) of magnesium hydroxide, $Mg(OH)_2$.

You should show your working.

(relative atomic masses: H = 1, Mg = 24, O = 16)

relative formula mass (RFM) of magnesium hydroxide = ... **[2]**

(ii) Work out the mass of hydrochloric acid in 23.5 cm^3 of the hydrochloric acid solution used in the titrations.

mass of hydrochloric acid = ... g **[1]**

(iii) Use the neutralization equation below to work out the mass of magnesium hydroxide that reacts with this mass of hydrochloric acid.

$$Mg(OH)_2 + 2HCl \longrightarrow MgCl_2 + 2H_2O$$

This is the average mass of magnesium hydroxide in each tablet.

mass of magnesium hydroxide in each tablet = ... g **[2]**

(b) Use the table of titration results to assess the degree of uncertainty in your calculated value of the mass of magnesium hydroxide in each tablet.

Explain your answer.

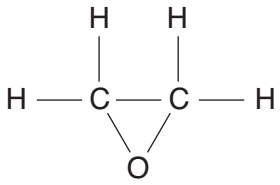
.....

.....

..... **[2]**

[Total: 7]

6 Epoxyethane, $(CH_2)_2O$, is an intermediate in the production of car anti-freeze, and is used to sterilize medical supplies.



epoxyethane

Epoxyethane is poisonous, carcinogenic and highly flammable.

The raw material used to make epoxyethane is ethene. This is obtained by the cracking of hydrocarbons from petroleum.

Two different methods have been used to make epoxyethane.

In the original method epoxyethane was manufactured in a two stage process.

1 Ethene was passed into an aqueous solution of chlorine.

$$C_2H_4 + Cl_2 + H_2O \rightarrow CH_2ClCH_2OH + HCl$$

2 The reaction mixture was treated with calcium hydroxide.

$$CH_2ClCH_2OH + HCl + Ca(OH)_2 \rightarrow (CH_2)_2O + CaCl_2 + 2H_2O$$

The modern method involves only one step. Ethene and oxygen are passed over a silver catalyst at 250-350 °C.

$$\text{ethene} + \text{oxygen} \rightarrow \text{epoxyethane}$$

(a) Compare the sustainability of the two methods in terms of the following:

(i) obtaining the hydrocarbon feedstock used for manufacture,

.....

.....

..... **[2]**

(ii) disposing of the by-products of manufacture.

.....

.....

..... **[2]**

(b) The catalyst speeds up the reaction.

Explain how a catalyst carries out this function.

.....

.....

..... **[2]**

(c) Write a balanced symbol equation for the reaction that produces epoxyethane in the modern method.

..... **[2]**

[Total: 8]

END OF QUESTION PAPER

The bioethanol dilemma

Life on Earth depends on energy from the Sun, which warms our atmosphere. But if too much energy is trapped by gases in the atmosphere, our globe warms up, and this can cause violent changes in the weather. Carbon dioxide from road vehicles is believed to add to this global warming.

28% of all carbon dioxide emissions in the United Kingdom come from the petrol and diesel burned by road traffic. The government is committed to a 20% reduction in these emissions by 2010. If the government is going to consider alternative fuels they need to carry out a whole Life Cycle Assessment for each fuel.

What is bioethanol?

Bioethanol is a fuel produced by fermentation of sugar. It is made from corn, maize, wheat or sugar beet. The plants absorb carbon dioxide from the air as they grow.

Most modern cars can use petrol with up to 5% of bioethanol added. Higher concentrations can only be used if car engines are modified.

The European Union (EU) recently issued a directive calling for biofuels to meet 5.75% of transport fuel needs by 2010. This table shows how use of bioethanol increased in some European countries during the years from 2005 to 2006.

	bioethanol consumption (energy units)	
	2005	**2006**
Austria	0	920
France	870	1750
Poland	330	610
Spain	1310	1330
Sweden	1680	1900
United Kingdom	500	560

Burning bioethanol

The mass of carbon dioxide produced by burning bioethanol can be calculated from this equation.

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Burning pure bioethanol produces 70% less carbon dioxide than burning the same volume of petrol. Even putting just 5% bioethanol into petrol reduces the carbon dioxide released by 3.5%.

