

## Development of the periodic table

Before the discovery of protons, neutrons and electrons, scientists attempted to classify the elements by arranging them in order of their atomic weights.

The early periodic tables were incomplete and some elements were placed in inappropriate groups if the strict order of atomic weights was followed.

John Dalton arranged the elements in order of atomic mass which had been measured using chemical reactions however the number of known elements was limited and patterns grouping the elements had not been fully classified.

ELEMENTS	
Hydrogen 1	Strontian 86
Azote 5	Barites 68
Carbon 5	Iron 50
Oxygen 7	Zinc 56
Phosphorus 9	Copper 56
Sulphur 13	Lead 99
Magnesia 20	Silver 199
Lime 24	Gold 196
Soda 28	Platina 190
Potash 42	Mercury 167

### Newlands' Arranged Elements in Octaves:

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

John Newlands arranged the elements in order of increasing atomic mass, he noticed that properties seemed to repeat every eight elements. He called this the law of octaves. Not all the elements fit the pattern and there was no room for new elements if they were to be discovered.

Dmitri Mendeleev also ordered elements by atomic mass but he grouped elements that had similar properties even if it did not go up in mass order. He also left gaps for elements that he thought had not been discovered and could predict what the properties of these elements were based on what he knew about elements around the gap. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.

Atomic Weight	Gruppo I. R <sup>0</sup>	Gruppo II. R <sup>0</sup>	Gruppo III. R <sup>0</sup>	Gruppo IV. R <sup>0</sup>	Gruppo V. R <sup>0</sup>	Gruppo VI. R <sup>0</sup>	Gruppo VII. R <sup>0</sup>	Gruppo VIII. R <sup>0</sup>
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,5	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Ca=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=101, Rh=104, Pd=106, Ag=108.
7	(Ag=105)	Cd=112	Ta=113	Sa=116	Sb=121	Te=125	J=127	
8	Ce=133	La=137	Di=138	Ce=140	—	—	—	
9	(—)	—	—	—	—	—	—	
10	—	—	Er=178	La=180	Ta=182	W=184	—	Os=190, Ir=197, Pt=198, Au=199.
11	(As=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Tl=211	—	U=240	—	

## The Modern Periodic Table

Mendeleev's Periodic Table was widely accepted by scientists when the discovery of Gallium had shown his predictions of its properties were correct.

In the modern Periodic Table we order the elements by atomic number and elements with similar chemical properties are in groups.

### Metals and non-metals

Elements that react to form positive ions are metals.

Elements that do not form positive ions are non-metals.

The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table.

Non-metals are found towards the right and top of the periodic table.



- b Which two elements (W, X, Y or Z) have the same number of electrons on their outer shell?

\_\_\_\_\_ and \_\_\_\_\_

[1 mark]

## Development of the periodic table

1. Use the words in the box to complete the sentences.

reactivity    atomic weight    groups    atomic number    rows

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

He arranged the elements in order of their \_\_\_\_\_

He then placed elements with similar properties into \_\_\_\_\_

[2 marks]

2. When the next element did not follow the pattern Mendeleev left a gap.

**Table 1** shows an example is in group 3.

**Table 1**

Row	Element	Metal or non-metal	Melting point in °C	Density in g/cm <sup>3</sup>	Formula of chloride compound
1	Boron	Metal	2076	2.34	BCl <sub>3</sub>
2	Aluminium	Metal	660	2.70	AlCl <sub>3</sub>
3	X				

Predict the properties of the missing element, X, in group 3.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

[4 marks]

### Analysing the question

You know that there are patterns in the elements as you go down a group, for example melting point may increase as you go down a group.

Look at the patterns in the two elements in the table and use the data to state what the properties of the missing element could be.

# Comparing metals and non-metals

1. **Figure 7** is a diagram of the periodic table.

Shade the area to show where **non-metals** are found.

[1 mark]

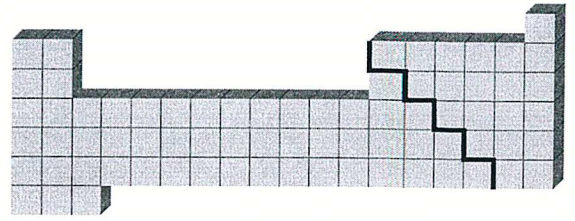


Figure 7

2. Sodium reacts with chlorine to form sodium chloride.

a Write a word equation to show this reaction.

