FOR OFFICIAL USE

X012/201

NATIONAL QUALIFICATIONS 2000

WEDNESDAY, 7 JUNE
9.00 AM – 11.00 AM

CHEMISTRY INTERMEDIATE 2

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

Necessary data will be found in the Chemistry Data Booklet for Standard Grade and Intermediate 2 (1999 Edition).

Section A —Part 1 Questions 1 to 25 and Part 2 Questions 26 and 27

Instructions for completion of **Part 1** and **Part 2** are given on pages two and seven respectively.

Section B (Questions 1 to 17)

All questions should be attempted.

The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, and must be written clearly and legibly in ink.

Rough work, if any should be necessary, as well as the fair copy, is to be written in this book.

Rough work should be scored through when the fair copy has been written.

Additional space for answers and rough work will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the invigilator and should be inserted inside the **front** cover of this book.

Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.

SCOTTISH QUALIFICATIONS AUTHORITY

SECTION A

PART 1

Check that the answer sheet provided is for Chemistry Intermediate 2 (Section A).

Fill in the details required on the answer sheet.

In questions 1 to 25 of this part of the paper, an answer is given by indicating the choice A, B, C or D by a stroke made in INK in the appropriate place in Part 1 of the answer sheet—see the sample question below.

For each question there is only ONE correct answer.

Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—**not** on the answer sheet.

At the end of the examination the answer sheet for Section A **must** be placed **inside** this answer book.

This part of the paper is worth 25 marks.

SAMPLE QUESTION

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

A fractional distillation

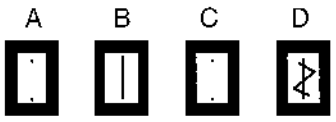
B chromatography

C fractional crystallisation

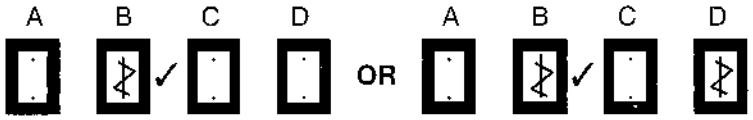
D filtration.

The correct answer is B—chromatography. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown **in the example on the answer sheet**.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer **D** to an answer **B**, your answer sheet would look like this:



If you want to change back to an answer which has already been scored out, you should **enter a tick (✓)** to the RIGHT of the box of your choice, thus:



SECTION A

PART 1

1. An atom has atomic number 23 and mass number 51.

The number of electrons in the atom is

A 23

B 28

C 51

D 74.

2. Different isotopes of the same element have identical

A nuclei

B mass numbers

C numbers of neutrons

D numbers of protons.

3. Which substance exists as diatomic molecules?

A Sodium chloride

B Nitrogen monoxide

C Silicon tetrachloride

D Sulphur dioxide

4. Which statement describes an exothermic reaction?

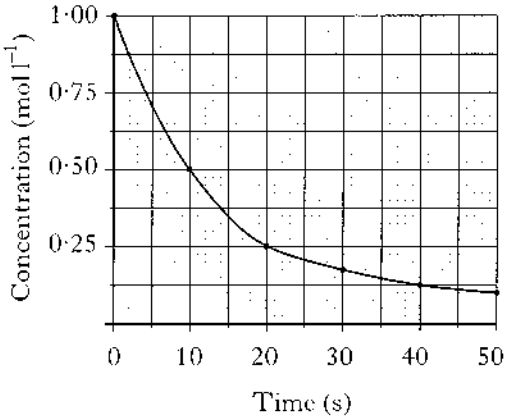
A Energy is taken in from the surroundings and the products have more chemical energy than the reactants.

B Energy is taken in from the surroundings and the products have less chemical energy than the reactants.

C Energy is released to the surroundings and the products have more chemical energy than the reactants.

D Energy is released to the surroundings and the products have less chemical energy than the reactants.

5. The graph below shows the variation of concentration of a reactant with time as a reaction proceeds.



During the first 20 s, the average reaction rate, in $mol\,l^{-1}\,s^{-1}$, is

A 0·0125

B 0·0180

C 0·0375

D 0·0450.

6. The fractional distillation of crude oil depends on the fact that the different hydrocarbons have different

A boiling points

B flammabilities

C solubilities

D viscosities.

7. Which molecule would most likely be present in petrol?

A CH_4

B C_3H_8

C C_8H_{18}

D $C_{14}H_{30}$

[Turn over

8. A compound has a relative formula mass of 30 and contains only carbon and hydrogen.

Which statement about the compound is true?

A It is a gas.

B It has a high viscosity.

C It undergoes addition polymerisation.

D It decolourises bromine water immediately.

Questions 9 and 10 refer to the following types of chemical reactions.

