Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

General Certificate of Secondary Education
June 2003

CHEMISTRY (MODULAR) SPECIFICATION A   3423/H
HIGHER TIER

Monday 9 June 2003   9.00 am to 10.30 am

H

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

In addition to this paper you will require:
    the Data Sheet (enclosed).
You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 90.
- Mark allocations are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8		16	
		17	
		18	
Total (Column 1)			
Total (Column 2)			
TOTAL			
Examiner's Initials			

PATTERNS OF CHEMICAL CHANGE

1   A student investigated what conditions altered the rate of reaction between 2.0 g of magnesium carbonate and 100 cm³ of dilute hydrochloric acid (an excess).

The diagram shows the apparatus used.
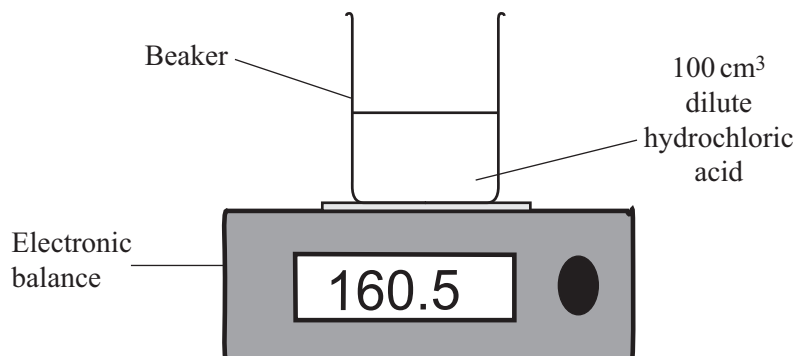
Details of the four experiments are given below.

Experiment	Form of magnesium carbonate	Concentration of acid in moles per dm³	Temperature of acid
A	lump	2	20 °C
B	lump	2	15 °C
C	powder	4	25 °C
D	powder	2	20 °C

(a)   The student recorded the loss in mass of the beaker and its contents every 10 seconds. Explain why there was a loss in mass in each experiment.

....

....

(1 mark)

(b) The results of the four experiments were plotted on graph paper.
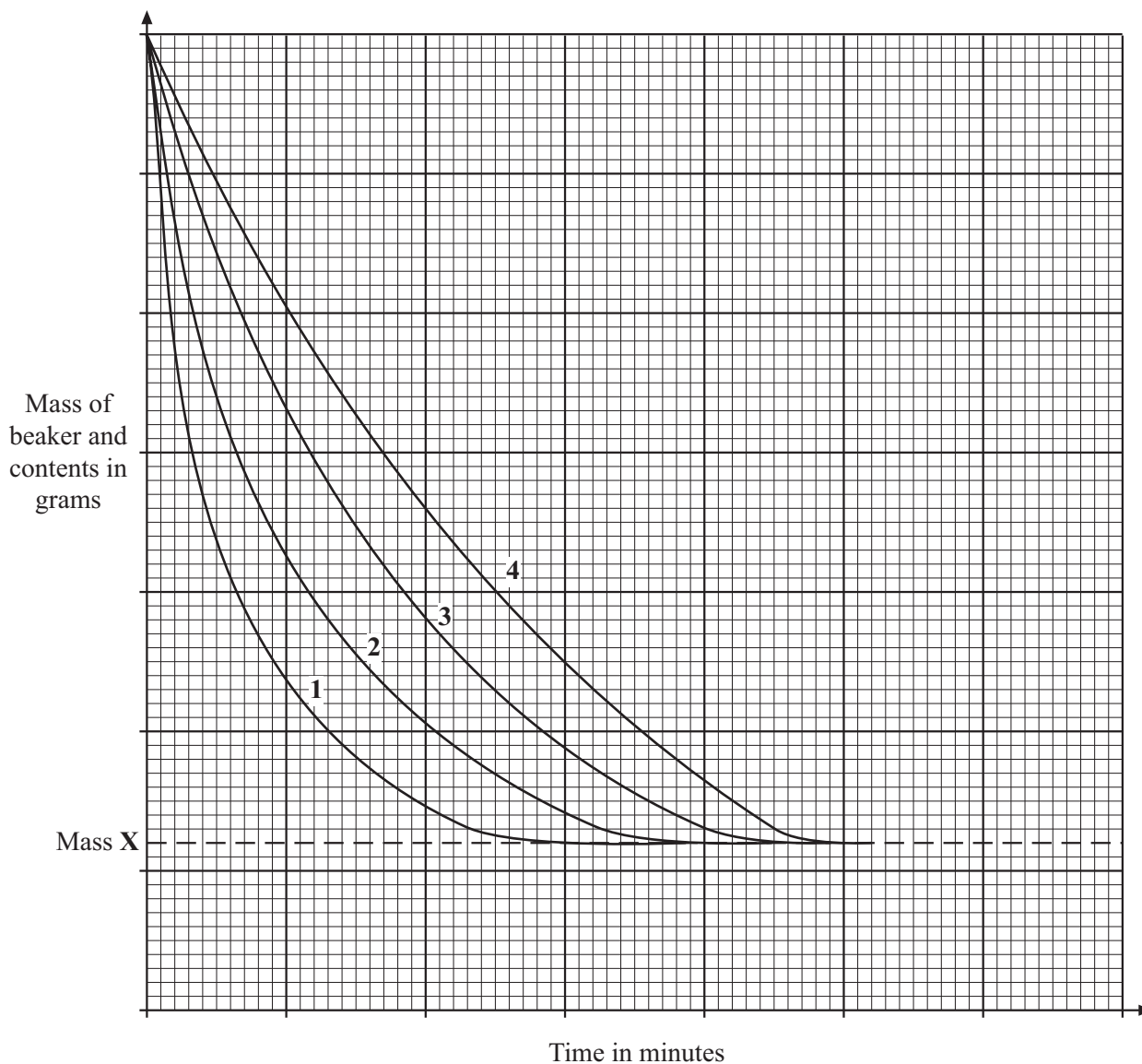
Match up the graph plots with the correct experiments (**A**, **B**, **C** or **D**).

