Title – C1 – Atomic structure

Monday, 25 September 2023

1. What is potable water?

Water that is safe to drink.

2. What are the 3 ways that water can be sterilised?

UV light, chlorine, ozone

3. State three of earth's resources that are finite.

Coal, oil, gas, metals

4. Why is desalination the least favourable method of obtaining potable water?

It requires a large amount of energy which is expensive.

5. Describe a method for measuring mass of dissolved solids in a water sample.

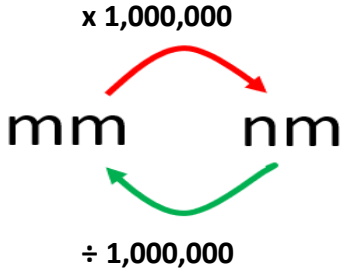
Weigh an empty evaporating basin. Add 50cm^3 of water to the evaporating dish. Heat the water sample (using a Bunsen burner, a gauze and a tripod) until all water is evaporated. Re-weigh the empty dish. The change in mass is the mass of dissolved solids in the sample.

Maths challenge!

Convert 0.1 nanometres into millimetres.

0.1 nm = 0.1 / 1,000,000 mm

= 0.0000001 or 1x10^{-7} mm



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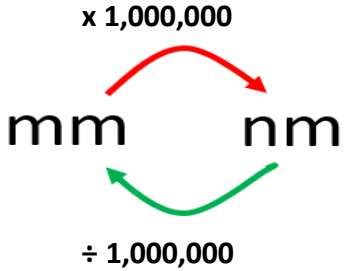
1. What is potable water?	3. State three of earth's resources that are finite.	5. Describe a method for measuring mass of dissolved solids in a water sample.
2. What are the 3 ways that water can be sterilised?	4. Why is desalination the least favourable method of obtaining potable water?	

Maths challenge!

The diameter of an atom ranges from about 0.1 to 0.5 **nanometres.**

Convert 0.1 nanometres into millimetres.



C1 - Atomic structure and the periodic table

C1 - Atomic structure and the periodic table

- Elements and compounds
  - Atoms and formulae
  - Purification
  - Model of the atom
  - Subatomic particles
- The periodic table
  - Development of the periodic table
  - Metals and non-metals
  - Group 0
  - Group 1
  - Group 7
  - Reaction trends
  - Transition metals

C2 - Bonding, structure, and the properties of matter

C3 - Quantitative chemistry

C4 - Chemical changes

C5 - Energy changes

C6 - The rate and extent of chemical change

C7 - Organic chemistry

C8 - Chemical analysis

C9 - Chemistry of the atmosphere

C10 - Using resources

TRIPLE **HIGHER**

Elements are made of only one type of atom. Each element has its own **symbol.**
e.g. Na is sodium.

Compounds contain more than one type of atom that are chemically bonded.
e.g. water, carbon dioxide

Mixtures contain more than one type of atom that are **NOT** chemically bonded.
e.g. air, milk

Naming a compound with **two elements:**
- The metal name does not change
- The non-metal's name ends in **ide**

For example:
Na_2S = sodium sulf**ide**
K_2O = potassium ox**ide**

Naming a compound **two elements and oxygen:**
- The metal name does not change
- The non-metal's name ends in **ate**

For example:
Na_2CO_3 = sodium carbon**ate**
KNO_3 = potassium nitr**ate**

Mixtures can be separated by **physical processes** including:

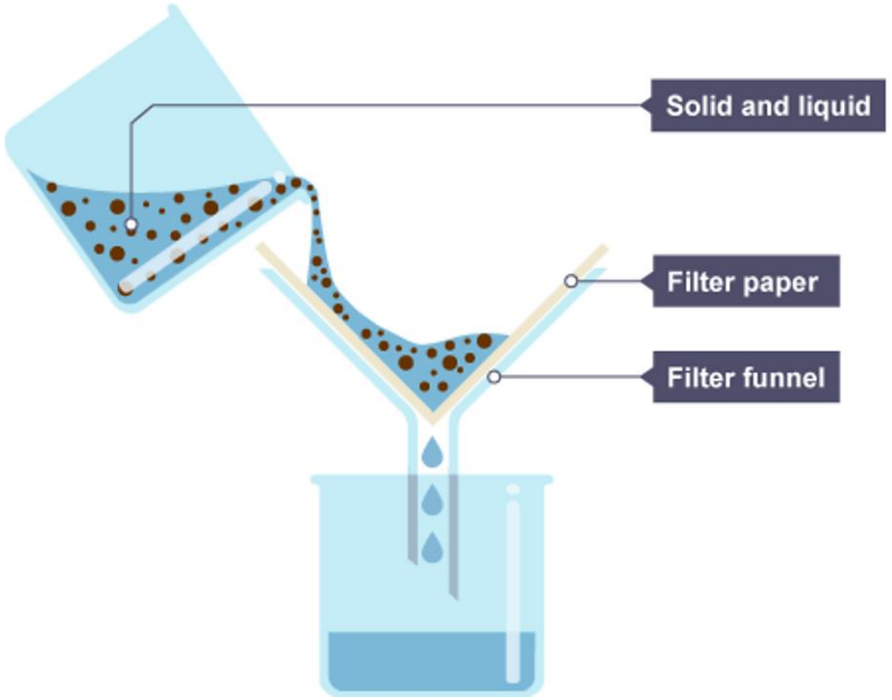
1. Filtration
2. Crystallisation
3. Simple distillation
4. Fractional distillation
5. Chromatography

These physical processes do not involve chemical reactions and no new substances are made.

Filtration

This technique separates an in**soluble** substance from a **solvent**

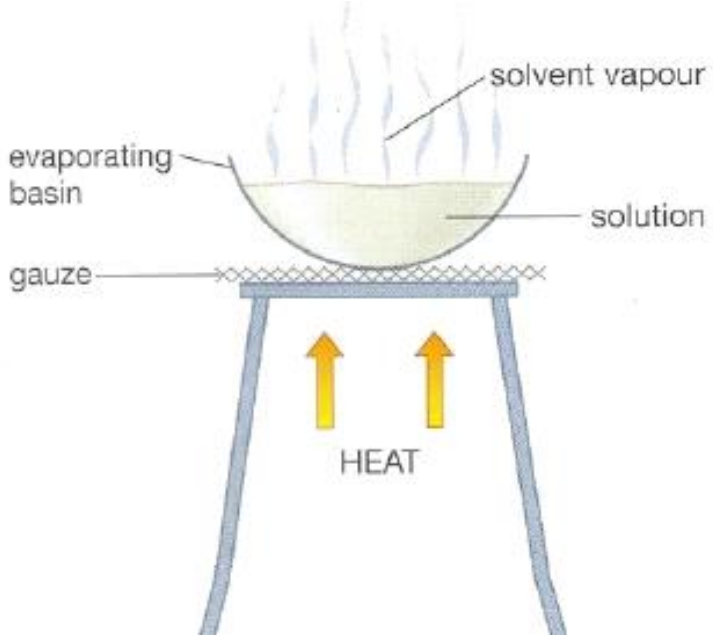
Example – sand from water



Crystallisation

This technique separates a **soluble** substance from a **solvent** by evaporation

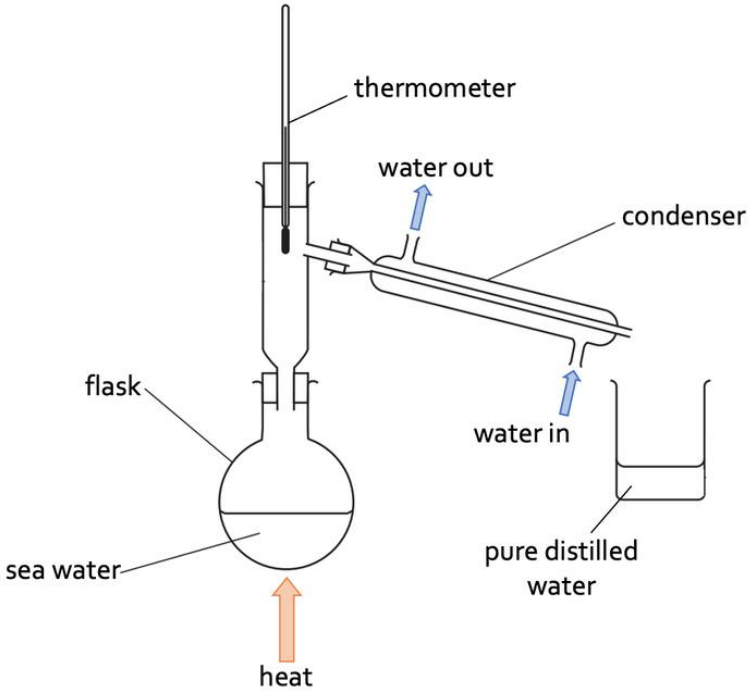
Example - crystallisation of salt from salt water



Distillation

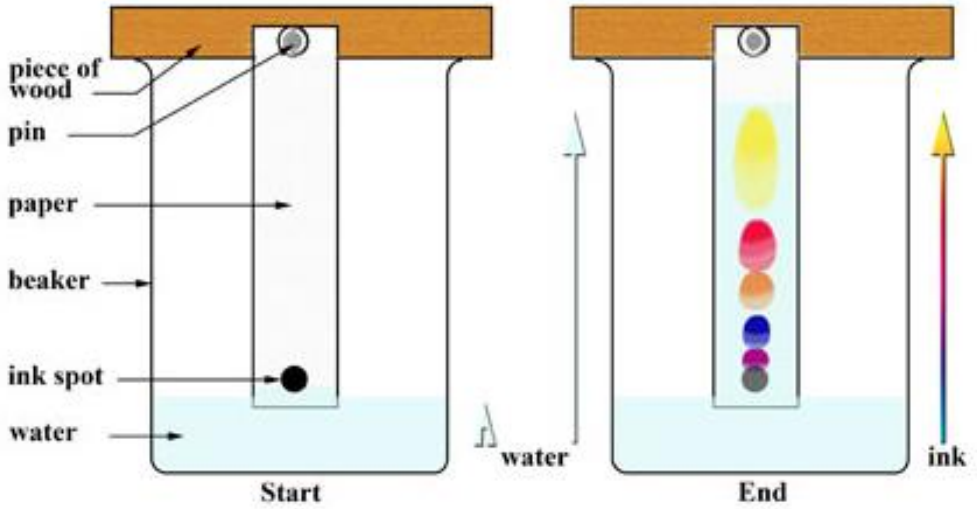
This technique separates a liquid from a mixture by **evaporation** follow by **condensation**

Example - obtaining pure water from sea water



Chromatography

This technique separates small amounts of dissolved substances by running a solvent along absorbent paper

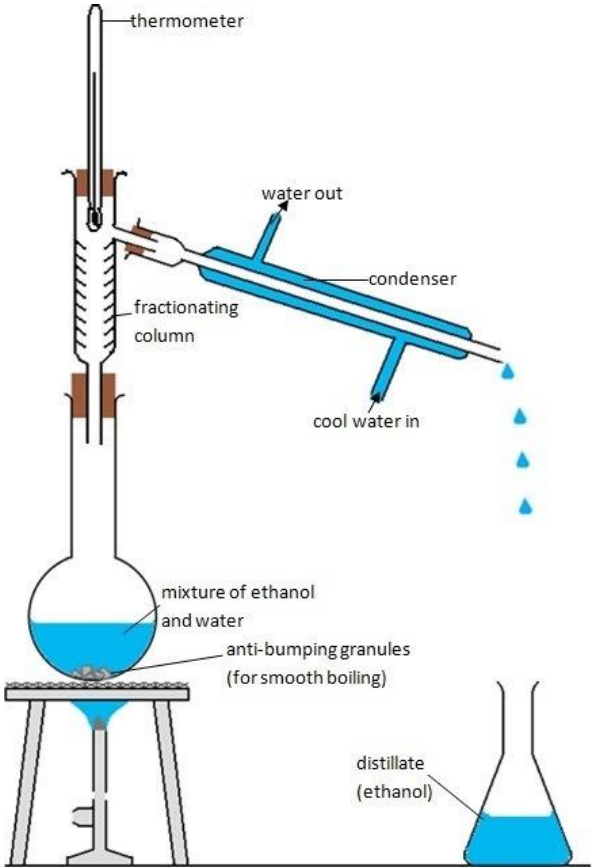


Example - separating the different colours in ink

Fractional distillation

This technique separates a mixture into a number of different parts, called **fractions**. Substances with **high** boiling points **condense at the bottom** and substances with **low** boiling points **condense at the top**.

Example - separating hydrocarbons in crude oil



Q1. Rock salt is a mixture of sand and salt.

Salt dissolves in water. Sand does **not** dissolve in water. Some students separated rock salt.

This is the method used.

Exam practice

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

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

_____

_____

(1)

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

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

_____

_____

(1)

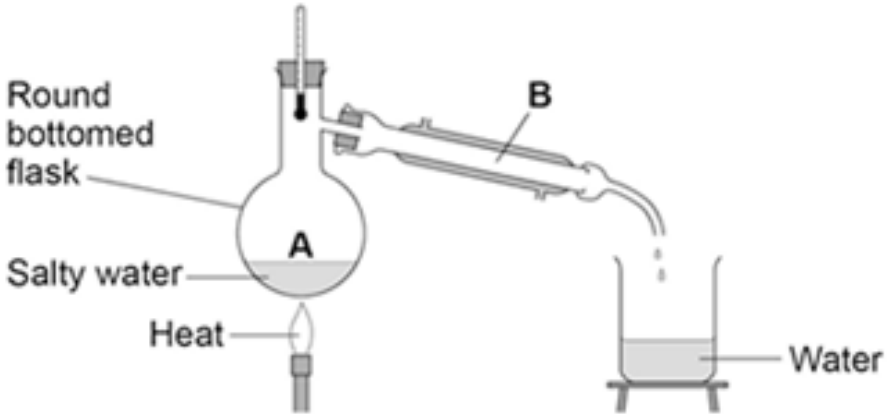
(c) Suggest **one** safety precaution the students should take in step 5.

_____

_____

(1)

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



Exam practice

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

_____

_____

_____

_____

(2)

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

_____ °C

(1)

Q1.