A Hydration

B Hydrolysis

C Dehydration

D Condensation

9. Which type of reaction occurs during the formation of proteins from amino acids?

10. Which type of reaction is represented by the equation

$$C_2H_4 + H_2O \xrightarrow{\text{catalyst}} C_2H_5OH$$

11. Which of the following is a naturally occurring ester?

A Fat

B Protein

C Starch

D Sucrose

12. Which compound is a carbohydrate?

A $C_6H_{14}O$

B $C_6H_{12}O_2$

C $C_6H_{10}O_4$

D $C_6H_{12}O_6$

13. Which compound could be obtained by the hydrolysis of a fat?

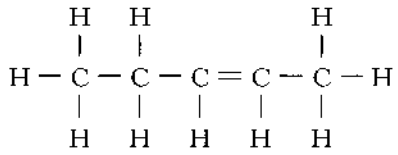
A Ethanol

B Glucose

C Glycerol

D Propanol

14.



The name of the above compound is

A but-2-ene

B pent-2-ene

C but-3-ene

D pent-3-ene.

15. Which polymer dissolves readily in water?

A Polystyrene

B Nylon

C Poly(ethenol)

D Kevlar

16. The molecular formula for cyclohexane is

A C_6H_6

B C_6H_{10}

C C_6H_{12}

D C_6H_{14}.

17. Which equation does **not** represent a redox reaction?

A $Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$

B $Br_2(aq) + 2Fe^{2+}(aq) \rightarrow 2Fe^{3+}(aq) + 2Br^-(aq)$

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

D $Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$

18. Which oxide, when shaken with water, would leave the pH unchanged?

A Calcium oxide

B Carbon dioxide

C Sulphur dioxide

D Zinc oxide

19. In water, an equilibrium exists between water molecules and hydrogen and hydroxide ions.

$$H_2O(\ell) \rightleftharpoons H^+(aq) + OH^-(aq)$$

At equilibrium

A the water molecules have stopped changing into ions

B the molecules of water have all changed into ions

C the concentrations of water molecules and hydrogen ions are equal

D the concentrations of water molecules and ions are constant.

20. Which compound is a salt?

A Ammonium chloride

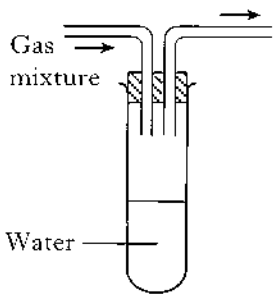
B Calcium oxide

C Hydrogen chloride

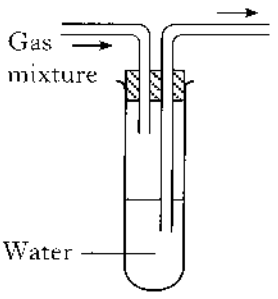
D Sodium hydroxide

21. Which diagram shows the apparatus which would allow a soluble gas to be removed from a mixture of gases?

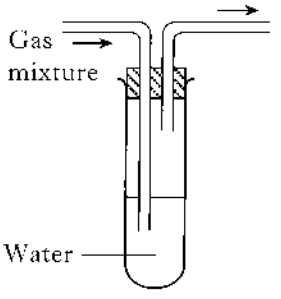
A



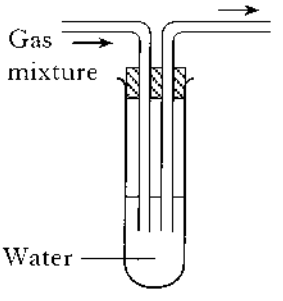
B



C



D



[Turn over

22. Excess magnesium is burned in an enclosed volume of air.

Which mixture is nearest to the composition of the gas after burning is complete?

	Oxygen	Nitrogen	Carbon dioxide
A	1%	98%	0·03%
B	1%	79%	19%
C	16%	79%	4%
D	20%	79%	0·03%

23. An iron nail is covered with water.

Which of the following would increase the rate at which the iron nail rusts?

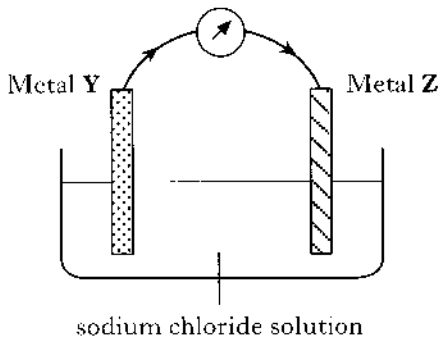
A Adding glucose to the water

B Wrapping zinc around the nail

C Adding potassium nitrate to the water

D Attaching the nail to the negative terminal of a d.c. power supply

24. In the cell shown, the electron flow through the meter is from Metal **Y** to Metal **Z**.



Which pair of metals would give an electron flow in this direction?

	Metal **Y**	Metal **Z**
A	gold	copper
B	copper	tin
C	gold	tin
D	tin	copper

25. 0·25 mol of pure citric acid was dissolved in water and the solution made up to 500 cm^3.

What was the concentration of the solution formed?

A 0·25 $mol\,l^{-1}$

B 0·5 $mol\,l^{-1}$

C 1·0 $mol\,l^{-1}$

D 2·0 $mol\,l^{-1}$

SECTION A

PART 2

In Questions 26 and 27 of this part of the paper, an answer is given by circling the appropriate letter (or letters) in the answer grid provided.

In some questions, two letters are required for full marks.

