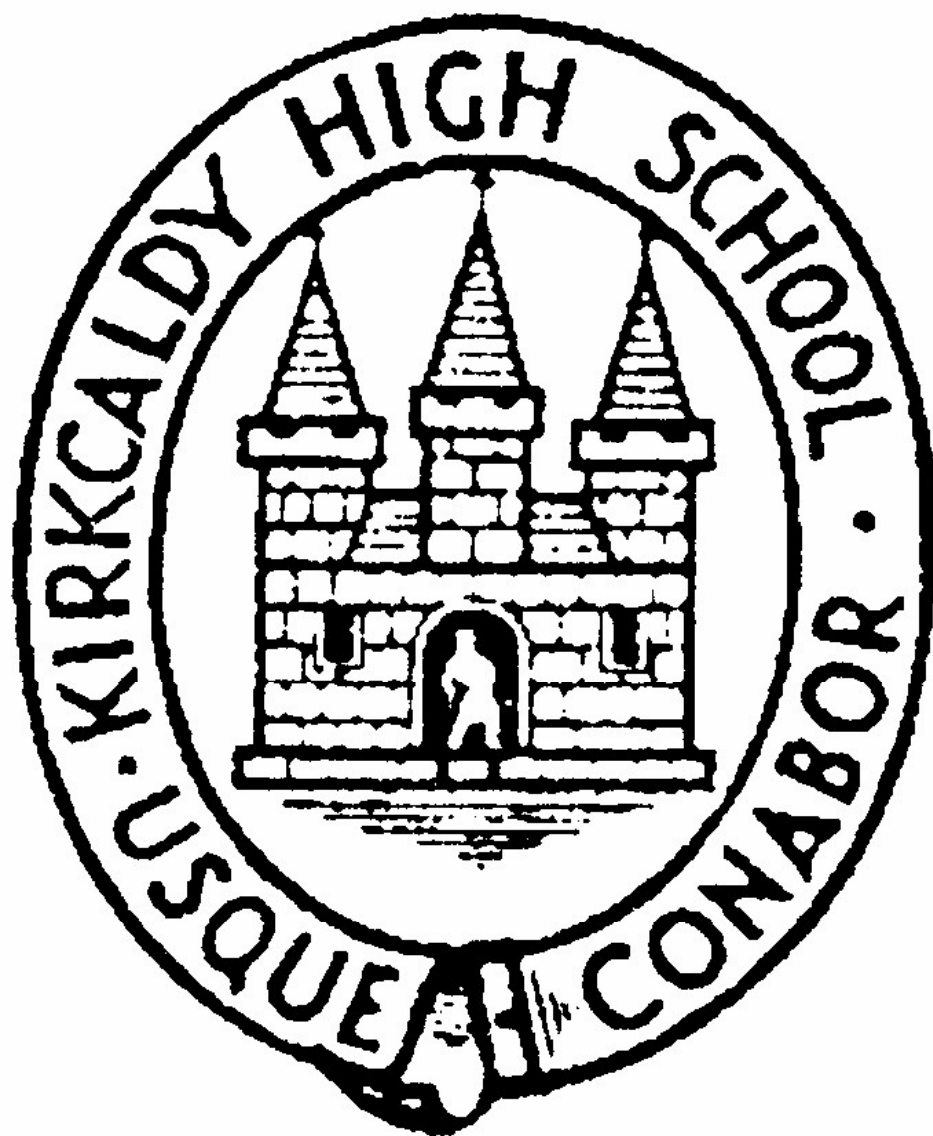


# National 5 Chemistry

Past Paper Questions – Book 1



National 5 2014

National 5 2015

National 5 2016

**2014**

## SECTION 1

1. In a reaction,  $60 \text{ cm}^3$  of hydrogen gas was collected in 20 s.  
What is the average rate of reaction, in  $\text{cm}^3 \text{ s}^{-1}$ , over this time?

A  $\frac{60}{20}$

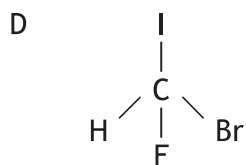
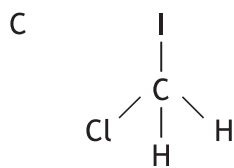
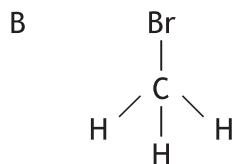
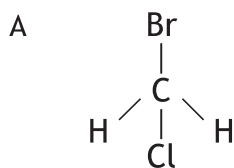
B  $\frac{20}{60}$

C  $\frac{1}{60}$

D  $\frac{1}{20}$

2. Molecules in which four different atoms are attached to a carbon atom are said to be chiral.

Which of the following molecules is chiral?



3. What is the charge on the zinc ion in the compound zinc phosphate  $Zn_3(PO_4)_2$ ?

- A 2+
- B 3+
- C 2-
- D 3-

4.  $Fe_2O_3 + x CO \longrightarrow y Fe + 3CO_2$

This equation will be balanced when

- A  $x = 1$  and  $y = 2$
- B  $x = 2$  and  $y = 2$
- C  $x = 3$  and  $y = 2$
- D  $x = 2$  and  $y = 3$ .

5. An acidic solution contains

- A only hydrogen ions
- B only hydroxide ions
- C more hydrogen ions than hydroxide ions
- D more hydroxide ions than hydrogen ions.

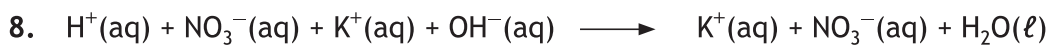
6. Which of the following oxides, when shaken with water, would give an alkaline solution?

- A Calcium oxide
- B Nickel oxide
- C Nitrogen dioxide
- D Sulfur dioxide

7. Which of the following compounds is **not** a salt?

- A Calcium nitrate
- B Sodium chloride
- C Potassium sulfate
- D Magnesium hydroxide





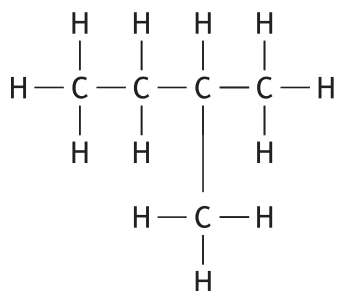
The spectator ions present in the reaction above are

- A  $\text{K}^+(\text{aq})$  and  $\text{NO}_3^-(\text{aq})$
- B  $\text{K}^+(\text{aq})$  and  $\text{H}^+(\text{aq})$
- C  $\text{OH}^-(\text{aq})$  and  $\text{NO}_3^-(\text{aq})$
- D  $\text{H}^+(\text{aq})$  and  $\text{OH}^-(\text{aq})$ .

9. The molecular formula for cyclohexane is

- A  $\text{C}_6\text{H}_6$
- B  $\text{C}_6\text{H}_{10}$
- C  $\text{C}_6\text{H}_{12}$
- D  $\text{C}_6\text{H}_{14}$ .

10.



The systematic name for the structure shown is

- A 1,1-dimethylpropane
- B 2-methylbutane
- C 3-methylbutane
- D 2-methylpentane.

11. Petrol is a mixture of hydrocarbons.

The tendency of a hydrocarbon to ignite spontaneously is measured by its octane number.

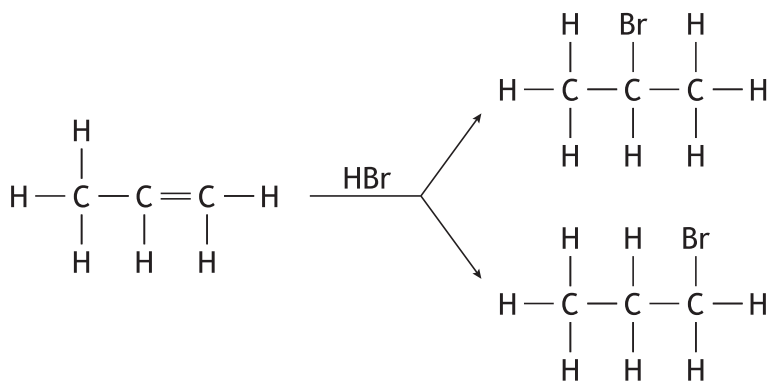
	<i>Hydrocarbon</i>	<i>Octane number</i>
1	3-methylpentane	74.5
2	butane	93.6
3	pentane	61.7
4	2-methylpentane	73.4
5	hexane	24.8
6	methylcyclopentane	91.3

A student made the hypothesis that as the chain length of a hydrocarbon increases, the octane number decreases.

Which set of three hydrocarbons should have their octane numbers compared in order to test this hypothesis?

- A 1, 4, 6
- B 1, 2, 4
- C 2, 3, 5
- D 3, 4, 5

12. Propene reacts with hydrogen bromide to form two products.

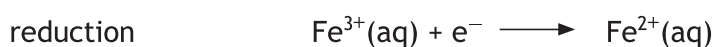
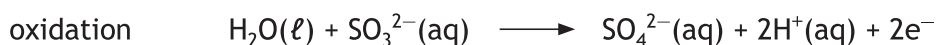


Which of the following alkenes does **not** form two products on reaction with hydrogen bromide?

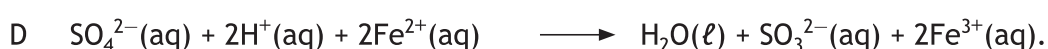
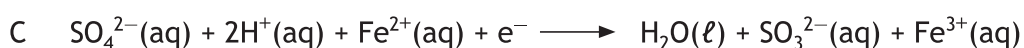
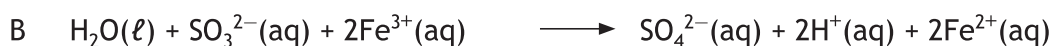
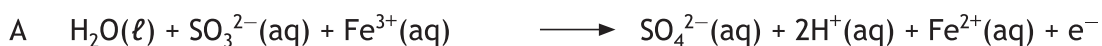
- A But-1-ene
- B But-2-ene
- C Pent-1-ene
- D Pent-2-ene

13. Which of the following alcohols has the highest boiling point?  
You may wish to use your data booklet to help you.
- A Propan-1-ol
  - B Propan-2-ol
  - C Butan-1-ol
  - D Butan-2-ol
14. A reaction is endothermic if
- A energy is required to start the reaction
  - B heat is released during the reaction
  - C the temperature drops during the reaction
  - D the temperature rises during the reaction.
15. Which of the following metals will **not** react with a dilute solution of hydrochloric acid?
- A Copper
  - B Iron
  - C Magnesium
  - D Zinc
16. Which metal can be extracted from its oxide by heat alone?
- A Tin
  - B Zinc
  - C Lead
  - D Silver

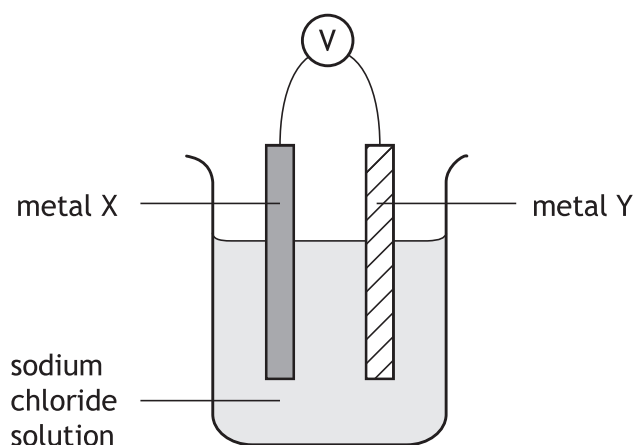
17. The ion-electron equations for the oxidation and reduction steps in the reaction between sulfite ions and iron(III) ions are given below.



The redox equation for the overall reaction is



18. The apparatus below was set up.

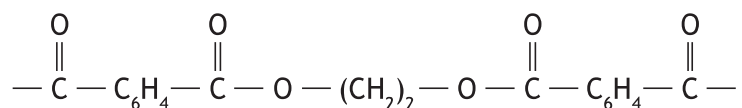


Which of the following pairs of metals would give the highest reading on the voltmeter?

