

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

General Certificate of Secondary Education
Winter 2003



SCIENCE: CHEMISTRY (MODULAR)
Aqueous and Organic Chemistry (Module 21)

346021

Thursday 27 November 2003 Morning Session

In addition to this paper you will require:

- a black ball-point pen;
- an answer sheet.

You may use a calculator.

Time allowed: 30 minutes

Instructions

- Fill in the boxes at the top of this page.
- Check that your name, candidate number and centre number are printed on the separate answer sheet.
- Check that the separate answer sheet has the title “Aqueous and Organic Chemistry” printed on it.
- Attempt **one Tier only, either** the Foundation Tier **or** the Higher Tier.
- Make sure that you use the correct side of the separate answer sheet; the Foundation Tier is printed on one side and the Higher Tier on the other.
- Answer **all** the questions for the Tier you are attempting.
- Record your answers on the separate answer sheet only. Rough work may be done on the question paper.

Instructions for recording answers

- Use a **black ball-point pen**.

- For each answer **completely fill in the circle** as shown:

1	2	3	4
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

- Do **not** extend beyond the circles.

- If you want to change your answer, **you must** cross out your original answer, as shown:

1	2	3	4
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

- If you change your mind about an answer you have crossed out and now want to choose it, draw a ring around the cross as shown:

1	2	3	4
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Information

- The maximum mark for this paper is 36.

Advice

- Do **not** choose more responses than you are asked to. You will lose marks if you do.
- Make sure that you hand in both your answer sheet and this question paper at the end of the test.
- If you start to answer on the wrong side of the answer sheet by mistake, make sure that you cross out **completely** the work that is not to be marked.

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Higher Tier starts on page 14 of this booklet.

FOUNDATION TIER

SECTION A

Questions **ONE** to **FIVE**.

In these questions match the words in the list with the numbers.

Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

The diagram shows some of the substances that can be produced when coal burns.

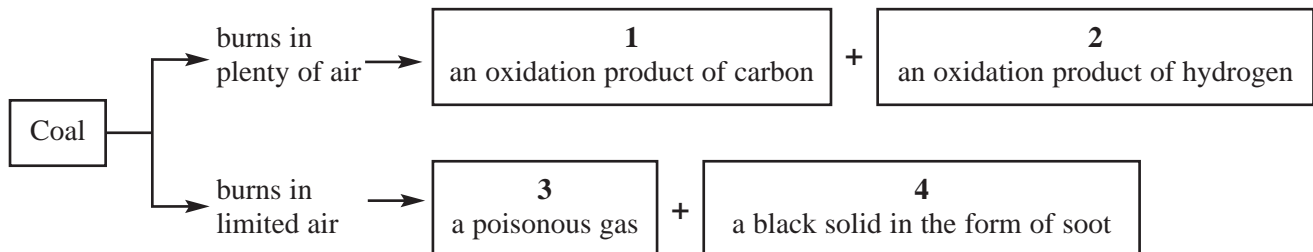
Match words from the list with the spaces **1 – 4** in the diagram.

carbon

carbon dioxide

carbon monoxide

water (vapour)



QUESTION TWO

This question is about the water cycle and drinking water.

Match words from the list with the numbers **1 – 4** in the sentences.

cooled

dissolved

evaporated

filtered

Water is **1** from the Earth's surface by the heat from the Sun.

As the water vapour rises it is **2** and forms clouds.

Some of the rain that falls is treated before being supplied to homes. The water is **3** to remove solid particles.

Chlorine is **4** in the water to kill bacteria.

TURN OVER FOR THE NEXT QUESTION

Turn over ►

QUESTION THREE

This question is about four substances that dissolve in water.

Match words from the list with the numbers **1 – 4** in the table.

ammonium nitrate

calcium sulphate

sodium carbonate

sodium hydroxide

Substance	What we can say about the substance
1	it is an artificial fertiliser that can get into drinking water
2	it can help the body to develop strong bones
3	it dissolves in water to produce a strong, alkaline solution
4	it is used to make hard water soft

QUESTION FOUR

The diagram shows stages in the preparation of almost pure ethanol.

