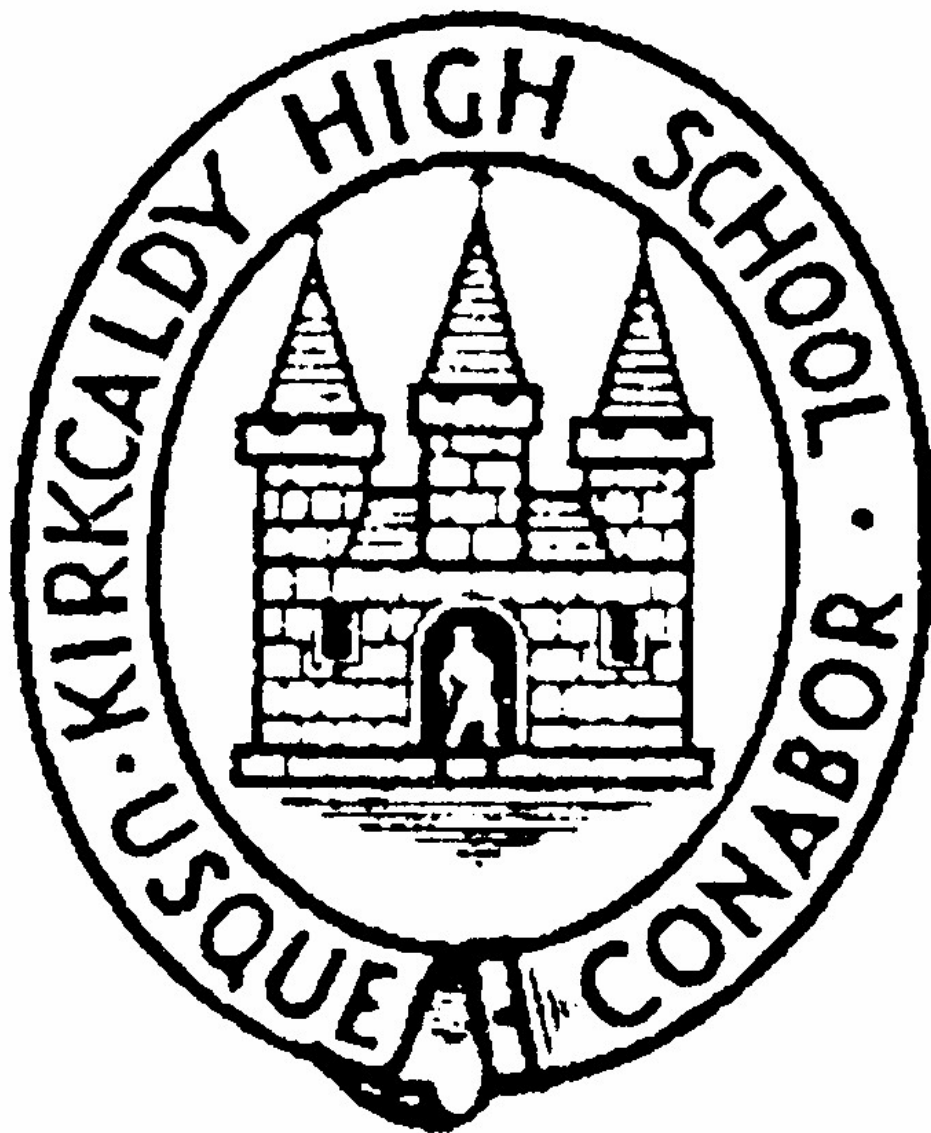


National 5 Chemistry

Past Paper Questions – Book 2



National 5 2017

Specimen Paper 2017

National 5 2018

2017

SECTION 1

1. In a reaction, the mass lost in 30 seconds was 2 g.
What is the average rate of reaction, in g s^{-1} , over this time?

- A $\frac{1}{30}$
B $\frac{30}{2}$
C $\frac{1}{2}$
D $\frac{2}{30}$

2. An atom has 21 protons, 21 electrons and 24 neutrons.
The atom has

- A atomic number 24 and mass number 42
B atomic number 45 and mass number 21
C atomic number 21 and mass number 45
D atomic number 24 and mass number 45.

3. What is the charge on the zinc ion in zinc dichromate, ZnCr_2O_7 ?
You may wish to use the data booklet to help you.

- A 2+
B 2-
C 1+
D 1-

4. The table contains information about magnesium and magnesium chloride.

	<i>Melting Point</i> ($^{\circ}\text{C}$)	<i>Density</i> (g cm^{-3})
Magnesium	650	1.74
Magnesium chloride	714	2.32

When molten magnesium chloride is electrolysed at 730°C the magnesium appears as a

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

5. Which of the following compounds is a base?

- A Sodium carbonate
- B Sodium chloride
- C Sodium nitrate
- D Sodium sulfate

6. $\text{AgNO}_3(\text{aq}) + \text{KCl}(\text{aq}) \longrightarrow \text{AgCl}(\text{s}) + \text{KNO}_3(\text{aq})$
Which of the following are the spectator ions in this reaction?

- A Ag^+ and Cl^-
- B K^+ and NO_3^-
- C Ag^+ and NO_3^-
- D K^+ and Cl^-

7. $x \text{H}_2\text{O}_2 \longrightarrow y \text{H}_2\text{O} + z \text{O}_2$
This equation will be balanced when

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

8. 0.25 moles of a gas has a mass of 7 g.
Which of the following could be the molecular formula for the gas?

- A C_2H_6
- B C_2H_4
- C C_3H_8
- D C_3H_6

9. Which of the following solutions contains the **least** number of moles of solute?

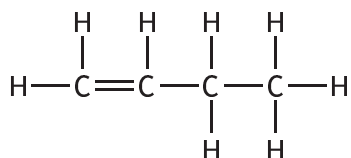
- A 100 cm^3 of 0.4 mol l^{-1} solution
- B 200 cm^3 of 0.3 mol l^{-1} solution
- C 300 cm^3 of 1.0 mol l^{-1} solution
- D 400 cm^3 of 0.5 mol l^{-1} solution

[Turn over

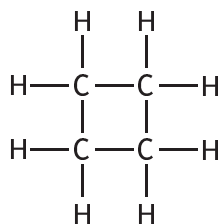
10. Which of the following could be the molecular formula for an alkane?

- A C_7H_{16}
- B C_7H_{14}
- C C_7H_{12}
- D C_7H_{10}

11. A student added bromine solution to compound X and compound Y.



Compound X



Compound Y

Which line in the table is correct?

<i>Decolourises bromine solution immediately</i>		
	Compound X	Compound Y
A	no	no
B	no	yes
C	yes	yes
D	yes	no

12. A compound burns in air. The only products of the reaction are carbon dioxide, sulfur dioxide and water.

The compound **must** contain

- A carbon and sulfur only
- B carbon and hydrogen only
- C carbon, hydrogen and sulfur
- D carbon, hydrogen, sulfur and oxygen.

13. Vinegar is a solution of

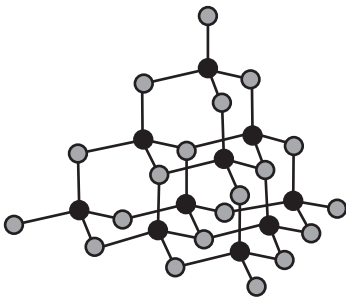
- A ethanol
- B methanol
- C ethanoic acid
- D methanoic acid.

14. A reaction is exothermic if

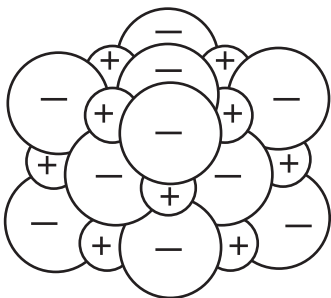
- A energy is absorbed from the surroundings
- B energy is released to the surroundings
- C energy is required to start the reaction
- D there is no energy change.

15. Which of the following diagrams could be used to represent the structure of copper?

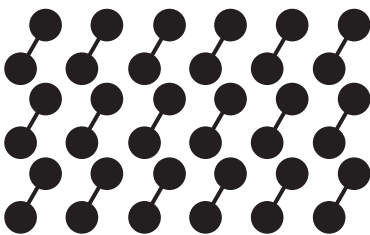
A



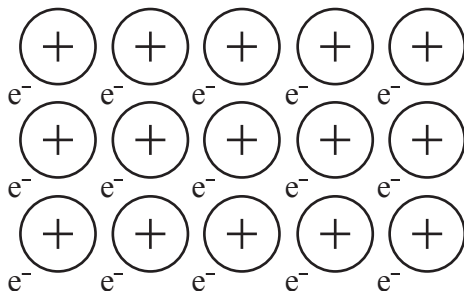
B



C



D



16. Which of the following metals is found uncombined in the Earth's crust?
You may wish to use the data booklet to help you.
- A Tin
 - B Magnesium
 - C Gold
 - D Sodium
17. Which of the following is **not** an essential element for healthy plant growth?
- A Oxygen
 - B Nitrogen
 - C Potassium
 - D Phosphorus
18. The Haber process is the industrial process for the manufacture of
- A nitric acid
 - B ammonia
 - C alkenes
 - D esters.
19. Which of the following salts can be prepared by a precipitation reaction?
You may wish to use the data booklet to help you.
- A Barium sulfate
 - B Lithium nitrate
 - C Calcium chloride
 - D Ammonium phosphate
20. A solution of accurately known concentration is more commonly known as a
- A correct solution
 - B precise solution
 - C standard solution
 - D prepared solution.

[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. A sample of argon contains three types of atom.



(a) State the term used to describe these different types of argon atom. 1

(b) Explain why the mass number of each type of atom is different. 1

(c) This sample of argon has an average atomic mass of 36.2.
State the mass number of the most common type of atom in the sample of argon. 1

[Turn over



2. Read the passage below and attempt the questions that follow.

Hydrogen Storage

The portable storage of hydrogen (H_2) is key to the development of hydrogen fuel cell cars. While many chemists focus their attention on the use of metal alloys and hydrides for storing hydrogen, others have investigated the potential use of carbon nanotubes.

A carbon nanotube is a tiny rolled up sheet of graphite. A research team has designed a pillared structure made up of vertical columns of carbon nanotubes which stabilise parallel graphene sheets. Graphene sheets are layers of carbon which are one atom thick.

Lithium atoms are added to the pillared structure to increase the hydrogen storage capacity. Researchers claim that one litre of the structure can store 41 g of hydrogen gas, which comes close to the US Department of Energy's target of 45 g.

Adapted from *InfoChem Magazine* (RSC), Nov 2008

- (a) Name the term used to describe a tiny rolled up sheet of graphite. 1
- (b) Name the metal added to the pillared structure to increase the hydrogen storage capacity. 1
- (c) Calculate the number of moles of hydrogen that, researchers claim, can be stored by one litre of this structure. 2
- Show your working clearly.



3. Chlorine can form covalent and ionic bonds.

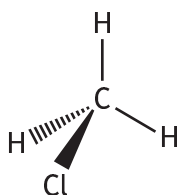
(a) Chlorine gas is made up of diatomic molecules.

Draw a diagram, showing all outer electrons, to represent a molecule of chlorine, Cl_2 .

1

(b) Chloromethane is a covalent gas with a faint sweet odour.

The structure of a chloromethane molecule is shown.



State the name used to describe the shape of a molecule of chloromethane.

1



3. (continued)

(c) When chlorine reacts with sodium the ionic compound sodium chloride is formed.

A chloride ion has a stable electron arrangement.

Describe how a chlorine atom achieves this stable electron arrangement.

1

(d) Covalent and ionic compounds have different physical properties.

Complete the table by circling the words which correctly describe the properties of the two compounds.

2

<i>Compound</i>	<i>Melting point</i>	<i>Conductor of electricity</i>
chloromethane gas	high / low	yes / no
solid sodium chloride	high / low	yes / no

[Turn over

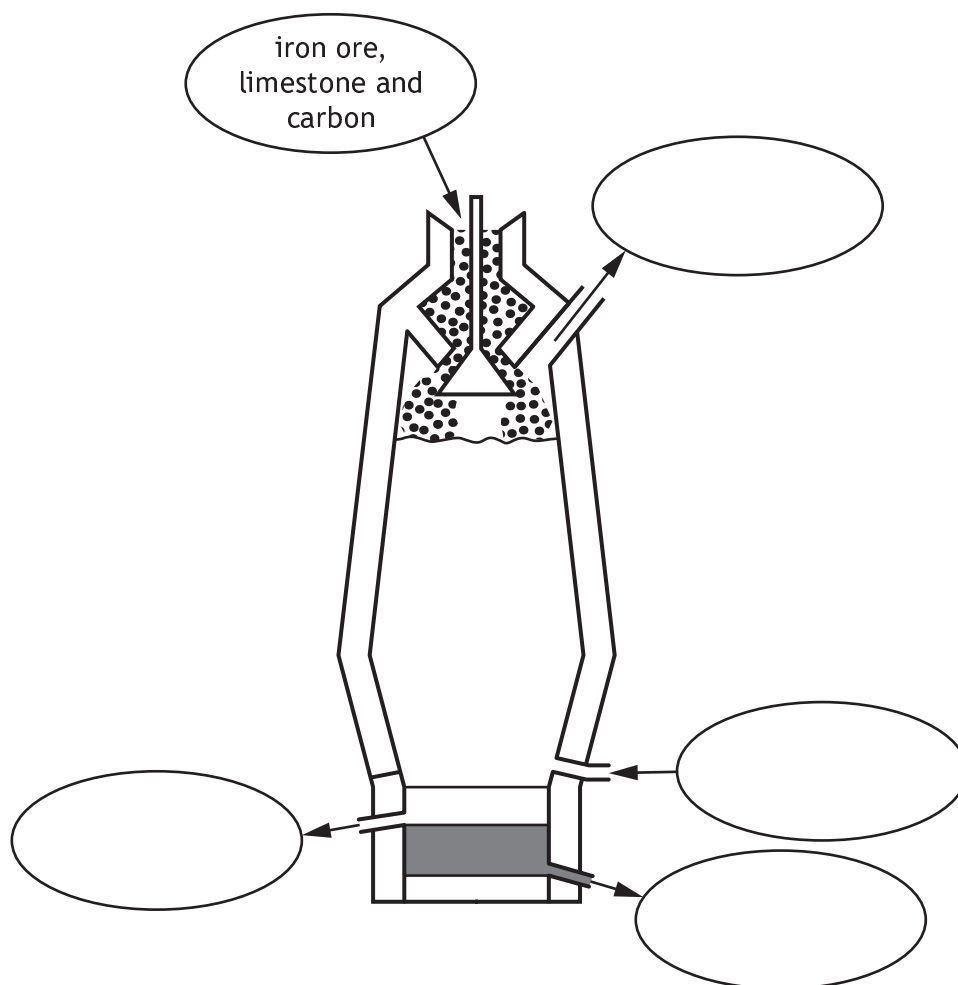


4. Iron is produced from iron ore in a blast furnace.

(a) Iron ore, limestone and carbon are added at the top of the blast furnace. Hot air is blown in near the bottom of the furnace and, through a series of chemical reactions, iron is produced. Waste gases are released near the top of the furnace. A layer of impurities is also produced which floats on top of the iron. The iron and impurities both flow off separately at the bottom of the furnace.

(i) Use this information to complete the diagram.

2



4. (a) (continued)

(ii) Explain why the temperature at the bottom of the blast furnace should not drop below 1538 °C.

1

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

(b) Rusting occurs when iron is exposed to air and water.

During rusting, iron initially loses two electrons to form iron(II) ions. These ions are further oxidised to form iron(III) ions.