Self assessment

(a) any **one** from:

- heat
- stir

1

(b) filter

accept use a centrifuge

accept leave longer (to settle)

1

(c) any **one** from:

- wear safety spectacles
- wear an apron

1

(d) evaporation at **A**

1

condensation at **B**

1

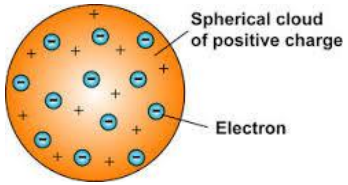
(e) 100

1

Development of the atomic model – same as physics!

1800s

- **John Dalton** – tiny spheres that could not be divided.

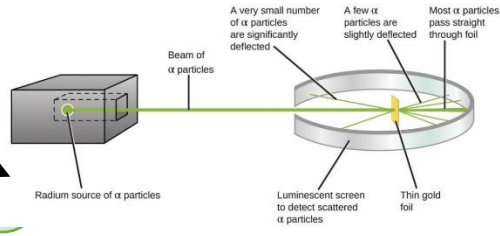


1890s

- **JJ Thomson** – **discovered electrons** and came up with the **plum pudding model** - spheres of positive charge with negative charges spread evenly though.

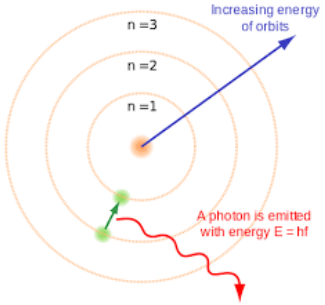
1908 -1913

- **E. Rutherford** – **gold foil experiment,** suggested that the atom was **mostly empty space** and had a **concentration mass in the centre** (nucleus).



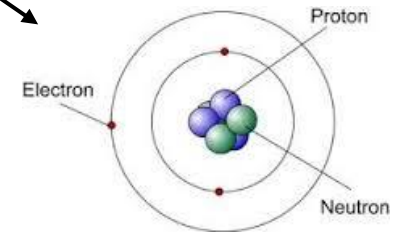
1914

- **Niels Bohr** – electrons orbit nucleus at **specific distances in fixed energy levels** (shells).

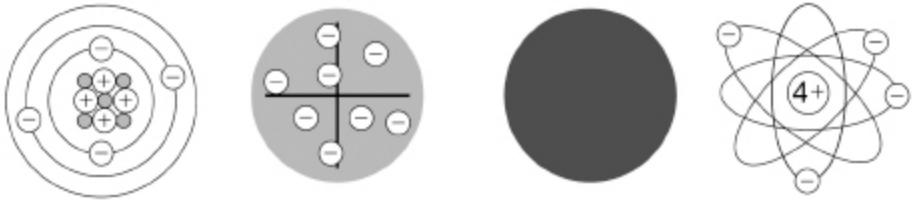


1932

- **James Chadwick** – provided evidence for the existence of **neutrons** within the nucleus.



Exam practice - FOUNDATION



A B C D

(b) Which model represents the plum pudding model? Tick (✓) **one** box.

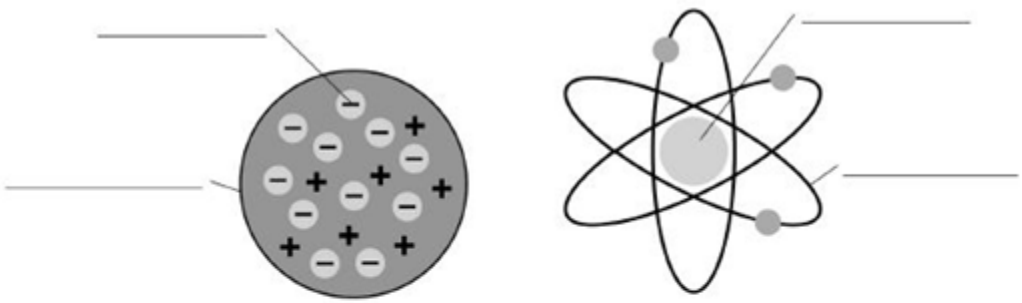
A ☐ B ☐ C ☐ D ☐

(1)

(c) Which model resulted from Chadwick's experimental work? Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐

(1)



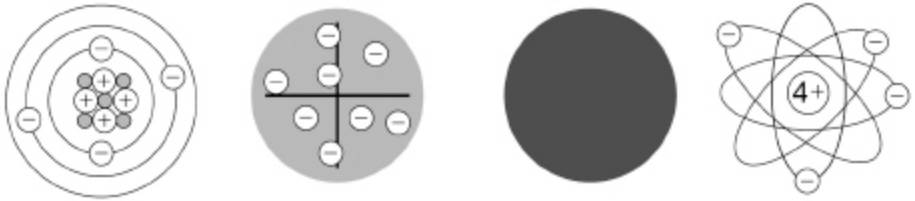
Plum pudding model Nuclear model

(a) Write the labels on **Figure 1.** Choose the answers from the box.

atom	**electron**	**nucleus**
neutron	**orbit**	**proton**

(4)

Exam practice - FOUNDATION



A B C D

(b) Which model represents the plum pudding model? Tick (✓) **one** box.

A ☐ B ☒ X C ☐ D ☐

(1)

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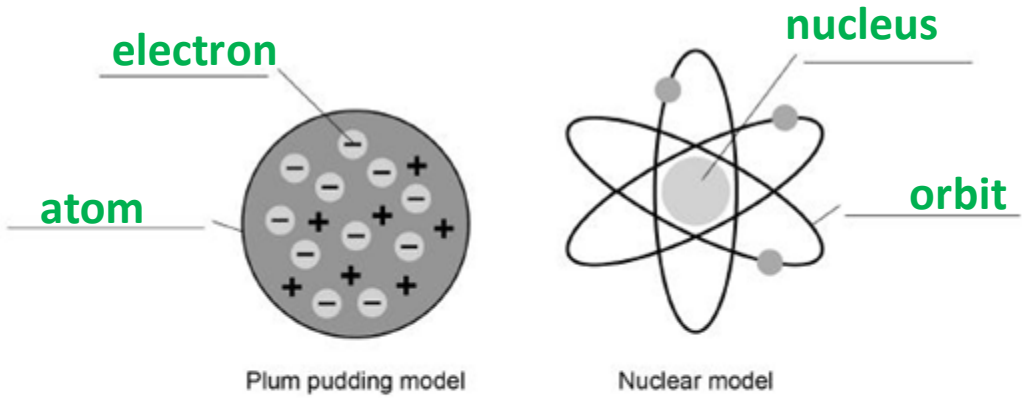
(1)



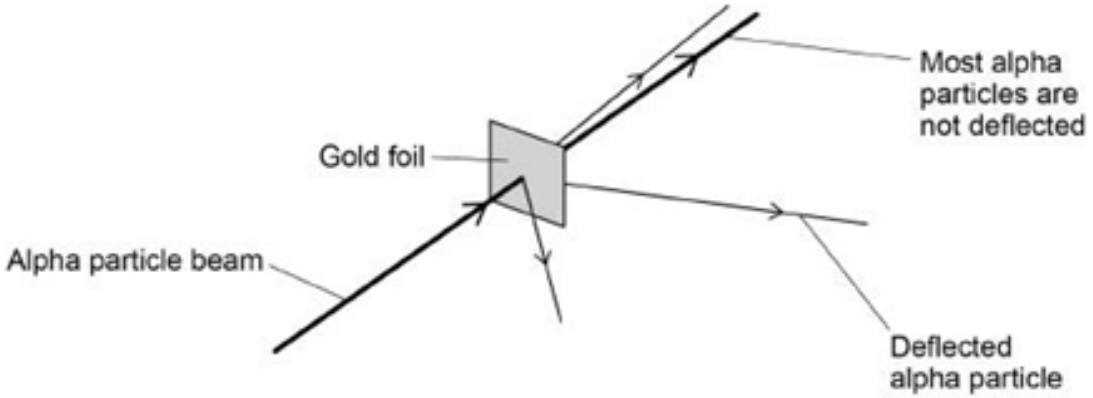
(a) Write the labels on **Figure 1.** Choose the answers from the box.

atom	**electron**	**nucleus**
neutron	**orbit**	**proton**

(4)

In the alpha particle scattering experiment alpha particles are fired at gold foil. Alpha particles are positively charged. The diagram below shows the results.

Exam practice – FOUNDATION/HT



(a) Some alpha particles are deflected. Complete the sentence. Choose the answer from the box.

negatively charged	**not charged**	**positively charged**

Some alpha particles are deflected because the nucleus of the

atom is _____.

(1)

(b) Why are most alpha particles **not** deflected? Tick (✓) **one** box.

The atom is a tiny sphere that cannot be divided. ☐

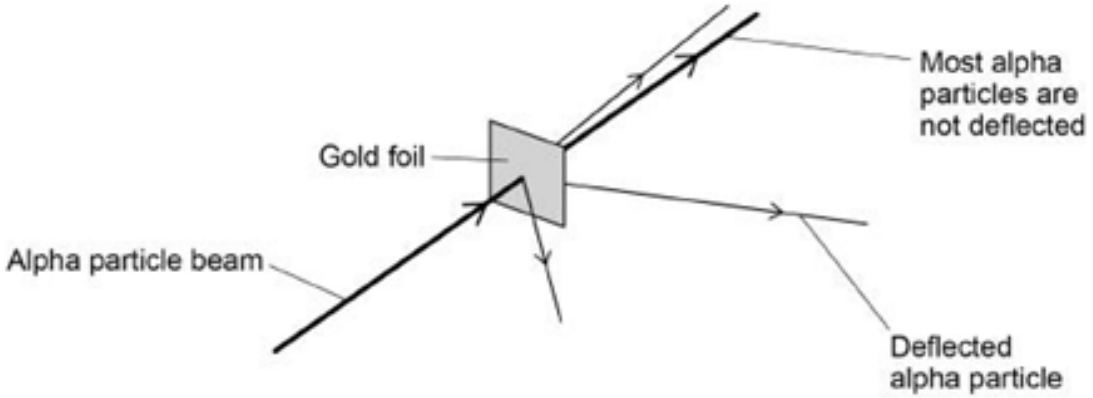
The atom is mainly empty space. ☐

The electrons orbit the nucleus at specific distances. ☐

(1)

In the alpha particle scattering experiment alpha particles are fired at gold foil. Alpha particles are positively charged. The diagram below shows the results.

Exam practice – FOUNDATION/HT



(a) Some alpha particles are deflected. Complete the sentence. Choose the answer from the box.

negatively charged	not charged	positively charged

Some alpha particles are deflected because the nucleus of the atom is positively charged.

(1)

(b) Why are most alpha particles **not** deflected? Tick (✓) **one** box.

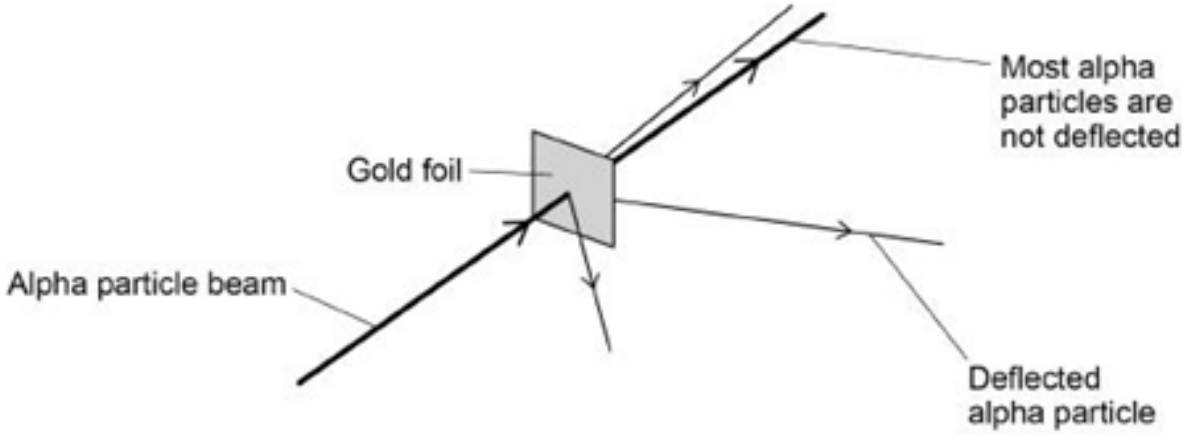
- The atom is a tiny sphere that cannot be divided. ☐
- The atom is mainly empty space. X
- The electrons orbit the nucleus at specific distances. ☐

(1)

Exam practice – HT

(a) In the alpha particle scattering experiment alpha particles are fired at gold foil.

Alpha particles are positively charged. The diagram below shows the results.



What **two** conclusions can be made from the results? Tick (✓) **two** boxes.

Atoms are balls of positive charge with embedded electrons. ☐

Atoms are tiny spheres that cannot be divided. ☐

Atoms have a positively charged nucleus. ☐

Mass is concentrated in the nucleus in the centre of atoms. ☐

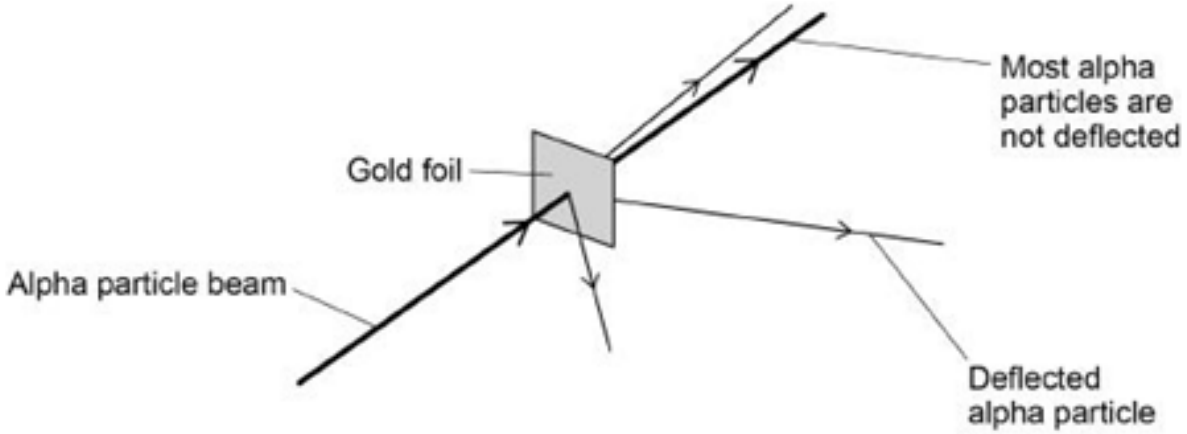
Neutrons exist within the nucleus. ☐

(2)

Exam practice – HT

(a) In the alpha particle scattering experiment alpha particles are fired at gold foil.