Burning bioethanol releases 34% less energy than burning the same volume of petrol. So, the 'miles per gallon' figure for a car would be reduced by about one-third, and it would need to refuel more often. Some scientists believe that using bioethanol rather than petrol reduces total emissions of carbon dioxide by only about 13% because of the pollution caused by the production process, and because bioethanol gets only about 70% of the mileage of petrol.

Using bioethanol can help reduce the amount of carbon monoxide and particulate carbon produced by vehicles, thus improving air quality.

Can we make enough bioethanol?

The UK grows a surplus of about 3.5 million tons of wheat each year. This could be used to make bioethanol without affecting the production of food. This wheat surplus could produce about 1 million tons of fuel, which is equivalent to 5% of the UK petrol market.

Most UK wheat crops are high starch varieties which give the highest bioethanol yield. One hectare of wheat would produce enough bioethanol to run an average car for about 30 000 miles and one lorry load of wheat will produce enough bioethanol for 100 000 miles of motoring.

Environmental benefits of using bioethanol as transport fuel

The UK Central Science Laboratory says that bioethanol requires 61% less energy to produce than petrol. Also less energy is used, and less pollution caused, when transporting it to the filling station.

Bioethanol is considered to be a sustainable material because it uses the Earth's resources in a way that can continue in the future. Photosynthesis absorbs carbon dioxide from the air as the fuel crops grow. The sugar produced is later processed into bioethanol. The carbon dioxide that was absorbed by the crops as they were grown is returned to the air as the bioethanol is burned. This cycle can be continued indefinitely.

Blending bioethanol with petrol will help extend the life of the UK's own oil supplies and reduce our dependence on other oil producing nations. Bioethanol is also biodegradable and far less toxic than fossil fuels.

Turn over

What are the disadvantages of using bioethanol?

Growing crops to produce bioethanol would use a large area of cultivated land. It has been estimated that meeting the 5.75% EU target would use a quarter of the EU's arable land. Other concerns are a possible decline in soil fertility, a decrease in water availability and quality, and an increase in the use of fertilizers.

To obtain a large enough supply, the UK may need to import bioethanol. If bioethanol is imported from the USA, it will likely come from maize, which uses fossil fuels at every stage of production. Fossil fuels are used in cultivation, production of fertilizers, harvesting, processing and transportation. Growing maize appears to use 30% more energy than the bioethanol produces when used as a fuel.

As demand for bioethanol increases, food crops are replaced by fuel crops, driving food prices up. This leads to higher prices for animal products like chicken, beef, and cheese. Food prices are already increasing. With just 10% of the world's sugar harvest being converted to bioethanol, the price of sugar has doubled.

As more wheat is used to make bioethanol, the price of bread will rise.

The amount of grain required to make enough bioethanol to run one large car would feed the population of an African village.

1. Lithium, sodium and potassium are members of group 1 in the periodic table.

(a) What is the symbol for a lithium atom?

.....

(1)

(b) What name is given to the elements in group 1 of the periodic table?

.....

(1)

(c) When sodium is added to water, it forms sodium hydroxide and a gas.

(i) Complete the word equation for this reaction.

[ ] + [ ] → sodium hydroxide + [ ]

(2)

(ii) Name a group 1 metal that reacts more vigorously than sodium with water.

.....

(1)

(iii) Sodium hydroxide is used to make several products.

Put a cross in a box to show a product manufactured using sodium hydroxide.

poly(ethene) ☒

soap ☒

fertiliser ☒

(1) **Q1**

(Total 6 marks)

2. Read the following extract from a website.

> On 6 July 1988, twenty tonnes of aluminium sulphate were accidentally emptied into the water supply at the treatment works in Lowermoor, Cornwall. As a result, the maximum aluminium concentration in the water supply exceeded that allowed by the European Community. The highly acidic water entered the system which distributed water to 12 000 local residents.
>
> Scientists monitored the health records of residents who were supplied with this water and those who were not. They found no statistically significant difference in the number of deaths between the people who drank this water and the people who did not.

(Source: www.studentbmj.com)

(a) Explain why it is necessary to have purified water supplied to our homes.

.....

.....

.....

(2)

(b) Give **two** reasons why it is important not to waste water supplied to our homes.

.....

.....

.....

.....