Write an ion-electron equation to show iron(II) ions forming iron(III) ions.

1

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

[Turn over

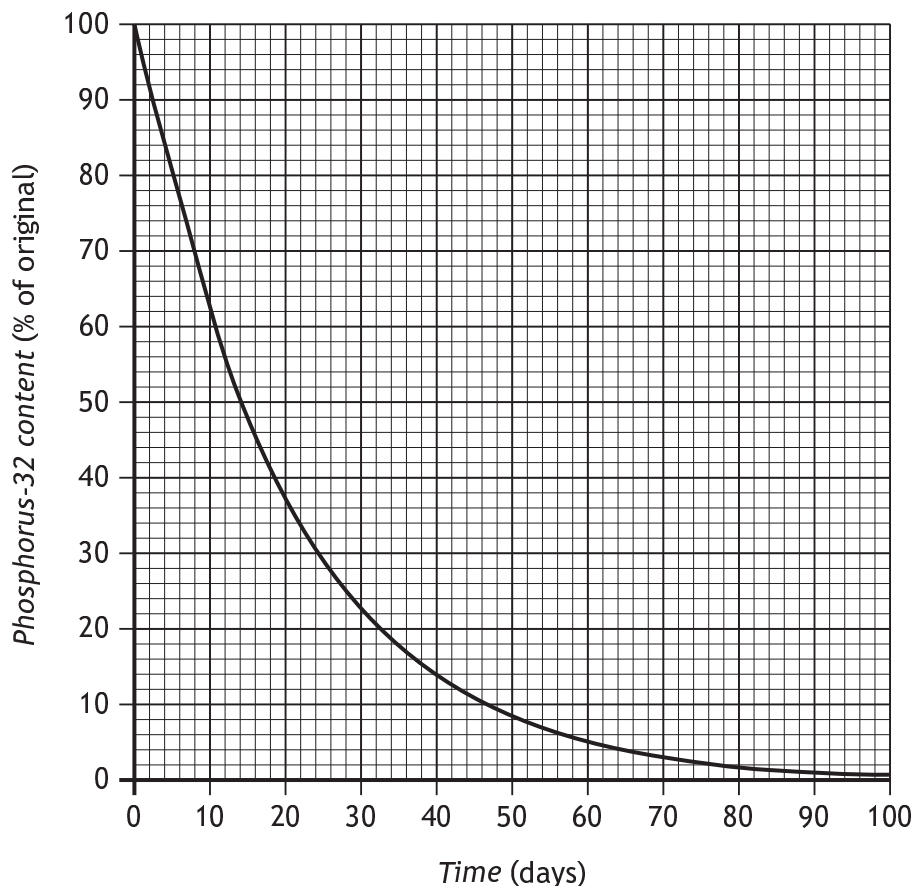


* X 7 1 3 7 5 0 1 1 1 *

5. Phosphorus-32 is a radioisotope used in the detection of cancerous tumours.

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(a) The graph shows how the percentage of phosphorus-32 in a sample changes over a period of time.



(i) Using the graph, calculate the half-life, in days, of phosphorus-32. 1

(ii) Using your answer to part (a) (i), calculate the time, in days, it would take for the mass of a 20 g sample of the radioisotope to decrease to 2.5 g. 2

(b) Phosphorus-32 decays by emitting radiation.

During this decay the atomic number increases by 1.

Name the type of radiation emitted when phosphorus-32 decays. 1



6. A student wanted to investigate whether copper could be used as a catalyst for the reaction between zinc and sulfuric acid.



Using your knowledge of chemistry, suggest how the student could investigate this.

3

[Turn over



7. Carboxylic acids can be used in household cleaning products.

(a) Name the functional group found in all carboxylic acids.

1

(b) Carboxylic acids have a range of physical and chemical properties. Melting point is an example of a physical property.

The table gives information about propanoic acid and butanoic acid.

<i>Carboxylic acid</i>	<i>Melting point (°C)</i>
propanoic acid	-21
butanoic acid	-5

(i) Draw a structural formula for butanoic acid.

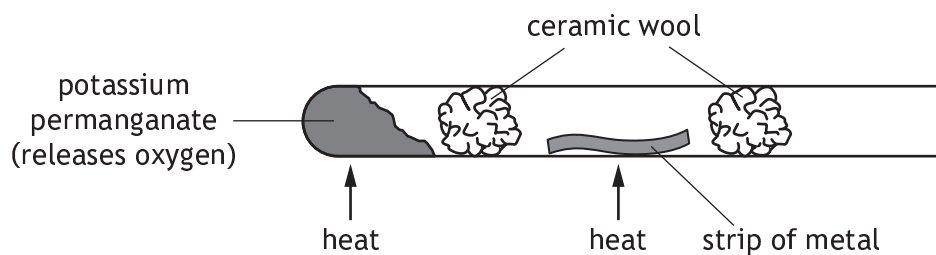
1

(ii) Explain why butanoic acid has a higher melting point than propanoic acid.

2



8. A teacher demonstrated the following experiment.



The results are shown in the table.

<i>Metal</i>	<i>Observation</i>
zinc	glowed brightly
copper	dull red glow
silver	no reaction

(a) (i) Describe what would be observed if the experiment was repeated using magnesium. 1

(ii) The teacher repeated the experiment using copper powder. State the effect this would have on the rate of the reaction between copper and oxygen. 1

(b) Magnesium also reacts with steam to produce magnesium oxide and hydrogen gas.



Identify the substance which is being oxidised. 1

[Turn over

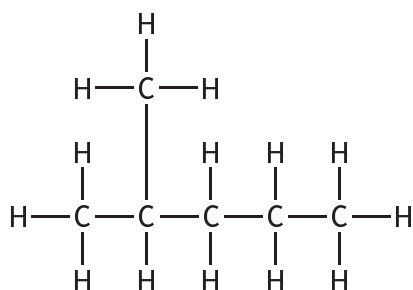


9. The alkanes are a homologous series of saturated hydrocarbons.

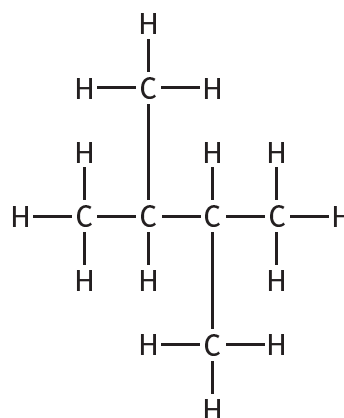
(a) State what is meant by the term homologous series.

1

(b) The structural formula of two alkanes is shown.



2-methylpentane



2,3-dimethylbutane

State the term used to describe a pair of alkanes such as 2-methylpentane and 2,3-dimethylbutane.

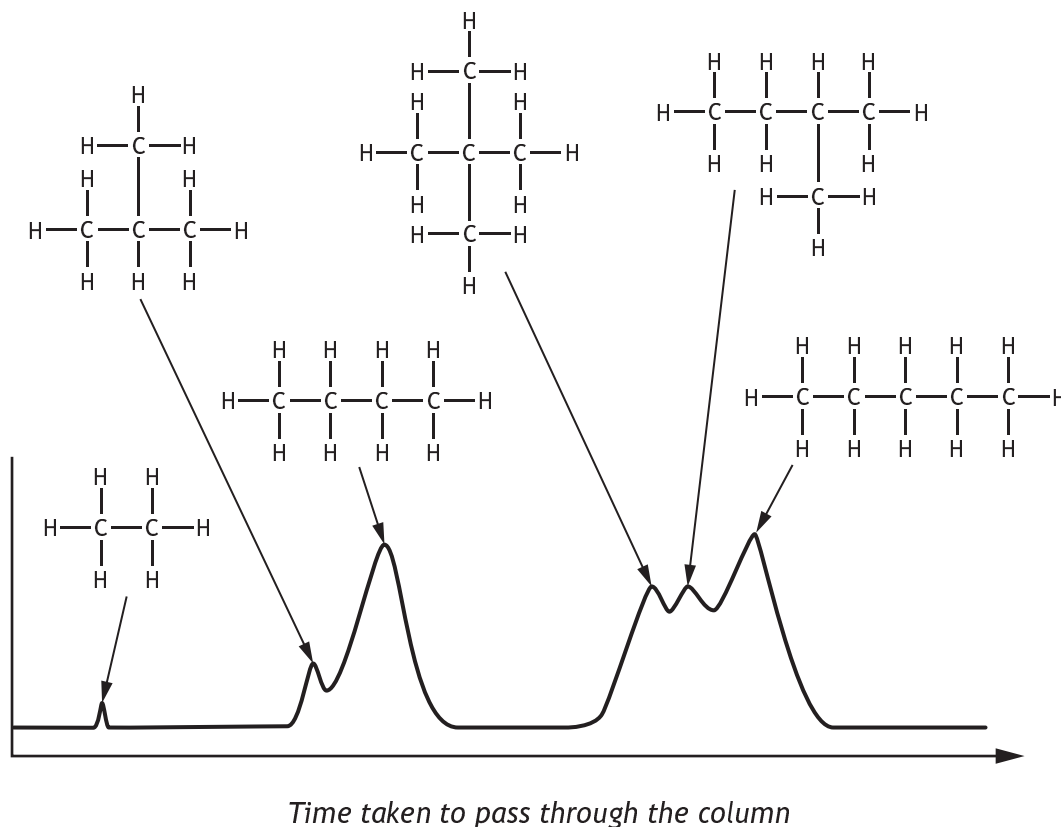
1

9. (continued)

MARKS
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- (c) The alkanes present in a mixture were separated using a technique known as HPLC. The mixture was vaporised and then passed through a special column. Different alkanes take different amounts of time to pass through the column.

The results are shown.



- (i) Write a general statement linking the structure of the alkane to the length of time taken to pass through the column. 1

- (ii) Propane was added to the mixture and the HPLC technique was repeated.

Draw an arrow on the graph to show the expected time taken for propane to pass through the column. 1

(An additional diagram, if required, can be found on *Page 27*.)



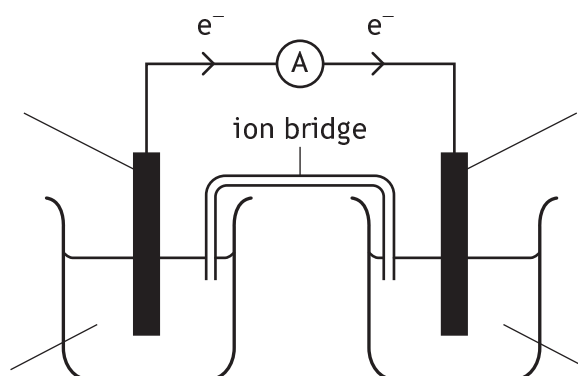
10. A student set up an electrochemical cell using aluminium and copper electrodes as well as aluminium sulfate solution and copper(II) sulfate solution.

- (a) (i) Complete the labels on the diagram to show the electrochemical cell which would give the direction of electron flow indicated.

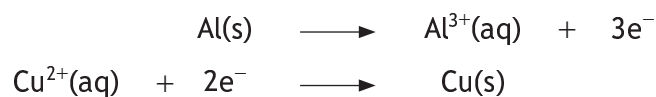
1

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

(An additional diagram, if required, can be found on *Page 27*.)



- (ii) The two reactions which take place in the cell are



Write the redox equation for the overall reaction.

1

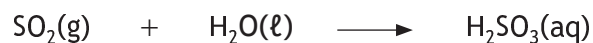
- (b) Calculate the percentage by mass of aluminium in aluminium sulfate, $\text{Al}_2(\text{SO}_4)_3$.

3

Show your working clearly.

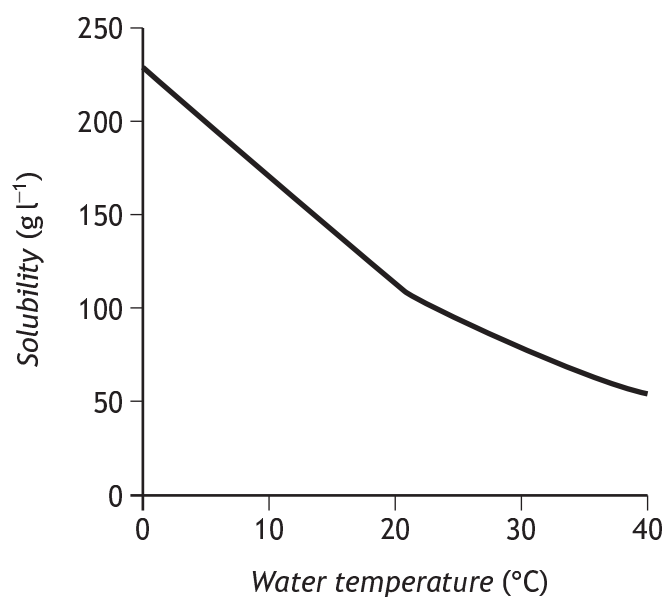


11. Sulfur dioxide is an important industrial chemical.
Sulfur dioxide dissolves in water to produce sulfurous acid.



- (a) Explain the change in the pH of the solution as sulfur dioxide dissolves. 2

- (b) The graph shows the solubility of sulfur dioxide at different temperatures.

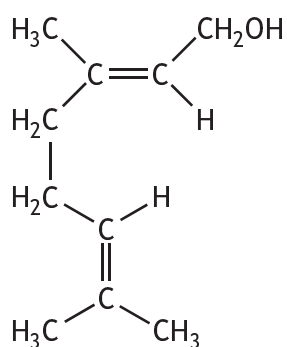


Describe the general trend in solubility as the temperature of the water increases. 1

[Turn over



12. Geraniol is an essential oil known to have anti-inflammatory properties. A structure for the geraniol molecule is shown.



- (a) Circle a functional group found in the geraniol molecule.
(An additional diagram, if required, can be found on *Page 28*.)

1

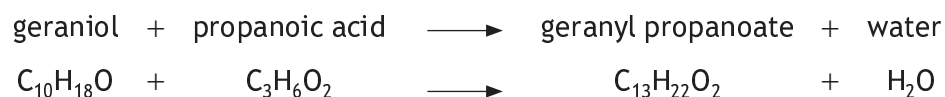


12. (continued)

- (b) One of the compounds used to flavour foods is geranyl propanoate.
Name the family to which geranyl propanoate belongs.

1

- (c) A student prepared a sample of geranyl propanoate from geraniol and propanoic acid.



15.4 g of geraniol was reacted with excess propanoic acid.

Calculate the mass, in grams, of geranyl propanoate which would be produced.

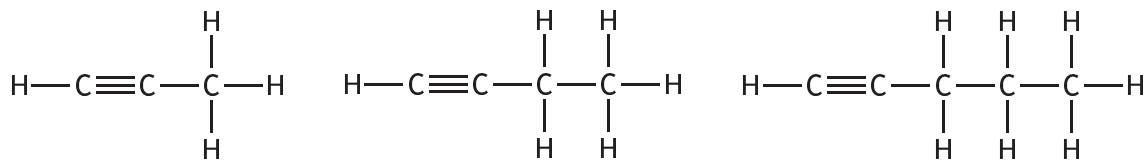
3

Show your working clearly.

[Turn over



13. The alkynes are a family of hydrocarbons which contain a carbon to carbon triple bond. Three members of this family are shown.