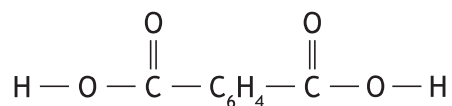
- |   | <b>Metal X</b> | <b>Metal Y</b> |
|---|----------------|----------------|
| A | Iron           | Zinc           |
| B | Magnesium      | Silver         |
| C | Zinc           | Copper         |
| D | Zinc           | Silver         |

[Turn over

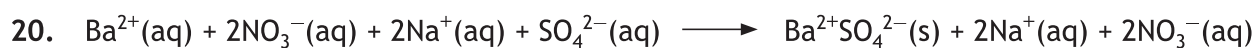
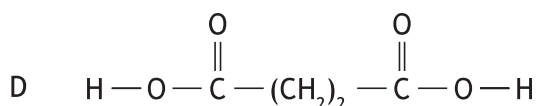
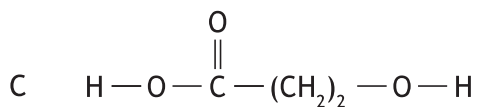
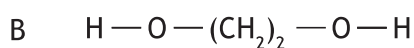
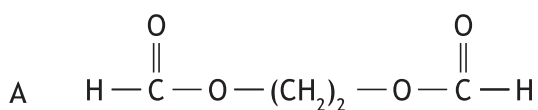
19. A section of a condensation polymer is shown below.



One of the monomers is



The structural formula for the other monomer is



The type of reaction represented by the equation above is

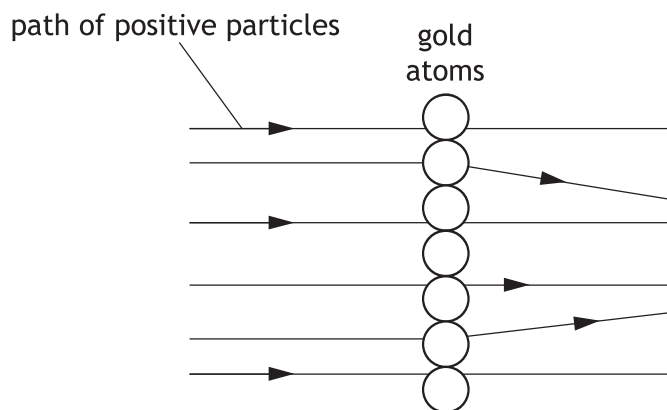
- A addition
- B displacement
- C neutralisation
- D precipitation.

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]

SECTION 2—60 marks  
Attempt ALL questions

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

1. In 1911, Ernest Rutherford carried out an experiment to confirm the structure of the atom. In this experiment, he fired positive particles at a very thin layer of gold foil. Most of the particles passed straight through but a small number of the positively charged particles were deflected.



- (a) What caused some of the positive particles to be deflected in this experiment? 1

- (b) Gold is the heaviest element to have only one naturally occurring isotope.

The isotope has a mass number of 197.

- (i) Complete the table to show the number of each type of particle in this gold atom. 1

*You may wish to use the data booklet to help you.*

Particle	Number
Proton	
Electron	
Neutron	

- (ii) Most elements have more than one isotope.

State what is meant by the term isotope. 1

Total marks 3



2. (a) The properties of a substance depend on its type of bonding and structure. There are four types of bonding and structure.

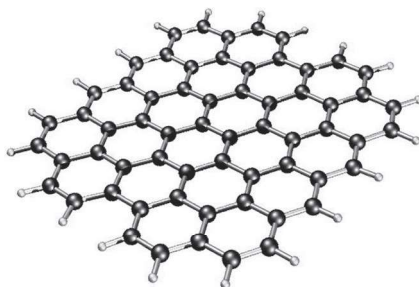
Discrete covalent molecular	Covalent network	Ionic lattice	Metallic lattice
-----------------------------------	---------------------	------------------	---------------------

Complete the table to match up each type of bonding and structure with its properties.

Type of bonding and structure	Properties
	do not conduct electricity and have high melting points
	have high melting points and conduct electricity when liquid but not when solid
	conduct electricity when solid and have a wide range of melting points
	do not conduct electricity and have low melting points

2

- (b) Graphene is a substance made of a single layer of carbon atoms.



Graphene can conduct electricity.

Suggest what this indicates about some of the electrons in graphene.

1

Total marks 3



3. Read the passage below and answer the questions that follow.

**Potassium - The Super Element**

Potassium is an essential element for almost all living things. The human body requires a regular intake of potassium because humans have no mechanism for storing it. Foods rich in potassium include raisins and almonds. Raisins contain 0.86 g of potassium in every 100 g.

Naturally occurring salts of potassium such as saltpetre (potassium nitrate) and potash (potassium carbonate) have been known for centuries. Potassium salts are used as fertilisers.

Potassium was first isolated by Humphry Davy in 1807. Davy observed that when potassium was added to water it formed globules which skimmed about on the surface, burning with a coloured flame and forming an alkaline solution.

- |   |   |
|---|---|
| (a) State why the human body requires a regular intake of potassium.  | 1 |
| (b) Calculate the number of moles of potassium in 100 g of raisins.<br>Show your working clearly.                                       | 2 |
| (c) State the colour of the flame which would be seen when potassium burns.<br><i>You may wish to use the data booklet to help you.</i> | 1 |
| (d) Write the ionic formula for saltpetre.  | 1 |

Total marks 5

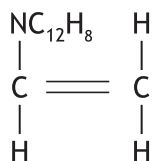




**MARKS**DO NOT  
WRITE IN  
THIS  
MARGIN

4. Poly(vinylcarbazole) is a plastic which conducts electricity when exposed to light.

The structure of the monomer used to make poly(vinylcarbazole) is



- (a) Draw a section of the polymer showing three monomer units joined together. 1

- (b) Name the type of polymerisation taking place when these monomers join together. 1

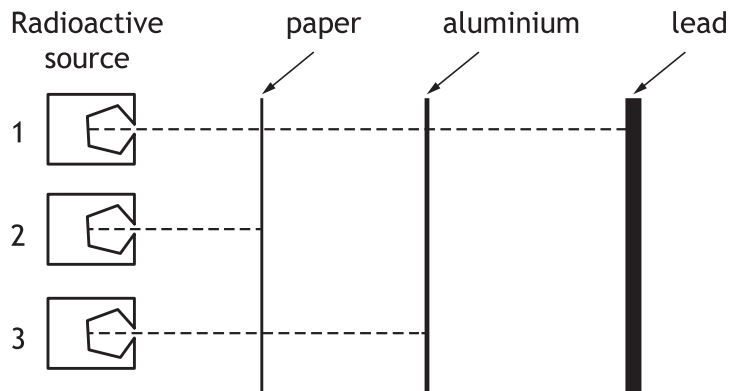
Total marks **2**

[Turn over



\* X 7 1 3 7 5 0 1 0 9 \*

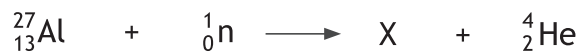
5. Different types of radiation have different penetrating properties. An investigation was carried out using three radioactive sources.



- (a) Name the type of radiation emitted by source 2. 1

- (b) The half-life of source 3 is 8 days.  
Calculate the fraction of source 3 that would remain after 16 days. 2  
Show your working clearly.

- (c) Radioisotopes can be made by scientists.  
The nuclear equation shows how a radioisotope of element X can be made from aluminium.



- Name element X. 1

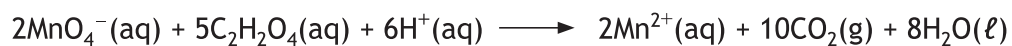
Total marks 4



MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

6. A student reacted acidified potassium permanganate solution with oxalic acid,  $C_2H_2O_4$ .



Using your knowledge of chemistry, comment on how the student could have determined the rate of the reaction.

3

[Turn over



\* X 7 1 3 7 5 0 1 1 1 \*

7. The manufacture of potassium nitrate, for use in fertilisers, can be split into three stages.

(a) (i) In stage 1, ammonia is produced.

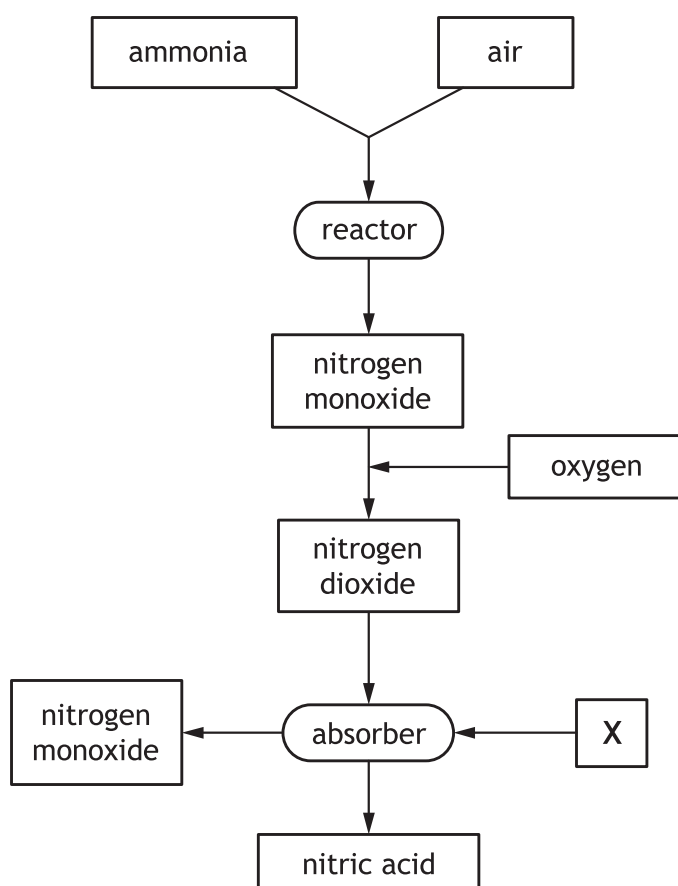
Name the industrial process used to manufacture ammonia.

1

(ii) Draw a diagram to show how **all** the outer electrons are arranged in a molecule of ammonia,  $\text{NH}_3$ .

1

(b) In stage 2, ammonia is converted into nitric acid,  $\text{HNO}_3$ , as shown in the flow diagram.



7. (b) (continued)

(i) Name substance X.

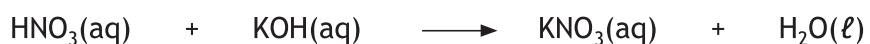
1

(ii) On the flow diagram, draw an arrow to show how the process can be made more economical.

1

(c) In stage 3, nitric acid is converted to potassium nitrate.

The equation for the reaction taking place is



(i) Name the type of chemical reaction taking place in stage 3.

1

(ii) State how a sample of **solid** potassium nitrate could be obtained from the potassium nitrate solution.

1

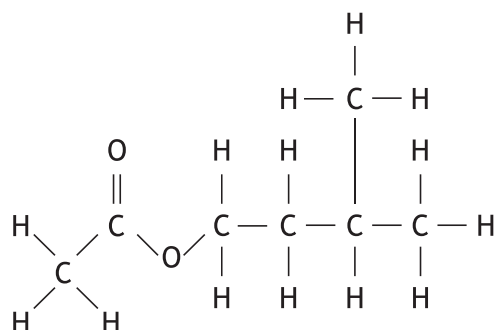
Total marks 6

[Turn over



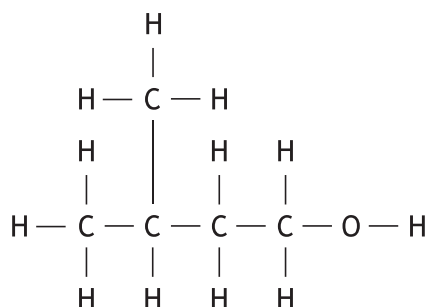
8. Pheromones are chemicals, produced by living things, that trigger a response in members of the same species.

When a bee stings an animal the bee also releases a pheromone containing the ester below.



- (a) State another use for esters. 1

- (b) A student made the ester above using ethanoic acid and the following alcohol.

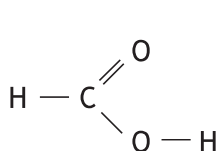


- (i) Name the functional group present in this alcohol. 1
- (ii) Draw a structural formula for an isomer of this alcohol. 1

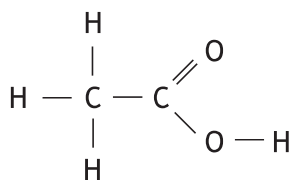
8. (b) (continued)

(iii) Ethanoic acid is the second member of a family of compounds which contain the carboxyl functional group.

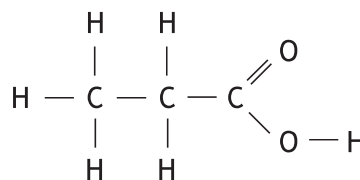
The full structural formulae for the first three members of this family are shown.



methanoic acid



ethanoic acid



propanoic acid

Suggest a general formula for this family of compounds.

1

(c) The table gives information on some other esters.

