

## Atomic Structure part 4

### Q1.

- (a) Use the periodic table on the Data Sheet to help you answer these questions.

Part of the periodic table is shown below.

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

<b>B</b>														<b>C</b>			
							<b>D</b>										
														<b>E</b>			
											<b>F</b>						

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

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

- (i) hydrogen

Letter

(1)

- (ii) a Group 3 element

Letter

(1)

- (iii) a halogen

Letter

(1)

- (iv) the element with atomic (proton) number of 7

Letter

(1)

- (v) an element with one electron in its outer shell?

Letter

(1)

- (b) The table shows the melting points of the Group 1 metals arranged in alphabetical order.

Group 1 metal		
Name	Symbol	Melting point in °C
Caesium	Cs	29
Francium	Fr	27
Lithium	Li	180
Potassium	K	64
Rubidium	Rb	39
Sodium	Na	98

- (i) Arrange these metals in order of increasing melting point. Three have been done for you.

Fr      Cs      \_\_\_\_\_      \_\_\_\_\_      \_\_\_\_\_      Li

Lowest  $\xrightarrow{\hspace{15em}}$  Highest

(1)

- (ii) Use the periodic table on the Data Sheet **and** your answer in part (b)(i) above to complete this sentence about how the melting points change.

Going down Group 1, the melting points \_\_\_\_\_

(1)

- (c) The transition metals are a block of elements between Groups 2 and 3 of the periodic table. Transition metals have different properties to Group 1 metals.

Put ticks (✓) next to the **three** correct statements about transition metals in the table below.

Statement	(✓)
They are harder than Group 1 metals	
They have lower densities than Group 1 metals	
They have higher melting points than Group 1 metals	
They are more reactive with water than Group 1 metals	
They often form coloured compounds but Group 1 compounds are usually white	

(3)

(Total 10 marks)

## Q2.

Sodium is a Group 1 element.

- (a) (i) A small piece of sodium is added to some water containing Universal Indicator solution.

Describe what you would **see** happening.

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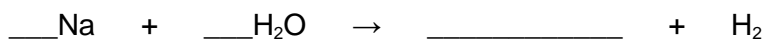
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(3)

- (ii) Complete **and** balance the equation for the reaction of sodium with water.



(2)

- (b) Francium is the most reactive element in Group 1.

Explain why in terms of electronic structure.

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(3)

- (c) The transition elements have different properties from the elements in Group 1.

Give **two** of these different properties of transition elements.

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

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

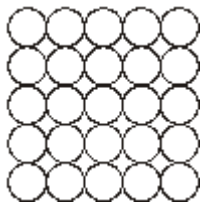
(2)

(Total 10 marks)

### Q3.

Iron is the main structural metal used in the world.

- (a) The diagram represents the particles in iron, Fe.



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

Iron is described as an element because all the

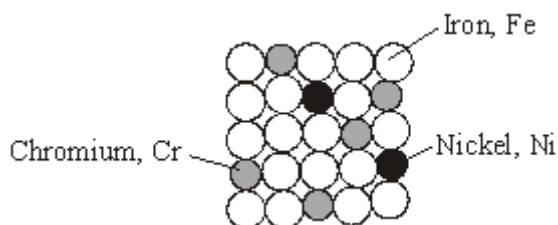
atoms
compounds
metals

are the same.

(1)

(b) Stainless steel is mostly iron.

The diagram represents the particles in stainless steel.



Use the correct words from the box to complete the sentences about alloys.

metal	mixture	molecule	polymer	smart	structure
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Stainless steel is an alloy because it is a \_\_\_\_\_ of iron, chromium and nickel.

An alloy is made up of more than one type of \_\_\_\_\_.

Stainless steel alloys are harder than iron because the different sized atoms added change the \_\_\_\_\_.

An alloy that can return to its original shape after being deformed is called a \_\_\_\_\_ alloy.

(4)

(c) In the UK, we use about 1.8 billion steel cans every year but only 25% are recycled. Used steel cans are worth about £100 per tonne.

Recycling saves raw materials and reduces waste that would end up in landfill. Producing steel by recycling used cans saves 75% of the energy that would be needed to produce steel from iron ore. This also reduces carbon dioxide emissions.

(i) Give **two** reasons, from the information above, to explain why recycling used steel cans is a good idea.

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

(2)

- (ii) Suggest how the local council could increase the percentage of used steel cans that are recycled.

\_\_\_\_\_

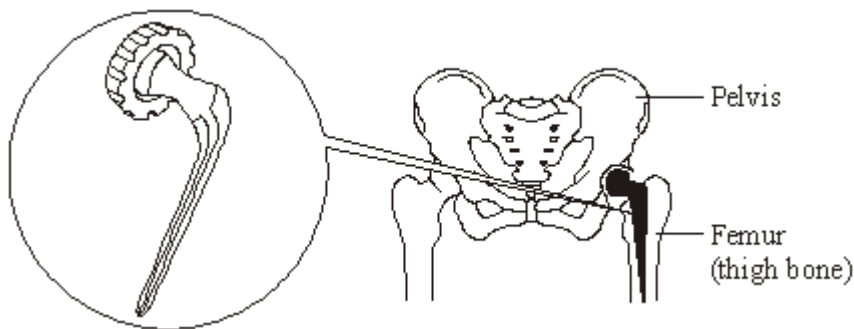
\_\_\_\_\_

(1)

(Total 8 marks)

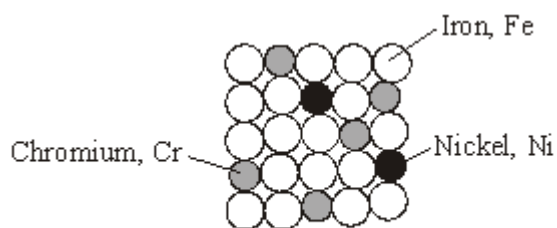
**Q4.**

The hip joint between the femur and pelvis sometimes has to be replaced. Early hip replacement joints were made from stainless steel.



Stainless steel is an alloy of iron, chromium and nickel.

The diagram below represents the particles in stainless steel.



Particle diagram of stainless steel

- (a) Use the particle diagram to complete the percentages of metals in this stainless steel.

The first one has been done for you.

Element	Percentage (%)
Iron, Fe	72
Chromium, Cr	

Nickel, Ni	
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(2)

(b) Pure iron is a relatively soft, metallic element.

(i) Why is iron described as an *element*?

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(1)

(ii) Suggest why pure iron would **not** be suitable for a hip replacement joint.

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(1)

(iii) Use the particle diagram to help you to explain why stainless steel is harder than pure iron.

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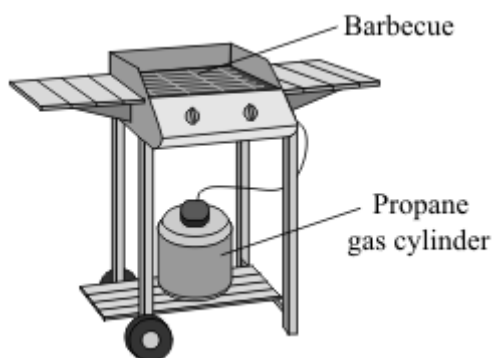
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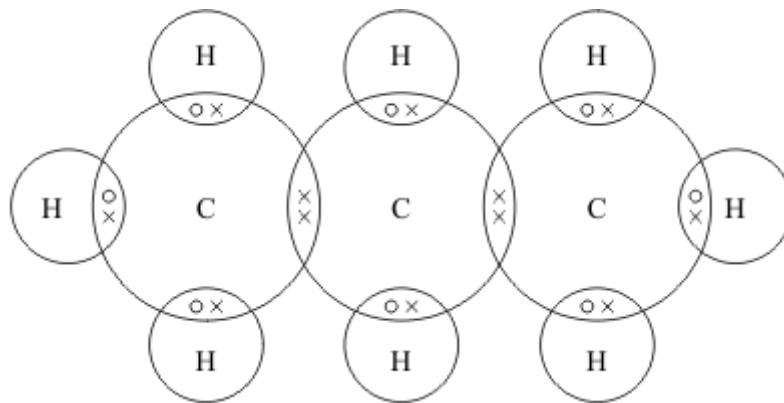
(Total 6 marks)

**Q5.**

This barbecue burns propane gas.



The diagram represents a propane molecule.



(a) What is the formula of propane?

\_\_\_\_\_

(1)

(b) (i) Draw a ring around the name of the particle represented by the symbols  $\circ$  and  $\times$  in the diagram.

**electron**

**neutron**

**proton**

(1)

(ii) Draw a ring around the type of bonding that holds the atoms together in a propane molecule.

**covalent**

**ionic**

**metallic**

(1)

(c) Under high pressure in the cylinder propane is a liquid. Liquid propane evaporates easily to form a gas when the tap on the cylinder is opened.

Draw a ring around the correct answer in each box to explain why propane evaporates easily.

Propane has a 

high
low

 boiling point because it consists of 

large
small

 molecules.

(1)

(Total 4 marks)

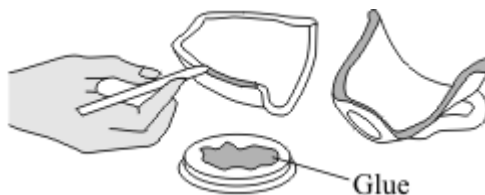
## Q6.

The following steps show how to use a type of glue.

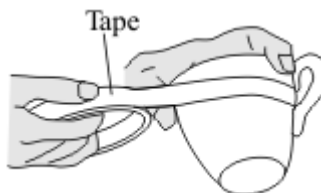
**Step 1** Measure out equal amounts of the liquids from tubes **A** and **B**.