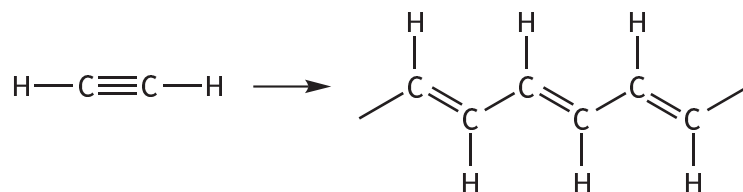
propyne

but-1-yne

pent-1-yne

- (a) Suggest a general formula for the alkyne family. 1

- (b) Ethyne can undergo polymerisation to form poly(ethyne).



- (i) Draw the repeating unit in the polymer poly(ethyne). 1

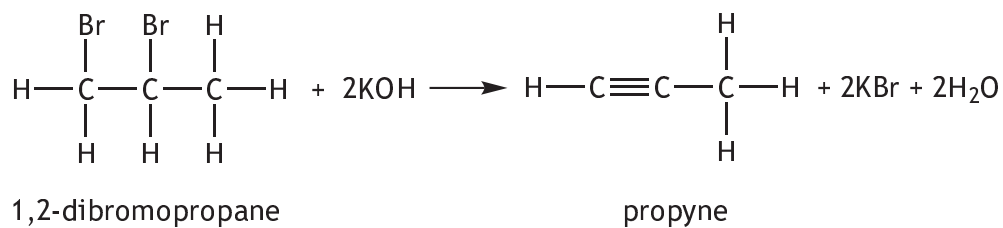
- (ii) Name the type of polymerisation taking place when ethyne is converted to poly(ethyne). 1



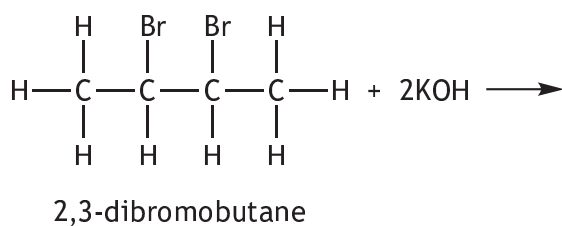
13. (continued)

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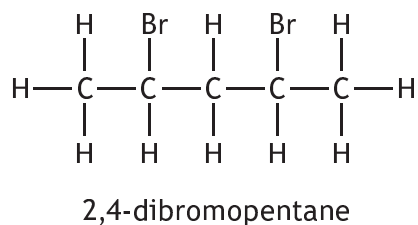
- (c) Alkynes can be prepared by reacting a dibromoalkane with potassium hydroxide solution.



- (i) Draw the **full** structural formula for the alkyne formed when 2,3-dibromobutane reacts with potassium hydroxide. 1



- (ii) The structure for 2,4-dibromopentane is shown below.



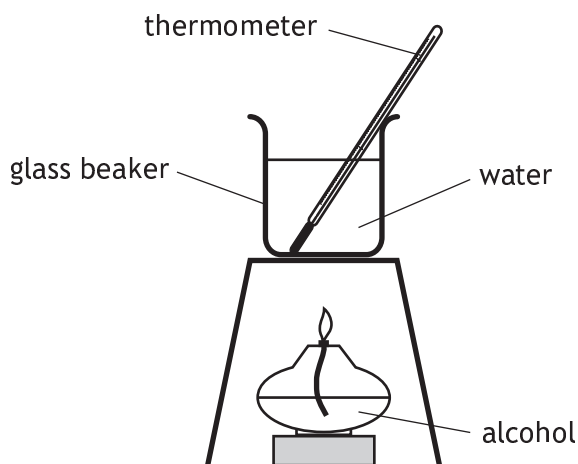
- Suggest a reason why 2,4-dibromopentane does **not** form an alkyne when it is added to potassium hydroxide solution. 1

[Turn over



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

14. (a) A group of students carried out an experiment to measure the energy produced when 5 g samples of different alcohols were burned.



The results are shown.

<i>Alcohol</i>	<i>Energy released (kJ)</i>
propan-1-ol	158
butan-1-ol	170
pentan-1-ol	179
hexan-1-ol	185

- (i) Draw a structural formula for hexan-1-ol.

1

- (ii) Predict the energy released, in kJ, if the same mass of heptan-1-ol was burned.

1



14. (continued)

- (b) The energy released when an alcohol burns can be used to heat liquids other than water.

The data below was collected when the energy released, by burning an alcohol, was used to heat a sodium chloride solution.

Energy released when the alcohol was burned (kJ)	13.3
Initial temperature of sodium chloride solution (°C)	15
Final temperature of sodium chloride solution (°C)	49
Mass of sodium chloride solution heated (g)	100

Calculate the specific heat capacity, in $\text{kJ kg}^{-1} \text{°C}^{-1}$, of the sodium chloride solution.

3

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

Show your working clearly.

[Turn over for next question



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

MARKS

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15. A student was given two solutions of sodium carbonate, one solution with a concentration of 0.1 mol l^{-1} and the other with a concentration of 0.2 mol l^{-1} .
Using your knowledge of chemistry, suggest how the student could distinguish between the solutions.

3

[END OF QUESTION PAPER]



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

Specimen

SECTION 1 — 25 marks

Attempt ALL questions

1. Which of the following elements usually exists as diatomic molecules?

- A Helium
- B Nitrogen
- C Silicon
- D Sulfur

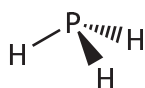
2. Which line in the table correctly describes a proton?

	Mass (atomic mass units)	Charge
A	negligible	+1
B	negligible	-1
C	1	+1
D	1	0

3. Ionic compounds conduct electricity when molten because they have

- A ions that are free to move
- B delocalised electrons
- C metal atoms
- D a lattice structure.

4. A molecule of phosphine is shown below.



The shape of a molecule of phosphine is

- A linear
- B angular
- C tetrahedral
- D trigonal pyramidal.

5. The table gives information about some particles.
Identify the particle which is a negative ion.

<i>Particle</i>	<i>Number of</i>		
	<i>protons</i>	<i>neutrons</i>	<i>electrons</i>
A	9	10	10
B	11	12	11
C	15	16	15
D	19	20	18

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

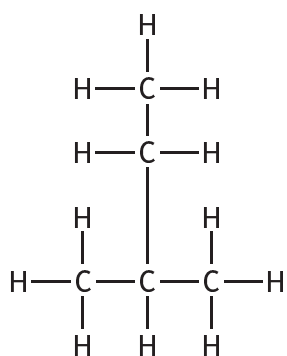
<i>Compound</i>	<i>Colour</i>
copper nitrate	blue
copper chromate	green
strontium nitrate	colourless
strontium chromate	yellow

The colour of the chromate ion is

- A blue
B green
C colourless
D yellow.
7. Which of the following statements correctly describes the concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions in pure water?
- A The concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions are equal.
B The concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions are zero.
C The concentration of $\text{H}^+(\text{aq})$ ions is greater than the concentration of $\text{OH}^-(\text{aq})$ ions.
D The concentration of $\text{H}^+(\text{aq})$ ions is less than the concentration of $\text{OH}^-(\text{aq})$ ions.

[Turn over

8.



The name of the above compound is

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

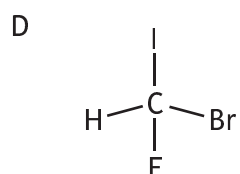
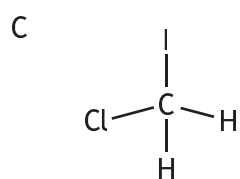
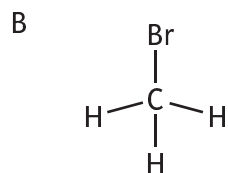
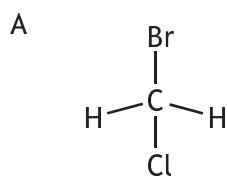
9. Which of the following could be the molecular formula for a cycloalkane?

- A C_6H_8
- B C_6H_{10}
- C C_6H_{12}
- D C_6H_{14}

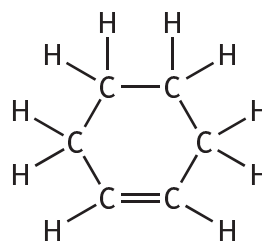
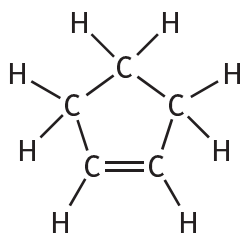
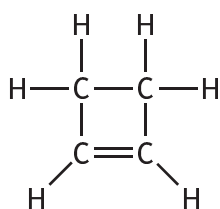
10. In which of the following types of reaction is oxygen a reactant?

- A Combustion
- B Neutralisation
- C Polymerisation
- D Precipitation

11. Molecules in which four different atoms are attached to a carbon atom are said to be chiral. Which of the following molecules is chiral?



12. Three members of the cycloalkene family are



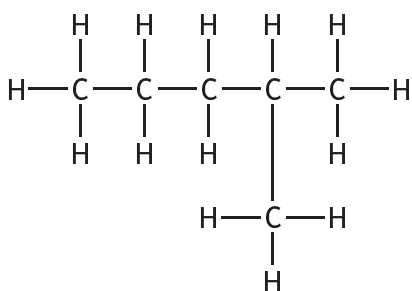
The general formula for the cycloalkene family is

- A $\text{C}_n\text{H}_{2n-2}$
- B $\text{C}_n\text{H}_{2n-4}$
- C C_nH_{2n}
- D $\text{C}_n\text{H}_{2n+2}$

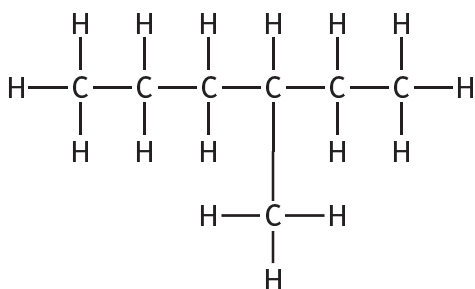
[Turn over

13. Which of the following molecules is an isomer of hept-2-ene?

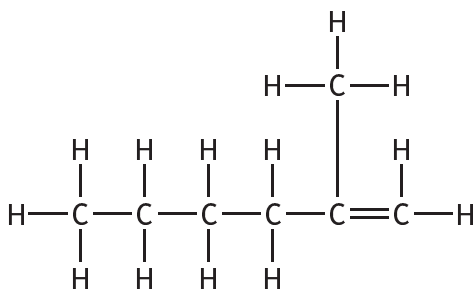
A



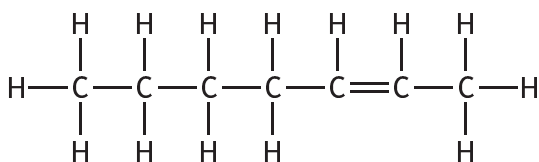
B



C



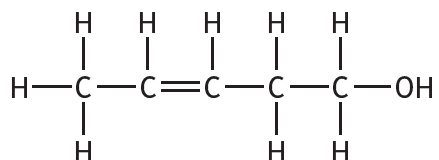
D



14. A student tested some compounds. The results are given in the table.

<i>Compound</i>	<i>pH of aqueous solution</i>	<i>Effect on bromine solution</i>
$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{C} \\ \quad \quad // \\ \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \quad \backslash \\ \quad \quad \quad \text{OH} \end{array} $	4	no effect
$ \begin{array}{c} \text{H} \quad \quad \text{O} \\ \quad \quad // \\ \text{H}-\text{C}=\text{C}-\text{C} \\ \quad \quad \backslash \\ \text{H} \quad \text{H} \quad \text{OH} \end{array} $	4	decolourised
$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{OH} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $	7	no effect
$ \begin{array}{c} \quad \quad \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}=\text{C}-\text{C}-\text{OH} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $	7	decolourised

Which line in the table below shows the correct results for the following compound?

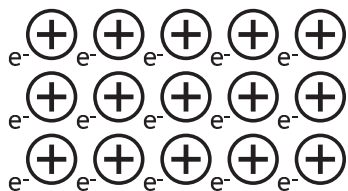


	<i>pH of aqueous solution</i>	<i>Effect on bromine solution</i>
A	4	decolourised
B	7	decolourised
C	4	no effect
D	7	no effect

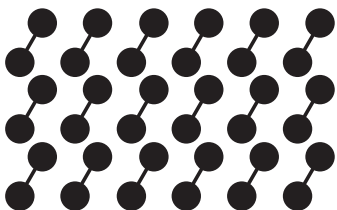
[Turn over

15. Which of the following diagrams could be used to represent the structure of a metal?

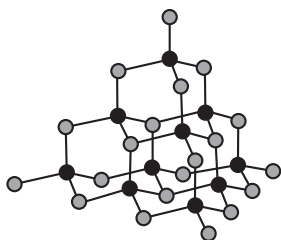
A



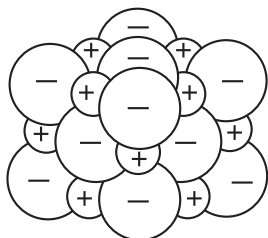
B



C



D



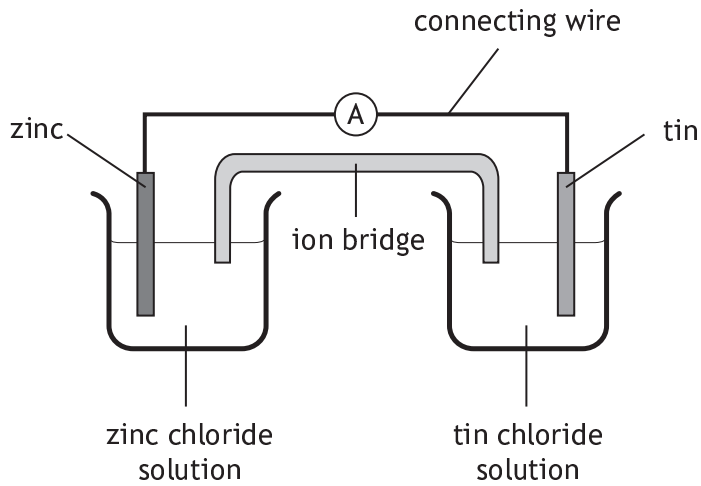
16. Which of the following substances does **not** produce water when it reacts with dilute acid?

- A Sodium hydroxide
- B Magnesium
- C Copper oxide
- D Ammonia solution

17. Which of the following metals can be extracted from its oxide by heat alone?

- A Aluminium
- B Zinc
- C Gold
- D Iron

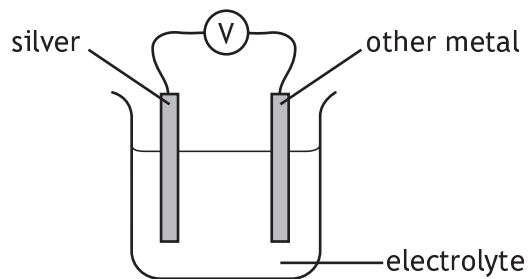
18.



In the cell shown above, electrons flow through

- A the solution from tin to zinc
- B the solution from zinc to tin
- C the connecting wire from tin to zinc
- D the connecting wire from zinc to tin.

19. Four cells were made by joining silver to copper, iron, tin and zinc.



The voltages for the four cells are shown in the table.

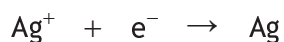
Which cell contained silver joined to copper?