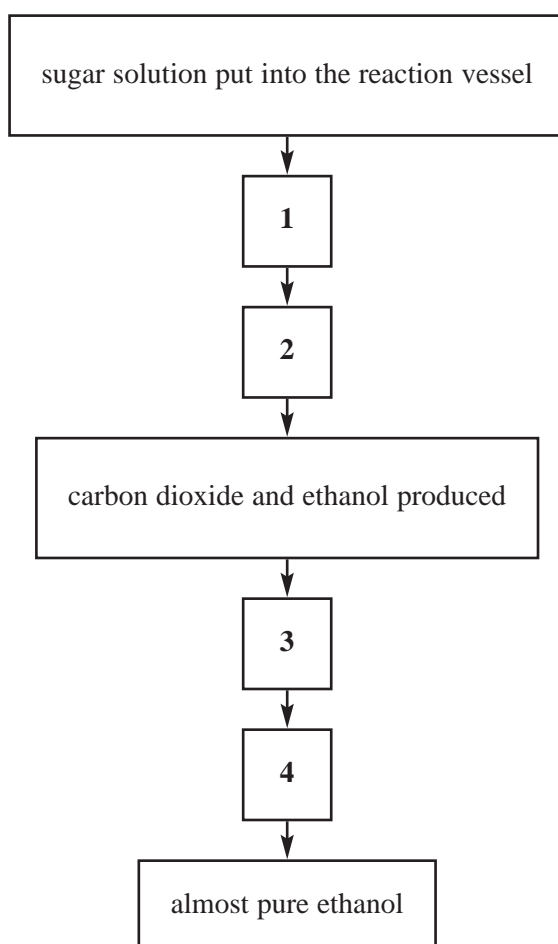
Match words from the list with each of the spaces **1 – 4**, to explain how the ethanol can be made.

carbon dioxide escapes from the reaction vessel

fractional distillation of the reaction mixture

sugar fermented by yeast

yeast is added



Turn over ►

QUESTION FIVE

Word equations can be used to represent chemical reactions.

Match words from the list with the spaces **1 – 4** in the word equations.

calcium carbonate

iron chloride

lead sulphate

nitric acid

calcium sulphate + sodium carbonate \longrightarrow **1** + sodium sulphate

iron + chlorine \longrightarrow **2**

iron + **3** \longrightarrow iron nitrate + hydrogen

sodium sulphate + lead nitrate \longrightarrow **4** + sodium nitrate

SECTION BQuestions **SIX** and **SEVEN**.In these questions choose the best **two** answers.Do **not** choose more than two.Mark your choices on the answer sheet.

QUESTION SIX

This question is about hard water.

Which **two** of the statements are correct?**hard water easily forms a lather with soap****hard water reacts with soap to form a scum****kettles used to boil hard water often get a layer of scale****water in rivers is made hard when it flows over granite rocks****water is made hard by dissolved sodium and potassium ions****QUESTION SEVEN**

This question is about ions.

Which **two** of the statements are correct?**sodium hydroxide in aqueous solution produces H^+ ions****sodium hydroxide in aqueous solution produces $OH^+(aq)$ ions****sulphuric acid is an acid because it donates protons****the $H^+(aq)$ ion is a hydrated proton****the H^+ ion is an electron**

Turn over ►

SECTION CQuestions **EIGHT** to **TEN**.