Alpha particles are positively charged. The diagram below shows the results.



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Atoms are balls of positive charge with embedded electrons.	
Atoms are tiny spheres that cannot be divided.	
Atoms have a positively charged nucleus.	X
Mass is concentrated in the nucleus in the centre of atoms.	X
Neutrons exist within the nucleus.	

(2)

Exam practice – TRIPLE

(a) Complete the table to show when each subatomic particle was discovered.

Date of discovery	Subatomic particle
1897	electron
1920	proton
1932	neutron

(2)

(b) A beam of electrons, neutrons and protons travelling at the same speed is passed through two oppositely charged plates.

The diagram shows the directions of three particles after passing through the charged plates.

A = electron has less mass so is deflected more or electron deflected towards positive because it is negatively charged

B = neutron because the neutron's path does not change as not charged

C = proton and proton has greater mass (accept heavier) so is deflected less (than electron) or proton is deflected towards negative because it is positively charged

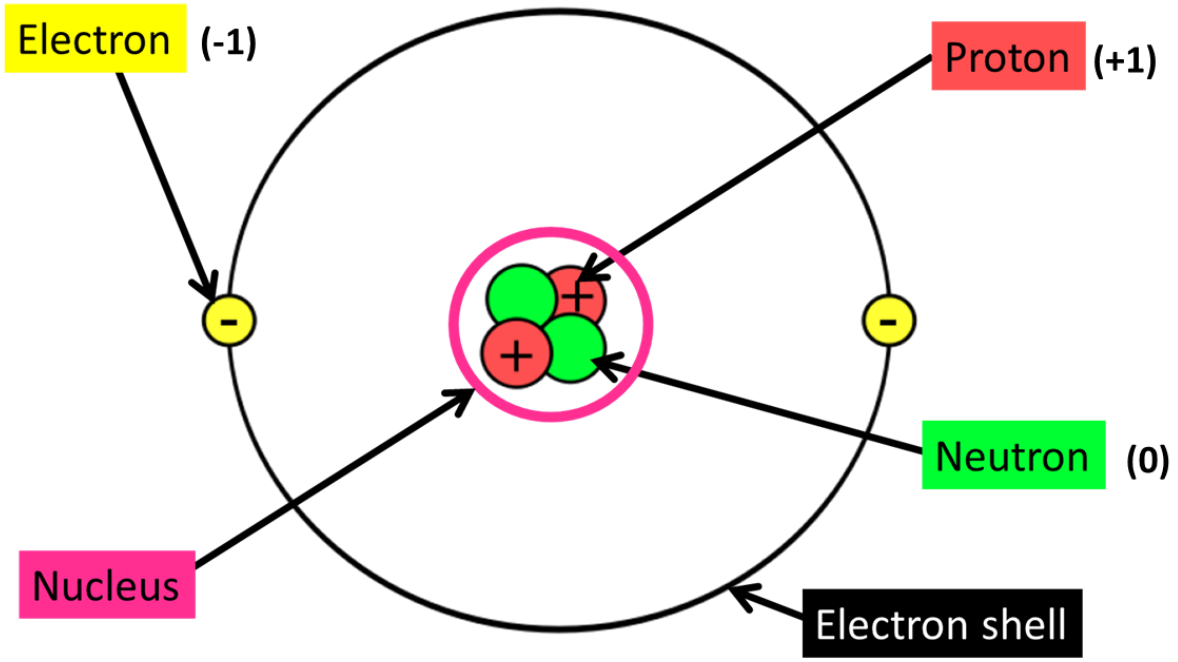
this is because the lower plate is negative or upper plate is positive

(4)

An atom is made of a nucleus (containing protons and neutrons) that is surrounded by electrons in shells.

Radius of an atoms = **0.1nm** (1 x 10^{-10} m)

Radius of the nucleus = **10,000x smaller** than the atom (1 x 10^{-14} m)

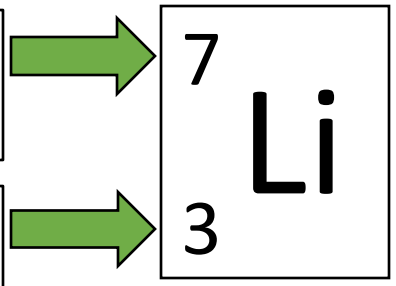


	Mass	Charge	Location
Proton	1	+	nucleus
Neutron	1	0	nucleus
Electron	Very small	-	shells

Subatomic particles

Biggest number = **Mass number** *(number of protons + neutrons)*

Smallest number = **Atomic/proton number** *(number of protons)*



A lithium atom has:

3 protons
3 electrons
4 neutrons (7-3)

All atoms of an element have the same number of protons.
If an atom gains or loses ELECTRONS, IONS ARE FORMED.
If an atom gains or loses NEUTRONS, ISOTOPES ARE FORMED.

Using a periodic table, you must be able to calculate the number of protons, neutrons and electrons in any given atom:

Number of **protons** = atomic number
Number of **electrons** = atomic number

In an atom, the number of protons and electrons is equal. This is why atoms have no overall charge.

Number of **neutrons** = mass number – atomic number

LO: Calculate the number of protons, neutrons and electrons in any given atom.

Task: Using the rules on the last slide, calculate the number of protons, neutrons and electrons in each of the atoms below.

4	11	16	200	238
He	**B**	**O**	**Hg**	**U**
2	5	8	80	92

Challenge – *How many electrons would a lithium* ***ion*** *have?*

LO: Calculate the number of protons, neutrons and electrons in any given atom.

Task: Using the rules on the last slide, calculate the number of protons, neutrons and electrons in each of the atoms below.

4	11	16	200	238
He	**B**	**O**	**Hg**	**U**
2	5	8	80	92

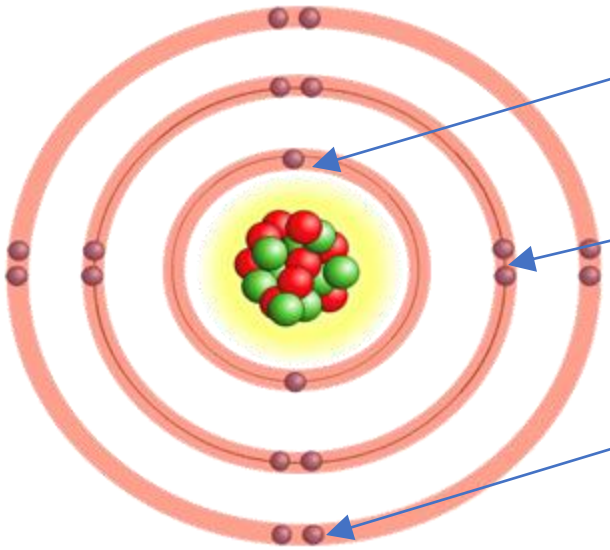
Helium	Boron	Oxygen	Mercury	Uranium
P = 2	P = 5	P = 8	P = 80	P = 92
E = 2	E = 5	E = 8	E = 80	E = 92
N = 2	N = 6	N = 8	N = 120	N = 146

Challenge – *How many electrons would a lithium* ***ion*** *have?*

Electronic configuration

The electrons in an atom are found in **energy levels** (shells) orbiting the nucleus.

The electronic structure of an atom describes how these electrons are arranged in each shell and can be represented by numbers or by a diagram.



1st shell holds a maximum of **2 electrons**

2nd shell holds a maximum of **8 electrons**

3rd shell holds a maximum of **8 electrons**

Electronic configuration

Step 1: Calculate how many electrons are in the atom using the periodic table.

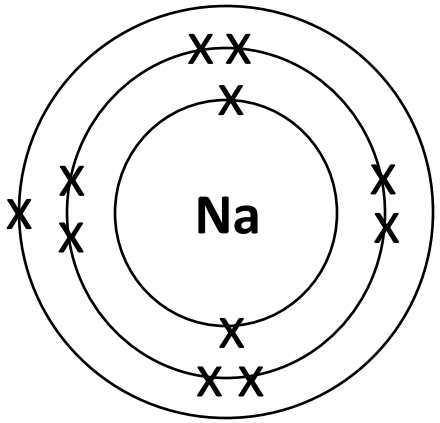
23
Na
11

p = 11
e = 11
n = 23-11
= 12

Step 2: Write the chemical symbol in the middle of your diagram.

Step 3: Fill the energy shells with electrons using a cross to show each electron.

Sodium has 2 electrons in the first shell…
8 electrons in the second shell…
1 electron in the third shell
= 11 electrons in total!



The electronic configuration of sodium can also be written like this: ***2, 8, 1***

Task 1: Draw the electronic configurations of the atoms below.
Task 2: Write the electronic configurations of the atoms below.

11	12	14	16	19
B	C	N	O	F
5	6	7	8	9

Challenge – *What do you notice about the number of electrons in the outer shell as you go across the periodic table? How does this relate to the group that the atom is in?*

Task 1: Draw the electronic configurations of the atoms below.

Task 2: Write the electronic configurations of the atoms below.

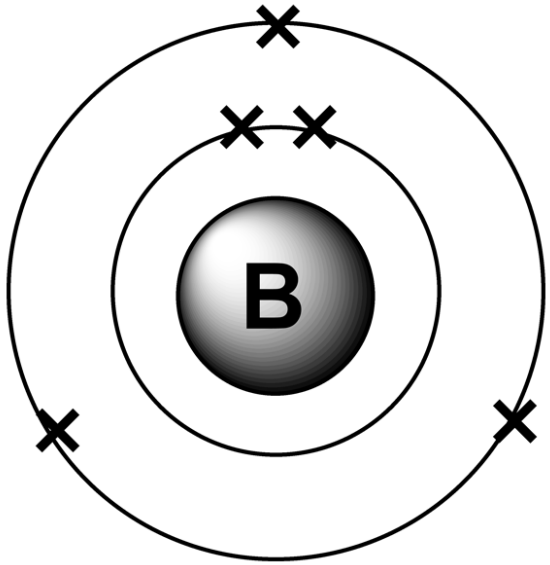
11	12	14	16	19
B	C	N	O	F
5	6	7	8	9

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36

Key: relative atomic mass / atomic symbol / name / atomic (proton) number

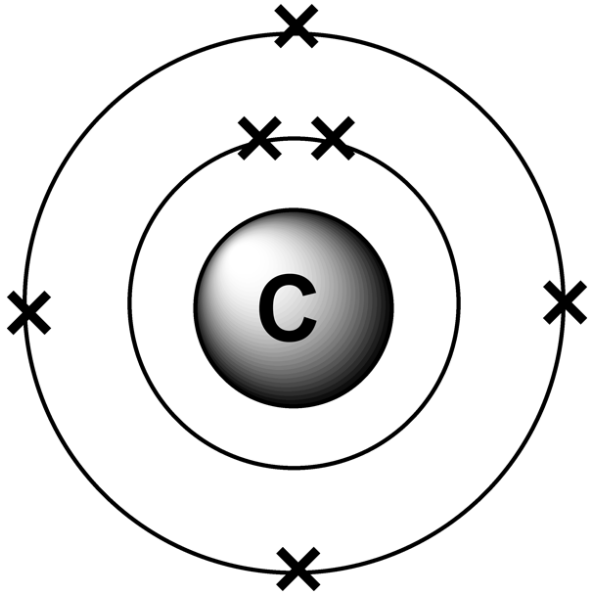
Challenge – *What do you notice about the number of electrons in the outer shell as you go across the periodic table? How does this relate to the group that the atom is in?*

11
B
5



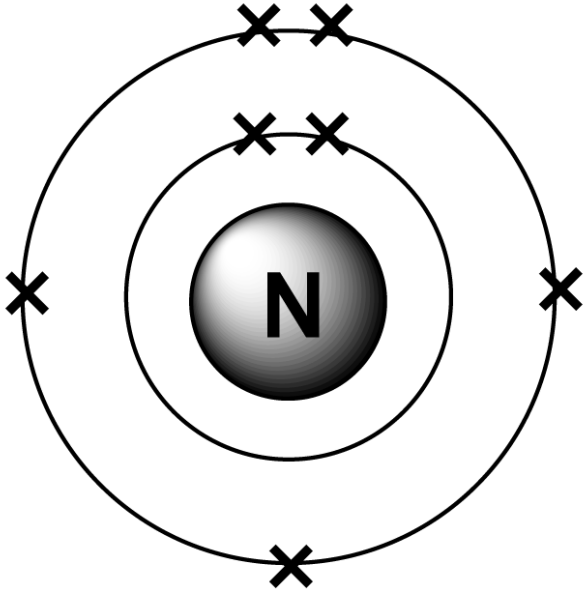
2, 3

12
C
6



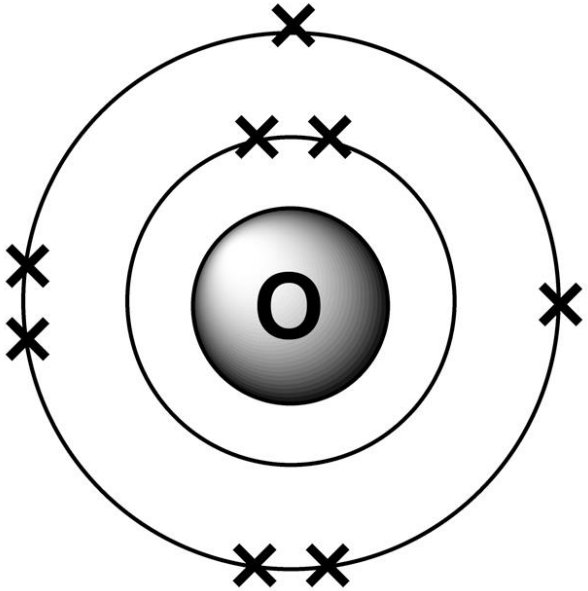
2, 4

14
N
7



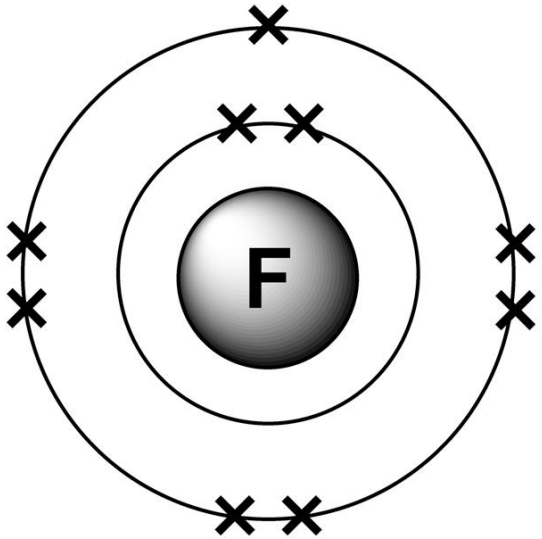
2, 5

16
O
8



2, 6

19
F
9



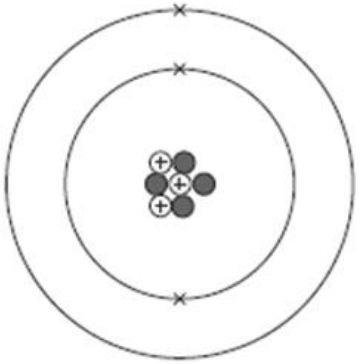
2, 7

Challenge – *What do you notice about the number of electrons in the outer shell as you go across the periodic table? How does this relate to the group that the atom is in?*

As you go across the periodic table, the number of electrons in the outer shell increases by one. The number of electrons in the outer shell is the same as the group number that the atom is in. For example, fluorine's electronic configuration shows that it is in group 7.