\_\_\_\_\_

[1 mark]

b Draw **one** line from each substance to the correct description.

Substance

Description

Sodium

Metal

Sodium chloride

Non-metal

Chlorine

[3 marks]

3. **Table 2** shows physical properties of different elements.

Table 2

Element	Does it conduct electricity?	Melting point in °C	Boiling point in °C	Density in g/cm <sup>3</sup>
A	Yes	180.5	1342	0.53
B	No	-7.2	58.8	3.10
C	No	115.2	444.6	2.07
D	Yes	419.5	907	7.13

a Which elements (A, B, C or D) are non-metals?

\_\_\_\_\_ and \_\_\_\_\_

[2 marks]

b Which element (A, B, C or D) is a liquid at room temperature?

\_\_\_\_\_

[1 mark]

c State **two** physical properties that the metals in **Table 2** share.

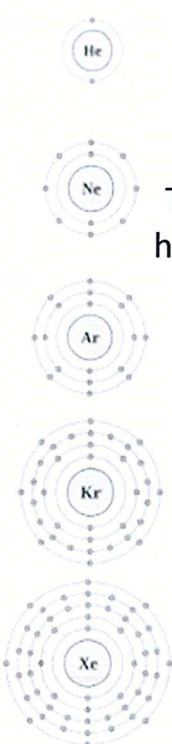
1 \_\_\_\_\_ 2 \_\_\_\_\_

[2 marks]



## Group 0

2	<b>He</b> Helium 4.000
10	<b>Ne</b> Neon 20.180
18	<b>Ar</b> Argon 39.948
36	<b>Kr</b> Krypton 84.90
54	<b>Xe</b> Xenon 131.29



The elements in Group 0 of the periodic table are called the noble gases. They are unreactive and do not easily form molecules because their atoms have stable arrangements of electrons – full outer shells.

The noble gases have eight electrons in their outer shell, except for helium, which has only two electrons.

The boiling points of the noble gases increase with increasing relative atomic mass (going down the group).

## Group 1

The elements in Group 1 of the periodic table are known as the alkali metals and have characteristic properties because of the single electron in their outer shell.

The elements in Group 1 of the periodic table:

- Are metals with low density (the first three elements in the group are less dense than water)
- React with non-metals to form ionic compounds in which the metal ion carries a charge of +1.
- Their ionic compounds are white solids that dissolve in water to form colourless solutions
- They react with water, releasing hydrogen gas.
- Form hydroxides that dissolve in water to give alkaline solutions.  
(e.g.  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$ )

In Group 1, the further down the group an element is:

- the more reactive the element
- The lower its melting point and boiling point.

3	<b>Li</b> Lithium 6.941	
11	<b>Na</b> Sodium 22.990	
19	<b>K</b> Potassium 39.098	
37	<b>Rb</b> Rubidium 84.468	
55	<b>Cs</b> Cesium 132.905	
87	<b>Fr</b> Francium 223.020	

Group 1 metals get more reactive as you go down the group because the size of the atom increases. The outer electron is more shielded from the positive charge of the nucleus because there are more electron shells in the way. This decreases the attraction between the outer shell electron and the nucleus, making it easier to lose to become a +1 ion.



## Group 7

The elements in Group 7 of the periodic table are known as the halogens and have similar reactions because they all have seven electrons in their outer shell.

The elements in group 7:

- Are non-metals and consist of molecules made of pairs of atoms.
- React with metals to form ionic compounds in which the non-metal ion carries a charge of -1.
- Can form covalent compounds by sharing electrons with other non-metals.

In Group 7, the further down the group an element is:

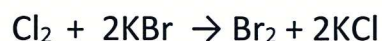
- The less reactive it is.
- The higher it's melting and boiling point is.

Group 7 elements reactivity decreases going down the group because the size of the atom increases. The outer shell electrons are more shielded from the positive charge of the nucleus because there are more electron shells in the way. This decreases the attraction between the incoming electron and the nucleus, making it harder to gain one to become a -1 ion.

Halogens can also take part in displacement reactions:

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

e.g. chlorine + potassium bromide → bromine + potassium chloride



The colour change for this reaction is the colour of the halogen that has been displaced.

9	<b>F</b> Fluorine 18.998
17	<b>Cl</b> Chlorine 35.453
35	<b>Br</b> Bromine 79.904
53	<b>I</b> Iodine 126.904
85	<b>At</b> Astatine 209.987

# Elements in group 0

1. Which statements are true about **all** elements in group 0?

Tick **two** boxes.