Line **1** is experiment   ....

Line **2** is experiment   ....

Line **3** is experiment   ....

Line **4** is experiment   ....   *(2 marks)*

(c) Explain why the reaction stopped at mass **X** in each experiment.

....

....
                                                                                                                            (1 mark)

$\dfrac{}{4}$

Turn over ▶

2 (a) Nitrogen-based fertilisers are used to increase crop yields.
Calculate the percentage of nitrogen in the fertiliser ammonium sulphate, $(NH_4)_2SO_4$.

(Relative atomic masses: H = 1; N = 14; O = 16; S = 32)

....

....

....

....

(2 marks)

(b) *To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Explain why the amount of fertiliser used is increasing, and describe the damage that fertilisers can cause to life in rivers and lakes.

....

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....

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(4 marks)

$\overline{6}$

STRUCTURES AND BONDING

3 (a) The symbols for two *isotopes* of oxygen are:

$$^{16}_{8}O \qquad\qquad ^{18}_{8}O$$

(i) Explain why they can be described as *isotopes* of oxygen.

....

....
(1 mark)

(ii) The arrangement of electrons in energy levels (shells) for an oxygen atom is 2,6.
Give the electron arrangement of an oxide ion.

....
(1 mark)

(iii) Give the chemical formula of potassium oxide.

....
(1 mark)

(b) Using dot and cross symbols, complete the diagram to show how the outer electrons are arranged in a molecule of ammonia, NH_3.
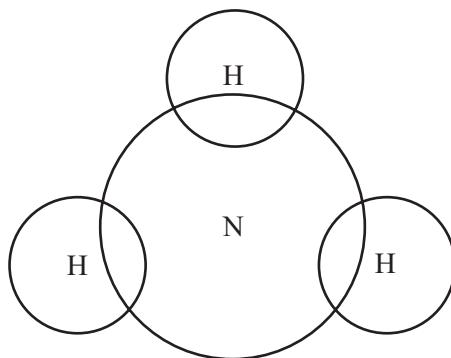
(2 marks)