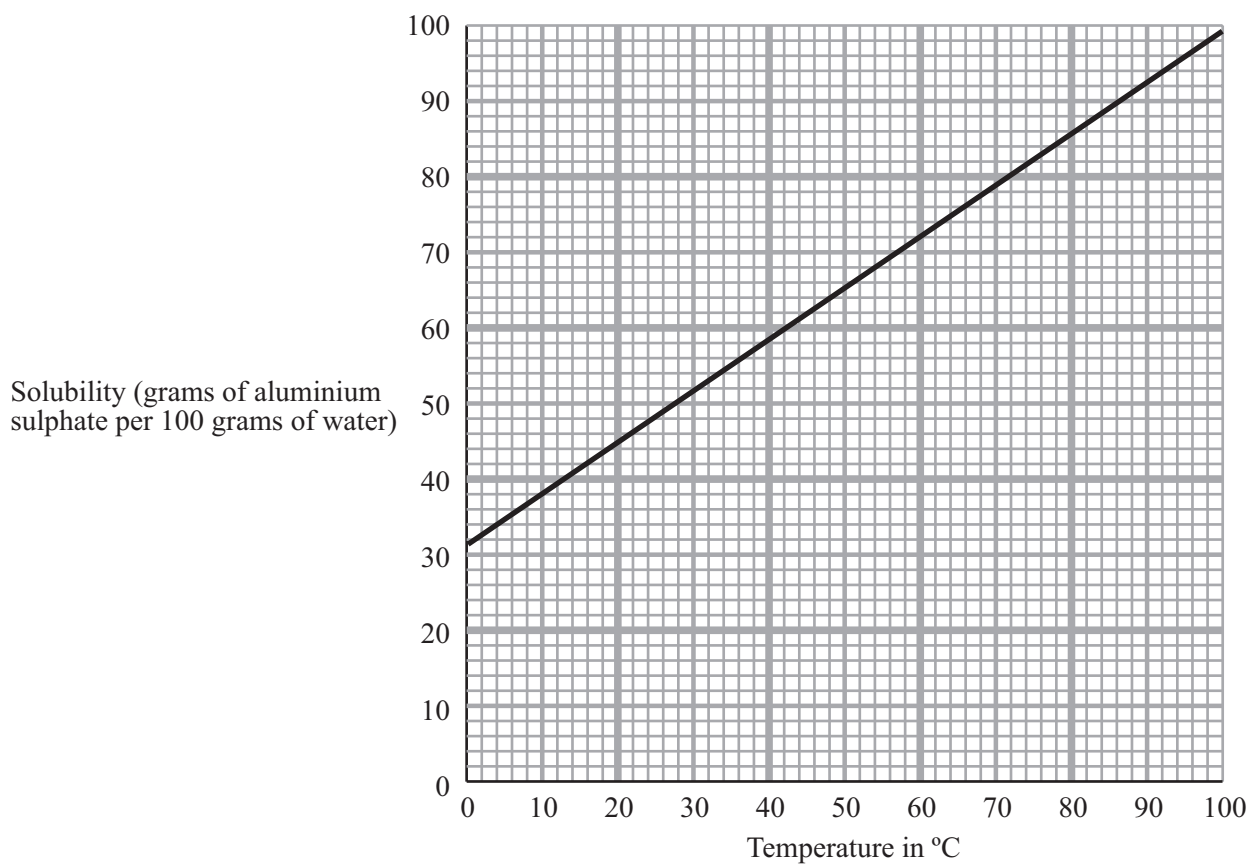
Each of these questions has four parts.

In each part choose only **one** answer.

Mark your choices on the answer sheet.

QUESTION EIGHT

The graph shows the solubility of aluminium sulphate in water between 0 °C and 100 °C.

**8.1** What mass of aluminium sulphate will dissolve in 100 grams of water at 50 °C?

- A 27 g
- B 65 g
- C 71 g
- D 98 g

8.2 What mass of aluminium sulphate will dissolve in 200 grams of water at 35 °C?

- A 5 g
- B 10 g
- C 55 g
- D 110 g

A solution contains 75 grams of aluminium sulphate in 100 grams of water at 95 °C.
The solution cools.

8.3 At what temperature will crystals start to form?

- A 58 °C
- B 65 °C
- C 81 °C
- D 90 °C

8.4 The solution cools to 20 °C.
What is the total mass of the aluminium sulphate crystals which form?

- A 10 g
- B 20 g
- C 30 g
- D 45 g

TURN OVER FOR THE NEXT QUESTION

Turn over ►

QUESTION NINE

The diagrams show some of the particles present in four different acid solutions in water.

The acids are:

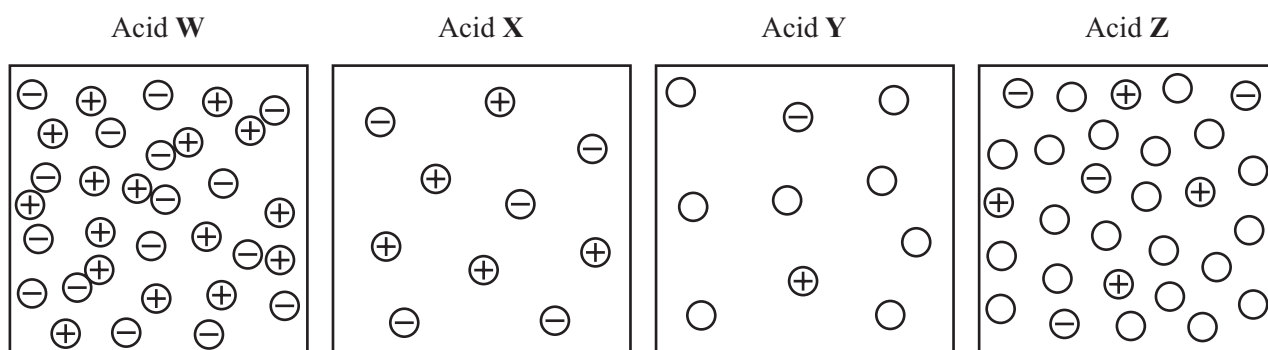
- dilute ethanoic acid
- concentrated ethanoic acid
- dilute hydrochloric acid
- concentrated hydrochloric acid.