- They exist as single atoms.
- They have 8 electrons on their outer shell.
- They have a full outer shell of electrons.
- They have high melting and boiling points.

**Common misconception**

The elements in group 0 do not all have 8 electrons on their outer shell. Helium only has 2.

[2 marks]

2. **Table 3** shows data on the group 0 elements.

**Table 3**

Element	Helium	Neon	Argon	Krypton	Xenon	Radon
Atomic number	2	10	18	36	54	86
Density (g/dm <sup>3</sup> )	0.18	0.90	1.78	3.71	5.85	9.97

Maths

a Calculate the mass of 10 dm<sup>3</sup> of argon. Give your answer to 2 significant figures.

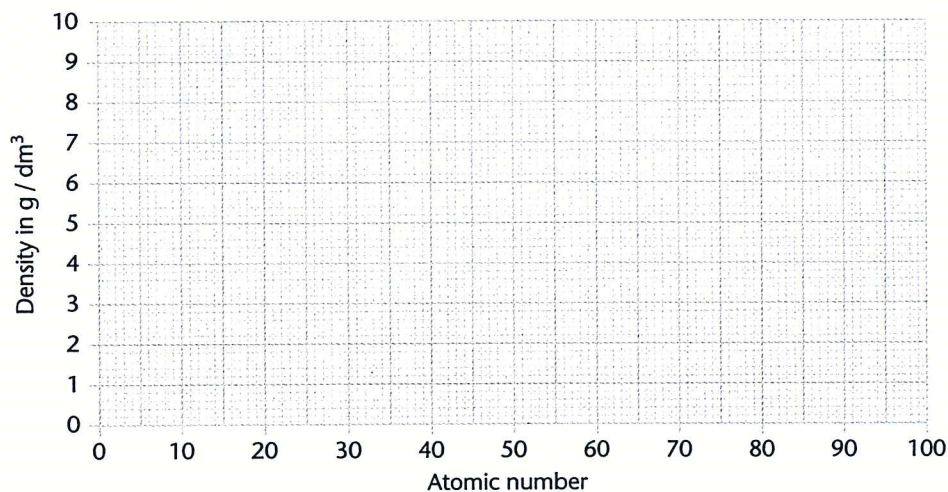
\_\_\_\_\_ g [2 marks]

Maths

b Plot the data on the graph axes on **Figure 8**.

Draw a line of best fit.

[3 marks]



**Figure 8**



3. Use electronic structure to explain why elements in group 0 of the periodic table are unreactive.

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[3 marks]

## Elements in group 1

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A teacher demonstrates the reactions of the group 1 metals with water.

1. The group 1 metals are also known as:

Tick **one** box.

- The halogens                       The noble gases  
 The alkali metals                 The transition metals

[1 mark]

2. First, they cut a piece of lithium from a larger block.

**Practical**

The students observe that the cut surface of lithium is shiny but it slowly goes dull.

- a Name the element that the lithium is reacting with when it becomes dull. [1 mark]  
b They put the piece of lithium into the water.

Complete the word equation for the reaction that takes place.

lithium + water → \_\_\_\_\_ + \_\_\_\_\_ [2 marks]

- c State **one** safety precaution they will take when carrying out this demonstration.

\_\_\_\_\_ [1 mark]

3. The teacher then cuts a piece of sodium.

Sodium is found below lithium in group 1 of the periodic table.

Tick the correct statement.

- The sodium will go dull more quickly than lithium because it is more reactive.  
 The sodium will go dull more slowly than lithium because it is less reactive. [1 mark]

4. Compare the reaction of sodium and lithium with water.

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[4 marks]

## Elements in group 7

1. Bromine is found in group 7 of the periodic table. Its formula is Br<sub>2</sub>.

What does this tell you about bromine?

Tick **one** box.

- Bromide ions have a charge of -2.
- There are always 2 bromine atoms in a compound.
- Bromine exists as pairs of atoms.
- Bromine is a reactive element.

[1 mark]

2. Use the information in **Table 4** to answer the following questions.

**Table 4**

↑ Increase in atomic number ↓	Name of element	Melting point in °C	Boiling point in °C
	fluorine	-220	-188
	chlorine	-102	-34
	bromine	-7	59
	iodine		184

- a Name **one** group 7 element that is a gas at room temperature.