(2)

(c) A student living in the area, tested the tap water from her home. She took a sample to her school laboratory where she was able to use the following

barium chloride solution
dilute hydrochloric acid
limewater
sodium hydroxide solution
blue litmus paper
red litmus paper

Use only the above to answer the questions.

(i) What test could she do to show that the water was acidic?

.....

(1)

(ii) What test would she do to show that the sample contained sulphate ions?

.....

.....

.....

.....

(3)

(iii) What test would she do to show that the sample contained aluminium ions?

.....

.....

.....

.....

(3)

(d) When scientists tested the polluted water in Cornwall they conducted a quantitative test.
Why did they use a quantitative test, rather than a qualitative test?

.....

.....

.....

(1)

Q2

(Total 12 marks)

Turn over

3. Copper is a red-brown metal.
It has a melting point of 1085 °C.
It is used to make electrical wires.
Compounds of copper are often blue.

(a) Copper is in the middle section of the periodic table.
What name is given to the elements in this part of the table?

.....

(1)

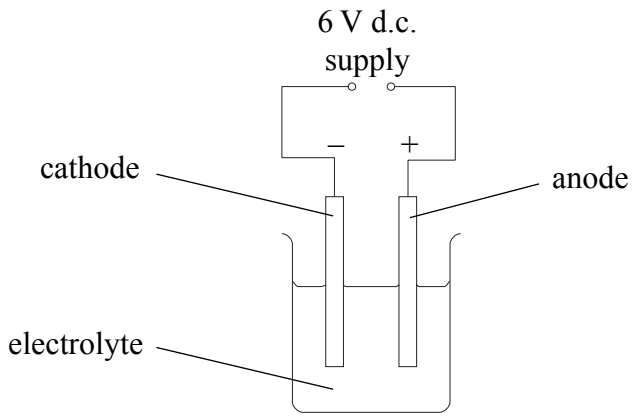
(b) Using only the information above, state two properties of copper typical of elements found in this part of the periodic table.

.....

.....

(2)

(c) The diagram shows the apparatus used to purify copper



(i) Name the electrolyte used.

.....

(1)

(ii) What would you see happening at the cathode?

.....

(1)

(iii) In terms of electrons, what happens to the copper ions at the cathode?

.....

.....

(1)

Q3

(Total 6 marks)

4. Sulphuric acid is manufactured by the Contact process.

(a) During the process sulphur is burned in air.

Write the balanced equation for this reaction.

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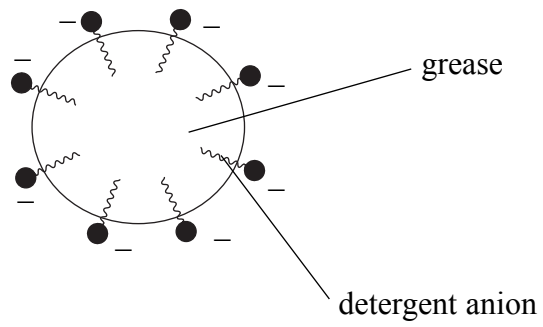
(2)

(b) Detergents are made using sulphuric acid.

The diagram shows the interaction between detergent and grease.



(i) Explain how detergents work to remove grease.

.....

.....

.....

.....

(2)

(ii) Why is it better to use a detergent rather than soap in hard water areas?

.....

.....

(1)

(iii) Suggest how biological detergents are more effective than non-biological detergents.

.....

.....

(1)

Q4

(Total 6 marks)

5. When hydrogen peroxide solution is added to a solution of iron(II) chloride, iron(III) chloride is formed.

The hydrogen peroxide causes the following change to take place:

$$Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e$$

(a) Explain why this is described as an oxidation reaction.

.....

(1)

(b) When sodium hydroxide solution is added to iron(III) chloride solution, iron(III) hydroxide is formed.

(i) Describe what would be **seen** in this reaction.

.....

.....

(2)

(ii) Write the ionic equation for this reaction.

.....

(3) **Q5**

(Total 6 marks)

6. In the manufacture of methanol, the final stage involves the following reaction

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

(a) What is the maximum volume of methanol vapour that can be obtained from 1000 dm^3 of hydrogen gas under the conditions of the reaction?
(All gases are measured at the same temperature and pressure.)

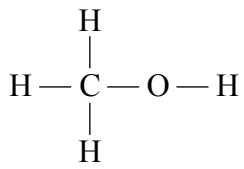
.....

