AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.1.1.7

Electronic structure

Past-paper questions

Tier	**Higher**
Question groups	**35**
Available paper years	**2008–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.1.1.7 Electronic structure

Question 01

January 2008 | CHY2H | Original Q5 | Legacy

5 Distress flares are used to attract attention in an emergency.



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

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

State the meaning of *exothermic*.

.....

.....

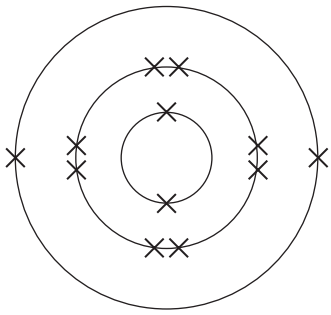
(1 mark)

(b) Write a balanced symbol equation for the reaction between magnesium (Mg) and oxygen (O_2) to form magnesium oxide (MgO).

.....

(1 mark)

(c) 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 mark)

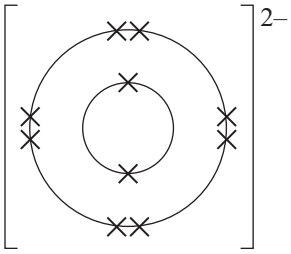
4.1.1.7 Electronic structure

Question 01 · continued

BLANK

(d) 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 mark)

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

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

.....

.....

.....

.....

(2 marks)

(f) 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 → ..... + water.

(1 mark)

7

4.1.1.7 Electronic structure

Question 02

June 2008 | CHY2H | Original Q1 | Legacy

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



Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2.

1 (a) Calculate the relative formula mass (M_r) of SnF_2.
Relative atomic masses: F = 19; Sn = 119

.....

.....

.....

.....

Relative formula mass (M_r) = ...
(2 marks)

1 (b) Calculate the percentage by mass of fluorine in SnF_2.

.....

.....

.....

.....

Percentage by mass of fluorine = ... %
(2 marks)

4.1.1.7 Electronic structure

Question 02 · continued

for mark

1 (c) A tube of toothpaste contains 1.2 g of SnF_2.

Calculate the mass of fluorine in this tube of toothpaste.

.....

.....

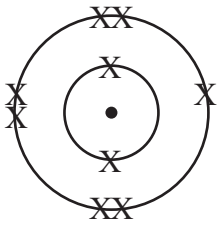
.....

.....

Mass of fluorine = ... g

(1 mark)

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



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

.....

.....

.....

.....

(2 marks)

7

4.1.1.7 Electronic structure

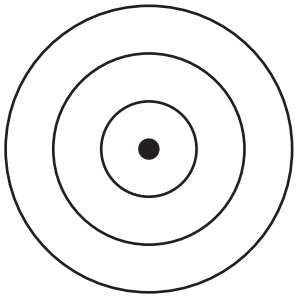
Question 03

June 2008 | CHY2H | Original Q7 | Legacy

7 Aluminium is a useful metal.

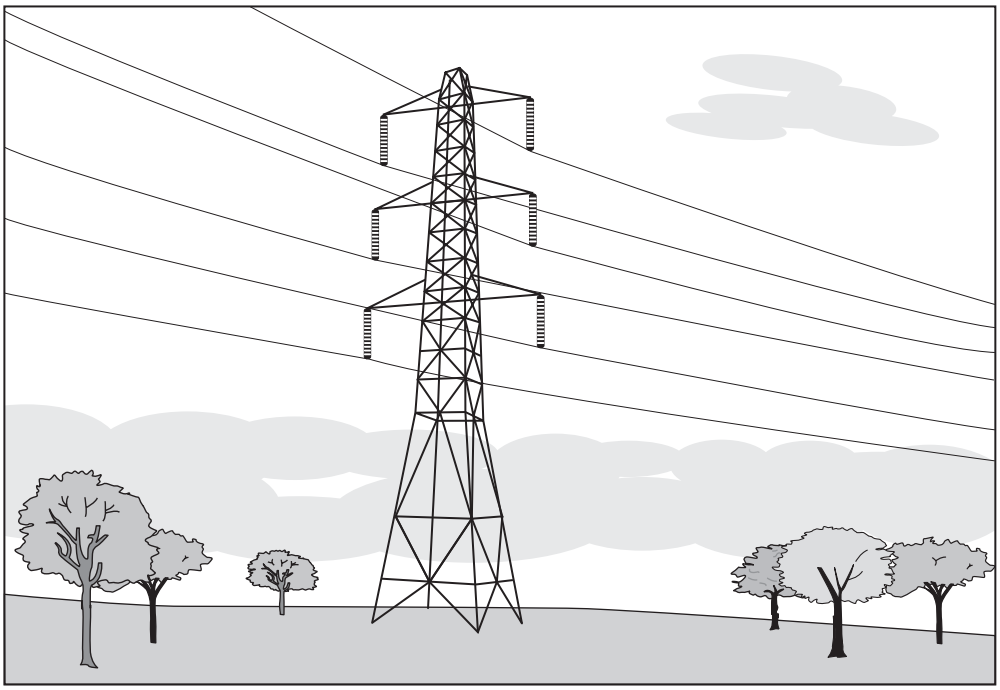
7 (a) The atomic number (proton number) of aluminium is 13.

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



(1 mark)

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



Explain why metals are good conductors of electricity.

.....

.....

.....

.....

(2 marks)

3

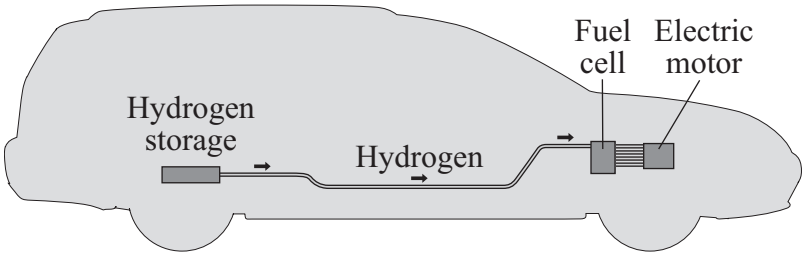
4.1.1.7 Electronic structure

Question 04

June 2009 | CHY2H | Original Q5 | Legacy

5 Read the article and then answer the questions that follow.

Hydrogen fuel for cars?



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.

4.1.1.7 Electronic structure

Question 04 · continued

for mark

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

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

.....

.....

.....

(1 mark)

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

Explain why hydrogen gas is formed but not potassium.

.....

.....

.....

(1 mark)

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

Balance the equation for this reaction.

..... Li + N_2 → ..... Li_3N

(1 mark)

Question 5 continues on the next page

4.1.1.7 Electronic structure

Question 04 · continued June 2009 | CHY2H | Original Q5 | Legacy

for mark

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

$$Li_3N + 2H_2 \rightleftharpoons LiNH_2 + 2LiH$$

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

.....

.....

(1 mark)

5 (c) (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.

.....

.....

.....

.....

.....

(2 marks)

5 (d) (i) State how 'nanosized' particles will be different from normal sized particles of lithium nitride.

.....

.....

(1 mark)

5 (d) (ii) Suggest why the 'nanosized' particles of lithium nitride absorb and release the hydrogen more quickly than normal sized particles.

.....

.....

.....

(1 mark)

4.1.1.7 Electronic structure

Question 04 · continued

for mark

5 (e) Lithium nitride is an ionic compound which contains lithium ions (Li^{+}) and nitride ions (N^{3-}).

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

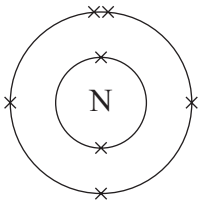
Explain why.

.....

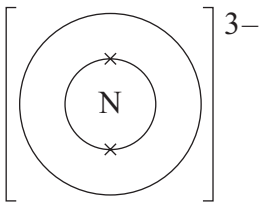
.....

(1 mark)

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



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



(1 mark)

10

4.1.1.7 Electronic structure

Question 05

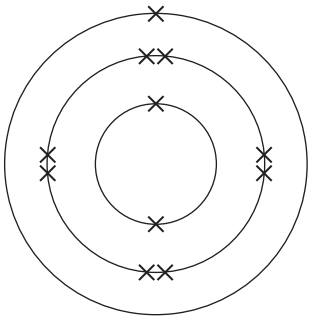
January 2010 | CHY2H | Original Q1 | Legacy

1 Sodium chloride is a raw material.

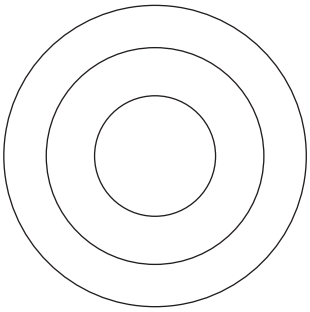
1 (a) The electronic structure of a sodium atom is shown below.

Complete the diagram for the electronic structure of a chlorine atom. A chlorine atom has 17 electrons.

Sodium atom



Chlorine atom



(1 mark)

1 (b) When sodium and chlorine react to form sodium chloride they form sodium ions (Na^+) and chloride ions (Cl^-).

How does a sodium atom change into a sodium ion?

.....

.....

.....

.....

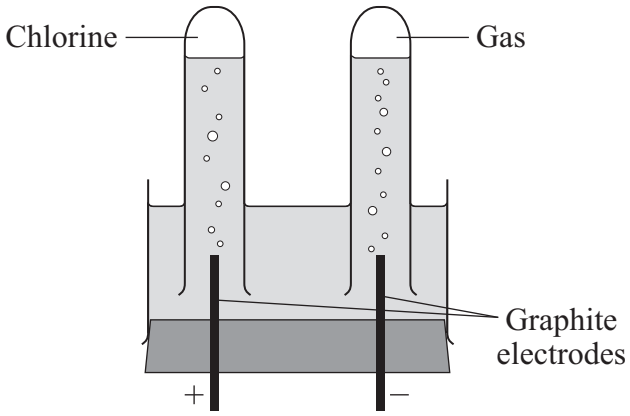
(2 marks)

4.1.1.7 Electronic structure

Question 05 · continued

for mark

1 (c) The diagram shows apparatus used in a school laboratory for the electrolysis of sodium chloride solution.



The solution contains sodium ions (Na^+), chloride ions (Cl^-), hydrogen ions (H^+) and hydroxide ions (OH^-).

1 (c) (i) Why do chloride ions move to the positive electrode?

.....

(1 mark)

1 (c) (ii) Name the gas formed at the negative electrode.

.....

(1 mark)

Question 1 continues on the next page

4.1.1.7 Electronic structure

Question 05 · continued

for mark

1 (d) Chlorine and chlorine compounds are used to bleach wood pulp that is used to make paper.

The article below is from a newspaper.

> Local people have been protesting outside a paper factory. They say:
> 'We want the company to stop using chlorine compounds. Chlorine compounds release poisons into the environment. The company should use safer compounds.'
>
> The company replied:
> 'Chlorine has been used safely for many years to treat drinking water. Only tiny amounts of chlorine are released, which cause no harm. Using other compounds will be more expensive and may put us out of business.'

