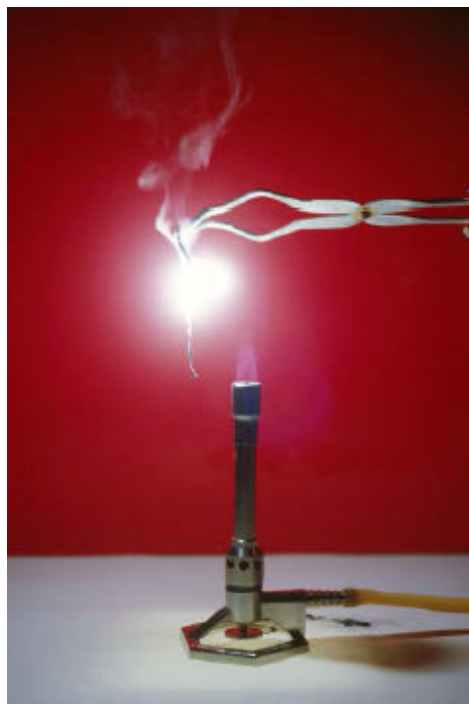


1

The figure below shows magnesium burning in air.



© Charles D Winters/Science Photo Library

(a) Look at the figure above.

How can you tell that a chemical reaction is taking place?

.....
.....

(1)

(b) Name the product from the reaction of magnesium in the figure.

.....

(1)

- (c) The magnesium needed heating before it would react.

What conclusion can you draw from this?

Tick **one** box.

The reaction is reversible

☐

The reaction has a high activation energy

☐

The reaction is exothermic

☐

Magnesium has a high melting point

☐

(1)

- (d) A sample of the product from the reaction in the figure above was added to water and shaken.

Universal indicator was added.

The universal indicator turned blue.

What is the pH value of the solution?

Tick **one** box.

1

☐

4

☐

7

☐

9

☐

(1)

- (e) Why are nanoparticles effective in very small quantities?

Tick **one** box.

They are elements

☐

They are highly reactive

☐

They have a low melting point

☐

They have a high surface area to volume ratio

☐

(1)

- (f) Give **one** advantage of using nanoparticles in sun creams.

.....

.....

(1)

- (g) Give **one** disadvantage of using nanoparticles in sun creams.

.....

.....

(1)

- (h) A coarse particle has a diameter of 1×10^{-6} m.
A nanoparticle has a diameter of 1.6×10^{-9} m.

Calculate how many times bigger the diameter of the coarse particle is than the diameter of the nanoparticle.

.....

.....

.....

.....

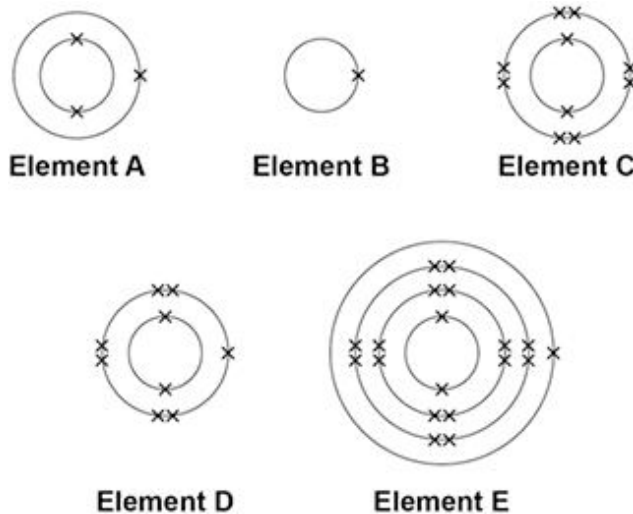
(2)

(Total 9 marks)

2

The electronic structure of the atoms of five elements are shown in the figure below.

The letters are **not** the symbols of the elements.



Choose the element to answer the question. Each element can be used once, more than once or not at all.

Use the periodic table to help you.

(a) Which element is hydrogen?

Tick **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(b) Which element is a halogen?

Tick **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

(c) Which element is a metal in the same group of the periodic table as element **A**?

Tick **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

- (d) Which element exists as single atoms?

Tick **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

(1)

- (e) There are two isotopes of element **A**. Information about the two isotopes is shown in the table below.

Mass number of the isotope	6	7
Percentage abundance	92.5	7.5

Use the information in the table above to calculate the relative atomic mass of element **A**.

Give your answer to 2 decimal places.

.....

.....

.....

.....

.....

.....

.....

Relative atomic mass =

(4)

(Total 8 marks)

3

An atom of aluminium has the symbol ${}_{13}^{27}\text{Al}$

- (a) Give the number of protons, neutrons and electrons in this atom of aluminium.

Number of protons

Number of neutrons

Number of electrons

(3)

- (b) Why is aluminium positioned in Group 3 of the periodic table?

.....

.....

(1)

- (c) In the periodic table, the transition elements and Group 1 elements are metals.

Some of the properties of two transition elements and two Group 1 elements are shown in the table below.

	Transition elements		Group 1 elements	
	Chromium	Iron	Sodium	Caesium
Melting point in °C	1857	1535	98	29
Formula of oxides	CrO Cr ₂ O ₃ CrO ₂ CrO ₃	FeO Fe ₂ O ₃ Fe ₃ O ₄	Na ₂ O	Cs ₂ O

Use your own knowledge **and** the data in the table above to compare the chemical and physical properties of transition elements and Group 1 elements.

.....

.....

.....

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.....

.....

(6)
(Total 10 marks)

4

Rock salt is a mixture of sand and salt.

Salt dissolves in water. Sand does **not** dissolve in water.

Some students separated rock salt.

This is the method used.

1. Place the rock salt in a beaker.
2. Add 100 cm³ of cold water.
3. Allow the sand to settle to the bottom of the beaker.
4. Carefully pour the salty water into an evaporating dish.
5. Heat the contents of the evaporating dish with a Bunsen burner until salt crystals start to form.

- (a) Suggest **one** improvement to step 2 to make sure all the salt is dissolved in the water.

.....
.....

(1)

- (b) The salty water in step 4 still contained very small grains of sand.

Suggest **one** improvement to step 4 to remove all the sand.

.....
.....

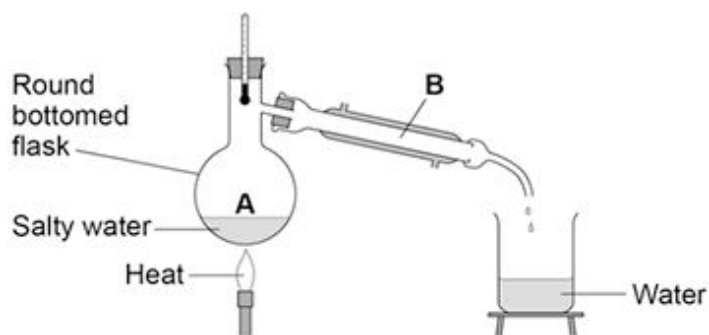
(1)

- (c) Suggest **one** safety precaution the students should take in step 5.

.....
.....

(1)

- (d) Another student removed water from salty water using the apparatus in the figure below.



Describe how this technique works by referring to the processes at **A** and **B**.

.....

.....

.....

.....

(2)

- (e) What is the reading on the thermometer during this process?

..... °C

(1)

(Total 6 marks)

5

This question is about halogens and their compounds.

The table below shows the boiling points and properties of some of the elements in Group 7 of the periodic table.

Element	Boiling point in °C	Colour in aqueous solution
Fluorine	-188	colourless
Chlorine	-35	pale green
Bromine	X	orange
Iodine	184	brown

(a) Why does iodine have a higher boiling point than chlorine?

Tick **one** box.

Iodine is ionic and chlorine is covalent

☐

Iodine is less reactive than chlorine

☐

The covalent bonds between iodine atoms are stronger

☐

The forces between iodine molecules are stronger

☐

(1)

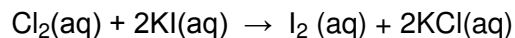
(b) Predict the boiling point of bromine.

.....

(1)

- (c) A redox reaction takes place when aqueous chlorine is added to potassium iodide solution.

The equation for this reaction is:



Look at table above.

What is the colour of the final solution in this reaction?

Tick **one** box.

Brown

☐

Orange

☐

Pale green

☐

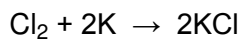
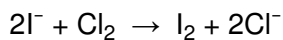
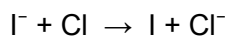
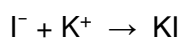
Colourless

☐

(1)

- (d) What is the ionic equation for the reaction of chlorine with potassium iodide?

Tick **one** box.

☐☐☐☐

(1)

(e) Why does potassium iodide solution conduct electricity?

Tick **one** box.

It contains a metal

☐

It contains electrons which can move

☐

It contains ions which can move

☐

It contains water

☐

(1)

(f) What are the products of electrolysis of potassium iodide solution?

Tick **one** box.

Product at cathode

Product at anode

hydrogen

iodine

☐

hydrogen

oxygen

☐

potassium

iodine

☐

potassium

oxygen

☐

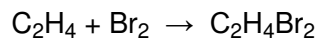
(1)

(Total 6 marks)

6

This question is about the reaction of ethene and bromine.

The equation for the reaction is:

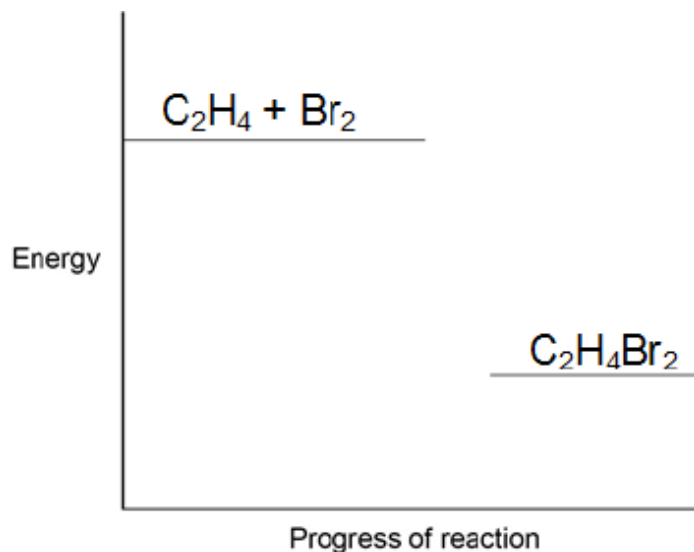


(a) Complete the reaction profile in **Figure 1**.

Draw labelled arrows to show:

- The energy given out (ΔH)
- The activation energy.

Figure 1



(3)

(b) When ethene reacts with bromine, energy is required to break covalent bonds in the molecules.

Explain how a covalent bond holds two atoms together.

.....

.....

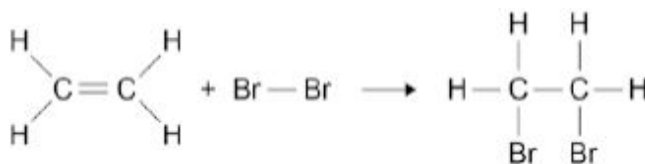
.....

.....

(2)

- (c) **Figure 2** shows the displayed formulae for the reaction of ethene with bromine.

Figure 2



The bond enthalpies and the overall energy change are shown in the table below.

	C=C	C-H	C-C	C-Br	Overall energy change
Energy in kJ / mole	612	412	348	276	-95

Use the information in the table above and **Figure 2** to calculate the bond energy for the Br-Br bond.

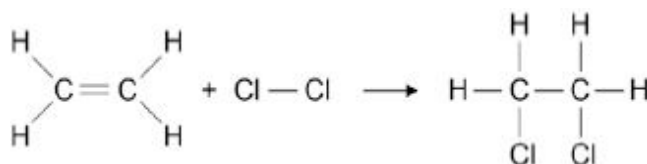
.....

Bond energy kJ / mole

(3)

- (d) **Figure 3** shows the reaction between ethene and chlorine and is similar to the reaction between ethene and bromine.

Figure 3



“The more energy levels (shells) of electrons an atom has, the weaker the covalent bonds that it forms.”

Use the above statement to predict and explain how the overall energy change for the reaction of ethene with chlorine will differ from the overall energy change for the reaction of ethene with bromine.

.....

.....

.....

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.....

.....

(6)
(Total 14 marks)

7

This question is about mixtures and analysis.

(a) Which **two** substances are mixtures?Tick **two** boxes.

Air

☐

Carbon dioxide

☐

Graphite

☐

Sodium Chloride

☐

Steel

☐**(2)**(b) Draw **one** line from each context to the correct meaning.**Context****Meaning****Pure** substance
in chemistryA substance that has had nothing
added to it

A single element or a single compound

A substance containing only atoms which
have different numbers of protons**Pure** substance
in everyday lifeA substance that can be separated by
filtrationA useful product made by mixing
substances**(2)**

(c) What is the test for chlorine gas?

Tick **one** box.

A glowing splint relights

☐

A lighted splint gives a pop

☐

Damp litmus paper turns white

☐

Limewater turns milky

☐

(1)

(d) A student tested a metal chloride solution with sodium hydroxide solution.

A brown precipitate formed.

What was the metal ion in the metal chloride solution?

Tick **one** box.

Calcium

☐

Copper(II)

☐

Iron(II)

☐

Iron(III)

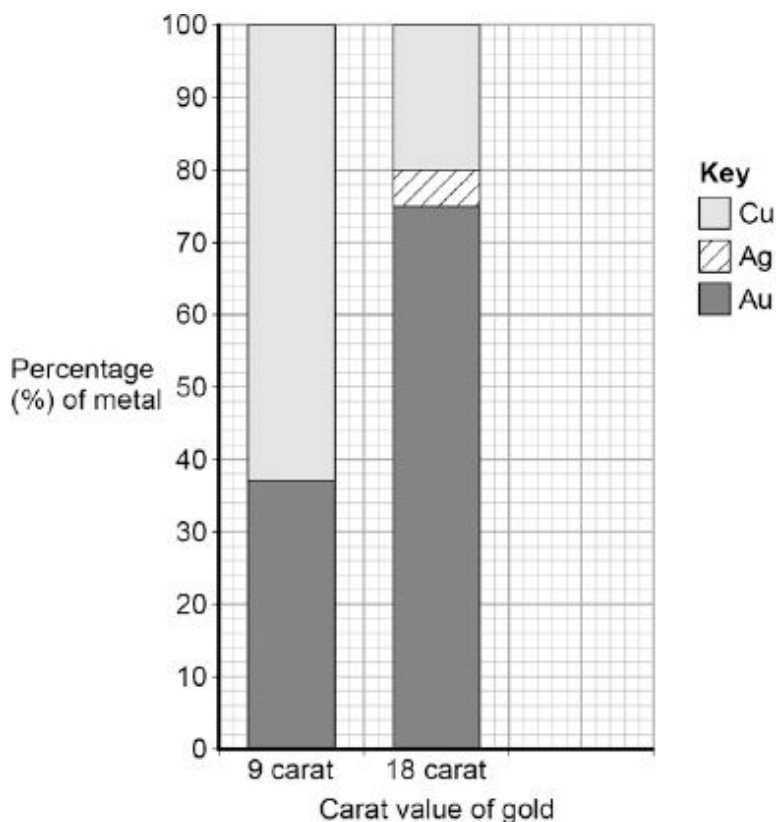
☐

(1)
(Total 6 marks)

8

Gold is mixed with other metals to make jewellery.

The figure below shows the composition of different carat values of gold.



(a) What is the percentage of gold in 12 carat gold?

Tick **one** box.

12 % ☐ 30 % ☐ 50 % ☐ 80 % ☐

(1)

(b) Give the percentage of silver in 18 carat gold.

Use the figure above to answer this question.

Percentage = %

(1)

(c) Suggest **two** reasons why 9 carat gold is often used instead of pure gold to make jewellery.

1

.....

2

.....

(2)

(Total 4 marks)

9

The table below gives information about four alcohols.

Alcohol	Formula	Melting point in °C	Boiling point in °C
Methanol	CH ₃ OH	-94	65
Ethanol	CH ₃ CH ₂ OH	-118	78
Propanol	CH ₃ CH ₂ CH ₂ OH	-129	97
Butanol	CH ₃ CH ₂ CH ₂ CH ₂ OH	-89	118

(a) Which alcohol in the table is liquid over the greatest temperature range?

.....

(1)

(b) Which statement is correct?

Tick **one** box.

A molecule of ethanol has 5 hydrogen atoms

☐

Butanol has the highest boiling point

☐

Methanol has the largest molecules

☐

Propanol has the highest melting point

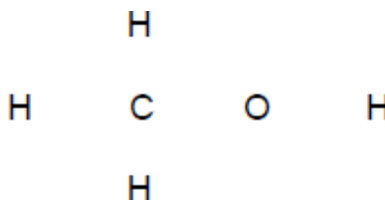
☐

(1)

(c) A molecule of methanol has five single covalent bonds.

Draw the missing bonds in **Figure 1** to complete the displayed formula for methanol.