<i>Alcohol</i>	<i>Carboxylic acid</i>	<i>Ester</i>
methanol	ethanoic acid	methyl ethanoate
propanol	methanoic acid	propyl methanoate
butanol	ethanoic acid	butyl ethanoate
pentanol	butanoic acid	pentyl butanoate
X	Y	ethyl propanoate

Name X and Y.

2

Total marks 6



9. Liquefied petroleum gas (LPG), which can be used as a fuel for heating, is a mixture of propane and butane.

(a) Propane and butane are members of the homologous series of alkanes.

Tick (✓) the **two** boxes that correctly describe members of the same homologous series.

1

	Tick (✓)
They have similar chemical properties.	
They have the same molecular formula.	
They have the same general formula.	
They have the same physical properties.	
They have the same formula mass.	

(b) The table gives some information about propane and butane.

<i>Alkane</i>	<i>Boiling Point (°C)</i>
propane	-42
butane	-1

Explain why butane has a higher boiling point than propane.

2





9. (continued)

- (c) 25 kg of water at 10 °C is heated by burning some LPG.

Calculate the energy, in kJ, required to increase the temperature of the water to 30 °C.

3

*You may wish to use the data booklet to help you.*

Show your working clearly.

- (d) LPG is odourless. In order to detect gas leaks, ethyl mercaptan, C<sub>2</sub>H<sub>6</sub>S, a smelly gas, is added in small quantities to the LPG mixture.

Suggest one disadvantage of adding sulfur compounds, such as ethyl mercaptan, to fuels such as LPG.

1

Total marks 7



10. The lowest temperature at which a hydrocarbon ignites is called its flash point.

<i>Hydrocarbon</i>	<i>Flash point (°C)</i>
hexane	-23
heptane	-4
octane	13
nonane	31

(a) (i) Using the information in the table, make a general statement linking the flash point to the number of carbon atoms. 1

(ii) Predict the flash point, in °C, of decane, C<sub>10</sub>H<sub>22</sub>. 1

MARKS DO NOT WRITE IN THIS MARGIN

10. (continued)

(b) Nonane burns to produce carbon dioxide and water.



Calculate the mass, in grams, of carbon dioxide produced when 32 g of nonane is burned.

3

Show your working clearly.

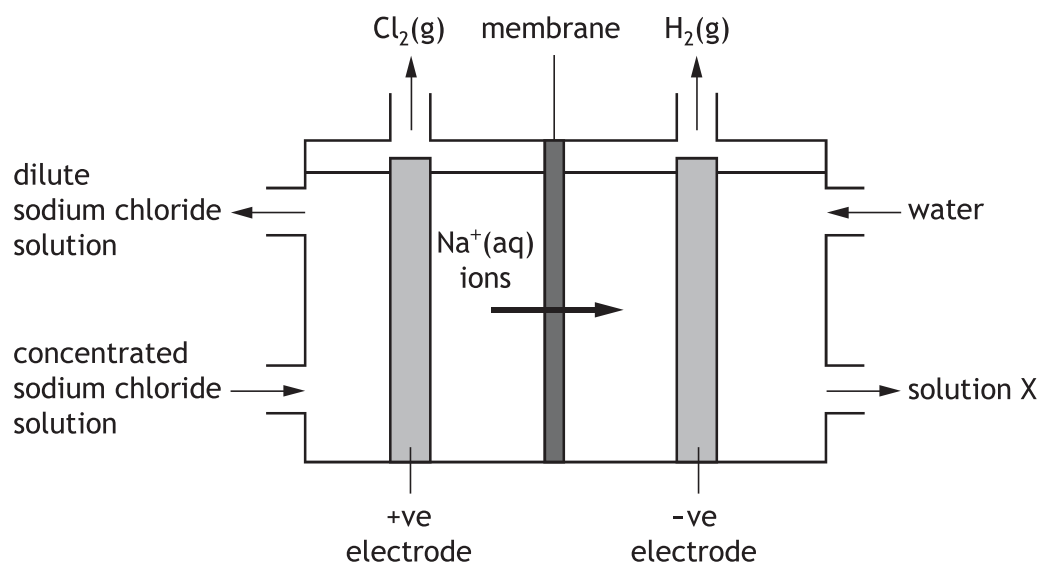
Total marks 5

[Turn over



\* X 7 1 3 7 5 0 1 1 9 \*

11. Chlorine can be produced commercially from concentrated sodium chloride solution in a membrane cell. Only sodium ions can pass through the membrane. These ions move in the direction shown in the diagram.



- (a) Write the ion-electron equation for the change taking place at the positive electrode. 1

*You may wish to use the data booklet to help you.*

- (b) (i) Name solution X. 1

- (ii) The hydrogen gas produced, at the negative electrode, can be used as a fuel.

Suggest an advantage of using hydrogen as a fuel. 1





**MARKS**

DO NOT  
WRITE IN  
THIS  
MARGIN

11. (continued)

- (c) The chlorine gas produced can be used to make phosgene,  $\text{COCl}_2$ . Phosgene is used in the manufacture of drugs and plastics.

Draw a possible structure for phosgene.

1

Total marks 4

[Turn over



\* X 7 1 3 7 5 0 1 2 1 \*

12. Ores are naturally occurring compounds from which metals can be extracted.

(a) When a metal is extracted from its ore, metal ions are changed to metal atoms.

Name this type of chemical reaction.

1

(b) Iron can be extracted from its ore haematite, Fe<sub>2</sub>O<sub>3</sub>, in a blast furnace.

Calculate the percentage by mass of iron in haematite.

3

Show your working clearly.

(c) Magnesium cannot be extracted from its ore in a blast furnace.

Suggest a method that would be suitable for the extraction of magnesium from its ore.

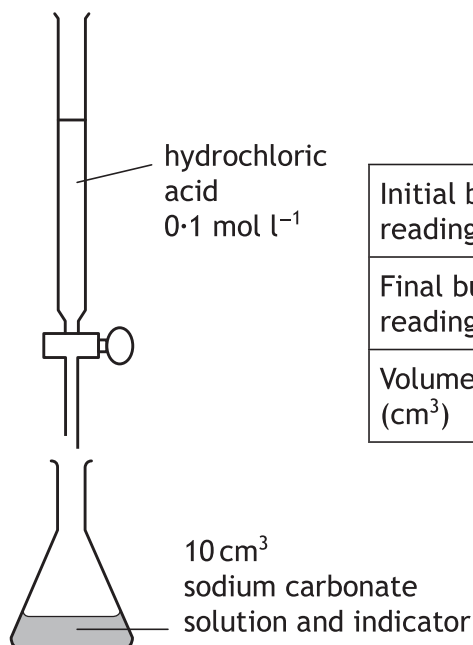
1

**Total marks 5**



13. Sodium carbonate solution can be added to the water in swimming pools to neutralise the acidic effects of chlorine.

A student carried out a titration experiment to determine the concentration of a sodium carbonate solution.



	<i>Rough titre</i>	<i>1st titre</i>	<i>2nd titre</i>
Initial burette reading (cm <sup>3</sup> )	0.0	0.0	0.0
Final burette reading (cm <sup>3</sup> )	16.5	15.9	16.1
Volume used (cm <sup>3</sup> )	16.5	15.9	16.1

- (a) Using the results in the table, calculate the average volume, in cm<sup>3</sup>, of hydrochloric acid required to neutralise the sodium carbonate solution. 1

- (b) The equation for the reaction is



Using your answer from part (a) calculate the concentration, in mol l<sup>-1</sup>, of the sodium carbonate solution. 3

Show your working clearly.

Total marks 4



14. Chemistry in the cinema.

In the film Dante's Peak, a family trapped by red hot lava escape by crossing a large lake in a boat made from aluminium. The volcano releases heat and the gases hydrogen chloride, sulfur dioxide and sulfur trioxide into the water in the lake. While crossing the lake, holes begin to appear in the bottom of the boat. Just after the family leave the boat, on the other side of the lake, the boat sinks.

Using your knowledge of chemistry, comment on whether or not the events described in the film could take place.

3

[END OF QUESTION PAPER]



\* X 7 1 3 7 5 0 1 2 4 \*



**2015**

## SECTION 1

1. An atom has 26 protons, 26 electrons and 30 neutrons.

The atom has

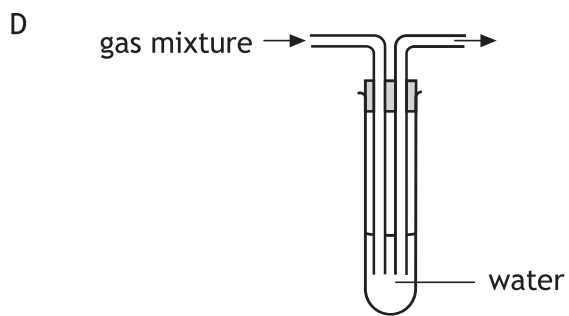
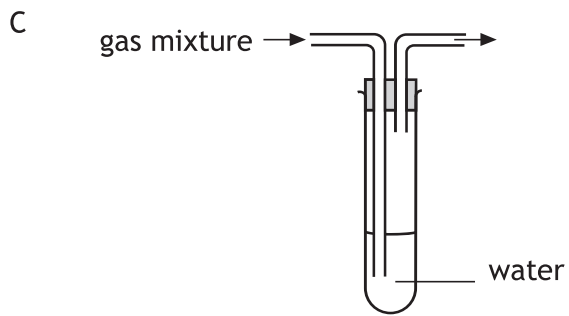
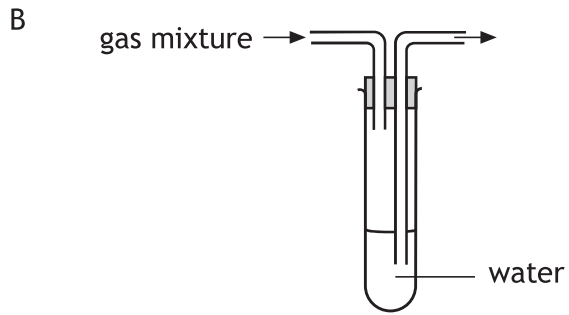
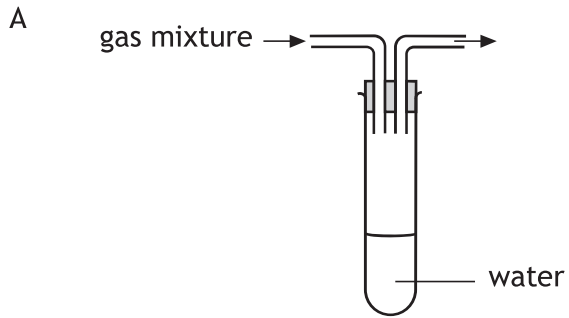
- A atomic number 26, mass number 56
  - B atomic number 56, mass number 30
  - C atomic number 30, mass number 26
  - D atomic number 52, mass number 56.
2. The table shows the numbers of protons, electrons and neutrons in four particles, W, X, Y and Z.

<i>Particle</i>	<i>Protons</i>	<i>Electrons</i>	<i>Neutrons</i>
<b>W</b>	17	17	18
<b>X</b>	11	11	12
<b>Y</b>	17	17	20
<b>Z</b>	18	18	18

Which pair of particles are isotopes?

- A W and X
  - B W and Y
  - C X and Y
  - D Y and Z
3. Which of the following particles contains a different number of electrons from the others?  
You may wish to use the data booklet to help you.
- A  $\text{Cl}^-$
  - B  $\text{S}^{2-}$
  - C Ar
  - D  $\text{Na}^+$

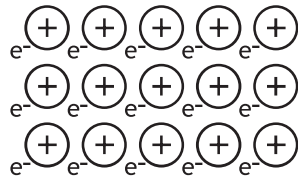
4. Which of the following diagrams shows the apparatus which would allow a soluble gas to be removed from a mixture of gases?



