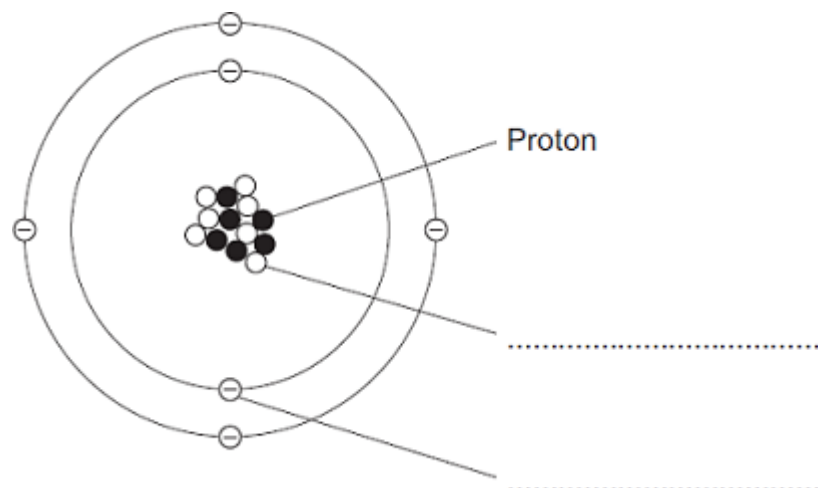


## Atomic Structure- 2

### Q1.

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
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(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

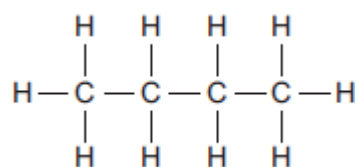
(1)

- (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.

<b>bond</b>	<b>compound</b>	<b>helium</b>	<b>hydrogen</b>	<b>mixture</b>	<b>oxygen</b>
-------------	-----------------	---------------	-----------------	----------------	---------------

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.

C<sub>4</sub>H<sub>4</sub>

C<sub>4</sub>H<sub>8</sub>

C<sub>4</sub>H<sub>10</sub>

(1)

(Total 8 marks)

## Q2.

Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, SO<sub>2</sub>

- (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.

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(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.

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(3)

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

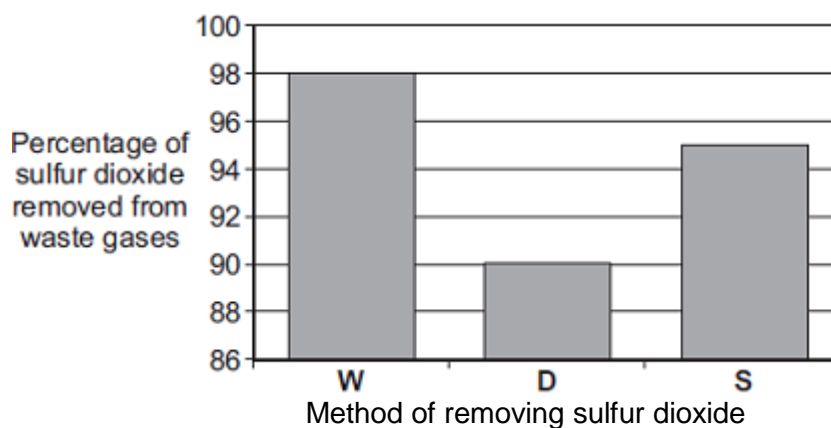
Sulfur dioxide is produced when fossil fuels are burned.

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**.

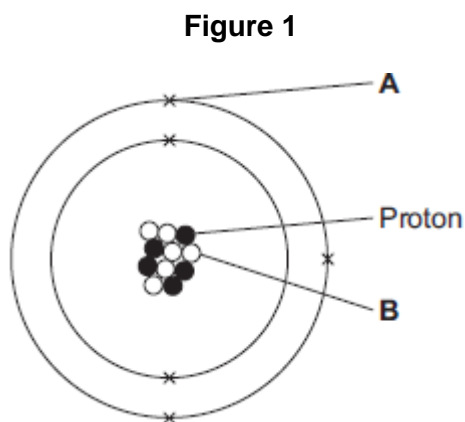


**Table 1**



**Q3.**

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



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

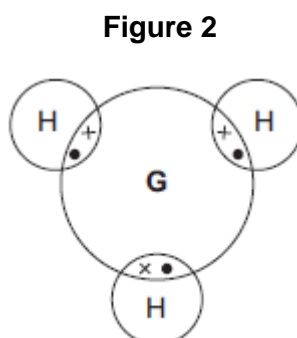
**boron**

**carbon**

**sodium**

(1)

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



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



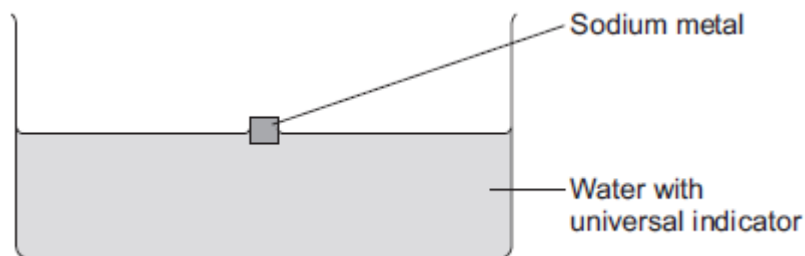
(v) an element that forms a chloride with the formula XCl

\_\_\_\_\_

(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)

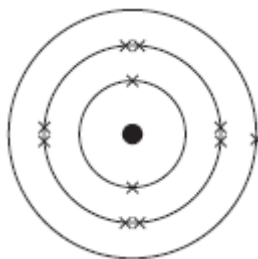
(ii) Name the ion that made the universal indicator turn purple.

\_\_\_\_\_

(1)

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

**Figure 3**



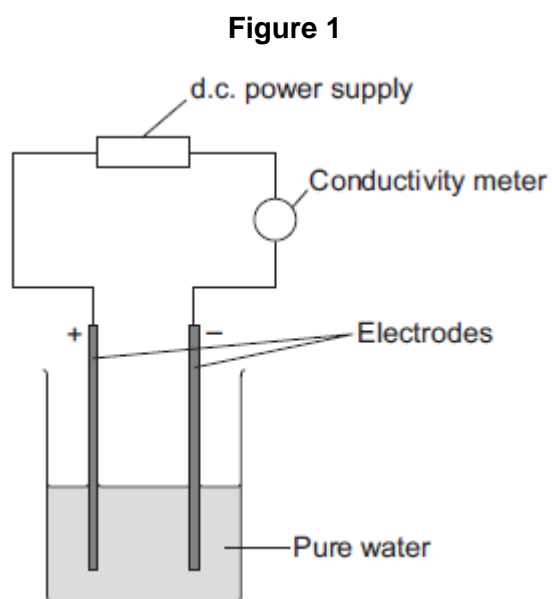
In the space below, draw the electronic structure of a sodium ion. Include the charge on the ion.

(2)  
(Total 11 marks)

**Q5.**

A student investigated the conductivity of different concentrations of sodium chloride solution.

The student set the apparatus up as shown in **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.



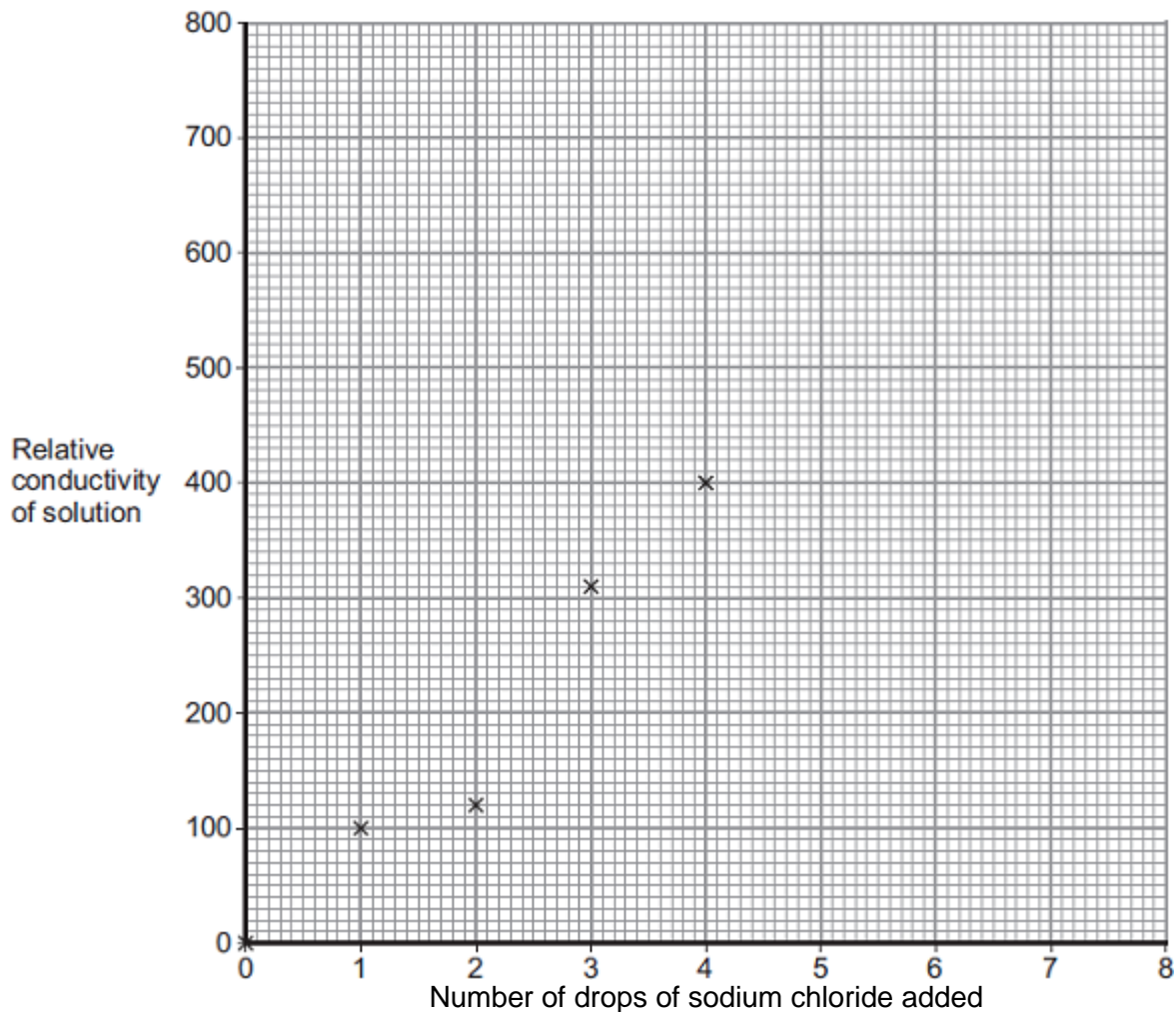
Number of drops of sodium chloride solution added	Relative conductivity of solution
0	0
1	100
2	120
3	310
4	400
5	510
6	590
7	710
8	800

(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.

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(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.

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(1)

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

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(2)

(ii) Explain why sodium chloride solution conducts electricity.

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(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)

### Q6.

Use the periodic table and the information in the table below to help you to answer the questions.

The table shows part of an early version of the periodic table.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl

(a) Hydrogen was placed at the top of Group 1 in the early version of the periodic table.

The modern periodic table does **not** show hydrogen in Group 1.

(i) State one **similarity** between hydrogen and the elements in Group 1.

---

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(1)

(ii) State one **difference** between hydrogen and the elements in Group 1.

---

---

(1)

(b) Fluorine, chlorine, bromine and iodine are in Group 7, the halogens.

The reactivity of the halogens decreases down the group.

Bromine reacts with a solution of potassium iodide to produce iodine.



- (i) In the reaction between bromine and potassium iodide, there is a reduction of bromine to bromide ions.

In terms of electrons, what is meant by reduction?

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(1)

- (ii) Complete the half equation for the oxidation of iodide ions to iodine molecules.



(2)

- (iii) Explain, in terms of electronic structure, why fluorine is the most reactive element in Group 7.

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(3)

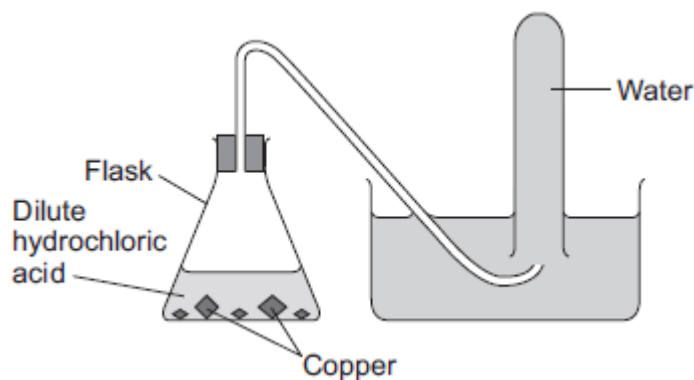
(Total 8 marks)

### Q7.

A student was trying to produce hydrogen gas.