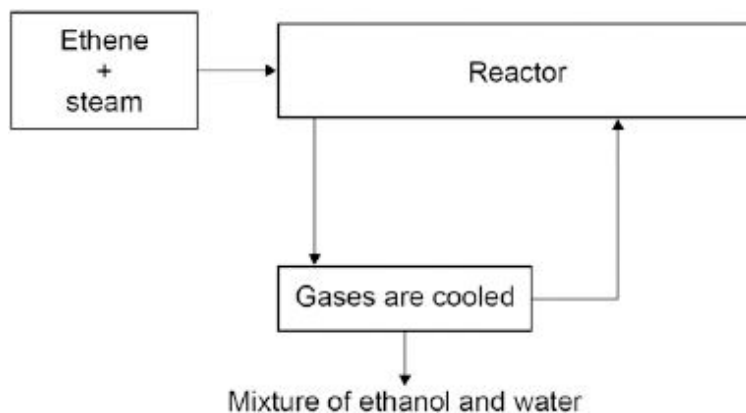
Figure 1



(1)

- (d) **Figure 2** shows a flow diagram of the process to produce ethanol.

Figure 2



Complete the word equation for the reaction to produce ethanol.

..... + → ethanol

(1)

- (e) What happens to the unreacted ethene?

.....

(1)

- (f) Wine contains ethanol.

A bottle of wine was left open in air.

After a few days, the wine tasted of vinegar.

Vinegar is a solution of ethanoic acid in water.

Explain how oxidation causes the wine to taste of vinegar after a few days.

.....

(3)

(Total 8 marks)

10

This question is about hydrocarbons.

- (a) The names and formulae of three hydrocarbons in the same homologous series are:

Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

The next member in the series is pentane.

What is the formula of pentane?

.....

(1)

- (b) Which homologous series contains ethane, propane and butane?

Tick **one** box.

Alcohols

☐

Alkanes

☐

Alkenes

☐

Carboxylic acids

☐**(1)**

- (c) Propane (
- C_3H_8
-) is used as a fuel.

Complete the equation for the complete combustion of propane.

**(2)**

- (d) Octane (
- C_8H_{18}
-) is a hydrocarbon found in petrol.

Explain why octane is a hydrocarbon.

.....

.....

(2)

- (e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

Fuel	Relative amounts of pollutants		
	Oxides of Nitrogen	Particulate matter	Carbon dioxide
Diesel	31	100	85
Petrol	23	0	100

Compare the pollutants from cars using diesel with those from cars using petrol.

.....

.....

.....

.....

.....

.....

(3)

- (f) Pollutants cause environmental impacts.

Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

Pollutant	Environmental impact caused by the pollutant
	Acid rain
Oxides of nitrogen	Flooding
	Global dimming
Particulate matter	Global warming
	Photosynthesis

(2)
(Total 11 marks)

11

Water from a lake in the UK is used to produce drinking water.

- (a) What are the two main steps used to treat water from lakes?

Give a reason for each step.

Step 1

Reason

Step 2

Reason

(2)

- (b) Explain why it is more difficult to produce drinking water from waste water than from water in lakes.

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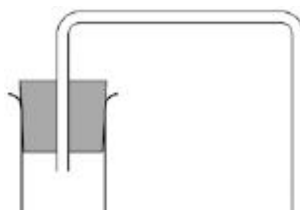
(3)

- (c) Some countries make drinking water from sea water.

Complete the figure below to show how you can distil salt solution to produce and collect pure water.

Label the following:

- pure water
- salt solution



(3)

- (d) How could the water be tested to show it is pure?

Give the expected result of the test for pure water.

.....

.....

.....

.....

.....

(2)

- (e) Why is producing drinking water from sea water expensive?

.....

.....

(1)

(Total 11 marks)

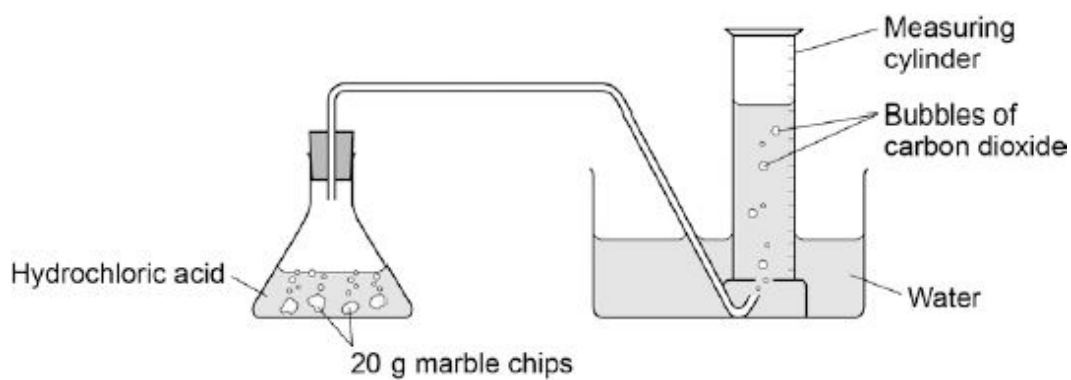
12

Marble chips are mainly calcium carbonate (CaCO_3).

A student investigated the rate of reaction between marble chips and hydrochloric acid (HCl).

Figure 1 shows the apparatus the student used.

Figure 1



- (a) Complete and balance the equation for the reaction between marble chips and hydrochloric acid.



(2)

(b) The table below shows the student's results.

Time in s	Volume of gas in dm ³
0	0.000
30	0.030
60	0.046
90	0.052
120	0.065
150	0.070
180	0.076
210	0.079
240	0.080
270	0.080

On **Figure 2**:

- Plot these results on the grid.
- Draw a line of best fit.

Figure 2

Volume
of gas
in dm^3



Time in s

(4)

- (c) Sketch a line on the grid in **Figure 2** to show the results you would expect if the experiment was repeated using 20 g of smaller marble chips.

Label this line **A**.

(2)

- (d) Explain, in terms of particles, how and why the rate of reaction changes during the reaction of calcium carbonate with hydrochloric acid.

.....

.....

.....

.....

.....

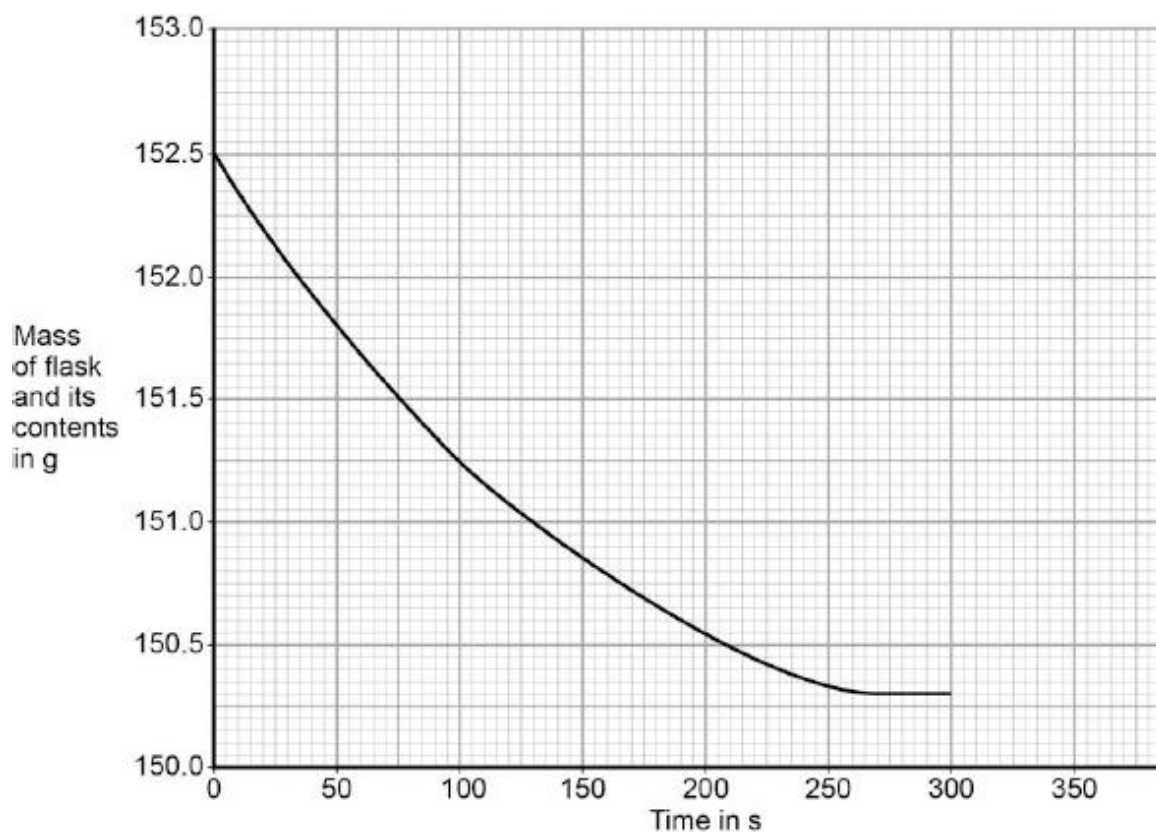
.....

(4)

- (e) Another student investigated the rate of reaction by measuring the change in mass.

Figure 3 shows the graph plotted from this student's results.

Figure 3



Use **Figure 3** to calculate the mean rate of the reaction up to the time the reaction is complete.

Give your answer to three significant figures.

.....

.....

.....

.....

.....

.....

.....

.....

Mean rate of reaction = g / s

(4)

- (f) Use **Figure 3** to determine the rate of reaction at 150 seconds.

Show your working on **Figure 3**.

Give your answer in standard form.

.....

.....

.....

.....

.....

Rate of reaction at 150 s = g / s

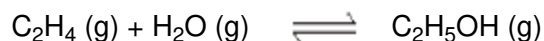
(4)

(Total 20 marks)

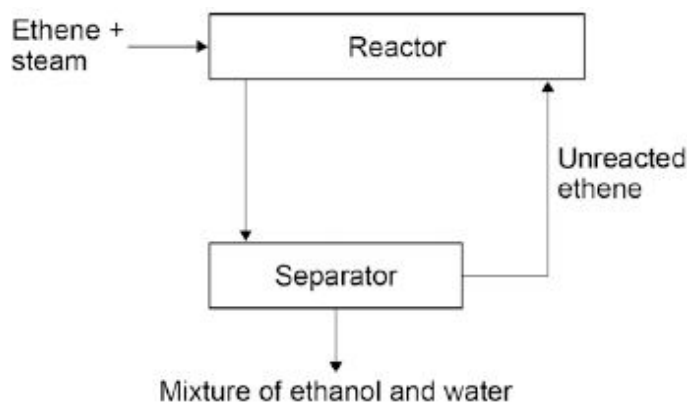
13

In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is:



The figure below shows a flow diagram of the process.



- (a) Why does the mixture from the separator contain ethanol and water?

.....

.....

(1)

- (b) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium.

Give a reason for your prediction.

.....

.....

.....

.....

(2)

- (c) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium.

.....

.....

.....

.....

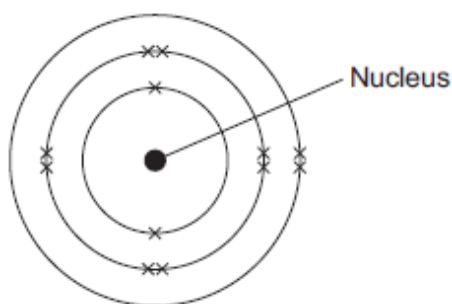
(2)

(Total 5 marks)

14

This question is about magnesium.

- (a) (i) The electronic structure of a magnesium atom is shown below.



Use the correct answer from the box to complete each sentence.

electrons	neutrons	protons	shells
------------------	-----------------	----------------	---------------

The nucleus contains protons and

The particles with the smallest relative mass that move around the nucleus are called

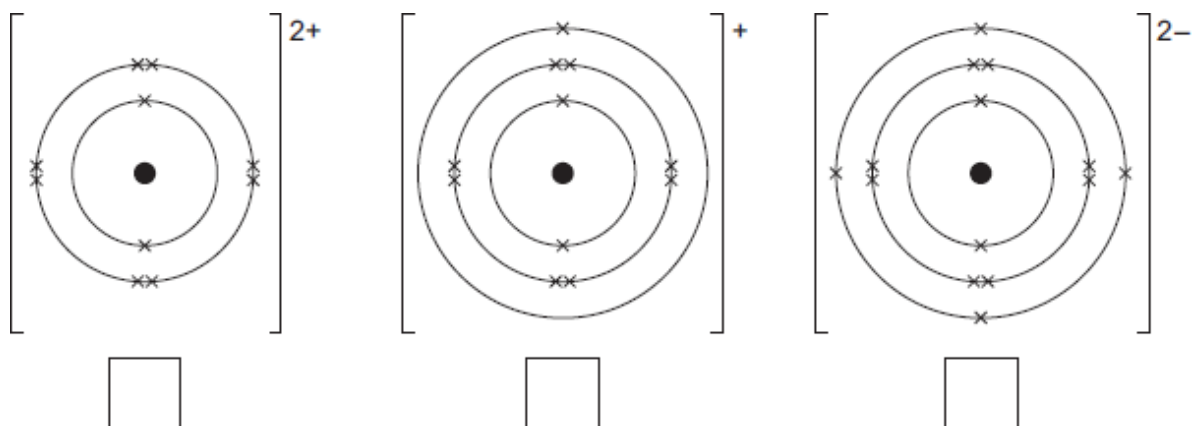
Atoms of magnesium are neutral because they contain the same number of electrons and

(3)

- (ii) A magnesium atom reacts to produce a magnesium ion.

Which diagram shows a magnesium ion?

Tick (✓) **one** box.



(1)

- (b) Magnesium and dilute hydrochloric acid react to produce magnesium chloride solution and hydrogen.



- (i) State **two** observations that could be made during the reaction.

1

.....

2

.....

(2)

- (ii) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Describe a method for making pure crystals of magnesium chloride from magnesium and dilute hydrochloric acid.

In your method you should name the apparatus you will use.

You do **not** need to mention safety.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)
(Total 12 marks)

15

This question is about atoms.

Atoms contain electrons, neutrons and protons.

- (a) (i) Which of these particles has a positive charge?

Tick (✓) **one** box.

Electron

☐

Neutron

☐

Proton

☐

(1)

(ii) Which of these particles does **not** have an electrical charge?

Tick (✓) **one** box.

Electron

☐

Neutron

☐

Proton

☐

(1)

(b) How are the elements in the periodic table arranged?

Tick (✓) **one** box.

In order of increasing atomic number

☐

In order of increasing mass number

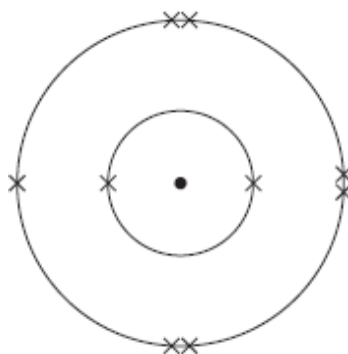
☐

In order of increasing reactivity

☐

(1)

- (c) The diagram shows the arrangement of the electrons in an atom of fluorine.



- (i) How many protons are in an atom of fluorine?

Tick (✓) **one** box.

2

☐

7

☐

9

☐

(1)

- (ii) The boiling point of fluorine is -188°C .

What is the state of fluorine at room temperature?

Tick (✓) **one** box.

Solid

☐

Liquid

☐

Gas

☐

(1)

(d) Fluorine reacts with copper to form an ionic compound.

- (i) Explain, in terms of electrons and electronic structure, what happens to a fluorine atom when it reacts with copper.

Use Above **Figure** to help you to answer this question.

.....

.....

.....

.....

.....

(2)

- (ii) Describe a chemical test which would show that a solution contains copper(II) ions.

.....

.....

.....

.....

.....

(2)

(Total 9 marks)

16

This question is about metals.

- (a) Which unreactive metal is found in the Earth as the metal itself?

Tick (✓) **one** box.

aluminium

☐

gold

☐

magnesium

☐

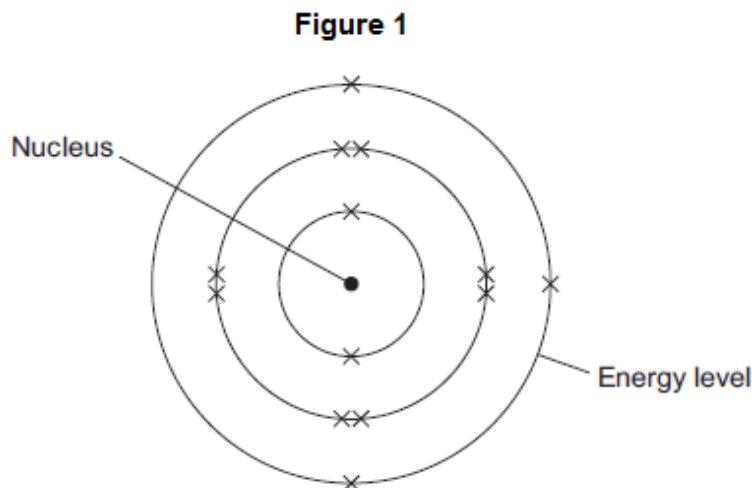
(1)

- (b) Complete the sentence.

Aluminium is an element because aluminium is made of
only one type of

(1)

- (c) **Figure 1** shows the electronic structure of an aluminium atom.



- (i) Use the correct words from the box to complete the sentence.

electrons	ions	protons	neutrons	shells
------------------	-------------	----------------	-----------------	---------------

The nucleus of an aluminium atom contains and
.....