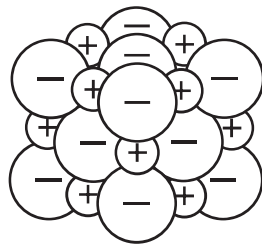
[Turn over

5. Which of the following diagrams could be used to represent the structure of a covalent network?

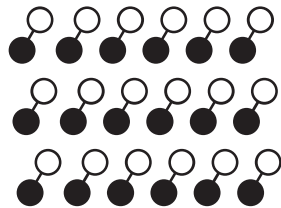
A



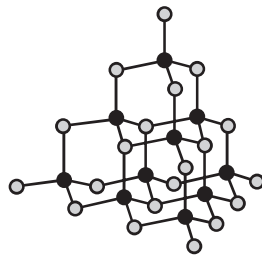
B



C



D



6. What is the charge on the chromium ion in  $\text{CrCl}_3$ ?

A 1+

B 1-

C 3+

D 3-

7. The table contains information about calcium and calcium chloride.

	<i>Melting point</i> (°C)	<i>Density</i> (g cm <sup>-3</sup> )
Calcium	842	1.54
Calcium chloride	772	2.15

When molten calcium chloride is electrolysed at 800 °C the calcium appears as a

- A solid at the bottom of the molten calcium chloride
- B liquid at the bottom of the molten calcium chloride
- C solid on the surface of the molten calcium chloride
- D liquid on the surface of the molten calcium chloride.

8.  $x \text{Al(s)} + y \text{Br}_2(\ell) \rightarrow z \text{AlBr}_3(\text{s})$

This equation will be balanced when

- A  $x = 1, y = 2$  and  $z = 1$
- B  $x = 2, y = 3$  and  $z = 2$
- C  $x = 3, y = 2$  and  $z = 3$
- D  $x = 4, y = 3$  and  $z = 4$ .

9. 0.2 mol of a gas has a mass of 12.8 g.

Which of the following could be the molecular formula for the gas?

- A SO<sub>2</sub>
- B CO
- C CO<sub>2</sub>
- D NH<sub>3</sub>

[Turn over

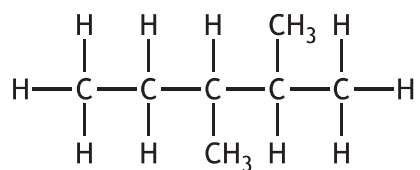
10. Which of the following oxides, when shaken with water, would leave the pH unchanged?  
You may wish to use the data booklet to help you.

- A Carbon dioxide
- B Copper oxide
- C Sodium oxide
- D Sulfur dioxide

11. Which compound would **not** neutralise hydrochloric acid?

- A Sodium carbonate
- B Sodium chloride
- C Sodium hydroxide
- D Sodium oxide

12.



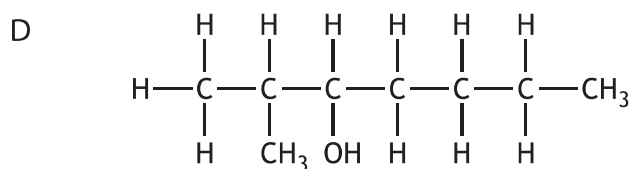
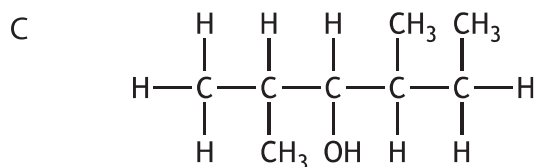
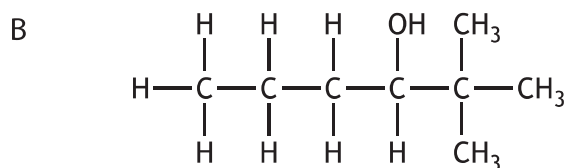
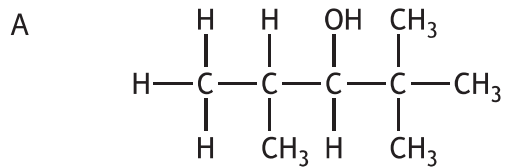
The name of the above compound is

- A 2,3-dimethylpropane
- B 3,4-dimethylpropane
- C 2,3-dimethylpentane
- D 3,4-dimethylpentane.

13. The shortened structural formula for an organic compound is

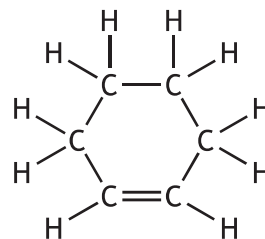
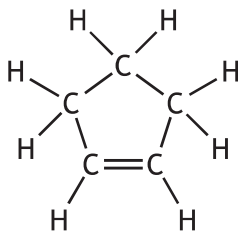
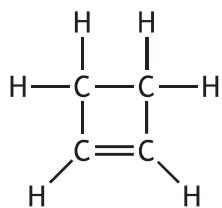


Which of the following is another way of representing this structure?



[Turn over

14. Three members of the cycloalkene homologous series are



Which of the following is the general formula for this homologous series?



15. Metallic bonding is a force of attraction between

A negative ions and positive ions

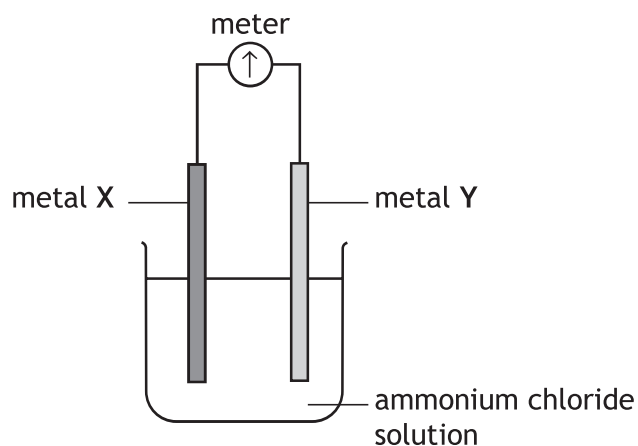
B a shared pair of electrons and two nuclei

C positive ions and delocalised electrons

D negative ions and delocalised electrons.



16. Which pair of metals, when connected in a cell, would give the highest voltage and a flow of electrons from X to Y?

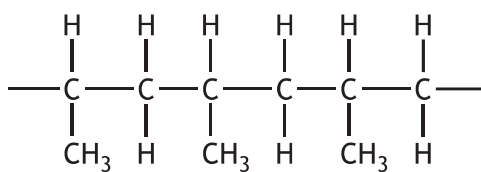


You may wish to use the data booklet to help you.

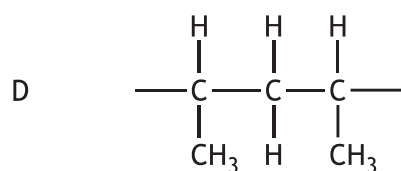
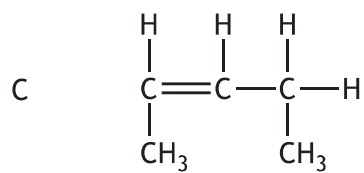
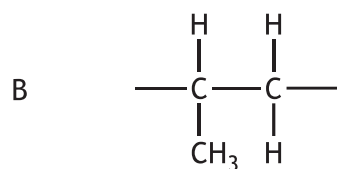
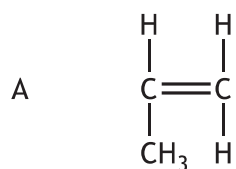
	<i>Metal X</i>	<i>Metal Y</i>
A	zinc	tin
B	tin	zinc
C	copper	magnesium
D	magnesium	copper

[Turn over

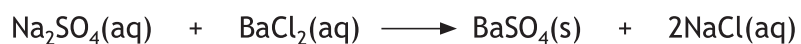
17. Part of the structure of a polymer is drawn below.



The monomer used to make this polymer is



18. Sodium sulfate solution reacts with barium chloride solution.



The spectator ions present in this reaction are

- A  $\text{Na}^+$  and  $\text{Cl}^-$
  - B  $\text{Na}^+$  and  $\text{SO}_4^{2-}$
  - C  $\text{Ba}^{2+}$  and  $\text{Cl}^-$
  - D  $\text{Ba}^{2+}$  and  $\text{SO}_4^{2-}$ .
19. Which of the following solutions would produce a precipitate when mixed together?  
You may wish to use the data booklet to help you.
- A Ammonium chloride and potassium nitrate
  - B Zinc nitrate and magnesium sulfate
  - C Calcium nitrate and nickel chloride
  - D Sodium iodide and silver nitrate

[Turn over for Question 20 on *Page twelve*

20. The table shows the colours of some ionic compounds in solution.

<i>Compound</i>	<i>Colour</i>
copper sulfate	blue
copper chromate	green
potassium chloride	colourless
potassium chromate	yellow

The colour of the chromate ion is

- A blue
- B green
- C colourless
- D yellow.

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2  
OF YOUR QUESTION AND ANSWER BOOKLET]**

SECTION 2—60 marks  
Attempt ALL questions

1. Ethyne is the first member of the alkyne family.  
It can be produced by the reaction of calcium carbide with water.  
The equation for this reaction is



- (a) The table shows the results obtained in an experiment carried out to measure the volume of ethyne gas produced.

<i>Time (s)</i>	0	30	60	90	120	150	180	210
<i>Volume of ethyne (cm<sup>3</sup>)</i>	0	60	96	120	140	148	152	152

Calculate the average rate of reaction between 60 and 90 seconds.  
Your answer must include the appropriate unit.

3

Show your working clearly.



MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

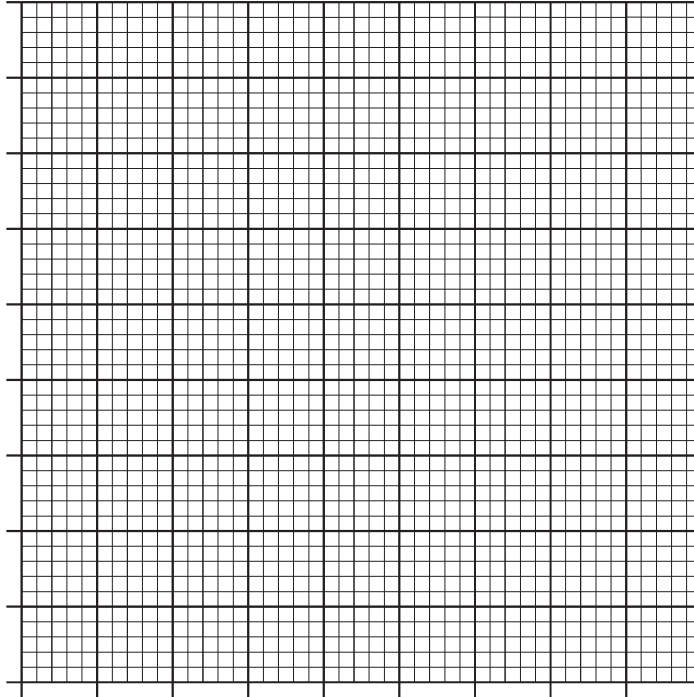
1. (continued)

(b) Draw a line graph of the results.

Use appropriate scales to fill most of the graph paper.

(Additional graph paper, if required, will be found on  
*Page twenty-seven.*)

3



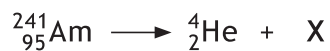
[Turn over



\* X 7 1 3 7 5 0 1 0 7 \*

2. Americium-241, a radioisotope used in smoke detectors, has a half-life of 432 years.

(a) The equation for the decay of americium-241 is



Name element X.

1

(b) Name the **type** of radiation emitted by the americium-241 radioisotope.

1

(c) Another radioisotope of americium exists which has an atomic mass of 242.

Americium-242 has a half-life of 16 hours.

(i) A sample of americium-242 has a mass of 8 g.

Calculate the mass, in grams, of americium-242 that would be left after 48 hours.

2

Show your working clearly.

(ii) Suggest why americium-241, and not americium-242, is the radioisotope used in smoke detectors.

1



\* X 7 1 3 7 5 0 1 0 8 \*

3. Butter contains different triglyceride molecules.

(a) A triglyceride molecule is made when the alcohol glycerol reacts with carboxylic acids.

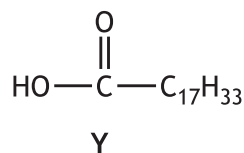
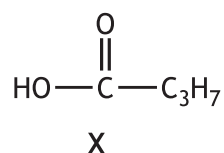
(i) Name the functional group present in glycerol.

1

(ii) Name the family to which triglycerides belong.

1

(b) When butter goes off, a triglyceride molecule is broken down, producing compounds X and Y.



(i) Name compound X.

1

(ii) Describe the chemical test, including the result, to show that compound Y is unsaturated.

1





4. Some sources of methane gas contain hydrogen sulfide, H<sub>2</sub>S.

(a) Draw a diagram, showing all outer electrons, to represent a molecule of hydrogen sulfide, H<sub>2</sub>S.

1

(b) If hydrogen sulfide is not removed before methane gas is burned, sulfur dioxide is formed.

When sulfur dioxide dissolves in water in the atmosphere, acid rain is produced.

Circle the correct words to complete the sentence.