.....

volume = ...

(1)

(b) The structural formula of methanol is



Put a ring around the part of the molecule that is responsible for it reacting as an alcohol does.

(1)

(c) Ethanoic acid can be manufactured from methanol.

Which gas is produced when ethanoic acid solution reacts with magnesium?

.....

(1)

(d) Esters are formed when alcohols react with organic acids.

(i) Name the ester formed when methanol reacts with ethanoic acid.

.....

(1)

(ii) Draw the structural formula of this ester, showing all covalent bonds.

(2) **Q6**

(Total 6 marks)

7. The industrial production of sodium carbonate is a complicated process involving many stages.

(a) The equation for the overall reaction is

$$CaCO_3(s) + 2NaCl(aq) \rightarrow Na_2CO_3(aq) + CaCl_2(s)$$

Calculate the minimum mass of calcium carbonate required to produce 1 million tonnes of sodium carbonate.

(Relative atomic masses: C = 12.0, O = 16.0, Na = 23.0, Ca = 40.0)

.....

.....

.....

.....

.....

answer = ... tonnes

(4)

(b) When the sodium carbonate solution crystallises, washing soda crystals are formed. These can be used to neutralise acids.

Write the balanced chemical equation for the reaction that takes place when sodium carbonate is used to neutralise sulphuric acid.

.....

(3)

Q7

(Total 7 marks)

8. In an experiment to determine the solubility of calcium hydroxide in water, Jacqui shook excess calcium hydroxide with water in a large, stoppered flask. She allowed the mixture to stand for 24 hours. She then filtered the mixture to remove excess solid.

Jacqui took 100 cm^3 of the solution for analysis. She titrated 10.0 cm^3 portions of the solution with 0.0500 mol dm^{-3} hydrochloric acid, HCl, to determine how much calcium hydroxide had been dissolved. She used methyl orange as the indicator.

Here are her results.

volume of calcium hydroxide solution used for each titration = 10.0 cm^3

volume of hydrochloric acid added		
	trial titration	= 9.30 cm^3
	1st titration	= 8.90 cm^3
	2nd titration	= 8.80 cm^3
	average	= 8.85 cm^3

(a) Jacqui used methyl orange as the indicator in the titration.
Why is universal indicator **not** suitable for this titration?

.....

.....

(1)

(b) Describe how Jacqui should carry out this titration.

.....

.....

.....

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.....

.....

.....

.....

.....

.....

(4)

(c) The equation for the reaction is

$$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

Calculate the number of moles of calcium hydroxide, $Ca(OH)_2$, present in the **original** 100 cm^3 of solution.

You may do the calculation
either by following steps (i), (ii) and (iii)
or by using another method in (iii) only.

(i) Calculate the number of moles of hydrochloric acid, HCl, used in the titration.

.....

.....

(ii) Use the equation for the reaction to calculate the number of moles of calcium hydroxide, $Ca(OH)_2$, (in 10.0 cm^3 of solution) that reacted with this amount of hydrochloric acid.

.....

.....

(iii) Calculate the number of moles of calcium hydroxide, $Ca(OH)_2$, present in the **original** 100 cm^3 solution.

.....

.....

.....

.....

.....

.....

.....

answer = ...

(3)

(d) The relative formula mass of calcium hydroxide is 74.0.
Use your answer to (c)(iii) to calculate the mass of calcium hydroxide dissolved in the original 100 cm^3 solution.

.....

answer = ... g
(1)

(e) The solubility of barium chloride in water cannot be determined by titrating with an acid.
Describe an alternative method for finding the mass of barium chloride present in 100 cm^3 of saturated solution.

.....

.....

.....

.....
(2)

Q8

(Total 11 marks)

TOTAL FOR PAPER: 60 MARKS

END

mock papers 6-higher

1. Tammy was given a substance to analyse.
She was told that it contained two metal ions and two non-metal ions.

(a) Tammy carried out a flame test on the substance and found that it produced a yellow flame.

(i) Describe how Tammy could carry out the flame test.

.....

.....

.....

(2)

(ii) Which ion caused the yellow flame?

Put a cross (☒) in the correct box.

calcium ions	☒
iron(III) ions	☒
potassium ions	☒
sodium ions	☒

(1)

(b) Tammy dissolved some of the substance in distilled water to form a solution.