Exam practice - foundation

The figure below represents the structure of a lithium atom.



(a) Name the particle in the atom that has a positive charge.

_____

(1)

(b) Name the particle in the atom that has the smallest mass.

_____

(1)

(c) Complete the sentences.

Choose the answers from the box.

3	4	7	10

The mass number of the lithium atom is _____.

The number of neutrons in the lithium atom is _____.

(2)

(d) Complete these sentences.

(i) The mass number of the aluminium atom is _____.

(ii) In an atom of aluminium there are _____ electrons.

(2)

Exam practice - foundation

Figure 1 represents an atom of sulphur.

Figure 1

$^{32}_{16}S$

(a) Complete the table below.

Particle	**Number of particles in a sulphur atom**
Electron	16
Neutron	
Proton	16

(b) Sulphur is in Group 6 of the periodic table.

Complete the electronic structure of the sulphur atom represented in **Figure 2**

An argon atom can be represented as $^{40}_{18}Ar$

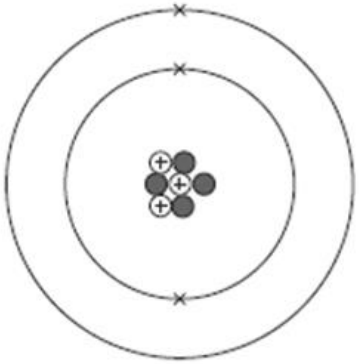
(c) What does the number 40 represent in $^{40}_{18}Ar$?

(d) How many protons does this atom of argon have?

(e) How many neutrons does this atom of argon have?

Self assessment

The figure below represents the structure of a lithium atom.



(a) Name the particle in the atom that has a positive charge.

proton

(1)

(b) Name the particle in the atom that has the smallest mass.

electron

(1)

(c) Complete the sentences.

Choose the answers from the box.

3	4	7	10

The mass number of the lithium atom is 7.

The number of neutrons in the lithium atom is 4.

(2)

(d) Complete these sentences.

(i) The mass number of the aluminium atom is 27

(ii) In an atom of aluminium there are 13 electrons.

(2)

Self assessment

Figure 1 represents an atom of sulphur.

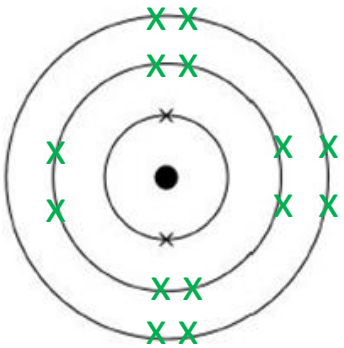
Figure 1

$^{32}_{16}S$

(a) Complete the table below.

Particle	Number of particles in a sulphur atom
Electron	16
Neutron	**16**
Proton	16

Figure 2



(b) Sulphur is in Group 6 of the periodic table.

Complete the electronic structure of the sulphur atom represented in **Figure 2**

An argon atom can be represented as $^{40}_{18}Ar$

Mass number = number of protons and neutrons

(c) What does the number 40 represent in $^{40}_{18}Ar$?

(d) How many protons does this atom of argon have? **18**

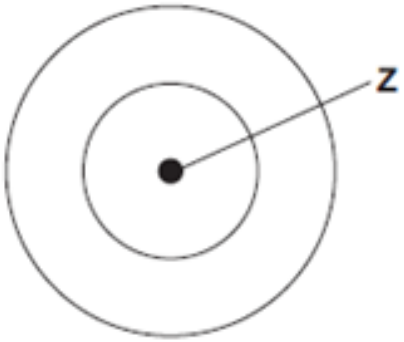
(e) How many neutrons does this atom of argon have? **40 – 18 = 22**

Exam practice – higher/triple

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

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

Figure 1



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

(1)

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

_____

(1)

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

Give the relative charges of these sub-atomic particles.

_____

_____

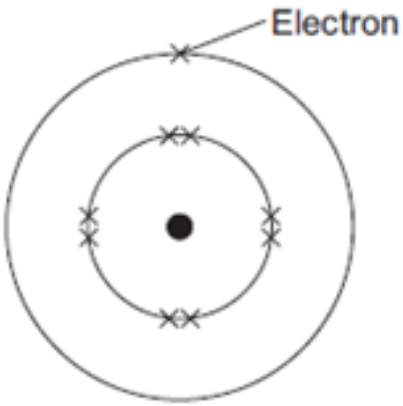
_____

(3)

Exam practice – higher/triple

(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)

Exam practice – higher/triple

(e) Calculate the mass of one atom of sodium. Use the equation:

$$\text{mass of one atom of sodium} = \frac{\text{relative atomic mass}}{\text{Avogadro constant}}$$

Avogadro constant = 6.02×10^{23}. Give your answer to 2 significant figures.

Mass = _____ g

(3)

(f) The radius of a sodium atom is 227 picometres. 1 picometre = 10^{-12} metres (m)

The radius of a nucleus is $\frac{1}{10\,000}$ of that of the atom.

Which calculation shows the radius of a sodium atom's nucleus? Tick **one** box.

- $227 \times 10\,000$ m ☐
- $227 \times \frac{1}{10\,000}$ m ☐
- $227 \times 10^{-12} \times 10\,000$ m ☐
- $227 \times 10^{-12} \times \frac{1}{10\,000}$ m ☐

(1)

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

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

Self assessment

Figure 1

(a) (i) electronic structure 2,3 drawn

allow any representation of electrons, such as, dots, crosses, or numbers (2,3)

1

(ii) nucleus

1

(iii) protons and neutrons

*do **not** allow electrons in nucleus*

1

(relative charge of proton) +1

allow positive

1

(relative charge of neutron) 0

allow no charge/neutral

1

ignore number of particles

(i)

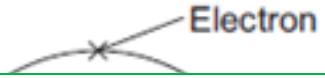
(ii)

(iii)

(3)

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

Figure 2



Self assessment

(b) too many electrons in the first energy level or inner shell

allow inner shell can only have a maximum of 2 electrons

1

too few electrons in the second energy level or outer shell

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

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

1

neon does not have 9 electrons **or** neon has 10 electrons

allow one electron missing

allow fluorine has 9 electrons

1

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

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

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

(e) Calculate the mass of one atom of sodium. Use the equation:

$$\text{mass of one atom of sodium} = \frac{\text{relative atomic mass}}{\text{Avogadro constant}}$$

Self assessment

Avogadro constant = 6.02×10^{23}. Give your answer to 2 significant figures.

$\frac{23}{6.02 \times 10^{23}}$

1

$3.820598... \times 10^{-23}$

1

3.8×10^{-23}

*an answer of 3.8×10^{-23} scores **3** marks*

1

(f) The radius of a sodium atom is 227 picometres. 1 picometre = 10^{-12} metres (m)

The radius of a nucleus is $\frac{1}{10\,000}$ of that of the atom.

Which calculation shows the radius of a sodium atom's nucleus? Tick **one** box.

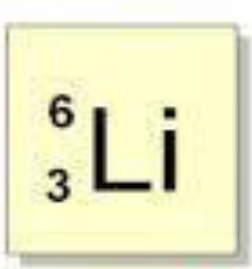
- 227 × 10 000 m ☐
- 227 × $\frac{1}{10\,000}$ m ☐
- 227 × 10^{-12} × 10 000 m ☐
- 227 × 10^{-12} × $\frac{1}{10\,000}$ m ☐

$227 \times 10^{-12} \times \frac{1}{10\,000}$ m

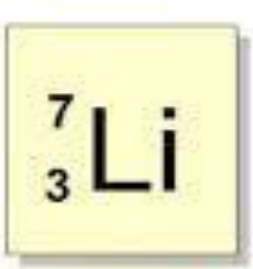
(1)

Isotopes are atoms of an element with the **same number of protons**, but **different numbers of neutrons**.

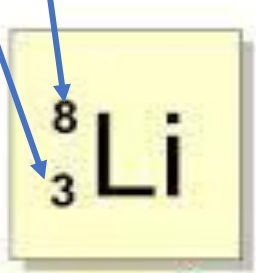
They have the **same proton number**, but **different mass numbers**.



P = 3
E = 3
N = 3



P = 3
E = 3
N = 4

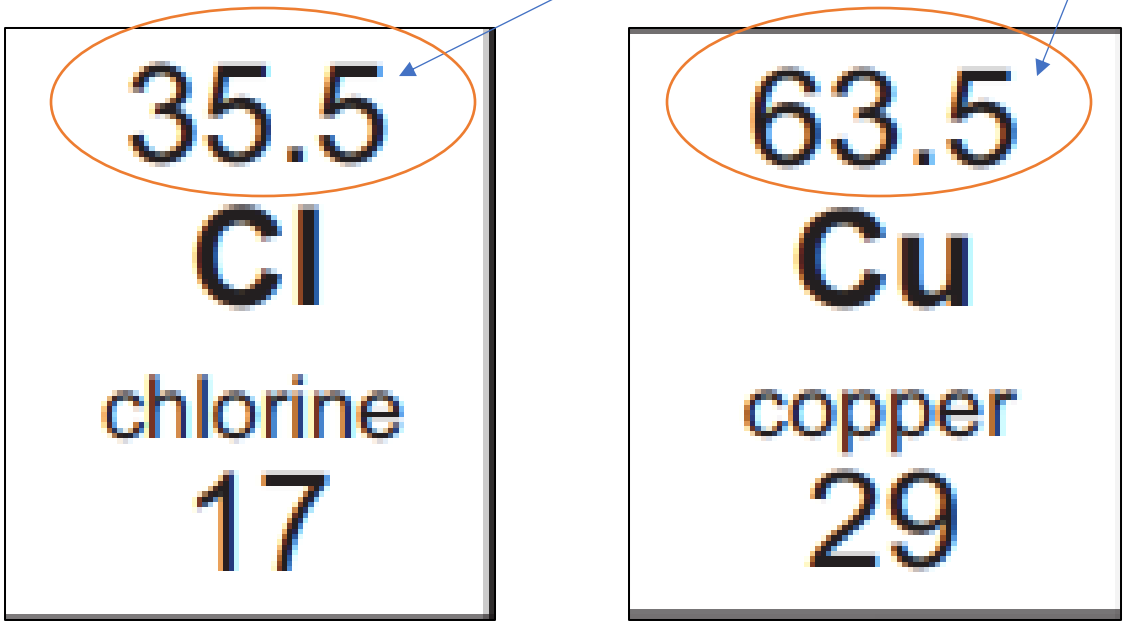


P = 3
E = 3
N = 5

They have the **same chemical properties** (they react in the same way) as they contain the **same number of electrons.**

Task: Calculate the number of protons, neutrons and electrons in each of the lithium isotopes above.

Half a neutron?!