1 (d) (i) Why are some local people worried about the use of chlorine compounds?

.....

.....

(1 mark)

1 (d) (ii) Why might other local people want the company to continue to use chlorine compounds?

.....

.....

(1 mark)

1 (d) (iii) It is decided to have an enquiry.
Why should this be done by independent scientists?

.....

.....

(1 mark)

8

4.1.1.7 Electronic structure

Question 06

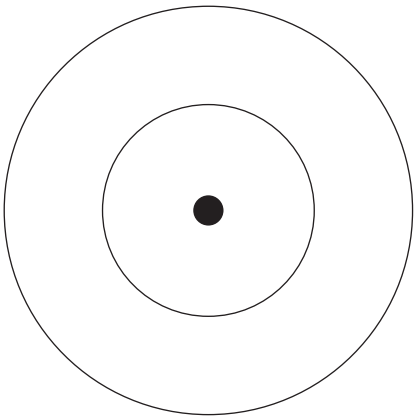
June 2010 | CHY2H | Original Q3 | Legacy

3 Pure carbon can exist in two forms, diamond and graphite.

3 (a) Complete the diagram to show the electronic structure of a carbon atom.

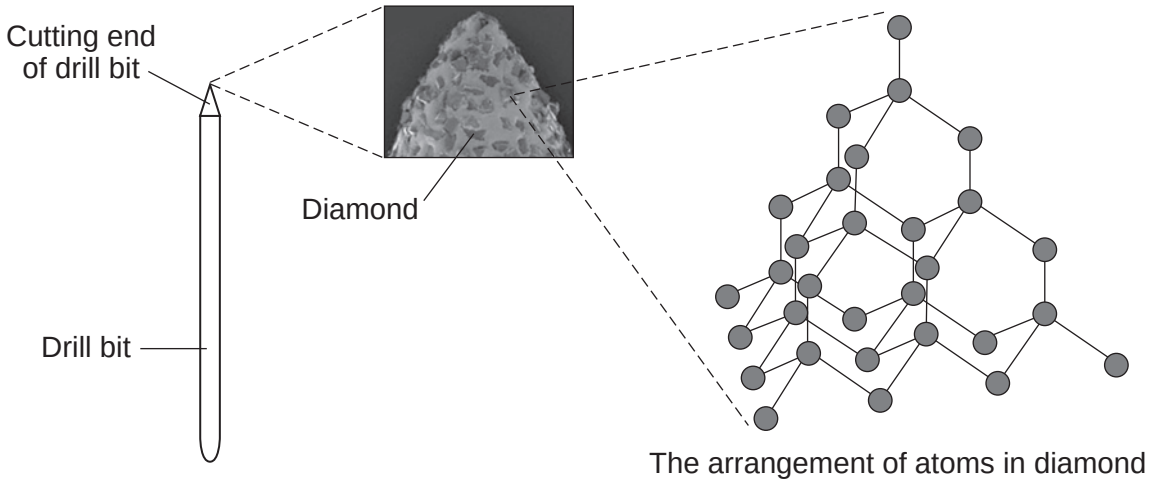
A carbon atom has 6 electrons.

Show the electrons as crosses (x).



(1 mark)

3 (b) A drill bit is used to cut holes through materials. The cutting end of this drill bit is covered with very small diamonds.



4.1.1.7 Electronic structure

Question 06 · continued

3 (b) (i) What property of diamond makes it suitable for use on the cutting end of a drill bit?

.....

(1 mark)

3 (b) (ii) Explain, as fully as you can, why diamond has this property. Use your knowledge of the structure and bonding of diamond and the information shown opposite to help you to answer this question.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

3 (c) Explain why graphite is a good conductor of electricity and why diamond does **not** conduct electricity.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

8

4.1.1.7 Electronic structure

Question 07

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



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

The formula of this metal oxide is MO.
(M is **not** the correct symbol for the metal.)

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

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

.....

.....

.....

Relative atomic mass (A_r) = ...
(2 marks)

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

The name of metal M is ..... .
(1 mark)

4.1.1.7 Electronic structure

Question 07 · continued

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

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

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

.....

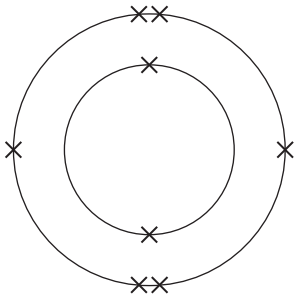
.....

.....

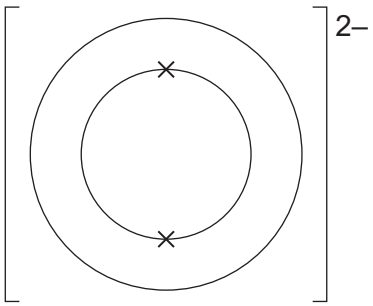
.....

(2 marks)

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



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



(1 mark)

6

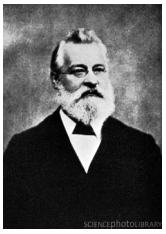
4.1.1.7 Electronic structure

Question 08

January 2011 | CHY3H | Original Q4 | Legacy

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

4 (a) Many chemists have contributed to the development of the periodic table.



John Newlands was one of the first chemists who attempted to classify elements in a systematic way based on atomic weight. In 1866 he suggested that there was a repeating pattern of elements with similar properties every eighth element.
Part of Newlands' periodic table is shown below.

H	Li	Be	B	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

Many chemists in 1866 did not accept Newlands' periodic table.

4 (a) (i) Give **one** piece of evidence which supports Newlands' ideas.

.....

.....

(1 mark)

4 (a) (ii) Suggest **two** reasons why many chemists in 1866 did not accept Newlands' ideas.

1 .....

.....

.....

2 .....

.....

.....

(2 marks)

Question 08 · continued

4 (b) Chlorine, bromine and iodine are Group 7 elements.

A student investigated the reactivity of these 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 below.

Solution	Potassium chloride	Potassium bromide	Potassium iodide
Chlorine		Solution turned orange-brown	Solution turned brown
Bromine	No reaction		Solution turned brown
Iodine	No reaction	No reaction	

4 (b) (i) Use these results to state **and** explain the trend in reactivity of these Group 7 elements.

.....

.....

.....

.....

(2 marks)

4 (b) (ii) Complete the equation below, which represents the reaction between chlorine and potassium bromide.

Cl_2 + 2KBr ⟶ ..... + 2KCl

(1 mark)

4 (b) (iii) In terms of electronic structure, state why chlorine, bromine and iodine are in Group 7.

.....

.....

(1 mark)

4.1.1.7 Electronic structure

Question 08 · continued

4 (c) Lithium, sodium and potassium are Group 1 elements.

Group 1 elements become **more** reactive down the group.

Explain why in terms of electronic structure.

.....

.....

.....

.....

.....

.....

(3 marks)

10

Turn over for the next question

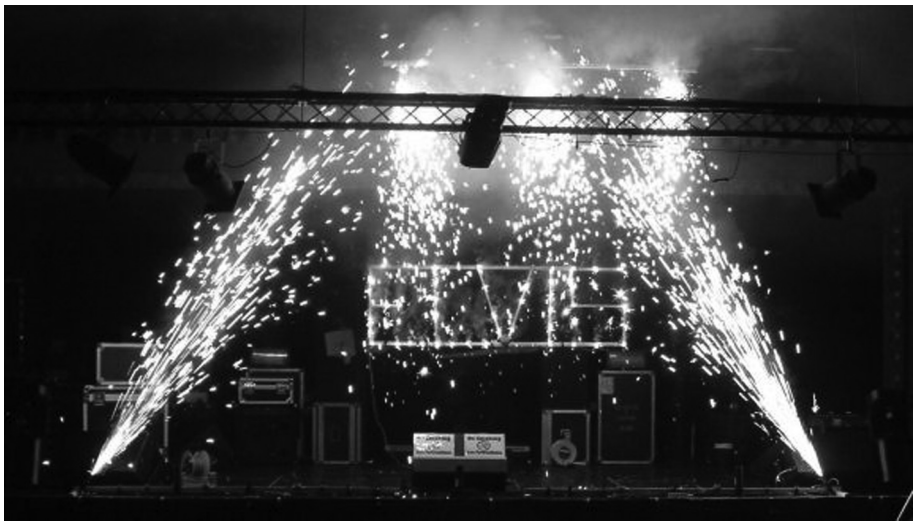
4.1.1.7 Electronic structure

Question 09

June 2011 | CHY2H | Original Q4 | Legacy

4 Read the information in the box.

Flash powder is used to produce special effects at pop concerts.



Flash powder contains aluminium. The powder burns with a bright white flame and gives out lots of heat and light. It also produces white smoke.

The flash powder is placed on stage in a special container. At the bottom of the container there is a thin piece of wire. When the flash is needed, electricity is passed through the wire. The wire gets hot and starts the aluminium burning.

4 (a) When aluminium burns the reaction is *exothermic*.

What is the meaning of *exothermic?*

.....

.....

(1 mark)

4 (b) The hot wire provides energy to start the aluminium burning.

What is the name given to the heat energy needed to start a chemical reaction?

..... energy

(1 mark)

4.1.1.7 Electronic structure

Question 09 · continued

4 (c) The white smoke produced is aluminium oxide.

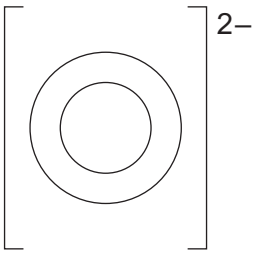
Aluminium oxide contains aluminium ions (Al^{3+}) and oxide ions (O^{2-}).

4 (c) (i) Complete the diagram to show the electronic structure of an oxide ion.

The atomic number of oxygen = 8

Use crosses (x) to represent the electrons.

oxide ion



(1 mark)

4 (c) (ii) The bonding in aluminium oxide is ionic.

What causes the aluminium ions and oxide ions to be held together strongly?

.....

.....

(1 mark)

4

4.1.1.7 Electronic structure

Question 10

June 2011 | CHY2H | Original Q6 | Legacy

6 Lead compounds have been used for thousands of years as colours in paint.



6 (a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

Calculate the empirical (simplest) formula of this compound.

You **must** show all your working to gain full marks.

Relative atomic masses: O = 16; Pb = 207.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

4.1.1.7 Electronic structure

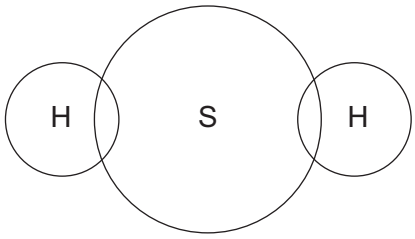
Question 10 · continued

6 (b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

6 (b) (i) Hydrogen sulfide has the formula H_2S. The bonding in a molecule of hydrogen sulfide can be represented as:

H–S–H

Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.
Use dots (•) and crosses (x) to represent the electrons.
You need only show the outer shell electrons.
(Atomic numbers: H = 1; S = 16.)