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

Cell	Voltage (V)
A	1.6
B	1.2
C	0.9
D	0.5

[Turn over

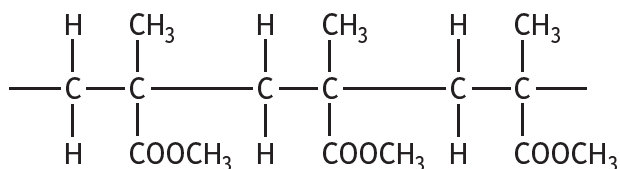
20. The ion-electron equation for the oxidation and reduction steps in the reaction between magnesium and silver(I) ions are:



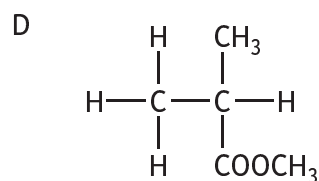
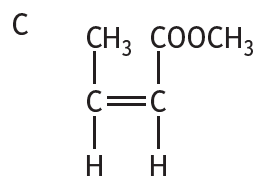
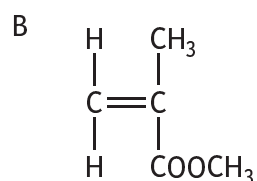
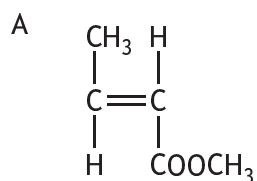
The overall redox equation is

- A $\text{Mg} + 2\text{Ag}^{+} \rightarrow \text{Mg}^{2+} + 2\text{Ag}$
 B $\text{Mg} + \text{Ag}^{+} \rightarrow \text{Mg}^{2+} + \text{Ag}$
 C $\text{Mg} + \text{Ag}^{+} + \text{e}^{-} \rightarrow \text{Mg}^{2+} + \text{Ag} + 2\text{e}^{-}$
 D $\text{Mg} + 2\text{Ag} \rightarrow \text{Mg}^{2+} + 2\text{Ag}^{+}$.

21. The structure below shows a section of an addition polymer.



Which of the following molecules is used to make this polymer?



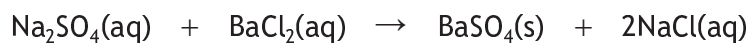
22. Hydrogen gas

- A burns with a pop
- B relights a glowing splint
- C turns damp pH paper red
- D turns limewater cloudy.

23. What is the charge on an iron ion in $\text{Fe}_2(\text{SO}_4)_3$?

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

24. Sodium sulfate solution reacts with barium chloride solution.



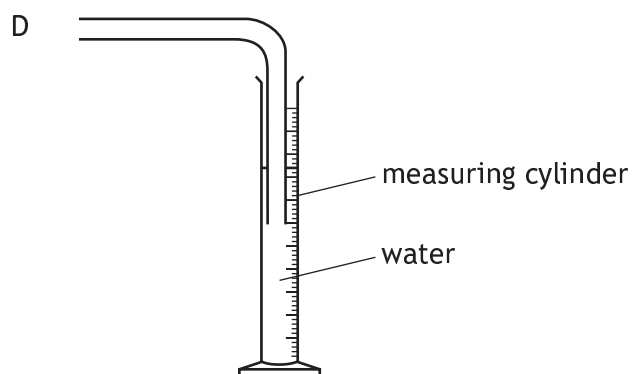
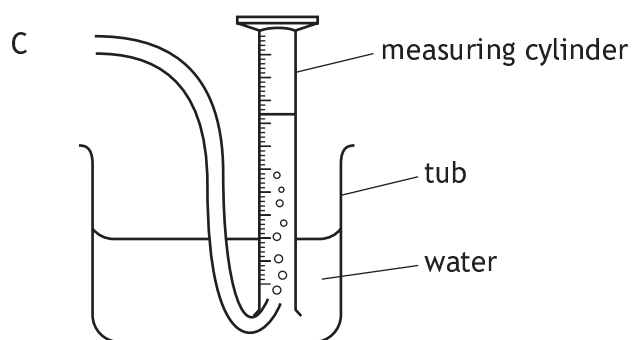
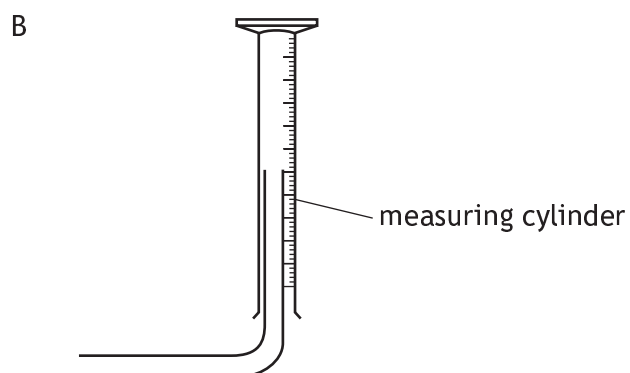
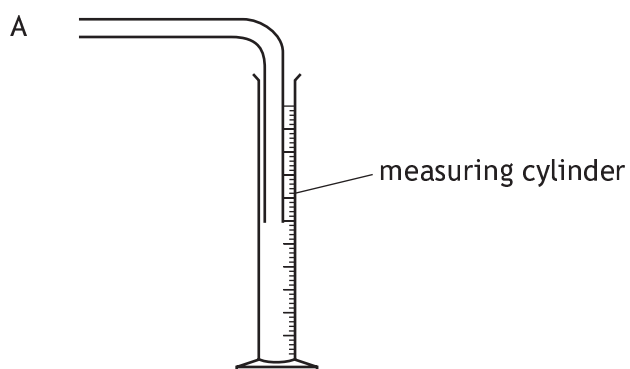
The spectator ions present in this reaction are

- A Ba^{2+} and Cl^-
- B Ba^{2+} and SO_4^{2-}
- C Na^+ and Cl^-
- D Na^+ and SO_4^{2-}

[Turn over

25. But-1-ene is a colourless, insoluble gas which is more dense than air but less dense than water.

Which of the following diagrams shows the most appropriate apparatus for collecting and measuring the volume of but-1-ene?



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

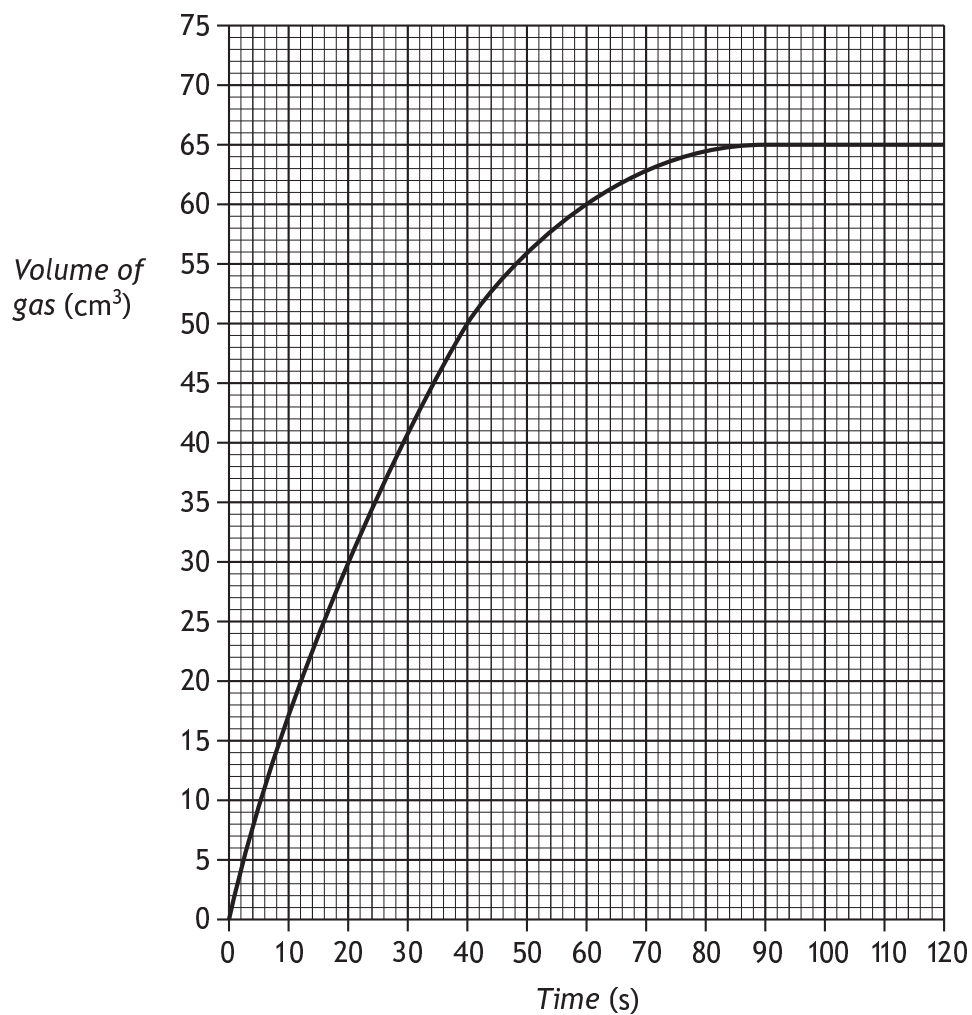
SECTION 2 — 75 marks

Attempt ALL questions

MARKS
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1. Graphs can be used to show the change in the rate of a reaction as the reaction proceeds.

The graph shows the volume of gas produced in an experiment over a period of time.



- (a) State the time, in seconds, at which the reaction stopped.

1

[Turn over



MARKS

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1. (continued)

(b) Calculate the average rate of reaction for the first 20 seconds.

3

Your answer must include the appropriate unit.

Show your working clearly.

(c) The graph shows that the rate of reaction decreases as the reaction proceeds.

1

Suggest a reason for this decrease.



* S 8 1 3 7 5 0 1 0 6 *

2. The group 7 element bromine was discovered by Balard in 1826.
Bromine gets its name from the Greek “bromos” meaning stench.

A sample of bromine consists of a mixture of two isotopes, ${}^{79}_{35}\text{Br}$ and ${}^{81}_{35}\text{Br}$.

(a) State what is meant by the term isotope. 1

(b) Complete the table for ${}^{79}_{35}\text{Br}$. 1

<i>Isotope</i>	<i>Number of protons</i>	<i>Number of neutrons</i>
${}^{79}_{35}\text{Br}$		

(c) The sample of bromine has an average atomic mass of 80.
Suggest what this indicates about the amount of each isotope in this sample. 1

[Turn over



2. (continued)

- (d) In 1825 bromine had been isolated from sea water by Liebig who mistakenly thought it was a compound of iodine and chlorine.

Using your knowledge of chemistry, comment on why Liebig might have made this mistake.

3



* S 8 1 3 7 5 0 1 0 8 *

3. Antacid tablets are used to treat indigestion which is caused by excess acid in the stomach.

Different brands of tablets contain different active ingredients.

<i>Name of active ingredient</i>	magnesium carbonate	calcium carbonate	magnesium hydroxide	aluminium hydroxide
<i>Reaction with acid</i>	fizzes	fizzes	does not fizz	does not fizz
<i>Cost per gram (pence)</i>	16	11	7.5	22
<i>Mass of solid needed to neutralise 20 cm³ of acid (g)</i>	0.7	1.2	0.6	0.4
<i>Cost of neutralising 20 cm³ of acid (pence)</i>		13.2	4.5	8.8

- (a) Write the formula, showing the charge on each ion, for aluminium hydroxide. 1
- (b) (i) Complete the table to show the cost of using magnesium carbonate to neutralise 20 cm³ of acid. 1
- (ii) Using information from the table, state which **one** of the four active ingredients **you** would use to neutralise excess stomach acid. Explain your choice. 1

[Turn over



4. Sulfur dioxide gas is produced when fossil fuels containing sulfur are burned.

(a) When sulfur dioxide dissolves in water in the atmosphere “acid rain” is produced.

Circle the correct phrase to complete the sentence.

Compared with pure water, acid rain contains $\left. \begin{array}{l} \text{a higher} \\ \text{a lower} \\ \text{the same} \end{array} \right\}$ concentration of hydrogen ions.

1

(b) The table gives information about the solubility of sulfur dioxide.

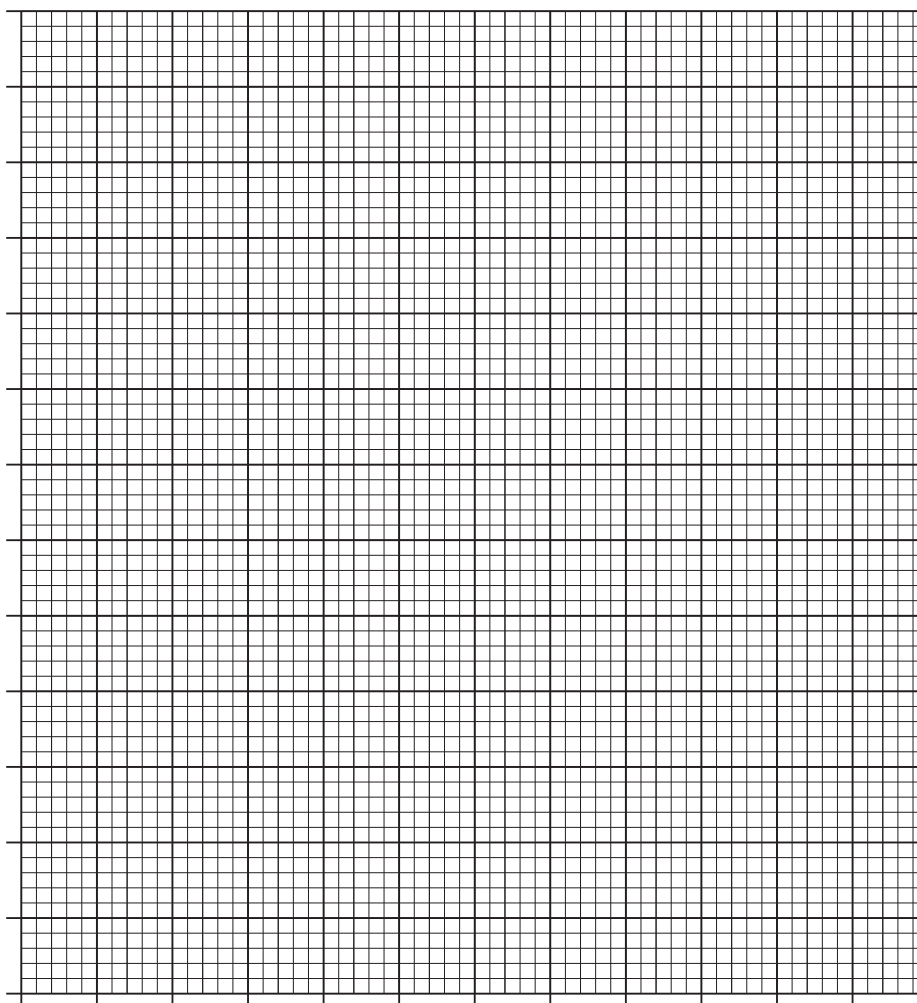
Temperature (°C)	18	24	30	36	42	48
Solubility (g/100 cm ³)	11.2	9.2	7.8	6.5	5.5	4.7

(i) Draw a graph of solubility against temperature.

Use appropriate scales to fill most of the graph paper.

(Additional graph paper, if required, can be found on page 28.)

4



MARKS

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4. (b) (continued)

(ii) Estimate the solubility of sulfur dioxide, in g/100 cm³, at 21 °C.

1

[Turn over



* S 8 1 3 7 5 0 1 1 1 *

5. A student investigated the reaction of carbonates with dilute hydrochloric acid.

(a) In one reaction lithium carbonate reacted with dilute hydrochloric acid.

The equation for the reaction is:



(i) Balance this equation.

1

(ii) Identify the salt produced in this reaction.

1

(b) In another reaction 1.0 g of calcium carbonate reacted with excess dilute hydrochloric acid.



(i) Calculate the mass, in grams, of carbon dioxide produced.