If more than the correct number of answers is given, marks will be deducted.

In some cases, the number of correct responses may NOT be identified in the question.

A total of 5 marks is available in this part of the paper.

SAMPLE QUESTION

A CH_4	B H_2	C CO_2
D CO	E C_2H_5OH	F C

(*a*) Identify the hydrocarbon.

(A)	B	C
D	E	F

The one correct answer to part (*a*) is A. This should be circled.

(*b*) Identify the **two** elements.

A	(B)	C
D	E	(F)

As indicated in this question, there are **two** correct answers to part (*b*). These are B and F. Both answers are circled.

(*c*) Identify the substance(s) which can burn to produce **both** carbon dioxide and water.

(A)	B	C
D	(E)	F

There are **two** correct answers to part (*c*). These are A and E.

Both answers are circled.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and circle the answer you now consider to be correct. Thus, in part (*a*), if you want to change an answer A to an answer D, your answer sheet would look like this:

~~(A)~~	B	C
(D)	E	F

If you want to change back to an answer which has already been scored out, you should enter a tick (✓) in the box of the answer of your choice, thus:

✓ ~~(A)~~	B	C
~~(D)~~	E	F

26. The grid shows six elements from the Periodic Table.

A chlorine	B calcium	C oxygen
D phosphorus	E sodium	F sulphur

(*a*) Which element forms an ion with a single positive charge?

(*b*) Which **two** elements react with water to produce alkaline solutions?

(*c*) Which **two** elements form ions with the same electron arrangement as neon atoms?

27. The properties of substances are related to bonding.

Substance	**Melting Point (°C)**	**Boiling Point (°C)**	**Ability to conduct**	
			as a solid	**as a liquid**
A	7	81	no	no
B	712	1418	no	yes
C	2623	4639	yes	yes
D	113	445	no	no
E	1700	2230	no	no
F	−183	−89	no	no

(*a*) Identify the substance which is an ionic compound.

(*b*) Identify the substance which is a covalent network compound.

Candidates are reminded that the answer sheet MUST be returned INSIDE this answer book.

[Turn over for Section B on *Page ten*]

Marks

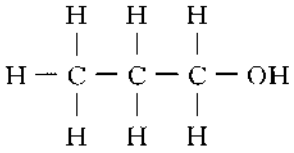
SECTION B

50 marks are available in this section of the paper.

1. (*a*) The alcohols are a family of carbon compounds.
Methanol reacts with ethanoic acid to form an ester.
Name the ester formed.

_____ **1**

(*b*) Propan-1-ol has the following full structural formula.



Draw the full structural formula for an isomer of propan-1-ol. **1**

(2)

DO NOT WRITE IN THIS MARGIN

Marks

2. Copper metal can be obtained from sulphide ores by a two-stage process.

Stage 1 The sulphide ores are heated in air

eg $2CuS + 3O_2 \rightarrow 2CuO + 2SO_2$

Stage 2 The copper oxide is heated with carbon

$2CuO + C \rightarrow 2Cu + CO_2$

(*a*) Suggest why Stage 1 of this process could be environmentally damaging.

_____

_____

_____ **1**

(*b*) Name the type of reaction occurring in Stage 2.

_____ **1**

(*c*) Name a metal which **cannot** be obtained from its ore by heating with carbon.

_____ **1**

(3)

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

3. (*a*) The elements calcium and strontium have similar chemical properties. Suggest why calcium and strontium have similar chemical properties.

1

(*b*) Explain why strontium has a relative atomic mass of 87·6 yet no strontium atom has this mass.