(1 mark)

6 (b) (ii) Hydrogen sulfide has a low boiling point.

Explain why.

.....

.....

.....

.....

(2 marks)

6 (b) (iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).

$$PbS(s) + ...H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

(1 mark)

8

4.1.1.7 Electronic structure

Question 11

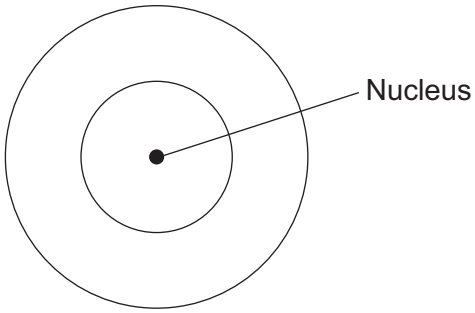
January 2012 | CH1HP | Original Q1 | Legacy

1 The picture shows a diamond ring.



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

Draw the electronic structure of a carbon atom.



(1 mark)

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.

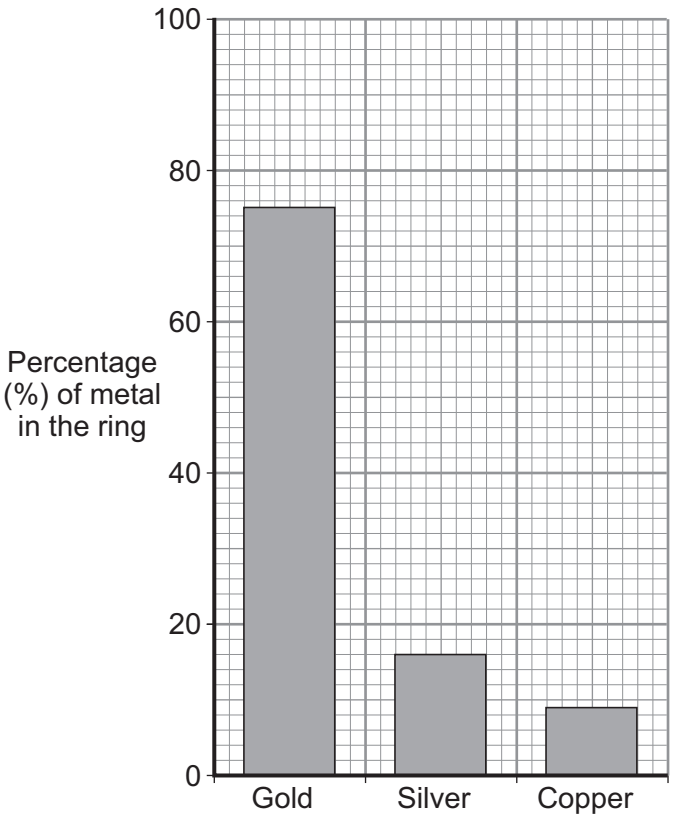
Name	Number
Proton	79
Electron	.....
.....	.....

(3 marks)

4.1.1.7 Electronic structure

Question 11 · continued

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



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

Silver is ..... % and copper is ..... %

(1 mark)

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

Give **two** reasons why.

1 .....

.....

.....

2 .....

.....

.....

(2 marks)

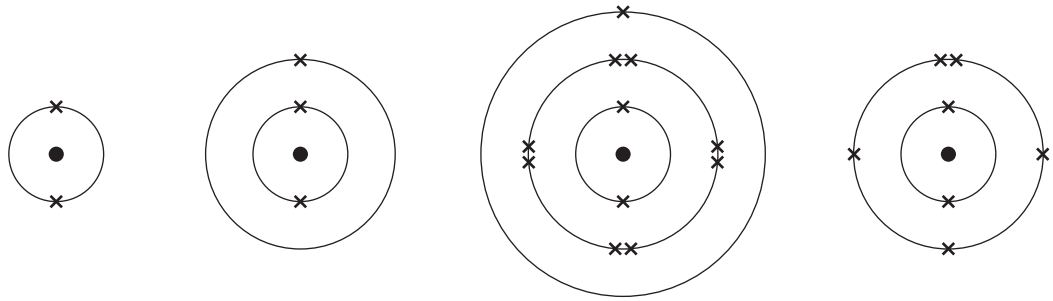
7

4.1.1.7 Electronic structure

Question 12

June 2012 | CH1HP | Original Q1 | Legacy

1 The diagrams show the electronic structure of four different atoms.



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

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

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

.....

(1 mark)

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

.....

.....

(1 mark)

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

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

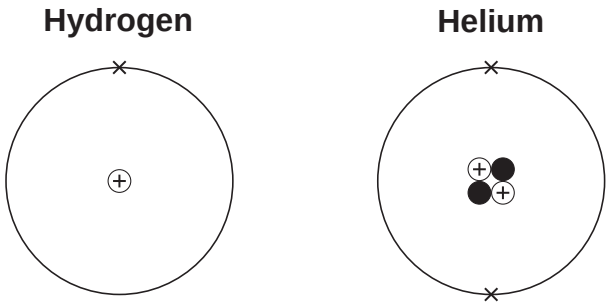
5

4.1.1.7 Electronic structure

Question 13

January 2013 | CH1HP | Original Q1 | Legacy

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



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

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

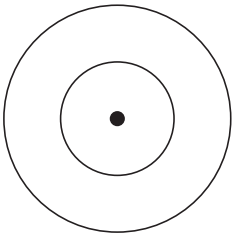
4.1.1.7 Electronic structure

Question 13 · continued

1 (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.

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



(1 mark)

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

.....

.....

.....

(1 mark)

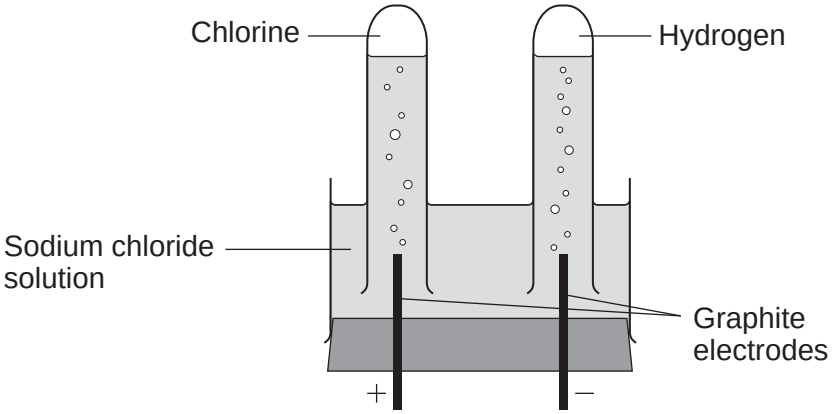
5

4.1.1.7 Electronic structure

Question 14

2 The electrolysis of sodium chloride solution is an industrial process.

The diagram shows the apparatus used in a school experiment.



2 (a) One of the products of the electrolysis of sodium chloride solution is hydrogen.

2 (a) (i) Why do hydrogen ions move to the negative electrode?

.....

.....

(1 mark)

2 (a) (ii) How does a hydrogen ion change into a hydrogen atom?

.....

.....

(1 mark)

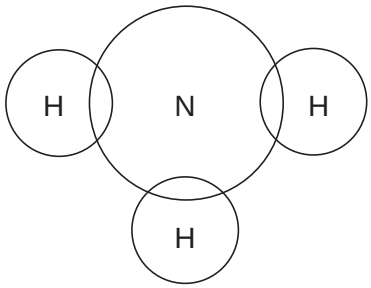
Question 14 · continued

2 (b) Hydrogen is used to make ammonia (NH_3).

Complete the diagram to show the bonding in ammonia.

Use dots (●) and crosses (x) to show electrons.

Show only outer shell electrons.



(2 marks)

2 (c) The table shows the ions in sodium chloride solution.

Positive ions	Negative ions
hydrogen	chloride
sodium	hydroxide

In industry, some of the waste from the electrolysis of sodium chloride solution is alkaline and has to be neutralised.

2 (c) (i) Which ion makes the waste alkaline?

.....

(1 mark)

2 (c) (ii) This waste must be neutralised.

Write the ionic equation for the neutralisation reaction.

.....

(1 mark)

Question 2 continues on the next page

4.1.1.7 Electronic structure

Question 14 · continued

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

The electrolysis of sodium chloride solution also produces chlorine and sodium hydroxide.

In industry, the electrolysis of sodium chloride solution can be done in several types of electrolysis cell.

Some information about two different types of electrolysis cell is given below.

	Mercury cell	Membrane cell
Cost of construction	Expensive	Relatively cheap
Additional substances used	Mercury, which is recycled. Mercury is toxic so any traces of mercury must be removed from the waste.	Membrane, which is made of a polymer. The membrane must be replaced every 3 years.
Amount of electricity used for each tonne of chlorine produced in kWh	3400	2950
Quality of chlorine produced	Pure	Needs to be liquefied and distilled to make it pure.
Quality of sodium hydroxide solution produced	50% concentration. Steam is used to concentrate the sodium hydroxide solution produced.	30% concentration. Steam is used to concentrate the sodium hydroxide solution produced.

Use the information and your knowledge and understanding to compare the environmental and economic advantages and disadvantages of these **two** types of electrolysis cell.

.....

.....

.....

.....

.....

.....

.....

.....

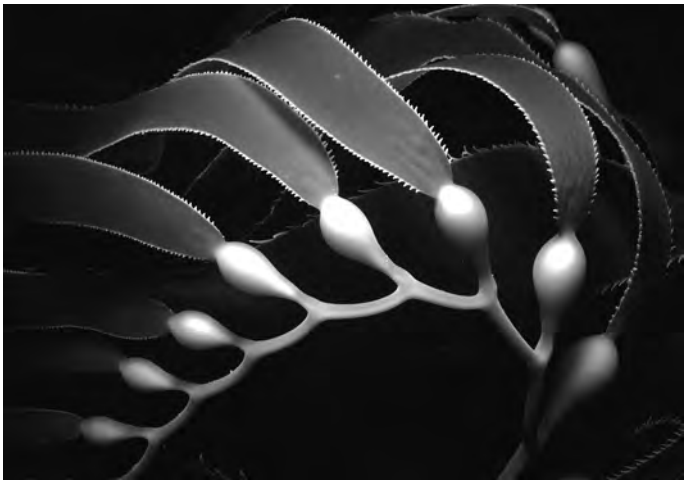
4.1.1.7 Electronic structure

Question 15

January 2013 | CH2HP | Original Q5 | Legacy

5 Kelp is a seaweed.

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



5 (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 mark)

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

Give **two** reasons why.

.....

.....

.....

.....

(2 marks)

4.1.1.7 Electronic structure

Question 15 · continued

5 (c) Sodium iodide can be produced from kelp.

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

(1 mark)

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

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

You may use a diagram in your answer

.....

.....

.....

.....

.....

.....