**Step 2** Mix the liquids to make the glue.  
Put a thin layer of the glue onto each of the surfaces to be joined.



**Step 3** Assemble the pieces to be joined and then hold them together with tape.



**Step 4** Leave the glue to set.

(a) When liquids **A** and **B** are mixed a chemical reaction takes place.

(i) This reaction is exothermic.

Complete the sentence below using a word or phrase from the box.

**decrease      increase      stay the same**

During the reaction the temperature of the mixture will \_\_\_\_\_.

(1)

(ii) When the glue sets it forms a giant covalent structure.

Draw a ring around **one** property that you would expect the set glue to have.

**good conductor of electricity      low melting point      high melting point**

(1)

(b) The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days
60	6 hours
90	1 hour

(i) Complete the sentences below using words or phrases from the box.

**decrease      increase      stay the same**



When the temperature is increased the time taken for the glue to set

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When the temperature is increased the rate of the setting reaction

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(2)

- (ii) Put a tick (✓) next to the **two** reasons why an increase in temperature affects the rate of reaction.

Reason	(✓)
It gives the particles more energy.	<input type="checkbox"/>
It increases the concentration of the particles.	<input type="checkbox"/>
It increases the surface area of the particles.	<input type="checkbox"/>
It makes the particles move faster.	<input type="checkbox"/>

(2)

(Total 6 marks)

### Q7.

Iron is an essential part of the human diet. Iron(II) sulfate is sometimes added to white bread flour to provide some of the iron in a person's diet.



- (a) The formula of iron(II) sulfate is  $\text{FeSO}_4$

Calculate the relative formula mass ( $M_r$ ) of  $\text{FeSO}_4$

Relative atomic masses: O = 16; S = 32; Fe = 56.

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The relative formula mass ( $M_r$ ) = \_\_\_\_\_

(2)

(b) What is the mass of one mole of iron(II) sulfate? Remember to give the unit.

\_\_\_\_\_

(1)

(c) What mass of iron(II) sulfate would be needed to provide 28 grams of iron?

Remember to give the unit.

\_\_\_\_\_

(1)

(Total 4 marks)

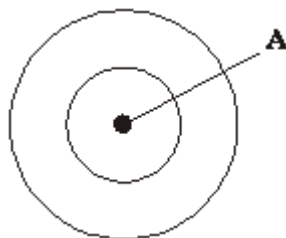
### Q8.

This question is about oxygen atoms. The periodic table on the Data Sheet may help you to answer this question.

(a) (i) Oxygen atoms have 8 electrons.

Complete the diagram to represent the arrangement of electrons in an oxygen atom.

Use crosses (x) to represent the electrons.



(1)

(ii) Name the part of the oxygen atom that is labelled **A** on the diagram.

\_\_\_\_\_

(1)

(b) Two isotopes of oxygen are oxygen-16 and oxygen-18.



Explain, in terms of particles, how the nucleus of an oxygen-18 atom is different from the nucleus of an oxygen-16 atom.

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

(2)

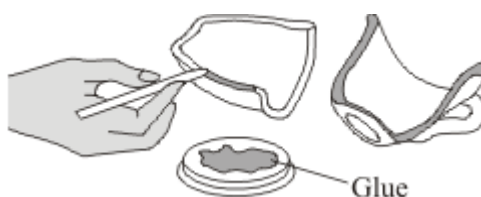
**Q9.**

The following steps show how to use a type of glue.

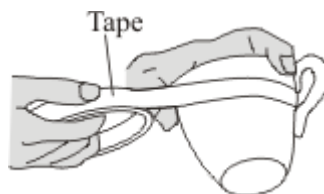
**Step 1** Measure out equal amounts of the liquids from tubes **A** and **B**.



**Step 2** Mix the liquids to make the glue.  
Put a thin layer of the glue onto each of the surfaces to be joined.



**Step 3** Assemble the pieces to be joined and then hold them together with tape.



**Step 4** Leave the glue to set.

(a) When liquids **A** and **B** are mixed a chemical reaction takes place.

(i) This reaction is exothermic.

State how the temperature of the mixture will change as the glue is mixed.

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(1)

(ii) When the glue sets it forms a giant covalent structure.

Explain why substances with giant covalent structures have high melting points.

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(2)

- (b) The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days
60	6 hours
90	1 hour

Explain, in terms of particles, why increasing the temperature changes the rate of the reaction which causes the glue to set.

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(2)

(Total 5 marks)

### Q10.

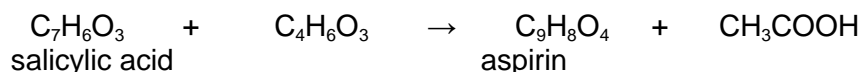
Aspirin tablets have important medical uses.



A student carried out an experiment to make aspirin. The method is given below.

1. Weigh 2.00 g of salicylic acid.
2. Add 4 cm<sup>3</sup> of ethanoic anhydride (an excess).
3. Add 5 drops of concentrated sulfuric acid.
4. Warm the mixture for 15 minutes.
5. Add ice cold water to remove the excess ethanoic anhydride.
6. Cool the mixture until a precipitate of aspirin is formed.
7. Collect the precipitate and wash it with cold water.
8. The precipitate of aspirin is dried and weighed.

(a) The equation for this reaction is shown below.



Calculate the maximum mass of aspirin that could be made from 2.00 g of salicylic acid.

The relative formula mass ( $M_r$ ) of salicylic acid,  $\text{C}_7\text{H}_6\text{O}_3$ , is 138

The relative formula mass ( $M_r$ ) of aspirin,  $\text{C}_9\text{H}_8\text{O}_4$ , is 180

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Maximum mass of aspirin = \_\_\_\_\_ g

(2)

(b) The student made 1.10 g of aspirin from 2.00 g of salicylic acid.

Calculate the percentage yield of aspirin for this experiment.

(If you did not answer part (a), assume that the maximum mass of aspirin that can be made from 2.00 g of salicylic acid is 2.50 g. This is **not** the correct answer to part (a).)

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Percentage yield of aspirin = \_\_\_\_\_ %

(2)

(c) Suggest **one** possible reason why this method does **not** give the maximum amount of aspirin.

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(1)

(d) Concentrated sulfuric acid is a catalyst in this reaction.

Suggest how the use of a catalyst might reduce costs in the industrial production of aspirin.

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(1)

(Total 6 marks)

**Q11.**

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

(a) Draw a ring around the correct answer to complete these sentences.

(i)

Dimitri Mendeleev attempted to classify

compounds.
elements.
mixtures.

(1)

(ii)

He arranged them in order of their

atomic weight.
boiling point.
electrical conductivity.

(1)

(iii)

They are now arranged in order of their

atomic (proton) number.
atomic weight.
mass number.

(1)

(b) In the periodic table between Groups 2 and 3 there is a block of metals which includes chromium, iron and nickel.

(i) Which **one** of the following is the correct name for this block of metals?

Draw a ring around the correct answer.

**alkali metals**

**reactive metals**

**transition metals**

(1)

(ii) The properties of iron and those of the Group 1 metal sodium are different.

Put a tick (✓) next to the **two** correct phrases which could complete the following sentence.

Compared to sodium, iron

	(✓)
has a higher melting point.	
has a lower density.	

is harder.	
is more reactive.	
is weaker.	

(2)  
(Total 6 marks)

**Q12.**

Read the information about the development of the periodic table and answer the questions that follow:

Johann Döbereiner was a chemist who realised there was a link between atomic weight and chemical properties. Although it was difficult to measure atomic weights accurately, by 1829 Döbereiner had arranged many elements with similar chemical reactions in groups of three. He noticed that the middle element had an atomic weight that was approximately the average of the other two. These groupings were known as triads. Three of these triads are shown below:

Li 7	S 32	Cl 35.5
Na 23	Se 79	Br 80
K 39	Te 128	I 127

As new elements were discovered, it became difficult to group them in triads, and it was left to others to build on Döbereiner's work. The result was the first periodic table, suggested by Dimitri Mendeleev in 1869.

Our modern periodic table has evolved from Mendeleev's Table. Lithium, sodium and potassium are still together in Group 1, and chlorine, bromine and iodine are in Group 7.

It was many years before chemists understood the nature of the transition elements.

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

- (a) Döbereiner suggested that calcium (Ca), strontium (Sr) and barium (Ba) were also a triad.

Use relative atomic masses to explain why.

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(1)

- (b) Suggest why Döbereiner's ideas were replaced by those of Mendeleev.

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(1)

- (c) Lithium, sodium and potassium are in Group 1. All these elements react with water. Describe what you **see** when potassium is added to water.

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(2)

- (d) In terms of electronic structure, explain why:

- (i) elements in the same group of the periodic table have similar chemical properties

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(1)

- (ii) transition elements have similar properties even though they are not in the same group

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(2)

- (iii) in Group 1, lithium is **less** reactive than potassium.

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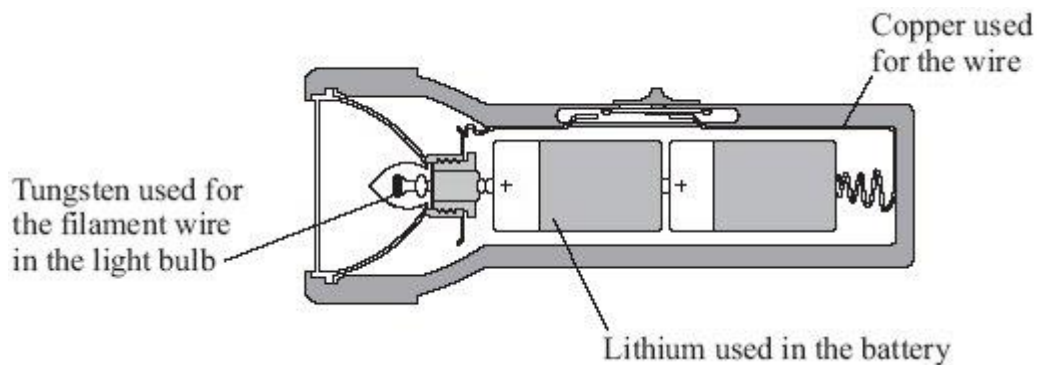
(2)

(Total 9 marks)

**Q13.**

The diagram shows a circuit that is used in a torch. Electrons flow through this circuit.