2

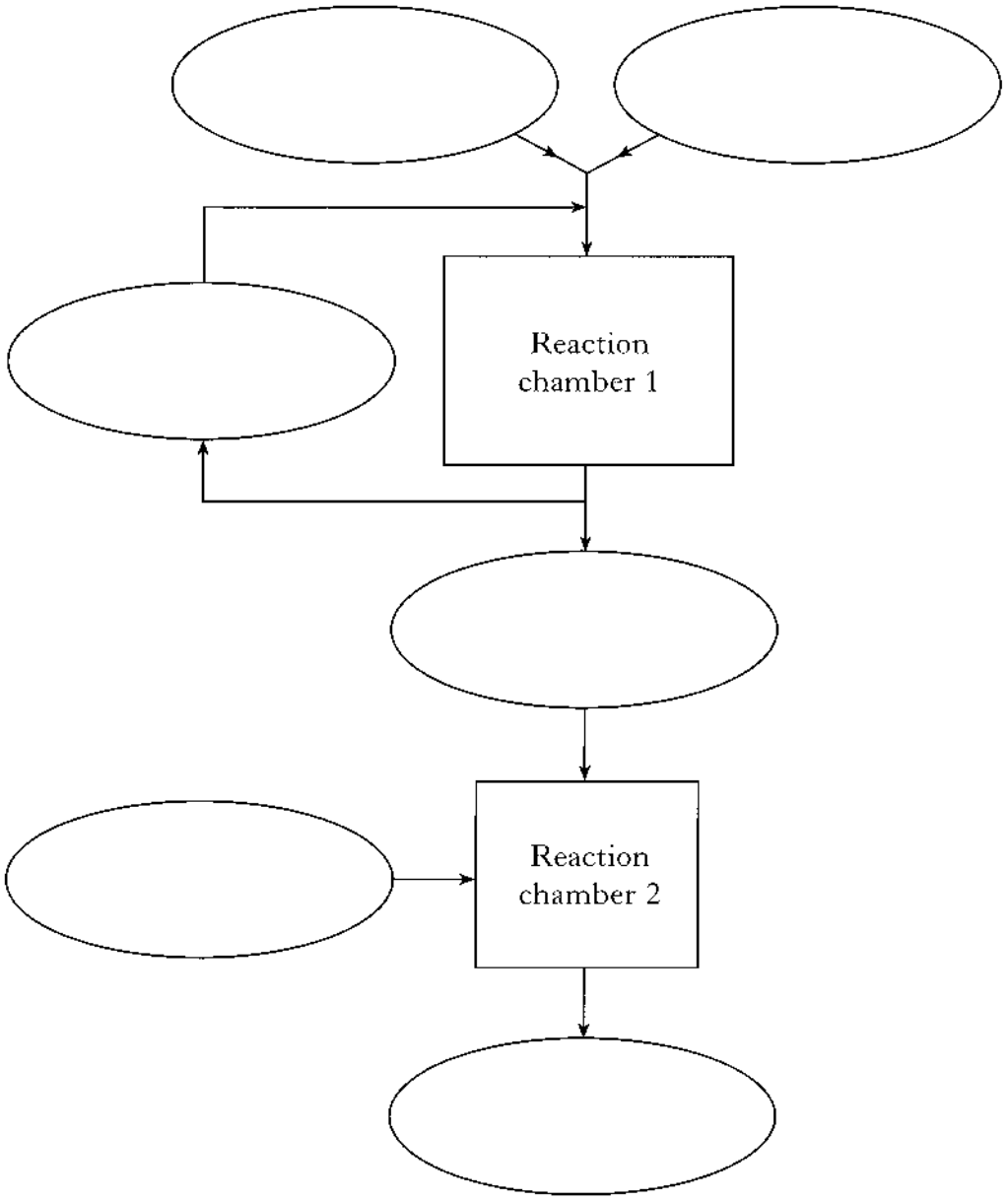
(3)

Marks

4. (*a*) Ammonium nitrate is an important chemical. It is made by reacting ammonia with nitric acid.

The ammonia is made by passing a mixture of nitrogen and hydrogen gases through a reaction chamber. Approximately 18% of the reactants are converted to ammonia. Unreacted nitrogen and hydrogen are returned to the reaction chamber. The ammonia gas then enters a second reaction chamber in which ammonium nitrate is produced.

Use this information to complete the flow diagram below.



2

[Turn over

Marks

4. (continued)

(*b*) Give a use for ammonium nitrate.

_____

_____

_____ **1**

(*c*) Ammonia has the formula NH_3.

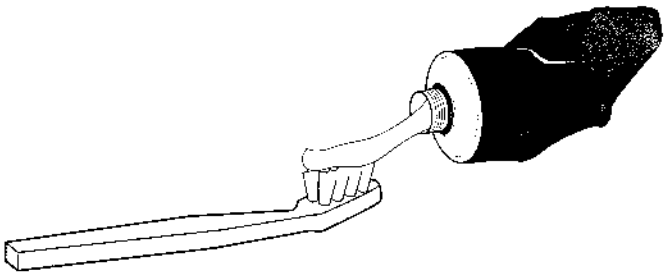
In an ammonia molecule the atoms are held together by covalent bonds. Draw a diagram to show the sharing of the outer electrons of all the atoms in an ammonia molecule.

1

(4)

Marks

5.



Many toothpastes contain fluoride compounds to reduce tooth decay.

Early attempts to produce fluoride toothpastes were not successful because the fluoride ions reacted with calcium ions present in the toothpaste.

$$Ca^{2+}(aq) + 2F^{-}(aq) \rightarrow CaF_2(s)$$

(*a*) Name this type of chemical reaction.

_____ **1**

(*b*) Some modern toothpastes contain tin(II) fluoride.
Write the formula for tin(II) fluoride.

_____ **1**

(*c*) Another fluoride compound added to toothpaste is sodium monofluorophosphate.
The formula for sodium monofluorophosphate is Na_2PO_3F.
Calculate the mass of one mole of sodium monofluorophosphate.

1

(3)

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

6. Scientists have been experimenting to find ways of reducing carbon dioxide in the atmosphere. One of these ways involves placing concrete balls on the sea bed. They hope that green plants called algae will grow on the balls and this will help to reduce the carbon dioxide level.

(*a*) Give a reason why the amount of carbon dioxide in the air is increasing.