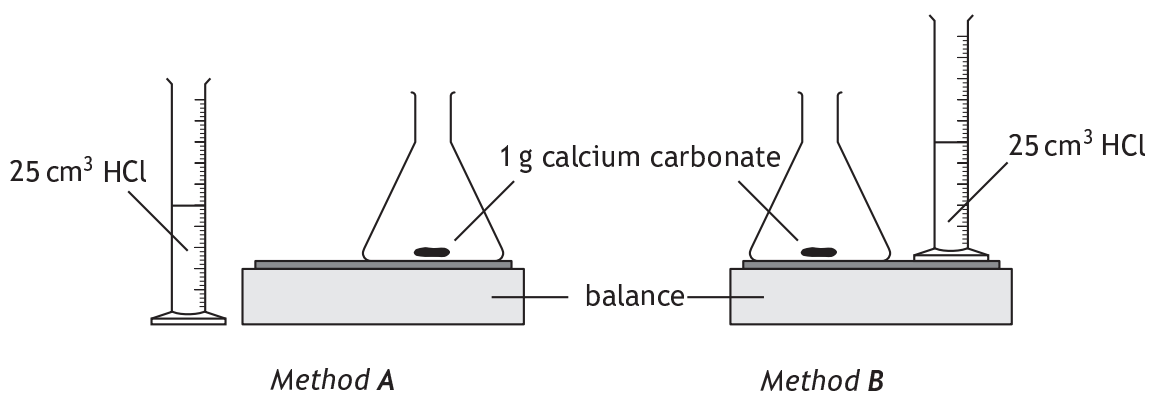
3

Show your working clearly.



5. (b) (continued)

(ii) The student considered two methods to confirm the mass of carbon dioxide gas produced in this reaction.



Method A	Method B
1. Add the acid from the measuring cylinder to the calcium carbonate in the flask.	1. Weigh the flask with the calcium carbonate and the acid in the measuring cylinder together.
2. Weigh the flask and contents.	2. Add the acid from the measuring cylinder to the calcium carbonate in the flask and replace the empty measuring cylinder on the balance.
3. Leave until no more bubbles are produced.	3. Leave until no more bubbles are produced.
4. Reweigh the flask and contents.	4. Reweigh the flask, contents and the empty measuring cylinder together.

Explain which method would give a more reliable estimate of the mass of carbon dioxide produced during the reaction.

2

[Turn over



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

Potassium Permanganate (KMnO₄)

Potassium permanganate's strong oxidising properties make it an effective disinfectant. Complaints such as athlete's foot and some fungal infections are treated by bathing the affected area in KMnO₄ solution.

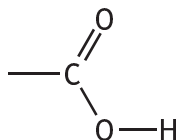
In warm climates vegetables are washed in KMnO₄ to kill bacteria such as *E. coli*. Chemists use KMnO₄ in the manufacture of saccharin and benzoic acid.

Baeyer's reagent is an alkaline solution of KMnO₄ and is used to detect unsaturated organic compounds. The reaction of KMnO₄ with alkenes is also used to extend the shelf life of fruit. Ripening fruit releases ethene gas which causes other fruit to ripen. Shipping containers are fitted with gas scrubbers that use alumina or zeolite impregnated with KMnO₄ to stop the fruit ripening too quickly.



Adapted from an article by Simon Cotton on "Soundbite molecules" in "Education in Chemistry" November 2009.

- (a) Suggest an experimental test, including the result, to show that potassium is present in potassium permanganate. 1
 You may wish to use the data booklet to help you.
- (b) Suggest a pH for Baeyer's reagent. 1
- (c) Name the gas removed by the scrubbers. 1
- (d) Name a chemical mentioned in the passage which contains the following functional group. 1



- (e) Zeolite is a substance that contains aluminium silicate. 1
 Name the elements present in aluminium silicate.



7. In the 2012 London Olympics, alkanes were used as fuels for the Olympic flame.

(a) The torches that carried the Olympic flame across Britain burned a mixture of propane and butane.

Propane and butane are members of the same homologous series.

State what is meant by the term homologous series.

1

(b) Natural gas, which is mainly methane, was used to fuel the flame in the Olympic cauldron.

(i) Draw a diagram to show how **all** the outer electrons are arranged in a molecule of methane, CH₄.

1

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

Explain why methane is a gas at room temperature.

2

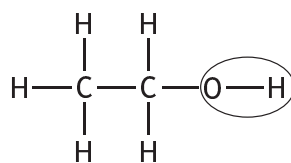
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* S 8 1 3 7 5 0 1 1 5 *

8. Car manufacturers have developed vehicles that use ethanol as fuel.

(a) The structure of ethanol is shown below.



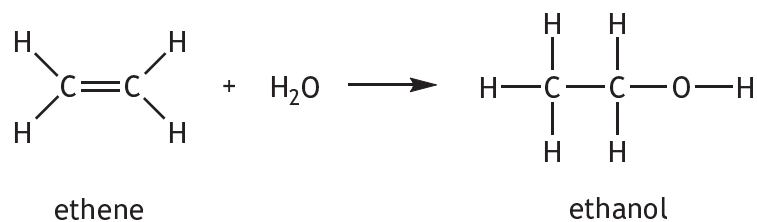
Name the functional group circled in the diagram.

1

(b) Name the two substances produced when ethanol burns in a plentiful supply of oxygen.

1

(c) Ethanol can be produced from ethene as shown.



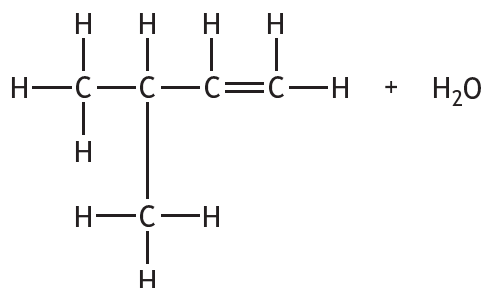
(i) Name the **type** of chemical reaction taking place.

1



8. (c) (continued)

(ii) Draw a structural formula for a product of the following reaction. 1



(d) Ethanol can be used to produce ethanoic acid.

(i) Draw a structural formula for ethanoic acid. 1

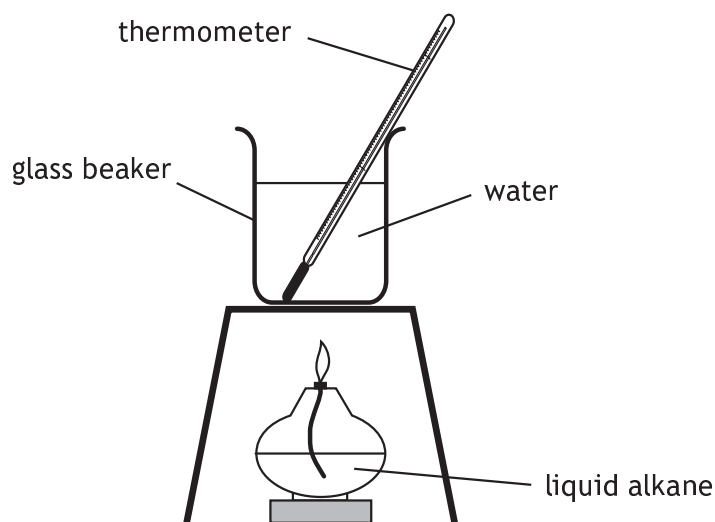
(ii) Name the family of compounds to which ethanoic acid belongs. 1

[Turn over



9. Alkanes burn, releasing heat energy.
- (a) State the term used to describe all chemical reactions that release heat energy.
- (b) A student investigated the amount of energy released when an alkane burns using the apparatus shown.

1



The student recorded the following data.

Mass of alkane burned	1 g
Volume of water	200 cm ³
Initial temperature of water	15 °C
Final temperature of water	55 °C

- (i) Calculate the energy released, in kJ.
Show your working clearly.

3



9. (b) (continued)

(ii) Suggest **one** improvement to the student's investigation.

1

(c) The table gives information about the amount of energy released when one mole of some alkanes are burned.

<i>Name of alkane</i>	<i>Energy released when one mole of alkane is burned (kJ)</i>
methane	891
ethane	1561
propane	2219
butane	2878

(i) Write a statement linking the amount of energy released to the number of carbon atoms in the alkane molecule.

1

(ii) Predict the amount of heat released, in kJ, when one mole of pentane is burned.

1

[Turn over



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

(a) Essential oils contain compounds made up of a number of isoprene molecules joined together.

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

Draw the full structural formula for isoprene.

1

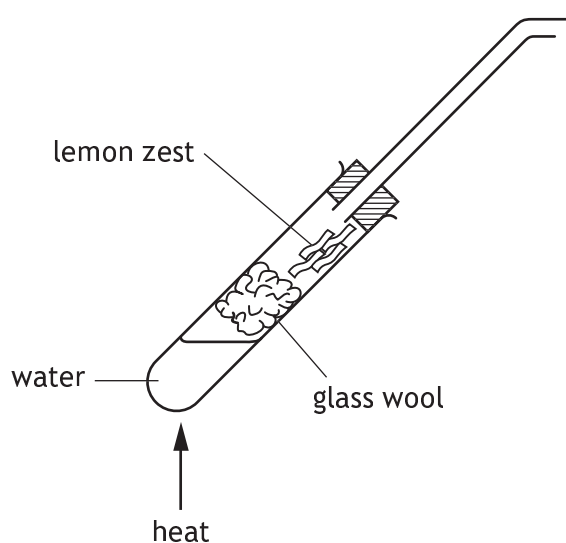
(b) Essential oils can be extracted from the zest of lemons in the laboratory by steam distillation.

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 essential oils into the 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 needed to collect the essential oils.

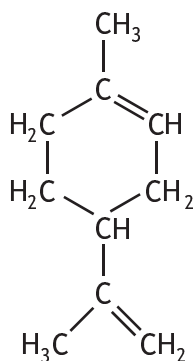
1

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



10. (continued)

(c) Limonene, $C_{10}H_{16}$, is a compound found in lemon zest.



Write the molecular formula for the product formed when limonene reacts completely with bromine solution.

1

[Turn over

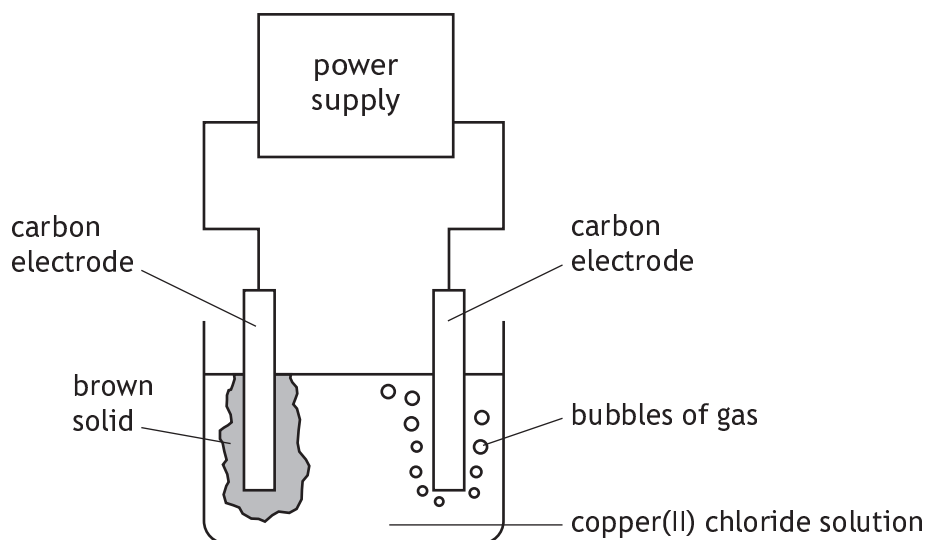


11. Metals can be extracted from metal compounds by electrolysis.

(a) During electrolysis, metal ions are changed to metal atoms.
Name this type of chemical reaction.

1

(b) A student set up the following experiment to electrolyse copper(II) chloride solution.



(i) Name the type of power supply that **must** be used to electrolyse the solution.

1

(ii) Complete the table by adding the charge on each electrode.

1

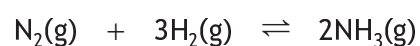
<i>Observation at the</i> _____ <i>electrode</i>	<i>Observation at the</i> _____ <i>electrode</i>
brown solid formed	bubbles of gas

12. Urea, H_2NCONH_2 , can be used as a fertiliser.

(a) Calculate the percentage of nitrogen in urea.

3

(b) Other nitrogen based fertilisers can be produced from ammonia. Ammonia is produced in an industrial process using a catalyst.



(i) Name the industrial process that produces ammonia.

1

(ii) Suggest why a catalyst may be used in an industrial process.

1

(c) In another industrial process, ammonia is used to produce nitric acid. Name the catalyst used in this process.

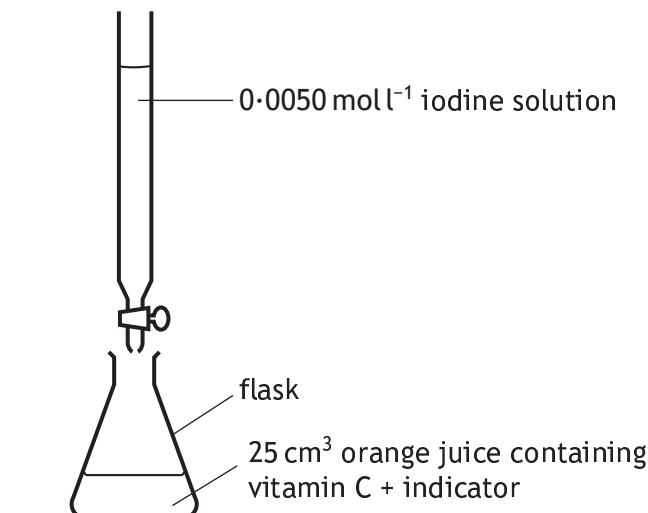
1

[Turn over



13. Vitamin C is found in fruits and vegetables.

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

The results of the experiments are shown.

<i>Experiment</i>	<i>Initial volume of iodine solution (cm³)</i>	<i>Final volume of iodine solution (cm³)</i>	<i>Volume of iodine solution added (cm³)</i>
1	1.2	18.0	16.8
2	18.0	33.9	15.9
3	0.5	16.6	16.1

(a) (i) Name the piece of apparatus used to measure the volume of iodine solution added to the orange juice. 1

(ii) Calculate the average volume, in cm³, of iodine solution that should be used in calculating the concentration of vitamin C. 1

Show your working clearly.

(b) Name the experimental method, carried out by the student, to accurately determine the concentration of vitamin C in the orange juice. 1



14. In medicine, technetium-99m is injected into the body to detect damage to heart tissue.

It is a gamma-emitting radioisotope with a half-life of 6 hours.

(a) A sample of technetium-99m has a mass of 2 g.

Calculate the mass, in grams, of technetium-99m that would be left after 12 hours.

2

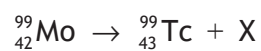
Show your working clearly.

(b) Suggest one reason why technetium-99m can be used safely in this way.

1

(c) Technetium-99m is formed when molybdenum-99 decays.

The decay equation is:



Identify X.

1

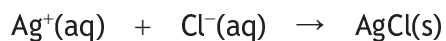
[Turn over



15. The concentration of chloride ions in water affects the ability of some plants to grow.

A student investigated the concentration of chloride ions in the water at various points along the river Tay.

The concentration of chloride ions in water can be determined by reacting the chloride ions with silver ions.



A 20 cm³ water sample gave a precipitate of silver chloride with a mass of 1.435 g.

- (a) Calculate the number of moles of silver chloride, AgCl, present in this sample.