Figure 1 shows the apparatus she used.

Figure 1



- (a) No gas was produced.

The student's teacher said that this was because the substances in the flask did **not** react.

- (i) Suggest why the substances in the flask did **not** react.

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(1)

- (ii) Which two substances could the student have put in the flask to produce hydrogen safely?

Tick (✓) **one** box.

Gold and dilute hydrochloric acid

Potassium and dilute hydrochloric acid

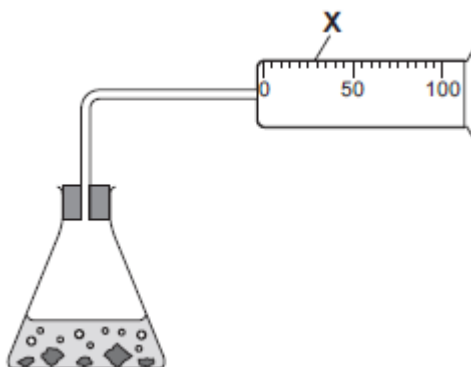
Zinc and dilute hydrochloric acid

(1)

- (b) Another student did produce hydrogen from two substances.

**Figure 2** shows the apparatus the student used to collect and measure the volume of the hydrogen gas.

**Figure 2**



Give the name of the apparatus labelled **X**.

---

(1)

- (c) The student did the experiment four times. Her results are shown in the table below.

Experiment	Volume of hydrogen collected in one minute in $\text{cm}^3$
------------	---

1	49
2	50
3	35
4	48

- (i) One of the results is anomalous.

Which result is anomalous? Write your answer in the box.

Give a reason for your choice.

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(2)

- (ii) Calculate the mean volume of hydrogen collected in one minute.

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Mean volume = \_\_\_\_\_ cm<sup>3</sup>

(2)

- (iii) Give a reason why the experiment should be repeated several times.

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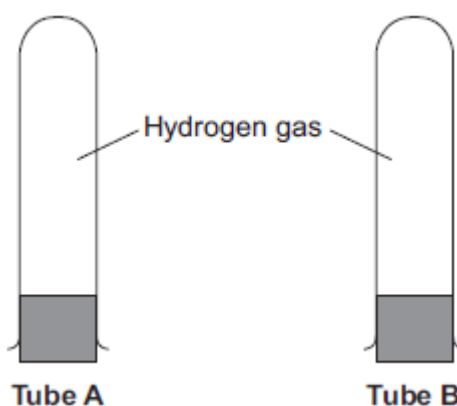


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(1)

- (d) A teacher collected two tubes full of hydrogen gas, as shown in **Figure 3**.

**Figure 3**



She tested tube **A** with a lighted splint as soon as she took the bung out.

She tested tube **B** with a lighted splint a few seconds after taking the bung out.

- (i) Suggest why tube **B** gave a much louder pop than tube **A**.

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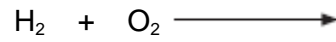
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(1)

- (ii) Complete and balance the chemical equation for the reaction that takes place when the hydrogen reacts in this test.



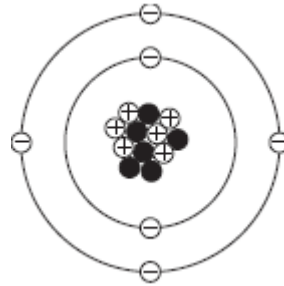
(2)

(Total 11 marks)

**Q8.**

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
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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

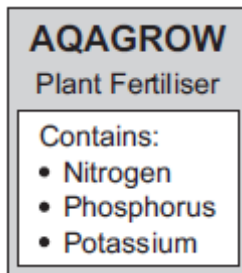
(3)

(Total 8 marks)

**Q9.**

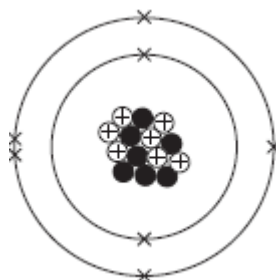
Fertilisers contain elements that plants need.





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

**Figure 1**



Complete each sentence.

(i) The mass number of this nitrogen atom is \_\_\_\_\_ .

(1)

(ii) Atoms of nitrogen with different numbers of neutrons are called

\_\_\_\_\_ .

(1)

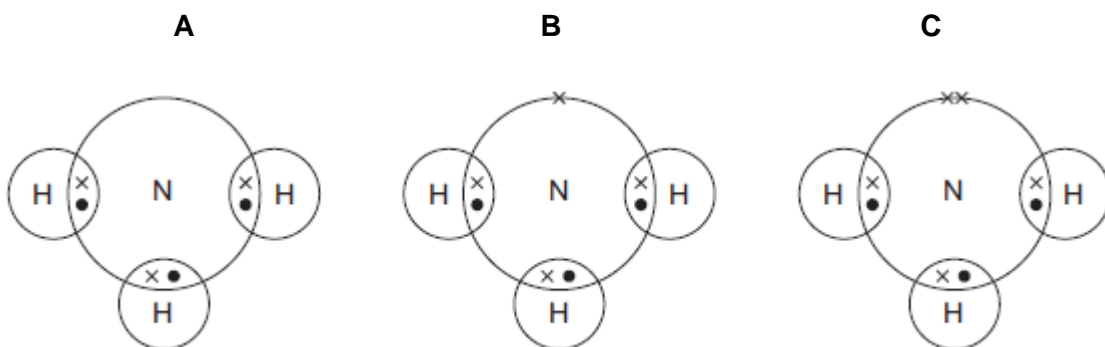
(iii) Compared with a proton, the mass of an electron is

\_\_\_\_\_ .

(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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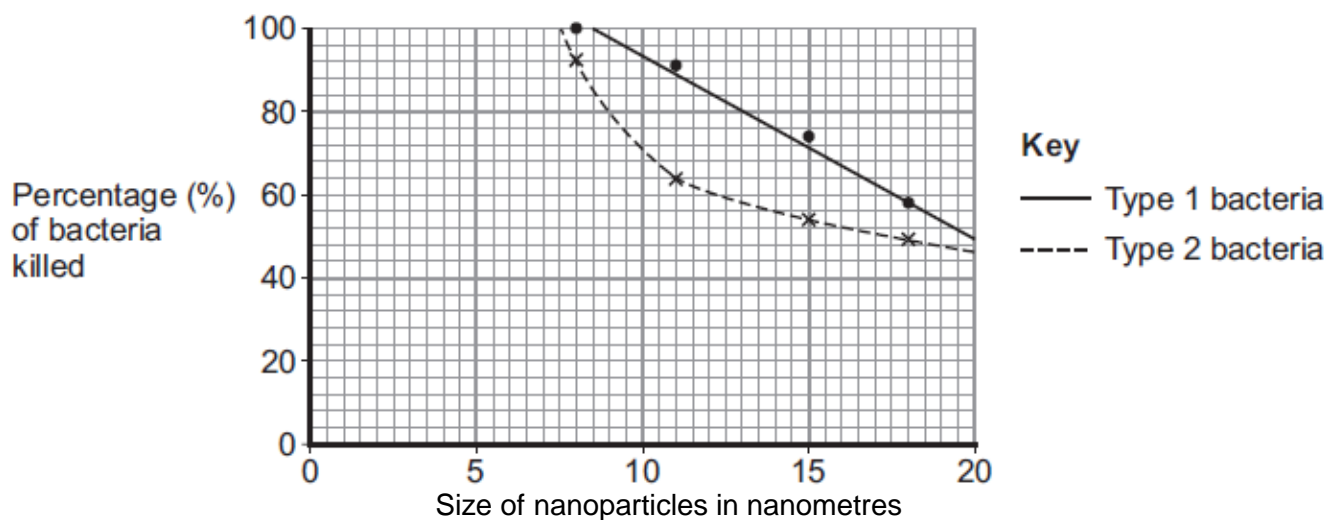
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(4)  
(Total 13 marks)

**Q10.**

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.

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(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.

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(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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(4)

(Total 7 marks)

**Q11.**

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.

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(1)

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

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

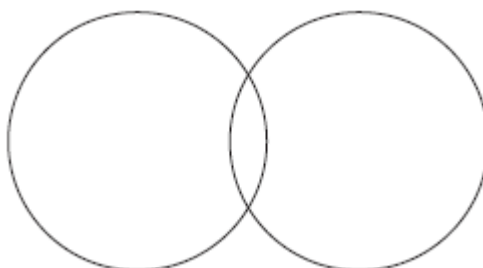
Give the formula of sodium oxide.

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(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 ( $\text{O}_2$ ).



(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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(3)  
(Total 7 marks)

**Q12.**

This question is about the periodic table of elements.

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

In 1869 Dmitri Mendeleev produced an early version of the periodic table.

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

(i) Mendeleev first arranged the elements in order of

their

atomic weight.
date of discovery.
electron number.

(1)

(ii) Mendeleev then placed elements with similar properties in columns

called

groups.
periods.
shells.

(1)

(iii) When the next element did not fit the pattern,

Mendeleev

ignored the element.
left a gap.
put the element at the end of the row.

(1)

(iv) Mendeleev was not able to include the noble gases (Group 0) in his periodic

table because the noble gases

are not elements.

are not reactive.

had not been discovered by 1869.

(1)

- (b) Use the correct word from the box to complete each sentence.

**electrons      molecules      neutrons      protons**

In the modern periodic table elements are arranged in order of the number of \_\_\_\_\_ in their nucleus. Elements in the same group have the same number of \_\_\_\_\_ in their highest energy level (outer shell).

(2)

- (c) Sodium (Na) is in Group 1 of the periodic table.

Nickel (Ni) is a transition element.

Tick (✓) **two** correct statements about sodium and nickel.

Statement	Tick (✓)
Sodium and nickel are both metals.	
Sodium has a higher melting point than nickel.	
Sodium is more reactive than nickel.	
Sodium is harder than nickel.	

(2)

- (d) Chlorine, bromine and iodine are in Group 7 of the periodic table.

Chlorine is more reactive than bromine.

- (i) Complete the word equation for the reaction between chlorine and sodium bromide.

chlorine + sodium bromide  $\longrightarrow$  \_\_\_\_\_ + sodium chloride

(1)

- (ii) Why does iodine **not** react with sodium bromide solution?

\_\_\_\_\_  
\_\_\_\_\_

(1)

(Total 10 marks)

**Q13.**

In 1869, Dmitri Mendeleev produced his periodic table of the elements.

Mendeleev placed the alkali metals in the same group.

- (a) What evidence did Mendeleev use to decide that the alkali metals should be in the same group?

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(1)

- (b) Describe how the elements in the modern periodic table are arranged:

- (i) in terms of protons

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(1)

- (ii) in terms of electrons.

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(1)

- (c) State **two** properties of transition elements that make them more useful than alkali metals for making water pipes.

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(2)

- (d) Describe and explain the trend in reactivity of the alkali metals (Group 1).

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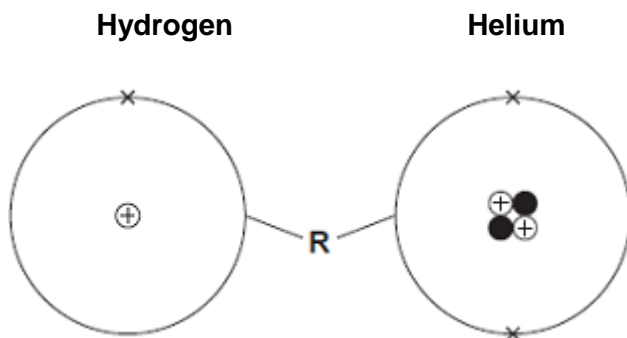
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**Q14.**

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?

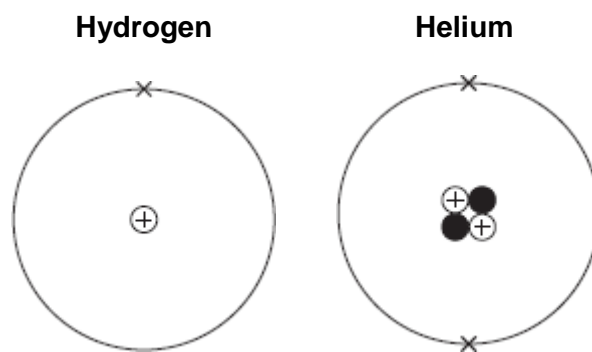
\_\_\_\_\_

(1)

(Total 8 marks)

**Q15.**

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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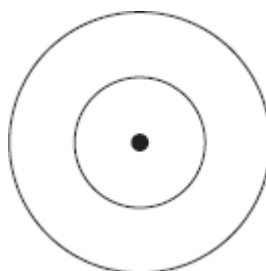
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(3)

- (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?