Water particles are present but not shown.

⊕ = hydrogen ions $\text{H}^+(\text{aq})$

⊖ = negative ions

○ = acid particles not ionised



9.1 Which diagram could represent a dilute solution of hydrochloric acid?

- A Acid W
- B Acid X
- C Acid Y
- D Acid Z

9.2 Which diagram could represent a concentrated solution of ethanoic acid?

- A Acid W
- B Acid X
- C Acid Y
- D Acid Z

9.3 Which substances are correct examples of a weak acid and a strong alkali?

	Weak acid	Strong alkali
A	citric acid	potassium hydroxide
B	ethanoic acid	ammonia solution
C	nitric acid	potassium hydroxide
D	sulphuric acid	sodium hydroxide

9.4 Which statements **A**, **B**, **C** or **D** could be true for a weak acid and a strong acid of the same concentration?

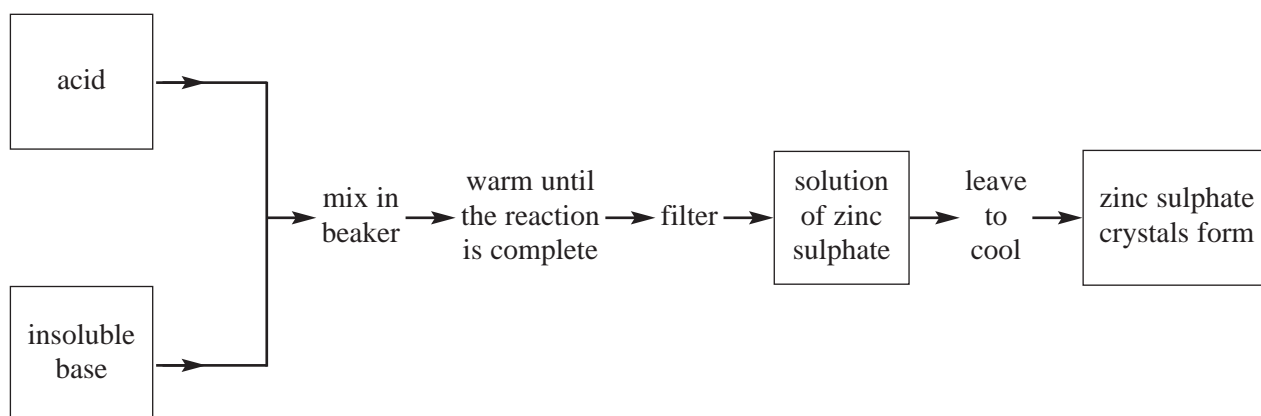
	Weak acid	Strong acid
A	pH number 4, fast reaction with zinc	pH number 4, slow reaction with zinc
B	pH number 4, slow reaction with zinc	pH number 1, fast reaction with zinc
C	pH number 1, fast reaction with zinc	pH number 4, slow reaction with zinc
D	pH number 1, slow reaction with zinc	pH number 1, fast reaction with zinc

TURN OVER FOR THE NEXT QUESTION

Turn over ►

QUESTION TEN

The flow diagram shows how you can make crystals of zinc sulphate.



10.1 Which acid and base would you use?

	Acid	Base
A	hydrochloric	zinc hydroxide
B	hydrochloric	zinc oxide
C	sulphuric	zinc chloride
D	sulphuric	zinc oxide

10.2 When the reaction has finished, the contents of the beaker are filtered

- A** to remove excess acid.
- B** to remove the excess base.
- C** to remove the precipitate that has formed.
- D** to remove the scum that has formed.

10.3 Why do crystals form only when the solution has gone cold?

- A** Zinc sulphate crystals only form when all the acid has evaporated
- B** Zinc sulphate is insoluble in cold water
- C** Zinc sulphate is more soluble in cold water than in hot water
- D** Zinc sulphate is more soluble in hot water than in cold water

10.4 Another way you can make zinc sulphate is

- A** by reacting a metal with an acid.
- B** by reacting a soluble base with an acid.
- C** by reacting an alkali with an acid.
- D** by reacting two elements directly.

END OF TEST

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Foundation Tier is earlier in this booklet.

HIGHER TIER**SECTION A**Questions **ONE** and **TWO**.

In these questions match the words in the list with the numbers.

Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

Word equations can be used to represent chemical reactions.