\_\_\_\_\_

[1 mark]

- b Describe the trend in boiling points as you go down the group.

\_\_\_\_\_

[1 mark]



3. **Figure 9** shows the electronic structure of the first three group 7 elements.

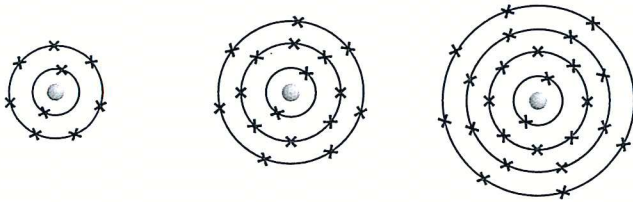


Figure 9

**Literacy**

Use the diagrams to explain why the reactivity of the halogens decreases as you go down the group.

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[6 marks]

## Properties of the transition metals

*\*Separate sciences & only.*

1. **Figure 10** is a diagram of the periodic table.

Shade the area to show where transition metals are found.

[1 mark]

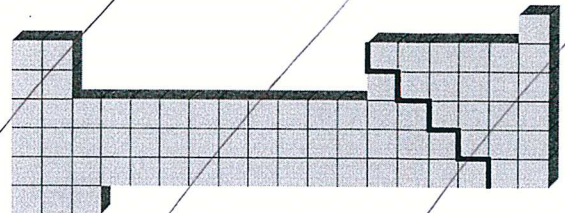


Figure 10

2. Which metals are transition metals?

Tick **two** boxes.

Copper (Cu)

Aluminium (Al)

Magnesium (Mg)

Manganese (Mn)

[2 marks]

\* create a revision mindmap to summarise this topic \*





## Topic 1 – Atomic Structure and the Periodic Table Glossary

Key Word	Definition
Alkali Metal	Elements in Group 1 of the Periodic Table.
Atom	The smallest part of an element that can exist.
Atomic Number	The number of protons (which equals the number of electron) in an atom. It is sometimes called the proton number.
Chromatography	The process where small amounts of dissolved substances are separated by running a solvent along a material such as absorbent paper.
Compound	A substance made when two or more elements are chemically bonded together.
Condensation	The process in which a gas becomes a liquid.
Crystallisation	The method used to separate a soluble substance from the liquid it is dissolved in.
Dimitri Mendeleev	The scientist credited with developing the modern Periodic Table.
Displacement	A reaction in which a more reactive element takes the place of a less reactive element.
Distillation	The method used to separate a liquid from a mixture by evaporation followed by condensation.
Dot and Cross diagram	A diagram used to illustrate electron arrangement using dots and crosses to represent electrons.
Electron	A tiny particle with a negative charge. Electrons orbit the nucleus of atom/ion in shells.
Electron Shell	These are where electrons are found orbiting the nucleus.
Electronic Structure	A set of numbers to show the arrangement of electrons in their shells (up to 2,8,8,2).
Evaporation	The process in which a liquid becomes a gas.
Element	A substance made up of only one type of atom. An element cannot be broken down chemically into any simpler substance.
Filtration	The method used to separate an insoluble solid from a liquid.
Fractional Distillation	The method used to separate liquids from a mixture by boiling off the substances at different temperatures, then condensing and collecting the liquids.
Group	All the elements in the same column in the Periodic Table.



Halogen	The elements found in Group 7 of the Periodic Table.
Inert	Unreactive.
Insoluble	Will not dissolve in a particular solvent.
Ion	An atom that has a positive or negative charge due to losing or gaining electrons.
Isotopes	Atoms that have the same number of protons (and electrons) but a different number of neutrons.
John Dalton	One of the first scientists to arrange the elements
John Newlands	A scientist that arranged the known elements into groups of eight (octaves).
Mass Number	The number of protons and neutrons in the nucleus of an atom.
Metal	Elements found on the left hand side and middle of the Periodic Table.
Mixture	Two or more different substances (elements or compounds) that are not chemically joined together and easily separated.
Neutral	An atom with no overall charge.
Neutron	A subatomic particle found in the nucleus with no overall charge.
Noble Gas	Elements found in Group 8 of the Periodic Table.
Non-metal	Elements found on the right hand side of the Periodic Table.
Nuclear Model	A model of the atom where protons and neutrons are found in the nucleus of an atom (at the centre) with electrons orbiting outside in shells.
Nucleus	The very small and dense central part of the atom that contains protons and neutrons.
Period	All the elements in the same row of the Periodic Table.
Periodic Table	An arrangement of elements in order of increasing atomic number, forming groups and periods.
Plum Pudding Model	A model of the atom where electrons were spread out in a sphere of positive charge.
Product	A substance made as a result of a chemical reaction.
Proton	A positive sub-atomic particle found in the nucleus of an atom.
Reactant	A substance that we start with before a chemical reaction take place.