(2)

- (ii) Complete the sentence.

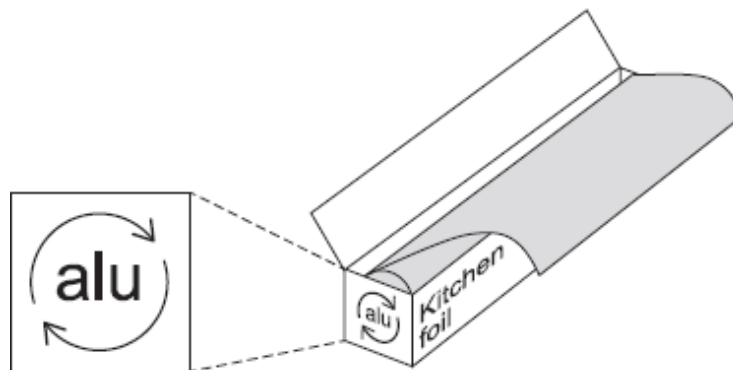
In the periodic table, aluminium is in Group

(1)

- (d) Aluminium is used for kitchen foil.

Figure 2 shows a symbol on a box of kitchen foil.

Figure 2



The symbol means that aluminium can be recycled. It does not show the correct chemical symbol for aluminium.

- (i) What is the correct chemical symbol for aluminium?

.....

(1)

- (ii) Give **two** reasons why aluminium should be recycled.

.....

(2)

- (e) Aluminium has a low density, conducts electricity and is resistant to corrosion.

Which **one** of these properties makes aluminium suitable to use as kitchen foil?
 Give a reason for your answer.

.....

(2)

(Total 10 marks)

17

This question is about atomic structure and elements.

(a) Complete the sentences.

(i) The atomic number of an atom is the number of

(1)

(ii) The mass number of an atom is the number of

.....

(1)

(b) Explain why an atom has no overall charge.

Use the relative electrical charges of sub-atomic particles in your explanation.

.....

.....

.....

.....

(2)

(c) Explain why fluorine and chlorine are in the same group of the periodic table.

Give the electronic structures of fluorine and chlorine in your explanation.

.....

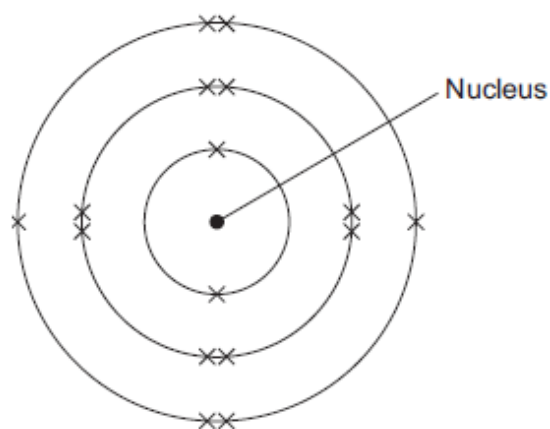
.....

.....

.....

(2)

- (d) The diagram shows the electronic structure of an atom of a non-metal.



What is the chemical symbol of this non-metal?

Tick (✓) **one** box.

Ar ☐

O ☐

S ☐

Si ☐

(1)

- (e) When elements react, their atoms join with other atoms to form compounds.

Complete the sentences.

- (i) Compounds formed when non-metals react with metals consist of particles called

(1)

- (ii) Compounds formed from only non-metals consist of particles called

(1)

(Total 9 marks)

18

This question is about carbon and gases in the air.

- (a) Carbon atoms have protons, neutrons and electrons.

Complete the table by writing the relative mass of a neutron and an electron.

Name of particle	Relative mass
proton	1
neutron	
electron	

(2)

- (b) What is the total number of protons and neutrons in an atom called?

Tick (✓) **one** box.

The atomic number

☐

The mass number

☐

One mole of the atom

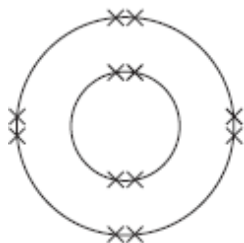
☐

(1)

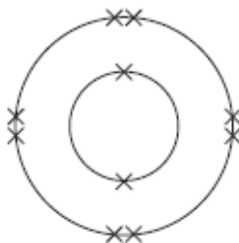
- (c) An atom of carbon has six electrons.

Which structure, **A**, **B** or **C**, represents the electronic structure of the carbon atom?

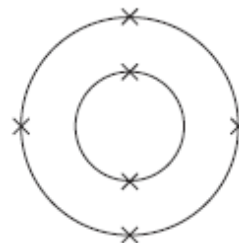
Structure A



Structure B



Structure C



The carbon atom is structure

☐

(1)

(d) Carbon reacts with oxygen to produce carbon dioxide (CO_2).

(i) How many different elements are in one molecule of carbon dioxide?

.....

(1)

(ii) What is the total number of atoms in one molecule of carbon dioxide?

.....

(1)

(e) Sometimes carbon reacts with oxygen to produce carbon monoxide (CO).

(i) Calculate the relative formula mass (M_r) of carbon monoxide.

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

.....

.....

M_r of carbon monoxide =

(1)

(ii) Calculate the percentage by mass of carbon in carbon monoxide.

.....

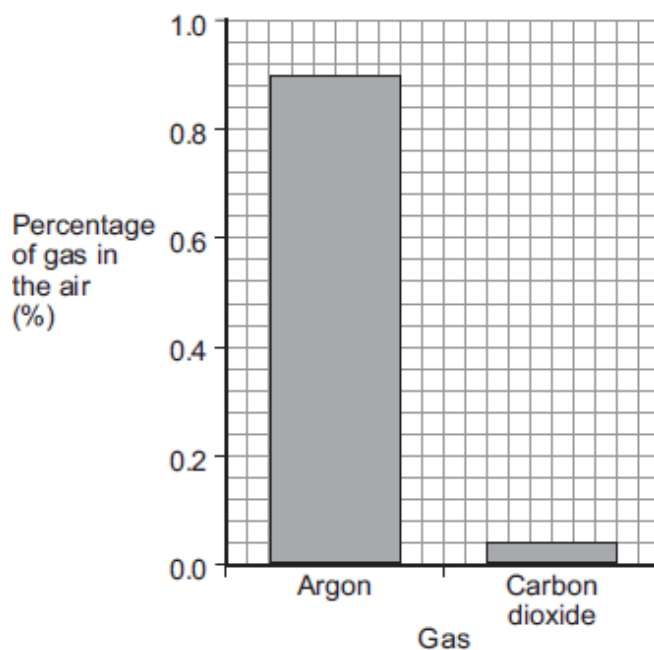
.....

Percentage by mass of carbon in carbon monoxide =%

(1)

(f) Carbon dioxide is one of the gases in the air.

- (i) The graph shows the percentage of argon and the percentage of carbon dioxide in the air.



What is the percentage of argon in the air?

Percentage of argon = %

(1)

- (ii) An instrumental method is used to measure the amount of carbon dioxide in the air.

Give **one** reason for using an instrumental method.

.....

(1)

(Total 10 marks)

19

This question is about atoms and isotopes.

- (a) Atoms contain protons, neutrons and electrons.

A lithium atom has the symbol ${}^7_3\text{Li}$

Explain, in terms of sub-atomic particles, why the mass number of this lithium atom is 7.

.....

.....

.....

.....

.....

.....

(3)

- (b) Amounts of substances can be described in different ways.

Complete the sentences.

One mole of a substance is the relative formula mass in

.....

The relative atomic mass of an element compares the mass of an atom of an element with the mass of an atom of

.....

(2)

- (c) Two isotopes of oxygen are ${}^{18}_8\text{O}$ and ${}^{16}_8\text{O}$

Describe the similarities and differences between the isotopes ${}^{18}_8\text{O}$ and ${}^{16}_8\text{O}$

You should refer to the numbers of sub-atomic particles in each isotope.

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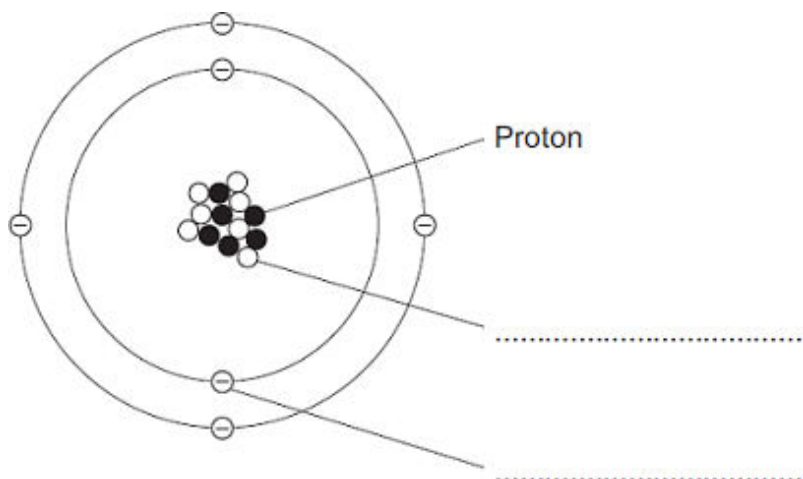
.....

(3)

(Total 8 marks)

20

The diagram shows a carbon atom.



- (a) (i) A proton is labelled.

Use the correct answer from the box to label each of the other sub-atomic particles.

electron

ion

molecule

neutron

(2)

- (ii) The atom of carbon is represented as:



What is the mass number of this carbon atom?

Draw a ring around the correct answer.

6 13 19

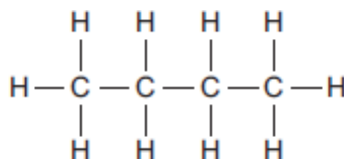
(1)

- (iii) Complete the sentence.

Atoms of carbon have no overall electrical charge because the number of protons is the same as the number of

(1)

- (b) Butane is represented as:



- (i) Use the correct answer from the box to complete each sentence.

bond	compound	helium	hydrogen	mixture	oxygen
-------------	-----------------	---------------	-----------------	----------------	---------------

Butane is a

Butane contains atoms of carbon and

Each line between the atoms in butane represents a chemical

.....

(3)

- (ii) Which is the correct formula for butane?

Tick (✓) **one** box.

C₄H₄

☐

C₄H₈

☐

C₄H₁₀

☐

(1)

(Total 8 marks)

21

Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, SO₂

- (a) Why is it important that sulfur dioxide is **not** released into the atmosphere?

Tick (✓) **one** box.

Sulfur dioxide causes acid rain.

☐

Sulfur dioxide causes global dimming.

☐

Sulfur dioxide causes global warming.

☐

(1)

- (b) Sulfur dioxide dissolves in water.

What colour is universal indicator in a solution of sulfur dioxide?
Give a reason for your answer.

.....

.....

.....

.....

(2)

- (c) Sulfur dioxide is a gas at room temperature.

The bonding in sulfur dioxide is covalent.

Explain, in terms of its structure and bonding, why sulfur dioxide has a low boiling point.

.....

.....

.....

.....

.....

.....

(3)

- (d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Sulfur dioxide is produced when fossil fuels are burned.

It is important that sulfur dioxide is not released into the atmosphere.

Three of the methods used to remove sulfur dioxide from gases produced when fossil fuels are burned are:

- wet gas desulfurisation (**W**)
- dry gas desulfurisation (**D**)
- seawater gas desulfurisation (**S**).

Information about the three methods is given in the bar chart and in **Table 1** and **Table 2**.

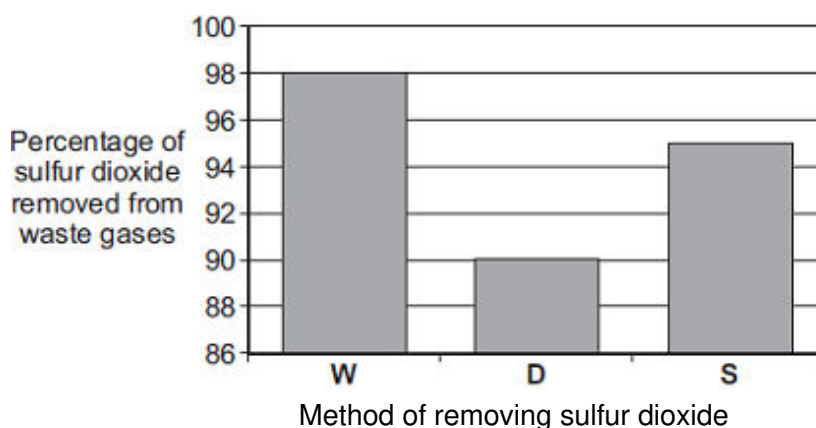


Table 1

Method	Material used	How material is obtained
W	Calcium carbonate, CaCO_3	Quarrying
D	Calcium oxide, CaO	Thermal decomposition of calcium carbonate: $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$
S	Seawater	From the sea

Table 2

Method	What is done with waste material
W	Solid waste is sold for use in buildings. Carbon dioxide is released into the atmosphere.
D	Solid waste is sent to landfill.
S	Liquid waste is returned to the sea.

Evaluate the three methods of removing sulfur dioxide from waste gases.

Compare the three methods and give a justified conclusion.

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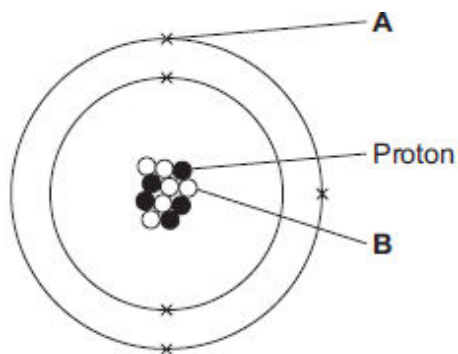
.....

(6)
(Total 12 marks)

22

- (a) **Figure 1** shows an atom of element **G**.

Figure 1



Draw a ring around the correct answer to complete each sentence.

- (i) Label **A** shows

an electron

an ion

a nucleus

(1)

- (ii) The particle labelled **B** is

an isotope

a molecule

a neutron

(1)

- (iii) The mass number of element **G** is

5

6

11

(1)

- (iv) Use the periodic table to identify element **G**.

Element **G** is

boron

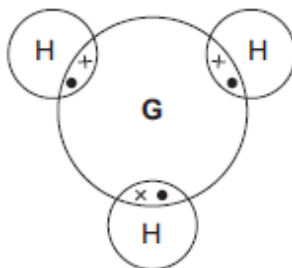
carbon

sodium

(1)

- (b) **Figure 2** shows a compound of **G** and hydrogen.

Figure 2



Draw a ring around the correct answer to complete each sentence.

- (i) The formula of the compound in **Figure 2** is

GH₃

G₃H

3HG

(1)

- (ii) The type of bonding shown in **Figure 2** is

covalent

ionic

metallic

(1)

(Total 6 marks)

23

- (a) The symbols for seven different elements are shown in **Figure 1**.

Figure 1

[illegible]

Choose the correct symbol from **Figure 1** to answer each question.

You may use each symbol once, more than once or not at all.

Write the symbol that represents:

- (i) a Group 1 element

.....

(1)

(ii) a transition metal

.....

(1)

(iii) an element with electrons in the same number of energy levels as an atom of argon (Ar)

.....

(1)

(iv) an element which forms an oxide that dissolves in water to form an acidic solution

.....

(1)

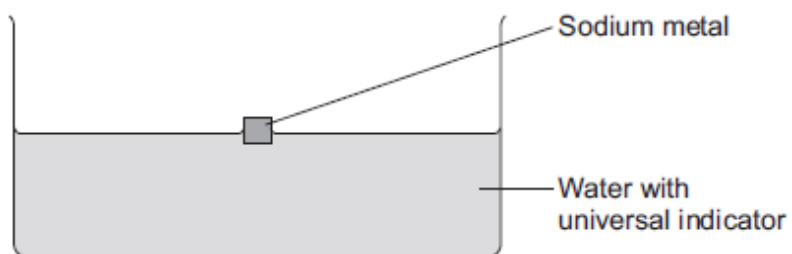
(v) an element that forms a chloride with the formula XCl

.....

(1)

- (b) A teacher put a cube of sodium metal into water containing universal indicator, as shown in **Figure 2**.

Figure 2



The equation for the reaction is:



- (i) The sodium floated on the surface of the water. The universal indicator turned purple.

Give **three other** observations that would be seen during the reaction.

1

.....

2

.....

3

.....

(3)

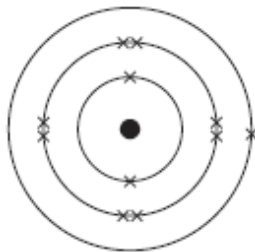
- (ii) Name the ion that made the universal indicator turn purple.

.....

(1)

- (c) **Figure 3** represents the electronic structure of a sodium atom.

Figure 3

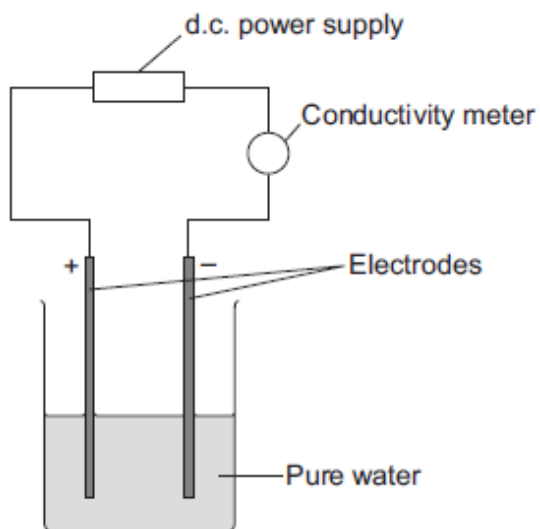


In the space below, draw the electronic structure of a sodium ion. Include the charge on the ion.