Match words from the list with the spaces **1 – 4** in the word equations.**calcium carbonate****iron chloride****lead sulphate****nitric acid**calcium sulphate + sodium carbonate \longrightarrow **1** + sodium sulphateiron + chlorine \longrightarrow **2**iron + **3** \longrightarrow iron nitrate + hydrogensodium sulphate + lead nitrate \longrightarrow **4** + sodium nitrate

QUESTION TWO

This question is about one of the products in each of four reactions. The reactions involve organic compounds.

Match words from the list with the numbers **1 – 4** in the table.

an alkane

an ester

carbon dioxide

hydrogen

Product	Reaction in which it is produced
1	ethanoic acid + sodium carbonate
2	ethanol + ethanoic acid
3	ethanol + sodium
4	ethene + hydrogen

TURN OVER FOR THE NEXT QUESTION

Turn over ►

SECTION BQuestions **THREE** and **FOUR**.In these questions choose the best **two** answers.Do **not** choose more than two.Mark your choices on the answer sheet.

QUESTION THREE

This question is about ions.

Which **two** of the statements are correct?

sodium hydroxide in aqueous solution produces H^+ ions

sodium hydroxide in aqueous solution produces $OH^+(aq)$ ions

sulphuric acid is an acid because it donates protons

the $H^+(aq)$ ion is a hydrated proton

the H^+ ion is an electron

QUESTION FOUR

This question is about melamine.

Which **two** statements about melamine are correct?

it can be re-moulded after heating

it contains strong covalent bonds between chains of molecules, formed during heating

it is a thermosetting polymer

it is formed from a compound with a $-C-C-$ bond by addition polymerisation

it softens when heated and hardens again as it cools

NO QUESTIONS APPEAR ON THIS PAGE

TURN OVER FOR THE NEXT QUESTION

Turn over ►

SECTION CQuestions **FIVE** to **TEN**.

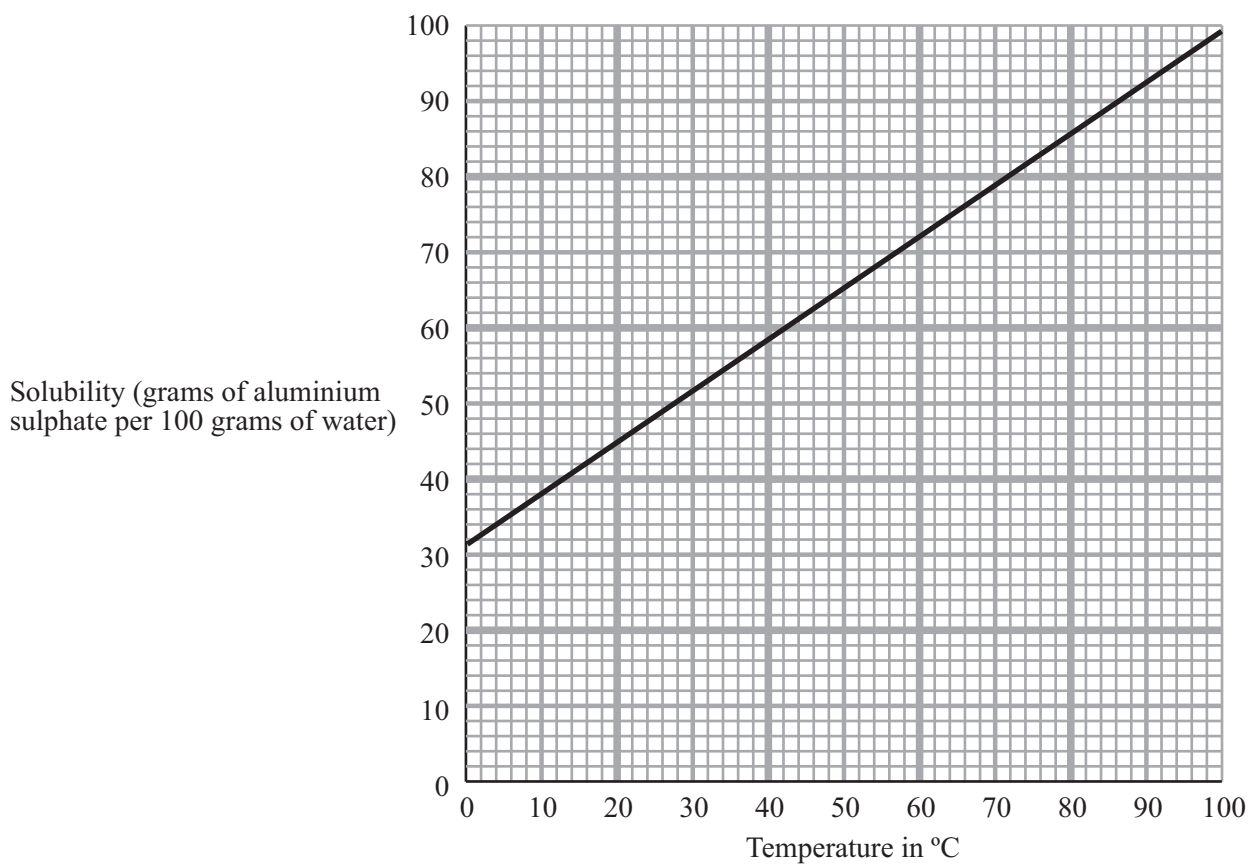
Each of these questions has four parts.