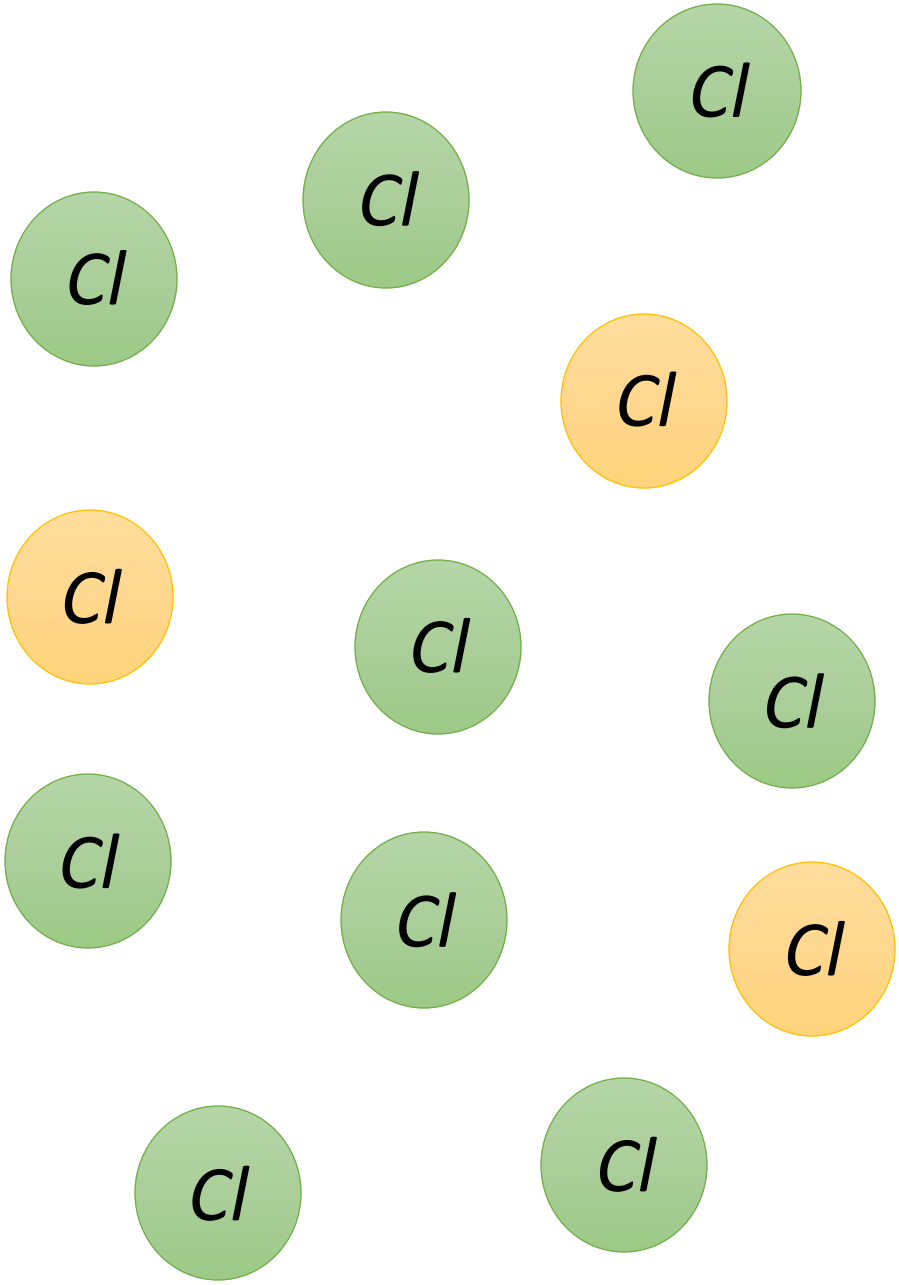
The relative atomic mass of an element is the **average mass** of the different isotopes of an element.

If you took a random sample of chlorine atoms:

75% of them have a mass of 35...

...25% of them have a mass of 37

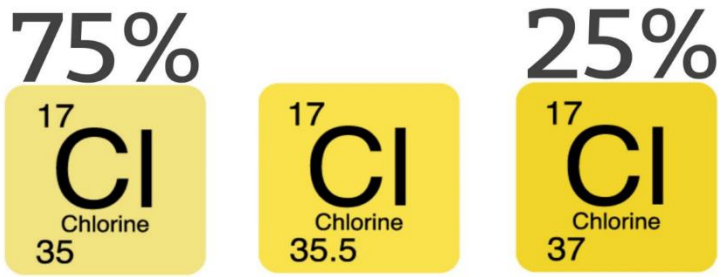
So the **average** mass would be somewhere in between 35 and 37!



The relative atomic mass of an element is the **average mass** of the different isotopes of an element.

There are 2 main isotopes of chlorine; Cl-35 and Cl-37…

75% of all chlorine atoms are ***Cl-35***
25% of all chlorine atoms are ***Cl-37***



We can calculate relative atomic mass using this calculation:

$$A_r = \frac{\begin{pmatrix} mass\ of\ first\ isotope \times \\ \%\ of\ first\ isotope \end{pmatrix} + \begin{pmatrix} mass\ of\ second\ isotope \times \\ \%\ of\ second\ isotope \end{pmatrix}}{100}$$

Worked example 1:

We know that 75% of chlorine has a mass of 35, and the other 25% has a mass of 37. What is the relative abundance of chlorine?

$$A_r = \frac{(35 \times 75) + (37 \times 25)}{100}$$

$$= \frac{2625 + 925}{100}$$

$$= \mathbf{35.5}$$

Worked example 2:

We know that 51% of bromine has a mass of 79, and the other 49% has a mass of 81. What is the relative abundance of bromine?

Worked example 3:

Element X has 2 isotopes: X-27 and X-29. Calculate the relative atomic mass if X-27 has an abundance of 65%, and X-29 has an abundance of 35%.

Worked example 1:

We know that 75% of chlorine has a mass of 35, and the other 25% has a mass of 37. What is the relative abundance of chlorine?

$$A_r = \frac{(35 \times 75) + (37 \times 25)}{100}$$

$$= \frac{2625 + 925}{100}$$

$$= \mathbf{35.5}$$

Worked example 2:

We know that 51% of bromine has a mass of 79, and the other 49% has a mass of 81. What is the relative abundance of bromine?

$$A_r = \frac{(79 \times 51) + (81 \times 49)}{100}$$

$$= \frac{4029 + 3969}{100}$$

$$= \mathbf{80}$$

Worked example 3:

Element X has 2 isotopes: X-27 and X-29. Calculate the relative atomic mass if X-27 has an abundance of 65%, and X-29 has an abundance of 35%.

$$A_r = \frac{(27 \times 65) + (29 \times 35)}{100}$$

$$= \frac{1755 + 1015}{100}$$

$$= \mathbf{27.7}$$

Exam practice - foundation

The figure below shows the atoms of five elements.

$^{6}_{3}R$ $^{7}_{3}S$ $^{23}_{11}T$ $^{39}_{19}U$ $^{85}_{37}V$

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

Complete the sentence.

All of the elements in the figure above are in Group

_____ of the periodic table.

(1)

Which **two** atoms in the figure above are isotopes of the same element?

Explain your answer fully.

(3)

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

_____ and _____ **(2)**

There are two isotopes of the element chlorine:

$^{35}_{17}Cl$ $^{37}_{17}Cl$

Describe, in terms of sub-atomic particles, **one** similarity and **one** difference between atoms of the two isotopes of chlorine. **(2)**

Self assessment

1 / one

allow alkali metals

1

R and S

1

because they have the same number of protons

allow same atomic number, different mass number

1

and a different numbers of neutrons

1

neutron(s)

1

proton(s)

1

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

if candidate chooses to quote numbers, they must be correct

1

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

1

Potassium has different isotopes.

Exam practice - higher

(d) What is meant by 'isotopes'? You should refer to subatomic particles.

_____

_____

_____

_____

(2)

(e) The table below shows the mass numbers and the percentage abundance of two isotopes of potassium.

Mass number	**Percentage abundance**
39	93.1
41	6.9

Calculate the relative atomic mass (A_r) of potassium. Give your answer to 1 decimal place.

_____

_____

_____

_____

Relative atomic mass (1 decimal place) = _____

(3)

Self assessment

(d) (atoms with the) same number of protons

allow atoms with the same atomic number

allow atoms of the same element

ignore the same number of electrons

1

(but with) different numbers of neutrons

ignore (but with) different mass numbers

*do **not** accept (but with) different relative atomic mass*

1

(e) $\dfrac{(39 \times 93.1) + (41 \times 6.9)}{100}$

1

= 39.138

1

= 39.1

1

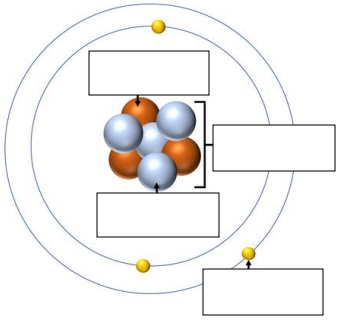
Title – C1 – Periodic table

Monday, 25 September 2023

State the relative charges of the subatomic particles.

Proton +1
Neutron 0
Electron -1

Copy and complete the diagram below:



What are groups in the periodic table? What are periods in the periodic table?

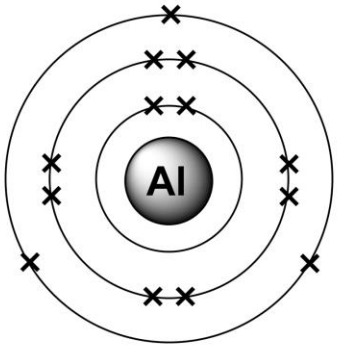
Groups are the vertical columns
Periods are the horizontal rows.

Calculate the number of protons, neutrons and electrons in aluminium.

Protons = 13
Electrons = 13
Neutrons = 27-13

27
Al
aluminium
13

Draw
configura



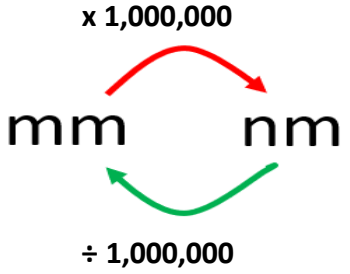
How many of each element are in Na_2SO_4?

2 sodium atoms
1 sulphur atom
4 oxygen atoms

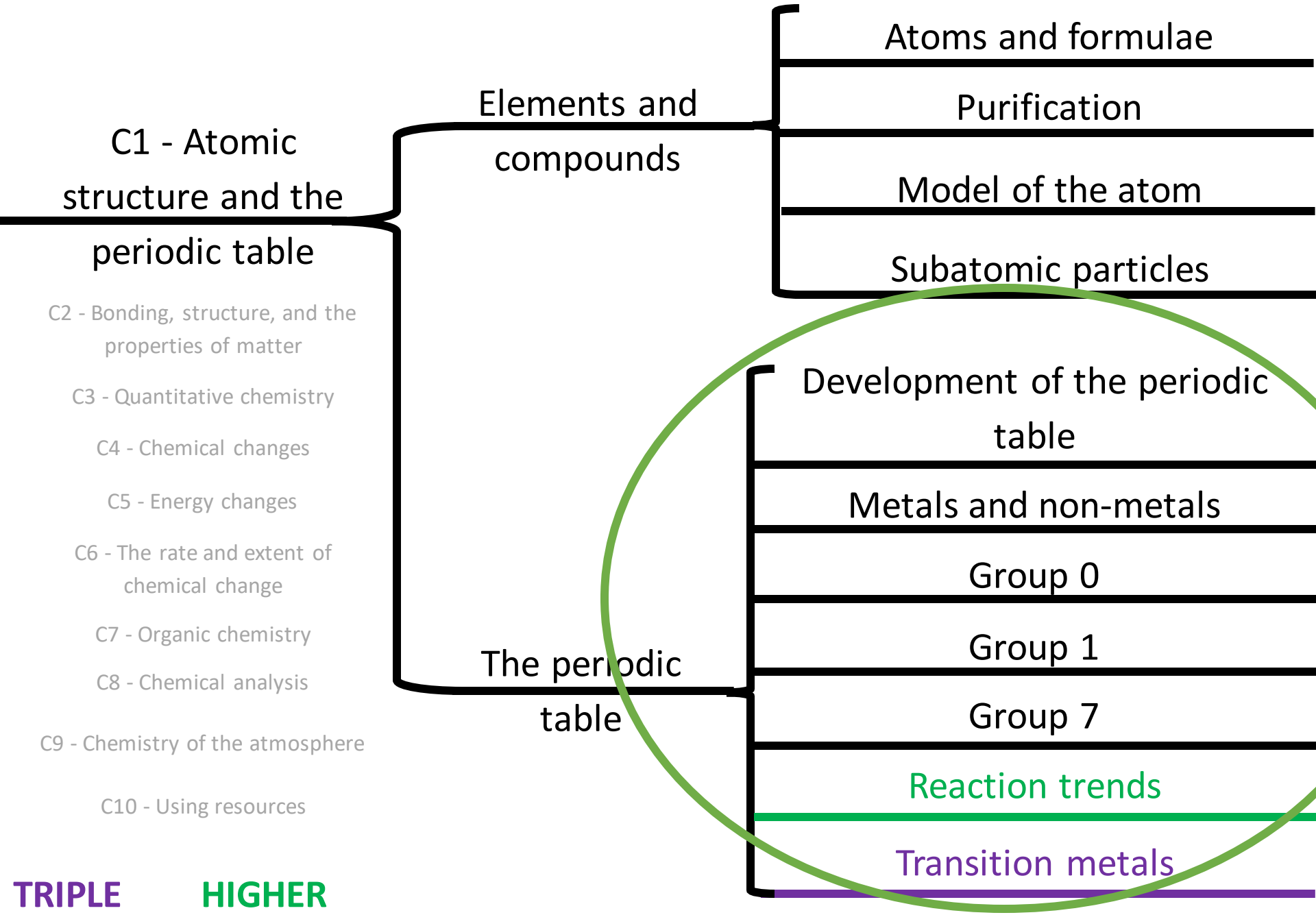
Maths challenge!

Convert 0.1 nanometres into millimetres.

0.1 nm = 0.1 / 1,000,000 mm
= 0.0000001 or $1x10^{-7}$ mm



C1 - Atomic structure and the periodic table



C2 - Bonding, structure, and the properties of matter

C3 - Quantitative chemistry

C4 - Chemical changes

C5 - Energy changes

C6 - The rate and extent of chemical change

C7 - Organic chemistry

C8 - Chemical analysis

C9 - Chemistry of the atmosphere

C10 - Using resources

TRIPLE **HIGHER**

DECODE IT NOW

Word:

Periodic

Define it:

Appearing or occurring at intervals.

Write a sentence of your own that uses the word **periodic.**

Write your own definition of the word **periodic.**

Which subjects or topics will this word be relevant to?

Digging Deeper:

The periodic table is arranged so that elements with similar properties are grouped together. In each group, patterns are repeated at regular intervals (periodically).