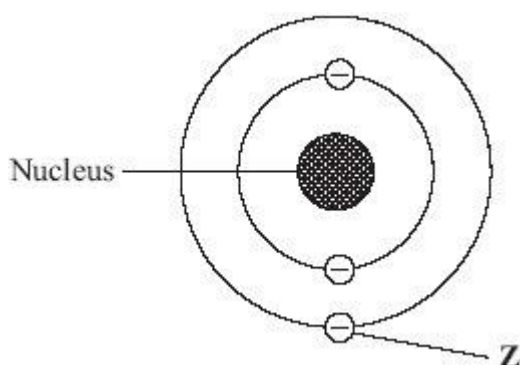


(a) Why is copper used for the wire?

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(1)

(b) The diagram shows the structure of an atom of lithium.



Name the particle labelled Z.

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(1)

(c) The table shows some properties of the metals used in the electrical circuit.

Metal	Melting point in °C	Boiling point in °C	Reaction with oxygen
Copper	1083	2582	Reacts <b>slowly</b> to form a thin oxide layer on surface
Lithium	179	1317	Reacts <b>rapidly</b> to form oxide
Tungsten	3370	5930	Reacts <b>only</b> when very hot to form oxide

(i) Use information from the table to suggest the order of reactivity for copper, lithium and tungsten.

**most reactive** \_\_\_\_\_

\_\_\_\_\_

**least reactive** \_\_\_\_\_

(2)

(ii) The filament wire glows because it gets very hot.

Use information from the table to suggest **one** reason why tungsten is used for the filament wire in the light bulb.

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(1)

(d) The gas used in the light bulb is argon.

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

Argon is used in the light bulb because it is

dense.

solid.

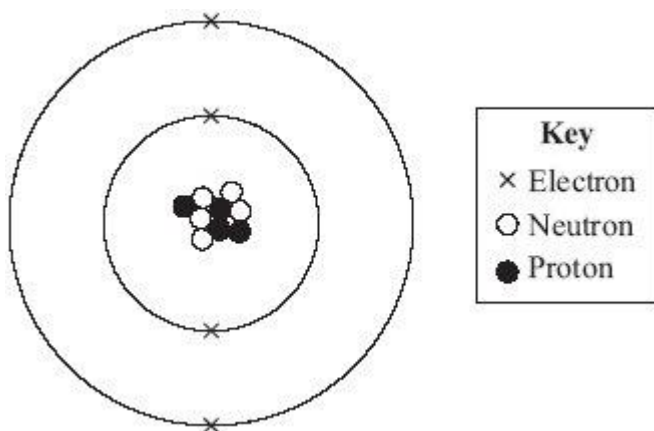
unreactive.

(1)

(Total 6 marks)

### Q14.

The diagram represents an atom of beryllium.



Use a number from the box to complete each sentence.

4	7	9	12
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(a) The atomic number (proton number) of this atom is .

(1)

(b) The mass number of this atom is .

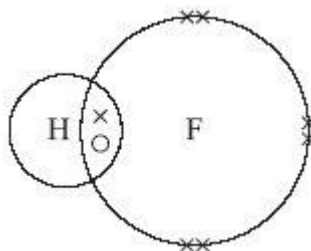
(1)

(Total 2 marks)

**Q15.**

This question is about fluorine and some of its compounds.

- (a) The diagram represents a molecule of hydrogen fluoride.



Draw a ring around the type of bonding that holds the hydrogen and fluorine atoms together in this molecule.

**covalent**

**ionic**

**metallic**

(1)

- (b) Fluorine is made in industry by the electrolysis of a mixture of potassium fluoride and hydrogen fluoride.

- (i) Use **one** word from the box to complete the sentence.

<b>gas</b>	<b>liquid</b>	<b>solid</b>
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To allow electrolysis to take place the mixture of potassium fluoride and hydrogen fluoride must be \_\_\_\_\_.

(1)

- (ii) The mixture of potassium fluoride and hydrogen fluoride contains fluoride ions ( $F^-$ ), hydrogen ions ( $H^+$ ) and potassium ions ( $K^+$ ).

Use **one** word from the box to complete the sentence.

<b>fluorine</b>	<b>hydrogen</b>	<b>potassium</b>
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During electrolysis the element formed at the **positive** electrode is

\_\_\_\_\_.

(1)

- (c) Fluoride ions are sometimes added to drinking water. It is thought that these ions help to reduce tooth decay.

- (i) Tick (✓) **one** question that **cannot** be answered by scientific investigation alone.

Question	Tick (✓)
Do fluoride ions in drinking water reduce tooth decay?	
Are fluoride ions in drinking water harmful to health?	

Should fluoride ions be added to drinking water?

(1)

(ii) Explain why you have chosen this question.

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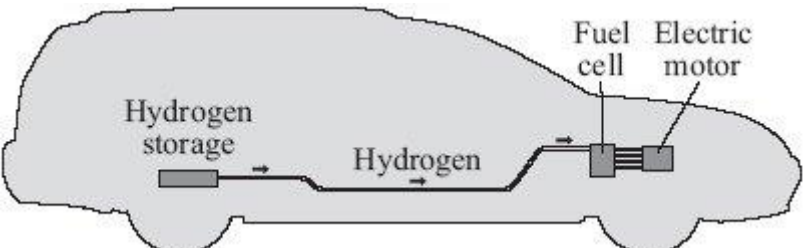
(1)

(Total 5 marks)

### Q16.

Read the article and then answer the questions that follow.

**Hydrogen fuel for cars?**



Hydrogen is an excellent fuel. On combustion it reacts with oxygen from the air to release a large amount of energy. The only product of combustion is water which does not cause pollution. Hydrogen gas can be stored under pressure in a cylinder but a leak of the gas could cause an explosion.

It has been found that lithium nitride can absorb and then release large volumes of hydrogen. Hydrogen stored in lithium nitride will not explode.

The problem is that the rate at which hydrogen is absorbed and then released from normal sized particles of lithium nitride is slow.

Recently scientists have made 'nanosized' particles of lithium nitride. The 'nanosized' particles have the advantage that they absorb and release the hydrogen much faster when needed in the fuel cell.

(a) Use information from the article to help you to answer these questions.

(i) Give **two** reasons why hydrogen is an excellent fuel.

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(2)

(ii) Hydrogen stored in lithium nitride is safer in an accident than a cylinder full of hydrogen gas.

State why.

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(1)

- (iii) What is the advantage of using 'nanosized' particles of lithium nitride instead of normal sized particles for storing hydrogen?

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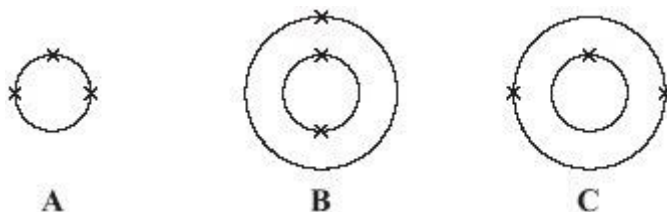
(1)

- (b) Lithium nitride is an ionic compound that contains lithium ions ( $\text{Li}^+$ ) and nitride ions ( $\text{N}^{3-}$ ).

- (i) The periodic table on the Data Sheet may help you to answer this question.

Which diagram, **A**, **B** or **C**, represents the electronic structure of a lithium atom?

Write your answer in the box.



Diagram

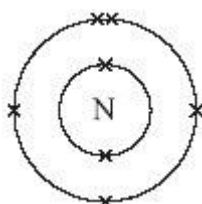
(1)

- (ii) Tick (✓) the statement which describes how a lithium atom ( $\text{Li}$ ) changes into a lithium ion ( $\text{Li}^+$ ).

Statement	Tick (✓)
A lithium atom loses a neutron.	
A lithium atom loses an electron.	
A lithium atom loses a proton.	

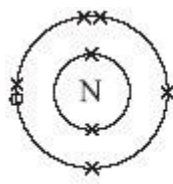
(1)

- (iii) The diagram shows the electronic structure of a nitrogen atom.

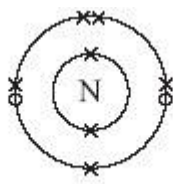


Which diagram, **A**, **B** or **C**, represents the electronic structure of a nitride ion ( $\text{N}^{3-}$ )?

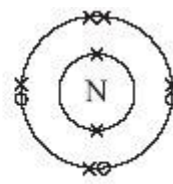
Write your answer in the box.



**A**



**B**



**C**

Diagram

(1)

(c) The equation for the reaction of lithium nitride with hydrogen is:



What does the symbol  $\rightleftharpoons$  mean?

Draw a ring around your answer.

**reversible reaction**

**endothermic reaction**

**neutralisation**

(1)

(d) Draw a ring around the correct answer in each box to complete the sentences.

(i) 'Nanosized' particles of lithium nitride will be

much larger
a little larger
much smaller

than normal sized particles of lithium nitride.

(1)

(ii) One of the reasons why 'nanosized' particles have different properties

from normal sized particles is that they have a greater

density
mass
surface area

than normal sized particles of lithium nitride.

(1)

(Total 10 marks)

### Q17.

Read the article and then answer the questions that follow.