(i) To one portion of the solution, she added drops of sodium hydroxide solution.
A red-brown precipitate formed.

Which ion did this test show to be present?

Put a cross (☒) in the correct box.

calcium ions	☒
iron(III) ions	☒
potassium ions	☒
sodium ions	☒

(1)

(ii) Tammy tested another portion of the solution by adding dilute nitric acid and then a few drops of silver nitrate solution.
From the colour of the precipitate that formed, she correctly concluded that chloride ions were present.

What was the colour of the precipitate that formed?

Put a cross (☒) in the correct box.

pale yellow	☒
red	☒
white	☒
yellow	☒

(1)

(c) Tammy decided to test for sulphate ions.
She added dilute hydrochloric acid to another portion of the solution.

Which reagent should Tammy add to this mixture to show the presence of sulphate ions?

Put a cross (☒) in the correct box.

ammonia solution	☒
barium chloride solution	☒
dilute sulphuric acid	☒
sodium hydroxide solution	☒

(1) **Q1**

(Total 6 marks)

2. Clothes can be washed using soaps or detergents.
In hard water areas, washing soda crystals are sometimes added before soap is used.

(a) Apart from washing, suggest another use of water in everyday life.

.....

.....

(1)

(b) Which sodium compound is contained in washing soda crystals?

.....

.....

(1)

(c) Name the **two** types of substances needed to make soap.

1 .....

2 .....

(2)

(d) Modern washing powders contain detergents.
They can be 'biological' or 'non-biological'.

(i) Describe differences between using detergents and using soaps in hard water areas.

.....

.....

.....

(2)

(ii) Give **one** difference between 'biological' and 'non-biological' washing powders.

.....

.....

(1)

(Total 7 marks)

Q2

3. Sulphuric acid is an important substance.
It is used to make many other substances.

(a) Name **two** substances that are produced from sulphuric acid.

1 .....

2 .....

(2)

(b) The first step in the manufacture of sulphuric acid is the burning of sulphur in air to form sulphur dioxide.

$$S + O_2 \rightarrow SO_2$$

Suggest why air rather than pure oxygen is used.

.....

.....

(1)

(c) The sulphur dioxide is then reacted with more oxygen from air in the presence of a hot catalyst.
The reaction is reversible.

(i) Name the catalyst used.

.....

(1)

(ii) Write the balanced equation for the reversible reaction.

.....

(3)

(d) Describe how the gas from (c) is made into sulphuric acid.

.....

.....

.....

(1)

Q3

(Total 8 marks)

4. Copper is used to make water pipes and in the electronics industry.

(a) Describe **two** properties of copper or its compounds that are typical of transition metals and their compounds.

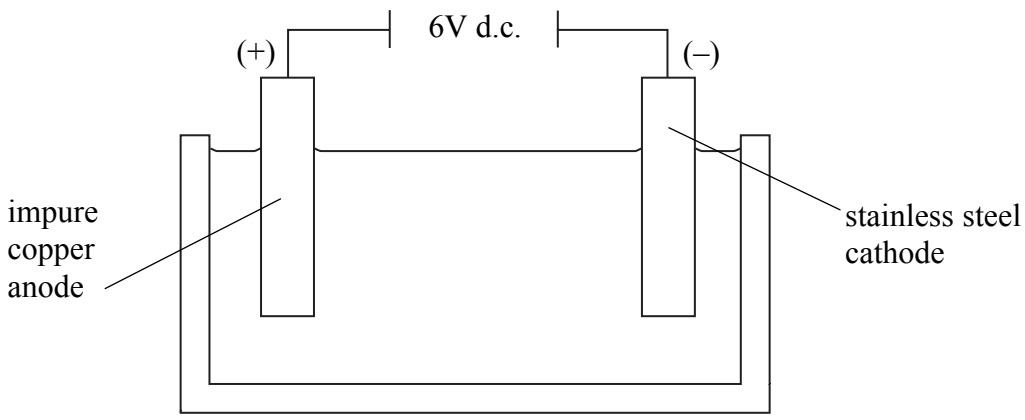
1 .....

2 .....

(2)

(b) Very pure copper is produced from impure copper by electrolysis.

The diagram shows a cell in which impure copper is the anode and the cathode is stainless steel.