CHEMISTRY IN ACTION

4   The iron produced from the blast furnace can be converted into steels for specific uses.

The flow diagram for the process is given below.

```
                          ┌──────────────────┐
                          │  Blast furnace   │
                          └──────────────────┘
                                   │
                                   ▼
┌──────────────────┐      ┌──────────────────┐
│ Molten scrap iron│      │   Molten iron    │
└──────────────────┘      └──────────────────┘
         │                         │
         │                         ▼
         │                ┌──────────────────┐      ┌──────────────────┐
         └───────────────▶│   Converter 1    │◀─────│   Pure oxygen    │
                   ┌──────└──────────────────┘      └──────────────────┘
                   ▼                 │
┌──────────────────┐      ┌──────────────────┐      ┌──────────────────────┐
│   Waste gases    │      │   Converter 2    │◀─────│ Add X to remove      │
│ (acidic oxides)  │      └──────────────────┘      │ acidic impurities    │
└──────────────────┘                 │              └──────────────────────┘
         │                           ▼
         │                ┌──────────────────┐
         │                │       Iron       │
         │                └──────────────────┘
         │                           │  Add carbon and other metals
         ▼                           ▼
  Treatment before        ┌──────────────────┐
  being released into     │      Steels      │
  the atmosphere          └──────────────────┘
```
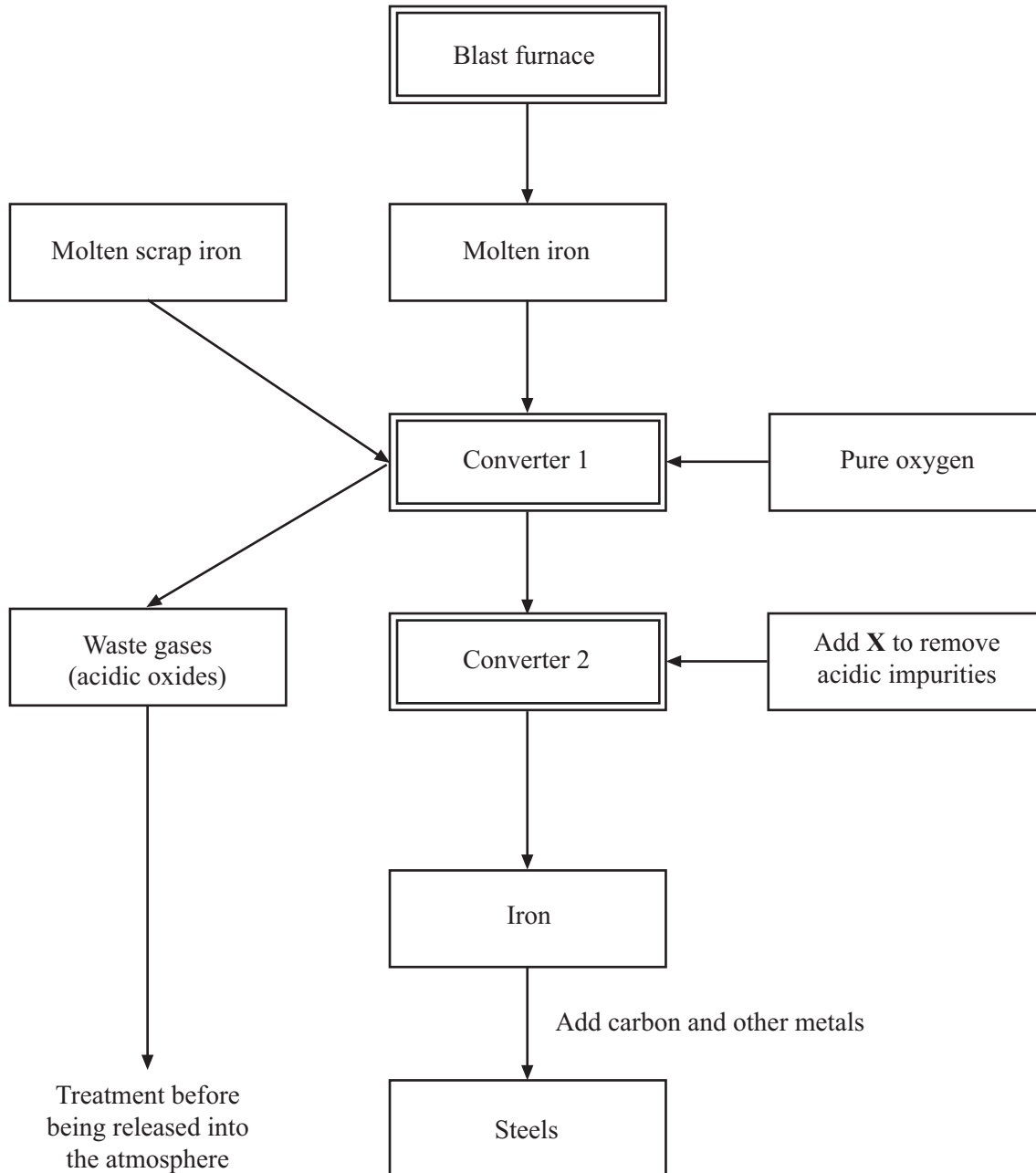
(a) Solid iron from the blast furnace is of little practical use.
    Explain why.

    ....

    ....

    ....