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(1)

(Total 5 marks)

### Q16.

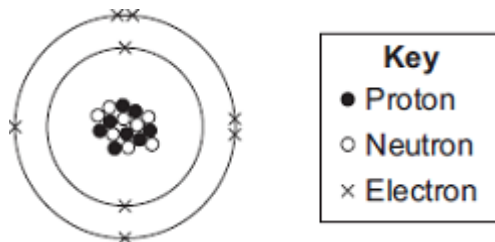
This question is about atoms and molecules.

- (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.

<b>8</b>	<b>16</b>	<b>18</b>	<b>24</b>
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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.

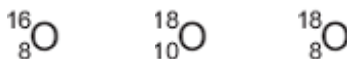
molecules.

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.

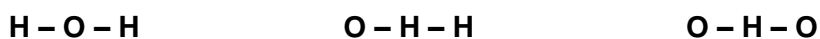
- (i) Use the correct answer to complete the sentence.

<b>a compound</b>	<b>an element</b>	<b>a mixture</b>
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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)

**Q17.**

Kelp is a seaweed.

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



© Ethan Daniels/Shutterstock

- (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.

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(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 ( $\text{Na}^+$ ) and iodide ions ( $\text{I}^-$ ).

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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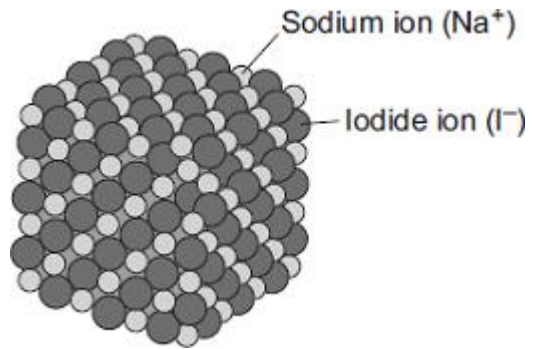
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(3)

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



Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

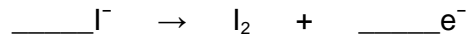
\_\_\_\_\_

\_\_\_\_\_

(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.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

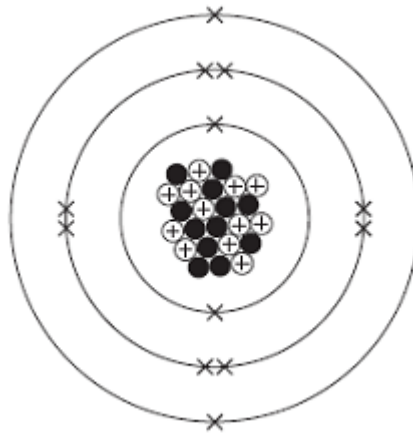
\_\_\_\_\_

(2)

(Total 11 marks)

### Q18.

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)



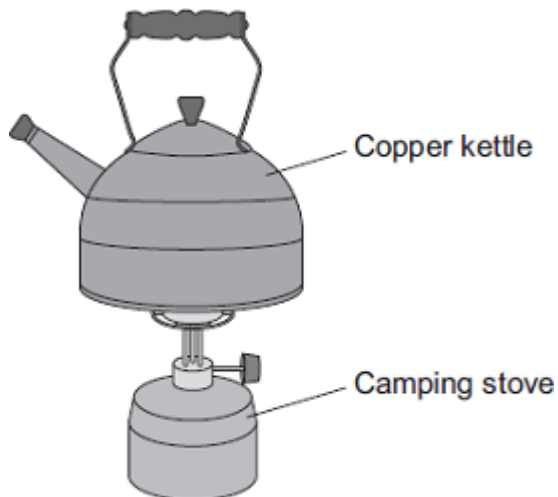


**Q19.**

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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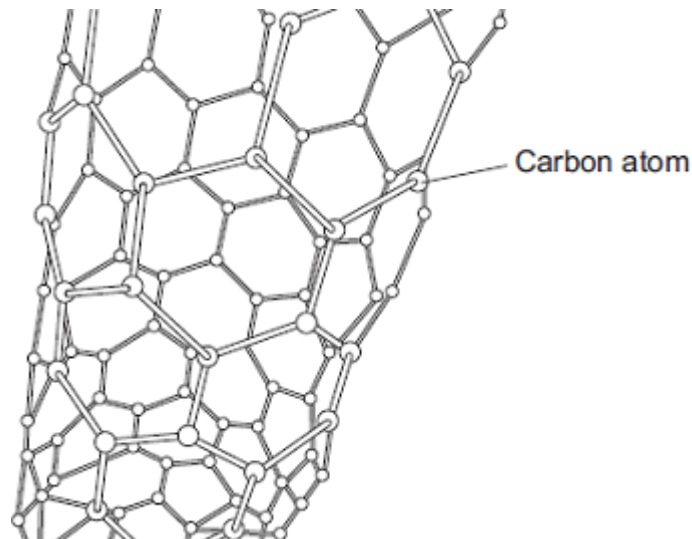
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(4)

- (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?

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(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.

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(2)

(Total 7 marks)

**Q20.**

The periodic table on the Data Sheet may help you to answer these questions.

Part of the periodic table is shown below.


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

Choose your answers **only** from the letters shown in the periodic table above.

Which letter, **A**, **B**, **C**, **D** or **E**, represents:

(a) (i) an alkali metal                      Letter  (1)

(ii) a transition element                      Letter  (1)

(iii) a Group 4 element                      Letter  (1)

(b) A chemistry teacher demonstrated the reaction between sodium and water to a class of students. One of the students wrote the following notes:

**The reaction between sodium and water**

A piece of sodium was cut easily into smaller pieces with a knife.

The sodium was added to some water in a trough.

The sodium:

- floated
- melted quickly to give a silvery ball
- moved on the surface of the water
- fizzed.

Use the information in the box to help you answer these questions.

What evidence is there that:

(i) sodium has a low melting point

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(1)

(ii) sodium is soft

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(1)

(iii) a gas was produced?

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(1)

(Total 6 marks)

**Q21.**

(a) Dmitri Mendeleev was one of the first chemists to classify the elements by arranging them in order of their atomic weights. His periodic table was published in 1869.

How did Mendeleev know that there must be undiscovered elements **and** how did he take this into account when he designed his periodic table?

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(2)

(b) By the early 20th century protons and electrons had been discovered.

Describe how knowledge of the numbers of protons and electrons in atoms allow chemists to place elements in their correct order and correct group.

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(3)

(c) The transition elements are a block of elements between Groups 2 and 3 of the periodic table.

(i) Transition elements have similar properties.

Explain why, in terms of electronic structure.

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(2)

(ii) There are **no** transition elements between the Group 2 element magnesium and the Group 3 element aluminium.

Give a reason why, in terms of electronic structure.

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(1)

(Total 8 marks)

## Q22.

A student was investigating the reaction of lithium and water.

She added a few drops of universal indicator to water in a trough and added a piece of lithium.



The word equation for the reaction is:



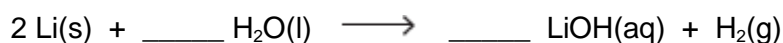
(a) (i) The lithium floated on the water.

State **two** other observations that the student would **see** during the reaction.

1. \_\_\_\_\_
2. \_\_\_\_\_

(2)

(ii) Balance the symbol equation for the reaction of lithium and water.



(2)

(iii) Describe a simple test and the result that would show the gas was hydrogen.

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(1)

(iv) All Group 1 metals have similar reactions with water.

State why, in terms of electronic structure.

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(1)

(b) Lithium and other Group 1 metals have different properties from the transition metals.

Tick (✓) **two** properties that are properties of Group 1 metals.

They react with oxygen.

They form coloured compounds.

They are strong and hard.

They have low melting points.

(2)

(c) The electronic structure of a potassium atom is 2, 8, 8, 1

(i) Draw a diagram to show the electronic structure of a potassium ion.

Show the charge on the potassium ion.

(2)

(ii) Potassium is more reactive than sodium.

Explain why, in terms of electronic structure.

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(3)  
(Total 13 marks)

**Q23.**

- (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 \_\_\_\_\_

\_\_\_\_\_

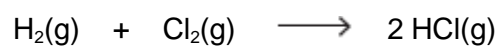
(2)

- (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 ( $\Delta H$ ) for the reaction.



\_\_\_\_\_

\_\_\_\_\_

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Enthalpy change ( $\Delta H$ ) = \_\_\_\_\_ 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 ( $\Delta H$ )
- the activation energy.

(3)

(Total 10 marks)

**Q24.**

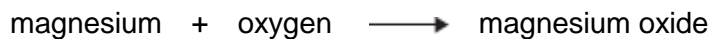
Magnesium burns in oxygen.





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

The word equation for magnesium burning is:

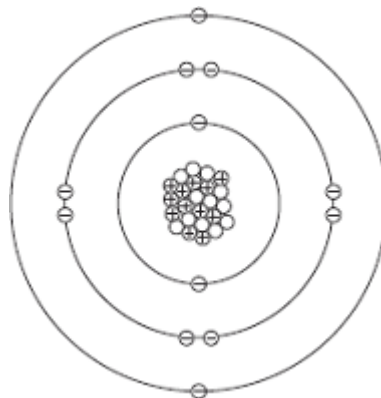


Draw **one** line from each substance to its correct description.

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)

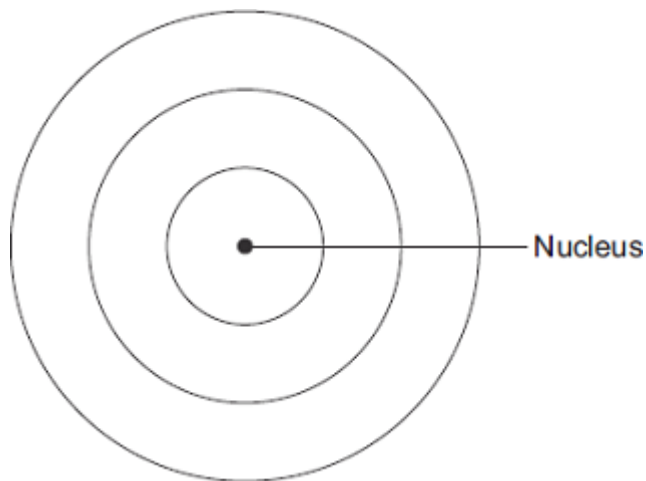
(Total 8 marks)

### Q25.

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)

### Q26.

This question is about lithium and sodium.

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

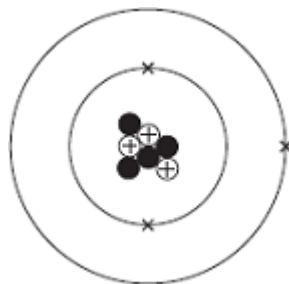
In which group of the periodic table are lithium and sodium?

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
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The mass number of this atom of lithium is

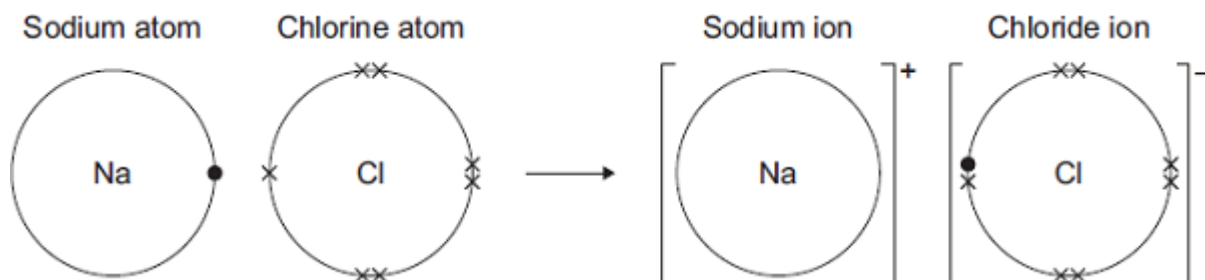
(1)

(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 <b>not</b> 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?

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(1)

(Total 12 marks)

**Q27.**

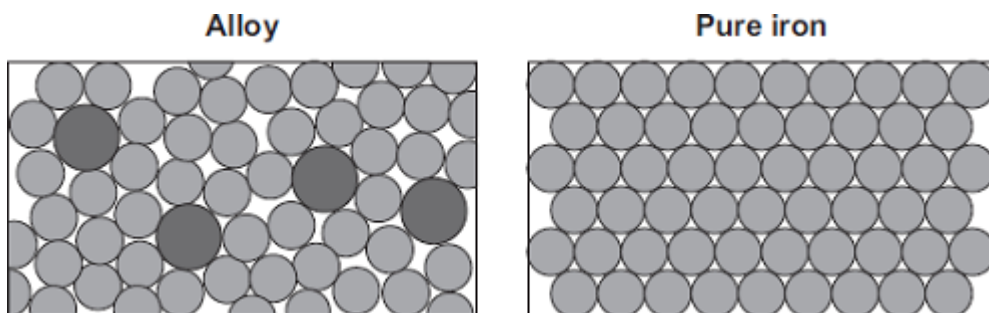
Oil rigs are used to drill for crude oil.



© 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.