In each part choose only **one** answer.

Mark your choices on the answer sheet.

QUESTION FIVE

The graph shows the solubility of aluminium sulphate in water between 0°C and 100°C.

**5.1** What mass of aluminium sulphate will dissolve in 100 grams of water at 50°C?

- A 27 g
- B 65 g
- C 71 g
- D 98 g

5.2 What mass of aluminium sulphate will dissolve in 200 grams of water at 35 °C?

- A** 5 g
- B** 10 g
- C** 55 g
- D** 110 g

A solution contains 75 grams of aluminium sulphate in 100 grams of water at 95 °C.
The solution cools.

5.3 At what temperature will crystals start to form?

- A** 58 °C
- B** 65 °C
- C** 81 °C
- D** 90 °C

5.4 The solution cools to 20 °C.
What is the total mass of the aluminium sulphate crystals which form?

- A** 10 g
- B** 20 g
- C** 30 g
- D** 45 g

TURN OVER FOR THE NEXT QUESTION

Turn over ►

QUESTION SIX

The diagrams show some of the particles present in four different acid solutions in water.

The acids are:

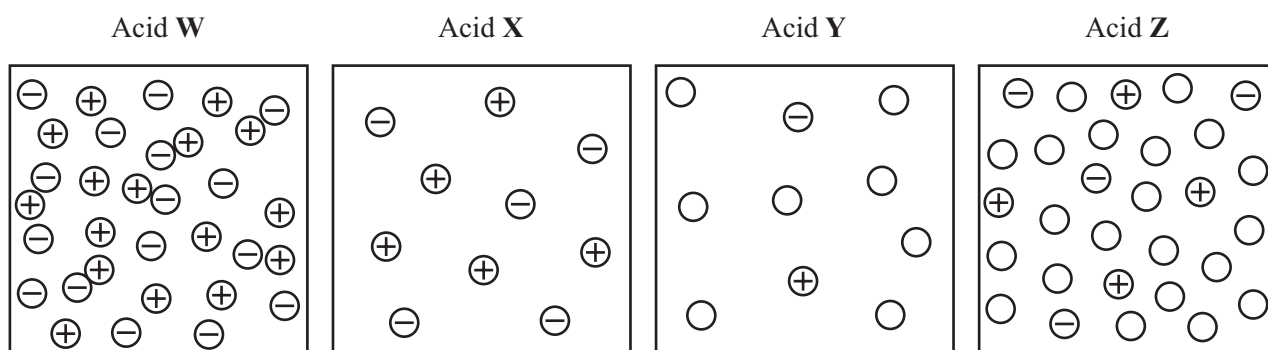
- dilute ethanoic acid
- concentrated ethanoic acid
- dilute hydrochloric acid
- concentrated hydrochloric acid.

Water particles are present but not shown.

⊕ = hydrogen ions $\text{H}^+(\text{aq})$

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6.1 Which diagram could represent a dilute solution of hydrochloric acid?

- A Acid W
- B Acid X
- C Acid Y
- D Acid Z

6.2 Which diagram could represent a concentrated solution of ethanoic acid?

- A Acid W
- B Acid X
- C Acid Y
- D Acid Z

6.3 Which substances are correct examples of a weak acid and a strong alkali?

	Weak acid	Strong alkali
A	citric acid	potassium hydroxide
B	ethanoic acid	ammonia solution
C	nitric acid	potassium hydroxide
D	sulphuric acid	sodium hydroxide

6.4 Which statements **A**, **B**, **C** or **D** could be true for a weak acid and a strong acid of the same concentration?