Reactivity	The tendency of a substance to take part in a chemical reaction.
Relative Atomic Mass ( $A_r$ )	The average mass of the atoms of an element compared with carbon-12. This average takes into account the naturally occurring isotopes of the element (this is the big number on the Periodic Table).
Relative Formula Mass ( $M_r$ )	The total of the relative atomic masses, added up in the ratio shown in the chemical formula of a substance.
Sub-Atomic Particle	A particle smaller than an atom – electron, proton and neutron.



# The Periodic Table of Elements

1	2	3	4	5	6	7	0										
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	11 <b>Na</b> sodium 11	12 <b>Mg</b> magnesium 12	13 <b>Al</b> aluminium 13	14 <b>Si</b> silicon 14	15 <b>P</b> phosphorus 15	16 <b>S</b> sulfur 16	17 <b>Cl</b> chlorine 17	18 <b>Ar</b> argon 18								
19 <b>K</b> potassium 19	20 <b>Ca</b> calcium 20	21 <b>Sc</b> scandium 21	22 <b>Ti</b> titanium 22	23 <b>V</b> vanadium 23	24 <b>Cr</b> chromium 24	25 <b>Mn</b> manganese 25	26 <b>Fe</b> iron 26	27 <b>Co</b> cobalt 27	28 <b>Ni</b> nickel 28	29 <b>Cu</b> copper 29	30 <b>Zn</b> zinc 30	31 <b>Ga</b> gallium 31	32 <b>Ge</b> germanium 32	33 <b>As</b> arsenic 33	34 <b>Se</b> selenium 34	35 <b>Br</b> bromine 35	36 <b>Kr</b> krypton 36
37 <b>Rb</b> rubidium 37	38 <b>Sr</b> strontium 38	39 <b>Y</b> yttrium 39	40 <b>Zr</b> zirconium 40	41 <b>Nb</b> niobium 41	42 <b>Mo</b> molybdenum 42	43 <b>Tc</b> technetium [97]	44 <b>Ru</b> ruthenium 44	45 <b>Rh</b> rhodium 45	46 <b>Pd</b> palladium 46	47 <b>Ag</b> silver 47	48 <b>Cd</b> cadmium 48	49 <b>In</b> indium 49	50 <b>Sn</b> tin 50	51 <b>Sb</b> antimony 51	52 <b>Te</b> tellurium 52	53 <b>I</b> iodine 53	54 <b>Xe</b> xenon 54
55 <b>Cs</b> caesium 55	56 <b>Ba</b> barium 56	57 <b>La*</b> lanthanum 57	72 <b>Hf</b> hafnium 72	73 <b>Ta</b> tantalum 73	74 <b>W</b> tungsten 74	75 <b>Re</b> rhenium 75	76 <b>Os</b> osmium 76	77 <b>Ir</b> iridium 77	78 <b>Pt</b> platinum 78	79 <b>Au</b> gold 79	80 <b>Hg</b> mercury 80	81 <b>Tl</b> thallium 81	82 <b>Pb</b> lead 82	83 <b>Bi</b> bismuth 83	84 <b>Po</b> polonium 84	85 <b>At</b> astatine 85	86 <b>Rn</b> radon 86
87 <b>Fr</b> francium 87	88 <b>Ra</b> radium 88	89 <b>Ac*</b> actinium 89	104 <b>Rf</b> rutherfordium 104	105 <b>Db</b> dubnium 105	106 <b>Sg</b> seaborgium 106	107 <b>Bh</b> bohrium 107	108 <b>Hs</b> hassium 108	109 <b>Mt</b> meitnerium 109	110 <b>Ds</b> darmstadtium 110	111 <b>Rg</b> roentgenium 111	112 <b>Cn</b> copernicium 112	113 <b>Nh</b> nihonium 113	114 <b>Fl</b> flerovium 114	115 <b>Mc</b> moscovium 115	116 <b>Lv</b> livermorium 116	117 <b>Ts</b> tennessine 117	118 <b>Og</b> oganeson 118