2

- (b) Using your answer to part (a), calculate the concentration, in mol l⁻¹, of chloride ions in this sample.

2



16. Nitrogen, phosphorus and potassium are elements essential for plant growth. A student was asked to prepare a dry sample of a compound which contained **two** of these elements. The student was given access to laboratory equipment and the following chemicals.

<i>Chemical</i>	<i>Formula</i>
ammonium hydroxide	NH ₄ OH
magnesium nitrate	Mg(NO ₃) ₂
nitric acid	HNO ₃
phosphoric acid	H ₃ PO ₄
potassium carbonate	K ₂ CO ₃
potassium hydroxide	KOH
sodium hydroxide	NaOH
sulfuric acid	H ₂ SO ₄
water	H ₂ O

Using your knowledge of chemistry, comment on how the student could prepare their dry sample.

3

[END OF SPECIMEN QUESTION PAPER]



* S 8 1 3 7 5 0 1 2 7 *

2018

SECTION 1 — 25 marks

Attempt ALL questions

1. Which of the following changes would **not** speed up a chemical reaction?

- A Increasing the particle size
- B Increasing the temperature
- C Increasing the concentration
- D Addition of a catalyst

2. Which line in the table identifies the correct location of a proton and an electron in an atom?

	<i>Proton</i>	<i>Electron</i>
A	inside the nucleus	inside the nucleus
B	inside the nucleus	outside the nucleus
C	outside the nucleus	outside the nucleus
D	outside the nucleus	inside the nucleus

3. Which of the following elements does **not** exist as diatomic molecules?

- A Oxygen
- B Helium
- C Bromine
- D Hydrogen

4. The shapes of some molecules are shown below.



tetrahedral



trigonal
pyramidal



angular



linear

The shape of a molecule of hydrogen bromide is likely to be

- A tetrahedral
- B trigonal pyramidal
- C angular
- D linear.

5. Which of the following elements forms an ion with a single positive charge and an electron arrangement of 2,8?

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

- A Sodium
- B Magnesium
- C Fluorine
- D Neon

6. Which line in the table shows the properties of a covalent network compound?

	Melting point (°C)	Boiling point (°C)	Conducts electricity	
			Solid	Liquid
A	-127	-100	no	no
B	795	1410	no	yes
C	30	2204	yes	yes
D	2700	3350	no	no

7. 0.1 mol of sodium hydroxide was dissolved in water and the solution made up to 250 cm³. What is the concentration, in mol l⁻¹, of the sodium hydroxide solution?

- A 0.0004
- B 0.025
- C 0.4
- D 2.5

8. An alkaline solution contains

- A only hydroxide ions
- B more hydroxide ions than hydrogen ions
- C more hydrogen ions than hydroxide ions
- D equal numbers of hydrogen ions and hydroxide ions.

[Turn over

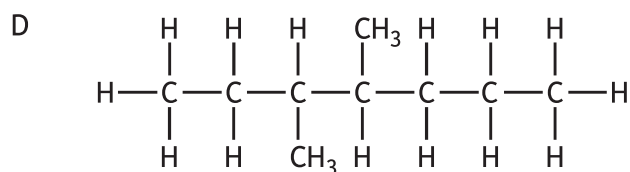
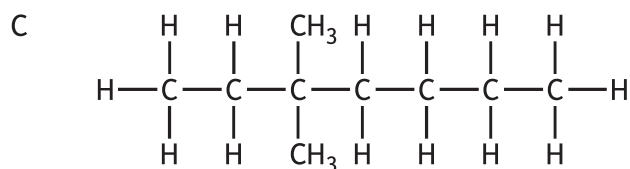
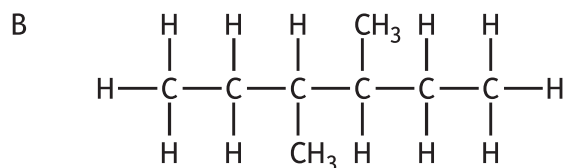
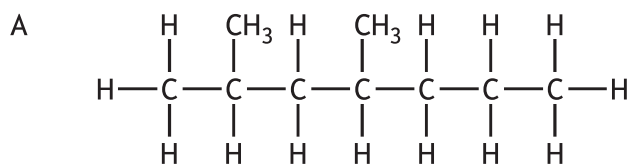
9. A student made some statements about the effect of adding water to an acidic solution. Identify the correct statement.

- A The pH of the solution will remain the same.
- B The pH of the solution will decrease.
- C The hydrogen ion concentration will decrease.
- D The hydrogen ion concentration will increase.

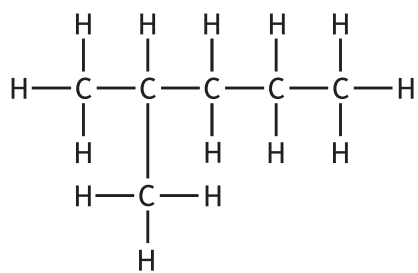
10. The shortened structural formula for a compound is



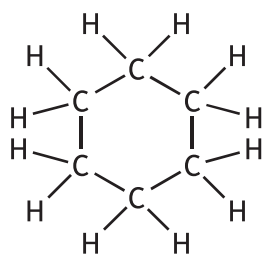
Which of the following is another way of representing this structure?



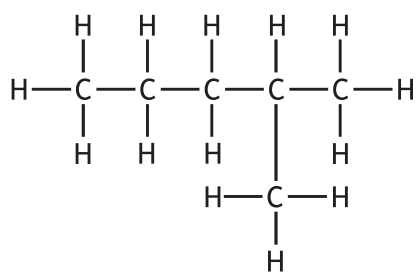
11. Identify which of the following is an isomer of



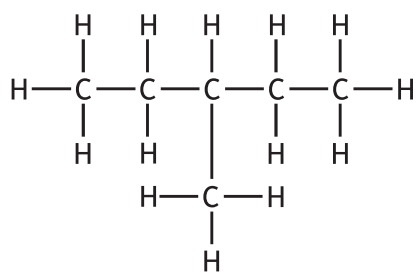
A



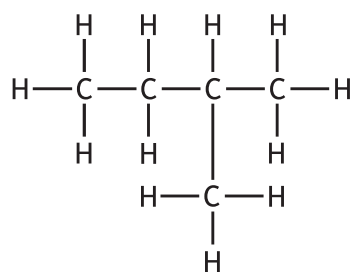
B



C



D

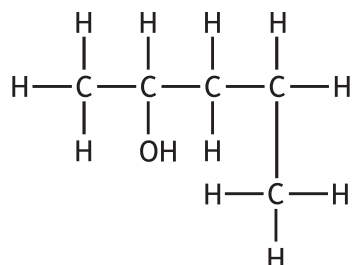


[Turn over

12. Which of the following reactions takes place when an alcohol is formed from an alkene?

- A Hydrogenation
- B Combustion
- C Hydration
- D Reduction

13.



The systematic name for the above compound is

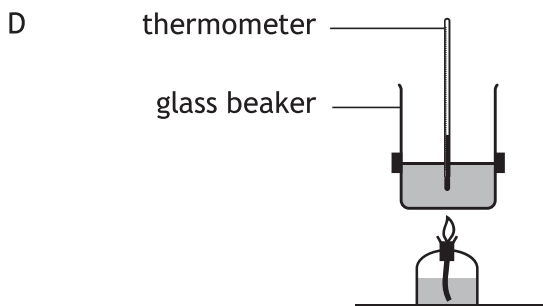
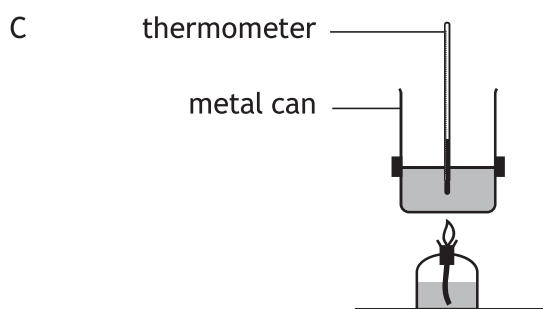
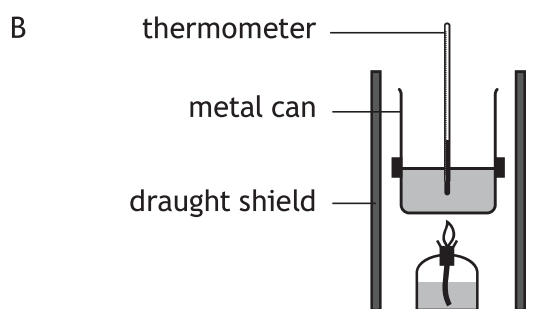
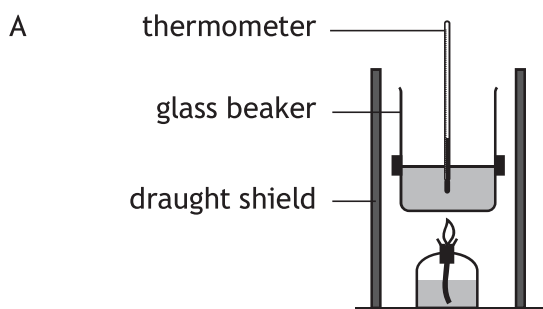
- A pentan-2-ol
- B pentan-4-ol
- C 1-methylbutan-3-ol
- D 4-methylbutan-2-ol.

14. Which of the following alcohols is the least soluble in water?

- A Butan-1-ol
- B Hexan-1-ol
- C Pentan-1-ol
- D Propan-1-ol

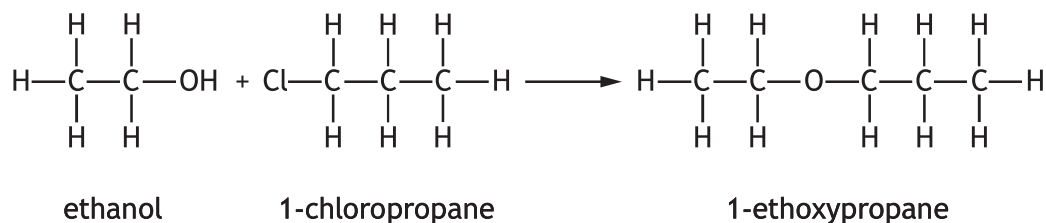
15. A student set up an experiment to determine the quantity of energy released when a hydrocarbon burns.

Which of the following diagrams shows the apparatus which would produce the most accurate result?

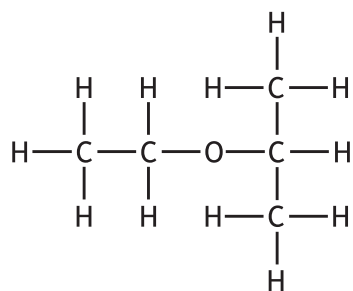


[Turn over

16. The ether, 1-ethoxypropane, can be made by the Williamson reaction.

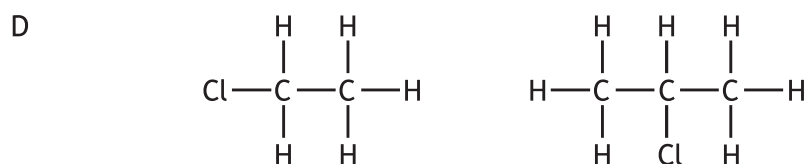
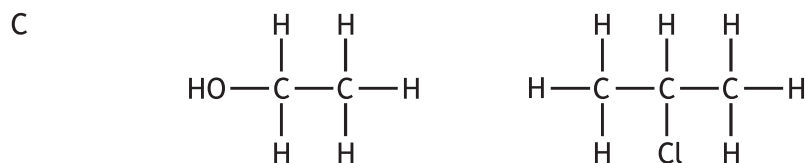
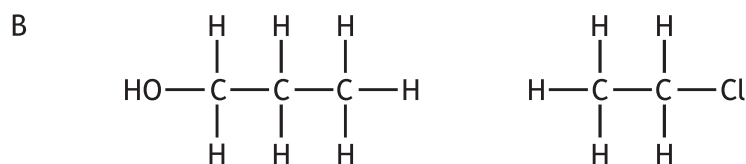
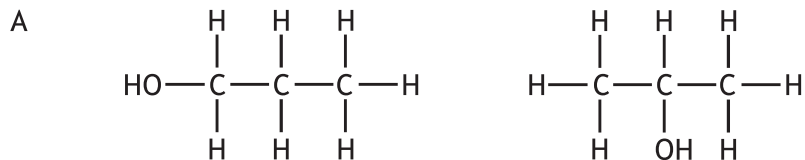


The structural formula for another ether is shown below.



2-ethoxypropane

Which of the following pairs of compounds would react together to produce 2-ethoxypropane?



17. Information about the reactions of four different metals, W, X, Y and Z is given in the table.

<i>Metal</i>	<i>Reaction with dilute acid</i>	<i>Reaction with water</i>
W	moderate reaction	no reaction
X	fast reaction	slow reaction
Y	slow reaction	no reaction
Z	fast reaction	no reaction

The order of reactivity of the metals, starting with the most reactive is

- A X, Z, W, Y
- B Y, W, Z, X
- C Z, X, W, Y
- D Y, W, X, Z.

18. The ion-electron equations for the oxidation and reduction steps in the reaction between hydrogen and oxygen are given below.



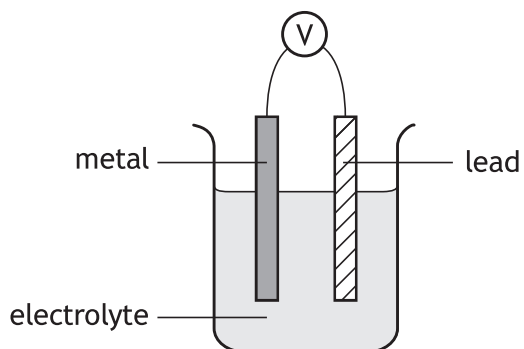
The redox equation for the overall reaction is

- A $\text{H}_2(\text{g}) + 2\text{H}_2\text{O}(\ell) + \text{O}_2(\text{g}) + 4\text{e}^- \rightarrow 2\text{H}^+(\text{aq}) + 4\text{OH}^-(\text{aq}) + 2\text{e}^-$
- B $2\text{H}_2(\text{g}) + 2\text{H}_2\text{O}(\ell) + \text{O}_2(\text{g}) \rightarrow 4\text{H}^+(\text{aq}) + 4\text{OH}^-(\text{aq})$
- C $\text{H}_2(\text{g}) + 2\text{H}_2\text{O}(\ell) + \text{O}_2(\text{g}) \rightarrow 2\text{H}^+(\text{aq}) + 4\text{OH}^-(\text{aq})$
- D $2\text{H}_2(\text{g}) + 2\text{H}_2\text{O}(\ell) + \text{O}_2(\text{g}) + 4\text{e}^- \rightarrow 4\text{H}^+(\text{aq}) + 4\text{OH}^-(\text{aq}) + 4\text{e}^-$

[Turn over

19. Which of the following metals, when connected to lead in a cell, would produce the highest reading on the voltmeter?

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



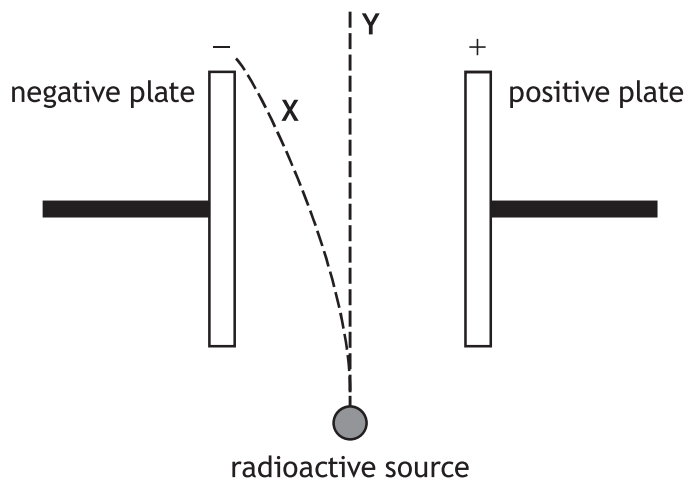
- A Zinc
 - B Tin
 - C Nickel
 - D Lead
20. Which of the following salts would **not** be used as a fertiliser?