Link it (similar words):

Regular, repeating, cycle

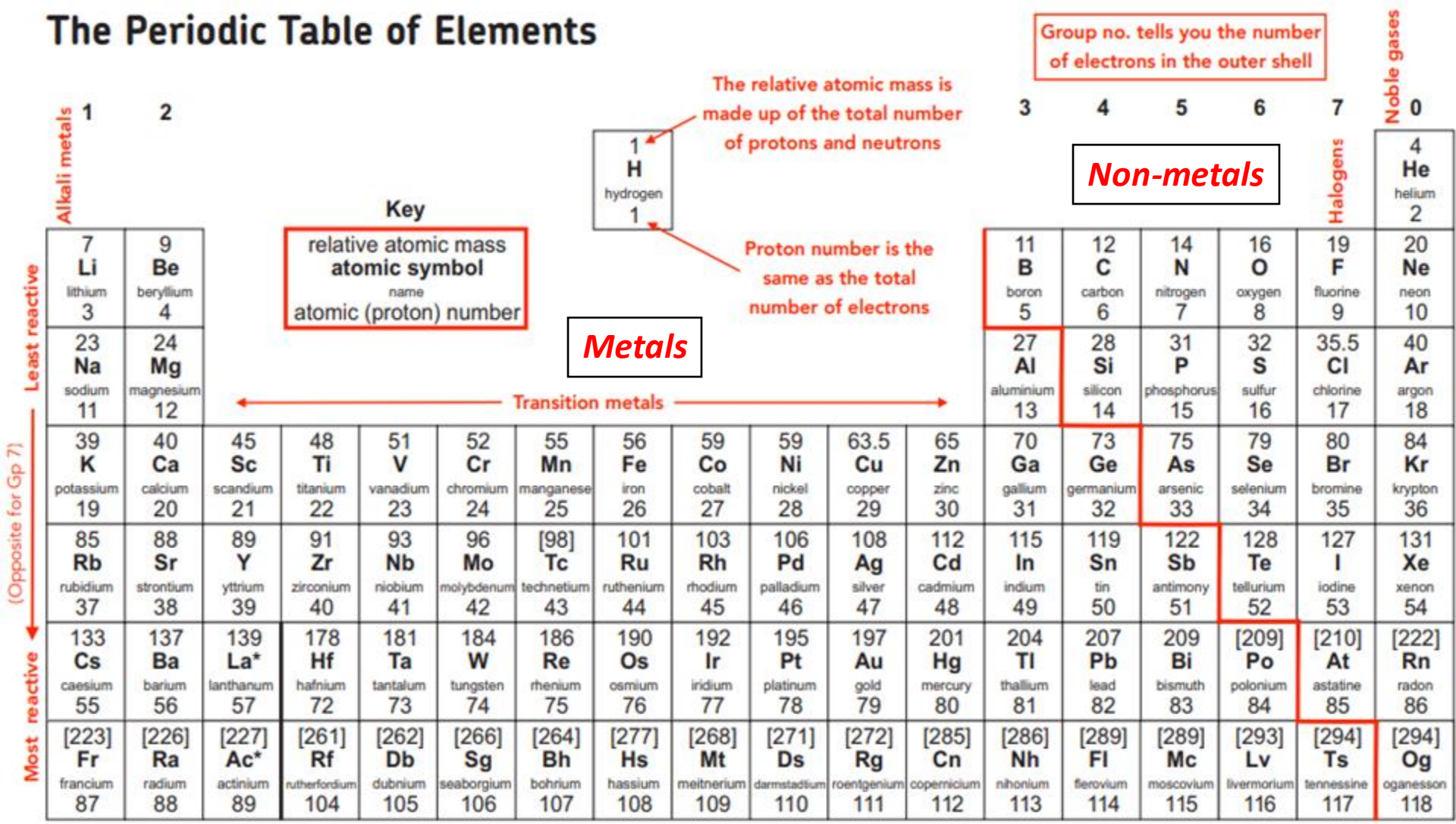
Use it:

She periodically visited her grandfather.

Deconstruct it (Root word):

*From Greek word '**periodos**' which means '**coming round at regular intervals'.***

The Periodic Table of Elements



- Elements are arranged in order of _____ number.
- The group number tells you _____
- Elements in the same group have similar properties because _____

_____

Task: As we go through the findings of each of scientist, add their discoveries to each box on your flow diagram.

Challenge – *Why did Mendeleev's periodic table finally become accepted?*

Development of the periodic table

1829 - **Döbereiner**

lithium, sodium and potassium

calcium, strontium and barium

chlorine, bromine and iodine

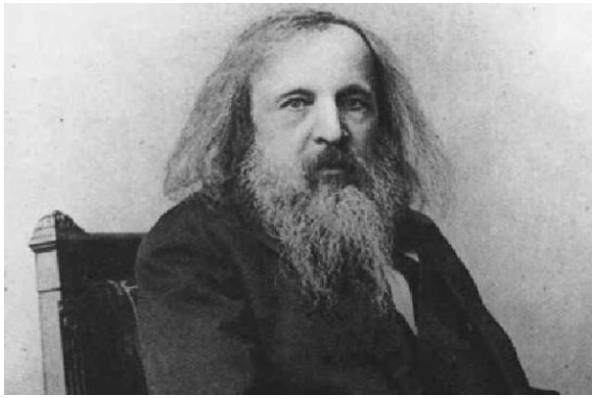
1864 – **John Newlands**

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca				

1869 - **Mendeleev**

Row	Groups							
	I	II	III	IV	V	VI	VII	VIII
1	H	–	–	–	–	–	–	–
2	Li	Be	B	C	N	O	F	–
3	Na	Mg	Al	Si	P	S	Cl	–
4	K	Ca	?	Ti	V	Cr	Mn	Fe, Co Ni, Cu
5	(Cu)	Zn	?	?	As	So	Br	–
6	Rb	Sr	Yt	Zr	Nb	Mo	?	Ru, Rh Pd, Ag

1869 - Mendeleev



He started off by putting the elements in order of **atomic weight… BUT** he noticed that the properties didn't match up!

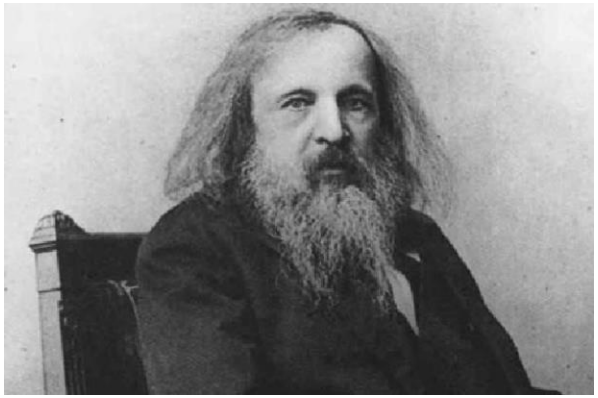
32 **S** sulfur 16	35.5 **Cl** chlorine 17
79 **Se** selenium 34	80 **Br** bromine 35
128 **Te** tellurium 52	127 **I** iodine 53

Initially, iodine and tellurium were the other way around (in order of atomic weight).

Mendeleev noticed that iodine's properties were more similar to those of chlorine and bromine than sulphur and selenium, so he swapped them around!

After the discovery of the proton, the new order fit perfectly with the atomic number of the elements.

1869 - Mendeleev



Mendeleev also left gaps in the periodic table for undiscovered elements.

A Mendeleev Prediction (1871)

	PREDICTED PROPERTIES Ekasilicon (Es)
ATOMIC WEIGHT	72
DENSITY	5.5 g/cm^3
VALENCE	4
MELTING POINT	high
COLOR OF METAL	dark gray
FORM OF OXIDE	EsO_2
DENSITY OF OXIDE	4.7 g/cm^3
FORM OF CHLORIDE	$EsCl_4$
DENSITY OF CHLORIDE	1.9 g/cm^3
B.P. OF CHLORIDE	<100°C

He predicted the properties of these elements, which ended up being correct!

DEVELOPMENT OF THE PERIODIC TABLE

1829 - Döbereiner

*Theory of **triads** – grouped in sets of 3 with similar properties*

lithium, sodium and potassium

calcium, strontium and barium

chlorine, bromine and iodine

1864 – John Newlands

*Theory of **octaves** – put elements in order of **ATOMIC WEIGHT**, noticed there were repeated patterns every 8 elements.*

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca				

1869 - Mendeleev

Realised that elements were in the wrong groups if placed in order of ATOMIC WEIGHT:

- *He **left gaps for undiscovered elements** (which were later discovered)*
- ***Swapped elements round so that they were in groups with similar properties** e.g. iodine and tellurium*

Row	Groups							
	I	II	III	IV	V	VI	VII	VIII
1	H	–	–	–	–	–	–	–
2	Li	Be	B	C	N	O	F	–
3	Na	Mg	Al	Si	P	S	Cl	–
4	K	Ca	?	Ti	V	Cr	Mn	Fe, Co Ni, Cu
5	(Cu)	Zn	?	?	As	So	Br	–
6	Rb	Sr	Yt	Zr	Nb	Mo	?	Ru, Rh Pd, Ag

Exam practice

(a) What property was used to arrange elements in early periodic tables?

Tick (✓) **one** box.

- Atomic number ☐
- Atomic weight ☑
- Mass number ☐

(1)

(b) In early periodic tables, iodine (I) was placed before tellurium (Te).

Mendeleev placed iodine after tellurium.

Figure 1 shows part of Mendeleev's periodic table.

Figure 1

16 **O**	19 **F**
32 **S**	35.5 **Cl**
79 **Se**	80 **Br**
128 **Te**	127 **I**

Suggest **one** reason why Mendeleev placed iodine in the column shown in **Figure 1**.

It had similar properties to bromine, chlorine and fluorine.

(1)

This question is about the periodic table.

In 1864 John Newlands suggested an arrangement of elements.

Figure 1 shows the arrangement Newlands suggested.

Figure 1

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

(a) Give **two** differences between column 1 in **Figure 1** and Group 1 in the modern periodic table.

Use the periodic table to help you.

any two from:

- **hydrogen is in group 1 on Newlands table**
- **fluorine / chlorine / halogens are in group 1 on Newlands table**
- **alkali metals are in group 2 on Newlands table**

(2)

(b) In 1869 Mendeleev produced his periodic table.

Complete the sentence.

Choose the answer from the box.

insoluble	**magnetic**	**undiscovered**	**unreactive**

Mendeleev left gaps in his periodic table for elements that were

undiscovered

(1)

(c) How are the elements ordered in the modern periodic table?

Tick **one** box.

- Atomic mass ☐
- Atomic number ☑
- Melting point ☐
- Reactivity ☐

Exam practice

Exam practice

The diagram below shows part of Mendeleev's periodic table.

16 **O**	19 **F**
32 **S**	35.5 **Cl**
79 **Se**	80 **Br**
128 **Te**	127 **I**

Explain why the early periodic tables placed iodine (I) before tellurium (Te), but then Mendeleev placed tellurium before iodine.

early periodic tables were arranged with elements in order of their atomic weights

1

iodine has a lower atomic weight than tellurium

1

(so) Mendeleev placed iodine with elements with same / similar properties
or
(so) Mendeleev placed tellurium with elements with same / similar properties

1

In 1864 John Newlands suggested an arrangement of elements.

Figure 1 shows the arrangement Newlands suggested.

Figure 1

1	2	3	4	5	6	7
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe

(a) Give **two** differences between the groupings in **Figure 1** compared with the modern periodic table.

any two from:

- hydrogen is in group 1 on Newlands table
- fluorine / chlorine / halogens are in group 1 on Newlands table
- alkali metals are in group 2 on Newlands table

(2)

In 1869 Mendeleev produced his periodic table.

(b) Why was Mendeleev's table called a periodic table?

There are similar properties which occur at regular intervals

(1)

(c) When Mendeleev was developing his periodic table he changed the order of some of the elements.

Explain why.

some elements appeared to be in the wrong group 1

so elements were arranged in order of relative atomic mass

OR

he placed them into groups with similar properties 1

(2)

Exam practice

METALS AND NON-METALS

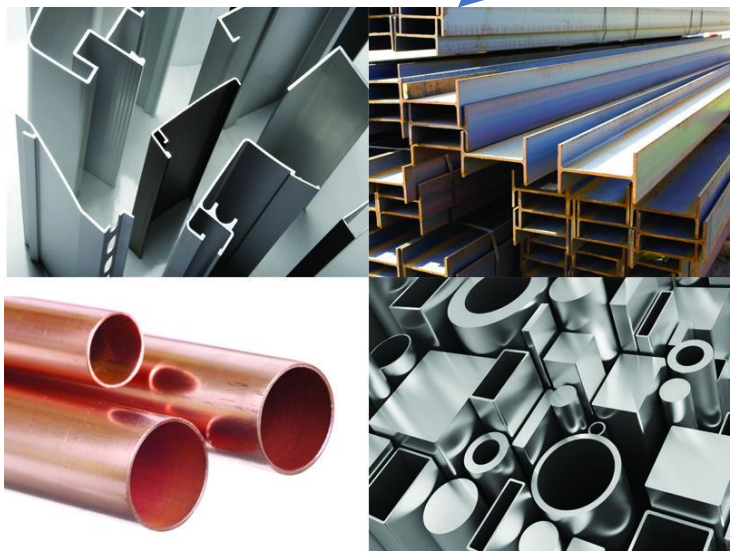
Non-metals are mostly on the right.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	?	?	?						

Metals are on the left and in the centre.