(2)
(Total 11 marks)

24

A student investigated the conductivity of different concentrations of sodium chloride solution. The student set the apparatus up as shown in **Figure 1**.

Figure 1

The student measured the conductivity of the pure water with a conductivity meter.

The reading on the conductivity meter was zero.

(a) The student:

- added sodium chloride solution one drop at a time
- stirred the solution
- recorded the reading on the conductivity meter.

The student's results are shown in the table below.

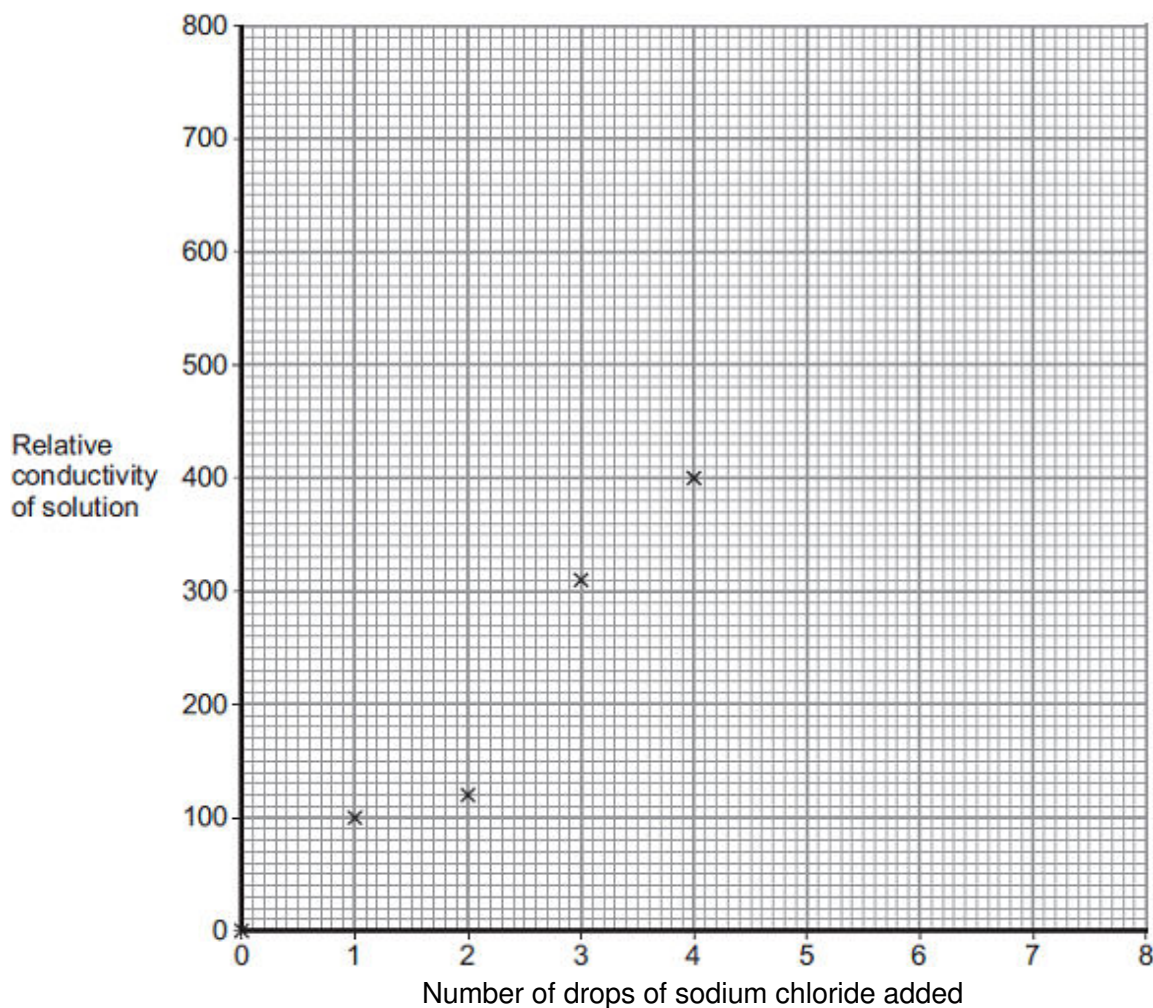
Number of drops of sodium chloride solution added	Relative conductivity of solution
0	0
1	100
2	120
3	310
4	400
5	510
6	590
7	710
8	800

- (i) The student plotted the results on the grid shown in **Figure 2**.

Plot the four remaining results.

Draw a line of best fit, ignoring the anomalous result.

Figure 2



(3)

- (ii) One of the points is anomalous.

Suggest **one** error that the student may have made to cause the anomalous result.

.....

(1)

- (iii) The student wanted to compare the conductivity of sodium chloride solution with the conductivity of potassium chloride solution.

State **one** variable he should keep constant when measuring the conductivity of the two solutions.

.....

(1)

- (b) (i) Explain, in terms of bonding, why pure water does **not** conduct electricity.

.....

.....

.....

.....

(2)

- (ii) Explain why sodium chloride solution conducts electricity.

.....

.....

.....

.....

(2)

- (iii) After he had added sodium chloride solution, the student noticed bubbles of gas at the negative electrode.

Complete the sentence.

The gas produced at the negative electrode is

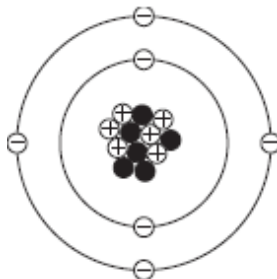
(1)

(Total 10 marks)

25

Fossil fuels contain carbon.

- (a) The figure below represents a carbon atom.



Draw a ring around the correct answer to complete each sentence.

- (i) The name of the particle with a positive charge is

an electron.
a neutron.
a proton.

(1)

(ii) The centre of the atom is called the

energy level. molecule. nucleus.
--

(1)

(iii) Use the Chemistry Data Sheet to help you to answer this question.

Use the correct number from the box to complete each sentence.

4	6	8	10	12
---	---	---	----	----

The mass number of this carbon atom is

In the periodic table, carbon is in Group

(b) Coal is a fossil fuel.

A piece of coal contains:

- 80% carbon
- 9% oxygen
- 1% sulfur
- 5% hydrogen.

The rest of the coal is other elements.

(i) What is the percentage of other elements in this piece of coal?

..... %

(1)

- (ii) Coal burns in air to produce carbon dioxide, sulfur dioxide and water.

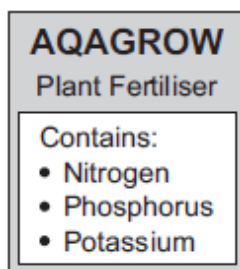
Draw **one** line from each product to the type of pollution caused by each product.

Product	Type of pollution
Carbon dioxide	Acid rain
Sulfur dioxide	Global dimming
Water	Global warming
	No pollution

(3)
(Total 8 marks)

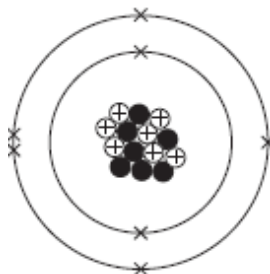
26

Fertilisers contain elements that plants need.



- (a) **Figure 1** represents a nitrogen atom.

Figure 1



Complete each sentence.

- (i) The mass number of this nitrogen atom is
- (ii) Atoms of nitrogen with different numbers of neutrons are called

(1)

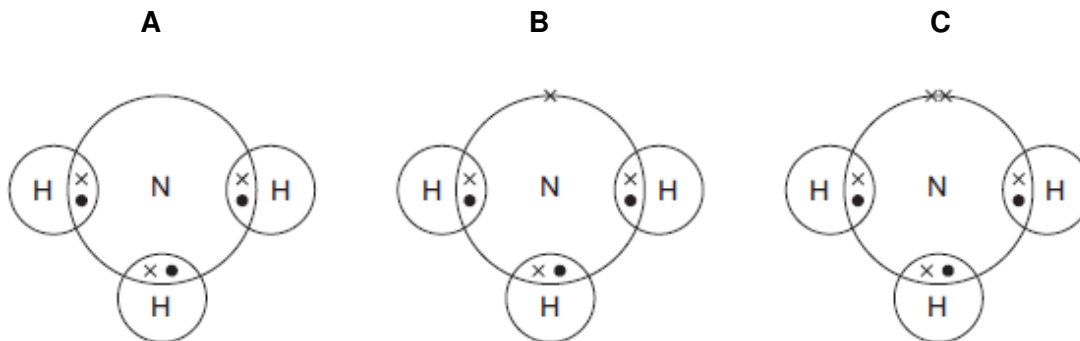
(1)

(iii) Compared with a proton, the mass of an electron is

(1)

(b) Fertilisers can be made from ammonia.

(i) Which diagram, **A**, **B**, or **C**, represents the electronic structure of an ammonia molecule?



(1)

The electronic structure of an ammonia molecule is shown in diagram

(ii) What is the correct formula of ammonia?

Draw a ring around the correct answer.



(1)

(c) A student made ammonium nitrate by reacting ammonia solution with an acid.

(i) Name the acid used to make ammonium nitrate.

.....

(1)

(ii) Complete the sentence.

The student added a few drops of, which changed colour when the ammonia solution had neutralised the acid.

(1)

(iii) The student added charcoal and filtered the mixture.

This produced a colourless solution of ammonium nitrate.

How is solid ammonium nitrate obtained from the solution?

.....

(1)

- (iv) A farmer put ammonium nitrate fertiliser onto a field of grass.

Suggest what would happen to the grass.

.....

.....

(1)

- (d) Some fertilisers contain potassium chloride.

Potassium reacts with chlorine to produce potassium chloride.

Figure 2 shows how this happens.

The dots (•) and crosses (x) represent electrons.

Only the outer shell is shown.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with chlorine to produce potassium chloride.

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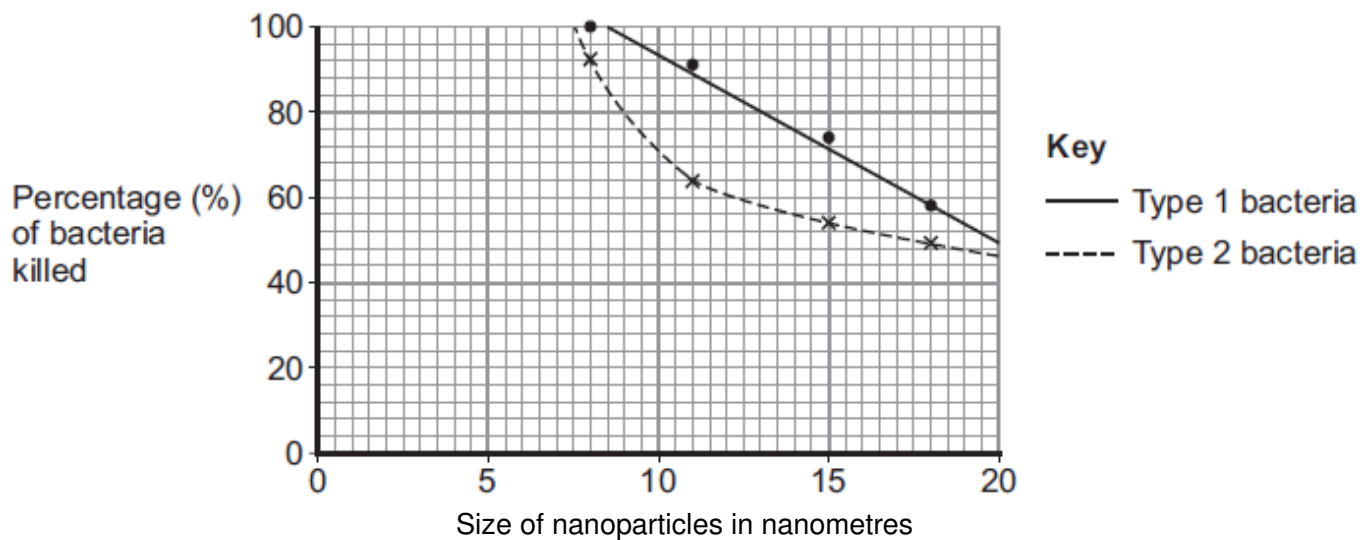
(4)

(Total 13 marks)

27

Magnesium oxide nanoparticles can kill bacteria.

The figure below shows the percentage of bacteria killed by different sized nanoparticles.



- (a) (i) Give **two** conclusions that can be made from the figure above.

.....

.....

.....

.....

.....

.....

(2)

- (ii) Points are plotted for only some sizes of nanoparticles.

Would collecting and plotting data for more sizes of nanoparticles improve the conclusions?

Give a reason for your answer.

.....

.....

(1)

- (b) Magnesium oxide contains magnesium ions (Mg^{2+}) and oxide ions (O^{2-}).

Describe, as fully as you can, what happens when magnesium atoms react with oxygen atoms to produce magnesium oxide.

.....

.....

.....

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.....

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.....

.....

.....

.....

(4)
(Total 7 marks)

28

Glass is made from silicon dioxide.



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- (a) Silicon dioxide has a very high melting point.

Other substances are added to silicon dioxide to make glass. Glass melts at a lower temperature than silicon dioxide.

Suggest why.

.....

(1)

- (b) Sodium oxide is one of the substances added to silicon dioxide to make glass.

- (i) Sodium oxide contains Na^+ ions and O^{2-} ions.

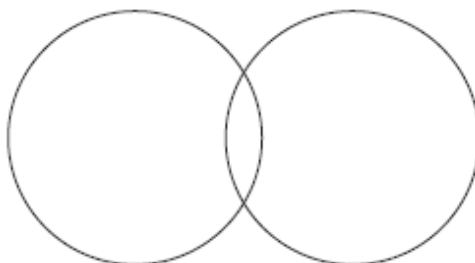
Give the formula of sodium oxide.

.....

(1)

- (ii) Sodium oxide is made by heating sodium metal in oxygen gas.

Complete the diagram to show the outer electrons in an oxygen molecule (O_2).



(2)

- (c) Glass can be coloured using tiny particles of gold. Gold is a metal.

Describe the structure of a metal.

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.....

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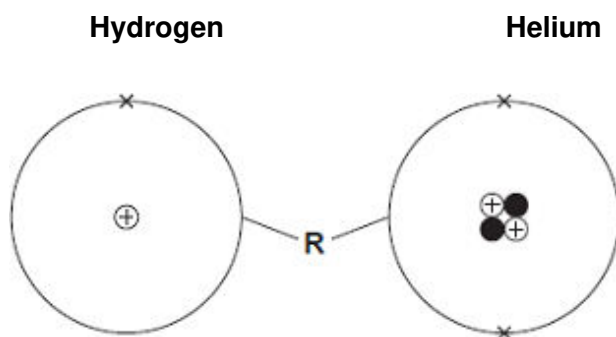
.....

(3)
(Total 7 marks)

29

The Sun is mainly hydrogen and helium.

The diagrams show an atom of hydrogen and an atom of helium.



- (a) Draw a ring around the correct answer to complete each sentence.

- (i) The centre of each atom is called the

molecule.

nucleus.

shell.

(1)

- (ii) The circle (labelled **R**) around the centre of each atom is called

a bond.

an electrical charge.

an energy level
(shell).

(1)

- (b) Use the diagrams in part (a) to help you to answer these questions.

Draw **one** line from each question to its correct answer.

Question	Answer
How many protons are there in the hydrogen atom?	1
How many electrons are there in the helium atom?	2
What is the mass number of the helium atom?	3
	4

(3)

- (c) The Sun is 73% hydrogen and 25% helium. The rest is other elements.

What is the percentage of other elements in the Sun?

..... %

(1)

- (d) One of the other elements in the Sun is neon.
Neon is in the same group of the periodic table as helium.

Use the Chemistry Data Sheet to help you to answer these questions.

- (i) How many protons are there in a neon atom?

.....

(1)

- (ii) Which group of the periodic table are helium and neon in?

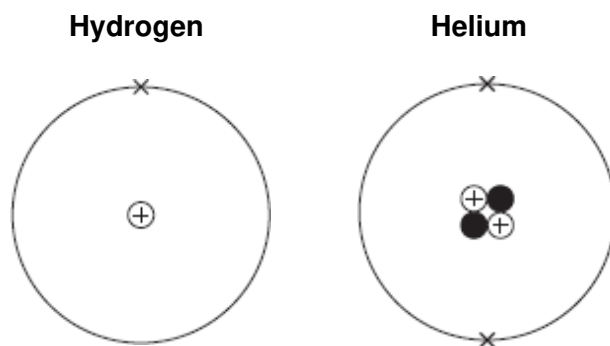
.....

(1)

(Total 8 marks)

30

The Sun produces helium atoms from hydrogen atoms by nuclear fusion reactions.



- (a) Describe the differences in the atomic structures of a hydrogen atom and a helium atom.

.....