- A Ammonium chloride
- B Ammonium phosphate
- C Sodium chloride
- D Sodium phosphate

21. Which metal is used as the catalyst in the industrial manufacture of ammonia?

- A Nickel
- B Platinum
- C Iron
- D Rhodium

22. The diagram shows the path of two different types of radiation as they pass through an electric field.



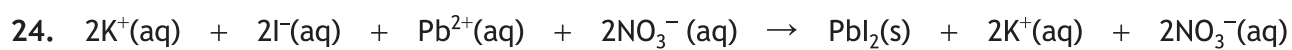
Which line in the table correctly identifies the types of radiation which follow paths X and Y?

	<i>Path X</i>	<i>Path Y</i>
A	alpha	beta
B	beta	alpha
C	beta	gamma
D	alpha	gamma

23. Metallic bonding is a force of attraction between

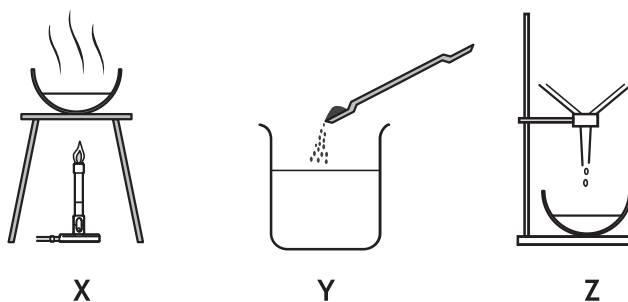
- A a shared pair of electrons and two nuclei
- B negative ions and delocalised electrons
- C negative ions and positive ions
- D positive ions and delocalised electrons.

[Turn over



The type of reaction represented by this equation is

- A neutralisation
 - B precipitation
 - C addition
 - D redox.
25. A student prepared a sample of copper sulfate crystals by reacting excess copper carbonate with acid.



Which line in the table shows the correct order in which this experiment would be carried out?

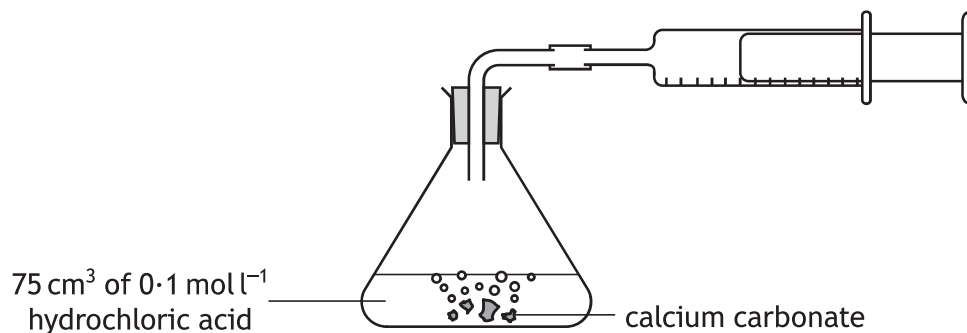
- A Y, X, Z
- B X, Y, Z
- C Z, Y, X
- D Y, Z, X

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

SECTION 2 — 75 marks

Attempt ALL questions

1. A student monitored the rate of reaction between excess calcium carbonate and dilute hydrochloric acid, HCl, using a gas syringe to collect the gas produced.



- (a) Name the gas produced in this reaction.

1

- (b) The student obtained the results shown.

<i>Time (s)</i>	0	10	20	40	50	60	70	80
<i>Volume of gas (cm³)</i>	0	48	62	74	77	79	80	80

- (i) Calculate the average rate of reaction between 20 and 50 seconds.

3

Your answer must include the appropriate unit.

Show your working clearly.



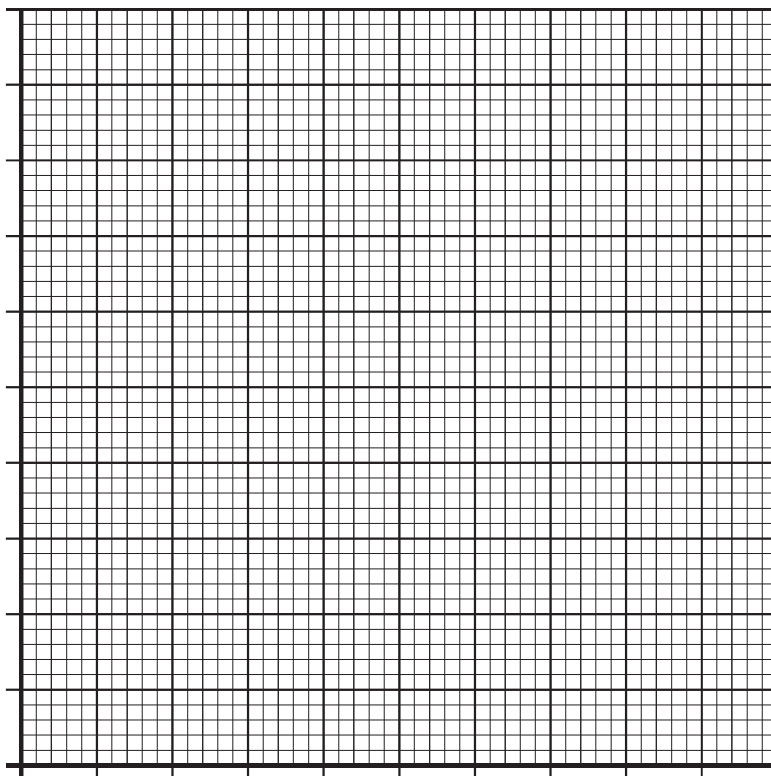
* X 8 1 3 7 5 0 1 0 6 *

1. (b) (continued)

(ii) Draw a graph of the student's results.

4

(Additional graph paper, if required, can be found on page 33).



(iii) Using your graph, estimate the volume of gas, in cm^3 , produced at 30 seconds.

1

(c) The student carried out a similar experiment using 75 cm^3 of 0.1 mol l^{-1} sulfuric acid, $\text{H}_2\text{SO}_4(\text{aq})$.

The total volume of gas collected was 160 cm^3 .

Explain why there was a greater volume of gas produced.

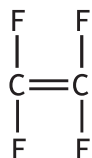
1



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

2. The retractable roof on Centre Court at Wimbledon Tennis Club is made of the polymer poly(tetrafluoroethene), PTFE.

(a) The monomer used to produce PTFE has the following structure.

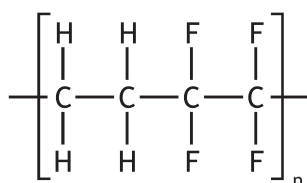


tetrafluoroethene

(i) Name the type of polymerisation used to produce PTFE. 1

(ii) Draw a section of poly(tetrafluoroethene) showing three monomer units joined together. 1

(b) The roof of the O₂ Arena in London is made from a co-polymer. A co-polymer is formed when two different monomers polymerise. The repeating unit of the co-polymer is shown.



One of the monomers in this co-polymer is tetrafluoroethene. Draw the full structural formula for the other monomer. 1



3. Coal is a fuel that contains carbon. Different types of coal contain different percentages of carbon.

Heat content is a measure of how much heat energy is released when coal is burned.

- (a) The table gives information about types of coal.

<i>Type of coal</i>	<i>Percentage of carbon</i>	<i>Average heat content (kJ kg⁻¹)</i>
Anthracite	86 - 98	32 500
Bituminous	45 - 85	27 850
Sub-bituminous	35 - 44	25 550
Lignite	25 - 34	13 950

Describe how the percentage of carbon in coal affects the average heat content.

1

- (b) Iron pyrite, FeS₂, is an impurity found in coal.
Calculate the percentage of iron in iron pyrite.
Show your working clearly.

3

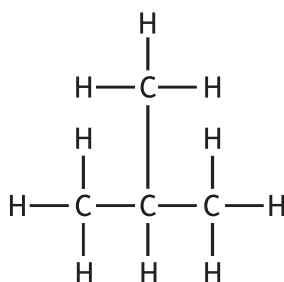


4. During the FIFA World Cup, referees will spray foam onto the pitch to ensure players stand the correct distance from the ball when a free kick is taken. The foam contains a hydrocarbon mixture of isobutane, butane and propane.

(a) Name the elements present in a hydrocarbon.

1

(b) The full structural formula for isobutane is



Write the systematic name for isobutane.

1

(c) Alkanes have different physical properties.

The table gives some information about isobutane and butane.

<i>Alkane</i>	<i>Boiling point (°C)</i>
isobutane	-12
butane	-1

Circle the correct words to complete the sentence.

1

Compared to isobutane, butane has a higher boiling point

as it contains $\left\{ \begin{array}{l} \text{weaker} \\ \text{stronger} \end{array} \right\} \left\{ \begin{array}{l} \text{covalent bonds} \\ \text{intermolecular forces} \end{array} \right\}$.



4. (continued)

(d) The table shows the boiling points of some alkanes.

<i>Alkane</i>	<i>Boiling point (°C)</i>
pentane	36
hexane	69
heptane	98
octane	126
nonane	

Predict the boiling point, in °C, of nonane, C₉H₂₀.

1

[Turn over



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

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

The Chemistry within Airbags

Airbags, an important safety feature in cars, inflate rapidly on collision. Inside the airbag is a gas generator containing a mixture of sodium azide (NaN_3), potassium nitrate and silicon dioxide.

When a car is involved in a collision, a series of three chemical reactions takes place.

In the first reaction, electrical energy causes sodium azide to decompose producing sodium metal and nitrogen gas. The nitrogen gas that is generated fills the airbag.

In the second reaction, the sodium reacts with potassium nitrate producing more nitrogen gas, sodium oxide and potassium oxide.

In the final reaction, the metal oxides react with silicon dioxide to produce silicate fibres, which are harmless and stable.

This process, from the initial impact of the crash to full inflation of the airbag, takes a fraction of a second.

- (a) Name the three chemicals found inside the gas generator before any chemical reactions take place. 1

- (b) Name the compound produced in the second reaction which would give a lilac flame colour. 1

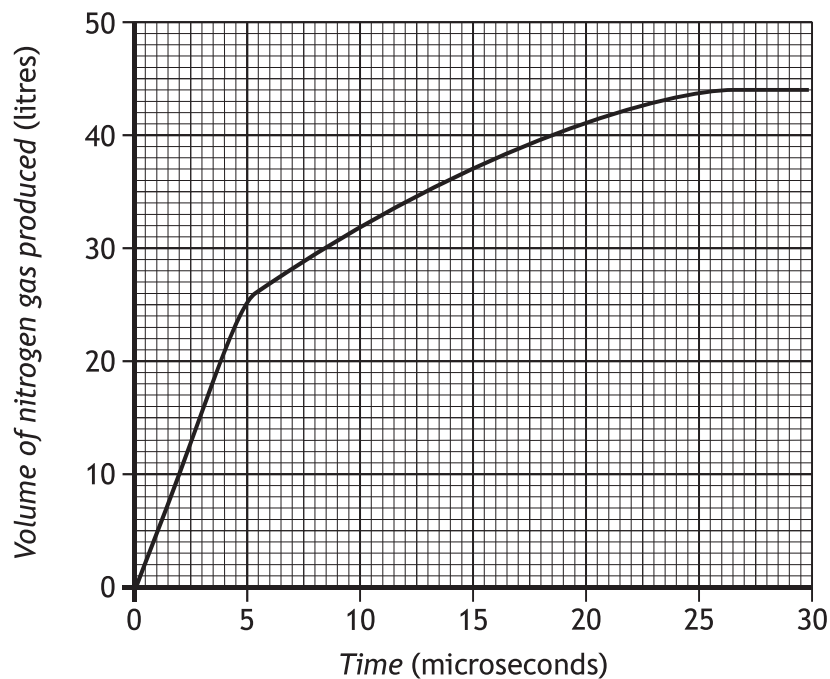
You may wish to use the data booklet to help you.

- (c) Write the formula for the compound which reacts with the metal oxides in the final reaction. 1



5. (continued)

(d) The graph below gives information on the volume of nitrogen gas produced by the gas generator.



State the total volume, in litres, of nitrogen gas produced.

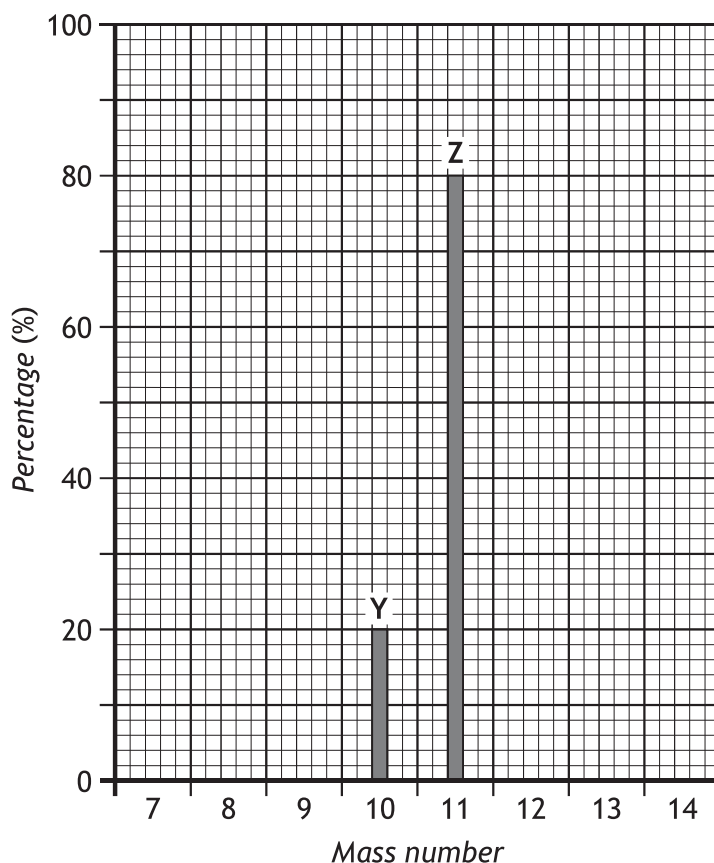
1

[Turn over



6. Scientists use an instrument called a mass spectrometer to determine the number of isotopes and the percentage of each isotope in a sample of an element.

(a) When a sample of boron is passed through a mass spectrometer the following graph is obtained.



(i) State the number of isotopes present in this sample of boron.

1

6. (a) (continued)

(ii) The relative atomic mass can be calculated using:

$$\frac{(\text{mass of isotope Y} \times \% \text{ of Y}) + (\text{mass of isotope Z} \times \% \text{ of Z})}{100}$$

Using the information from the graph, calculate the relative atomic mass of the sample of boron.

2

Show your working clearly.

(b) Carbon also has more than one isotope.

The nuclide notation for an isotope of carbon can be represented as



Write the nuclide notation for the isotope of carbon with 8 neutrons.