Acid rain contains more  $\left\{ \begin{array}{l} \text{hydrogen} \\ \text{hydroxide} \end{array} \right\}$  ions than  $\left\{ \begin{array}{l} \text{hydrogen} \\ \text{hydroxide} \end{array} \right\}$  ions.

1

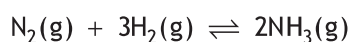
(c) In industry, calcium oxide is reacted with sulfur dioxide to reduce the volume of sulfur dioxide released into the atmosphere.

Explain why calcium oxide is able to reduce the volume of sulfur dioxide gas released.

2



5. A researcher investigated the conditions for producing ammonia.



(a) Name the catalyst used in the production of ammonia.

1

(b) In her first experiment she measured how the percentage yield of ammonia varied with pressure at a constant temperature of 500 °C.

<i>Pressure (atmospheres)</i>	100	200	300	400	500
<i>Percentage yield (%)</i>	10	18	26	32	40

Predict the percentage yield of ammonia at 700 atmospheres.

1

(c) In a second experiment the researcher kept the pressure constant, at 200 atmospheres, and changed the temperature as shown.

<i>Temperature (°C)</i>	200	300	400	500
<i>Percentage yield (%)</i>	89	67	39	18

Describe how the percentage yield varies with temperature.

1

(d) Using the information in both tables, suggest the combination of temperature and pressure that would produce the highest percentage yield of ammonia.

1



6. Read the passage below and answer the questions that follow.

**Clean coal technology comes a step closer**

It is claimed a process called Coal-Direct Chemical Looping (CDCL) is able to release energy from coal while capturing 99% of the carbon dioxide emitted. CDCL works by extracting the energy from coal using a reaction other than combustion.

A mixture of powdered coal and beads of iron(III) oxide is heated inside a metal cylinder. Carbon in the coal and oxygen from the beads react to form carbon dioxide which can be captured for recycling or stored.

This reaction gives off heat energy that could be used to heat water in order to drive electricity-producing steam turbines.

*Adapted from Focus: Science and Technology, April 2013*

- (a) The CDCL process produced 300 tonnes of carbon dioxide.  
Calculate the mass, in tonnes, of carbon dioxide released into the atmosphere. 1
  
- (b) Write the ionic formula for the iron compound used in CDCL. 1
  
- (c) State the term used to describe all chemical reactions that release heat energy. 1



7. A student was asked to carry out an experiment to determine the concentration of a copper(II) sulfate solution.

Part of the work card used is shown.

Determination of the Concentration of Copper(II) Sulfate Solution

1. Weigh an empty crucible
2. Add 100 cm<sup>3</sup> copper(II) sulfate solution
3. Evaporate the solution to dryness
4. Weigh the crucible containing dry copper(II) sulfate

- (a) Suggest how the student could have evaporated the solution to dryness. 1

- (b) The student found that the 100cm<sup>3</sup> solution contained 3.19 g of copper(II) sulfate, CuSO<sub>4</sub>.

Calculate the concentration of the solution in mol l<sup>-1</sup>. 2

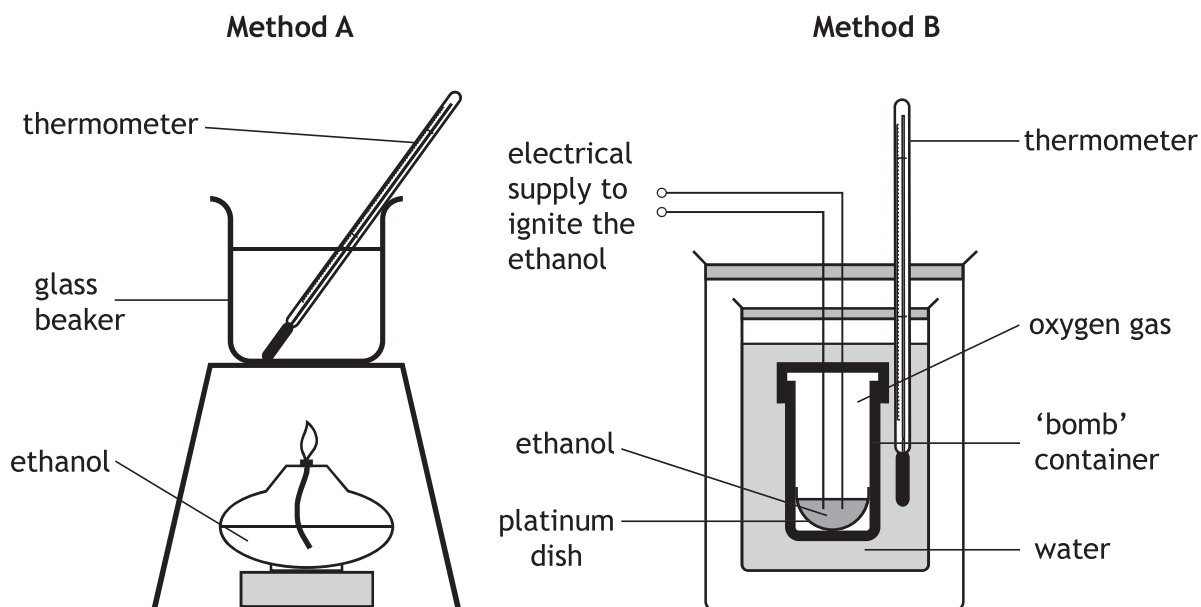
Show your working clearly.

[Turn over



\* X 7 1 3 7 5 0 1 1 3 \*

8. A student calculated the energy absorbed by water when ethanol is burned using two different methods.



The student recorded the following data.

	<i>Method</i>	
	<b>A</b>	<b>B</b>
Mass of ethanol burned (g)	0.5	0.5
Mass of water heated (g)	100	100
Initial temperature of water (°C)	24	24
Final temperature of water (°C)	32	58

(a) The final temperature of water in method **B** is higher than in method **A**. Suggest why there is a difference in the energy absorbed by the water.

1

**MARKS**

DO NOT  
WRITE IN  
THIS  
MARGIN

**8. (continued)**

- (b) Calculate the energy, in kJ, absorbed by the water in method B.  
You may wish to use the data booklet to help you.  
**Show your working clearly.**

**3**

[Turn over



\* X 7 1 3 7 5 0 1 1 5 \*

9. Aluminium can be extracted from naturally occurring metal compounds such as bauxite.

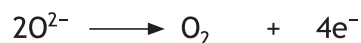
(a) State the term used to describe naturally occurring metal compounds such as bauxite.

1

(b) Bauxite is refined to produce aluminium oxide.

Electrolysis of molten aluminium oxide produces aluminium and oxygen gas.

The ion-electron equations taking place during the electrolysis of aluminium oxide are



(i) Write the redox equation for the overall reaction.

1

(ii) State why ionic compounds, like aluminium oxide, conduct electricity when molten.

1



MARKS DO NOT WRITE IN THIS MARGIN

9. (continued)

- (c) Bauxite contains impurities such as silicon dioxide.  
Silicon can be extracted from silicon dioxide as shown.



Identify the reducing agent in this reaction.

1

[Turn over



\* X 7 1 3 7 5 0 1 1 7 \*



10. A group of students were given strips of aluminium, iron, tin and zinc.  
Using your knowledge of chemistry, suggest how the students could identify each of the four metals.

MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

3



\* X 7 1 3 7 5 0 1 1 8 \*

11. Electrons can be removed from all atoms.

The energy required to do this is called the ionisation energy.

The first ionisation energy for an element is defined as the energy required to remove one mole of electrons from one mole of atoms, in the gaseous state.

The equation for the first ionisation energy of chlorine is



(a) State the electron arrangement for the  $\text{Cl}^{\text{+}}$  ion.

1

You may wish to use the data booklet to help you.

(b) Write the equation for the first ionisation energy of magnesium.

1

(c) Information on the first ionisation energy of some elements is given in the table.

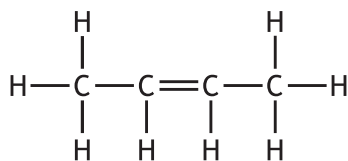
<i>Element</i>	<i>First ionisation energy (kJ mol<sup>-1</sup>)</i>
lithium	526
fluorine	1690
sodium	502
chlorine	1260
potassium	425
bromine	1150

Describe the trend in the first ionisation energy going down a group in the Periodic Table.

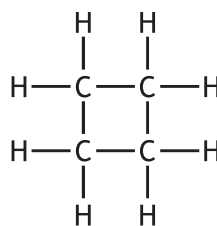
1



12. The structural formulae of two hydrocarbons are shown.



A



B

(a) Name hydrocarbon A.

1

(b) Hydrocarbons A and B can be described as isomers.  
State what is meant by the term isomer.

1

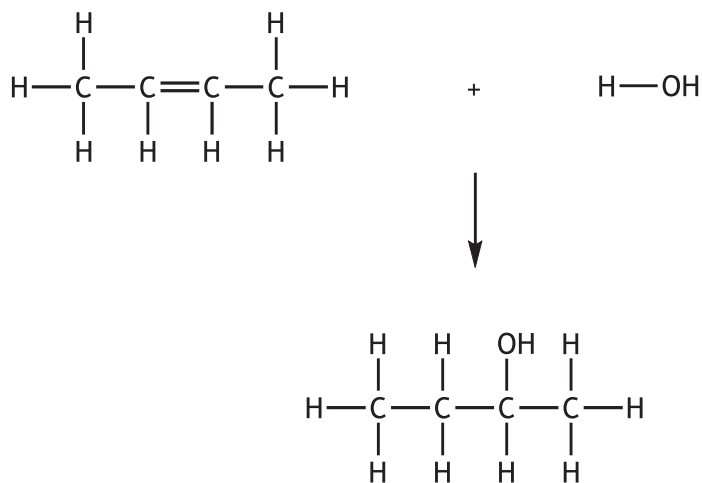
MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN



\* X 7 1 3 7 5 0 1 2 0 \*

12. (continued)

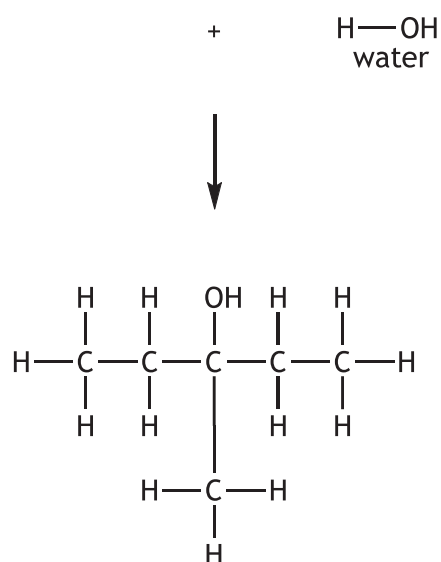
(c) Hydrocarbon A can undergo an addition reaction with water to form butan-2-ol as shown.



A similar reaction can be used to produce 3-methylpentan-3-ol.

Draw a structural formula for the hydrocarbon used to form this molecule.

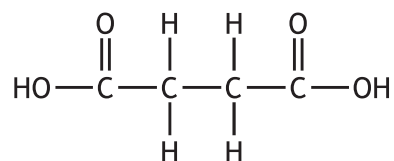
1



3-methylpentan-3-ol



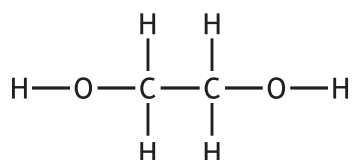
13. Succinic acid is a natural antibiotic.  
The structure of succinic acid is shown.



- (a) Name the functional group present in succinic acid.

1

- (b) Succinic acid can form a polymer with ethane-1,2-diol.  
The structure of ethane-1,2-diol is shown.



- (i) Name the type of polymerisation which would take place between succinic acid and ethane-1,2-diol.

1

- (ii) Draw the repeating unit of the polymer formed between succinic acid and ethane-1,2-diol.

1



14. Titanium is the tenth most commonly occurring element in the Earth's crust.

- (a) The first step in the extraction of titanium from impure titanium oxide involves the conversion of titanium oxide into titanium(IV) chloride.



- (i) Identify X.

1

- (ii) Titanium(IV) chloride is a liquid at room temperature and does not conduct electricity.

Suggest the type of bonding that is present in titanium(IV) chloride.

1

- (b) The next step involves separating pure titanium(IV) chloride from other liquid impurities that are also produced during the first step.

Suggest a name for this process.

1

- (c) The equation for the final step in the extraction of titanium is



The sodium chloride produced can be electrolysed.