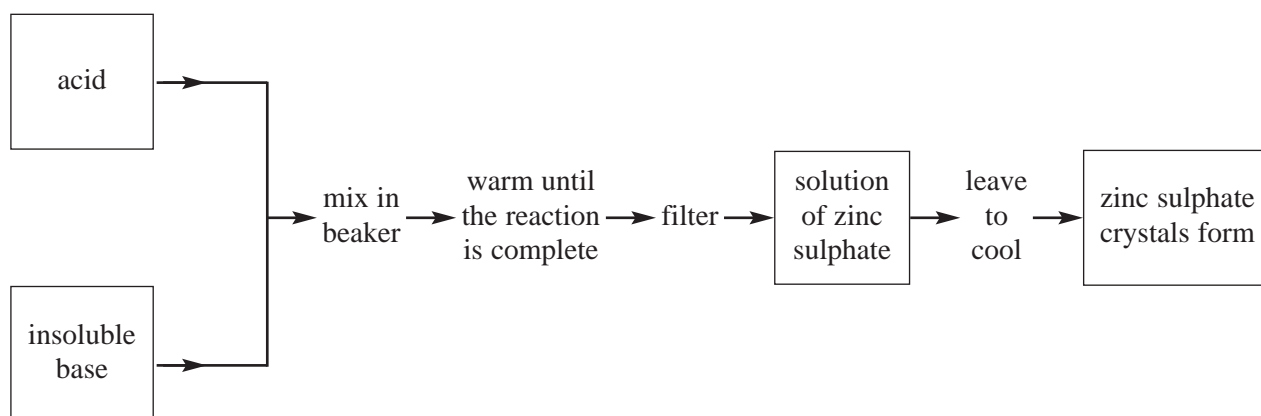
	Weak acid	Strong acid
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B	pH number 4, slow reaction with zinc	pH number 1, fast reaction with zinc
C	pH number 1, fast reaction with zinc	pH number 4, slow reaction with zinc
D	pH number 1, slow reaction with zinc	pH number 1, fast reaction with zinc

TURN OVER FOR THE NEXT QUESTION

Turn over ►

QUESTION SEVEN

The flow diagram shows how you can make crystals of zinc sulphate.



7.1 Which acid and base would you use?

	Acid	Base
A	hydrochloric	zinc hydroxide
B	hydrochloric	zinc oxide
C	sulphuric	zinc chloride
D	sulphuric	zinc oxide

7.2 When the reaction has finished, the contents of the beaker are filtered

- A** to remove excess acid.
- B** to remove the excess base.
- C** to remove the precipitate that has formed.
- D** to remove the scum that has formed.

7.3 Why do crystals form only when the solution has gone cold?

- A** Zinc sulphate crystals only form when all the acid has evaporated
- B** Zinc sulphate is insoluble in cold water
- C** Zinc sulphate is more soluble in cold water than in hot water
- D** Zinc sulphate is more soluble in hot water than in cold water

7.4 Another way you can make zinc sulphate is

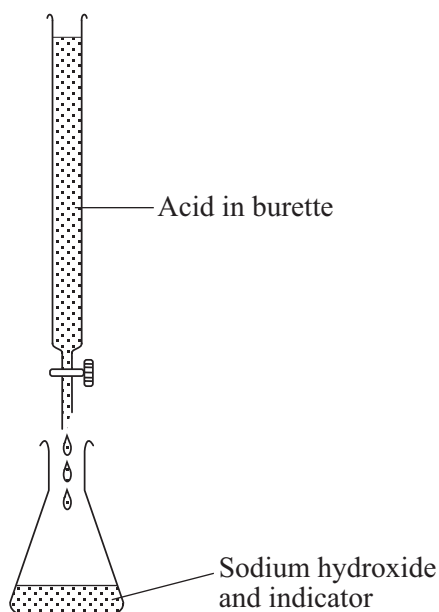
- A** by reacting a metal with an acid.
- B** by reacting a soluble base with an acid.
- C** by reacting an alkali with an acid.
- D** by reacting two elements directly.

TURN OVER FOR THE NEXT QUESTION

Turn over ►

QUESTION EIGHT

A student titrates a solution of sulphuric acid against a solution of sodium hydroxide which has a concentration of 0.05 mol dm^{-3} .



The student puts exactly 25 cm^3 of the alkali into a conical flask along with a few drops of indicator, and then records the level of the acid in the burette.

The student adds the acid to the flask a little at a time, swirling to mix the solutions, until the indicator just begins to change colour.

The student then takes the reading on the burette. This first titration gives an approximate result.

The student repeats the titration three more times to find an accurate result.

Results

	1st titration	2nd titration	3rd titration	4th titration
Reading on the burette at the start (cm^3)	0.0	24.4	0.0	22.4
Reading on the burette at the end (cm^3)	24.4	47.0	22.4	44.9

8.1 25 cm^3 of the sodium hydroxide solution react exactly with

- A 22.4 cm^3 of the sulphuric acid solution.
- B 22.5 cm^3 of the sulphuric acid solution.
- C 22.6 cm^3 of the sulphuric acid solution.
- D 24.4 cm^3 of the sulphuric acid solution.