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(2)

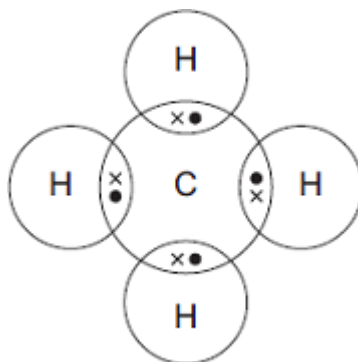
(b) Drill heads contain diamonds.

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)

**Q28.**

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.

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(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.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(3)

(Total 8 marks)

### Q29.

This question is about the periodic table.

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

(a) Complete the sentences.

Elements in the periodic table are arranged in order of atomic

\_\_\_\_\_ .

The elements in Group \_\_\_\_\_ are called the noble gases.

(2)

(b) Calcium (Ca) is in Group 2.

Name **one** other element in Group 2.

\_\_\_\_\_ (1)

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

(i)

Sodium (Na) is

an alkali metal.  
a non-metal.  
a transition metal.

(1)

(ii)

Nickel (Ni) is

an alkali metal.  
a non-metal.  
a transition metal.

(1)

(d) In 1869 Mendeleev produced his periodic table.

Why did Mendeleev leave gaps in his periodic table?

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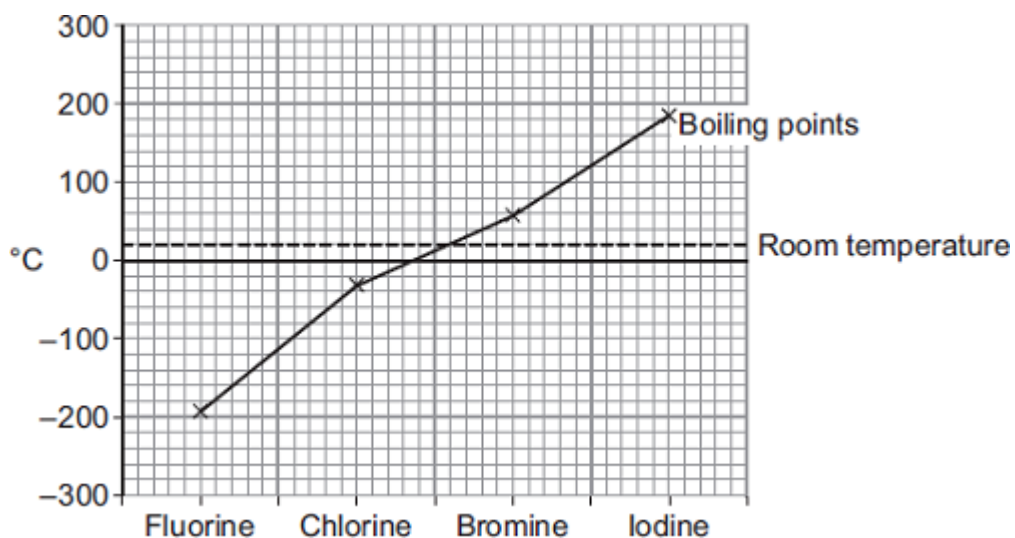
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(1)

(Total 6 marks)

### Q30.

The graph shows the boiling points of the halogens.



(a) Use the graph to help you answer these questions.

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

gas      liquid      solid

At room temperature chlorine is a \_\_\_\_\_ .

(1)

(ii) Describe the trend in boiling point from fluorine to iodine.

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(1)

(b) Chlorine reacts with metals to produce metal chlorides.

(i) When a chlorine atom forms a chloride ion it gains one electron.

What is the charge on a chloride ion?

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(1)

(ii) Write a word equation for the reaction between sodium and chlorine.

---

(1)

(c) In the UK water companies add chlorine to tap water.

Why is chlorine added to tap water?

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(1)

(d) Water companies add fluoride to tap water in some parts of the UK.

Fluoride is added to improve dental health.

Suggest **one** reason why some people are against adding fluoride to tap water.

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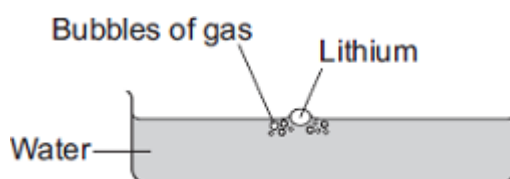
(1)

(Total 6 marks)

### Q31.

Lithium is in Group 1 of the periodic table.

Lithium reacts with water to produce a gas and an alkaline solution.



(a) (i) Name the gas produced.

---

(1)

(ii) Which ion causes the solution to be alkaline?

\_\_\_\_\_

(1)

(b) Potassium is also in Group 1 of the periodic table.  
Potassium reacts with water in a similar way to lithium.

Write down **two** differences you would see between the reactions of potassium and lithium with water.

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

(2)

(Total 4 marks)

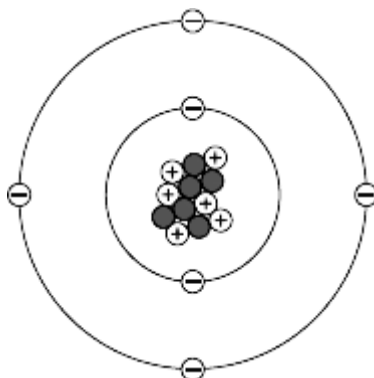
**Q32.**

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)

**Q33.**

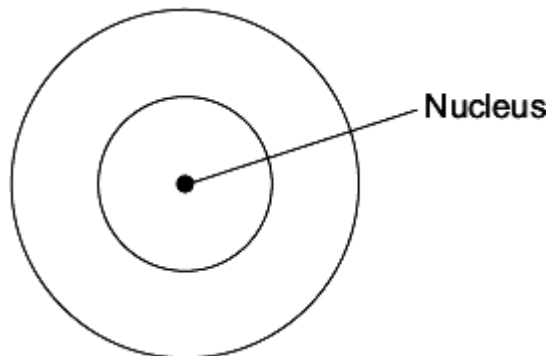
The picture shows a diamond ring.



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)

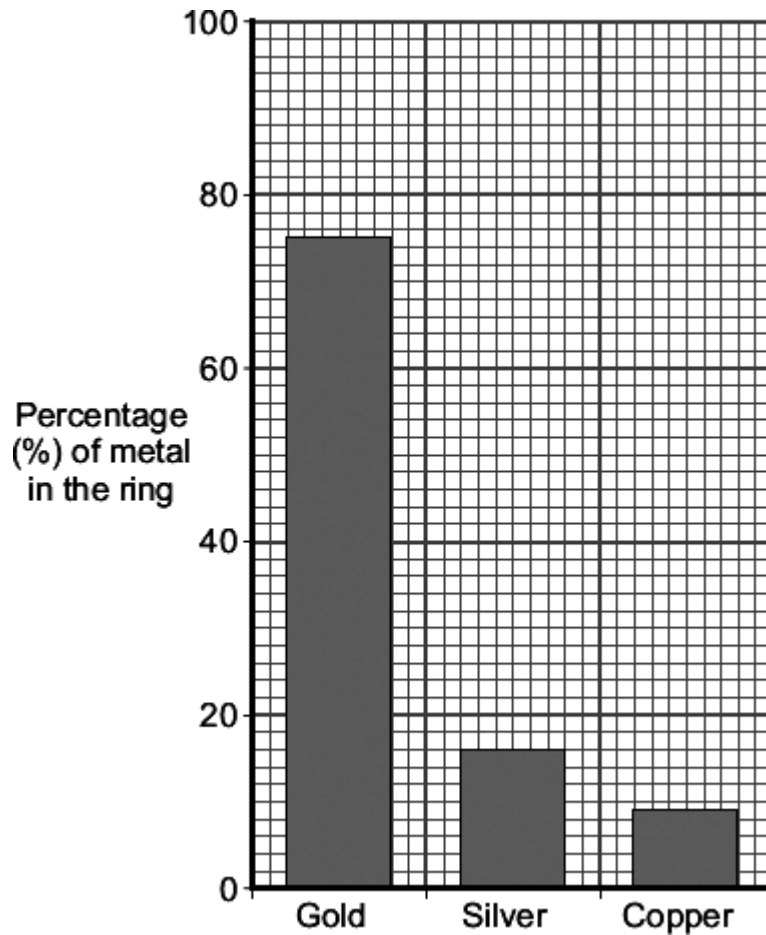
- (b) A gold atom has an atomic number of 79 and a mass number of 197.

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. \_\_\_\_\_

**Q34.**

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.

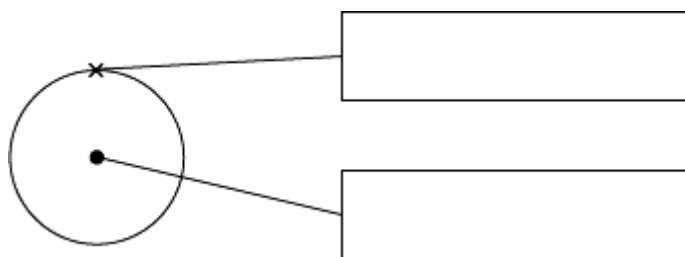
Diagram	Description
	Compound
	Element
	Mixture
	Polymer

(b) The diagram below shows a hydrogen atom.



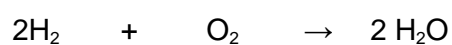
Use words from the box to write the correct labels on the diagram.

alloy	electron	group	nucleus
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(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 \_\_\_\_\_

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(2)

(Total 6 marks)

## Atomic Structure Mark schemes Part -2

### Q1.

- (a) any **one** from:
- there was a flame
  - energy was given out
  - a new substance was formed
  - the magnesium turned into a (white) powder
- answers must be from the figure*
- (b) Magnesium oxide
- (c) The reaction has a high activation energy
- (d) 9
- (e) They have a high surface area to volume ratio
- (f) any **one** from:
- Better coverage
  - More protection from the Sun's ultraviolet rays
- (g) any **one** from:
- Potential cell damage to the body
  - Harmful effects on the environment
- (h) indication of  $\frac{1}{1.6} = 0.625$   
**and**  
use of indices  $10^{-9} - 10^{-6} = 10^3$   
*Both steps must be seen to score first mark*
- $0.625 \times 1000 = 625$  (times bigger)

[9]

### Q2.

- (a) **B**
- (b) **D**
- (c) **E**
- (d) **C**

(e)  $92.5 \times 6$  and  
 $7 \times 7.5$

1

1

$$\frac{607.5}{100}$$

1

6.075

1

6.08

1

*allow 6.08 with no working shown for 4 marks*

[8]

### Q3.

(a) 13 (protons)

*The answers must be in the correct order.*

*if no other marks awarded, award 1 mark if number of protons and electrons are equal*

1

14 (neutrons)

1

13 (electrons)

1

(b) has three electrons in outer energy level / shell

*allow electronic structure is 2.8.3*

1

(c) **Level 3 (5–6 marks):**

A detailed and coherent comparison is given, which demonstrates a broad knowledge and understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.

**Level 2 (3–4 marks):**

A description is given which demonstrates a reasonable knowledge and understanding of the key scientific ideas. Comparisons are made but may not be fully articulated and / or precise.

**Level 1 (1–2 marks):**

Simple statements are made which demonstrate a basic knowledge of some of the relevant ideas. The response may fail to make comparisons between the points raised.

**0 marks:**

No relevant content.

**Indicative content**

Physical

Transition elements

- high melting points

- high densities
  - strong
  - hard
- Group 1
- low melting points
  - low densities
  - soft
- Chemical
- Transition elements
- low reactivity / react slowly (with water or oxygen)
  - used as catalysts
  - ions with different charges
  - coloured compounds
- Group 1
- very reactive / react (quickly) with water / non-metals
  - not used as catalysts
  - white / colourless compounds
  - only forms a +1 ion

6

[10]

**Q4.**

(a) any **one** from:

- heat
- stir

1

(b) filter

*accept use a centrifuge*  
*accept leave longer (to settle)*

1

(c) any **one** from:

- wear safety spectacles
- wear an apron

1

(d) evaporation at **A**

1

condensation at **B**

1

(e) 100

1

[6]

**Q5.**

(a) The forces between iodine molecules are stronger

1

(b) anything in range +30 to +120

1

(c) Brown

1

- (d)  $2 \text{I}^- + \text{Cl}_2 \rightarrow \text{I}_2 + 2 \text{Cl}^-$  1
- (e) It contains ions which can move 1
- (f) hydrogen iodine 1

[6]

**Q6.**

- (a) line goes up before it goes down 1
- energy given out correctly labelled 1
- activation energy labelled correctly 1

- (b) electrostatic force of attraction between shared pair of negatively charged electrons 1
- and both positively charged nuclei 1

- (c) bonds formed =  $348 + 4(412) + 2(276) = 2548 \text{ kJ / mol}$  1
- bonds broken – bonds formed =  $612 + 4(412) + (\text{Br-Br}) - 2548 = 95 \text{ kJ / mol}$  1

*Alternative approach without using C-H bonds*

*For step 1 allow =  $348 + 2(276) = 900 \text{ kJ / mol}$*

*Then for step 2 allow  $612 + (\text{Br-Br}) - 900 = 95 \text{ kJ / mol}$*

- 193 (kJ / mol) 1

*accept (+)193 (kJ / mol) with no working shown for 3 marks*

*-193(kJ / mol) scores 2 marks*

*allow ecf from step 1 and step 2*

- (d) **Level 3 (5–6 marks):**  
A detailed and coherent explanation is given, which demonstrates a broad understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links. A conclusion is reached.