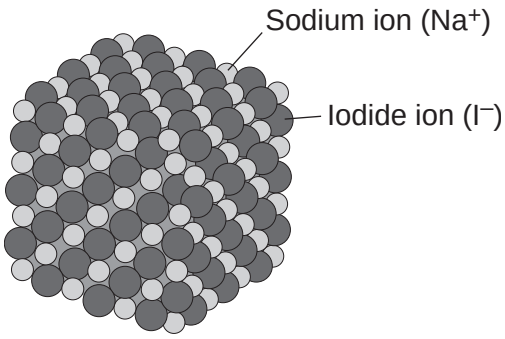
(3 marks)

Question 5 continues on the next page

4.1.1.7 Electronic structure

Question 15 · continued

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



Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

.....

.....

(1 mark)

5 (c) (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.

..... I^- $\rightarrow$ I_2 + ... e^-

(1 mark)

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

Explain why.

.....

.....

.....

.....

(2 marks)

11

4.1.1.7 Electronic structure

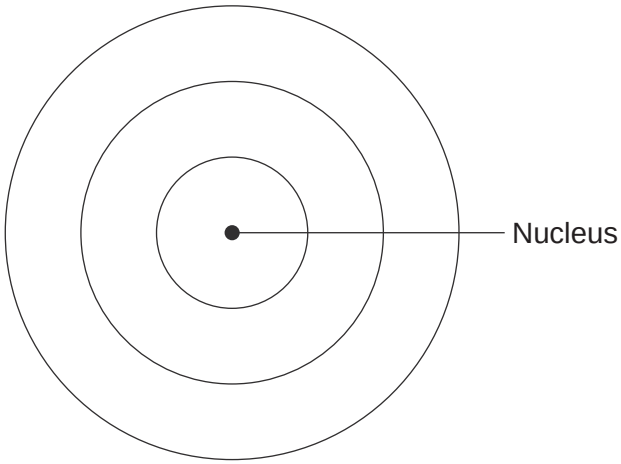
Question 16

June 2013 | CH1HP | Original Q1 | Legacy

1 Aluminium has many uses.

1 (a) An aluminium atom has 13 electrons.

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



(1 mark)

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

..... and .....

(1 mark)

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

.....

.....

(1 mark)

4.1.1.7 Electronic structure

Question 16 · continued

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.

1 (b) (i) Balance the chemical equation for the reaction.

$$\text{.....Al} + Fe_2O_3 \longrightarrow \text{.....Fe} + Al_2O_3$$

(1 mark)

1 (b) (ii) Why does aluminium react with iron oxide?

.....

.....

(1 mark)

5

Turn over for the next question

4.1.1.7 Electronic structure

Question 17

June 2013 | CH2HP | Original Q3 | Legacy

3 Ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

3 (a) (i) A company wants to make 6.8 tonnes of ammonia.

Calculate the mass of nitrogen needed.

Relative atomic masses (A_r): H = 1; N = 14

.....

.....

.....

.....

.....

Mass of nitrogen = ... tonnes

(3 marks)

3 (a) (ii) The company expected to make 6.8 tonnes of ammonia.

The yield of ammonia was only 4.2 tonnes.

Calculate the percentage yield of ammonia.

.....

.....

Percentage yield of ammonia = ... %

(2 marks)

3 (a) (iii) Use the equation above to explain why the percentage yield of ammonia was less than expected.

.....

.....

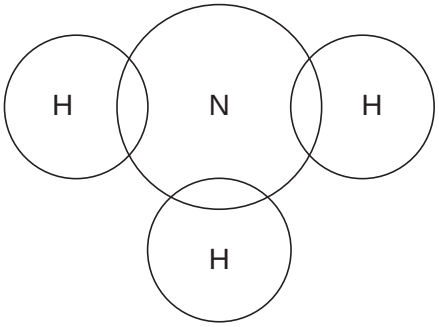
(1 mark)

4.1.1.7 Electronic structure

Question 17 · continued

3 (b) Complete the diagram to show the arrangement of the outer shell electrons of the nitrogen and hydrogen atoms in ammonia.

Use dots (●) and crosses (x) to represent the electrons.



(2 marks)

3 (c) Ammonia dissolves in water to produce an alkaline solution.

3 (c) (i) Which ion makes ammonia solution alkaline?

.....

(1 mark)

3 (c) (ii) Name the type of reaction between aqueous ammonia solution and an acid.

.....

(1 mark)

3 (c) (iii) Name the acid needed to produce ammonium nitrate.

.....

(1 mark)

3 (c) (iv) The reaction of ammonia with sulfuric acid produces ammonium sulfate.

Use the formulae of the ions on the Chemistry Data Sheet.

Write the formula of ammonium sulfate.

.....

(1 mark)

12

4.1.1.7 Electronic structure

Question 18

June 2013 | CH2HP | Original Q4 | Legacy

4 This question is about potassium.

4 (a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

4 (a) (i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

.....

.....

.....

.....

(2 marks)

4 (a) (ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

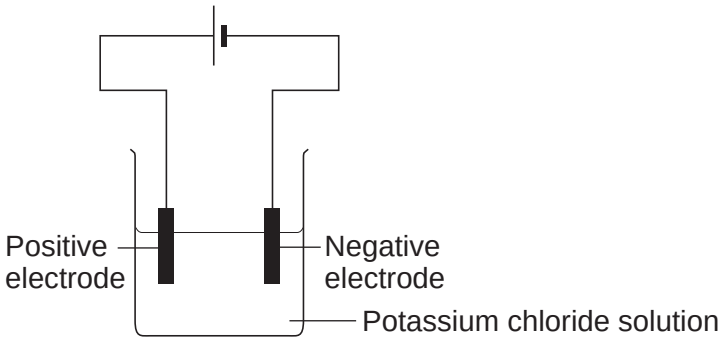
.....

.....

(1 mark)

4 (b) A student dissolved some potassium chloride in water.
The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



4.1.1.7 Electronic structure

Question 18 · continued

The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

.....

.....

.....

.....

.....

.....

(3 marks)

4 (c) The student tried to electrolyse molten potassium chloride to produce potassium.

4 (c) (i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

.....

.....

.....

.....

(2 marks)

Question 4 continues on the next page

4.1.1.7 Electronic structure

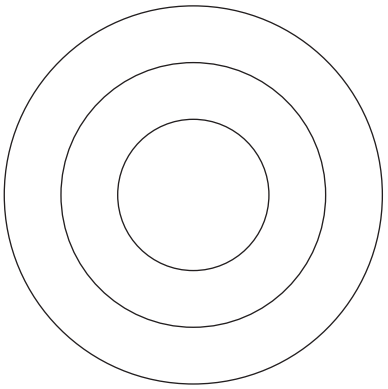
Question 18 · continued

4 (c) (ii) Complete and balance the equation for the reaction at the positive electrode.

.....Cl^- $\longrightarrow$ Cl_2 + ...

(1 mark)

4 (c) (iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).



(1 mark)

10

4.1.1.7 Electronic structure

Question 19

June 2014 | CH1HP | Original Q1 | Legacy

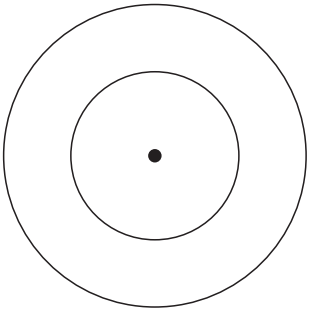
1 Fossil fuels contain carbon and hydrogen.

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

Complete **Figure 1** to show the electronic structure of a carbon atom.

[1 mark]

Figure 1



1 (a) (ii) Complete the word equation for the oxidation of hydrogen.

[1 mark]

hydrogen + oxygen ⟶ .....

1 (b) Coal is a fossil fuel.

Coal contains the elements hydrogen, sulfur, oxygen and carbon.

Name **two** products of burning coal that have an impact on the environment.

What impact does each of the products you named have on the environment?

[4 marks]

.....

.....

.....

.....

.....

.....

.....

.....

6

4.1.1.7 Electronic structure

Question 20

June 2015 | CH1HP | Original Q1 | Legacy

1 This question is about atomic structure and elements.

1 (a) Complete the sentences.

1 (a) (i) The atomic number of an atom is the number of ..... .

[1 mark]

1 (a) (ii) The mass number of an atom is the number of .....

..... .

[1 mark]

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

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

[2 marks]

.....

.....

.....

.....

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

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

[2 marks]

.....

.....

.....

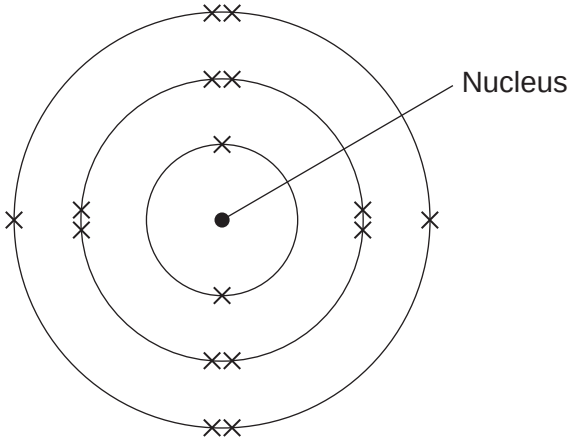
.....

4.1.1.7 Electronic structure

Question 20 · continued

1 (d) **Figure 1** shows the electronic structure of an atom of a non-metal.

Figure 1



What is the chemical symbol of this non-metal?

[1 mark]

Tick (✓) **one** box.

Ar ☐

O ☐

S ☐

Si ☐

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

Complete the sentences.

1 (e) (i) Compounds formed when non-metals react with metals consist of

particles called ..... .

[1 mark]

1 (e) (ii) Compounds formed from only non-metals consist of

particles called ..... .

[1 mark]

9

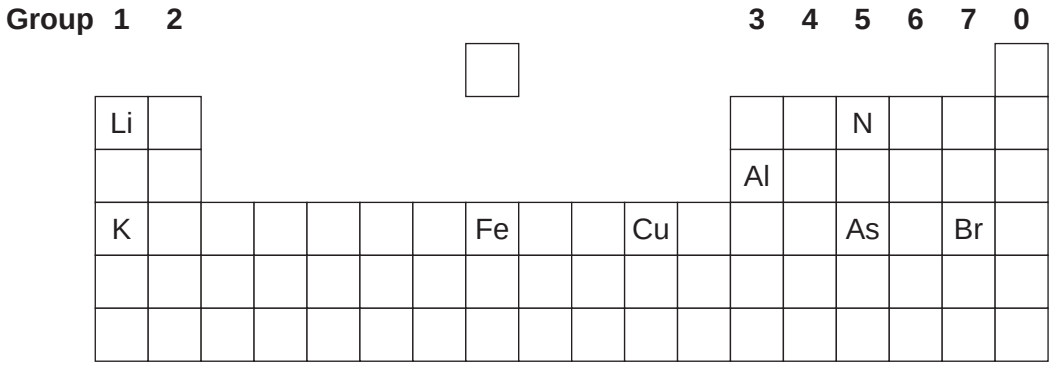
4.1.1.7 Electronic structure

Question 21

June 2015 | CH3HP | Original Q1 | Legacy

1 **Figure 1** shows the positions of eight elements in the modern periodic table.