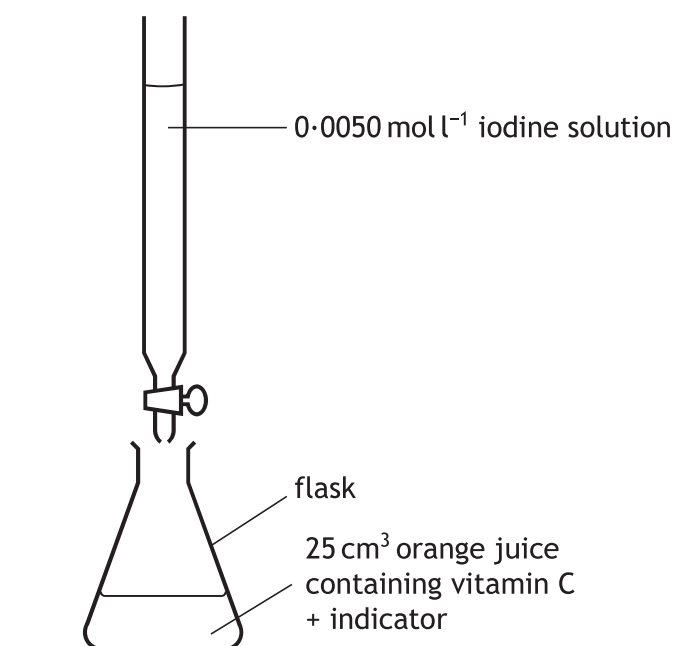
Suggest how this could make the extraction of titanium from titanium oxide more economical.

1



15. Vitamin C is found in fruits and vegetables.

Using iodine solution, a student carried out titrations to determine the concentration of vitamin C in orange juice.



The results of the titration are given in the table.

<i>Titration</i>	<i>Initial burette reading (cm<sup>3</sup>)</i>	<i>Final burette reading (cm<sup>3</sup>)</i>	<i>Titre (cm<sup>3</sup>)</i>
1	1.2	18.0	16.8
2	18.0	33.9	15.9
3	0.5	16.6	16.1

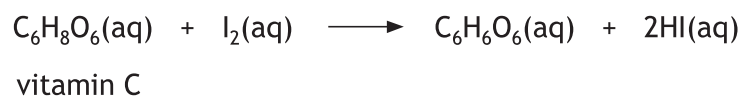
(a) Calculate the average volume, in cm<sup>3</sup>, that should be used in calculating the concentration of vitamin C.

1



15. (continued)

(b) The equation for the reaction is



Calculate the concentration, in  $\text{mol l}^{-1}$ , of vitamin C in the orange juice. **3**  
**Show your working clearly.**

[Turn over for Question 16 on *Page twenty-six*]





16. A student is given three different compounds each containing carbon.  
Using your knowledge of chemistry, describe how the student could identify the compounds.

MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

3

[END OF QUESTION PAPER]



\* X 7 1 3 7 5 0 1 2 6 \*

**2016**

## SECTION 1

1. When solid sodium chloride dissolves in water, a solution containing sodium ions and chloride ions is formed.

Which of the following equations correctly shows the state symbols for this process?

- A  $\text{NaCl(s)} + \text{H}_2\text{O(l)} \longrightarrow \text{Na}^+(\text{l}) + \text{Cl}^-(\text{l})$   
B  $\text{NaCl(s)} + \text{H}_2\text{O(aq)} \longrightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$   
C  $\text{NaCl(aq)} + \text{H}_2\text{O(l)} \longrightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$   
D  $\text{NaCl(s)} + \text{H}_2\text{O(l)} \longrightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$

2. The table shows the times taken for 0.5 g of magnesium to react completely with acid under different conditions.

<i>Acid concentration</i> (mol l <sup>-1</sup> )	<i>Temperature</i> (°C)	<i>Reaction time</i> (s)
0.1	20	80
0.1	25	60
0.2	30	20
0.2	40	10

The time for 0.5 g of magnesium to react completely with 0.2 mol l<sup>-1</sup> acid at 25 °C will be

- A less than 10 s  
B between 10 s and 20 s  
C between 20 s and 60 s  
D more than 80 s.
3. When an atom X of an element in Group 1 reacts to become X<sup>+</sup>
- A the mass number of X decreases  
B the atomic number of X increases  
C the charge of the nucleus increases  
D the number of occupied energy levels decreases.
4. Which of the following does **not** contain covalent bonds?
- A Sulfur  
B Copper  
C Oxygen  
D Hydrogen

5. Which of the following structures is **never** found in compounds?

- A Ionic
- B Monatomic
- C Covalent network
- D Covalent molecular

6. Which line in the table shows the properties of an ionic substance?

	<i>Melting point</i> (°C)	<i>Boiling point</i> (°C)	<i>Conducts electricity</i>	
			<i>Solid</i>	<i>Liquid</i>
A	19	80	no	no
B	655	1425	no	no
C	1450	1740	no	yes
D	1495	2927	yes	yes

7. What is the name of the compound with the formula  $\text{Ag}_2\text{O}$ ?

- A Silver(I) oxide
- B Silver(II) oxide
- C Silver(III) oxide
- D Silver(IV) oxide

8. An element was burned in air. The product was added to water, producing a solution with a pH less than 7. The element could be

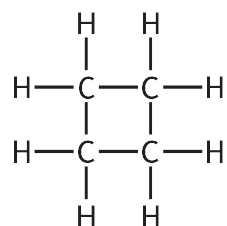
- A tin
- B zinc
- C sulfur
- D sodium.

9. When methane burns in a plentiful supply of air, the products are

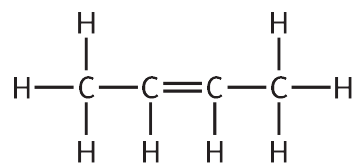
- A carbon and water
- B carbon dioxide and water
- C carbon monoxide and water
- D carbon dioxide and hydrogen.

10. Which of the following compounds belongs to the same homologous series as the compound with the molecular formula  $C_3H_8$ ?

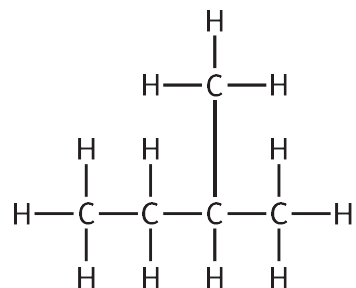
A



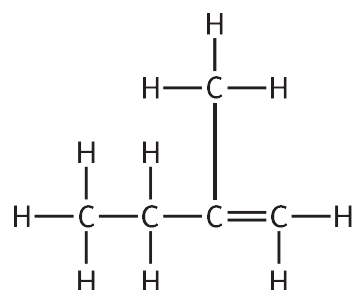
B

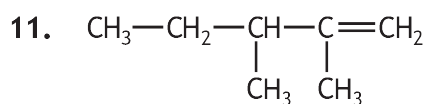


C



D

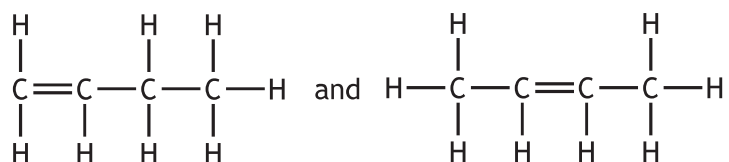




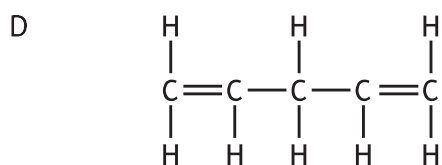
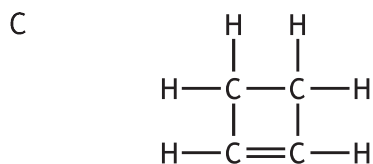
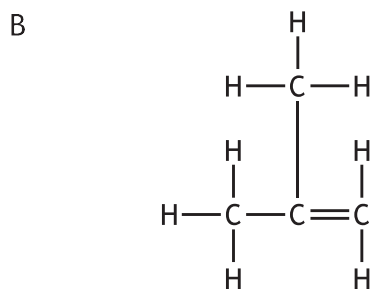
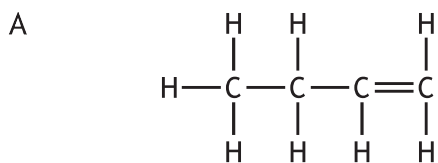
The systematic name for the structure shown is

- A 1,2-dimethylpent-1-ene
- B 2,3-dimethylpent-1-ene
- C 3,4-dimethylpent-4-ene
- D 3,4-dimethylpent-1-ene.

12. Two isomers of butene are

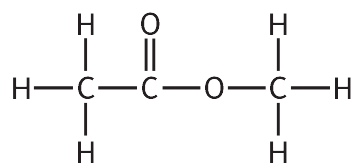


Which of the following structures represents a third isomer of butene?

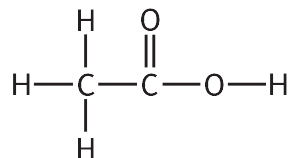


13. Which of the following structures represents an ester?

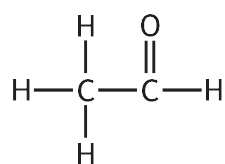
A



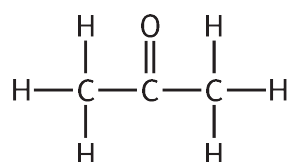
B



C



D



14. The lowest temperature at which a hydrocarbon ignites is called its flash point.

<i>Hydrocarbon</i>	<i>Formula</i>	<i>Boiling point (°C)</i>	<i>Flash point (°C)</i>
hexene	C <sub>6</sub> H <sub>12</sub>	63	-25
hexane	C <sub>6</sub> H <sub>14</sub>	69	-23
cyclohexane	C <sub>6</sub> H <sub>12</sub>	81	-20
heptane	C <sub>7</sub> H <sub>16</sub>	98	-1
octane	C <sub>8</sub> H <sub>18</sub>	126	15

Using information in the table, identify the correct statement.

- A Octane will ignite at 0 °C.
- B Hydrocarbons with the same molecular mass have the same flash point.
- C The flash point of a hydrocarbon increases as the boiling point increases.
- D In a homologous series the flash point decreases as the number of carbon atoms increases.

15. Which of the following metals can be obtained from its ore by heating with carbon monoxide?

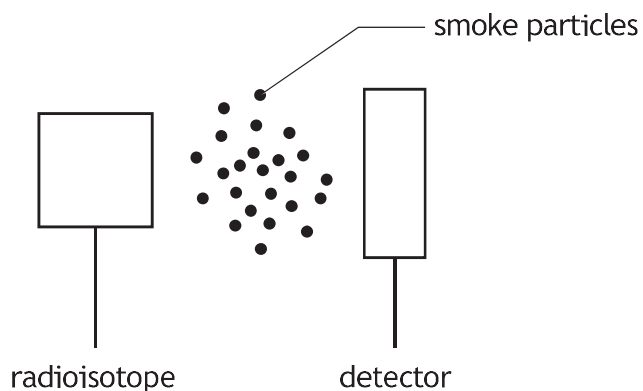
You may wish to use the data booklet to help you.

- A Magnesium
- B Aluminium
- C Calcium
- D Nickel

16. Polyesters are always made from monomers

- A which are the same
- B which are unsaturated
- C with one functional group per molecule
- D with two functional groups per molecule.

17. Some smoke detectors make use of radiation which is very easily stopped by tiny smoke particles moving between the radioactive source and the detector.



The most suitable type of radioisotope for a smoke detector would be

- A an alpha-emitter with a long half-life
- B a gamma-emitter with a short half-life
- C an alpha-emitter with a short half-life
- D a gamma-emitter with a long half-life.

[Turn over for next question



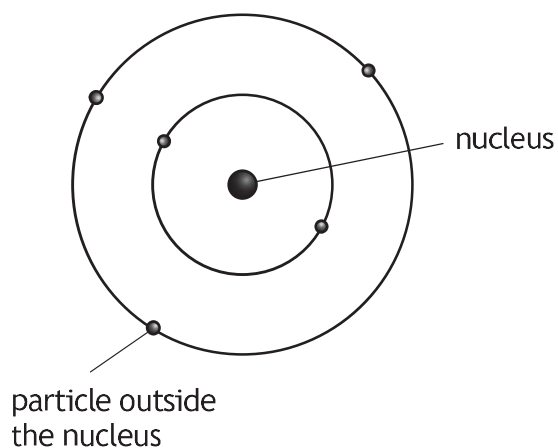
18. Which particle will be formed when an atom of  ${}^{234}_{90}\text{Th}$  emits a  $\beta$ -particle?
- A  ${}^{234}_{91}\text{Pa}$
  - B  ${}^{230}_{88}\text{Ra}$
  - C  ${}^{234}_{89}\text{Ac}$
  - D  ${}^{238}_{92}\text{U}$
19.  ${}^{14}\text{C}$  has a half life of 5600 years. An analysis of charcoal from a wood fire shows that its  ${}^{14}\text{C}$  content is 25 % of that in living wood.  
How many years have passed since the wood for the fire was cut?
- A 1400
  - B 4200
  - C 11 200
  - D 16 800
20. A solution of potassium carbonate, made up using tap water, was found to be cloudy. This could result from the tap water containing
- A lithium ions
  - B calcium ions
  - C sodium ions
  - D ammonium ions.