<b>Hydrogen fuel for cars?</b>
--------------------------------

Hydrogen is an excellent fuel. It can be made by the electrolysis of potassium hydroxide solution.

Hydrogen gas can be stored under pressure in a cylinder but a leak of the gas could cause an explosion.

It has been found that lithium nitride can absorb and then release large volumes of hydrogen. A chemical reaction takes place between the hydrogen and the lithium nitride. The hydrogen is held in the resulting compounds by chemical bonds.

The problem is that the rate at which hydrogen is absorbed and then released from normal sized particles of lithium nitride is slow.

Recently scientists have made 'nanosized' particles of lithium nitride. These particles absorb hydrogen in the same way as normal sized lithium nitride particles. The 'nanosized' particles have the advantage that they absorb and release the hydrogen much faster when needed in the fuel cell.

It is hoped that 'nanosized' particles of lithium nitride may provide a safe method of storing hydrogen in the future.

(a) Hydrogen is produced at the negative electrode during the electrolysis of potassium hydroxide solution.

(i) Why are hydrogen ions attracted to the negative electrode?

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(1)

(ii) Potassium ions are also attracted to the negative electrode.

Explain why hydrogen gas is formed but not potassium.

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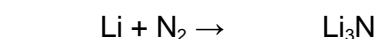


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(1)

(b) Lithium nitride is made by reacting lithium with nitrogen.

Balance the equation for this reaction.



(1)

- (c) (i) The equation for the reaction of lithium nitride with hydrogen is:



What feature of this reaction allows the hydrogen to be released?

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(1)

- (ii) Hydrogen stored in a fuel tank filled with lithium nitride would be safer in an accident than a cylinder full of hydrogen.

Suggest and explain why.

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(2)

- (d) Lithium nitride is an ionic compound which contains lithium ions ( $\text{Li}^+$ ) and nitride ions ( $\text{N}^{3-}$ ).

- (i) The formation of a lithium ion from a lithium atom is an oxidation reaction.

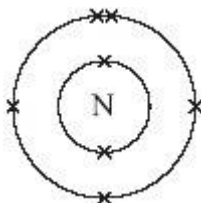
Explain why.

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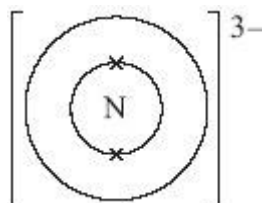
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(1)

- (ii) The diagram shows the electronic structure of a nitrogen atom.



Complete the diagram below to show the electronic structure of a nitride ion ( $\text{N}^{3-}$ ).





**Q18.**

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

Draw a ring around the correct answer to complete these sentences.

- (a) The Russian chemist who introduced his periodic table in 1869 was

Brønsted.  
Lowry.  
Mendeleev.

(1)

- (b) He put elements with similar chemical reactions in columns, known as

groups.  
periods.  
rows.

(1)

- (c) He left gaps for elements that were

insoluble.  
unreactive.  
undiscovered.

(1)

- (d) He did **not** put water, H<sub>2</sub>O, into the periodic table because water is a

compound.  
liquid.  
mixture.

(1)

(Total 4 marks)

**Q19.**

Group 7 is an important family of elements in the periodic table.

- (a) (i) What name is given to the Group 7 elements?

Draw a ring around your answer.

**Halogens**

**Noble gases**

**Transition elements**

(1)

- (ii) The grid shows some statements about Group 7 elements.

Tick (✓) the **two** correct statements.

Statement	(✓)
They are metals	
They consist of molecules	
They have coloured vapours	
They have high melting points	

(2)

(b) The table gives information about some of the Group 7 elements.

Name of element	Melting point in °C	Boiling point in °C	Electronic structure
Fluorine	-220	-188	2, 7
Chlorine	-101	-35	2, 8, 7
Bromine	-7	58	2, 8, 18, 7
Iodine	114	183	2, 8, 18, 18, 7

Use information from the table to help you to answer these questions.

Write the correct number in the box to complete the sentence.

(i) All these elements are in Group 7 because they have  electrons in their outer shell.

(1)

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

At 20 °C bromine is a

gas.
liquid.
solid.

(1)

(iii) Use the periodic table on the **Data Sheet** to name the Group 7 element that is **not** shown in the table.

---

(1)

(c) A student investigated the reactivity of three Group 7 elements.

The student added:

- aqueous chlorine to potassium bromide and potassium iodide solutions
- aqueous bromine to potassium chloride and potassium iodide solutions
- aqueous iodine to potassium chloride and potassium bromide solutions.

The student's results are shown in the table.

Solutions of	Potassium chloride	Potassium bromide	Potassium iodide
Chlorine		Solution turned orange-brown	Solution turned brown
Bromine	No change		Solution turned brown
Iodine	No change	No change	

Explain how these results show that chlorine is more reactive than bromine and iodine.

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(2)

(Total 8 marks)

### Q20.

Chlorine and bromine are important Group 7 elements.

- (a) Explain why chlorine is added to drinking water.

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(1)

- (b) Describe what you would **see** when bromine water is added to an unsaturated organic compound.

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(1)

- (c) Bromine can be extracted from seawater. The dissolved bromide ions are reacted with chlorine. Bromine and chloride ions are formed.

- (i) Complete and balance the equation below, which represents the reaction between chlorine and bromide ions.



(1)

- (ii) Describe what you **see** when chlorine is added to a solution containing bromide ions.

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(1)

(d) In terms of electronic structure:

(i) state why bromine and chlorine are both in Group 7

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(1)

(ii) explain why bromine is less reactive than chlorine.

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(3)

(e) What is the result of adding acidified silver nitrate solution to a solution containing:

(i) chloride ions

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(1)

(ii) bromide ions?

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(1)

(Total 10 marks)

### Q21.

Read the information about the periodic table.

In 1869 Dimitri Mendeleev classified the elements by first putting them in order of their atomic weights.

Then he arranged them in a table, so that elements with similar properties and reactions were in columns known as Groups.

He also left gaps in his table for undiscovered elements.

Use the modern periodic table on the Data Sheet to help you to answer these questions.

(a) Some elements were **not** placed in order of increasing atomic weights.

In terms of properties, suggest why potassium (atomic weight 39) should be placed after argon (atomic weight 40).

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(1)

(b) Some scientists thought that Mendeleev's table was **not** correct.

Suggest why, by referring to the elements in Group 4.

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(1)

(c) In the 1890s a new group of elements (Group 0) was discovered.

Suggest why they were easily fitted into Mendeleev's table.

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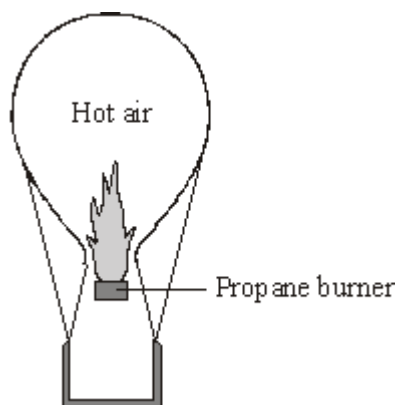
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(1)

(Total 3 marks)

## Q22.

Hot air balloons burn hydrocarbons to heat the air.



(a) The hot air contains these gases: nitrogen, N<sub>2</sub>  
oxygen, O<sub>2</sub>  
argon, Ar  
carbon dioxide, CO<sub>2</sub>  
water vapour, H<sub>2</sub>O

(i) Argon is an *element*.

What is an *element*?

\_\_\_\_\_

\_\_\_\_\_

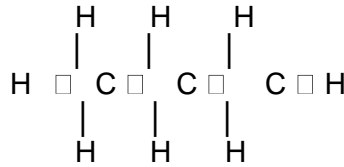
(1)

(ii) Name **one** other gas in the hot air that is also an element.

\_\_\_\_\_

(1)

(b) Propane,  $C_3H_8$ , can be represented as:



Use the correct words from the box to complete the sentences.

<b>bond</b>	<b>carbon</b>	<b>compound</b>	<b>element</b>	<b>mixture</b>
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(i) Propane is a \_\_\_\_\_ and is made up of atoms of hydrogen and \_\_\_\_\_

(2)

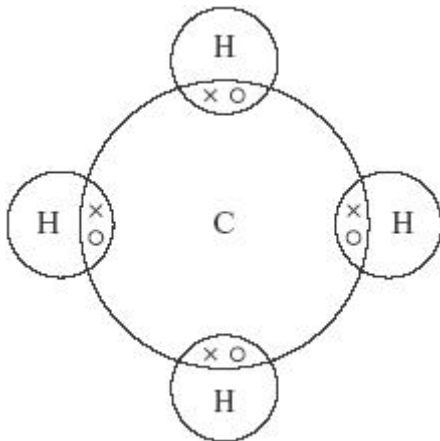
(ii) Each line between the atoms in propane represents a chemical \_\_\_\_\_

(1)

(Total 5 marks)

### Q23.

The diagram represents a particle of methane.



(a) What is the formula of methane? \_\_\_\_\_

(1)

(b) Choose a word from the box to answer the question.

atom                  ion                  molecule

Which of the words best describes the methane particle shown in the diagram?

\_\_\_\_\_

(1)

(c) Choose a word from the box to answer the question.

covalent                  ionic                  metallic

What is the type of bonding shown in the diagram?

\_\_\_\_\_

(1)

(Total 3 marks)

**Q24.**

Distress flares are used to attract attention in an emergency.



Flares often contain magnesium. Magnesium burns to form magnesium oxide.

(a) The distress flare burns with a bright flame because the reaction is very *exothermic*.