    ....
                                                                                          (2 marks)

(b) Identify the stage in the process where the recycling of resources is involved.

    ....
                                                                                          (1 mark)

(c) Name the chemical process taking place in Converter 1.

    ....
                                                                                          (1 mark)

(d) Sulphur dioxide is one of the acidic oxides produced in Converter 1. Explain why sulphur
    dioxide needs to be removed before the remaining waste gases are released into the atmosphere.

    ....

    ....

    ....
                                                                                          (2 marks)

(e) Name substance **X**.

    ....
                                                                                          (1 mark)

(f) Name **one** metal added to pure iron to produce steels.

    ....
                                                                                          (1 mark)
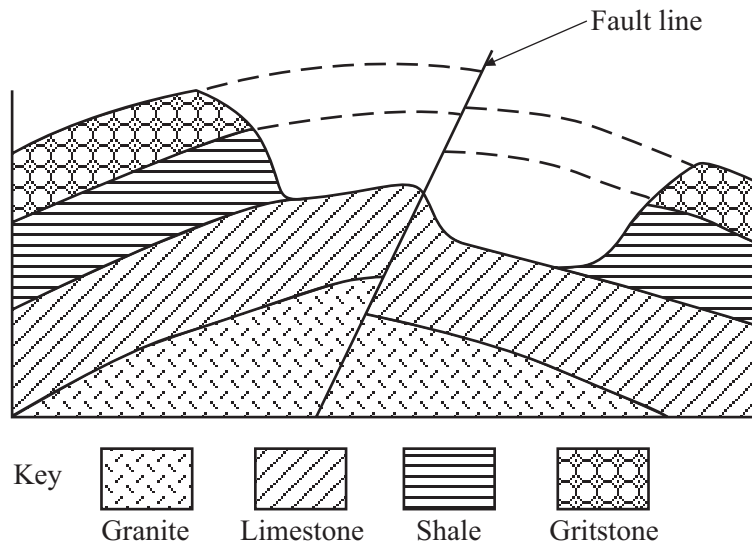
TURN OVER FOR THE NEXT QUESTION

QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES

5 The diagram shows the different layers of rock in a section of the Earth's crust.

Fault line

Key

Granite   Limestone   Shale   Gritstone

(a) Give the name of the youngest sedimentary rock in the diagram.

....
(1 mark)

(b) Give **one** piece of evidence that a rock is sedimentary.

....
(1 mark)

(c) What is a fault line?
What does the fault line tell you about this part of the Earth's crust?

....

....

....

....
(2 marks)

4

6 This question is about the metals given in the box. Each metal may be used once, more than once or not at all.

aluminium	**copper**	**gold**
iron	**silver**	**sodium**

(a) Give the name of the metal with the lowest density.

....
(1 mark)

(b) Give the names of **two** metals which are found uncombined with other elements in the Earth's crust.

.... and ....
(1 mark)

(c) Give the name of **one** metal that can only be extracted from its compounds by electrolysis. Explain why this metal cannot be extracted using carbon.

....

....

....
(2 marks)

$\overline{4}$

7 This question is about a white solid that is dissolved in water.
The solution has the following properties:

- pH = 4.7
- slow evolution of gas when a piece of magnesium ribbon is added to it.

(a) Which ion is produced in the solution when the solid dissolves?

....
(1 mark)

(b) What can be deduced about the white solid from the information provided?
Explain your answer.

....

....

....
(2 marks)

$\overline{3}$

Turn over ▶

8 The table gives information about three fuels that can be burned to heat a house.

Fuel	Heat produced (in kJ per gram)	Cost per gram in pence (p)	Products of burning	
			Soot from flame?	Solid left?
A	59	6	✓	✗
B	40	7	✗	✗
C	42	5	✓	✓

(a) Use the data to calculate which fuel produces most heat per penny.
Show clearly how you worked out your answer.

....

....

....

....

(2 marks)

(b) When burned, which fuel is the cleanest?
Explain your answer.

....

....

....

(2 marks)

(c) Write the word equation for the **incomplete** combustion of methane.

methane + oxygen → .... + ...

(2 marks)

6

PATTERNS OF CHEMICAL CHANGE

9 The following equation represents the formation of ammonia from nitrogen and hydrogen in the Haber Process.

$$N \equiv N + 3 (H - H) \rightleftharpoons 2 \left[\begin{array}{c} H - N - H \\ | \\ H \end{array} \right]$$
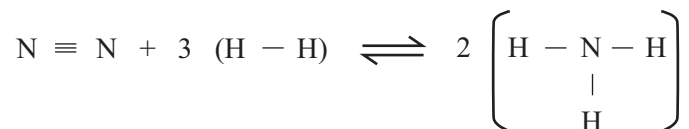
(a) Use the following information about bond energies to calculate the overall energy change for this reaction.