You may wish to use the data booklet to help you.

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF  
YOUR QUESTION AND ANSWER BOOKLET]

SECTION 2—60 marks  
Attempt ALL questions

1. Elements are made up of atoms.



(a) Complete the tables to show the missing information.

(i)

In the Nucleus		
<i>Particle</i>	<i>Relative Mass</i>	<i>Charge</i>
proton		+1
neutron	1	

1

(ii)

Outside the Nucleus		
<i>Particle</i>	<i>Relative Mass</i>	<i>Charge</i>
	almost zero	

1

(b) A sample of nitrogen was found to contain equal amounts of two isotopes. One isotope has mass number 14 and the other has mass number 15.

What is the relative atomic mass of this sample of nitrogen?

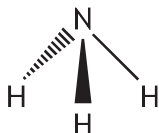
1



1. (continued)

(c) Nitrogen can form bonds with other elements.

The diagram shows the shape of a molecule of ammonia ( $\text{NH}_3$ ).



(i) State the name used to describe the shape of a molecule of ammonia.

1

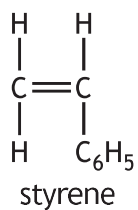
(ii) Name the industrial process used to manufacture ammonia.

1

[Turn over



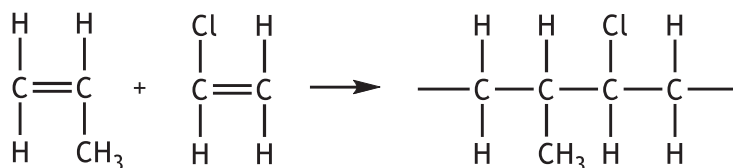
2. The monomer used to produce polystyrene has the following structure.



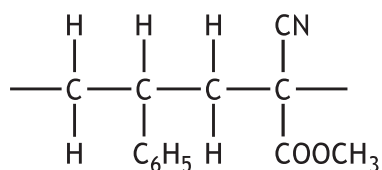
(a) Draw a section of polystyrene, showing three monomer units joined together.

1

(b) When two different monomers polymerise, a copolymer is formed as shown.



Another copolymer can be made from styrene and acrylonitrile monomers. A section of this copolymer is shown below.



Draw the structure of the acrylonitrile monomer.

1



3. Hydrogen gas can be produced in the laboratory by adding a metal to dilute acid. Heat energy is also produced in the reaction.

(a) State the term used to describe all chemical reactions that release heat energy.

1

(b) A student measured the volume of hydrogen gas produced when zinc lumps were added to dilute hydrochloric acid.

<i>Time (s)</i>	0	10	20	30	40	50	60	70
<i>Volume of hydrogen (cm<sup>3</sup>)</i>	0	12	21	29	34	36	37	37

(i) Calculate the average rate of reaction, in  $\text{cm}^3\text{s}^{-1}$ , between 10 and 30 seconds.

2

Show your working clearly.

(ii) Estimate the time taken, in seconds, for the reaction to finish.

1

(iii) The student repeated the experiment using the same mass of zinc. State the effect on the rate of the reaction if zinc powder was used instead of lumps.

1



3. (continued)

(c) Another student reacted aluminium with dilute nitric acid.



(i) Circle the formula for the salt in the above equation.

1

(ii) 1 mole of hydrogen gas has a volume of 24 litres.

Calculate the volume of hydrogen gas, in litres, produced when 0.01 moles of aluminium react with dilute nitric acid.

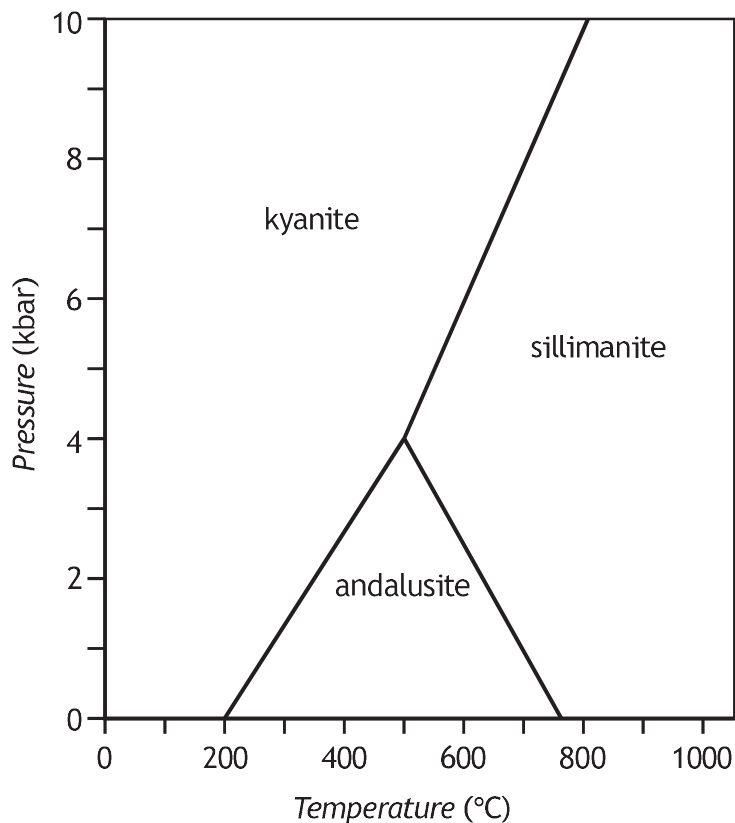
2

Show your working clearly.

[Turn over



4. Some rocks contain the mineral with the formula  $Al_2SiO_5$ .  
 This mineral exists in three different forms, andalusite, sillimanite, and kyanite. The form depends on the temperature and pressure.  
 The diagram shows this relationship.



- (a) (i) Name the **two** forms which could exist at 400 °C. 1
- (ii) Complete the table to show the temperature and pressure at which all three forms would exist. 1

Temperature (°C)	
Pressure (kbar)	

MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

4. (continued)

- (b) Calculate the percentage mass of silicon in andalusite,  $\text{Al}_2\text{SiO}_5$ .  
Show your working clearly.

3

[Turn over



\* X 7 1 3 7 5 0 1 1 3 \*



5. Read the passage and answer the questions that follow.

### Gold — a very useful metal

Gold has been associated with wealth since before the first gold coins were minted in Lydia (modern Turkey) about 550 BC. It does not react with water, air, alkalis and almost all acids. Gold only has one naturally occurring isotope with mass 197.

As an element it has many uses in the modern world. 1 gram of gold can be beaten into a gold film covering one square metre and thin coatings of gold are used as lubricants in aerospace applications. Gold electroplating can be used to coat electrical connectors and printed circuit boards.

Chemists have recently discovered that gold nanoparticles make superb catalysts for many reactions such as the conversion of alcohols into aldehydes and ketones. It can also be used as a catalyst for removing trace carbon monoxide from gases. In this reaction carbon monoxide reacts with oxygen to form carbon dioxide.

Gold nanorods can be grown from a dilute solution of auric acid and are used in the treatment of some forms of cancer.

Adapted from *Education in Chemistry*, Volume 45, November 2008

- (a) Suggest a reason why gold was used in the first coins minted. 1
- (b) Calculate the number of neutrons present in the naturally occurring isotope of gold. 1
- You may wish to use the data booklet to help you.



5. (continued)

- (c) (i) Write an equation, using symbols and formulae, to show the reaction for removing trace carbon monoxide from gases.

There is no need to balance this equation.

1

- (ii) State the role of gold in this reaction.

1

- (d) Circle the correct words to complete the sentence.

1

Gold nanorods can be grown from a solution which contains

more  $\left\{ \begin{array}{l} \text{hydroxide} \\ \text{hydrogen} \end{array} \right\}$  ions than  $\left\{ \begin{array}{l} \text{hydroxide} \\ \text{hydrogen} \end{array} \right\}$  ions.

[Turn over



6. (a) A fertiliser for tomato plants contains compounds of phosphorus and potassium.

(i) Suggest an experimental test, including the result, to show that potassium is present in the fertiliser.

1

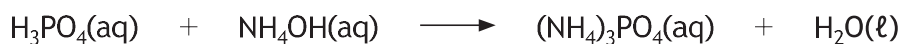
You may wish to use the data booklet to help you.

(ii) Ammonium citrate is included in the fertiliser because some phosphorus compounds are more soluble in ammonium citrate solution than they are in water.

1

Suggest another reason why ammonium citrate is added to the fertiliser.

(b) In the production of the fertiliser ammonium phosphate, phosphoric acid ( $\text{H}_3\text{PO}_4$ ) reacts with ammonium hydroxide as shown.



Balance this equation.

1



MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

7. The element strontium was discovered in 1790 in the village of Strontian in Scotland.

Using your knowledge of chemistry, comment on the chemistry of strontium.

3



\* X 7 1 3 7 5 0 1 1 7 \*

8. Essential oils can be extracted from plants and used in perfumes and food flavourings.

(a) Essential oils contain compounds called terpenes.

A terpene is a chemical made up of a number of isoprene molecules joined together.

The shortened structural formula of isoprene is  $\text{CH}_2\text{C}(\text{CH}_3)\text{CHCH}_2$ .

Draw the full structural formula for isoprene.

1

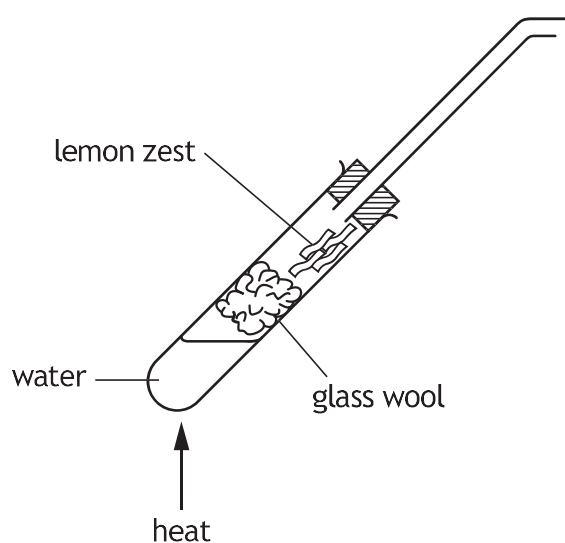
(b) Essential oils can be extracted from the zest of lemons in the laboratory by steam distillation.

The process involves heating up water in a boiling tube until it boils. The steam produced then passes over the lemon zest which is separated from the water by glass wool. As the steam passes over the lemon zest it carries the essential oils into a delivery tube. The condensed liquids (essential oils and water) are collected in a test tube placed in a cold water bath.

Complete the diagram to show the apparatus required to collect the essential oils.

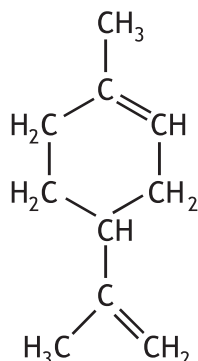
1

(An additional diagram, if required, can be found on Page 29.)



8. (continued)

- (c) Limonene,  $C_{10}H_{16}$ , is an essential oil which is added to some cleaning products to give them a lemon scent.



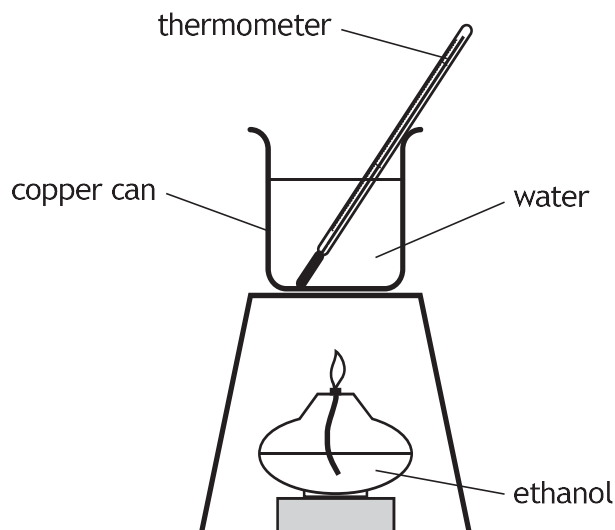
The concentration of limonene present in a cleaning product can be determined by titrating with bromine solution.