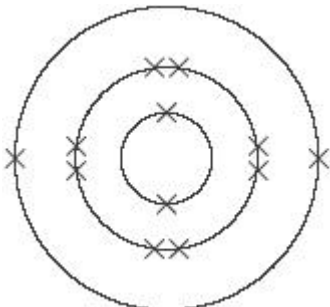
Complete the following sentence using the correct words from the box.

gives out heat                  stores heat                  takes in heat

An *exothermic* reaction is one which \_\_\_\_\_

(1)

(b) The diagram shows the electronic structure of a magnesium atom. The atomic (proton) number of magnesium is 12.



### Magnesium atom

The atomic (proton) number of oxygen is 8.

Which diagram, **A**, **B**, **C** or **D**, shows the electronic structure of an oxygen atom?

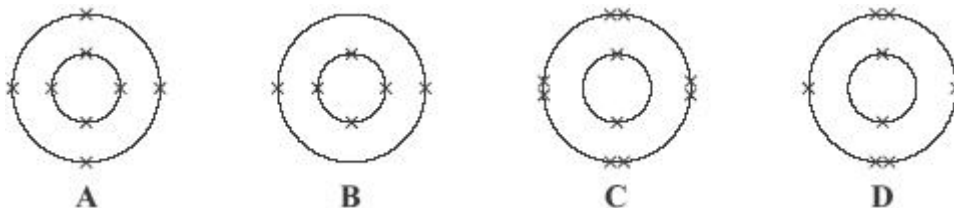
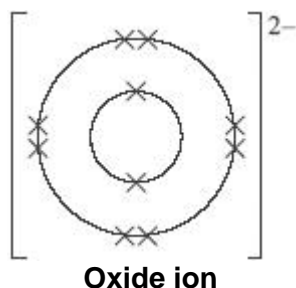


Diagram \_\_\_\_\_

(1)

- (c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen. The diagram shows the electronic structure of an oxide ion.



Which diagram, **J**, **K**, **L** or **M**, shows the electronic structure of a magnesium ion?

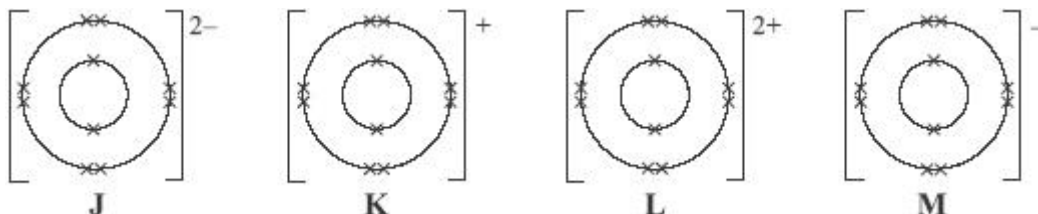


Diagram \_\_\_\_\_

(1)

- (d) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Draw a ring around the name of the salt formed when magnesium oxide reacts with hydrochloric acid.

**magnesium chloride**

**magnesium hydroxide**

**magnesium sulfate**

(1)

(Total 4 marks)

### Q25.

- (a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass ( $M_r$ ) of the compound.

The  $M_r$  of the compound was **44**.

Relative atomic masses: N = 14, O = 16



Draw a ring around the formula of the compound.

**NO**

**NO<sub>2</sub>**

**N<sub>2</sub>O<sub>4</sub>**

**N<sub>2</sub>O**

(1)

- (b) Potassium nitrate is another nitrogen compound. It is used in fertilisers. It has the formula **KNO<sub>3</sub>**.

The **M<sub>r</sub>** of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate.

Relative atomic mass: N = 14.

\_\_\_\_\_

\_\_\_\_\_

Percentage of nitrogen = \_\_\_\_\_ %

(2)

(Total 3 marks)

### Q26.

The *electrolysis* of sodium chloride solution produces useful substances.

- (a) Explain the meaning of *electrolysis*.

\_\_\_\_\_

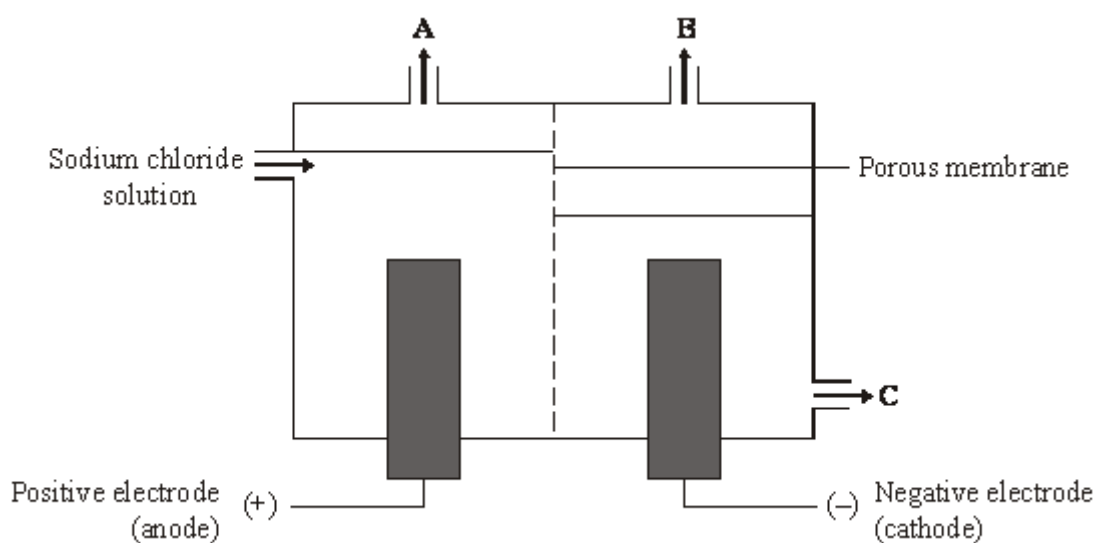
\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(2)

- (b) The diagram shows an apparatus used for the electrolysis of sodium chloride solution.



The electrolysis produces two gases, chlorine and Gas **A**.

Name Gas **A** \_\_\_\_\_ (1)

- (c) The electrodes used in this process can be made of graphite. Explain why graphite conducts electricity.

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(2)

(Total 5 marks)

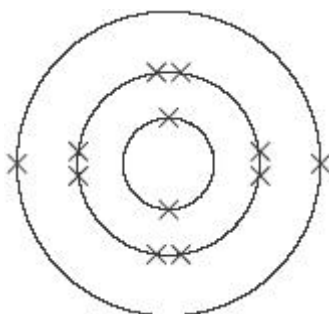
**Q27.**

- (a) Write a balanced symbol equation for the reaction between magnesium (Mg) and oxygen (O<sub>2</sub>) to form magnesium oxide (MgO).

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(1)

- (b) The diagram shows the electronic structure of a magnesium atom. The atomic (proton) number of magnesium is 12.



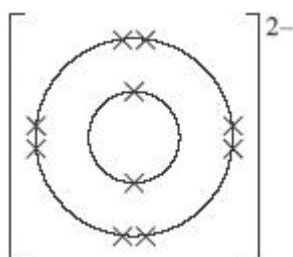
**Magnesium atom**

Draw a similar diagram to show the electronic structure of an oxygen atom. The atomic (proton) number of oxygen is 8.

(1)

- (c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

The diagram shows the electronic structure of an oxide ion.



**Oxide ion**

Draw a similar diagram to show the electronic structure of a magnesium ion.

(1)

(d) Magnesium oxide is a white solid with a high melting point.

Explain how the ions are held together in solid magnesium oxide.

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(2)

(e) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Complete the word equation for the reaction between magnesium oxide and hydrochloric acid.

hydrochloric acid + magnesium oxide  $\rightarrow$  \_\_\_\_\_ + water.

(1)

(Total 6 marks)

### Q28.

(a) The periodic table on the Data Sheet may help you to answer this question.

Part of the periodic table is shown below.


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

Which letter, **A** to **E**, represents:

(i) sodium

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

(ii) a non-metal

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

(iii) a Group 2 element

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

(iv) a transition element?

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

(b) Complete these sentences by drawing a ring around the correct answer.

(i) Attempts to classify the elements into a periodic table were made

by

Arrhenius and Dalton
Brønsted and Lowry
Mendeleev and Newlands

(1)

(ii) They arranged the elements in order of their

atomic weight
melting point
reactivity

(1)

(iii) They put elements in the same Group if they had similar

boiling points
chemical reactions
electrical

conductivities

(1)

(iv) We now know that elements in the same Group have the same number of

electrons

neutrons

protons

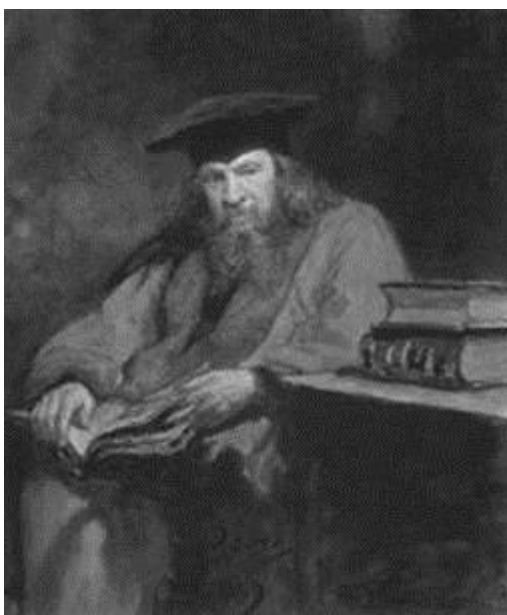
in their outer shell (energy level).

(1)

(Total 8 marks)

### Q29.

Read the information about the periodic table.