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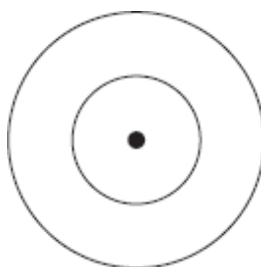
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(3)

- (b) The Sun consists of 73% hydrogen and 25% helium.
The rest is other elements.
One of the other elements in the Sun is neon.

Use the Chemistry Data Sheet to help you to answer these questions.

- (i) Complete the diagram to show the electronic structure of a neon atom.

**(1)**

- (ii) Why is neon in the same group of the periodic table as helium?

.....

.....

.....

(1)
(Total 5 marks)

31

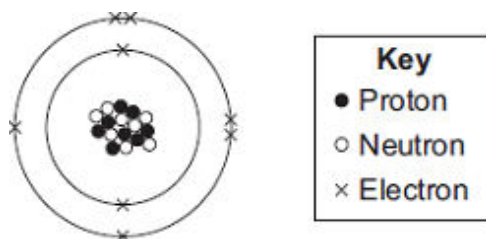
This question is about atoms and molecules.

- (a) Complete the table to show the relative masses of the particles in atoms.

Name of particle	Relative mass
Proton
Neutron	1
Electron

(2)

- (b) The diagram shows an oxygen atom.



Use the correct number to complete each sentence.

8	16	18	24
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The atomic (proton) number of the oxygen atom shown above is

The mass number of the oxygen atom shown above is

(2)

- (c) (i) Draw a ring around the correct answer to complete each sentence.

Oxygen atoms with different numbers of neutrons are called

isotopes.
molecules.
polymers.

(1)

- (ii) An oxygen atom with a different number of neutrons has 10 neutrons.

Draw a ring around the symbol which represents this atom.



(1)

- (d) A water molecule contains hydrogen and oxygen atoms.

- (i) Use the correct answer to complete the sentence.

a compound	an element	a mixture
-------------------	-------------------	------------------

Water is

(1)

- (ii) Draw a ring around the correct structure of a water molecule.



(1)

- (iii) Draw a ring around the type of bonding in a water molecule.

covalent

ionic

metallic

(1)

- (iv) Draw a ring around the correct answer to complete each sentence.

The bonds in a water molecule are formed by

gaining

losing

sharing

electrons.

(1)

(Total 10 marks)

32

Kelp is a seaweed.

Kelp can be used in foods and as a renewable energy source.



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- (a) Scientific experiments, on their own, **cannot** fully answer one of the following questions. Which one?

Tick (✓) **one** box.

Questions	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal?	
Will kelp last longer than coal as an energy source?	
Which fuel, kelp or coal, produces the most ash when burned?	

(1)

- (b) Scientists cannot answer the question ‘should people use kelp instead of coal as an energy source?’

Give **two** reasons why.

.....

.....

.....

.....

(2)

(c) Sodium iodide can be produced from kelp.

(i) How many electrons are in the outer shell of an iodine atom?

(1)

(ii) Sodium iodide contains sodium ions (Na^+) and iodide ions (I^-).

Describe, as fully as you can, what happens when sodium atoms react with iodine atoms to produce sodium iodide.

You may use a diagram in your answer

.....

.....

.....

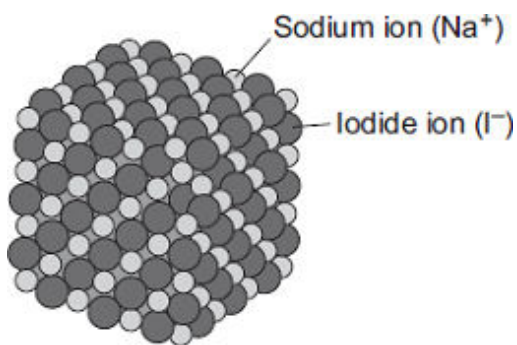
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(3)

- (iii) The diagram shows the structure of sodium iodide.



Solid sodium iodide does not conduct electricity.

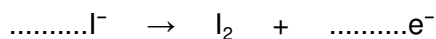
Why does sodium iodide solution conduct electricity?

.....

(1)

- (iv) When sodium iodide solution is electrolysed, iodine is formed at the positive electrode.

Complete and balance the half equation for the formation of iodine.



(1)

- (v) What is formed at the negative electrode when sodium iodide solution is electrolysed?

Explain why.

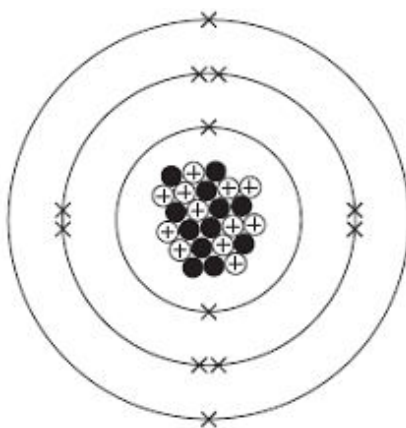
.....

(2)

(Total 11 marks)

33

The diagram represents a magnesium atom.



(a) Use words from the box to answer these questions.

electron	neutron	nucleus	proton
-----------------	----------------	----------------	---------------

(i) What is the name of the central part of the atom?

(1)

(ii) What is the name of the particle with no charge?

(1)

(iii) What is the name of the particle with a negative charge?

(1)

(b) Use the diagram above to help you answer these questions.

(i) Draw a ring around the atomic (proton) number of this magnesium atom.

12

24

36

(1)

(ii) Draw a ring around the mass number of this magnesium atom.

12

24

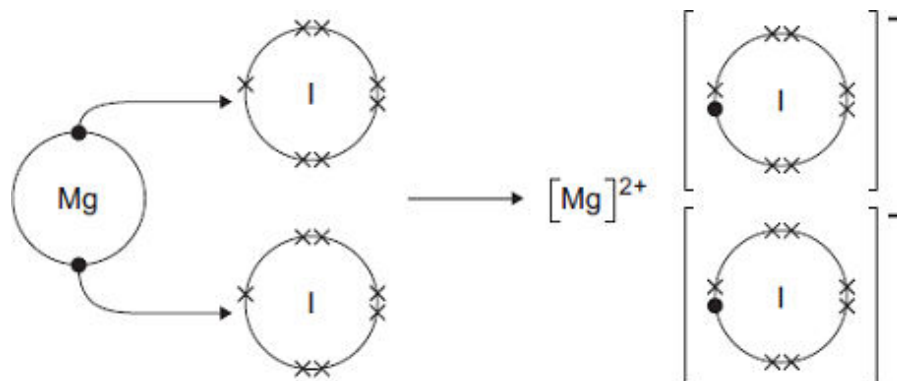
36

(1)

- (c) The diagram shows how magnesium and iodine atoms form magnesium iodide.

Only the outer electrons are shown.

The dots (•) and crosses (×) are used to represent electrons.



Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when magnesium reacts with iodine to make magnesium iodide.

To gain full marks you should use the words atom, electron and ion in your answer.

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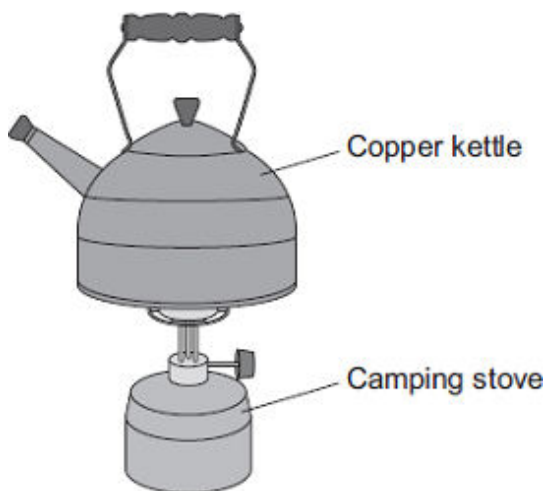
(4)
(Total 9 marks)

34

The picture shows a copper kettle being heated on a camping stove.

Copper is a good material for making a kettle because:

- it has a high melting point
- it is a very good conductor of heat.



- (a) Explain why copper, like many other metals, has a high melting point.

Your answer should describe the structure and bonding of a metal.

.....

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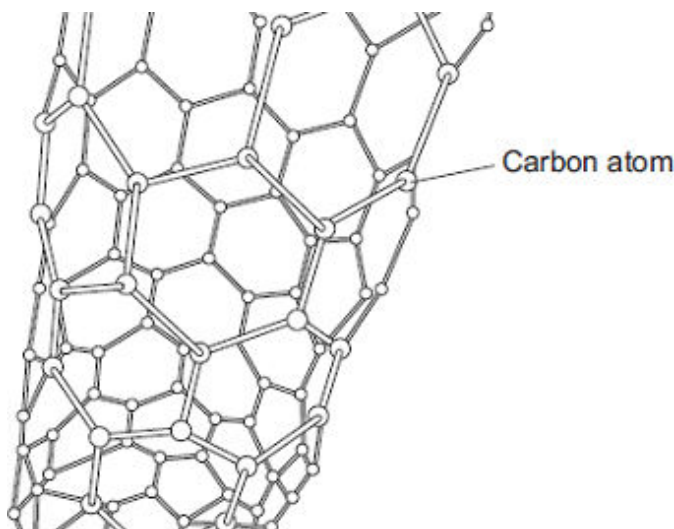
.....

(4)

- (b) Aeroplanes contain many miles of electrical wiring made from copper. This adds to the mass of the aeroplane.

It has been suggested that the electrical wiring made from copper could be replaced by carbon nanotubes which are less dense than copper.

The diagram shows the structure of a carbon nanotube.



- (i) What does the term 'nano' tell you about the carbon nanotubes?

.....

(1)

- (ii) Like graphite, each carbon atom in the carbon nanotube is joined to three other carbon atoms.

Explain why the carbon nanotube can conduct electricity.

.....

(2)

(Total 7 marks)

35

- (a) Which sub-atomic particles are present in the nucleus of an atom?

..... and

(2)

- (b) There are two isotopes of the element chlorine:



Describe, in terms of sub-atomic particles, **one** similarity and **one** difference between atoms of the two isotopes of chlorine.

Similarity

.....

Difference

.....

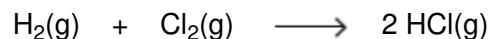
(2)

- (c) Chlorine reacts with hydrogen to produce hydrogen chloride.

- (i) The table shows the values of some bond dissociation energies.

Bond	H — H	Cl — Cl	H — Cl
Dissociation energy in kJ per mole	436	242	431

Use the values in the table to calculate the enthalpy change (ΔH) for the reaction.



.....

.....

.....

.....

.....

Enthalpy change (ΔH) = kJ per mole

(3)

(ii) Hydrogen also reacts with fluorine.



Draw an energy level diagram for this reaction.

Include on your diagram labels to show:

- the reactants and the products
- the overall enthalpy change (ΔH)
- the activation energy.

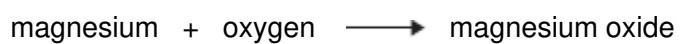
(3)
(Total 10 marks)



By Kingsway School [CC BY 2.0],
via Flickr

- (a) Use the Chemistry Data Sheet to help you to answer this question.

The word equation for magnesium burning is:

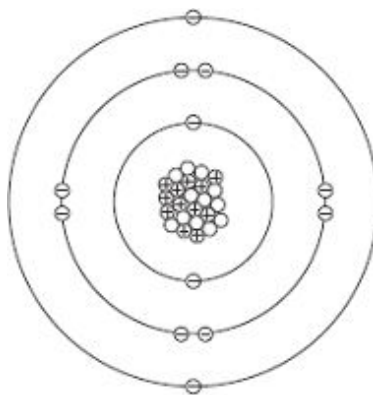


Draw **one** line from each substance to its correct description.

Substance	Description
magnesium	compound
magnesium oxide	metal
oxygen	mixture
	non-metal

(3)

- (b) The diagram represents a magnesium atom.



Complete the table to show the name of each particle and the charge of each particle in the magnesium atom.

Name of particle	Charge
proton	+1
neutron
.....	-1

(2)

- (c) Use the Chemistry Data Sheet to help you to answer these questions.

Draw a ring around the correct answer to complete each sentence.

- (i) In a magnesium atom, the protons and neutrons are in the

core.
nucleus.
shell.

(1)

- (ii) The number of protons in a magnesium atom is the

atomic number
mass number.
group number.

(1)

- (iii) The sum of the protons and neutrons in a magnesium atom is the

atomic number.
mass number.
group number.

(1)

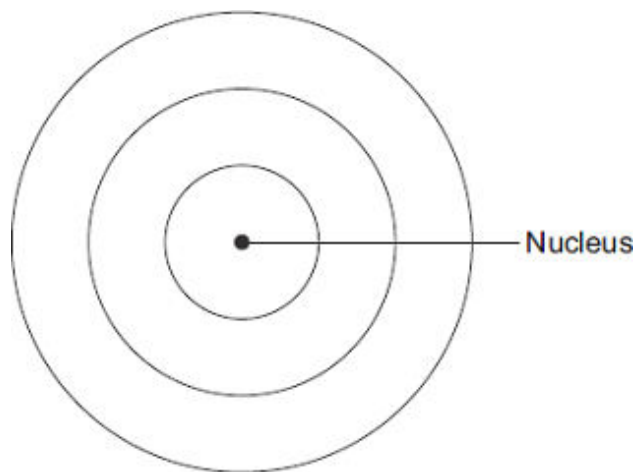
(Total 8 marks)

37

Aluminium has many uses.

(a) An aluminium atom has 13 electrons.

(i) Draw the electronic structure of an aluminium atom.



(1)

(ii) Name the **two** sub-atomic particles in the nucleus of an aluminium atom.

..... and

(1)

(iii) Why is there no overall electrical charge on an aluminium atom?

.....

.....

(1)

(b) Rail tracks are made from steel.

Molten iron is used to weld rail tracks.

The reaction of aluminium with iron oxide is used to produce molten iron.

(i) Balance the chemical equation for the reaction.



(1)

(ii) Why does aluminium react with iron oxide?

.....

.....

(1)

(Total 5 marks)

38

This question is about lithium and sodium.

- (a) Use the Chemistry Data Sheet to help you to answer this question.

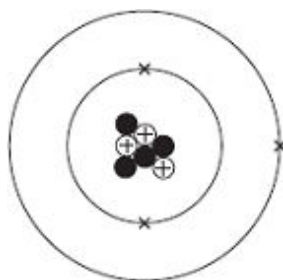
In which group of the periodic table are lithium and sodium?

Group

(1)

- (b) A lithium atom can be represented as ${}^7_3\text{Li}$

The diagram represents the lithium atom.



- (i) Some particles in the nucleus have a positive charge.

What is the name of these particles?

(1)

- (ii) Some particles in the nucleus have no charge.

What is the name of these particles?

(1)

- (iii) Use the correct answer from the box to complete the sentence.

3	4	7
---	---	---

The mass number of this atom of lithium is

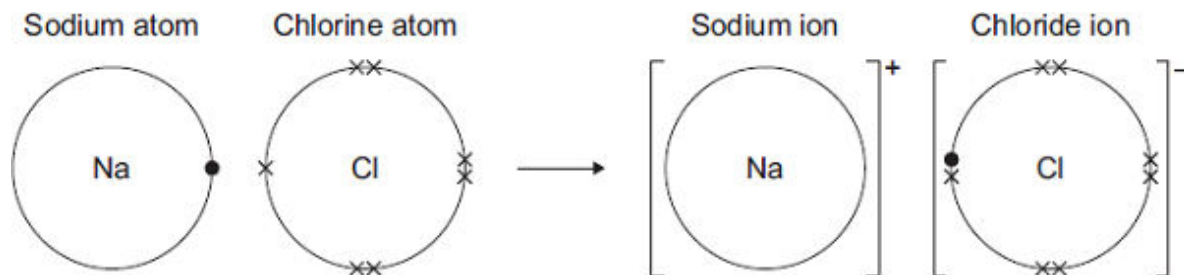
(1)

- (c) Sodium reacts with chlorine to produce sodium chloride.



The diagram shows how the reaction happens.

Only the outer electrons are shown.



Draw a ring around the correct answer to complete each sentence.

- (i) A sodium atom changes into a sodium ion by

gaining

losing

sharing

an electron.

(1)

- (ii)

A sodium ion has

a
negative

no

a positive

charge.

(1)

- (iii) The ions in sodium chloride are held together by strong

covalent

electrostatic

magnetic

forces.

(1)

- (d) Sodium chloride is an ionic compound.

Tick (✓) **two** properties of ionic compounds.

Property	Tick (✓)
Do not dissolve in water	
High melting points	
Low boiling points	
Strong bonds	

(2)

- (e) (i) The formula of sodium chloride is NaCl

Calculate the relative formula mass of sodium chloride.

Relative atomic masses: Na = 23; Cl = 35.5

.....

Relative formula mass =

(1)

- (ii) Draw a ring around the correct answer to complete each sentence.

The relative formula mass of a substance, in grams, is one

ion
isotope
mole

of the substance.

(1)

- (f) Nanoparticles of sodium chloride (salt) are used to flavour crisps.

What are nanoparticles?

.....