**Level 2 (3–4 marks):**

An explanation is given which demonstrates a reasonable understanding of the key scientific ideas. A conclusion may be reached but the logic used may not be clear or linked to bond energies.

**Level 1 (1–2 marks):**

Simple statements are made which demonstrate a basic understanding of some of the relevant ideas. The response may fail to make logical links between the points raised.

**0 marks:**

No relevant content.

**Indicative content**

Size and strength

- chlorine atoms have fewer electron energy levels/shells
- chlorine atoms form stronger bonds
- Cl–Cl bond stronger than Br–Br
- C–Cl bond stronger than C–Br

Energies required

- more energy required to break bonds with chlorine
- more energy given out when making bonds with chlorine
- overall energy change depends on sizes of energy changes

Conclusions

- if C–Cl bond changes less, then less exothermic
- if C–Cl bond changes more, then more exothermic
- can't tell how overall energy change will differ as do not know which changes more.

6

[14]

**Q7.**

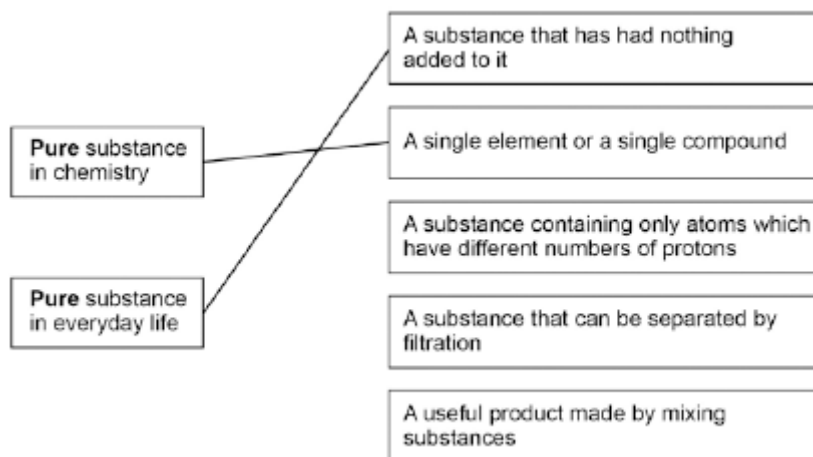
(a) Air

2

Steel

1

(b)



Allow 1 mark for the correct meanings linked to context but incorrect way around

1

(c) Damp litmus paper turns white

1

(d) Iron(III)

1

[6]

**Q8.**

(a) 50

1

(b) 5% 1

(c) any **two** from:

- cost (9 carat is cheaper)
- pure gold is soft  
**or**  
24 carat gold is soft  
**or**  
9 carat gold is harder  
*allow 9 carat gold is stronger*  
*allow gold is an alloy in 9 carat gold*
- can change the colour

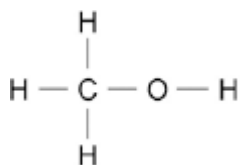
2

[4]

### Q9.

(a) Propanol 1

(b) Butanol has the highest boiling point 1



(c) 1

(d) ethene + water ( $\rightarrow$  ethanol)  
*allow answers in either order*  
*allow steam for water* 1

(e) goes back to reactor  
*allow is recycled* 1

(f) air contains oxygen 1

which oxidises ethanol  
*allow ethanol reacted with oxygen* 1

to produce ethanoic acid 1

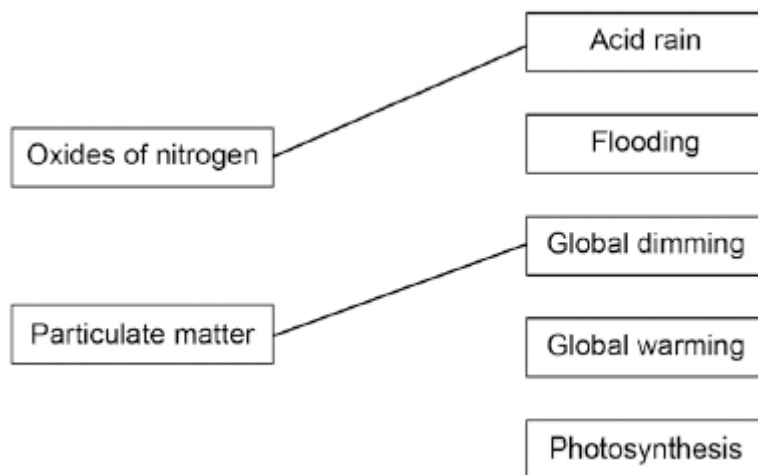
[8]

### Q10.

(a)  $\text{C}_5\text{H}_{12}$  1

(b) Alkanes 1

- (c) (3) CO<sub>2</sub> 1
- (4) H<sub>2</sub>O 1
- allow for 1 mark*  
4 CO<sub>2</sub> + 3 H<sub>2</sub>O
- (d) contains hydrogen and carbon 1
- (hydrogen and carbon) only 1
- (e) (*diesel*)  
produces more oxides of nitrogen  
*allow converse answers in terms of petrol* 1
- produces (more) particulate matter 1
- produces less carbon dioxide 1
- (f)



2

[11]

**Q11.**

- (a) filtration  
**or**  
by passing through filter beds to remove solids 1
- sterilisation to kill microbes  
*allow chlorine / ozone allow ultraviolet light* 1
- (b) water needs more / different processes 1
- because it contains any **two** from:
- more organic matter



- more microbes
  - toxic chemicals or detergents
- 2
- (c) *(as part of glassware attached to bung)*  
 salt solution in (conical) flask  
*allow suitable alternative equipment, eg boiling tube*
- 1
- (at end of delivery tube)*  
 pure water in test tube which must not be sealed  
*allow suitable alternative equipment, eg, beaker, condenser*
- 1
- heat source (to heat container holding salt solution)
- 1
- if no other mark obtained allow for 1 mark suitable equipment drawn as part of glassware attached to bung and at end of delivery tube*
- (d) determine boiling point
- 1
- should be at a fixed temperature 100°C  
*allow should be 100°C*  
*allow if impure will boil at a temperature over 100°C*
- 1
- (e) high energy requirement
- 1

[11]

**Q12.**

- (a)  $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$
- 2
- allow 1 mark for correct formulae*
- (b) sensible scales, using at least half the grid for the points
- 1
- all points correct  
*± ½ small square*  
*allow 1 mark if 8 or 9 of the points are correct*
- 2
- best fit line
- 1
- (c) steeper line to left of original
- 1
- line finishes at same overall volume of gas collected
- 1
- (d) acid particles used up  
*allow marble / reactant used up*
- 1
- so concentration decreases

- allow surface area of marble decreases* 1
- so less frequent collisions / fewer collisions per second  
*do not accept fewer collisions unqualified* 1
- so rate decreases / reaction slows down 1
- (e) mass lost of 2.2 (g) 1
- time taken of  
 270 s  
*allow values in range 265 – 270* 1
- $\frac{2.2}{270} = 0.00814814$   
*allow ecf for values given for mass and time* 1
- 0.00815 (g / s)  
 or  
 $8.15 \times 10^{-3}$   
*allow 1 mark for correct calculation of value to 3 sig figs  
 accept 0.00815 or  $8.15 \times 10^{-3}$  with no working shown for 4 marks* 1
- (f) correct tangent 1
- eg 0.35 / 50 1
- 0.007  
*allow values in range of 0.0065 – 0.0075* 1
- $7 \times 10^{-3}$  1
- accept  $7 \times 10^{-3}$  with no working shown for 4 marks*

[20]

**Q13.**

- (a) both water vapour and ethanol will condense  
*allow steam for water vapour  
 allow they both become liquids  
 allow ethane condenses at a lower temperature  
 allow some of the steam hasn't reacted  
 allow it is a reversible reaction / equilibrium* 1
- (b) amount will decrease

because the equilibrium will move to the left

1

- (c) more ethanol will be produced

1

because system moves to least / fewer molecules

1

1

[5]

**Q14.**

- (a) (i) 7

1

- (ii) -1

1

- (iii) neutrons

1

- (b) number of protons

1

- (c) atom Y

1

- (d) (i) Ne

*allow neon*

1

- (ii) has a full outer shell

*allow in Group 0*

*allow a noble gas*

**or**

full outer energy level

*allow the shells are full*

**or**

has 8 electrons in its outer shell

*ignore in Group 8*

1

[7]

**Q15.**

- (a) the Earth's (surface) temperature was high **or** at/above 100 °C

*allow the Earth's (surface) temperature was too / very hot **or** water evaporated / boiled **or** turned to steam / gas*

*allow because of heat from volcanoes*

*ignore the Earth's (surface) was covered by volcanoes*

*ignore water turned to water vapour*

1

- (b) (i) air \_\_\_\_\_ mixture 1
- carbon dioxide \_\_\_\_\_ compound 1
- argon \_\_\_\_\_ element 1
- allow only one line from each substance*
- (ii) oxygen 1
- (iii) about 80 % 1
- (c) (i) 0.03(0) (%) 1
- (ii) increased 1
- slowly then rapidly 1
- allow figures from graph to indicate increase*
- (iii) any **two** from: 2
- use of fossil fuels
  - deforestation  
*allow less trees / plants*
  - cars/transport
  - industry/factories  
*ignore more people*

[11]

**Q16.**

- (a) (i) electronic structure 2,3 drawn 1
- allow any representation of electrons, such as, dots, crosses, or numbers (2,3)*
- (ii) nucleus 1
- (iii) protons and neutrons 1
- do **not** allow electrons in nucleus*
- (relative charge of proton) +1 1
- allow positive*
- (relative charge of neutron) 0 1
- allow no charge/neutral*
- ignore number of particles*
- (b) too many electrons in the first energy level or inner shell 1
- allow inner shell can only have a maximum of 2 electrons*

too few electrons in the second energy level or outer shell

*allow neon has 8 electrons in its outer shell or neon does not have 1 electron in its outer shell*

*allow neon has a stable arrangement of electrons or a full outer shell*

1

neon does not have 9 electrons or neon has 10 electrons

*allow one electron missing*

*allow fluorine has 9 electrons*

1

*ignore second shell can hold (maximum) 8 electrons or 2,8,8 rule or is a noble gas or in Group 0*

*max 2 marks if the wrong particle, such as atoms instead of electrons*

*if no other mark awarded allow 1 mark for the electronic structure of neon is 2,8*

[8]

### Q17.

(a) add yeast

1

and ferment or by fermentation

*allow in a warm place or temperatures within the range 20-45°C or with an airlock / absence of air*

1

(b) heat (the mixture)

1

ethanol has a lower boiling point than water or more ethanol than water vaporises or ethanol evaporates first or when the temperature reaches 78°C

*allow ethanol and water boil at different temperatures*

1

condense (the vapour)

*allow condense at different temperatures for the last two marking points*

*if no other mark is awarded, allow repeat distillation or use fractional distillation apparatus for 1 mark*

1

[5]

### Q18.

(a) (i) 7 / seven

1

(ii) 1

*do not accept -1*

1

Electron

1

(iii) isotopes

1

- (b) (i) (sodium + ) fluorine → sodium fluoride 1
- (ii) compounds 1
- (iii) mole 1
- (iv) sodium (atom) loses 1  
 fluorine (atom) gains 1  
 one electron 1  
 ions formed 1
- allow sodium forms positive (ion) or fluorine forms negative (ion)*  
*allow form ionic bond*  
*allow to gain a full outer shell of electrons*  
*allow forms noble gas structure*  
**max 3** if reference to incorrect particle / bonding
- (v) Dissolve in water 1  
 High melting point 1

[13]

**Q19.**

- (a) (i) (mass number = 16) because there are 8 protons and 8 neutrons (in the nucleus) 2  
*accept mass number is total number of protons and neutrons for 1 mark*
- (ii) same number of protons or both have 6 protons 1  
*accept same atomic number*
- <sup>12</sup>C has 6 neutrons 1
- <sup>14</sup>C has 8 neutrons 1
- accept different number of neutrons for 1 mark numbers, if given, must be correct*  
*incorrect reference to electrons = max 2 marks*
- (b) (i) 2 bonding pairs 1  
*additional unbonded electrons negates this mark*
- 4 unbonded electrons around oxygen 1  
*accept dot, cross or e or – or any combination*
- (ii) covalent 1