_____ **1**

(*b*) The balanced equation for the removal of carbon dioxide by algae is

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

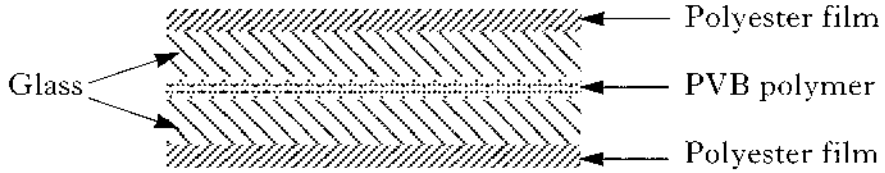
If 200 kg of carbon dioxide were removed by algae, calculate the mass of oxygen that would be produced.

2

(3)

Marks

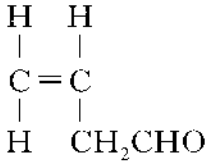
7. Polymers are used in the manufacture of glass windscreens. This makes the windscreens less likely to shatter into fragments.



(*a*) Name the type of polymerisation reaction used to make polyesters.

_____ **1**

(*b*) The PVB polymer is made from a monomer with the structure



Draw a section of the polymer showing **three** monomer units linked together.

1

(2)

[Turn over

Marks

8. Undersea pipelines are used to carry crude oil from North Sea oil fields to the refinery on the mainland.

(*a*) The iron pipelines are protected from rusting by welding lumps of zinc to them.

Explain **fully** how this protects the pipe from rusting.

2

(*b*) At the refinery, some fractions from the crude oil are cracked.

What is meant by cracking?

1

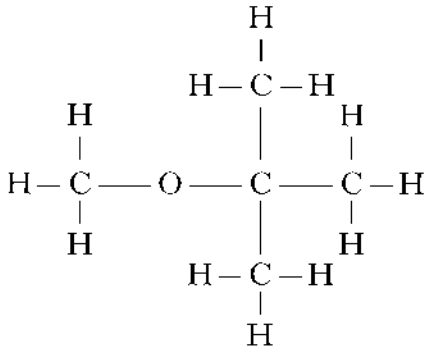
(3)

DO NOT WRITE IN THIS MARGIN

Marks

9. In some American states, chemicals called oxygenates are added to petrol to improve combustion.

One such compound is MTBE.



(*a*) Write the molecular formula for MTBE.

_____ **1**

(*b*) Name a pollutant in car exhausts which is due to incomplete combustion of the petrol.

_____ **1**

(*c*) Why must cars fitted with catalytic convertors use unleaded petrol?

_____

_____

_____ **1**

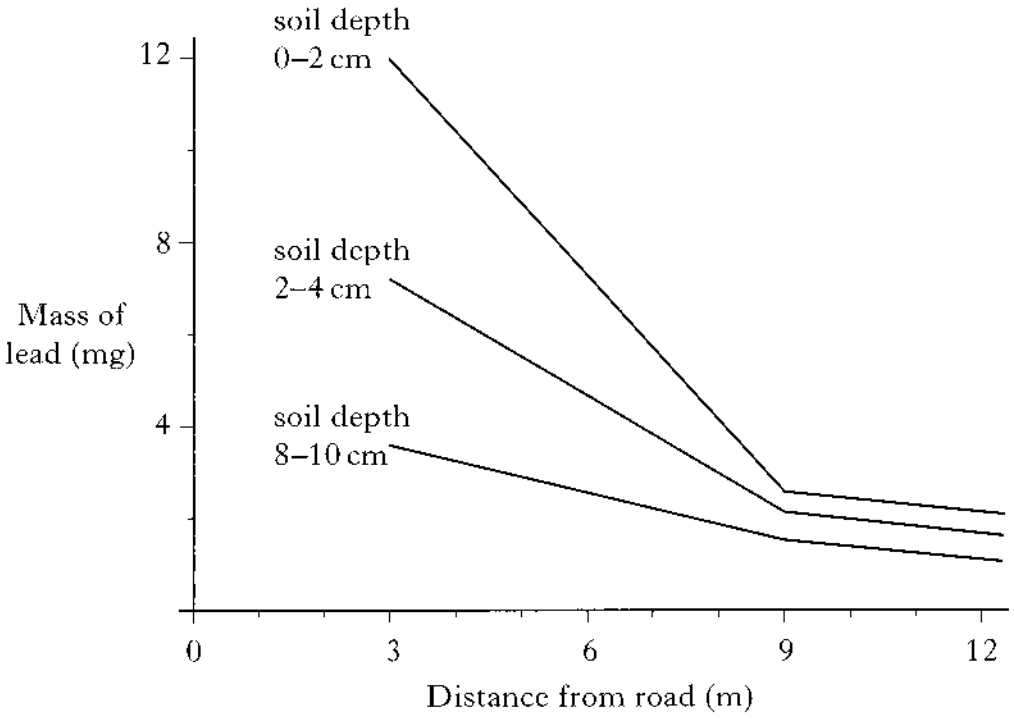
[Turn over

Marks

9. (continued)

(*d*) Leaded petrol has been a major source of lead pollution in the soil near to roads.

These graphs show how the mass of lead in one gram samples of soil varies.