1

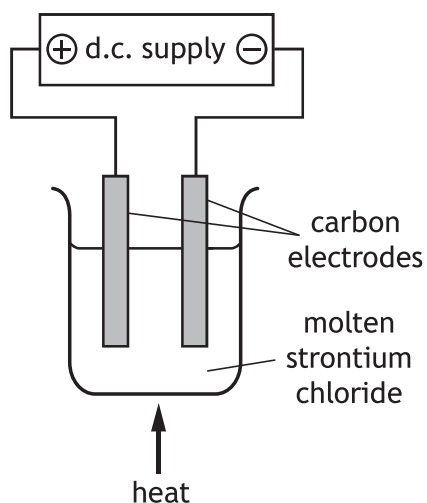
[Turn over



7. Strontium chloride, which is an ionic compound, is used in toothpaste to reduce tooth sensitivity.

(a) State the term used to describe the structure of solid strontium chloride. 1

(b) A sample of strontium chloride was electrolysed.



(i) State why ionic compounds, like strontium chloride, conduct electricity when molten. 1

(ii) During electrolysis, chloride ions lose electrons to form chlorine gas.
Name the type of chemical reaction taking place. 1

(iii) Explain why a d.c. supply **must** be used. 1



MARKS

DO NOT
WRITE IN
THIS
MARGIN

8. Water is one of the most versatile of all chemicals and features in many chemical reactions and processes.

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

3

[Turn over



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

9. Olive oil, which can be used in cooking, is a mixture of unsaturated molecules.

(a) (i) State what is meant by the term unsaturated.

1

(ii) Describe the chemical test, including the result, that can be used to show that olive oil is unsaturated.

1

(b) When frying food, it is recommended that the oil is heated before food is added.

The table gives information about olive oil used to fry food.

Specific heat capacity of olive oil	$1.97 \text{ kJ kg}^{-1} \text{ }^\circ\text{C}^{-1}$
Initial temperature of olive oil	$20 \text{ }^\circ\text{C}$
Mass of olive oil heated	1500 g

Calculate the energy, in kJ, required to increase the temperature of the olive oil to $180 \text{ }^\circ\text{C}$.

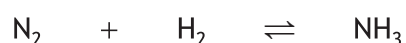
3

Show your working clearly



10. Ammonia is made industrially by reacting nitrogen with hydrogen.

(a) The equation for this reaction is



(i) Balance the equation above.

1

(ii) In the equation the symbol \rightleftharpoons is used.

State what this indicates about the reaction.

1

(b) Draw a diagram, showing all outer electrons, to represent a molecule of ammonia, NH_3 .

1

(c) In industry, ammonia can be converted into nitric acid.

Name this industrial process.

1

(d) Ammonia reacts with nitric acid to produce a salt.

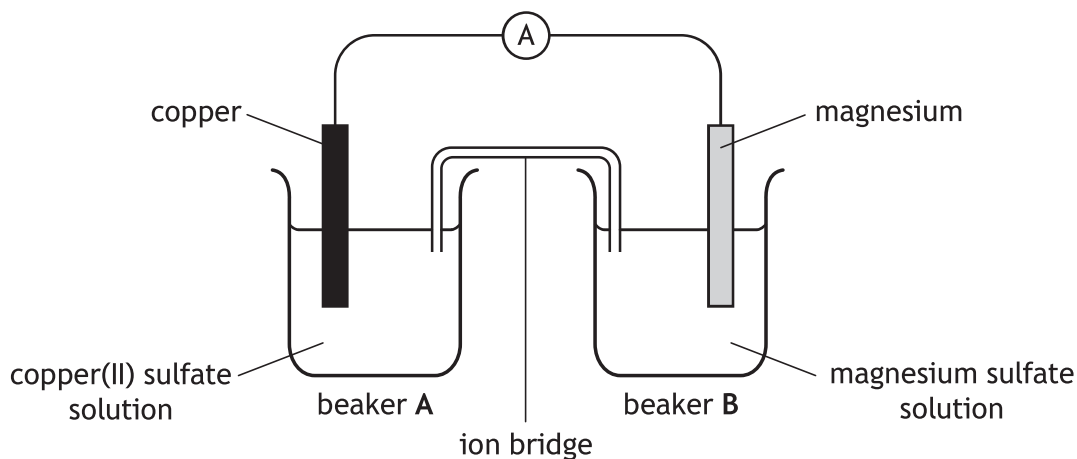
Name the salt produced in this reaction.

1



* X 8 1 3 7 5 0 1 1 9 *

11. A student set up the following cell.



(a) 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.

(b) Explain why an ion bridge is used to link the beakers.

1

(c) In this reaction, the copper ions are reduced.

Write the ion-electron equation for the reduction of copper(II) ions.

1

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



MARKS

DO NOT
WRITE IN
THIS
MARGIN

11. (continued)

(d) Other magnesium compounds could be used in place of magnesium sulfate when making this type of cell.

Suggest why magnesium phosphate would **not** be suitable.

1

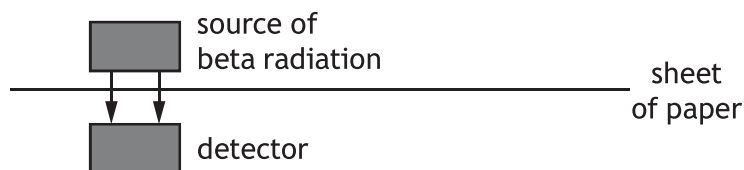
You may wish to use the data booklet to help you.

[Turn over



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

12. Thallium-204 decays by emitting beta particles and can be used in industry to measure the thickness of paper.



- (a) Suggest a reason why a radioisotope which emits alpha particles is not suitable for this purpose.

1

- (b) A paper manufacturer found a thallium-204 source had only $\frac{1}{16}$ of its original activity.

The half-life of thallium-204 is 3.7 years.

Calculate the age, in years, of the source.

2

Show your working clearly.

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

1

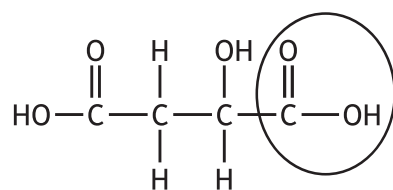
When an atom emits a beta particle,

the atomic number of the atom $\left\{ \begin{array}{l} \text{increases} \\ \text{decreases} \\ \text{stays the same} \end{array} \right\}$ and

the mass number $\left\{ \begin{array}{l} \text{increases} \\ \text{decreases} \\ \text{stays the same} \end{array} \right\}$.



13. Malic acid is a carboxylic acid found in some fruits.



- (a) (i) Name the functional group circled in the diagram above. 1
- (ii) Calculate the mass, in grams, of 1 mole of malic acid. 1

[Turn over



13. (continued)

(b) Carboxylic acids can contain a halogen atom. The pH of 1 mol⁻¹ solutions of some of these acids are given in the table.

<i>Carboxylic acid</i>	<i>pH</i>
$\begin{array}{c} \text{H} \quad \text{O} \\ \quad \\ \text{Br}-\text{C}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	1.45
$\begin{array}{c} \text{H} \quad \text{O} \\ \quad \\ \text{Cl}-\text{C}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	1.42
$\begin{array}{c} \text{H} \quad \text{O} \\ \quad \\ \text{F}-\text{C}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	1.33
$\begin{array}{c} \text{H} \quad \text{O} \\ \quad \\ \text{I}-\text{C}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	1.55

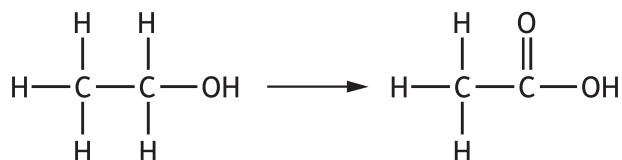
Describe how the acidity of the carboxylic acid is related to the position of the halogen in group 7 of the periodic table.

1

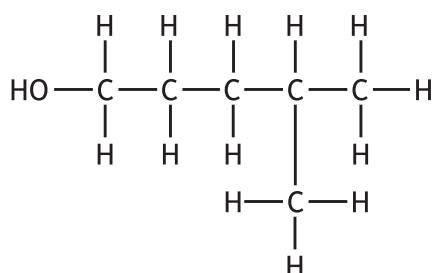


13. (continued)

- (c) The Jones oxidation reaction can be used to convert alcohols to carboxylic acids.



The following alcohol can also be converted to a carboxylic acid by the Jones oxidation reaction.



Draw a structural formula for the carboxylic acid produced in this reaction.

1

[Turn over



14. Chloride ion concentrations greater than 0.25 g l^{-1} can cause a noticeable taste in drinking water.

The table gives information about the chloride ion concentration in drinking water from different sources.

Source	Chloride ion concentration (g l^{-1})
A	0.26
B	0.28
C	0.24

- (a) One of the sources provides drinking water that does **not** have a noticeable taste.

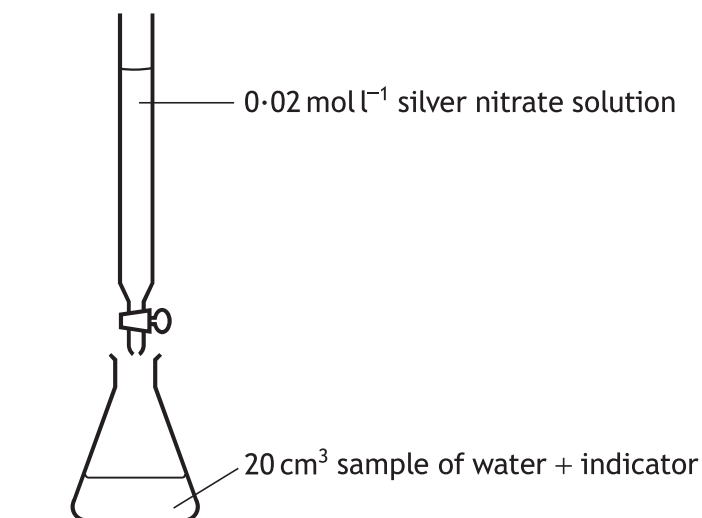
Identify this source.

1

- (b) A student investigated the concentration of chloride ions in drinking water from another source.

Samples of water were titrated with silver nitrate solution.

An indicator was used to show when the end-point was reached.



Titration	Volume of silver nitrate added (cm^3)
1	9.6
2	8.0
3	8.5
4	8.1



14. (b) (continued)

(i) Name the most appropriate piece of apparatus to measure 20 cm³ samples of water into the flask.

1

(ii) The average volume of silver nitrate that should be used to calculate the chloride ion concentration is 8.05 cm³.

Explain why only the results of titration 2 and titration 4 are used to calculate this average.

1

(iii) Calculate the number of moles of silver nitrate in 8.05 cm³.

1

Show your working clearly.

[Turn over

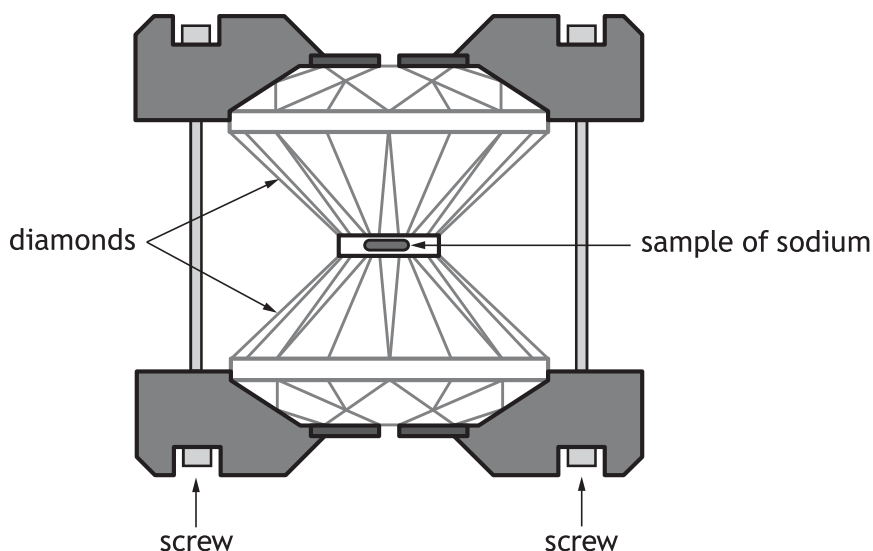


* X 8 1 3 7 5 0 1 2 7 *

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

The bizarre world of high pressure chemistry

What would happen if you put some sodium, normally a soft grey metal, under extremely high pressure?



Researchers investigated this using a piece of apparatus called a diamond anvil cell. The diamond anvil cell contains two diamonds and as the screws are tightened, high pressure is created. The pressure between the diamonds can reach 1000 gigapascals, which is a pressure of 10 million atmospheres.

When sodium is squeezed to 190 gigapascals it loses an important property of metals and becomes an insulator. This shows that there is a change in the structure and bonding of sodium.

The diamond anvil cell also allows scientists to create new materials, including superconductors.

Scientists are studying what happens to the materials thought to be deep inside the Earth, where high pressure occurs naturally.

Using this technique to mirror what may happen to materials deep in the Earth, iron(III) oxide is found to decompose, releasing oxygen, and forming the very unusual Fe_5O_7 .

Adapted from *The Catalyst*, Volume 27, Number 1, October 2016



15. (continued)

(a) Name the piece of apparatus used by researchers to create high pressure.

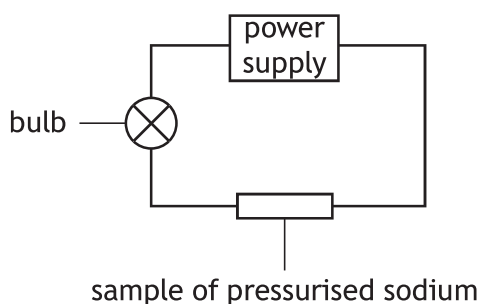
1

(b) (i) Calculate the pressure, in atmospheres, when sodium is squeezed at 190 gigapascals.

1

(ii) Suggest what would be observed if this pressurised sodium was placed in the circuit below.

1



(c) Write an equation, using symbols and formulae, to show the decomposition of iron(III) oxide, at high pressure.

1

There is no need to balance this equation.



16. The thiols are a family of compounds containing carbon, hydrogen and sulfur.

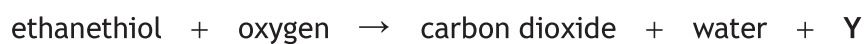
Name	Full structural formula
methanethiol	$ \begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{S} \\ \quad \diagdown \\ \text{H} \quad \text{H} \end{array} $
ethanethiol	$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{S} \\ \quad \quad \diagdown \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $
propanethiol	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{S} \\ \quad \quad \quad \diagdown \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} $

(a) Thiols have the same general formula and similar chemical properties.

(i) State the term used to describe a family of compounds such as the thiols. 1

(ii) Suggest a general formula for this family. 1

(b) Ethanethiol can react with oxygen as shown.



Identify Y. 1



16. (continued)

- (c) Methanethiol, which smells like rotting cabbage, is added to natural gas to allow gas leaks to be detected.

It is prepared industrially by the reaction of methanol with hydrogen sulfide gas.



Calculate the mass of methanethiol, in grams, produced when 640 grams of methanol reacts completely with hydrogen sulfide.

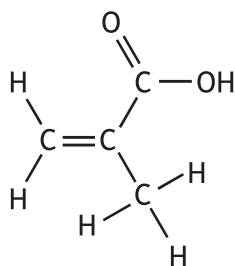
3

Show your working clearly.



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

17. Methacrylic acid is used to make methacrylates which are used in Shellac nail polish.



methacrylic acid

Using your knowledge of chemistry, comment on the chemistry of methacrylic acid.

3

[END OF QUESTION PAPER]



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