(1)
(Total 12 marks)

39

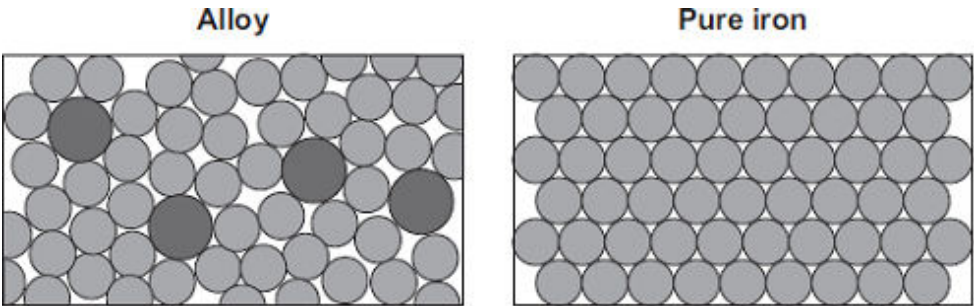
Oil rigs are used to drill for crude oil.



© Digital Vision/Photodisc

(a) Drills are made from an alloy of iron.

The diagrams show the particles in the alloy and in pure iron.



Use the diagrams to explain why the alloy is harder than pure iron.

.....

.....

.....

.....

(2)

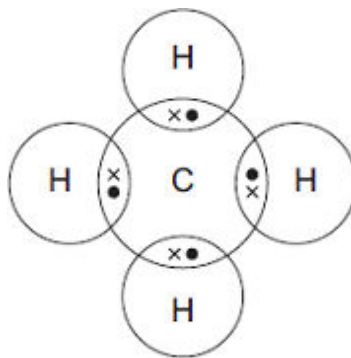
(b) Drill heads contain diamonds.

Tick (✓) **two** reasons why diamonds are hard.

Reason	Tick (✓)
Diamonds have a giant covalent structure.	
Diamonds have high melting points.	
Diamonds are unreactive.	
Diamonds have strong bonds between carbon atoms.	

(2)

- (c) Methane gas is often found where crude oil is found.
The diagram shows how atoms bond in methane.
Only the outer electrons are shown.



- (i) Draw a ring around the correct answer to complete the sentence.

Methane is

a compound.
an element.
a mixture.

(1)

- (ii) Draw a ring around the correct answer to complete each sentence.

The formula of methane is

C_4H_4
 C_4H
 CH_4

(1)

- (iii) Name the type of bond between the carbon and hydrogen atoms in methane.

.....

(1)

- (d) Explain why methane is a gas at 20°C.

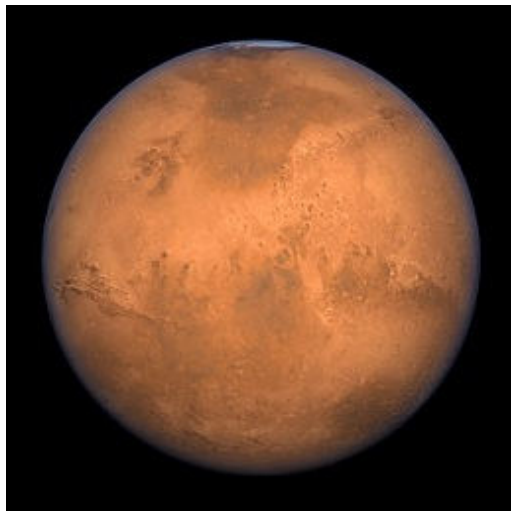
.....
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.....

(2)

(Total 9 marks)

40

Spacecraft have been to the planets Venus and Mars. The spacecraft have sent back information about the atmosphere of each planet.



© Tristan3D/Shutterstock

- (a) The main gas in the atmosphere of Mars is carbon dioxide.

Explain why, in terms of structure, carbon dioxide is a gas, even at low temperatures.

.....

.....

.....

.....

.....

.....

.....

(3)

- (b) The atmosphere on Venus contains droplets of sulfuric acid solution.

- (i) Suggest a pH value for sulfuric acid solution.

pH =

(1)

- (ii) Name the ion which makes sulfuric acid solution acidic.

.....

(1)

- (c) The atmosphere of Venus contains the isotopes ${}^2_1\text{H}$ and ${}^1_1\text{H}$

Describe the similarities and the differences in the isotopes ${}^2_1\text{H}$ and ${}^1_1\text{H}$

You should refer to the sub-atomic particles in each isotope.

.....

.....

.....

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.....

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(3)
(Total 8 marks)

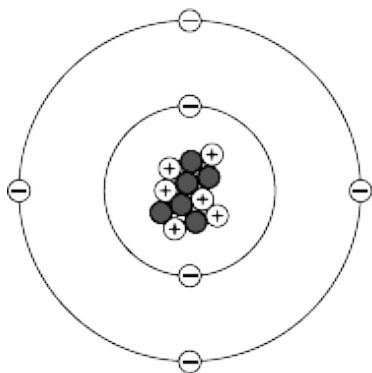
41

The picture shows a diamond ring.



Photograph supplied by Comstock/Thinkstock

- (a) Diamond is a form of carbon. The diagram represents a carbon atom.



Complete the table to show the name and charge of each type of particle in the carbon atom.

Name of particle	Charge
proton	
neutron	0
	-1

(2)

- (b) Use the Chemistry Data Sheet to help you to answer these questions.
- (i) Draw a ring around the correct answer to complete the sentence.

Gold and carbon are

compounds.
elements.
mixtures.

(1)

(ii) Complete the sentence.

Gold and carbon have different properties because gold is a metal
and carbon is a

(1)

(c) Draw a ring around the correct answer to complete each sentence.

Pure gold is not used to make the ring because pure gold is too

hard.
reactive.
soft.

The gold ring is made by mixing pure gold with other metals to form

a compound.
an atom.
an alloy.

(2)

- (d) The data in the table shows some information about the three metals in the gold ring.

Name of metal	Atomic number	Percentage (%) of metal
gold	79	
silver	47	16
copper	29	9

Draw **one** line from each question to its correct answer.

Question	Answer
What is the percentage of gold in this ring?	29
How many electrons are there in a copper atom?	61
How many neutrons are in an atom of silver with a mass number of 108?	75
	79

(3)
(Total 9 marks)

42

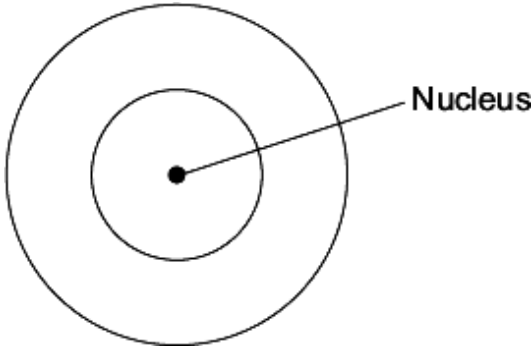
The picture shows a diamond ring.



Photograph supplied by Comstock/Thinkstock

(a) Diamond is a form of carbon. A carbon atom has six electrons.

Draw the electronic structure of a carbon atom.



(1)

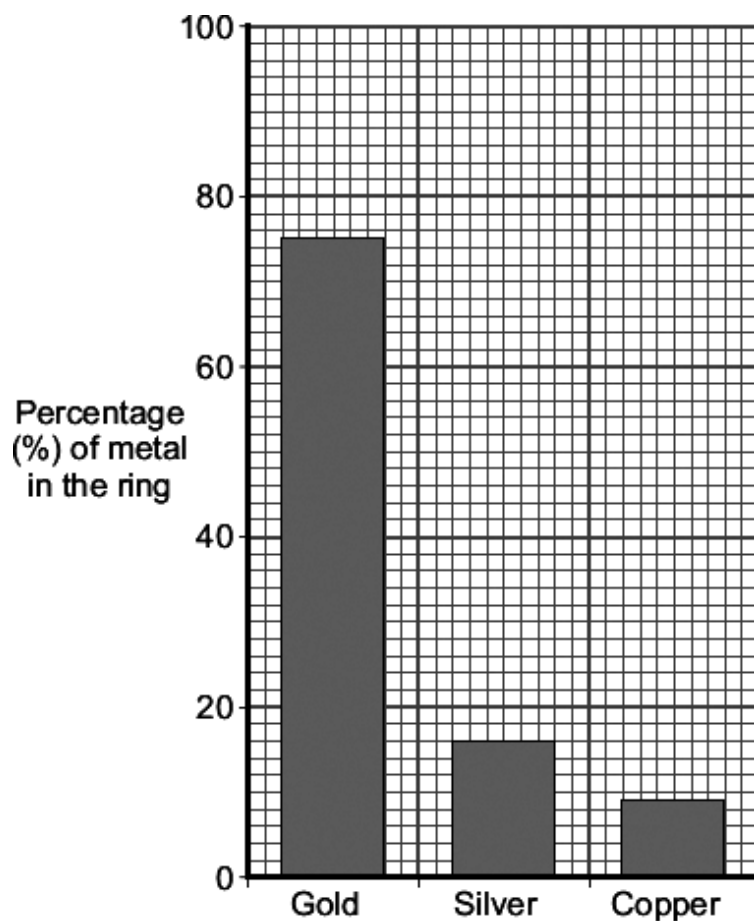
(b) A gold atom has an atomic number of 79 and a mass number of 197.

Complete the table to show the name and number of each sub-atomic particle in this gold atom.

Name	Number
Proton	79
Electron
.....

(3)

(c) The bar chart shows the composition of this gold ring.



- (i) Give the percentage of the other two metals in this gold ring.

Silver is % and copper is %

(1)

- (ii) This gold ring is not made from 100% gold.

Give **two** reasons why.

1

.....

.....

2

.....

.....


(2)


(Total 7 marks)


43

This question is about atoms and molecules.

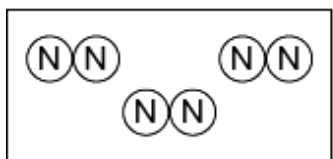
(a) In the diagrams below:

 is a nitrogen atom

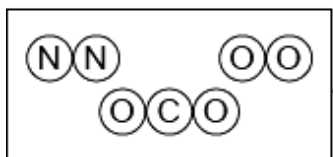
 is an oxygen atom

 is a carbon atom.

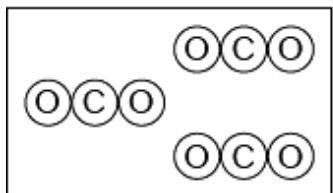
Draw **one** line from each diagram to its correct description.
One line has been done for you.

Diagram**Description**

Compound



Element



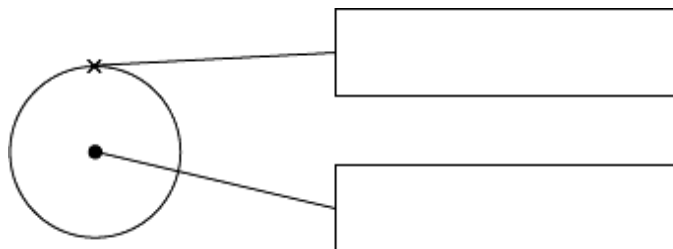
Mixture

Polymer

(2)

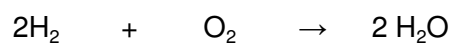
- (b) The diagram below shows a hydrogen atom.
Use words from the box to write the correct labels on the diagram.

alloy	electron	group	nucleus
-------	----------	-------	---------



(2)

- (c) This chemical equation represents the reaction of hydrogen burning.



Complete the sentence to describe what is happening in this chemical reaction.

Hydrogen reacts with

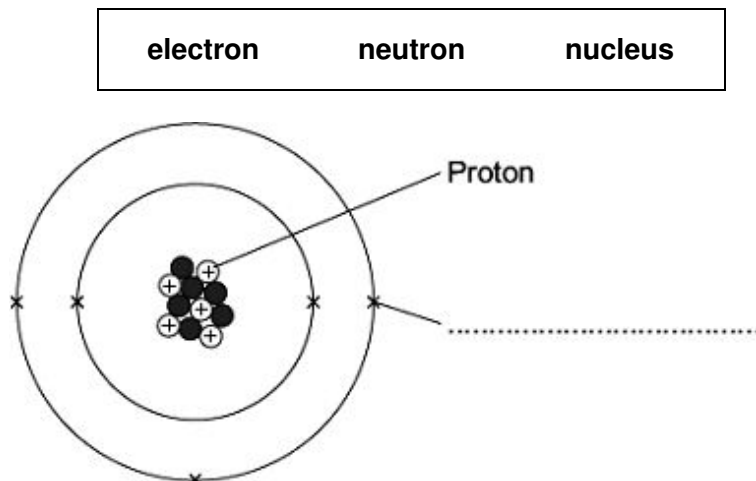
.....
.....
.....

(2)
(Total 6 marks)

44

The diagram represents an atom of an element.

- (a) Choose **one** word from the box to complete the label on the diagram.



- (b) (i) What is the atomic (proton) number of this atom? (1)

- (ii) Name the element. (1)

Use the periodic table on the Data Sheet to help you answer this question.

The name of the element is (1)

- (c) (i) Draw a ring around the mass number of this atom.

5 11 16

- (ii) Another atom of this element has a different mass number. (1)

Draw a ring around the correct word in the box to complete the sentence.

Atoms of the same element with different numbers of

electrons

neutrons

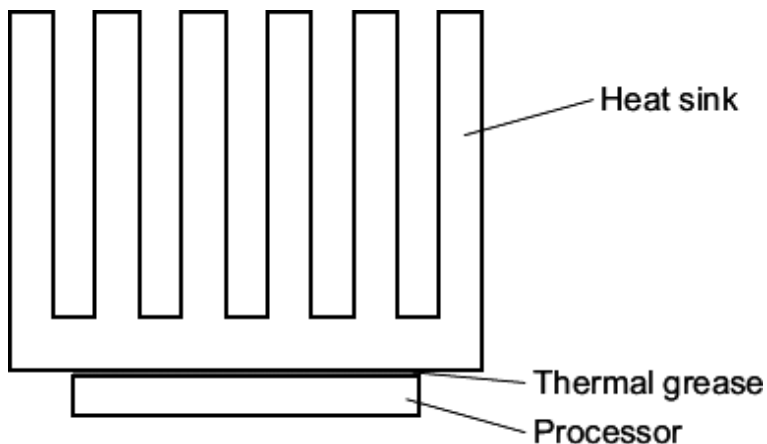
protons

are called isotopes.

(1)
(Total 5 marks)

45

The diagram shows how a heat sink is placed on top of a processor in a computer. The heat sink is a large piece of metal which conducts heat away from the processor. If the processor gets too hot it may be damaged.



- (a) (i) Describe the structure of a metal.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

- (ii) Why are metals very good conductors of heat?

.....

.....

(1)

- (b) When viewed under a microscope, it can be seen that the surfaces of the processor and the heat sink that are in contact are not flat.
There are lots of tiny gaps between the two surfaces.
The gaps contain air, which does not conduct heat very well.
Thermal grease is used to fill the gaps between the processor and the heat sink to improve the transfer of heat from the processor to the heat sink.

One type of thermal grease contains nanosized particles of silver.
The manufacturer claims that the nanosized particles help to transfer heat better than normal sized particles.

- (i) How are nanosized particles different from normal sized particles?

.....
.....

(1)

- (ii) Suggest **one** reason why nanosized particles of silver might help to transfer heat better than normal sized particles.

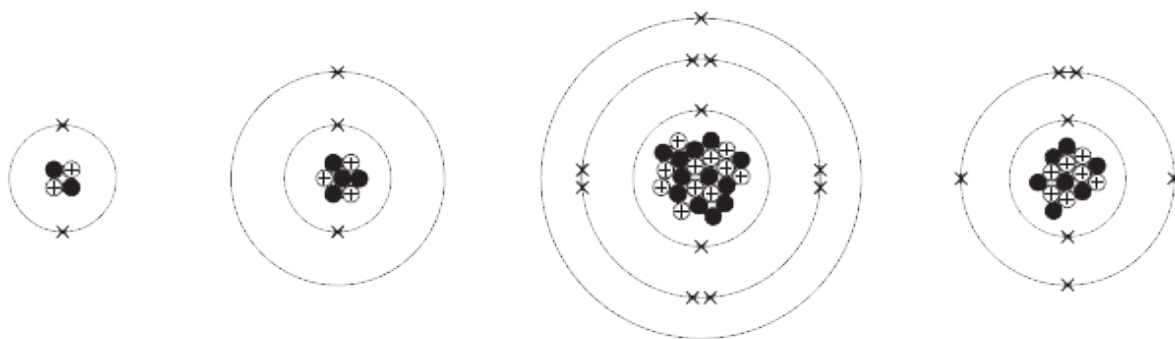
.....
.....

(1)

(Total 6 marks)

46

The diagrams show the sub-atomic particles in four different atoms.



Atom A

Atom B

Atom C

Atom D

Use the Chemistry Data Sheet to help you to answer these questions.

(a) Draw a ring around the correct answer to complete each sentence.

(i) The centre of each atom is called the

energy level.
molecule.
nucleus.

(1)

(ii) The centre of each atom contains neutrons and

bonds.
electrons.
protons.

(1)

(b) Complete the sentence.

There is no overall electrical charge on each atom because the
number of is equal to the number of

(1)

(c) What is the name of the element represented by atom **D**?

(1)

- (d) Which **two** of the atoms, **A**, **B**, **C** and **D**, are in the same group of the periodic table?

Give a reason for your answer.

Atom and atom

Reason

.....

(2)
(Total 6 marks)

47

Ethanol ($\text{C}_2\text{H}_5\text{OH}$) can be made from ethene or from sugar.