(i) Identify the electrolyte used in the cell.

.....

(1)

(ii) Describe what happens to the impure copper electrode during electrolysis.

.....

.....

(1)

(iii) Describe what happens at the negative electrode.

.....

.....

(2)

(iv) During the electrolysis, impurities collect below the positive electrode.
Explain the importance of these impurities.

.....

.....

(2) **Q4**

(Total 8 marks)

5. Drinking water in the United Kingdom is high quality and contains a very low concentration of lead ions.

In some parts of the United States drinking water contains a higher concentration of lead ions.
A group is campaigning for lead-free water.

Lead ions are toxic and it is important to know the concentration of these ions in the water.

(a) Arnie suggests

- take 1000 cm^3 of tap water
- heat to evaporate the tap water to dryness
- find the mass of the residue
- the mass of residue = the mass of lead

Suggest **two** reasons why this method would **not** give an accurate figure for the mass of lead ions in the water.

1 .....

.....

2 .....

.....

(2)

(b) David is trying to find the concentration of lead ions (Pb^{2+}) in a solution.
He adds a few drops of potassium iodide solution to the solution containing lead ions.
A yellow precipitate forms.
Lead iodide is an insoluble compound with a distinctive yellow colour.

(i) Write the ionic equation for the reaction.

.....

(3)

(ii) This is a reliable test for lead ions.
Why is it important that only lead ions give this distinctive yellow precipitate?

.....

.....

(1)

(iii) Faiza tells David that the test described above does not determine the **concentration** of lead ions in the solution but that this could be done by titration.
Explain why Faiza is correct.

.....

.....

.....

.....

(2)

(c) Titration can be used to find the concentration of a sodium hydroxide solution. In an experiment sodium hydroxide solution is titrated with dilute hydrochloric acid of known concentration. Describe how you would carry out this titration. Include the names of the pieces of apparatus you would use.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)

Q5

(Total 12 marks)

6. Alcohols and esters are some of the substances used to make cosmetics.

(a) Suggest a reason why

(i) alcohols are used in cosmetics.

.....

(1)

(ii) esters are used in cosmetics.

.....

(1)

(b) A molecule of ethanol reacts with a molecule of ethanoic acid to make one molecule of the ester ethyl ethanoate and one molecule of water.

Write the equation for this reaction.

.....

(2)

(c) Another ester, methyl methanoate, can be made as follows

$HCOOH$	+	CH_3OH	$\rightarrow$	$HCOOCH_3$	+	H_2O
methanoic acid		methanol		methyl methanoate		water

(i) Calculate the mass of methyl methanoate, $HCOOCH_3$, that can be made from 320 kg methanol, CH_3OH.
(Relative atomic masses: C = 12, H = 1.0, O = 16)

Answer..... kg

(3)

(ii) Suggest why a manufacturer would need to carry out this sort of calculation.

.....

.....

(1)

(iii) Describe another reaction of methanoic acid.

.....

.....

.....

(2)

Q6

(Total 10 marks)

7. The alkali metals react vigorously with water.

The following is a description of the reaction of potassium with water.

> A small piece of potassium was dropped onto a large volume of water. The potassium melted to form a ball. The ball whizzed across the surface of the water and a lilac flame was seen around it.

(a) Suggest why the potassium melts.

.....

.....

(1)

(b) What burns to produce the flame?

.....

(1)

(c) What causes the flame to be lilac coloured?

.....

(1)

(d) What would you **see** if litmus solution is added to the liquid?

.....

.....

(1)

(e) Sodium hydroxide is made by the electrolysis of brine.
This process produces sodium hydroxide, chlorine and hydrogen.

The overall equation for the electrolysis is

$$2NaCl(\quad) + 2H_2O(\quad) \longrightarrow 2NaOH(\quad) + H_2(\quad) + Cl_2(\quad)$$

(i) Add all the state symbols to the equation.

(1)

(ii) Suggest why this is an important industrial process.

.....

.....

(1)

(iii) In the electrolysis of brine, chloride ions are converted to chlorine.
Explain why this reaction is an oxidation reaction.

.....

.....

.....

(1)

(iv) Write the balanced half equation for the conversion of chloride ions, Cl^-, into chlorine.

.....

(2) **Q7**

(Total 9 marks)

TOTAL FOR PAPER: 60 MARKS

END