Figure 1



Choose the correct chemical symbols from **Figure 1** to complete each sentence.

1 (a) The **two** metals that react vigorously with water are ..... and ..... .

[1 mark]

1 (b) The element used as a catalyst in the Haber process is ..... .

[1 mark]

1 (c) The **two** elements with five electrons in their outer shell (highest energy level) are

..... and ..... .

[1 mark]

1 (d) Iron has ions with different charges.

The other metal that has ions with different charges is ..... .

[1 mark]

4

4.1.1.7 Electronic structure

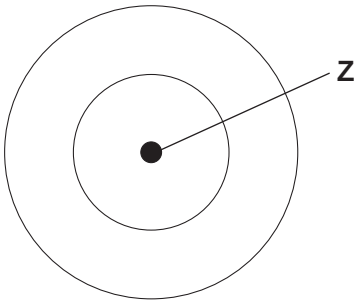
Question 22

June 2016 | CH1HP | Original Q1 | Legacy

1 There are eight elements in the second row (lithium to neon) of the periodic table.

1 (a) **Figure 1** shows an atom with two energy levels (shells).

Figure 1



1 (a) (i) Complete **Figure 1** to show the electronic structure of a boron atom.

[1 mark]

1 (a) (ii) What does the central part labelled **Z** represent in **Figure 1**?

[1 mark]

_____

1 (a) (iii) Name the sub-atomic particles in part **Z** of a boron atom.

Give the relative charges of these sub-atomic particles.

[3 marks]

_____

_____

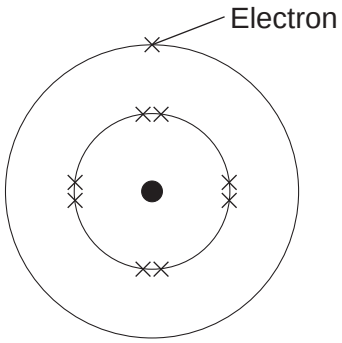
_____

4.1.1.7 Electronic structure

Question 22 · continued

1 (b) The electronic structure of a neon atom shown in **Figure 2** is **not** correct.

Figure 2



Explain what is wrong with the electronic structure shown in **Figure 2**.

[3 marks]

8

4.1.1.7 Electronic structure

Question 23

June 2016 | CH2HP | Original Q3 | Legacy

3 This question is about atoms, molecules and nanoparticles.

3 (a) Different atoms have different numbers of sub-atomic particles.

3 (a) (i) An oxygen atom can be represented as $^{16}_{8}O$

Explain why the mass number of this atom is 16.

You should refer to the numbers of sub-atomic particles in the nucleus of the atom.

[2 marks]

3 (a) (ii) Explain why $^{12}_{6}C$ and $^{14}_{6}C$ are isotopes of carbon.

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

[3 marks]

4.1.1.7 Electronic structure

Question 23 · continued

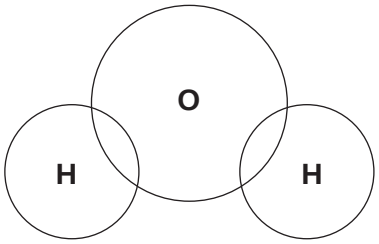
3 (b) Hydrogen atoms and oxygen atoms chemically combine to produce water molecules.

3 (b) (i) Complete **Figure 3** to show the arrangement of the outer shell electrons of the hydrogen and oxygen atoms in a molecule of water.

Use dots (•) or crosses (×) to represent the electrons.

[2 marks]

Figure 3



3 (b) (ii) Name the type of bonding in a molecule of water.

[1 mark]

_____

3 (b) (iii) Why does pure water **not** conduct electricity?

[1 mark]

_____

_____

3 (c) Nanoparticles of cobalt oxide can be used as catalysts in the production of hydrogen from water.

3 (c) (i) How does the size of a nanoparticle compare with the size of an atom?

[1 mark]

_____

_____

3 (c) (ii) Suggest **one** reason why 1 g of cobalt oxide nanoparticles is a better catalyst than 1 g of cobalt oxide powder.

[1 mark]

_____

_____

11

4.1.1.7 Electronic structure

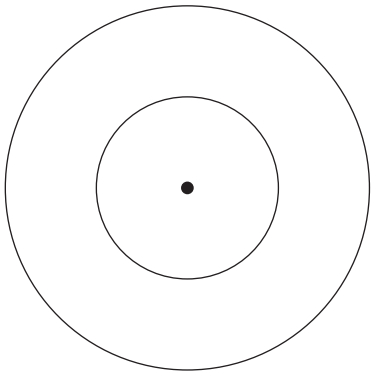
Question 24

June 2017 | CH1HP | Original Q2 | Legacy

2 This question is about compounds of carbon.

2 (a) **Figure 2** shows an atom with two energy levels (shells).

Figure 2



2 (a) (i) A carbon atom has six electrons.

Complete **Figure 2** to show the electronic structure of a carbon atom.

Use **x** to represent an electron.

[1 mark]

2 (a) (ii) Complete the following description about the central part of this carbon atom.

[3 marks]

The central part is made up of six neutrons that have no electrical charge and _____

_____

_____

_____

_____

2 (b) Crude oil is a mixture of compounds. These compounds are mainly hydrocarbons.

What does the term hydrocarbon mean?

[1 mark]

_____

_____

Question 24 · continued

2 (c) Alkanes and alkenes are hydrocarbons.

Table 2 shows the boiling points of some alkanes and alkenes.

Table 2

Alkanes

Name	Formula	Boiling point in °C
Ethane	C_2H_6	−88
Propane	C_3H_8	−42
Butane	C_4H_{10}	0
Pentane	C_5H_{12}	+36
Hexane	C_6H_{14}	+69

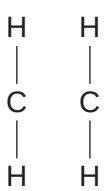
Alkenes

Name	Formula	Boiling point in °C
Ethene	C_2H_4	−104
Propene	C_3H_6	−48
Butene	C_4H_8	−6
Pentene	C_5H_{10}	+30
Hexene	C_6H_{12}	+64

2 (c) (i) Complete the displayed structure of ethane and the displayed structure of ethene.

[2 marks]

Ethane



Ethene



2 (c) (ii) Describe the relationship between the number of carbon atoms in an alkane molecule and the boiling point of the alkane molecule.

[1 mark]

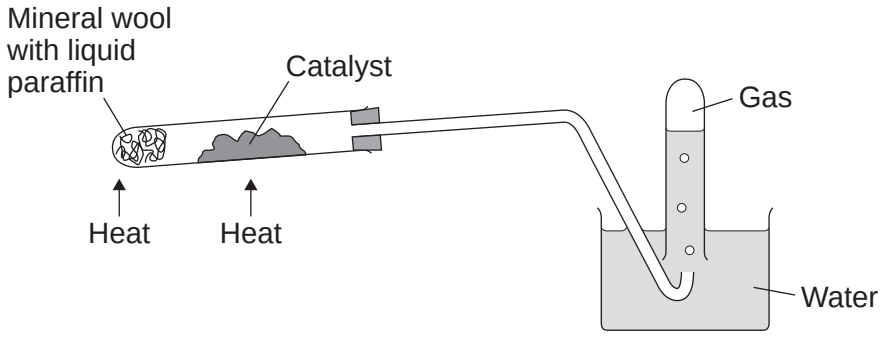
Question 24 · continued

2 (c) (iii) Use the information in **Table 2** to compare the boiling points of alkanes with the boiling points of alkenes.

[2 marks]

2 (d) A student used the apparatus in **Figure 3** to investigate what happens when liquid paraffin is heated to a high temperature.

Figure 3



Liquid paraffin contains alkanes.

Describe what happens to the alkane molecules in this investigation.

[3 marks]

13

4.1.1.7 Electronic structure

Question 25

June 2017 | CH2HP | Original Q3 | Legacy

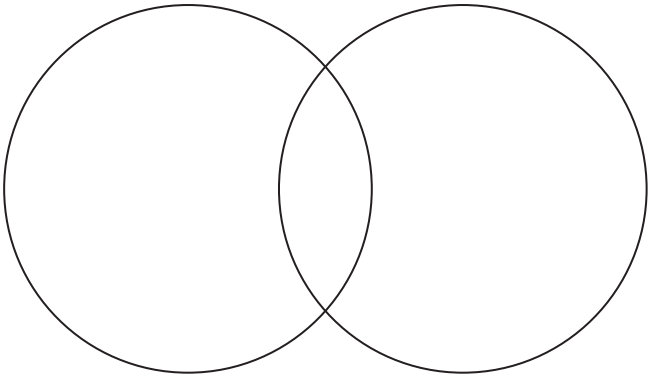
3 This question is about oxygen and substances containing oxygen.

3 (a) (i) Complete **Figure 4** to show the arrangement of the outer shell electrons in an oxygen molecule.

Use dots (•) and crosses (×) to represent the electrons.

[2 marks]

Figure 4



3 (a) (ii) Name the type of bonding in an oxygen molecule.

[1 mark]

_____

3 (a) (iii) Explain why oxygen has a low boiling point.

[2 marks]

_____

_____

_____

_____

4.1.1.7 Electronic structure

Question 25 · continued

3 (b) Magnesium oxide is produced when oxygen reacts with magnesium.

3 (b) (i) **Balance** the equation for the reaction.

[1 mark]

$$Mg + O_2 \longrightarrow MgO$$

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

Describe what happens, in terms of electrons, when magnesium atoms react with oxygen atoms to produce magnesium oxide.

[3 marks]

3 (b) (iii) Magnesium oxide nanoparticles can be made.

What are nanoparticles?

[1 mark]

Question 3 continues on the next page

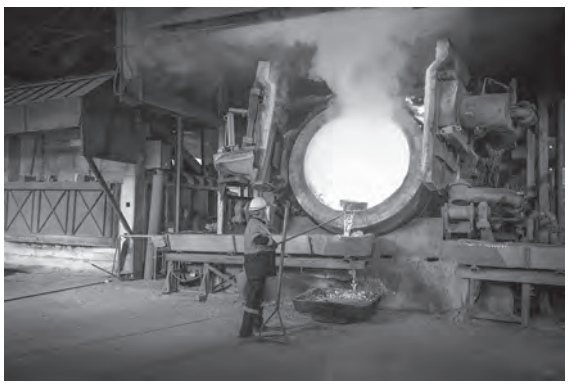
4.1.1.7 Electronic structure

Question 25 · continued

3 (c) **Figure 5** shows a furnace lined with silicon dioxide (SiO_2).

The temperature in the furnace is 1500 °C.

Figure 5



Explain, in terms of structure and bonding, why silicon dioxide is used to line furnaces.

[3 marks]

13

4.1.1.7 Electronic structure

Question 26

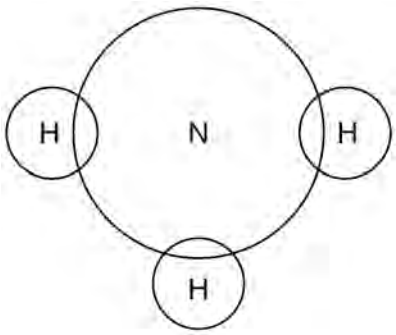
0 5 This question is about ammonia, NH_3

0 5 . 1 Complete the dot and cross diagram for the ammonia molecule shown in **Figure 6**.