- (a) Complete the table which shows the number of atoms of each element in the formula of ethanol.

Use the Chemistry Data Sheet to help you to complete the table.

Element	Symbol	Number of atoms in the formula $\text{C}_2\text{H}_5\text{OH}$
Carbon	C	2
Hydrogen	H
.....	O	1

(2)

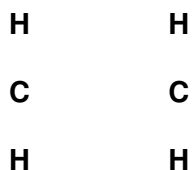
- (b) Ethene (C_2H_4) is produced when hydrocarbons are cracked.

- (i) Tick (✓) **two** conditions needed to crack a hydrocarbon.

Condition	Tick (✓)
The presence of an emulsifier.	
Heating the hydrocarbon to a high temperature.	
Adding oxygen to the hydrocarbon.	
The presence of a catalyst.	

(2)

- (ii) Draw the missing bonds to complete the displayed structure of ethene.



(1)

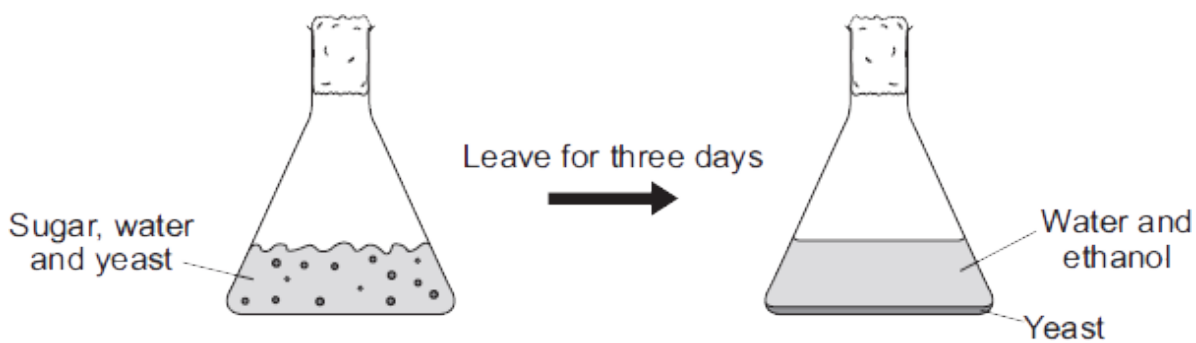
- (iii) Name the substance added to ethene (C_2H_4) to produce ethanol (C_2H_5OH).

.....

(1)

- (c) The diagram shows how a solution of ethanol is made from sugar dissolved in water.

The boiling point of ethanol is 78°C and the boiling point of water is 100°C .



- (i) Name the gas produced during this reaction.

.....

(1)

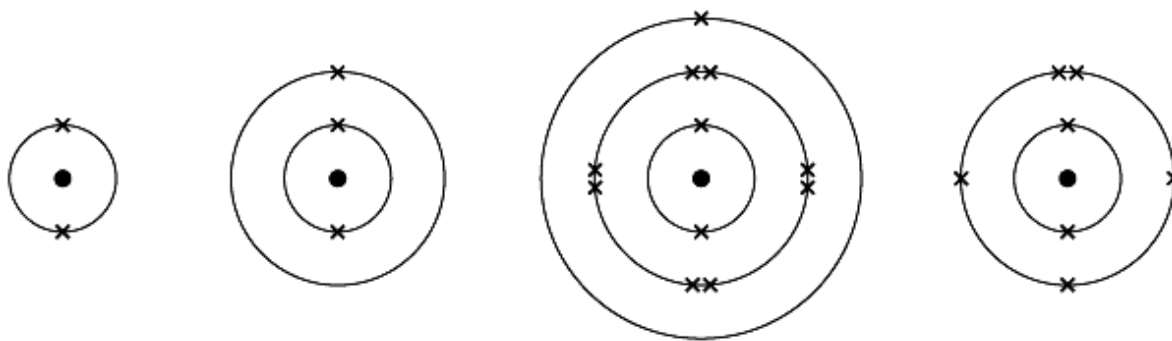
- (ii) What are the main steps needed to obtain pure ethanol from the mixture produced after three days?

.....

(2)

(Total 9 marks)

The diagrams show the electronic structure of four different atoms.

**Atom A****Atom B****Atom C****Atom D**

Use the Chemistry Data Sheet to help you to answer these questions.

- (a) Name the two sub-atomic particles in the nucleus of an atom.

.....

(1)

- (b) Why is there no overall electrical charge on each atom?

.....

.....

(1)

- (c) Why is **Atom A** unreactive?

.....

(1)

- (d) Which **two** of these atoms have similar chemical properties?
Give a reason for your answer.

.....

.....

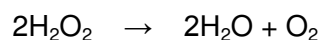
.....

.....

(2)
(Total 5 marks)

49

- (a) The symbol equation for the decomposition of hydrogen peroxide is:

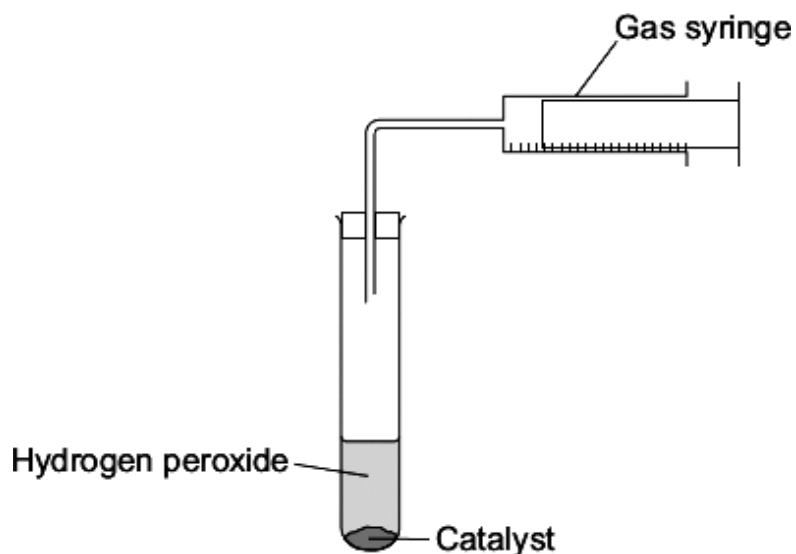


Complete the word equation for the decomposition of hydrogen peroxide.

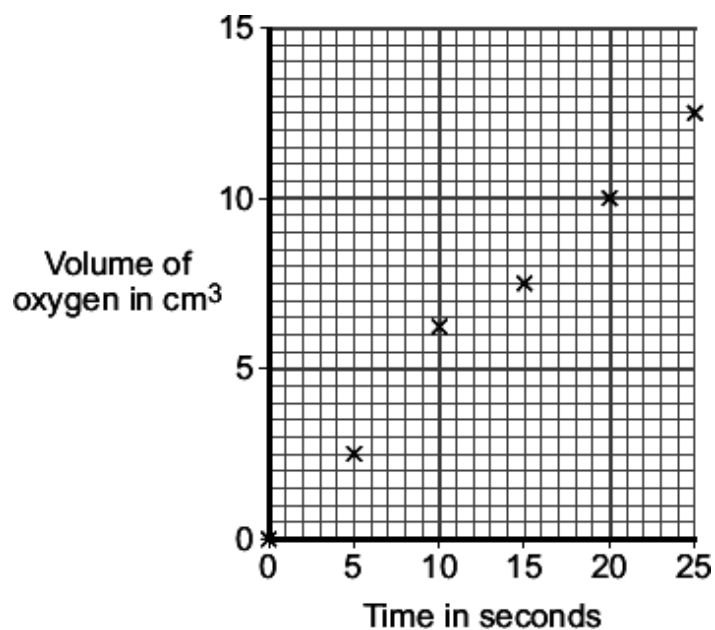
Hydrogen peroxide \rightarrow +

(1)

- (b) A student did an experiment to see how quickly hydrogen peroxide decomposes. The student used the apparatus shown below to measure the volume of oxygen.



- (i) Draw a straight line of best fit to complete the graph.



(1)

- (ii) Draw a circle around the anomalous point on the graph.

(1)

(iii) What is the volume of oxygen given off after 15 seconds?

..... cm³

(1)

(iv) How did the volume of oxygen change between 0 and 25 seconds?

.....

(1)

(c) The student wanted to make the reaction faster.

Draw a ring around the correct answer to complete each sentence.

(i) To make the reaction faster, the temperature should be

higher.

lower.

the same.

(1)

(ii) To make the reaction faster, the hydrogen peroxide should be

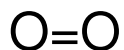
more dilute.

more concentrated.

the same.

(1)

(d) The diagram represents the bonding in oxygen.



Draw a ring around the correct answer to complete each sentence.

(i) When two oxygen atoms bond, the atoms

share

transfer

delocalise

electrons.

(1)

(ii) The oxygen atoms are joined by

ionic

metallic

covalent

bonds.

(1)

(iii) Oxygen is made of

simple molecules.
a giant lattice.
macromolecules.

(1)

- (e) When hydrogen peroxide decomposes water is produced.
Which **two** statements in the table explain why water is a liquid at room temperature?

Tick (✓) the **two** statements.

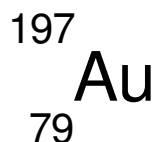
Statement	Tick (✓)
Water has a boiling point of 100 °C.	
Water is made of ions.	
Water has a melting point lower than room temperature.	
Water has a giant covalent structure.	

(2)
(Total 12 marks)

50

Gold and gold ions are used as catalysts.

- (a) An atom of gold is represented as:



Complete the sentences.

The atomic number of gold is

The number of electrons in an atom of gold is

(2)

- (b) Scientists have found that gold nanoparticles are very good catalysts.

Draw a ring around the correct answer to complete the sentence.

A gold nanoparticle contains a few

hundred
thousand
million

atoms.

(1)

- (c) The formation of a gold ion (Au^{3+}) from a gold atom (Au) is shown in the symbol equation.



- (i) Complete the sentence.

The particles lost when a gold atom becomes a gold ion

are called

(1)

- (ii) Draw a ring around the correct answer to complete the sentence.

The number of these particles lost when a gold atom becomes a gold ion is

one.
two.
three.

(1)

- (d) Gold ions are used as a catalyst in the reaction to make chloroethene.

How does a catalyst help a reaction?

.....

(1)

- (e) Chloroethene can react to make a thermosoftening polymer.

- (i) Draw a ring around the correct answer to complete the sentence.

When heated, a thermosoftening polymer will

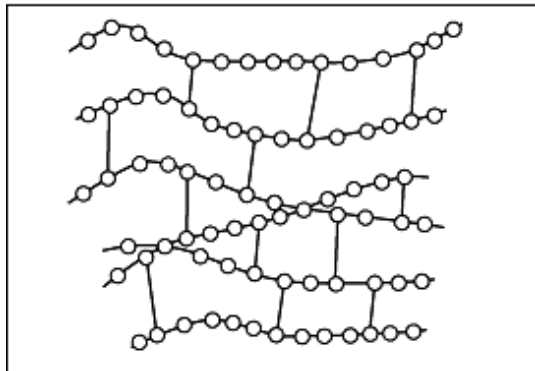
dissolve.
melt.
solidify.

(1)

- (ii) Polymer **B** is a different type of polymer.

The diagram shows the structure of polymer **B**.

Polymer B



How can you tell from the diagram that polymer **B** is **not** thermosetting?

.....

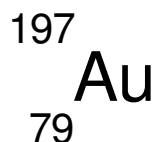
.....

(1)
(Total 8 marks)

51

This question is about gold (Au).

- (a) An atom of gold is represented as:



How many neutrons are in this atom of gold?

(1)

- (b) Gold ions are used as a catalyst.

How does a gold atom (Au) become a gold ion (Au^{3+})?

.....

.....

.....

.....

(2)

- (c) A gold catalyst can be used when carbon monoxide reacts with oxygen to make carbon dioxide.

- (i) Complete and balance the equation for this reaction.



(2)

- (ii) Carbon dioxide has a very low boiling point.

Explain why.

.....

.....

.....

.....

.....

.....

(3)

- (d) Gold is used as a catalyst in industrial processes. Gold is rare and increasingly expensive.

Suggest **three** reasons why gold is still used in industrial processes.

.....

.....

.....

.....

.....

.....

(3)

(Total 11 marks)

52

This question is about calcium hydroxide.

Ancient artworks and monuments can be protected from acid rain if the surface is sprayed with calcium hydroxide nanoparticles.



By Svilen Enev (Own work) [GFDL or CC-BY-SA-3.0], via Wikimedia Commons

- (a) Calcium hydroxide has the formula $\text{Ca}(\text{OH})_2$

Why are there two hydroxide ions for each calcium ion in the formula?

.....

.....

.....

(1)

- (b) The calcium hydroxide is used in the form of *nanoparticles*.

What are *nanoparticles*?

.....

.....

(1)

- (c) A student added water to calcium oxide to make calcium hydroxide.

The equation for the reaction is shown below.



Calculate the maximum mass of calcium hydroxide which could be made from 2.00 g of calcium oxide.

Relative atomic masses (A_r): H = 1; O = 16; Ca = 40.

.....

.....

.....

.....

.....

.....

Maximum mass of calcium hydroxide = g

(3)
(Total 5 marks)

53

 Iron is extracted from its ore.

(a) Iron ore is quarried.



Photograph supplied by Stockbyte/Thinkstock

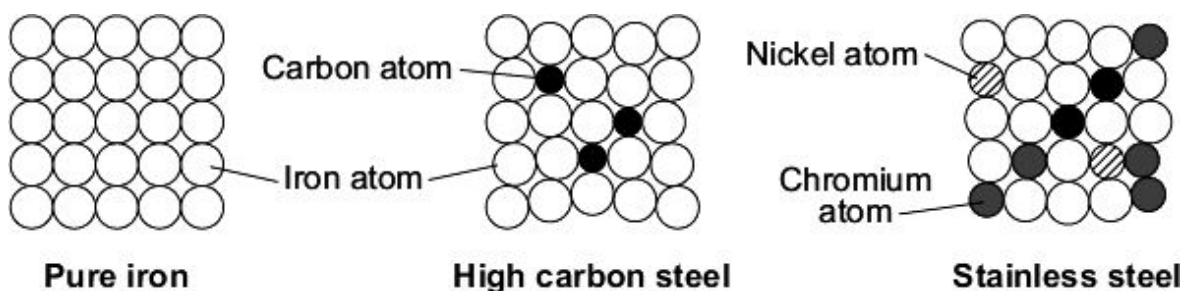
Quarrying iron ore has impacts that cause environmental problems.

Tick (✓) **two** impacts of quarrying that cause environmental problems.

Impact of quarrying	Tick (✓)
puts off tourists	
causes dust pollution	
increases jobs	
increases traffic	

(2)

(b) The diagrams represent the atoms in iron and the atoms in two alloys of iron.



Use the diagrams to help you to answer these questions.

(i) Complete the sentence.

Pure iron does **not** have many uses because

.....

(1)

(ii) Stainless steel is more expensive than pure iron.

Suggest why.

.....

.....

(1)

(c) Draw a ring around the correct answer to complete each sentence.

- (i) Pure iron is
- | |
|-------------|
| a compound. |
| an element. |
| a mixture. |

(1)

(ii) High carbon steel is used for a drill bit because it is

- | |
|--------------|
| brittle. |
| easily bent. |
| hard. |

(1)

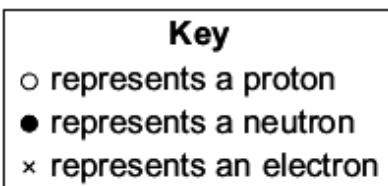
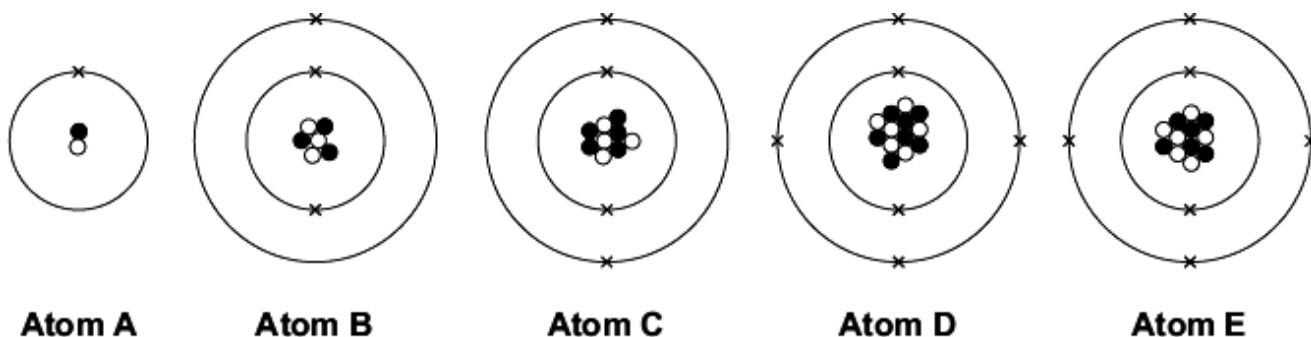
(iii) Stainless steel is used to make cutlery because it

contains three different atoms.
melts at a very high temperature.
is resistant to corrosion.