- (iii) any **one** from:
- no delocalised / free electrons  
*ignore mobile electrons*
  - no overall electric charge  
*accept no charge (carriers)*
  - no ions

1

*do **not** accept any implications of the presence of ions*

- (c) (i) larger
- accept the size of a few hundred atoms*  
*accept atoms are smaller (than nanoparticles)*  
*allow up to 1000 atoms)*

1

- (ii) (nanoparticles have) large(r) surface area

1

[11]

## Q20.

- (a) atomic weights  
*must be in this order*

1

electrons

1

proton numbers

1

- (b) (i) H/hydrogen  
*allow H<sub>2</sub> or h*

1

- (ii) one / 1  
*allow alkali metals*

1

- (iii) Potassium (K)

1

- (iv) Iron has a higher density than potassium

1

Iron forms ions that have different charges

1

- (c) any **three** from:
- melts
  - fizzes / bubbles / effervesces  
*allow gas produced*
  - sodium floats
  - size of the sodium decreases  
*allow dissolves / disappears*
  - sodium moves  
*allow two marks for moves around on the surface of the water*

3

[11]

**Q21.**

- (a) (i) atomic weights  
*allow atomic masses* 1
- (ii) proton  
*allow proton number* 1
- (b) (i) F/fluorine  
*allow F<sub>2</sub>* 1
- (ii) any **one** from:  
• copper has a higher density  
• copper is stronger  
• copper is harder  
• copper is less reactive  
*allow named property*  
*ignore colour, conductivity, melting point and boiling point*  
*allow converse for potassium* 1
- (iii) relative distance from nucleus  
*allow more / fewer energy levels / shells or larger / smaller atom* 1
- relative attraction to nucleus  
*allow more / less shielding* 1
- relative ease of gain or loss of electron 1
- opposite explanation of ease of gain or loss of electron for other group 1
- max 3 marks if 'outer' not mentioned*

[8]

**Q22.**

- (a) Y 1
- (b) W 1
- (c) V 1
- (d) W 1
- (e) X 1

[5]



**Q23.**

- (a) (i) neutrons  
*this order only* 1
- electrons 1
- protons 1
- (ii) box on the left ticked 1
- (b) (i) effervescence / bubbling / fizzing / bubbles of gas  
*do **not** accept just gas alone* 1
- magnesium gets smaller / disappears  
*allow magnesium dissolves*  
*allow gets hotter **or** steam produced*  
*ignore references to magnesium moving and floating /  
sinking and incorrectly named gases.* 1
- (ii) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content

**Level 1 (1–2 marks)**

There are simple statements of some of the steps in a procedure for obtaining magnesium chloride.

**Level 2 (3–4 marks)**

There is a description of a laboratory procedure for obtaining magnesium chloride from dilute hydrochloric acid and magnesium.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **or** a method of obtaining magnesium chloride crystals.

**Level 3 (5–6 marks)**

There is a well organised description of a laboratory procedure for obtaining magnesium chloride that can be followed by another person.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **and** a method of obtaining magnesium chloride crystals.

**examples of the points made in the response:**

- hydrochloric acid in beaker (or similar)
- add small pieces of magnesium ribbon
- until magnesium is in excess or until no more effervescence occurs \*
- filter using filter paper and funnel
- filter excess magnesium
- pour solution into evaporating basin / dish
- heat using Bunsen burner

- leave to crystallise / leave for water to evaporate / boil off water
- decant solution
- pat dry (using filter paper).

\*Student may choose to use a named indicator until it turns a neutral colour, record the number of pieces of magnesium added then repeat without the indicator.

6

[12]

**Q24.**

- (a) (i) Proton 1
- (ii) Neutron 1
- (b) In order of increasing atomic number 1
- (c) (i) 9 1
- (ii) Gas 1
- (d) (i) gains (one) electron 1
- (to gain a) full outer energy level **or** noble gas configuration  
*allow because it has seven outer electrons* 1
- (ii) add sodium hydroxide (solution)  
*allow ammonia (solution) or ammonium hydroxide or any other soluble hydroxide or flame test* 1
- (forms a) blue precipitate  
*second mark dependent on suitable reagent being added  
allow blue-green / blue / green if flame test given* 1

[9]

**Q25.**

- (a) gold 1
- (b) atom (s) 1
- (c) (i) protons  
*any order  
allow proton* 1
- neutrons  
*allow neutron*

		1
	(ii) 3 / three	1
(d)	(i) Al <i>ignore any numbers / charges</i>	1
	(ii) any <b>two</b> from: <ul style="list-style-type: none"> <li>• limited resource</li> <li>• expensive in terms of energy / mining</li> <li>• effects on the environment, such as, landfill, atmospheric pollution, quarrying</li> </ul> <i>allow uses a lot of energy to extract.</i>	2
(e)	resistant to corrosion	1
	does not react (with water or food) <i>allow <b>one</b> mark for low density with a suitable reason given</i>	1
		<b>[10]</b>

**Q26.**

(a)	(i) central block	1
	(ii) conducts electricity	1
(b)	any <b>two</b> from: <ul style="list-style-type: none"> <li>• visual pollution</li> <li>• noise pollution</li> <li>• dust pollution</li> <li>• habitat destruction.</li> </ul>	2
(c)	(i) to concentrate the ore / copper carbonate <b>or</b> to remove / separate the rock	1
	(ii) 12 (tonnes) <i>If answer is incorrect allow one mark for <math>(127 + 132) - 247</math> or <math>259 - 247</math></i>	2
	(iii) any <b>one</b> from: <ul style="list-style-type: none"> <li>• so no reactant is wasted / left unreacted</li> <li>• so they know how much product they will make</li> <li>• need to record / compensate for the carbon dioxide produced</li> </ul> <i>allow so they can work out their carbon footprint.</i>	1
		<b>[8]</b>

**Q27.**

- (a) (i) protons  
*allow "protons or electrons", but do not allow "protons and electrons"* 1
- (ii) protons plus / and neutrons 1
- (b) (because the relative electrical charges are)  $-(1)$  for an electron and  $+(1)$  for a proton  
*allow electrons are negative and protons are positive* 1
- and the number of electrons is equal to the number of protons  
*if no other mark awarded, allow 1 mark for the charges cancel out* 1
- (c) (the electronic structure of) fluorine is 2,7 and chlorine is 2,8,7  
*allow diagrams for the first marking point* 1
- (so fluorine and chlorine are in the same group) because they have the same number of or 7 electrons in their highest energy level or outer shell  
*if no other mark awarded, allow 1 mark for have the same / similar properties* 1
- (d) S 1
- (e) (i) ions 1
- (ii) molecules 1

[9]

**Q28.**

- (a) The ore is not pure or contains impurities or the ore does not contain 100% of the metal compound  
*allow to concentrate the metal or metal compound* 1
- rock / other compounds need to be removed / separated 1
- (b) (i) (cast iron is) brittle  
*allow not strong*  
*ignore weak* 1
- (ii) the oxygen reacts with carbon  
*allow carbon burns in oxygen or is oxidised* 1
- reducing the percentage of carbon in the mixture  
**or** producing carbon dioxide 1

- (c) (i) aluminium has a low density 1
- (ii) (because copper) is in the central / middle (block of the periodic table) 1
- whereas aluminium is in Group 3 (of the periodic table) 1
- (iii) iron is more reactive (than copper) 1
- ignore cost*
- so copper is displaced / reduced 1
- [10]**

**Q29.**

- (a) 1
- must be in this order* 1
- very small
- accept negligible, 1 / 2000*
- allow zero* 1
- (b) The mass number 1
- (c) C 1
- (d) (i) 2 1
- (ii) 3 1
- (e) (i) 28 1
- (ii) 42.9
- accept ecf from (e)(i)*
- accept 42 - 43* 1
- (f) (i) 0.9 1
- (ii) any **one** from:
- accurate
  - sensitive
  - rapid
  - small sample.
- 1

**Q30.**

(a) because this lithium atom has

3 protons

1

and 4 neutrons

1

mass number is total of neutrons and protons

*accept protons and neutrons have a mass of 1*

*accept number of neutrons = 7 - 3(protons)*

*ignore mass of electron is negligible*

1

(b) grams

*accept g*

1

<sup>12</sup>C

*allow carbon-12 or C-12*

*ignore hydrogen or H*

1

(c) any **three** from:

*max 2 if no numbers given*

*numbers if given must be correct*

- both have 8 protons

*accept same number of protons*

- <sup>18</sup>O has 10 neutrons

- <sup>16</sup>O has 8 neutrons

*accept different number of neutrons or <sup>18</sup>O has two more neutrons for 1 mark*

- both have 8 electrons.

*accept same number of electrons*

3

**[8]****Q31.**

(a) (i) Na

*allow sodium*

1

(ii) Cu

*allow copper*

1

(iii) C

*allow carbon*

1

(iv) He

*allow helium*

1

(b) H

*allow hydrogen*  
*do not allow H<sub>2</sub>*

1

[5]

**Q32.**

(a) (iron) is a metal

*accept transition element*  
*allow (iron) had different properties (to oxygen and sulfur)*  
*ignore electrons*

1

(b) so that elements with similar properties could be placed together

*allow to make the pattern fit*  
*ignore undiscovered elements*

1

(c) atomic number(s)

*allow proton number(s)*

1

(d) all have one electron in the outer shell (highest energy level)

*allow same number of electrons in the outer shell (highest energy level)*

1

(so they) have similar properties

**or**

react in the same way

*allow specific reactions e.g. with water*

1

[5]

**Q33.**

(a) increase

1

(b) (i) Na<sup>+</sup> and Br<sup>-</sup>

*both required*

1

(ii) sodium chloride

*allow NaCl*  
*do not allow sodium chlorine*

1

(iii) chlorine is more reactive than bromine

*allow converse argument*  
*allow symbols Cl, Cl<sub>2</sub>, Br and Br<sub>2</sub>*  
*allow chlorine / it is more reactive*  
*do not allow chloride or bromide*

1

- (iv) fluorine  
*allow F / F<sub>2</sub>.*  
*do **not** allow fluoride.*

1

[5]

**Q34.**

- (a) Li **and** K  
*either order*  
*allow lithium **and** potassium*

1

- (b) Fe  
*allow iron*

1

- (c) N **and** As  
*either order*  
*allow nitrogen **and** arsenic*

1

- (d) Cu  
*allow copper*

1

[4]

Mark schemes

**Q1.**

- (a) (i) Neutron (top label)  
Electron (bottom label)

1

1

- (ii) 13

1

- (iii) electrons

1

- (b) (i) compound

1

hydrogen

1

bond

1

- (ii) C<sub>4</sub>H<sub>10</sub>

1

[8]

**Q2.**

- (a) Sulfur dioxide causes acid rain.



- (b) red / orange / yellow  
*do not accept any other colours* 1
- because sulfur dioxide (when in solution) is an acid 1
- (c) (there are) weak forces (of attraction)  
*do not accept any reference to covalent bonds breaking* 1
- between the molecules  
*do not accept any other particles* 1
- (these) take little energy to overcome  
*award third mark only if first mark given* 1
- (d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content

**Level 1 (1 – 2 marks)**

A relevant comment is made about the data.

**Level 2 (3 – 4 marks)**

Relevant comparisons have been made, and an attempt made at a conclusion.

**Level 3 (5 – 6 marks)**

Relevant, detailed comparisons made and a justified conclusion given.