Show only the electrons in the outer shell of each atom.

[2 marks]

Figure 6



0 5 . 2 Give **one** limitation of using a dot and cross diagram to represent an ammonia molecule.

[1 mark]

0 5 . 3 Explain why ammonia has a low boiling point.

You should refer to structure and bonding in your answer.

[3 marks]

Ammonia reacts with oxygen in the presence of a metal oxide catalyst to produce nitrogen and water.

0 5 . 4 Which metal oxide is most likely to be a catalyst for this reaction?

[1 mark]

Tick (✓) **one** box.

- CaO ☐
- Cr_2O_3 ☐
- MgO ☐
- Na_2O ☐

Figure 7 shows the displayed formula equation for the reaction.

Figure 7

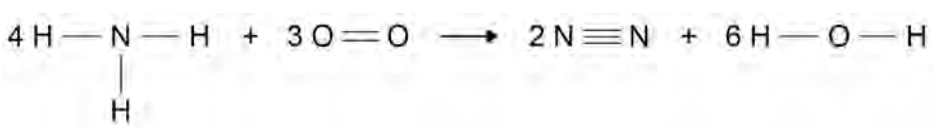


Table 3 shows some bond energies.

Table 3

Bond	N — H	O = O	N ≡ N	O — H
Bond energy in kJ/mol	391	498	945	464

Question 26 · continued

0 5 . 5 Calculate the overall energy change for the reaction.

Use **Figure 7** and **Table 3**.

[3 marks]

Overall energy change = _____ kJ

0 5 . 6 Explain why the reaction between ammonia and oxygen is exothermic.

Use values from your calculation in Question **05.5**

[2 marks]

Question 5 continues on the next page

4.1.1.7 Electronic structure

Question 26 · continued

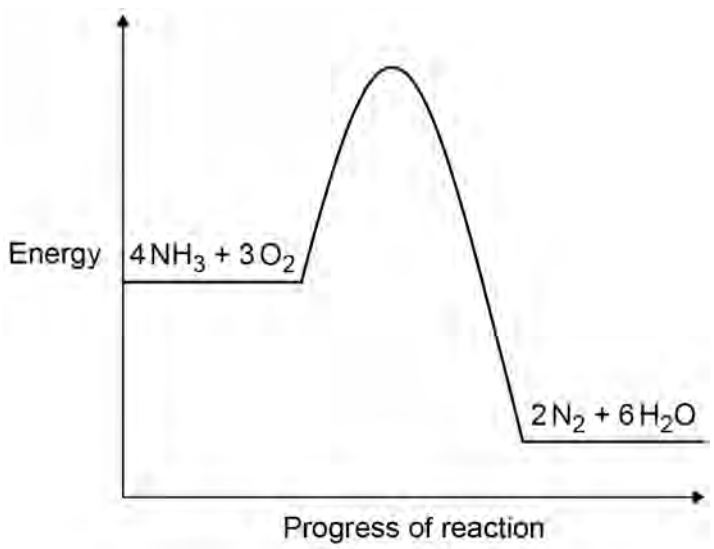
0 5 . 7 **Figure 8** shows the reaction profile for the reaction between ammonia and oxygen.

Complete **Figure 8** by labelling the:

- activation energy
- overall energy change.

[2 marks]

Figure 8



14

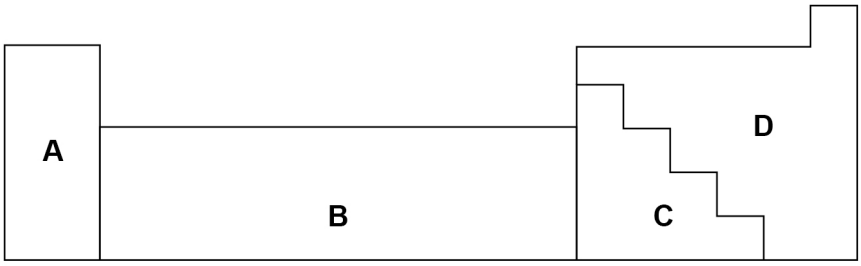
4.1.1.7 Electronic structure

Question 27

0 1 This question is about metals and non-metals.

Figure 1 shows an outline of part of the periodic table.

Figure 1



0 1 . 1 Element **Q** is a dull solid with a melting point of 44 °C.

Element **Q** does not conduct electricity.

Which section of the periodic table in **Figure 1** is most likely to contain element **Q**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 2 Element **R** forms ions of formula R^{2+} and R^{3+}

Which section of the periodic table in **Figure 1** is most likely to contain element **R**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 3 Give **two** differences between the physical properties of the elements in Group 1 and those of the transition elements.

[2 marks]

1 _____

_____

2 _____

_____

4.1.1.7 Electronic structure

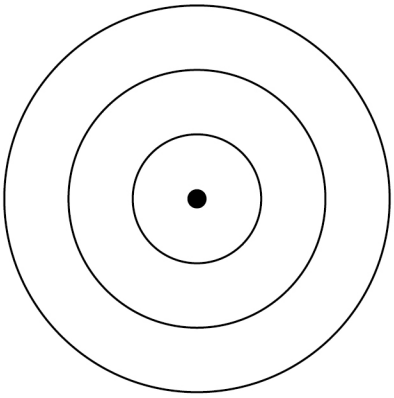
Question 27 · continued

0 1 . 4 Complete **Figure 2** to show the electronic structure of an aluminium atom.

Use the periodic table.

[1 mark]

Figure 2



0 1 . 5 Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

[3 marks]

0 1 . 6 Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

4.1.1.7 Electronic structure

Question 27 · continued

0 1 . 7 Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

[4 marks]

13

4.1.1.7 Electronic structure

Question 28

June 2022 | 8462/1H | Original Q7

0 7 This question is about silicon and compounds of silicon.

0 7 . 1 The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.

Silicon can be extracted by reducing silicon dioxide with different substances.

The equation for one possible reaction is:

$$2\,C(s) + SiO_2(s) \rightarrow Si(s) + 2\,CO(g)$$

Explain what this reaction shows about the position of silicon in the reactivity series.

[2 marks]

0 7 . 2 Aluminium also reduces silicon dioxide.

Carbon is used rather than aluminium to reduce silicon dioxide because carbon is cheaper than aluminium.

Carbon can be obtained by heating coal.

Aluminium is obtained from aluminium oxide.

Explain why aluminium is more expensive than carbon.

[2 marks]

Question 28 · continued

Magnesium also reduces silicon dioxide.

The equation for the reaction is:

$$2\,Mg(s) + SiO_2(s) \rightarrow Si(s) + 2\,MgO(s)$$

0 7 . 3 Give **one** reason why the products are difficult to separate if magnesium is used to reduce silicon dioxide.

[1 mark]

0 7 . 4 Calculate the minimum mass in grams of magnesium needed to completely reduce 1.2 kg of silicon dioxide.

Relative atomic masses (A_r): O = 16 Mg = 24 Si = 28

[5 marks]

Minimum mass of magnesium = _____ g

4.1.1.7 Electronic structure

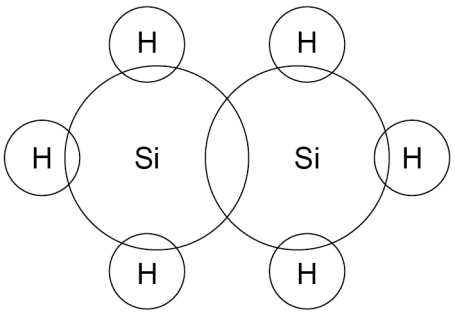
Question 28 · continued

Si_2H_6 is a covalent compound of silicon and hydrogen.

0 7 . 5 Complete **Figure 9** to show the outer shell electrons in a molecule of Si_2H_6

[1 mark]

Figure 9



0 7 . 6 Si_2H_6 reacts with oxygen.

The equation for the reaction is:

$$2\,Si_2H_6(g) + 7\,O_2(g) \rightarrow 4\,SiO_2(s) + 6\,H_2O(g)$$

30 cm^3 of Si_2H_6 is reacted with 150 cm^3 (an excess) of oxygen.

Calculate the total volume of gases present after the reaction.

All volumes of gases are measured at the same temperature and pressure.

[4 marks]

Volume of gases = _____ cm^3

15

4.1.1.7 Electronic structure

Question 29

June 2023 | 8462/1H | Original Q1

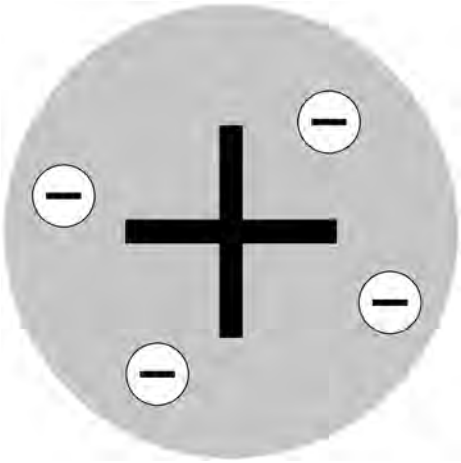
0 1 Discoveries in chemistry led to a better understanding of atomic structure.

0 1 . 1 Atoms were originally thought to be tiny spheres that could not be divided.

The plum pudding model of the atom was then developed.

Figure 1 represents the plum pudding model of the atom.

Figure 1



Describe the plum pudding model of the atom.

[2 marks]

0 1 . 2 Atoms contain electrons, neutrons and protons.

Write these three particles in order of their discovery.

[1 mark]

Earliest _____

_____

Latest _____

4.1.1.7 Electronic structure

Question 29 · continued

Very few atoms of the element tennessine (Ts) have ever been identified.

The atomic number of tennessine is 117

0 1 . 3 Predict the number of outer shell electrons in an atom of tennessine.

Give **one** reason for your answer.

Use the periodic table.

[2 marks]

Number of outer shell electrons _____

Reason _____

_____

0 1 . 4 Tennessine was first identified by a small group of scientists in 2010.

Suggest **one** reason why tennessine was **not** accepted as a new element by other scientists until 2015.

[1 mark]

_____

_____

Question 1 continues on the next page

Question 29 · continued

0 1 . 5 The discovery of isotopes explained why some relative atomic masses are not whole numbers.

Element **R** has two isotopes.

Table 1 shows the mass numbers and percentage abundances of the isotopes of element **R**.

Table 1

Mass number	Percentage abundance (%)
6	7.6
7	92.4

Calculate the relative atomic mass (A_r) of element **R**.

Give your answer to 1 decimal place.

[3 marks]

Relative atomic mass (1 decimal place) = _____

9

4.1.1.7 Electronic structure

Question 30

June 2023 | 8462/1H | Original Q4

0 4 This question is about hydrogen and compounds of hydrogen.