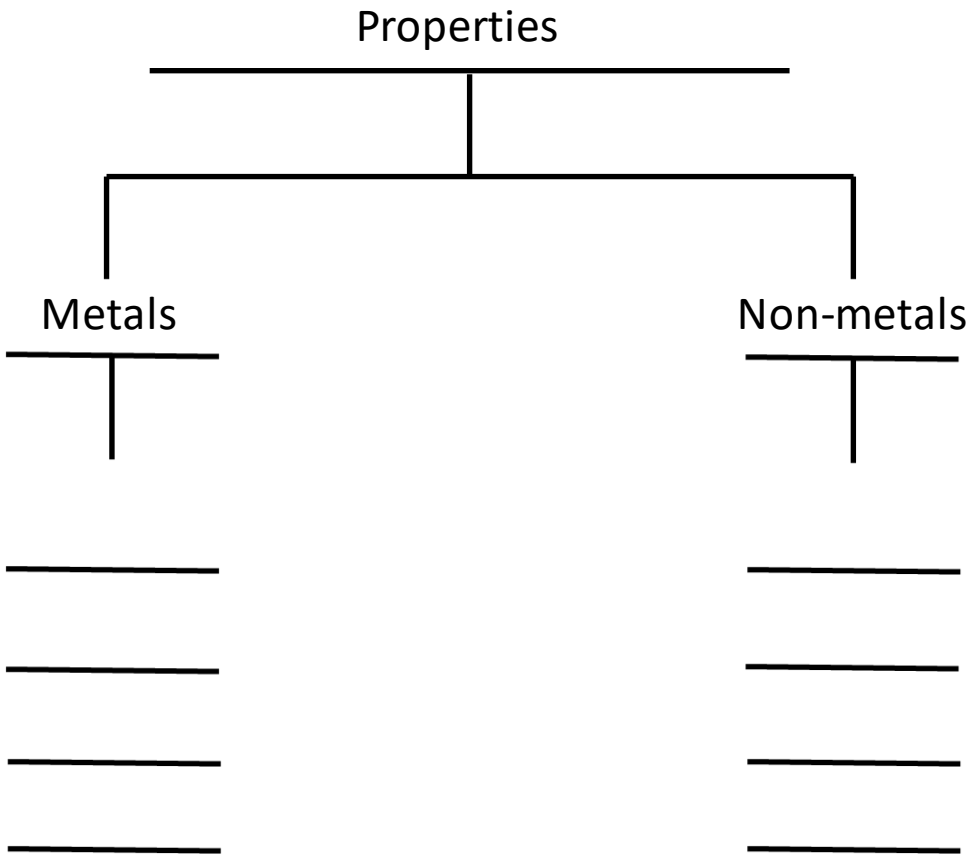
Metals

Non-metals



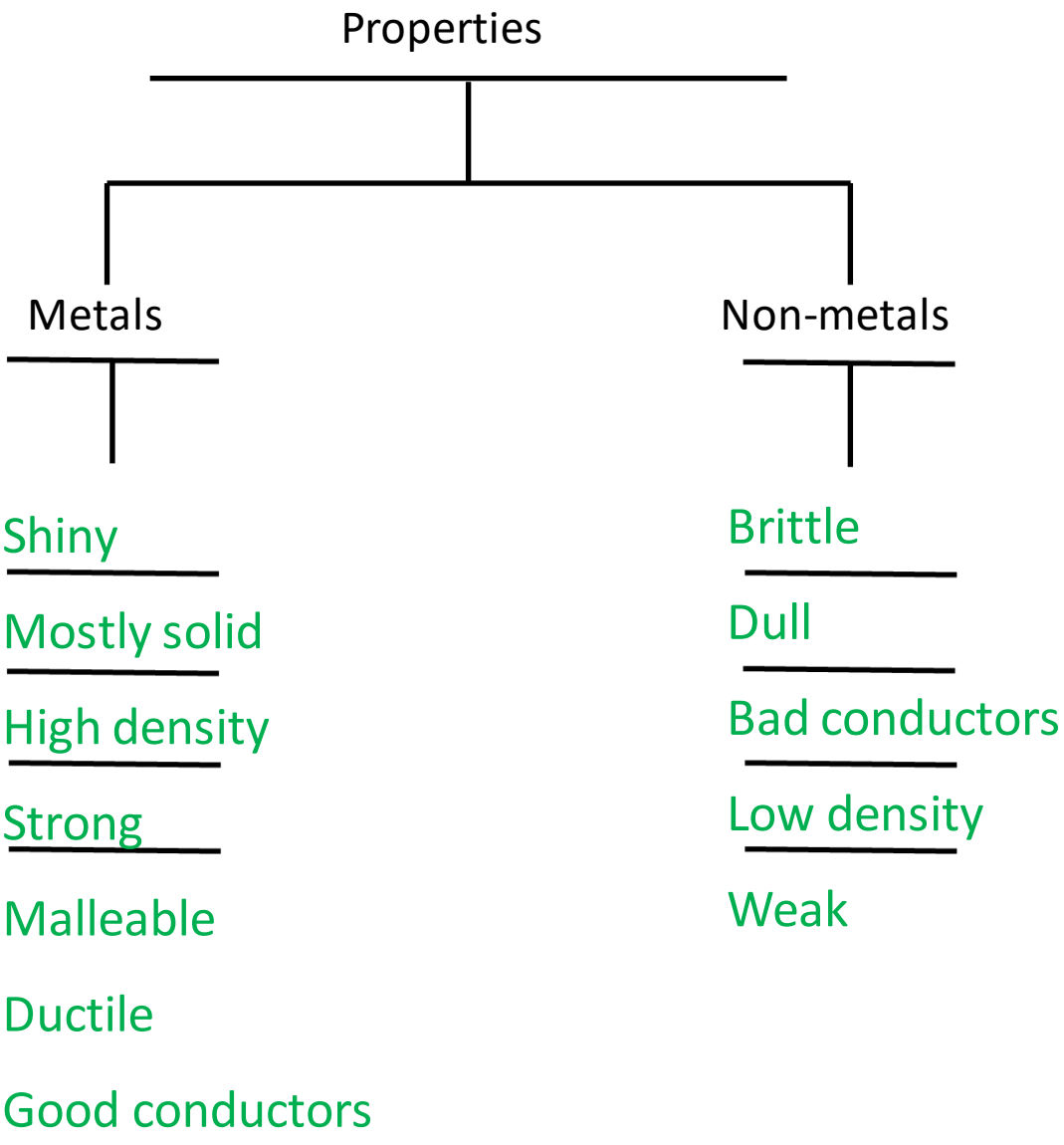
METALS AND NON-METALS

Task: Put each of the properties below into the tree map to show properties of metals and non-metals.



- Shiny
- Brittle (breaks easily)
- Mostly solid
- Dull
- Bad conductors
- Low density
- High density
- Strong
- Malleable (easily bent into shape)
- Ductile (can be stretched out into wires)
- Weak
- Good conductors

METALS AND NON-METALS



- Shiny
- Brittle (breaks easily)
- Mostly solid
- Dull
- Bad conductors of heat and electricity
- Low density
- High density
- Strong
- Malleable (easily bent into shape)
- Ductile (can be stretched out into wires)
- Weak
- Good conductors of heat and electricity

DECODE IT NOW

Word:

Ion (tier 3)

Define it:

An atom with a positive or negative charge formed by the loss or gain of electrons.

Write a sentence of your own that uses the word **ion.**

Write your own definition of the word **ion.**

Which subjects or topics will this word be relevant to?

Digging Deeper:

Electrons are negatively charged. Atoms that lose electrons formed positive ions. Atoms that gain electrons form negative ions.

Link it (similar words):

Charged, positive, negative

Deconstruct it (Root word):

The word **ion** is derived from the Greek word ***'ienai'*** which means ***'to go'***.

Use it:

Atoms in group 1 always form +1 ions because they lose one electron.

Chemical properties (or reactivity) of an element depend on the number of electrons in the outer shell. Every atom in the same group will form an ion with the same charge.

Metals ***lose*** ***electrons to become*** ***positive*** ***ions.***

Non-metals ***gain*** ***electrons to become*** ***negative*** ***ions.***

+1 +2 ***LEARN THIS!!*** +3 -3 -2 -1

1 H Hydrogen 1																2 He Helium 4
2 Li Lithium 3	3 Be Beryllium 9											5 B Boron 11	6 C Carbon 12	7 N Nitrogen 14	8 O Oxygen 16	9 F Fluorine 19	10 Ne Neon 20
11 Na Sodium 23	12 Mg Magnesium 24											13 Al Aluminum 27	14 Si Silicon 28	15 P Phosphorus 31	16 S Sulfur 32	17 Cl Chlorine 35.5	18 H Argon 40
19 K Potassium 39	20 Ca Calcium 40	21 Sc Scandium 45	22 Ti Titanium 48	23 V Vanadium 51	24 Cr Chromium 52	25 Mn Manganese 55	26 Fe Iron 56	27 Co Cobalt 59	28 Ni Nickel 59	29 Cu Copper 64	30 Zn Zinc 65	31 Ga Gallium 70	32 Ge Germanium 73	33 As Arsenic 75	34 Se Selenium 79	35 Br Bromine 80	36 Kr Krypton 84
37 Rb Rubidium 86	38 Sr Strontium 88	39 Y Yttrium 89	40 Zr Zirconium 91	41 Nb Niobium 93	42 Nb Niobium 96	43 Tc Technetium 98	44 Ru Ruthenium 101	45 Rh Rhodium 103	46 Pd Palladium 106	47 Ag Silver 108	48 Cd Cadmium 112	48 In Indium 115	50 Sn Tin 119	51 Sb Antimony 122	52 Te Tellurium 128	53 I Iodine 127	54 Xe Xenon 131
55 Cs Cesium 133	56 Ba Barium 137	57 La Lanthanum 139	72 Hf Hafnium 179	73 Ta Tantalum 181	74 W Tungsten 184	75 Re Rhenium 186	76 Os Osmium 190	77 Ir Iridium 192	78 Pt Platinum 195	79 Au Gold 197	80 Hg Mercury 201	81 Ti Thallium 204	82 Pb Lead 207	83 Bi Bismuth 209	84 Po Polonium 210	85 At Astatine 210	86 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226	89 Ac Actinium 227	104 Unq Unilquadium 257	105 Unp Unilpentium 260	106 Unh Unilhexium 263	107 Uns Unilseptium 262	108 Uno Uniloctium 265	109 Une Unicenium 266									

2 He Helium 4 ← Proton number ← Symbol ← Name of element ← Relative atomic mass

METALS AND NON-METALS

Task: Predict what the charge will be on each of the ions formed.

1. *Calcium* Ca^{+2}
2. *Chlorine* Cl^{-1}
3. *Magnesium* Mg^{+2}
4. *Lithium* Li^{+1}
5. *Sulphur* S^{-2}
6. *Potassium* K^{+1}
7. *Nitrogen* N^{-3}
8. *Boron* B^{+3}
9. *Oxygen* O^{-2}
10. *Neon* Ne

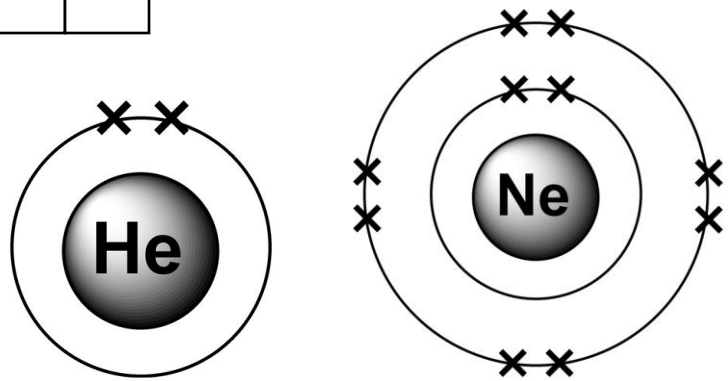
Challenge – *Draw the electronic structure for each of the ions formed. Don't forget to include square brackets and the charge for each one!*

GROUP 8/0

1	2											3	4	5	6	7	0
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	?	?	?						

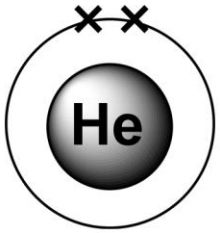
Group 8/0 elements are known as **THE NOBLE GASES**

***Task**: Draw the electronic structure of helium and neon*

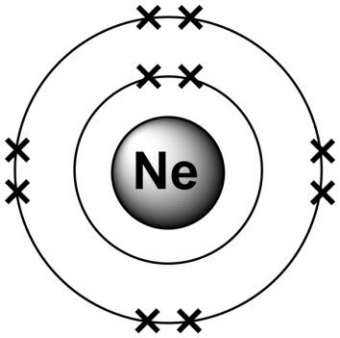


GROUP 8/0

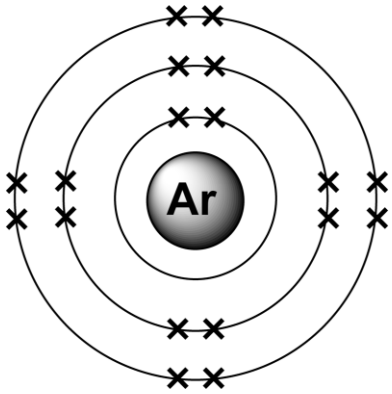
Boiling point:



-269°C



-246



-186

Q1: ***Describe*** and ***explain*** the reactivity of noble gases.

Noble gases are **unreactive** because they have a **full outer shell of electrons** (so don't want to lose or gain any).

Q2: ***Describe*** what happens to the boiling point as you go down the noble gases.

The boiling point **increases as you go down the group** of noble gases.

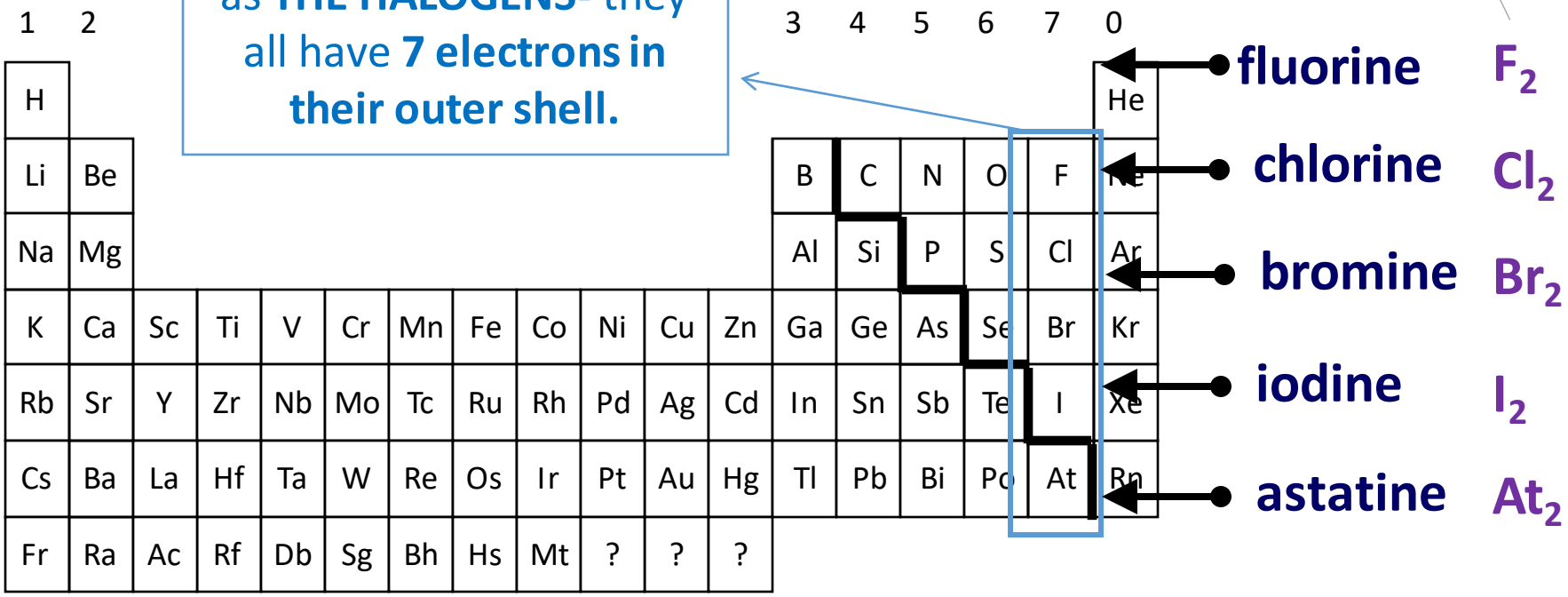
Challenge – *Explain your answer to Q2.*

The atoms are bigger, so the intermolecular forces are stronger.