**examples of the points made in the response**

**effectiveness**

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

**material used**

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy
- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap

**waste materials**

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate

- change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

6

[12]

**Q3.**

(a) (i) an electron

1

(ii) a neutron

1

(iii) 11

1

(iv) boron

1

(b) (i)  $\text{GH}_3$ 

1

(ii) covalent

1

[6]

**Q4.**

(a) (i) Na

*allow sodium / phonetic spelling**if more than one answer is given apply list principle*

1

(ii) Fe

*allow iron / phonetic spelling**if more than one answer is given apply list principle*

1

(iii) Na **or** S*allow sodium or sulfur / sulphur / phonetic spelling**if more than one answer is given apply list principle*

1

(iv) S

*allow sulfur / sulphur / phonetic spelling**if more than one answer is given apply list principle*

1

(v) Na

*allow sodium / phonetic spelling**if more than one answer is given apply list principle*

1

(b) (i) any **three** from:

- effervescence / fizzing **or** bubbles **or** gas produced  
*do not allow incorrectly named gas*
- sodium melts **or** turns into a ball

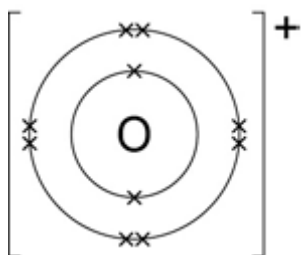
- sodium moves (on the surface)
- steam / mist / vapour is produced  
*ignore heat / temperature / flame / spark*
- sodium gets smaller / disappears  
*allow dissolves*
- colour of indicator is darker / more intense near the sodium  
*Must be linked to near the sodium.*

3

- (ii) hydroxide **or**  $\text{OH}^-$   
*allow OH without a charge*  
*do **not** allow  $\text{OH}^+$*

1

(c)



*diagram showing electron configuration of ion is 2,8*

1

*charge on ion is +*

*Bracket not necessary*

*[2,8]<sup>+</sup> is worth 1 mark as there is no diagram*

1

[11]

### Q5.

- (a) (i) points correctly plotted ( $\pm \frac{1}{2}$  small square)  
*four points = 2 marks*  
*three points = 1 mark*

Max 2

straight line of best fit using full range of points from 0,0

1

- (ii) any **one** from:  
*must explain why the point is below the line*

- the solution may not have been properly stirred
- the electrodes may have been a larger distance apart
- the drop of sodium chloride may have been a smaller volume / smaller

*allow not enough sodium chloride added*

*allow smaller amount of sodium chloride*

*do **not** allow too few drops added*

*ignore the student may have misread the conductivity meter*

1

- (iii) any **one** from:

- the volume of pure water

- allow amount*
    - the concentration (of the solutions added)
    - the volume (of the drops) of solution added
    - ignore number of drops*
    - the distance between the electrodes
    - the same electrodes **or** electrodes made of the same material
    - same depth **or** surface area of electrodes in the water
    - constant power supply
    - ignore current*
    - stirred
- 1
- (b) (i) because (pure) water is covalent / molecular (simple) **or** contains molecules
- 1
- therefore (pure) water has no free / mobile electrons **or** ions  
*molecules do not have a charge or molecules do not contain ions gains 2 marks*
- 1
- (ii) because there are ions in sodium chloride  
*allow Na<sup>+</sup> and / or Cl<sup>-</sup> (ions) or ionic bonding.*  
*Ignore particles other than ions for MP1.*
- 1
- which can move **or** carry the current / charge  
*MP2 must be linked to ions only.*
- 1
- (iii) Hydrogen  
*allow H<sub>2</sub> / H*
- 1
- [10]**

**Q6.**

- (a) (i) any **one** from:
- one electron in the outer shell / energy level
  - form ions with a 1+ charge
- 1
- (ii) any **one** from:
- hydrogen is a non-metal
  - (at RTP) hydrogen is a gas
  - hydrogen does not react with water
  - hydrogen has only one electron shell / energy level
  - hydrogen can gain an electron **or** hydrogen can form a negative / hydride / H<sup>-</sup> ion
  - hydrogen forms covalent bonds **or** shares electrons
- accept answers in terms of the Group 1 elements*
- 1
- (b) (i) (bromine) gains electrons  
*it = bromine*  
*do **not** accept bromide ion gains electrons*

*ignore loss of oxygen*

1

(ii)  $I_2$

*must both be on the right hand side of the equation*

1

$+ 2e^-$

$2I^- - 2e^- \rightarrow I_2$  for 2 marks

1

(iii) fluorine is the smallest atom in Group 7 **or** has the fewest energy levels in Group 7 **or** has the smallest distance between outer shell and nucleus

*the outer shell **must** be mentioned to score 3 marks*

1

fluorine has the least shielding **or** the greatest attraction between the nucleus and the outer shell

1

therefore fluorine can gain an electron (into the outer shell) more easily

1

[8]

### Q7.

(a) (i) copper is less reactive than hydrogen **or** copper is unreactive

1

(ii) Zinc and dilute hydrochloric acid

1

(b) (gas) syringe

1

(c) (i) 35

*allow 3*

1

because not close to others

*accept it is much lower than the others*

*ignore references to trends or patterns*

*dependent on the first mark*

1

(ii)  $(49 + 50 + 48) / 3$

$= 49$

*correct answer with or without working gains 2 marks*

1

*allow ecf from anomaly identified in (i) for 2 marks:*

- *Exp 1 anomalous gives 43.3*
- *Exp. 2 anomalous gives 44*
- *Exp. 4 anomalous gives 44.7*

*answer of 45.5 or 46 (anomaly not excluded) gains 1 mark*

*correct working **excluding anomaly** but with wrong answer gains 1 mark*

1

(iii) so that a mean can be calculated  
*accept improves accuracy of the mean or so anomalies can be identified / discarded or to reduce effect of random errors ignore makes it a fair test ignore reliability, validity, repeatability, reproducibility*

1

(d) (i) idea of mixing with oxygen / air, letting air / oxygen in  
*accept converse*

1

(ii) H<sub>2</sub>O  
*do not accept incorrect additional products*

1

balancing 2 ... (1) ... 2  
*allow fractions or multiples dependent on first mark*

1

[11]

**Q8.**

(a) (i) a proton

1

(ii) nucleus

1

(iii) 12  
*order must be correct*

1

4

1

(b) (i) 5 / five (%)

1

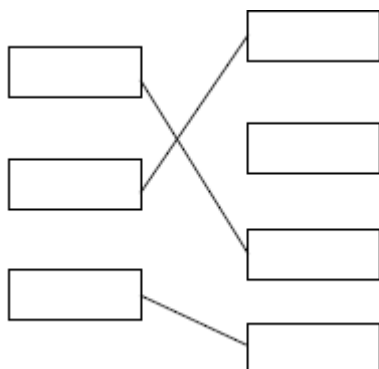
(ii) Carbon dioxide > global warming

1

Sulfur dioxide > acid rain

1

Water > no pollution



1

[8]

**Q9.**

- (a) (i) 14 1
- (ii) isotope 1
- (iii) (very) small  
*accept smaller / tiny / (very) little* 1
- (b) (i) C 1
- (ii) NH<sub>3</sub> 1
- (c) (i) nitric (acid) 1
- (ii) indicator 1
- (iii) crystallisation **or** evaporation  
*allow by heating **or** cooling **or** leave (on windowsill)*  
*do not accept freezing* 1
- (iv) any **one** from:  
• grass grows faster  
• grass grows taller **or** thicker  
*allow grass grows better / greener* 1
- (d) potassium (atom) loses (an electron)  
*reference to incorrect bonding or particle = max 3* 1
- chlorine (atom) gains (an electron)  
*ignore references to full outer shells* 1
- 1 (electron) 1
- electron 1

**[13]****Q10.**

- (a) (i) any **two** from:  
*ignore any conclusion drawn referring to data below 7.5 nm or above 20 nm*
- *100% of (type 1 and type 2) bacteria are killed with a particle size of 7.5 to 8.5 nm*  
*accept nanoparticles in the range of 7.5 to 8.5 nm are most effective at killing (type 1 and type 2) bacteria*
  - *as the size increases (beyond 8.5 nm), nanoparticles are less effective at killing (type 1 and type 2) bacteria*

- *type 1 shows a linear relationship or type 2 is non-linear*
- *type 1 bacteria more susceptible than type 2 (at all sizes of nanoparticles shown on the graph)*  
*allow type 2 bacteria are harder to kill*

2

- (ii) (yes) *because you could confirm the pattern that has been observed*  
*allow would reduce the effect of anomalous points / random errors*  
*allow would give better line of best fit*  
*ignore references to reliability / precision / accuracy / reproducibility / repeatability / validity*

**or**

(no) *because trend / conclusion is already clear*

1

- (b) magnesium loses electron(s)

1

oxygen gains electron(s)

1

two electrons (per atom)

1

gives full outer shells (of electrons) **or** *eight electrons in highest energy level*  
*reference to incorrect particles or incorrect bonding or*  
*incorrect structure = max 3*

1

**or**

(electrostatic) attraction between ions **or** forms ionic bonds  
*accept noble gas structure*

[7]

### Q11.

- (a) weaker bonds

*allow (other substances) react with the silicon dioxide*

**or**

fewer bonds

*ignore weaker / fewer forces*

**or**

disruption to lattice

*do not accept reference to intermolecular forces / bonds*

1

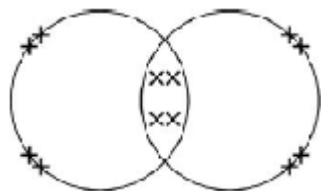
- (b) (i) Na<sub>2</sub>O

*do not accept brackets or charges in the formula*

1

(ii)





*electrons can be shown as dots, crosses, e or any combination*

2 bonding pairs

*accept 4 electrons within the overlap*

1

2 lone pairs on each oxygen

*accept 4 non-bonding electrons on each oxygen*

1

(c) *lattice / regular pattern / layers / giant structure / close-packed arrangement*

1

(of) positive ions **or** (of) atoms

1

(with) delocalised / free electrons

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max 2*

1

[7]

## Q12.

(a) (i) atomic weight

1

(ii) groups

1

(iii) left a gap

1

(iv) had not been discovered by 1869

1

(b) protons

*must be in correct order*

1

electrons

1

(c) sodium and nickel are both metals

1

sodium is more reactive than nickel

1

(d) (i) bromine

*allow Br<sub>2</sub> / Br*

*do **not** allow bromide*

1

(ii) iodine is less reactive (than bromine)

*it = iodine*

*allow converse*

*do **not** allow bromide*

1

[10]

**Q13.**

(a) similar properties

*allow same properties*

*allow correct example of property*

*ignore answers in terms of atomic structure*

1

(b) (i) in order of atomic / proton number

*allow increasing number (of protons)*

1

(ii) elements in same group have same number (of electrons) in outer shell  
**or** highest energy level

*allow number (of electrons) increases across a period*

1

(c) any **two** from:

*statements must be comparative*

• stronger / harder

*ignore higher densities*

• less reactive

• higher melting points

*ignore boiling point*

2

(d) reactivity increases down group

*allow converse throughout*

*for next three marks, outer electron needs to be mentioned  
once otherwise max = 2*

1

*outer electron is further from nucleus*

*allow more energy levels / shells*

*allow larger atoms*

1

*less attraction between outer electron and nucleus*

*allow more shielding*

1

*therefore outer electron lost more easily*

1

[9]

**Q14.**

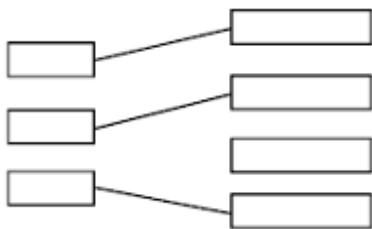
(a) (i) nucleus

1

(ii) an energy level (shell)

1

(b)



3

(c) 2 / two(%)

1

(d) (i) 10 / ten

1

(ii) (group) 0

*accept noble gases*

*ignore (group) 8*

1

[8]

### Q15.

(a) hydrogen has one proton whereas helium has two protons

*accept numbers for words*

*accept hydrogen only has one proton*

*ignore references to groups*

1

hydrogen has one electron whereas helium has two electrons

*accept hydrogen only has one electron*

*allow helium has a full outer shell (of electrons)*

1

hydrogen has no neutrons **or** helium has two neutrons

*if no other mark awarded, allow helium has more electrons / protons / neutrons for 1 mark*

1

(b) (i) 2 electrons on first shell **and**

8 electrons on outer shell

1

(ii) they have a stable arrangement of electrons

*accept they have full outer energy level / shell of electrons*

*do **not** accept they have the same number of electrons in their outer energy level / shell*

*allow they are noble gases*

*ignore they are in group 0*

1

[5]

### Q16.

- (a) proton 1  
*ignore ±* 1
- electron very small owtte  
*allow zero*  
*allow values from 1 / 1800 to 1 / 2000 or 0.0005 – 0.00055* 1
- (b) 8 1
- 16 1
- (c) (i) Isotopes 1
- (ii)  $^{18}_8\text{O}$  1
- (d) (i) compound 1
- (ii) H-O-H 1
- (iii) covalent 1
- (iv) sharing 1
- [10]**

### Q17.

- (a) Will kelp last longer than coal as an energy source? 1
- (b) any **two** from:
- cannot be determined by experiment  
*allow can't predict how long kelp / coal will last*  
*allow more testing needed*
  - based on opinion
  - ethical **or** environmental **or** economic reason  
*allow could damage ecosystem allow reference to cost*
- 2
- (c) (i) 7 1
- (ii) sodium (atom) loses (electron) **and** iodine (atom) gains (an electron)  
*reference to incorrect bonding or incorrectly named particle*  
*= max 2*  
*any or all marks can be obtained from a labelled diagram*  
*ignore inner shell electrons if shown*

1 electron

1

(electrostatic) attraction **or** forms ionic bond(s)

1

1

(iii) ions can move (in the solution)

1

(iv)  $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$

1

(v) hydrogen is formed

1

because sodium is more reactive (than hydrogen)

1

[11]

### Q18.

(a) (i) nucleus

1

(ii) neutron

1

(iii) electron

1

(b) (i) 12

1

(ii) 24

1

(c) any **four** from:

*sharing / covalent / metallic = max 3*

- magnesium (atom) reacts with **two iodine (atoms)**
- magnesium (atom) loses electrons
- **2** electrons (from each atom)
- Iodine (atom) gains electron(s)
- **1** electron or an electron (to each atom)
- iodide ion formed  
*allow iodine ion*
- iodide has negative charge / is a negative ion / particle  
*allow iodine*  
*ignore  $\text{I}^{2-}$*
- magnesium ion formed
- magnesium has positive charge