1 <b>H</b> hydrogen 1
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relative atomic mass
atomic symbol
name
atomic (proton) number

\* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted. Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

## Section 1: Atomic structure and the periodic table

### Atoms, elements and compounds

- Oxygen [1 mark]
- Ca [1 mark],  $\text{Cl}_2$  [1 mark]
- iron [1 mark], carbon [1 mark]
  - iron oxide [1 mark], carbon dioxide [1 mark]
- Contains two or more elements [1 mark] chemically combined [1 mark]

### Mixtures

- Numbering boxes 1 to 4 from top: 1 – 3 [1 mark], 2 – 1 [1 mark], 3 – 4 [1 mark], 4 – 2 [1 mark]
- Use a magnet. [1 mark] The iron will stick to the magnet, but the sulfur will not. [1 mark]
  - In the mixture the elements are not chemically combined together. [1 mark]  
In the compound the elements are chemically combined/can only be separated by a chemical reaction. [1 mark]

### Compounds, formulae and equations

- $\text{NaNO}_3$  [1 mark]
- KI – potassium iodide [1 mark], MgS – magnesium sulfide [1 mark],  $\text{MgSO}_4$  – magnesium sulphate [1 mark], Worked example answer given in workbook for the 4th mark.
- carbon, chlorine, fluorine [3 marks]
- magnesium chloride,  $.5\text{Mg}$ ,  $\text{H}_2$  [4 marks]

### Scientific models of the atom

- plum pudding model [1 mark]
  - Answers in order: neutrally [1 mark], negatively [1 mark], electrons [1 mark]
- Level 3: A number of reasons have been given. Student considers both the meaning of the results and the validity of the experiment. They show a clear understanding of how new evidence leads to changes in models or theories. [5–6 marks]

Level 2: A number of reasons have been given linked to why models change over time. Student mentions the validity of the experiment. [3–4 marks]

Level 1: One or more reasons have been given [1–2 marks]

#### Indicative content

New evidence was collected.

The results showed the (plum pudding) model was not correct.

The model had to change to explain the results.

The data was checked by other scientists/it was reproducible.

The conclusions drawn were valid.

The experiment was well designed/carried out by scientist

### Sizes of atoms and molecules

- $1000 - 1 \times 10^3$  [1 mark],  $100 - 1 \times 10^2$  [1 mark],  $11\,000 - 1 \times 10^4$  [1 mark], 1 million –  $1 \times 10^6$  [1 mark]
- $2 \times 10^{-10}$  m [1 mark]
- Worked example – full answer given in workbook.
- $150/10\,000$  [1 mark]  
 $0.015$  m [1 mark]  
 $0.015 \times 1000 = 15$  (mm) [1 mark]

### Relative masses and charges of subatomic particles

- X – neutron [1 mark]; Y – proton [1 mark]; Z – electron [1 mark] –1 [1 mark]
  - They contain the same number of protons and electrons. [1 mark]
  - 2 [1 mark]
    - 4 [1 mark]
    - He [1 mark]
- Both contain 6 protons. [1 mark]  
Both contain 6 electrons. [1 mark]  
Carbon-12 contains 6 neutrons. [1 mark]  
Carbon-14 contains 8 neutrons. [1 mark]

### Relative atomic mass

- It has a mass number of 23. [1 mark]  
It has an atomic number of 11. [1 mark]
- 46 [1 mark]
  - Worked example – full answer given in workbook.
- $35 \times 75 = 2625$  [1 mark]  $37 \times 25 = 925$  [1 mark]  
 $(2625 + 925) / 100$  [1 mark]  
Relative atomic mass of chlorine = 35.5 [1 mark]
- An average of the atomic masses of all the isotopes of an element [1 mark]  
Taking into account the relative abundances/percentages of each isotope [1 mark]

### Electronic structure

- Numbering boxes 1 to 4 from top: 1 – 3 [1 mark], 2 – 2 [1 mark], 3 – 4 [1 mark], 4 – 1 [1 mark]
- Answers in order: nucleus, energy, two, eight. [4 marks]
- 2 electrons on innermost energy level [1 mark]
  - 8 electrons on second energy level [1 mark]