*Portrait of Dimitri Mendeleev by Ilya Repin*

When the Russian chemist Dimitri Mendeleev put forward his periodic table in 1869, the atomic structure of elements was unknown.

Mendeleev tried to arrange the elements in a meaningful way based on their chemical reactions. First he put the elements in order of their increasing atomic weight.

He then put elements with similar properties in the same column.

However, he left gaps, and sometimes did not follow the order of increasing atomic weight – for example, he placed iodine (atomic weight 127) after

tellurium (atomic weight 128).

Within a few years there was sufficient evidence to prove that Mendeleev was correct.

Our modern periodic table has evolved from Mendeleev's table.

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

- (a) (i) State why Mendeleev left gaps.

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(1)

- (ii) State why some elements were **not** placed in order of increasing atomic weight.

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(1)

- (b) (i) The periodic table is now based on atomic structure.

Explain how.

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(3)

- (ii) Suggest why it is impossible to have an undiscovered element that would fit between sodium and magnesium.

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(1)

- (c) Explain, in terms of electrons, why fluorine is the most reactive element in Group 7.

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(3)  
(Total 9 marks)

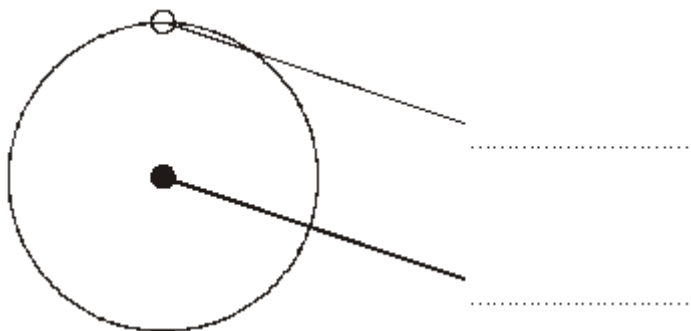
**Q30.**

Hydrogen is an element.

(a) The diagram shows the parts of a hydrogen atom.

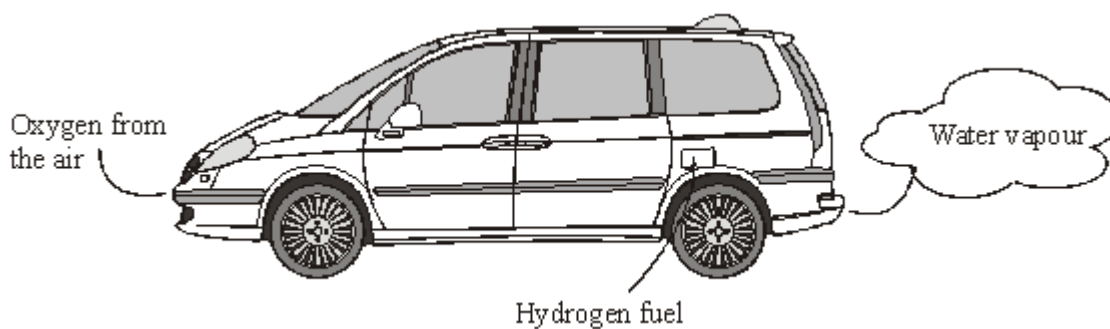
Use words from the box to label the diagram.

electron	group	nucleus	symbol
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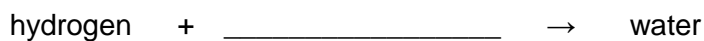
(2)

(b) Hydrogen can be used as a *clean fuel* for cars.



(i) When hydrogen burns in air, it reacts with another element.

Complete the word equation for this reaction.



(1)

(ii) Suggest **one** reason why hydrogen is called a *clean fuel*.

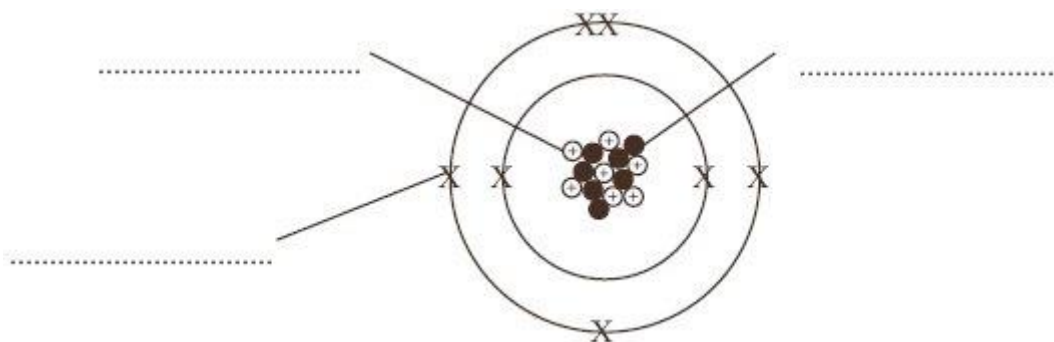
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**Q31.**

(a) The diagram represents an atom of nitrogen.

(i) Use words from the box to label the diagram.

electron	neutron	nucleus	proton
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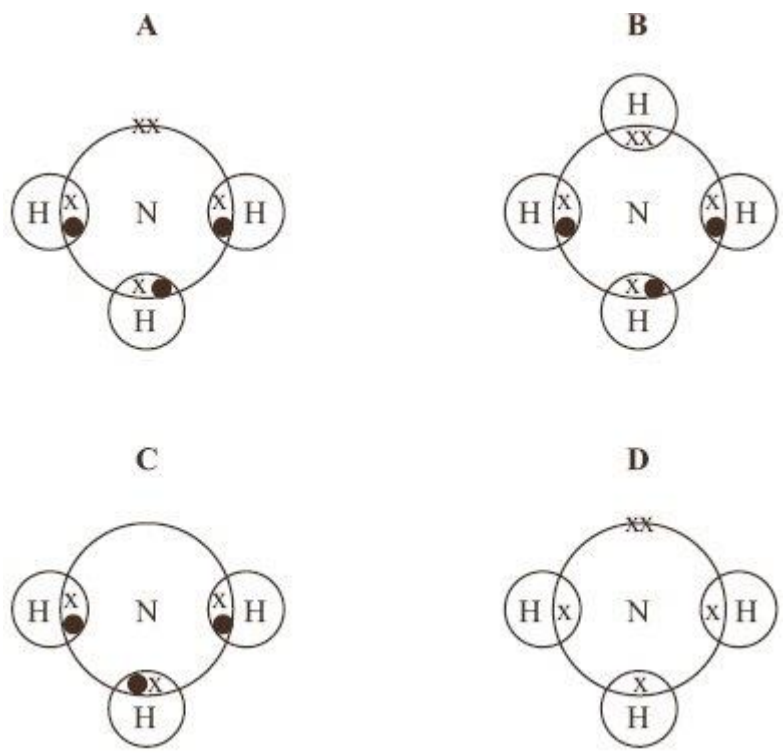
(2)

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

5      7      14      21

(1)

(b) Nitrogen can react with hydrogen to make ammonia,  $\text{NH}_3$ .





Which diagram, **A**, **B**, **C** or **D**, best represents an ammonia molecule?



(1)

(Total 4 marks)

**Q32.**

- (a) Read the article about the use of nanoparticles in sun creams.

**Sun creams**

Many sun creams use nanoparticles. These sun creams are very good at absorbing radiation, especially ultraviolet radiation. Owing to the particle size, the sun creams spread more easily, cover better and save money because you use less. The new sun creams are also transparent, unlike traditional sun creams which are white. The use of nanoparticles is so successful that they are now used in more than 300 sun cream products.

Some sun creams contain nanoparticles of titanium oxide. Normal-sized particles of titanium oxide are safe to put on the skin.

It is thought that nanoparticles can pass through the skin and travel around the body more easily than normal-sized particles. It is also thought that nanoparticles might be toxic to some types of cell, such as skin, bone, brain and liver cells.

- (i) How is the size of nanoparticles different from normal-sized particles of titanium oxide?

\_\_\_\_\_

(1)

- (ii) Suggest how the size of nanoparticles might help them to enter the body more easily.

\_\_\_\_\_

\_\_\_\_\_

(1)

- (b) Give **two** advantages of using nanoparticles in sun creams.

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

\_\_\_\_\_

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

\_\_\_\_\_

(2)

- (c) Why might nanoparticles be dangerous inside the body?

\_\_\_\_\_

\_\_\_\_\_

(1)

**Q33.**

Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.



Some toothpastes contain tin(II) fluoride.

This compound has the formula  $\text{SnF}_2$ .

- (a) Calculate the relative formula mass ( $M_r$ ) of  $\text{SnF}_2$ .

Relative atomic masses: F = 19; Sn = 119

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Relative formula mass ( $M_r$ ) = \_\_\_\_\_

(2)

- (b) Calculate the percentage by mass of fluorine in  $\text{SnF}_2$ .

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Percentage by mass of fluorine = \_\_\_\_\_ %

(2)

- (c) A tube of toothpaste contains 1.2 g of  $\text{SnF}_2$ .

Calculate the mass of fluorine in this tube of toothpaste.

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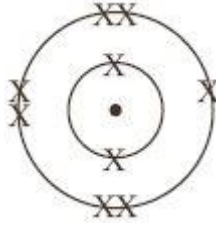
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Mass of fluorine = \_\_\_\_\_ g

(1)

- (d) The diagram represents the electron arrangement of a fluorine atom.



Explain how a fluorine atom can change into a fluoride ion,  $F^-$ .

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(2)

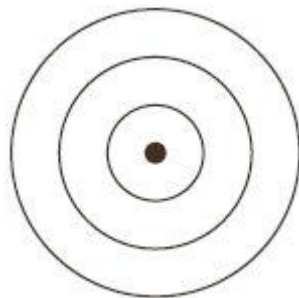
(Total 7 marks)

**Q34.**

Aluminium is a useful metal.