- (i) Name the type of chemical reaction taking place when limonene reacts with bromine solution. 1

- (ii) Write the molecular formula for the product formed when limonene,  $C_{10}H_{16}$ , reacts completely with bromine solution. 1



9. Ethanol can be used as an alternative fuel for cars.
- (a) A student considered two methods to confirm the amount of energy released when ethanol burns.



<i>Method A</i>	<i>Method B</i>
1. Record the initial temperature of the water.	1. Record the initial temperature of the water.
2. Weigh the burner containing the fuel.	2. Weigh the burner containing the fuel.
3. Place the burner under the copper can and then light the burner.	3. Light the burner and then place it under the copper can.
4. Extinguish the flame after 2 minutes.	4. Extinguish the flame after 2 minutes.
5. Record the final temperature and reweigh the burner.	5. Record the final temperature and reweigh the burner.

Explain which method would give a more accurate result.

2

9. (continued)

- (b) The table gives information about the amount of energy released when 1 mole of some alcohols are burned.

<i>Name of alcohol</i>	<i>Energy released when one mole of alcohol is burned (kJ)</i>
propan-1-ol	2021
propan-2-ol	2005
butan-1-ol	2676
butan-2-ol	2661
pentan-1-ol	3329
pentan-2-ol	3315
hexan-1-ol	3984

- (i) Write a statement linking the amount of energy released to the position of the functional group in an alcohol molecule. 1

- (ii) Predict the amount of energy released, in kJ, when 1 mole of hexan-2-ol is burned. 1

- (c) Ethanol can also be used in portable camping stoves.

The chemical reaction in a camping stove releases 23 kJ of energy. If 100g of water is heated using this stove, calculate the rise in temperature of the water, in °C. 3

You may wish to use the data booklet to help you.

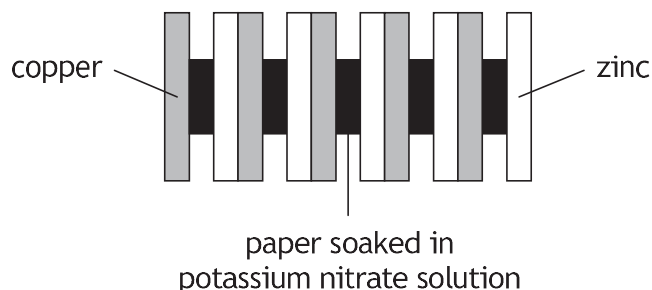
Show your working clearly.





10. A battery is a number of cells joined together.

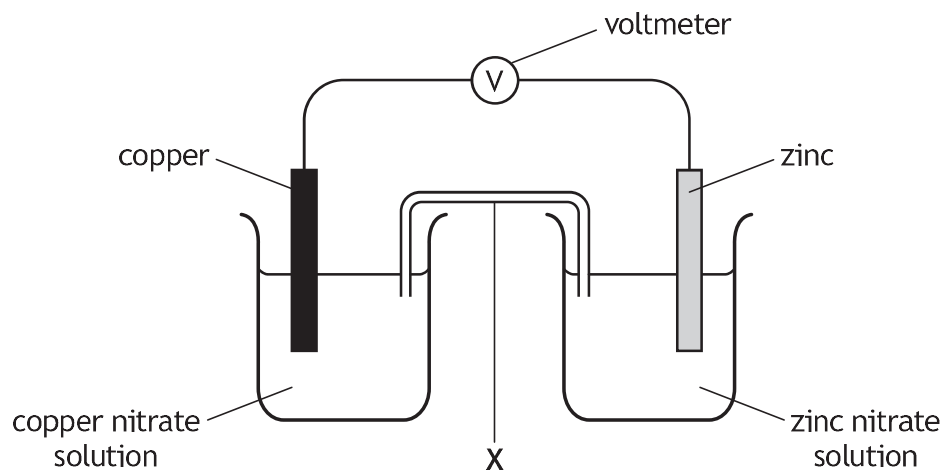
- (a) The diagram shows a simple battery made from copper and zinc discs separated by paper soaked in potassium nitrate solution.



The purpose of the potassium nitrate solution is to complete the circuit.  
State the **term** used to describe an ionic compound which is used for this purpose.

1

- (b) A student set up a cell using the same metals as those used in the battery.



- (i) **On the diagram**, draw an arrow to show the path and direction of electron flow.

1

You may wish to use the data booklet to help you.

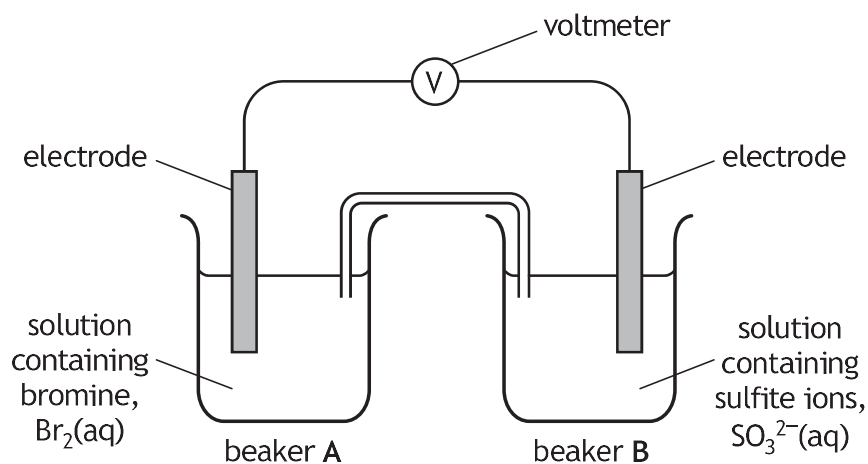
- (ii) Name the piece of apparatus labelled X.

1

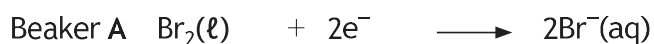


10. (continued)

(c) Electricity can also be produced in a cell containing non-metals.



The reactions occurring at each electrode are



(i) Name the type of chemical reaction taking place in beaker B. 1

(ii) Write the redox equation for the overall reaction. 1

(iii) Name a non-metal element which is suitable for use as the electrodes. 1



11. Ethers are a group of compounds containing carbon, hydrogen and oxygen.

Name of ether	Structural formula	Boiling point (°C)
methoxyethane	$\text{CH}_3-\text{O}-\text{CH}_2\text{CH}_3$	7
ethoxyethane	$\text{CH}_3\text{CH}_2-\text{O}-\text{CH}_2\text{CH}_3$	35
X	$\text{CH}_3-\text{O}-\text{CH}_2\text{CH}_2\text{CH}_3$	39
propoxybutane	$\text{CH}_3\text{CH}_2\text{CH}_2-\text{O}-\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$	117

(a) Name ether X. 1

(b) Suggest a general formula for this homologous series. 1

(c) Methoxyethane is a covalent molecular substance. It has a low boiling point and is a gas at room temperature.

Circle the correct words to complete the sentence. 1

The bonds between the molecules are  $\left\{ \begin{array}{l} \text{weak} \\ \text{strong} \end{array} \right\}$  and the bonds

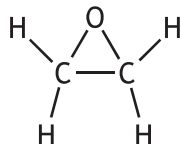
within the molecule are  $\left\{ \begin{array}{l} \text{weak} \\ \text{strong} \end{array} \right\}$ .



11. (continued)

(d) Epoxides are a family of cyclic ethers.

The full structural formula for the first member of this family is shown.



(i) Epoxides can be produced by reacting an alkene with oxygen.

Name the alkene which would be used to produce the epoxide shown.

1

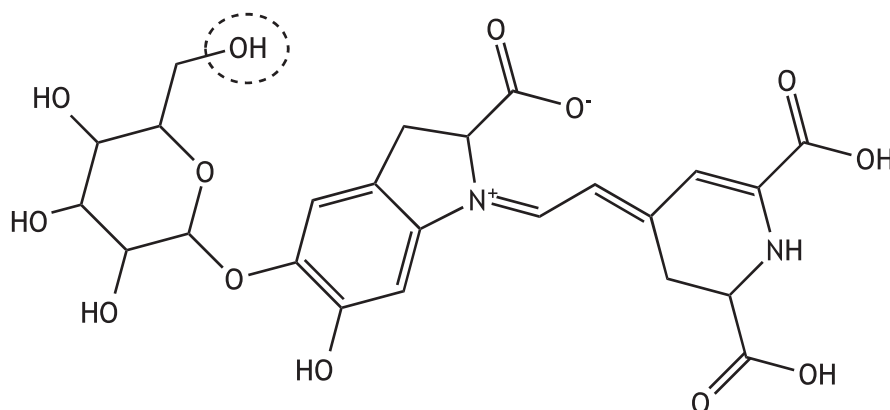
(ii) Epoxides have three atoms in a ring, one of which is oxygen.

Draw a structural formula for the epoxide with the chemical formula  $C_3H_6O$ .

1



12. Betanin is responsible for the red colour in beetroot and can be used as a food colouring.



- (a) Name the functional group circled in the diagram above. 1
- (b) Betanin can be used as an indicator in a neutralisation reaction.  
The pH range at which some indicators change colour is shown.

<i>Indicator</i>	<i>pH range of colour change</i>
methyl orange	3.2 to 4.4
litmus	5.0 to 8.0
phenolphthalein	8.2 to 10.0
betanin	9.0 to 10.0

The indicator used in a neutralisation reaction depends on the pH at the end point.

The table below shows the end point of neutralisation reactions using different types of acid and base.

<i>Type of acid</i>	<i>Type of base</i>	<i>pH at the end point</i>
strong	strong	7
strong	weak	below 7
weak	strong	above 7

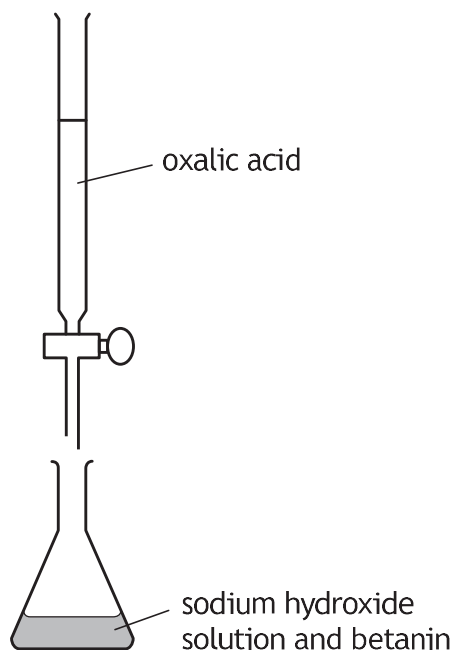
Betanin can be used to indicate the end point in the reaction between oxalic acid and sodium hydroxide solution.

- State the type of acid and the type of base used in this reaction. 1

## 12. (continued)

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

- (c) A student carried out a titration experiment to determine the concentration of a sodium hydroxide solution.



	<i>Initial burette reading (cm<sup>3</sup>)</i>	<i>Final burette reading (cm<sup>3</sup>)</i>	<i>Volume used (cm<sup>3</sup>)</i>
Rough titre	0.0	15.6	15.6
1st titre	15.6	30.5	14.9
2nd titre	30.5	45.6	15.1

Using the results in the table, calculate the average volume, in cm<sup>3</sup>, of oxalic acid required to neutralise the sodium hydroxide solution.

1

- (d) Oxalic acid is found naturally in rhubarb. A piece of rhubarb was found to contain 1.8 g of oxalic acid.

Calculate the number of moles of oxalic acid contained in the piece of rhubarb.

1

(Formula mass of oxalic acid = 90)



\* X 7 1 3 7 5 0 1 2 7 \*

13. Carbonated water, also known as sparkling water, is water into which carbon dioxide gas has been dissolved. This process is called carbonating.



A group of students are given two brands of carbonated water and asked to determine which brand contains more dissolved carbon dioxide.

Using your knowledge of chemistry, describe how the students could determine which brand of carbonated water contains more dissolved carbon dioxide.

3

[END OF QUESTION PAPER]



\* X 7 1 3 7 5 0 1 2 8 \*