## Answers

- b** It has one more proton than electrons/it has 11 protons and 10 electrons [1 mark]  
Protons have a positive charge and electrons have a negative charge [1 mark]

### Electronic structure and the periodic table

- In order of atomic number. [1 mark]
- They have the same number of electrons on their outer shell. [1 mark]
- a** **i** W [1 mark] **ii** Z [1 mark]  
**iii** Z [1 mark] **iv** X [1 mark]  
**b** X and Y [1 mark]

### Development of the periodic table

- atomic weight [1 mark], groups [1 mark]
- It is a metal. [1 mark]  
It has a melting point of less than 660 °C (accept an estimation if more than 660 °C). [1 mark]  
It has a density of more than 2.70 g/cm<sup>3</sup> (accept an estimation if more than 2.70 g/cm<sup>3</sup>). [1 mark]  
It will react with chlorine to form a compound that has the formula XCl<sub>3</sub>. [1 mark]

### Comparing metals and non-metals

- Area to the right of the zig-zag is shaded. [1 mark]
- a** sodium + chlorine → sodium chloride [1 mark]  
**b** Sodium – Metal [1 mark], Sodium chloride – Non-metal [1 mark], Chlorine – Non-metal [1 mark]
- a** B, C [2 marks] **b** B [1 mark]  
**c** Electrical conductor, high melting/boiling point [2 marks]

### Elements in group 0

- They exist as single atoms. [1 mark] They have a full outer shell of electrons. [1 mark]
- a**  $1.78 \times 10 = 17.8 = 18$  (g) (to 2 s.f.) [2 marks]  
**b** All points plotted correctly [2 marks]. Award 1 mark if one point plotted incorrectly. Line of best fit drawn [1 mark]
- They have a full outer shell of electrons. [1 mark]  
So do not have to lose or gain any electrons (to gain a full outer shell). [1 mark] So do not react/form molecules with other elements. [1 mark]

### Elements in group 1

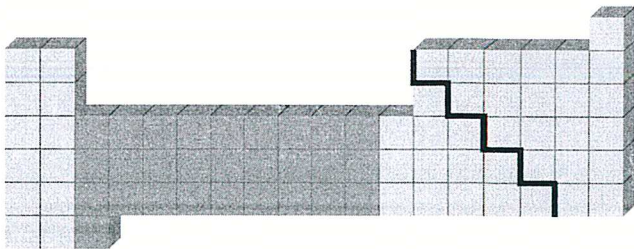
- The alkali metals [1 mark]
- a** oxygen [1 mark]  
**b** lithium hydroxide, hydrogen [2 marks]  
**c** One from safety glasses, tweezers, safety screen (or other sensible suggestion) [1 mark]

- The sodium will go dull more quickly than lithium because it is more reactive. [1 mark]
- Any 4 from:  
Both form hydrogen.  
Both form a hydroxide/alkali solution/the pH of the water will increase.  
Both will move around the surface of the water.  
Both will melt in the water.  
The sodium forms sodium hydroxide, the lithium forms lithium hydroxide.  
The sodium may give out a flame, the lithium will not.  
The sodium will react more quickly than the lithium. [4 marks]

### Elements in group 7

- Bromine exists as pairs of atoms. [1 mark]
- a** fluorine/chlorine [1 mark]  
**b** The boiling point increases. [1 mark]
- When a group 7 element reacts with a metal it gains an electron. [1 mark] To form a stable arrangement/to fill its outer shell of electrons/to get 8 electrons on its outer shell. [1 mark] The electron is attracted to the positive nucleus. [1 mark] As you go down the group the atom gets larger. [1 mark] The outer shell is further from the nucleus/nucleus is shielded by more electron shells. [1 mark] The larger the atom, the weaker the force of attraction from the nucleus on the electron. [1 mark]

### Properties of the transition metals

-   
[1 mark]
- Copper (Cu) [1 mark], Manganese (Mn) [1 mark]
- They increase the rate of chemical reactions. [1 mark]
- PbCl<sub>2</sub> [1 mark]
- No gas/bubbles/reaction [1 mark] because copper does not react with water/reacts very slowly with water. [1 mark]

## Section 2: Bonding, structure, and the properties of matter

### The three states of matter

- $\text{CuO (s)} + \text{H}_2\text{SO}_4\text{ (aq)} \rightarrow \text{CuSO}_4\text{ (aq)} + \text{H}_2\text{O (l)}$  [1 mark]