- (a) The atomic number (proton number) of aluminium is 13.

Complete the diagram to show the electronic structure of an aluminium atom.  
Use crosses (x) to represent the electrons.



(1)

- (b) Aluminium is used as the electrical conductor for overhead power cables.



Explain why metals are good conductors of electricity.

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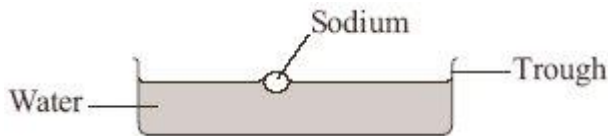
(2)  
(Total 3 marks)

**Q35.**

(a) Read a student's report about the reaction between sodium and water.

**The reaction between sodium and water**

A small piece of sodium was added to some water in a trough.



The sodium floated and started to react.

The sodium moved along the surface of the water and melted to give a ball of molten metal.

The ball became smaller and smaller until it had all gone.

A gas was given off and a colourless solution was left.

The word equation for this reaction is:



Use the information from the student's report to answer these questions.

- (i) Which information shows that sodium has a low density?

\_\_\_\_\_

(1)

- (ii) Which information shows that the reaction is exothermic?

\_\_\_\_\_

(1)

- (iii) Name the gas given off.

\_\_\_\_\_

(1)

- (b) The periodic table on the Data Sheet may help you to answer these questions.

- (i) Sodium is in Group 1.

Name a Group 1 element that is more reactive than sodium.

\_\_\_\_\_

(1)

- (ii) Here are some statements about Group 1 elements.

Only **two** of these statements are correct.

Put a tick (✓) next to the two correct statements.

Statement	(✓)
They are halogens	
They are metals	
They form covalent compounds	
They form ions with a +1 charge	

(2)

- (c) Dimitri Mendeleev put forward his periodic table in 1869.

Complete these sentences by drawing a ring around the correct answer.

(i) Mendeleev arranged the elements in order of their

atomic weight  
density  
reactivity

(1)

(ii) The table is called a periodic table because elements with

identical  
the same  
similar

properties occur at regular intervals.

(1)

(iii) The vertical columns are known as

groups  
periods  
rows

(1)

(d) How did Mendeleev overcome the problem of undiscovered elements when he designed his table?

(1)

(Total 10 marks)

### Q36.

The following article appeared recently in the *Manchester Gazette*.

#### Sodium Drum Blaze Scare

A 20 litre drum containing sodium burst into flames when it reacted violently with rainwater at a Manchester factory. It is believed that the sodium, which is normally stored under oil, had been accidentally left outside with the lid off.

A factory worker put out the blaze before the fire services arrived, and a leading fire fighter said, "It was fortunate that potassium wasn't involved as it would have reacted more violently and exploded. These Group 1 *alkali metals* can be very dangerous".

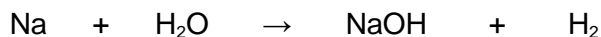
(a) Group 1 metals are stored under oil.

Suggest why.

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(1)

- (b) Balance the equation which represents the reaction between sodium and water.



(1)

- (c) Explain why the Group 1 metals are called the *alkali metals*.

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(1)

- (d) Explain, in terms of electrons, why potassium reacts more violently than sodium.

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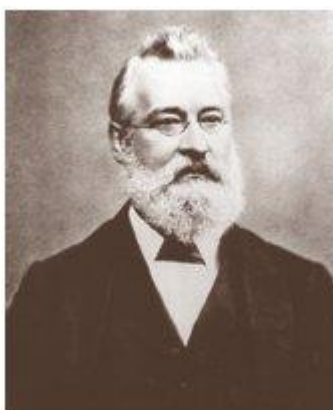
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(3)

(Total 6 marks)

**Q37.**

Read the information about the development of the periodic table and answer the questions that follow.



John Newlands was one of the first chemists to arrange the known elements in order of increasing atomic mass. In 1866, he put forward the Law of Octaves. He suggested that there was a repeating pattern of elements with similar chemical properties every eighth element, just like the eighth note of an octave of music. A version of his periodic table is shown below.

H	Li	G	Bo	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru
Pd	Ag	Cd	U	Sn	Sb	Te
I	Cs	Ba, V	Ta	W	Nb	Au
Pt, Ir	Os	Hg	Tl	Pb	Bi	Th

However, other chemists did not accept Newlands' ideas. It was not until much later that his contribution to the development of the modern periodic table was recognised.

*Reproduced courtesy of the library and information centre Royal Society of Chemistry*

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

(a) What is the modern symbol for the element 'Bo'? \_\_\_\_\_

(1)

(b) Describe **one** piece of evidence to support the Law of Octaves.

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(2)

(c) Suggest **two** reasons why other chemists did not accept Newlands' ideas.

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

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

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(2)

(d) The alkanes are a series of hydrocarbons with similar chemical properties. They have the general formula  $C_nH_{2n+2}$ .

Suggest why the alkanes do not appear in the periodic table.



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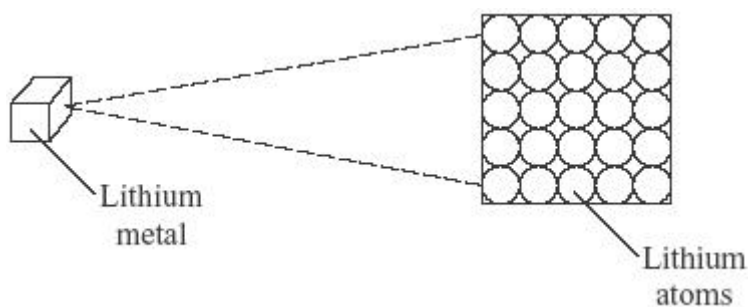
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(1)  
(Total 6 marks)

**Q38.**

Lithium metal is used in alkaline batteries.

- (a) The diagram shows the atoms in lithium metal.



Why is lithium metal described as an element?

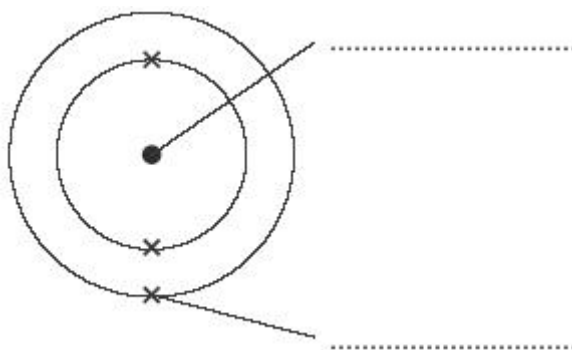
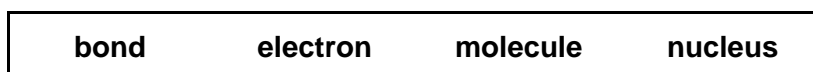
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(1)

- (b) The diagram below represents a lithium atom.

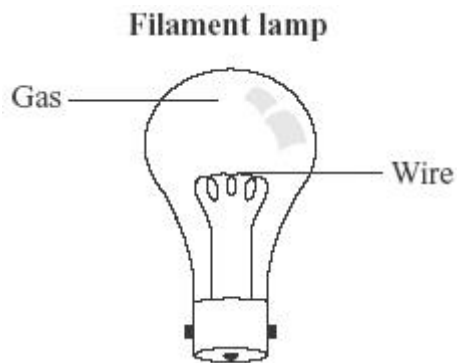
Choose words from the box to label parts of the atom.



(2)  
(Total 3 marks)

**Q39.**

When electricity passes through a thin wire, the wire gets hot. If the wire gets very hot, it may glow. This idea is used in filament lamps.



(a) The table shows some metals and their melting points.

Metal	Melting point in °C
Aluminium	660
Copper	1084
Iron	1540
Tungsten	3410

Which metal in the table should be used to make the wire in a filament lamp?

Give a reason for your answer.

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(2)

(b) The table shows some gases.

Gas
Argon
Carbon dioxide
Oxygen
Sulfur dioxide

Which gas in the table should be used in a filament lamp?

Give a reason for your answer.

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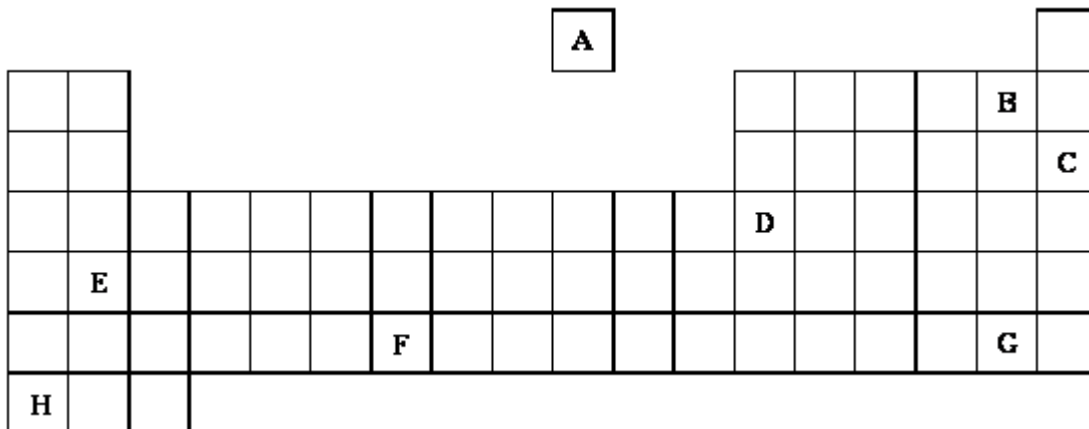
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(2)  
(Total 4 marks)

**Q40.**

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

The diagram shows an outline of the periodic table.