(1)
(Total 7 marks)

54

The diagrams show five different atoms, **A**, **B**, **C**, **D** and **E**.



(a) Which atom, **A**, **B**, **C**, **D** or **E**:

(i) has an atomic number (proton number) of 3

Atom

(1)

(ii) has a mass number of 2

Atom

(1)

(iii) is in Group 2 of the periodic table?

Atom

(1)

- (b) Which **two** atoms from **A**, **B**, **C**, **D** and **E** are isotopes of the same element?

Atom and Atom

(1)

- (c) Which particle in an atom has a negative charge?

(1)

(Total 5 marks)

55

Stage smoke is used for special effects at pop concerts.



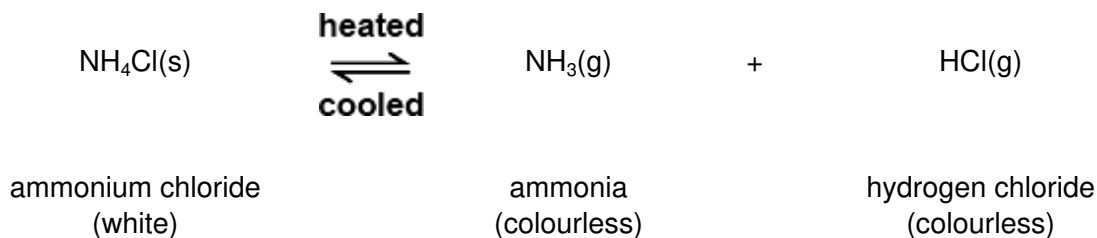
By Sam Cockman [CC BY 2.0], via Flickr

Ammonium chloride can be used to make stage smoke.

Ammonium chloride is a white solid.

When heated, ammonium chloride produces white smoke which can be blown onto the stage.

The equation shows what happens when ammonium chloride is heated and cooled.



- (a) The sentences explain how the smoke is made.

Draw a ring around the correct answer in each box to complete each sentence.

Use the information and the equation to help you.

When heated, ammonium chloride makes two colourless

solids.

liquids.

gases.

These are blown into the air where they cool and make a

colourless

black

white

solid.

liquid.

gas.

ammonia.

which is

ammonium chloride.

hydrogen chloride.

(4)

- (b) Complete the sentence.

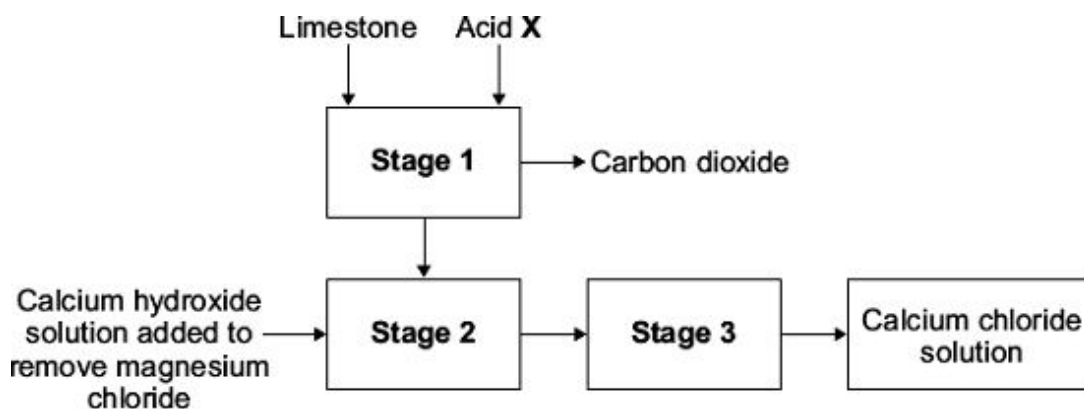
The symbol \rightleftharpoons means that the reaction is

(1)

(Total 5 marks)

56

- (a) Calcium chloride is made from limestone. Limestone contains mainly calcium carbonate and a small amount of magnesium carbonate.



- (i) In **stage 1** calcium carbonate reacts with acid **X** to form calcium chloride.

Draw a ring around the name of acid **X**.

hydrochloric

nitric

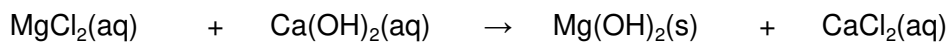
sulfuric

(1)

- (ii) **Stage 1** produces a concentrated solution of calcium chloride.
The solution also contains magnesium chloride.

Calcium hydroxide solution is added in **stage 2** to remove the magnesium chloride.

The equation for this reaction is:



Draw a ring around the correct answer to complete each sentence.

In **stage 2** a precipitate is made because magnesium hydroxide is

dissolved

insoluble

in water.

soluble

In **stage 3** the solid magnesium hydroxide can be separated from the calcium chloride

solution using

chromatography.

electrolysis.

filtration.

(2)

- (iii) What method can be used to change the calcium chloride solution into solid calcium chloride?

Draw a ring around your answer.

crystallisation

electrolysis

reduction

(1)

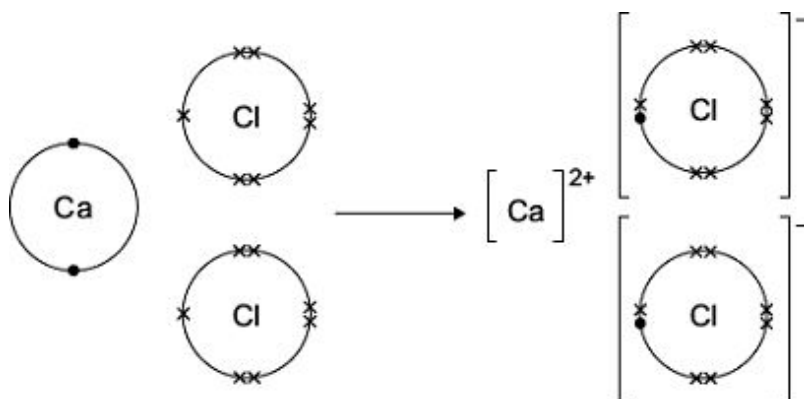
(b) Calcium chloride can also be made by reacting calcium with chlorine:



The diagram shows what happens to atoms of calcium and chlorine in this reaction.

The dots (•) and crosses (x) are used to represent electrons.

Only the outer electrons are shown.



Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when calcium reacts with chlorine to make calcium chloride.

.....

.....

.....

.....

.....

.....

.....

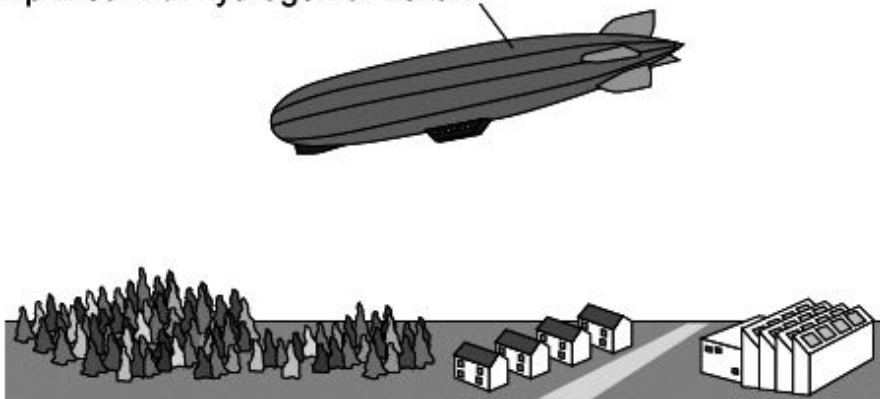
.....

(4)
(Total 8 marks)

57

Hydrogen and helium have both been used in airships.

Airship filled with hydrogen or helium



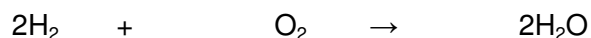
- (a) Tick (✓) the property which both hydrogen and helium have that makes an airship float in air.

Property	Tick (✓)
Colourless	
Less dense than air	
More dense than air	

(1)

- (b) (i) Hydrogen is no longer used in airships because it burns in oxygen.

The chemical equation for this reaction is shown.



Complete the word equation for this reaction

hydrogen + oxygen →

(1)

- (ii) Helium is safer than hydrogen because it does **not** burn in oxygen.

Draw a ring around the correct answer to complete the sentence.

Helium is now used in airships because it is

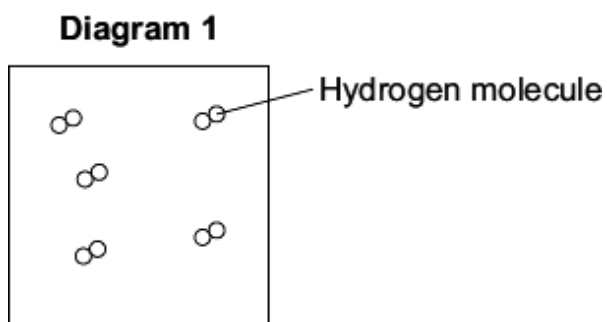
a fuel.

already in the air.

unreactive.

(1)

- (c) **Diagram 1** represents hydrogen molecules.



Draw a ring around the correct answer to complete the sentence.

Each hydrogen molecule is made up of two hydrogen

atoms.

compounds.

elements.

(1)

- (d) **Diagram 2** shows the parts of a helium atom.

Use words from the box to label **diagram 2**.

bond	electron	nucleus
------	----------	---------



(2)
(Total 6 marks)

58

Titanium is used for replacement hip joints because it has a low density, is strong and does not corrode.

Titanium is extracted from titanium dioxide (TiO_2) in three stages.

(a) **Stage 1**

Titanium dioxide is converted into titanium chloride (TiCl_4) because the metal cannot be extracted from its oxide by *reduction* with carbon.

(i) What does *reduction* mean?

.....

(1)

(ii) Balance the chemical equation for the conversion of titanium dioxide to titanium chloride.



(1)

(iii) Chemical equations are always balanced. Explain why.

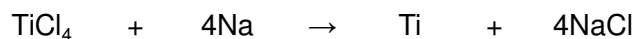
.....

(1)

(b) **Stage 2**

Titanium is extracted from the titanium chloride by reacting it with sodium at 1000 °C in a reactor.

The only other substance in the reactor is argon gas.



(i) What does this tell you about the reactivity of sodium compared with titanium?

.....

(1)

(ii) Suggest why the reactor contains argon and **not** air.

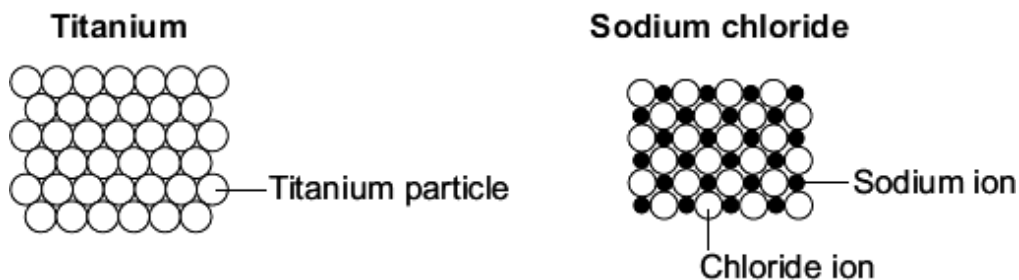
.....

(1)

(c) **Stage 3**

After **Stage 2** the titanium is separated from the products by washing out the sodium chloride with water.

The diagrams show sections through the lattice of titanium metal and the lattice of sodium chloride.



How do the diagrams show that:

- (i) titanium is an element

.....

.....

(1)

- (ii) sodium chloride is a compound?

.....

.....

.....

.....

(2)

(Total 8 marks)

59

- (a) A magnesium atom contains 12 protons (●), 12 neutrons (○) and 12 electrons (x).

Which diagram, **A**, **B** or **C**, represents this magnesium atom?

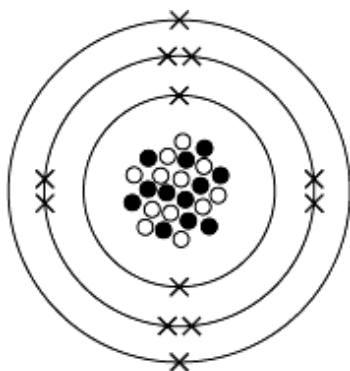


Diagram A

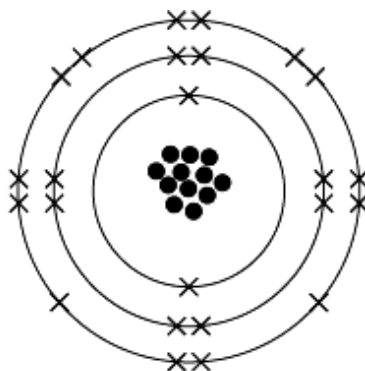


Diagram B

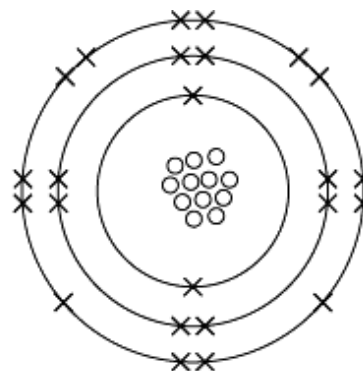
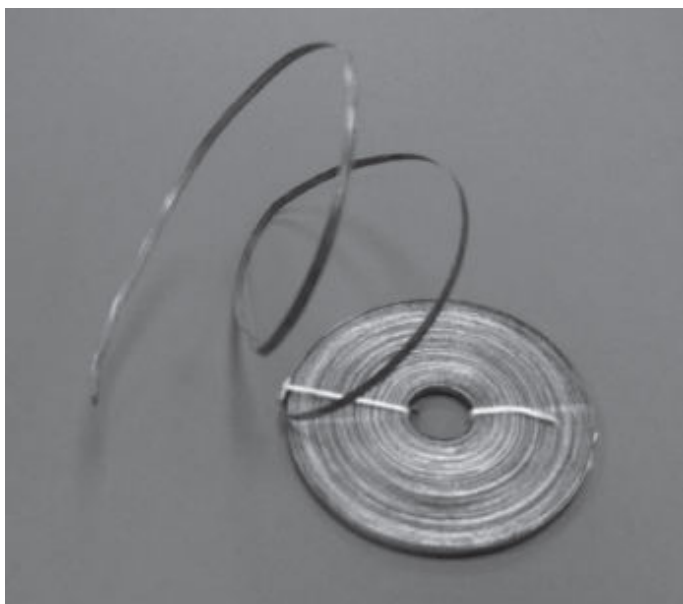


Diagram C

This magnesium atom is **Diagram**

(1)

- (b) Magnesium metal is shaped to make magnesium ribbon.



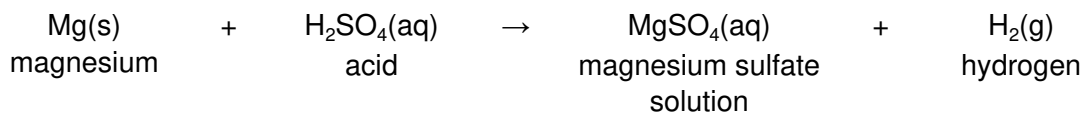
Tick (✓) **two** reasons which explain why metals can be shaped.

Reason why	Tick (✓)
The atoms are all joined by covalent bonds.	
The atoms can slide over each other.	
The atoms are large.	
The atoms are in layers.	

(2)

- (c) Magnesium sulfate is a salt of magnesium.

It can be prepared by the reaction of magnesium metal with an acid. The equation for the reaction of magnesium with this acid is:



- (i) Draw a ring around the name of the acid used in this reaction.

hydrochloric

nitric

sulfuric

(1)

- (ii) Use the equation to help you to answer this question.

Tick (✓) **two** things that happen when this reaction takes place.

	Tick (✓)
Bubbles are produced.	
The magnesium disappears.	
A solid is formed.	
Water is formed.	

(2)

- (iii) Draw a ring around a method to get solid magnesium sulfate from magnesium sulfate solution.

crystallisation

electrolysis

oxidation

(1)

(Total 7 marks)

60

Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



- (a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO.

(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

- (i) Calculate the relative atomic mass (A_r) of metal M.

.....

.....

.....

Relative atomic mass (A_r) =

(2)

- (ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M.

The name of metal M is

(1)

- (b) The other metal oxide is iron(III) oxide.

This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

- (i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

.....

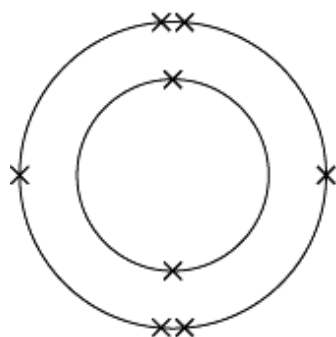
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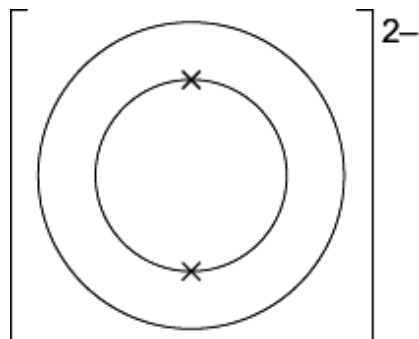
.....

(2)

- (ii) The diagram below represents the electronic structure of an oxygen atom (O).



Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).



(1)

(Total 6 marks)