Bond	Bond energy in kJ
$N \equiv N$	945
$H - H$	436
$N - H$	390

....

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Energy change = ... kJ

(3 marks)

(b) The reaction is heated in a closed system. What effect would this have on the amount of ammonia formed?
Explain how you decided on your answer.

....

....

....

....

(2 marks)

5

Turn over ▶

10   The equation shows the burning of carbon in a limited supply of air.

$$2C(s) \quad + \quad O_2(g) \quad \rightarrow \quad 2CO(g)$$
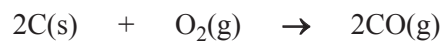
Calculate the volume of oxygen needed to convert 6 g of carbon to this oxide.

Show clearly how you work out your answer and give the units.

(Relative atomic masses: C = 12; O = 16)

(1 mole of O_2 has a volume of 24 dm^3 at room temperature and pressure)

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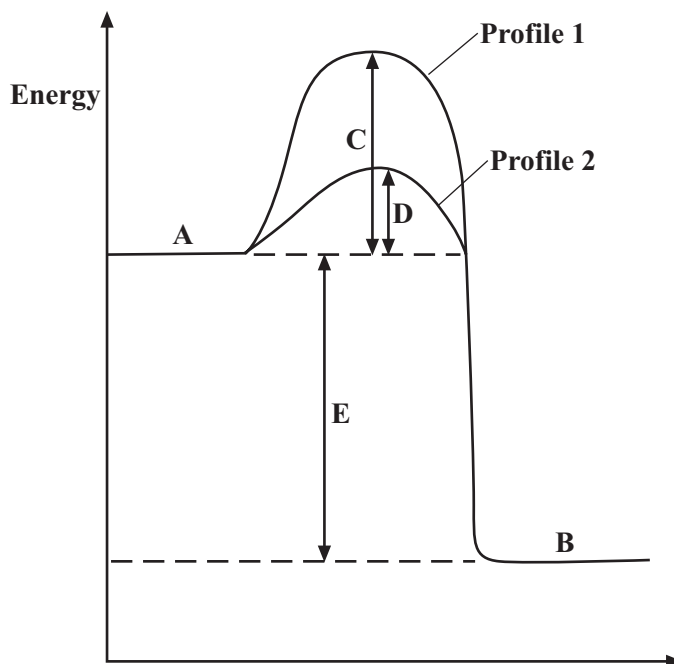
(4 marks)

$\dfrac{}{4}$

11 The diagram shows the energy profiles of a reaction both with and without a catalyst present.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

Explain, as fully as possible, what the energy diagram is showing about the two reactions.

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(5 marks)

STRUCTURES AND BONDING

12 The table below shows some information about the elements known as the halogens.

Halogen	Atomic Number	Melting point in °C	Boiling point in °C
Fluorine	9	−220	−188
Chlorine	17		−35
Bromine	35	−7	59
Iodine	53	114	184

(a) Use the trend in the data to put a value in the table for the melting point of chlorine.

(1 mark)

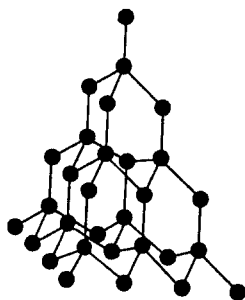(b) Explain why the halogens are in Group 7 of the periodic table.

....

....

....

(1 mark)

(c) Explain why fluorine is the most reactive halogen.

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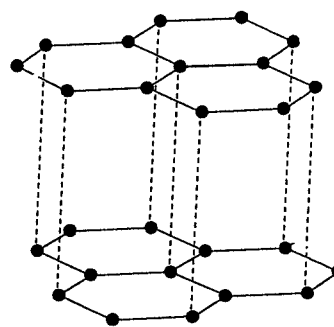
(2 marks)

4

13 (a) The structures of diamond and graphite are shown below.

Diamond   Graphite

Use these structures to explain why:

(i) both diamond and graphite have high melting and boiling points;

....

....
(1 mark)

(ii) diamond is harder than graphite;

....

....
(1 mark)

(iii) graphite is used as a lubricant.

....

....
(1 mark)

(b) State a property **not** mentioned above which graphite shares with metals.
Explain the cause of this property.

....

....

....

....