State **two** conclusions that can be drawn from these graphs.

(i) _____

_____ **1**

(ii) _____

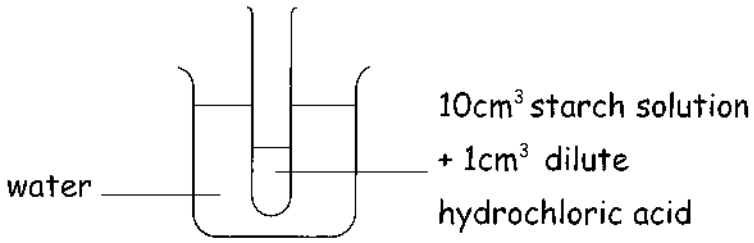
_____ **1**

(5)

Marks

10. A student was investigating the effect of acid on the hydrolysis of starch.
A section of the student's workcard is shown below.

1. Set up the experiment as shown in the diagram.



2. Boil the water in the beaker for 5 minutes and then turn off the bunsen.

3. Add a small amount of sodium hydrogencarbonate solid to the test tube.

4. Add 5cm³ of Benedict's solution to the test tube and warm gently.

5. Observe and record your results.

(*a*) What colour change would the student have observed?

_____ **1**

(*b*) A control experiment would be required for the investigation.
Draw a labelled diagram of the control experiment.

1

(2)

DO NOT WRITE IN THIS MARGIN

Marks

11. The American spaceshuttle is propelled into space by solid rocket boosters which contain aluminium as the fuel.

(*a*) What is a fuel?

_____

_____ **1**

(*b*) When the rocket booster is firing, the aluminium reacts to produce aluminium oxide.

$$Al + O_2 \rightarrow Al_2O_3$$

Balance this equation. **1**

(*c*) The polymer PVC is also used in the rocket boosters, causing hydrogen chloride to be given off in the exhaust fumes.

Pollution from the hydrogen chloride is prevented by spreading crushed sea shells (calcium carbonate) on the area surrounding the launch site to react as shown.

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

Name the type of chemical reaction which is occurring.

_____ **1**

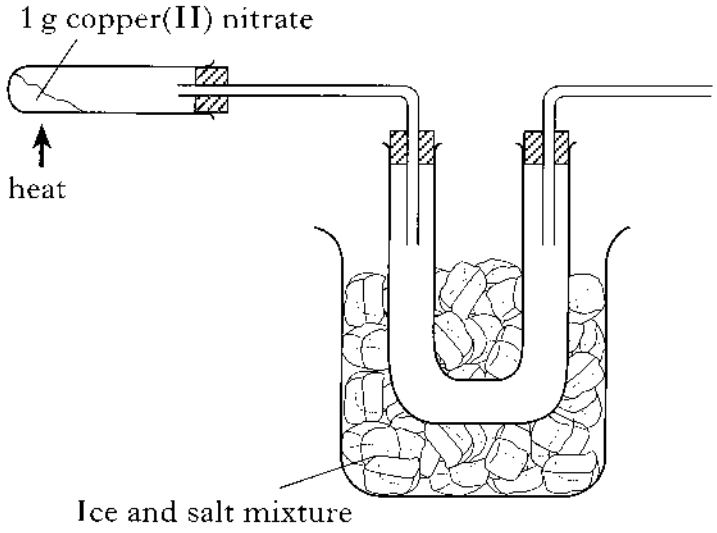
(3)

Marks

12. Nitrogen dioxide can be prepared by heating copper(II) nitrate powder in a test tube.

Both oxygen gas and nitrogen dioxide are formed and these are separated by passing them through a U-tube surrounded by a mixture of ice and salt. The nitrogen dioxide condenses in the U-tube. The oxygen gas can then be collected over water.

(*a*) Complete the diagram for the experiment.



1

(*b*) Add labels to show where each product is collected. **1**

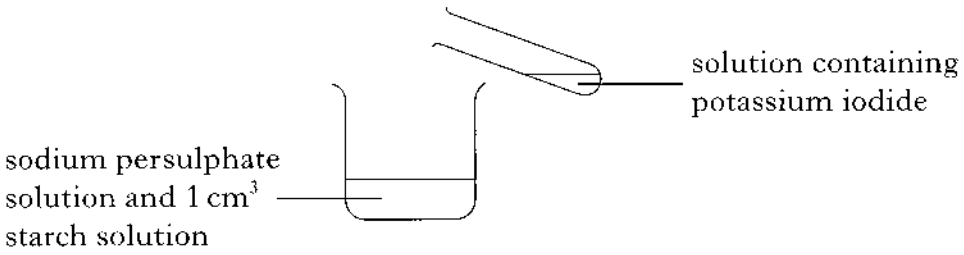
(2)

[Turn over

Marks

13. A student was investigating the rate of the reaction of sodium persulphate solution with potassium iodide solution.

The concentration of the sodium persulphate solution was varied and the time taken for each reaction was measured.



The results obtained are shown in the table.