Figure 3 shows the displayed formulae for the reaction between hydrogen and chlorine.

Figure 3

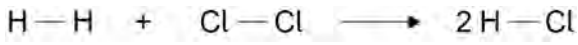


Table 4 shows the bond energies.

Table 4

Bond	H — H	Cl — Cl	H — Cl
Bond energy in kJ/mol	436	346	432

0 4 . 1 Which expression shows how to calculate the overall energy change for the reaction in **Figure 3**?

Use **Table 4**.

[1 mark]

Tick (✓) **one** box.

436 + 346 + 432 kJ/mol ☐

436 + 346 + (2 × 432) kJ/mol ☐

436 + 346 − 432 kJ/mol ☐

436 + 346 − (2 × 432) kJ/mol ☐

Question 30 · continued

The reaction between hydrogen and chlorine is exothermic.

0 4 . 2 Explain why this reaction releases energy to the surroundings.

[2 marks]

0 4 . 3 **Figure 4** shows part of a reaction profile for the reaction between hydrogen and chlorine.

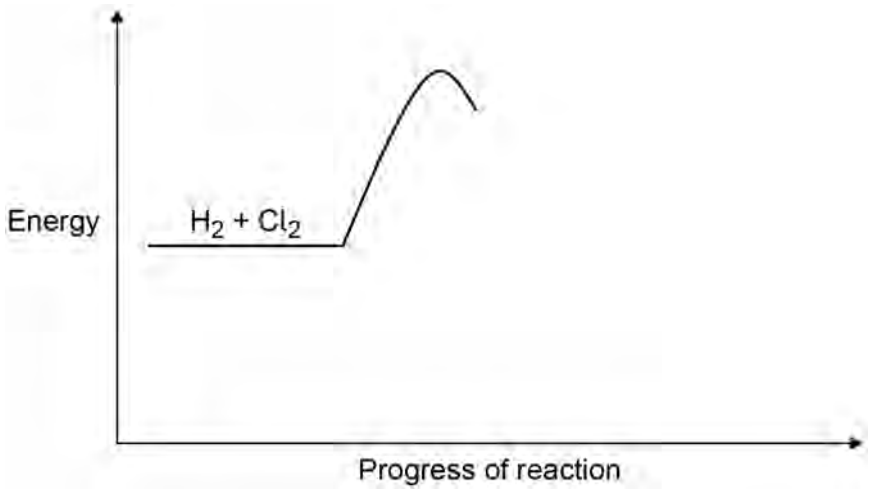
Complete the reaction profile in **Figure 4**.

You should:

- label the activation energy
- label the overall energy change.

[3 marks]

Figure 4



Question 4 continues on the next page

4.1.1.7 Electronic structure

Question 30 · continued

0 4 . 4 Draw a dot and cross diagram for a molecule of hydrogen chloride (HCl).

Show the outer shell electrons only.

[2 marks]

4.1.1.7 Electronic structure

Question 30 · continued

0 4 . 5 **Figure 5** represents molecules of methane and of poly(ethene).

Figure 5



Methane is a gas at room temperature but poly(ethene) is a solid at room temperature.

Explain why methane and poly(ethene) exist in different states at room temperature.

[4 marks]

12

4.1.1.7 Electronic structure

Question 31

June 2023 | 8462/1H | Original Q5

0 5 This question is about acids and alkalis.

0 5 . 1 Ethanoic acid is a weak acid.

What is meant by 'weak acid'?

Answer in terms of ionisation.

[1 mark]

_____

_____

0 5 . 2 The concentration of an acid can be measured in mol/dm^3.

Which combination of changes **increases** the concentration of an acid?

[1 mark]

Tick (✓) **one** box.

- The mass of acid dissolved is halved and the volume of the solution is halved. ☐
- The mass of acid dissolved is halved and the volume of the solution is doubled. ☐
- The mass of acid dissolved is doubled and the volume of the solution is halved. ☐
- The mass of acid dissolved is doubled and the volume of the solution is doubled. ☐

0 5 . 3 The concentration of an acid can be determined by titration.

An indicator is added to an alkali in a flask.

Name an indicator that can be used in this titration.

Give the colour change of the indicator when acid from a burette is added to the alkali in the flask.

[2 marks]

Name of indicator _____

Colour change from _____ to _____

4.1.1.7 Electronic structure

Question 31 · continued

0 5 . 4 Sodium carbonate dissolves in water to produce an alkaline solution.

Give the formula of the ion that makes a solution alkaline.

[1 mark]

_____

0 5 . 5 A student does a titration using sodium carbonate solution and nitric acid.

The equation for the reaction is:

$$Na_2CO_3 + 2\,HNO_3 \rightarrow 2\,NaNO_3 + CO_2 + H_2O$$

25.0 cm^3 of 0.124 mol/dm^3 sodium carbonate solution is neutralised by 23.6 cm^3 of nitric acid.

Calculate the concentration of the nitric acid.

Give your answer to 3 significant figures.

You should calculate:

- the number of moles of sodium carbonate in 25.0 cm^3 of the solution
- the number of moles of nitric acid in 23.6 cm^3 of the nitric acid
- the concentration of the nitric acid in mol/dm^3.

[5 marks]

Concentration (3 significant figures) = _____ mol/dm^3

4.1.1.7 Electronic structure

Question 31 · continued

When hydrochloric acid dissolves in water, hydrogen ions (H^+) and chloride ions (Cl^-) are produced.

0 5 . 6 A solution of hydrochloric acid with pH 4.5 has a concentration of H^+ ions of 3.16×10^{-5} mol/dm^3.

What is the concentration of H^+ ions in a solution of hydrochloric acid with pH 2.5?

[1 mark]

Concentration of H^+ ions = _____ mol/dm^3

0 5 . 7 Which element has atoms that have the same electronic structure as the chloride ion?

Use the periodic table.

[1 mark]

_____

12

4.1.1.7 Electronic structure

Question 32

June 2024 | 8462/1H | Original Q2

0 2 This question is about the periodic table.

Sodium and potassium are in Group 1 of the periodic table.

0 2 . 1 Give **one** similarity and **one** difference between the electronic structures of sodium and potassium.

[2 marks]

Similarity _____

_____

Difference _____

_____

Group 1 elements react with water.

0 2 . 2 Give **two** observations made when potassium reacts with water.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 3 Potassium hydroxide solution is produced when potassium reacts with water.

What is the colour of universal indicator when added to potassium hydroxide solution?

Give **one** reason for your answer.

[2 marks]

Colour of universal indicator _____

Reason _____

_____

Question 32 · continued

Table 1 shows the densities of some of the elements in Group 0 of the periodic table.

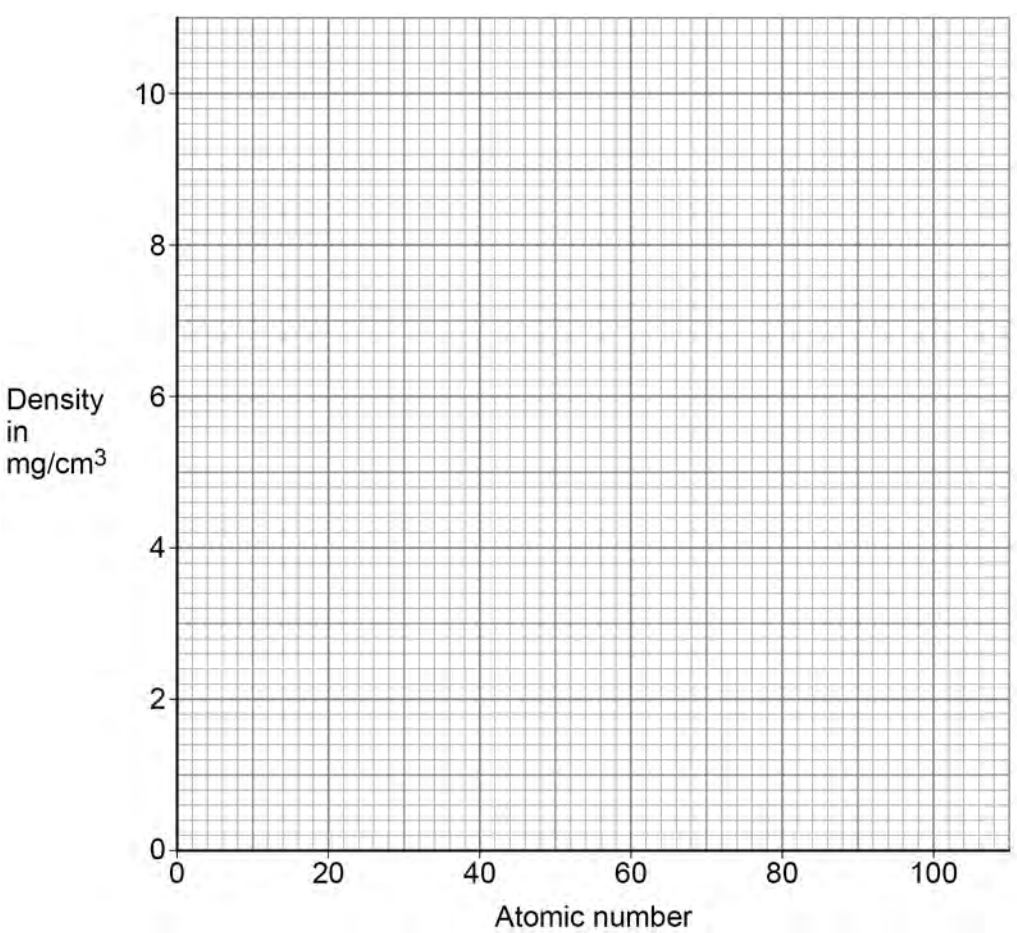
Table 1

Element	Atomic number	Density in mg/cm^3
Helium	2	0.2
Neon	10	0.8
Argon	18	1.6
Krypton	36	**X**
Xenon	54	5.4
Radon	86	9.1

0 2 . 4 Plot the data from **Table 1** on **Figure 1**.

[2 marks]

Figure 1



Question 32 · continued

0 2 . 5 Estimate the density (**X**) of krypton.

Use **Figure 1** and **Table 1**.

[1 mark]

Density = _____ mg/cm^3

0 2 . 6 The elements in Group 7 are called the halogens.

A more reactive halogen can displace a less reactive halogen from a solution of its salt.

Which combination of solutions will produce a reaction when mixed?

[1 mark]

Tick (✓) **one** box.

Chlorine and potassium fluoride ☐

Chlorine and potassium bromide ☐

Bromine and potassium fluoride ☐

Bromine and potassium chloride ☐

0 2 . 7 Which of the following describes the trends going down Group 7?

[1 mark]

Tick (✓) **one** box.

Relative molecular mass decreases and boiling point decreases. ☐

Relative molecular mass decreases and boiling point increases. ☐

Relative molecular mass increases and boiling point decreases. ☐

Relative molecular mass increases and boiling point increases. ☐

11

4.1.1.7 Electronic structure

Question 33

June 2025 | 8462/1H | Original Q1

0 1 This question is about elements in the periodic table.