Use the following information to help you to answer the next three parts of this question.

Relative atomic masses: H = 1; O = 16; Na = 23; Cl = 35.5



In a further experiment, the student finds that 25.0 cm³ of the 0.05 mol dm⁻³ sodium hydroxide solution is exactly neutralised by 20.0 cm³ of a solution of hydrochloric acid.

8.2 What is the relative formula mass of sodium hydroxide?

- A 39
- B 40
- C 75.5
- D 80

8.3 The number of moles in 25 cm³ of the sodium hydroxide solution is

- A 0.001
- B 0.00125
- C 0.0125
- D 2.0

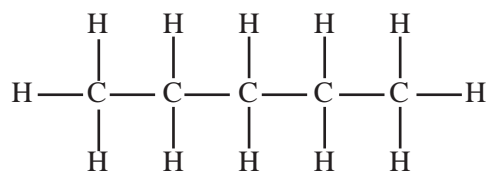
8.4 The concentration of the hydrochloric acid solution is

- A 0.04 mol dm⁻³
- B 0.0625 mol dm⁻³
- C 0.40 mol dm⁻³
- D 0.625 mol dm⁻³

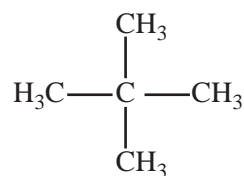
Turn over ►

QUESTION NINE

The diagram shows the structures of two of the isomers of pentane.

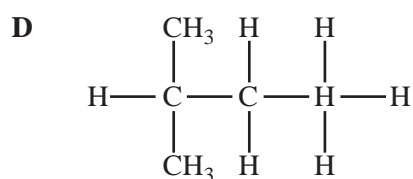
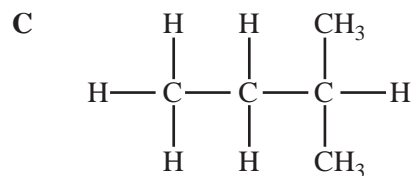
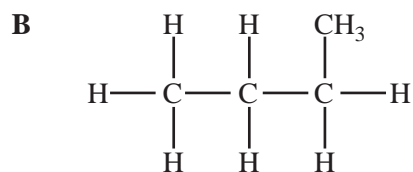
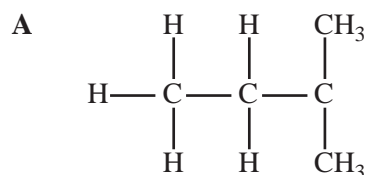


Isomer **J**
Boiling point +36°C



Isomer **K**
Boiling point +10°C

9.1 The structural formula for the third isomer of pentane is



9.2 The general formula for the homologous series to which these hydrocarbons belong is



9.3 Isomer **J** has a higher boiling point than isomer **K** because isomer **J**

- A** has molecules with loosely packed atoms.
- B** has stronger forces between atoms in its molecules.
- C** has stronger forces between its molecules.
- D** is a saturated hydrocarbon.

9.4 What would you estimate the boiling point of the third isomer to be?

- A** 4 °C
- B** 28 °C
- C** 44 °C
- D** 56 °C

TURN OVER FOR THE NEXT QUESTION

QUESTION TEN

Ethanol is produced by two different processes.

Process 1	Process 2
Fermentation of a sugar solution by yeast in a reaction vessel	Reaction of ethene (from crude oil) with steam

- 10.1** One advantage of Process 1 over Process 2 is
- A the ethanol is colourless.
 - B the raw materials are renewable.
 - C there are no additives in the ethanol.
 - D yeast is a living organism.
- 10.2** One advantage of Process 2 over Process 1 is
- A crude oil is readily available.
 - B lower temperatures are required for the reaction.
 - C no expensive catalysts are required.
 - D the ethanol is purer.
- 10.3** It is easier to produce a large quantity of ethanol in a given time by Process 2 because
- A crude oil is more easily transported than sugar.
 - B it is a batch process.
 - C the reaction is faster and is run as a continuous process.
 - D the reaction vessel is larger.
- 10.4** Alcoholic drinks can be produced by fermentation of fruit juices.
- They turn sour
- A if enzymes form in the reaction mixture.
 - B if the ethanol they contain is oxidised.
 - C if the sugar solution is used up.
 - D if the yeast in the reaction vessel dies.

END OF TEST