Experiment	**1**	**2**	**3**	**4**
Volume of sodium persulphate (cm^3)	10	8	6	4
Volume of water (cm^3)	0	2	4	6
Time taken for reaction (s)	51	67	96	152
$\left[\text{Rate} = \frac{1}{\text{time}}\ (s^{-1})\right] \times 100$	2·0	1·5	1·0	0·7

(*a*) How would you know when each reaction was complete?

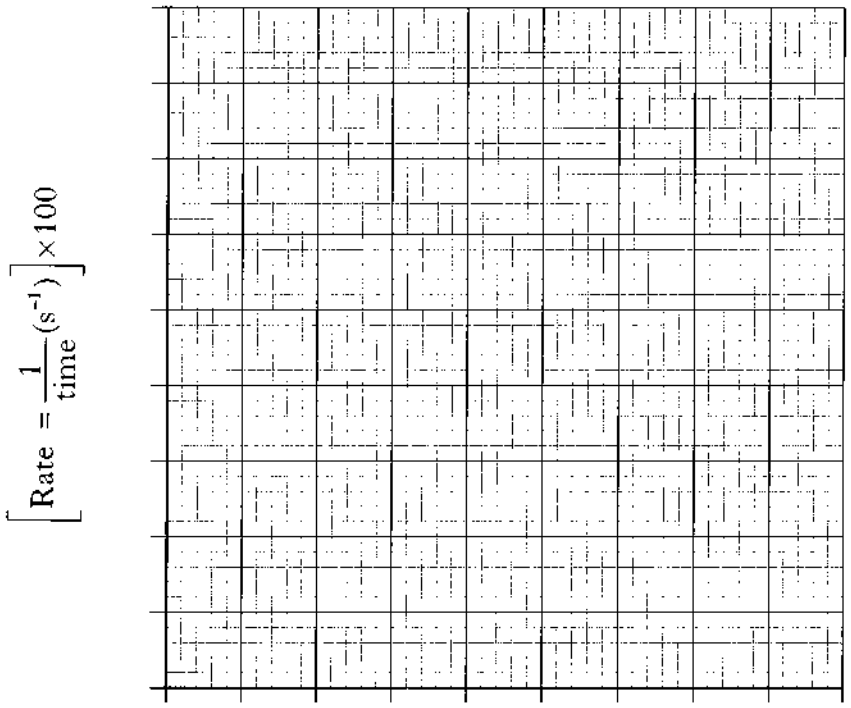
_____

_____ **1**

Marks

13. (continued)

(*b*) Using these results, plot a graph of rate against volume of sodium persulphate solution.
(Additional graph paper, if required, can be found on page 30.)



Volume of sodium persulphate solution (cm^3) **2**

(*c*) This reaction is catalysed by iron(II) sulphate solution.
What would happen to the time taken for each reaction if iron(II) sulphate solution was added to each experiment.

_____ **1**

(*d*) During the reaction, iodide ions are oxidised to iodine molecules.
Write the ion-electron equation for this reaction.

1

(5)

[Turn over

Marks

14. Carbohydrates in plant and animal waste can be digested by bacteria to produce biogas.

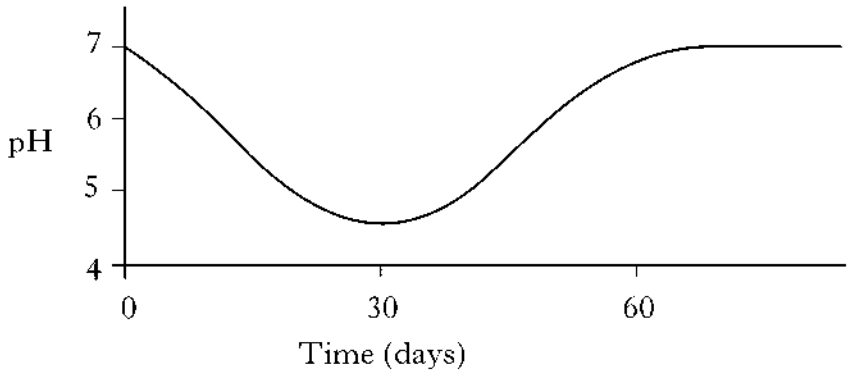
The digestion involves several steps.

Carbohydrates
↓
Glucose
↓
Ethanoic acid
↓
Biogas
(70% methane + 30% carbon dioxide)

(*a*) Draw the full structural formula for ethanoic acid. **1**

(*b*) Ethanoic acid is described as a weak acid. What is meant by a **weak** acid? **1**

(*c*) The graph shows how pH changes in a waste digestor.



Describe and explain the pH changes taking place in the waste digestor over 60 days. **2**

(4)

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Marks

15. Magnesium sulphate can be prepared in the laboratory by reacting either excess magnesium metal ribbon or excess magnesium carbonate powder with dilute sulphuric acid.

(*a*) What evidence would there be that all the acid has reacted?

_____

_____ **1**

(*b*) How would a pure sample of magnesium sulphate crystals be obtained from the reaction mixture?