0 1 . 1 Describe where the non-metallic elements are found in the periodic table.

[1 mark]

0 1 . 2 Gallium (Ga) is a metallic element in Group 3.

Which of these properties of gallium is **not** typical of most metals?

[1 mark]

Tick (✓) **one** box.

- A boiling point above 1000 °C ☐
- A melting point below 100 °C ☐
- Conducts electricity when solid ☐
- Forms positive ions ☐

4.1.1.7 Electronic structure

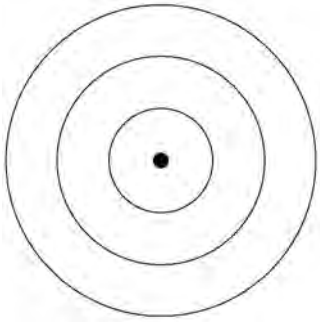
Question 33 · continued

0 1 . 3 A sodium atom can be represented as $^{23}_{11}Na$

Complete **Figure 1** to show the electronic structure of a sodium atom.

[1 mark]

Figure 1



0 1 . 4 Mendeleev created an early periodic table.

Mendeleev placed most of the elements in order of atomic weight.

Tellurium and iodine were not placed in order of atomic weight.

Why did Mendeleev **not** place tellurium and iodine in order of atomic weight?

[1 mark]

0 1 . 5 Argon is an element in Group 0 of the periodic table.

Explain why argon is unreactive.

[2 marks]

Question 33 · continued

An element **X** consists of two isotopes.

0 1 . 6 What is meant by 'isotopes'?

Answer in terms of subatomic particles.

[2 marks]

0 1 . 7 **Table 1** shows the mass numbers and percentage abundances of the isotopes of **X**.

Table 1

Mass number	Percentage abundance (%)
113	4
115	96

Which is the closest estimate to the relative atomic mass of **X**?

[1 mark]

Tick (✓) **one** box.

~113 ☐ ~114 ☐ ~115 ☐

9

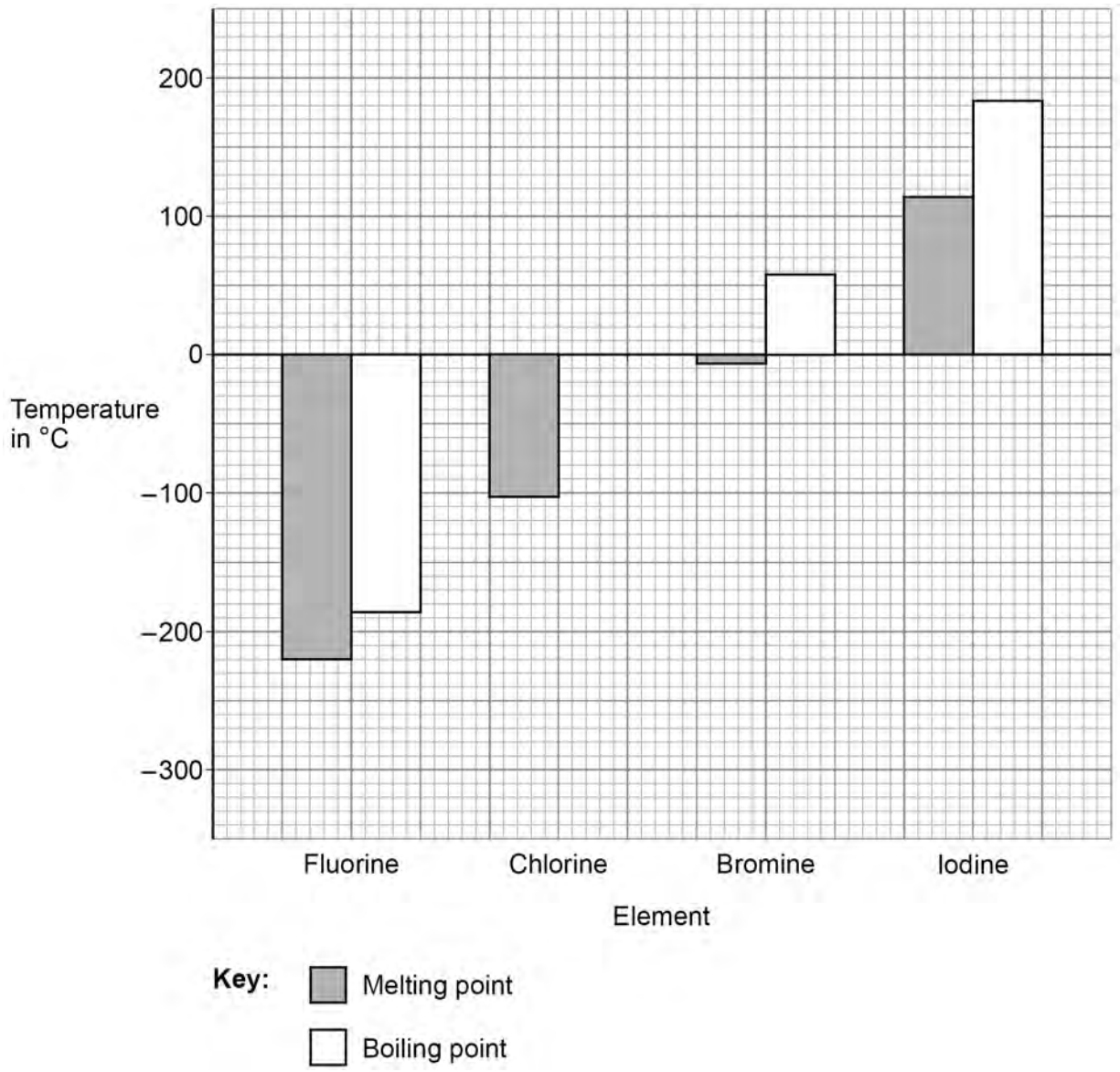
4.1.1.7 Electronic structure

Question 34

0 4 The elements in Group 7 of the periodic table are known as the halogens.

Figure 4 shows information about some of the elements in Group 7.

Figure 4



4.1.1.7 Electronic structure

Question 34 · continued

0 4 . 1 Predict the boiling point of chlorine.

Use **Figure 4**.

[1 mark]

_____ °C

0 4 . 2 What is the state of fluorine at –250 °C?

Use **Figure 4**.

[1 mark]

_____

Astatine (At) is an element in Group 7.

0 4 . 3 What is the number of electrons in the outer shell of an astatine atom?

[1 mark]

_____

0 4 . 4 Hydrogen reacts with astatine to produce hydrogen astatide.

Predict the formula of hydrogen astatide.

[1 mark]

_____

Question 4 continues on the next page

0 4 . 5 Explain the trend in reactivity of the elements going down Group 7.

[4 marks]

Extra space

0 4 . 6 A more reactive halogen can displace a less reactive halogen from a solution of its salt.

Write a balanced equation for the reaction between bromine and potassium iodide.

[3 marks]

_____ + _____ ⟶ _____ + _____

11

4.1.1.7 Electronic structure

Question 35

June 2025 | 8462/1H | Original Q7

0 7 Hydrazine (N_2H_4) is a compound of nitrogen and hydrogen.

0 7 . 1 Scientists are researching the use of hydrazine in fuel cells.

Table 2 gives some information about the use of hydrogen and hydrazine in fuel cells.

Table 2

	Hydrogen	**Hydrazine**
State at room temperature	Gas	Liquid
Hazards	Explosive	Toxic
Equation for fuel cell reaction	$2\ H_2\ +\ O_2\ \longrightarrow\ 2\ H_2O$	$N_2H_4\ +\ O_2\ \longrightarrow\ N_2\ +\ 2\ H_2O$
Voltage produced in volts	1.23	1.61
Catalyst needed for reaction	Platinum	None

Evaluate the use of hydrazine instead of hydrogen in a fuel cell.

[4 marks]

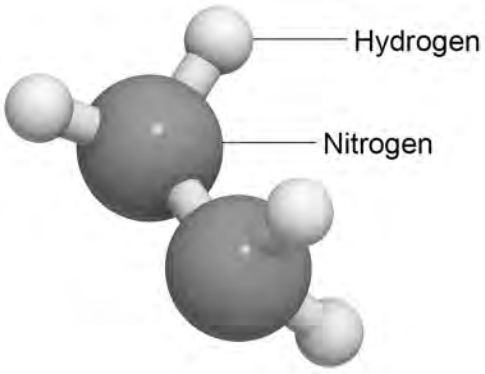
Extra space

4.1.1.7 Electronic structure

Question 35 · continued

Figure 6 shows a model of the hydrazine molecule.

Figure 6

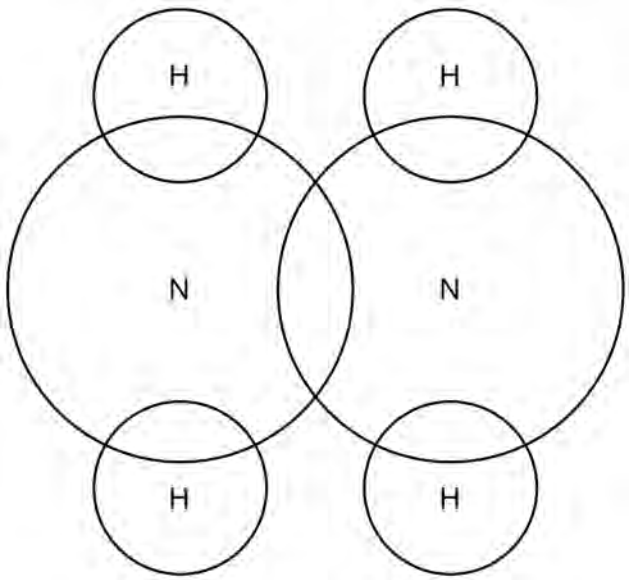


0 7 . 2 Complete the dot and cross diagram for hydrazine in **Figure 7**.

Show the outer shell electrons only.

[2 marks]

Figure 7

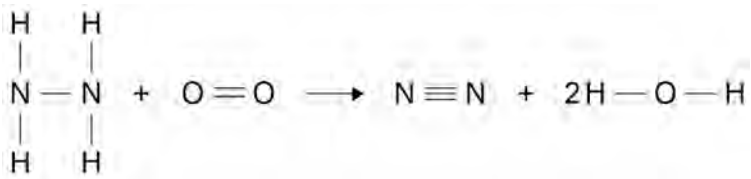


0 7 . 3 Give **one** advantage of the ball and stick model in **Figure 6** compared to the dot and cross diagram.

[1 mark]

0 7 . 4 **Figure 8** shows the displayed formula equation for the reaction of hydrazine with oxygen.

Figure 8



The reaction is exothermic.

The energy released forming new bonds is 581 kJ/mol greater than the energy needed to break existing bonds.

Table 3 shows some bond energies.

Table 3

Bond	N — N	N — H	O = O	N ≡ N	O — H
Bond energy in kJ/mol	X	391	498	945	464

Calculate the bond energy (**X**) of the N — N bond.

[4 marks]

X = _____ kJ/mol

11