- oppositely charged ions attract
- a giant structure / lattice is formed  
*allow 1 mark for unqualified reference to ion formation or ionic bonding*

4

[9]

**Q19.**

- (a) *reference to incorrect bonding or incorrect structure or incorrect particles = max 3*

giant structure / lattice  
*ignore many bonds*

1

made up of positive ions surrounded by delocalized / free electrons  
*allow positive ions surrounded by a sea of electrons*

1

with strong bonds / attractions  
*allow hard to break for strong*

1

so a lot of energy is needed to break these bonds / attractions / forces  
*ignore high temperature  
ignore heat*

1

- (b) (i) that they are very small

**or**

1-100 nanometres **or** a few(hundred) atoms  
*accept tiny / really small / a lot smaller / any indication of very small eg. microscopic, smaller than the eye can see  
ignore incorrect numerical values if very small is given*

1

- (ii) delocalised / free electrons  
*allow sea of electrons*

1

one non-bonded electron from each atom  
*accept electron(s) moving through the structure / nanotube  
allow electron(s) carry / form / pass current / charge*

1

[7]

**Q20.**

- (a) (i) E

1

- (ii) C

1

- (iii) A

(b) (i) quickly melted  
*allow melts in contact with water,*  
*allow bp 100 °C (of water) shows mp is low*  
*ignore one other piece of information*

1

1

(ii) easily cut  
*ignore one other piece of information*

1

(iii) effervescence / fizzing / bubbling  
*ignore named gas*  
*ignore one other piece of information*

1

[6]

### Q21.

(a) if placed consecutively, then elements would be in wrong group / have wrong properties

*allow some elements didn't fit pattern*

1

left gaps

1

(b) (elements placed in) atomic / proton number order

1

(elements in ) same group have same number of outer electrons

1

any **one** from:

- number of protons = number of electrons
- reactions/(chemical) properties depend on the (outer) electrons
- number of shells gives the period  
*allow number of shells increases down the group*

1

(c) (i) (transition elements usually) have same / similar number of outer / 4th shell electrons

*allow 2 electrons in outer shell*

1

(because) inner (3rd ) shell / energy level is being filled  
*ignore shells overlap*

1

(ii) 2<sup>nd</sup> shell / energy level can (only) have maximum of 8 electrons  
*accept no d-orbitals*

**or**

2<sup>nd</sup> shell / energy level cannot have 18 electrons

1

## Q22.

- (a) (i) any **two** from:
- bubbles / effervescence / fizzing  
*ignore hydrogen / gas produced*
  - lithium disappears / gets smaller  
*allow dissolves*  
*do **not** allow melts / burns*
  - lithium moves on the surface of the water  
*ignore floats*
  - (universal indicator) turns blue / purple
- 2
- (ii) 2
- left-hand side correct*
- 1
- 2
- right-hand side correct*  
*allow multiples for full credit*
- 1
- (iii) light / burn, which will give a (squeaky) pop / explosion
- 1
- (iv) all have 1 electron in their outer shell / energy level  
*allow have the same number of electrons in their outer shell / energy level*
- 1
- (b) They react with oxygen
- 1
- They have low melting points
- 1
- (c) (i) electronic structure [2,8,8] is drawn  
*incomplete inner shells scores a maximum of 1 mark*
- 1
- charge is +  
*allow [2,8,8]<sup>+</sup> for 1 mark*
- 1
- (ii) because (in potassium) the outer shell electron is further away from the nucleus **or** because potassium atoms are larger than sodium atoms  
*it should be clear that the candidate is referring to the outer shell electron: if this is not clear a maximum of 2 marks can be awarded*
- 1
- therefore the outer shell electron is less strongly attracted to the nucleus **or** is more shielded from the attraction of the nucleus and so the outer shell electron in potassium is more easily lost
- 1
- 3 marks can be scored for answering the question in terms**



of sodium

1

[13]

**Q23.**

(a) neutron(s)

*answers can be in either order*

1

proton(s)

1

(b) same number (17) protons **or** same number electrons

*if candidate chooses to quote numbers, they must be correct*

1

different numbers of neutrons ( $^{35}\text{Cl}$  has 18 and  $^{37}\text{Cl}$  has 20)

1

(c) (i)  $-184\text{kJ/mol}$

*correct answer with or without working gains 3 marks*

*allow 2 marks for  $184\text{kJ/mol}$*

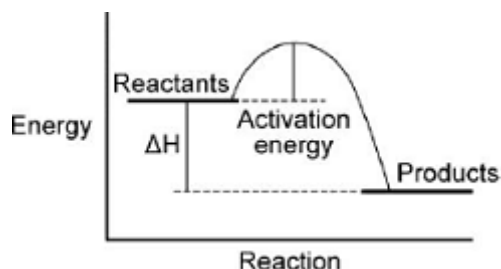
*If answer incorrect award up to 2 marks for any two of the steps below:*

- *bonds broken:  $(436 + 242) = 678\text{ (kJ)}$*
- *bonds formed:  $(2 \times 431) = 862\text{ (kJ)}$*
- *bonds broken – bonds formed*

*allow ecf for arithmetical errors*

3

(ii)



the reactants and the products at the correct level

*ignore labels on the axes*

1

$\Delta H$  correctly labelled

*allow  $-538$  if in correct place*

1

$E_a$  correctly labelled

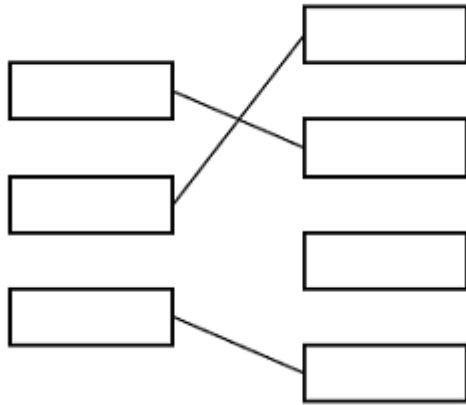
*correctly labelled endothermic reaction gains max. 2 marks*

1

[10]

**Q24.**

(a)



one mark for each substance linked correctly to its description

do **not** accept more than one line from each substance

3

- (b) 0 / zero / none / no charge

1

electron

1

- (c) (i) nucleus

1

- (ii) atomic number

1

- (iii) mass number

1

[8]

**Q25.**

- (a) (i) 2.8.3

*any sensible symbol can be used to represent an electron*

1

- (ii) proton(s) **and** neutron(s)

*both needed for the mark*

1

- (iii) number of protons is equal to number of electrons

*allow positive and negative charges cancel out*

*allow same amount of protons and electrons*

1

- (b) (i)  $2 \text{ Al} + \text{Fe}_2 \text{ O}_3 \rightarrow 2 \text{ Fe} + \text{Al}_2 \text{ O}_3$

*equation must be balanced*

1

- (ii) aluminium is more reactive (than iron)

*it = aluminium*

*accept converse*

*accept aluminium displaces iron*

*accept aluminium is higher in the reactivity series (than iron)*

1

**Q26.**

- (a) 1 / one 1
- (b) (i) protons 1
- (ii) neutrons 1
- (iii) 7 1
- (c) (i) losing 1
- (ii) a positive 1
- (iii) electrostatic 1
- (d) high melting points 1
- strong bonds 1
- (e) (i) 58.5 1
- (ii) mole 1
- (f) very small (particles) **or**  
*ignore tiny / small / smaller / microscopic etc.*  
 1-100nm in size **or**  
 (particle with a) few hundred atoms 1

[12]

**Q27.**

- (a) (alloy) atoms / ions / particles not in layers  
*accept layers are distorted*  
*accept different (size) particles / atoms* 1
- so, (alloy) layers / atoms / ions / particles can't slide  
*if no other mark awarded allow (an alloy) is a mixture of metals for 1 mark* 1
- (b) diamonds have a giant covalent structure 1
- diamonds have strong bonds between carbon atoms

- (c) (i) a compound 1
- (ii) CH<sub>4</sub> 1
- (iii) covalent 1
- (d) methane has a low boiling point  
or boiling point less than 20°C molecules 1
- because it has small molecules  
*accept it has forces between molecules*  
*accept weak forces between molecules for 2 marks* 1

[9]

**Q28.**

- (a) has simple / small molecules  
*accept molecular covalent* 1
- the intermolecular forces / intermolecular bonds (are weak)  
*do **not** accept weak covalent bonds **or** reference to incorrect bonding* 1
- only need a small amount of energy to be overcome  
*accept only need a small amount of energy to separate the molecules*  
*if no other mark awarded, allow it has a low boiling point for 1 mark* 1
- (b) (i) any pH value from 0 to 6.9 1
- (ii) hydrogen  
*allow H<sup>+</sup>*  
*ignore H / H<sub>2</sub> / H<sup>-</sup>* 1
- (c) any **three** from:
- same number of protons  
*accept same atomic number*  
*numbers if given must be correct*
  - <sup>2</sup>H has one neutron
  - <sup>1</sup>H has no neutrons  
*accept different mass number **or** different number of neutrons for 1 mark*  
*ignore relative atomic mass*

- same number of electrons  
*numbers if given must be correct*

3

**[8]****Q29.**

(a) number

1

0

*allow 8*

1

(b) beryllium **or** magnesium **or** strontium **or** barium **or** radium*allow correct symbols*

1

(c) (i) an alkali metal

1

(ii) a transition metal

1

(d) for undiscovered elements

*accept so elements with similar properties were in the same groups**accept so elements fitted the pattern of properties*

1

**[6]****Q30.**

(a) (i) gas

1

(ii) Increases

1

(b) (i) -1

*allow Cl<sup>-</sup>**allow -**allow negative*

1

(ii) sodium + chlorine → sodium chloride

*allow correct symbol equation*

1

(c) reduce microbes

*accept sterilise**accept prevent diseases**allow disinfect**allow kill bacteria / germs / microbes / micro-organisms**allow to make it safe to drink**ignore get rid of bacteria*

1

(d) any **one** from:

- no freedom of choice  
*allow unethical*
- fluoride in toothpaste
- too much can cause fluorosis  
*allow too much can cause damage to teeth*

1

[6]

### Q31.

(a) (i) hydrogen

*accept H<sub>2</sub>*  
*allow H*

1

(ii) hydroxide

*accept OH<sup>-</sup>*  
*allow OH*  
*do **not** accept lithium hydroxide*

1

(b) any **two** from:

*'it' = potassium*

potassium:

*accept converse for lithium*

- reacts / dissolves faster  
*allow reacts more vigorously / quickly / violently / explodes*  
*ignore reacts more*
- bubbles / fizzes faster  
*allow fizzes more*  
*allow more gas*
- moves faster (on the surface)  
*allow moves more*
- melts  
*allow forms a sphere*
- produces (lilac / purple) flame  
*allow catches fire / ignites*  
*do **not** accept other colours*

2

[4]

### Q32.

(a) +1/+

*do **not** accept 1 without the +*

1

electron

*allow phonetic spelling*

1

(b) (i) elements

1

(ii) non-metal

1

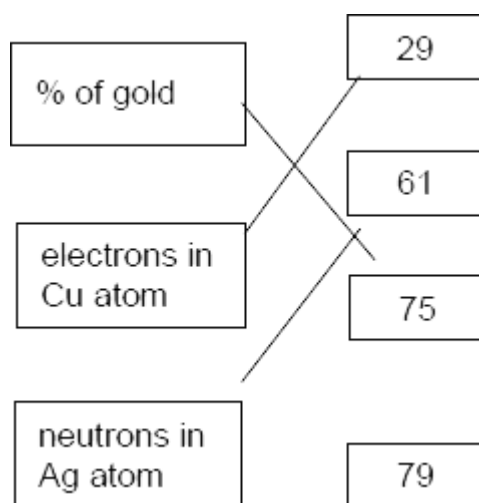
(c) soft

1

an alloy

1

(d)



**one** mark for each correct link  
*extra lines lose the mark*

3

[9]

**Q33.**

(a) 2,4

*allow electrons in any position on correct shells*

1

(b) (electron) 79

1

neutron

*allow phonetic spelling*

1

118

1

(c) (i) 16 **and** 9

*in this order*

1

(ii) any **two** from:

*ignore reasons about colour / lustre / corrosion / rarity*

- (100% / pure) gold is soft  
*allow layers can slide in pure gold*
- (alloyed) to make the metal hard(er)  
*ignore just 'the ring is an alloy'*  
*allow (alloyed) to stop the layers sliding*  
*allow (alloyed) to make the metal strong*
- gold is expensive **or** alloy is less expensive

2

[7]

**Q34.**

(a) NN linked to element

1

OCO linked to compound

1

(b) electron

1

nucleus

*must be correct order*

1

(c) (reacts with) oxygen

1

to produce water

*must be names*

*accept hydrogen oxide*

*allow steam*

1

[6]