Choose your answers **only** from the letters shown on this outline table.

Which letter, **A** to **H**, represents an element which:

- (a) is in Group 3,

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

- (b) is in Period 2,

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

- (c) is a transition element,

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

- (d) is the least reactive element in Group 7,

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

- (e) is the most reactive metal?

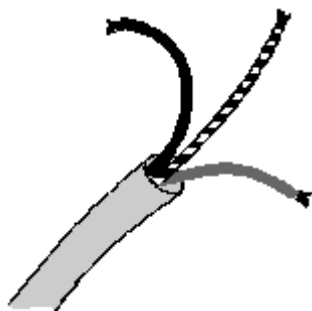
Letter \_\_\_\_\_ (1)

(Total 5 marks)

**Q41.**

The properties of transition metals make them useful elements.

- (a) Why is copper used for electrical wiring?

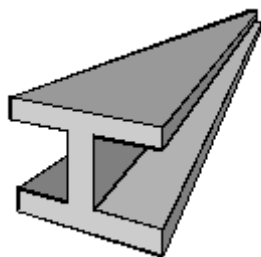


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(1)

- (b) Why is iron used for girders in buildings?



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(1)

- (c) Why are transition metal compounds added to glazes for pottery?



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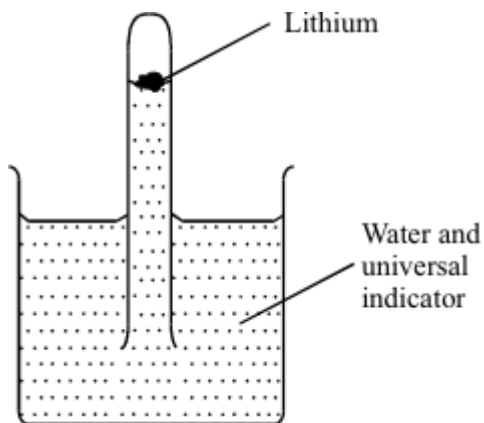
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(1)

(Total 3 marks)

**Q42.**

The diagram shows an experiment to study the reaction of lithium with water.



- (a) Describe, as fully as you can, what you would see as the lithium reacts with the water in this experiment.

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

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(3)

- (b) The reaction has two products. Complete the word equation for this reaction by choosing the correct substances from the box.

hydrogen	lithium hydride	lithium hydroxide
lithium oxide		oxygen

lithium + water → \_\_\_\_\_ + \_\_\_\_\_

(2)

- (c) Caesium is lower down in Group 1 of the periodic table than lithium. Suggest how the reaction of caesium with water might be different from lithium's reaction.

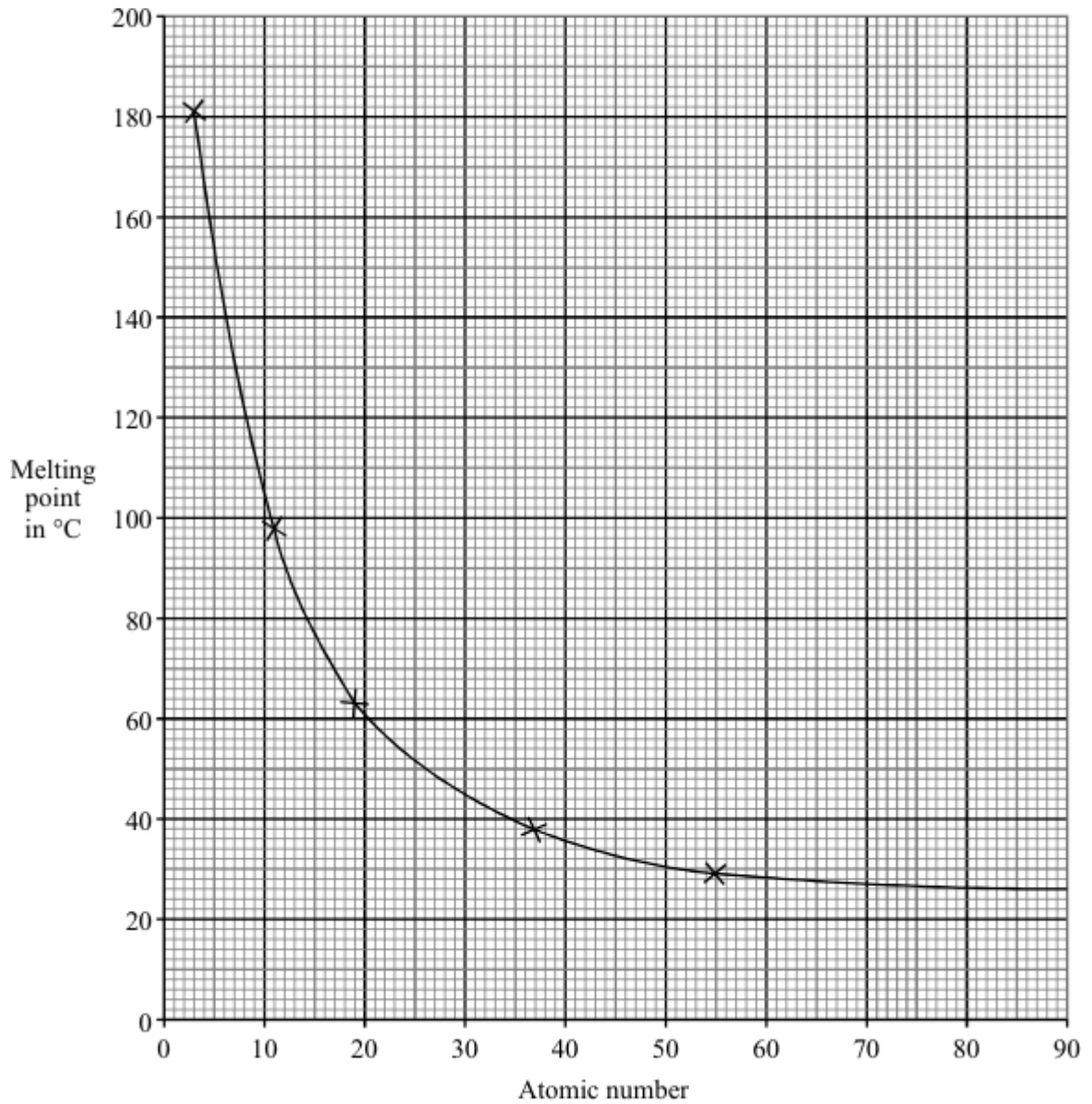
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(1)

- (d) The graph shows the melting points of the Group 1 metals plotted against their atomic numbers.



- (i) Describe fully how the melting points change as the atomic number increases.

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(2)

- (ii) Francium has an atomic number of 87.  
Use the graph to estimate the melting point of francium.

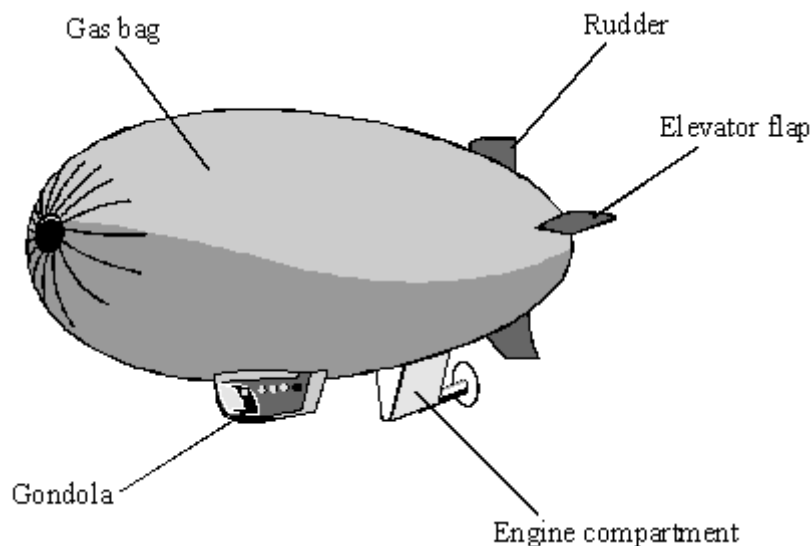
Estimate of melting point \_\_\_\_\_ °C

(1)

(Total 9 marks)

**Q43.**

The drawing shows an airship that was used about 80 years ago.



- (a) The gas bag was filled with hydrogen. A leak from the gas bag could be very dangerous. Use your knowledge of the reactions of hydrogen to explain why.

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(2)

- (b) Modern airships are filled with helium.

- (i) What property makes both hydrogen and helium suitable for use in airships?

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(1)

- (ii) Helium is safer than hydrogen for use in airships. Explain why. You should use the position of helium in the periodic table in your answer.

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(2)

(Total 5 marks)

#### Q44.

John Dalton wrote these statements in 1808.

- "All substances are made of a vast number of extremely small particles called atoms."

- “Every particle of water is like every other particle of water, every particle of hydrogen is like every other particle of hydrogen, etc.”
- (a) “Every particle of water is like every other particle of water.” Use Dalton’s ideas and your knowledge of water to explain why.

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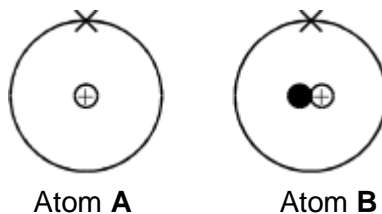
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(2)

- (b) Dalton thought that all atoms of an element are exactly the same. We now know that it is possible to have atoms of the same element but with different mass numbers.  
The diagrams represent two atoms of hydrogen.



State, in terms of particles, how these two atoms are different.

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(1)

(Total 3 marks)