....
(2 marks)

5

Turn over ▶

14   In 1866, John Newlands produced a table which arranged the elements in order of their relative atomic masses. He based the table on the 'Law of Octaves'.

A version of the table is shown below.

Columns	1	2	3	4	5	6	7
	Li	Be	B	C	N	O	H
	Na	Mg	Al	Si	P	S	F
	K	Ca	Cr	Ti	Mn	Fe	Cl
	Cu	Zn	Y	In	As	Se	Co and Ni
	Rb	Sr	Ce and La	Zr	Di and Mo	Ro and Ru	Br

(a)   Explain how the 'Law of Octaves' related to the arrangement of elements in columns.

....

....

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....

(2 marks)

(b)   How did Mendeleev improve on Newlands' table?

....

(1 mark)

(c)   Which group of elements in the modern periodic table is missing from Newlands' table?

....

....

(1 mark)

4

CHEMISTRY IN ACTION

15 Titanium is extracted from its ore, rutile, which contains titanium dioxide TiO_2.
TiO_2 is first converted to its chloride, $TiCl_4$.
Describe how titanium is obtained from the chloride.

Your answer should include:

- *the conditions and reagents used;*
- *the balanced chemical equation;*
- *an explanation of why this is a reduction process.*

....

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(5 marks)

5

TURN OVER FOR THE NEXT QUESTION

16 (a) A sample of tap water is thought to contain aluminium sulphate. Describe fully the chemical tests that would show the presence of each ion.

  (i) Aluminium ion

  Test ....

  ....

  Result of test ....

  ....

  (2 marks)

  (ii) Sulphate ion

  Test ....

  ....

  Result of test ....

  ....

  (2 marks)

(b) Name an instrumental method of analysis that could be used instead of chemical tests. Give **one** advantage of using an instrumental method.

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  ....

  (2 marks)

$\dfrac{}{6}$

NO QUESTIONS APPEAR ON THIS PAGE

TURN OVER FOR THE NEXT QUESTION
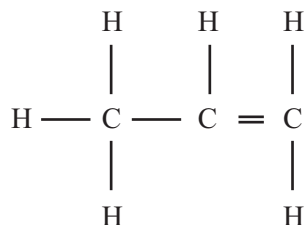
Turn over ▶

QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES

17 (a) Propene (C_3H_6) and butene (C_4H_8) can both be obtained from crude oil. A propene molecule has the structure shown below.

$$
\begin{array}{ccccc}
 & H & H & H & \\
 & | & | & | & \\
H - & C - & C = & C & \\
 & | & & | & \\
 & H & & H &
\end{array}
$$

Both molecules belong to the same homologous series.

(i) What is the name of this homologous series?

....

(1 mark)

(ii) Give the general formula for the homologous series.

....
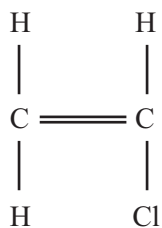
(1 mark)

(iii) Draw the structure of **two** *isomers* of butene C_4H_8.

ISOMER 1   ISOMER 2

(2 marks)

(b)   Chloroethene has the structure shown below.

$$
\begin{array}{ccc}
H & & H \\
| & & | \\
C & \!\!=\!\!\!=\!\! & C \\
| & & | \\
H & & Cl
\end{array}
$$

It forms poly(chloroethene) or PVC by addition polymerisation.

   (i)   Draw the structure of poly(chloroethene) showing **three** of the repeating units.

(2 marks)

   (ii)   Name the strongly acidic gas from the combustion of poly(chloroethene) which is an environmental pollutant.

....

(1 mark)

7

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

18   A student carried out a titration to find the concentration of phosphoric acid in a solution.

50.00 cm^3 of phosphoric acid solution was neutralised by 28.00 cm^3 of a sodium hydroxide solution of concentration 0.50 mol dm^{-3}.

The equation for the reaction is:

$$3 \text{ NaOH(aq)} \quad + \quad \text{H}_3\text{PO}_4\text{(aq)} \quad \rightarrow \quad \text{Na}_3\text{PO}_4\text{(aq)} \quad + \quad 3\text{H}_2\text{O(l)}$$

(a)   Calculate the number of moles of NaOH used.

....

....

....

Number of moles = ...

(2 marks)

(b)   Calculate the concentration of the phosphoric acid in moles per cubic decimetre (mol dm^{-3}).

....

....

....

....

....

Concentration = ... mol dm^{-3}

(3 marks)

$\dfrac{\quad}{5}$

END OF QUESTIONS