_____

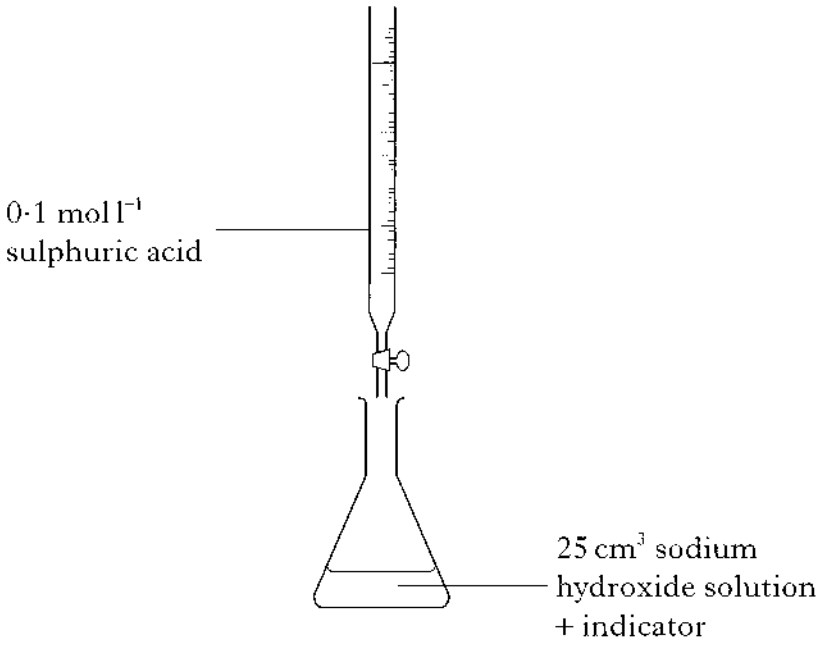
_____ **1**

(2)

[Turn over

Marks

16. A laboratory technician was titrating sodium hydroxide solution with dilute sulphuric acid to accurately determine the concentration of the alkali.



Volume of 0·1 mol l^{-1} sulphuric acid required = 22·5 cm^3

The equation for the reaction is

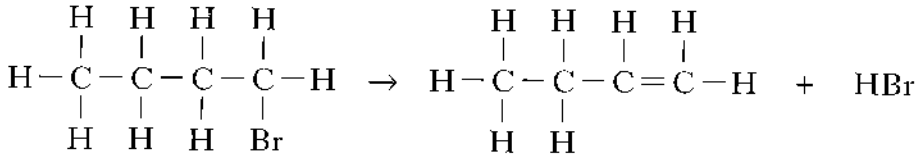
$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$

Calculate the concentration of the sodium hydroxide solution.

(2)

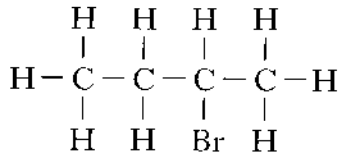
Marks

17. Alkenes can be made from bromoalkanes. Bromoalkanes are alkane molecules in which a hydrogen atom has been replaced by a bromine atom.

eg 

1-bromobutane but-1-ene

Draw the full structural formula for the **two** alkenes which can be formed from 2-bromobutane.



2-bromobutane

(2)

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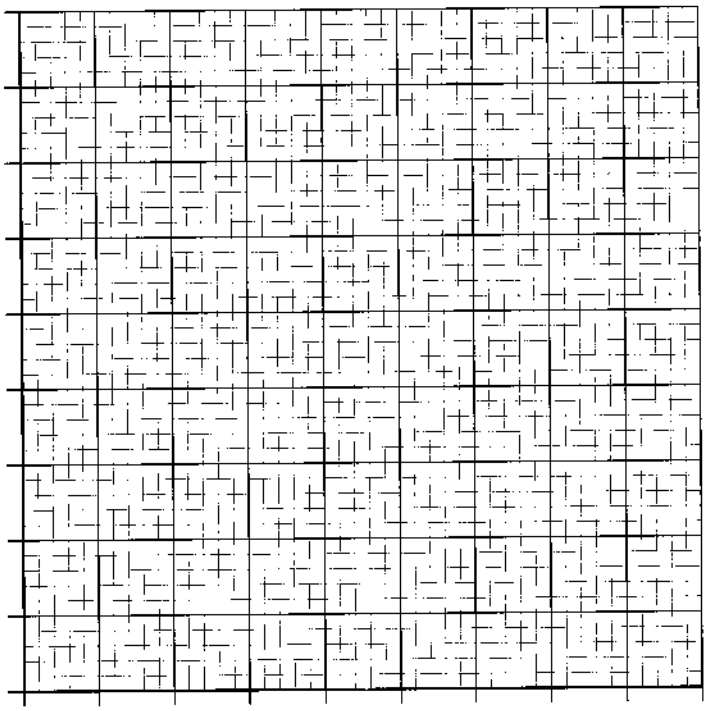
ADDITIONAL GRAPH PAPER FOR QUESTION 13(*b*)

$\left[\text{Rate} = \frac{1}{\text{time}}(s^{-1})\right] \times 100$



Volume of sodium persulphate solution (cm^3)

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