GROUP 7

*Halogen molecules are **always** diatomic (X_2)!*

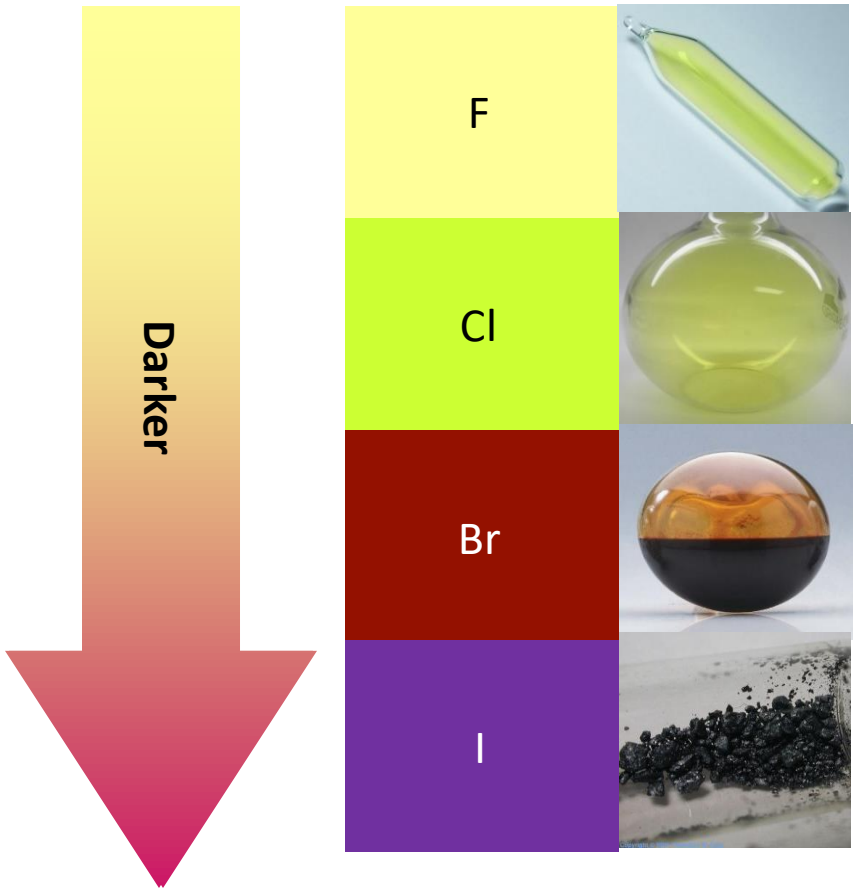
Group 7 metals are known as **THE HALOGENS-** they all have **7 electrons in their outer shell.**



Challenge: What group do halogens usually react with? Why?

Halogens usually react with group 1 metals because halogens want to gain one electron and group 1 metals want to lose one electron.

GROUP 7



Element	Melting point (°C)	Boiling point (°C)
Fluorine	-220	-188
Chlorine	-101	-35
Bromine	-17	59
Iodine	114	184

1. Describe the trend in boiling point as you go down group 7.

   As you go down group 7, the melting and boiling points get higher.

2. Explain the trend in boiling point as you go down group 7.

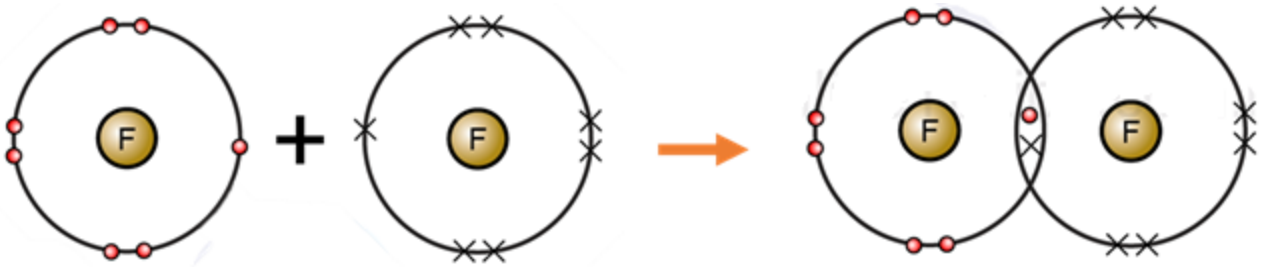
   As you go down group 7, the molecule gets bigger. This means the intermolecular forces get stronger, so more energy is needed to break them.

Challenge: Draw a dot and cross diagram for chlorine, Cl_2.

What bonding will occur between two halogen atoms?

COVALENT BONDING (between 2 non-metals)

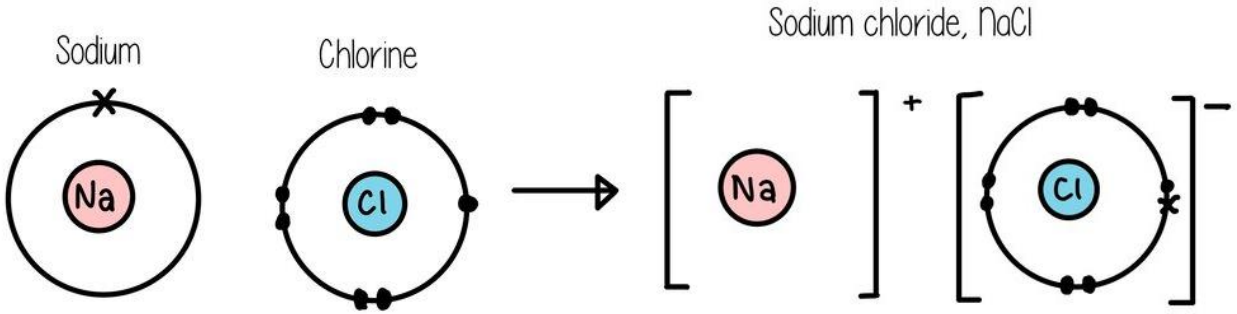
Task: *Draw a dot and cross diagram showing the bonding in a fluorine molecule, F_2:*



What bonding will occur between a halogen and a group 1 metal?

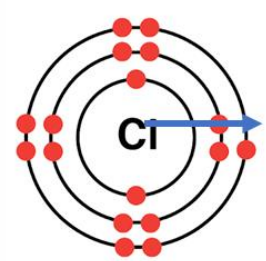
IONIC BONDING (between a metal and non-metal)

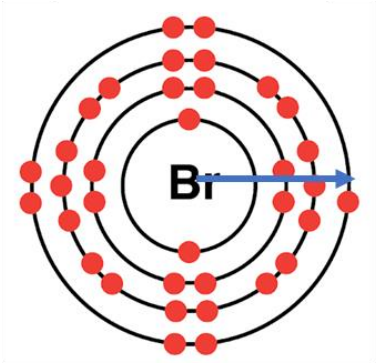
Task: *Draw a dot and cross diagram showing the bonding in sodium chloride, NaCl:*

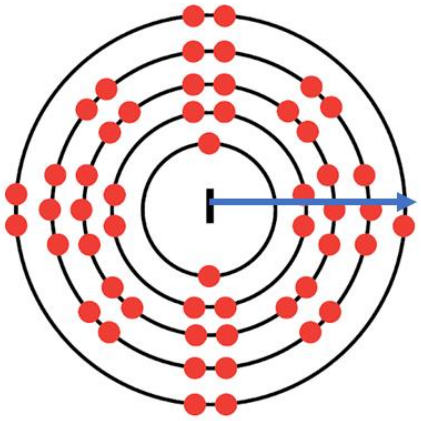


GROUP 7

Reactivity DECREASES as you go down group 7







In chlorine, the outer shell is ___*closer to*___ the nucleus.

This means there is a __*stronger*__ attraction between the nucleus and the outer electrons.

This makes it _____*easier*_____ for chlorine to _____*gain*_____ an electron, so ***chlorine is*** _____*more*_____ ***reactive.***

Because all group 7 elements have 7 electrons in their outer shell and want to gain an electron

DECODE IT NOW

Word:

Displace

Define it:

To take the place of.

Write a sentence of your own that uses the word **displace.**

Write your own definition of the word **displace.**

Which subjects or topics will this word be relevant to?

Digging Deeper:

The word displace can also be used in medicine, to describe a bone or joint that may have been moved from it's usual position e.g. "he seems to have displaced a vertebrae".

Link it (similar words):

Replace, move, override

Use it:

*Fluorine would **displace** iodine because it is more reactive.*

Deconstruct it (Root word):

From mid 16th century French word 'displacer' which means 'to move'.

LO: **Describe** what happens in a displacement reaction.

Key definition:

A **more reactive** halogen will **displace** a **less reactive** halogen from a compound.

A halogen will be **more reactive** if it is **above** the other halogen in the group.

TOP TIP! Do NOT say 'stronger'… you must say 'more reactive'

TOP TIP! Do NOT say 'replace' or 'take' or 'steal'… you must say 'more reactive'

LO: **Describe** what happens in a displacement reaction.

Bromine + sodium iodide → Sodium bromide + iodine

Chlorine + lithium bromide → Lithium chloride + bromine

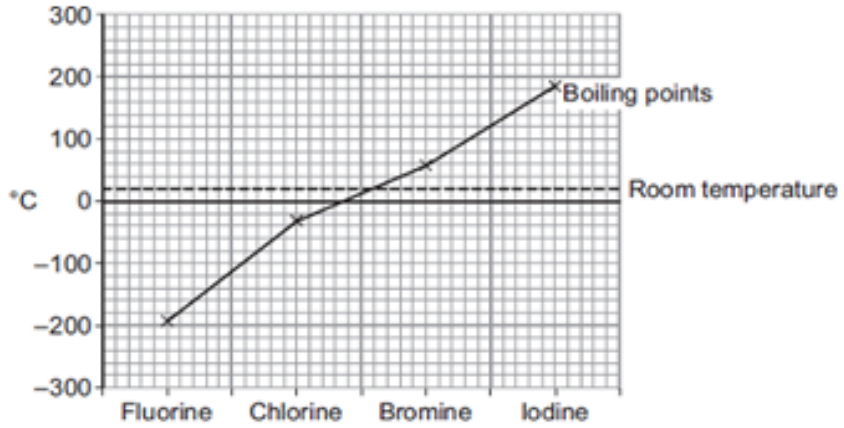
Iodine + potassium fluoride → NO REACTION

Challenge: What would you ***see*** *in reaction 2?*
Hint: Think about what each of the halogens look like!

19 **F** fluorine 9
35.5 **Cl** chlorine 17
80 **Br** bromine 35
127 **I** iodine 53

Exam practice

Q1. The graph shows the boiling points of the halogens.



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

gas	liquid	solid

At room temperature chlorine is a gas

(1)

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

The boiling point INCREASES from fluorine to iodine

(1)

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

(i) When a chlorine atom forms a chloride ion it gains one electron. What is the charge on a chloride ion?

- 1

(1)

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

sodium + chlorine -> sodium chloride

(1)

Exam practice

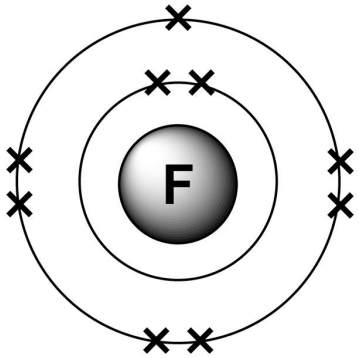
(b) (i) Draw a diagram to show the arrangement of electrons in an atom of fluorine.

(1)

(ii) The elements of Group 7 have similar chemical properties. Explain, in terms of electrons, why they have similar chemical properties.

All halogens have 7 electrons in their outer shell

(1)



(c) (i) Xenon is a very unreactive element Explain, in terms of electrons, why xenon is so unreactive.

Xenon is in group 8/0, so it has a full outer shell of electrons and does not need to gain or lose any electrons

(2)

(ii) Fluorine reacts with xenon, but iodine does not. Explain, in terms of atomic structure, why fluorine is more reactive than iodine.

Fluorine atom is smaller so the outer shell is more strongly attracted (to nucleus). This means it is easier for fluorine to gain an electron.

(3)

Exam practice

(a) How do the boiling points of the halogens change down the group from fluorine to iodine? (1)

Boiling points increase as you go down the group.

(b) Sodium bromide is produced by reacting sodium with bromine.

Sodium bromide is an ionic compound.

(i) Write down the symbols of the **two** ions in sodium bromide. (1) **Na+ and Br-**

(ii) Chlorine reacts with sodium bromide solution to produce bromine and one other product.

Complete the word equation for the reaction.

chlorine + sodium bromide ⟶ bromine + **sodium chloride** (1)

(iii) Why does chlorine displace bromine from sodium bromide? (1)

Chlorine is more reactive than bromine

(iv) Suggest which halogen could react with sodium chloride solution to produce chlorine. (1)

Fluorine (because it is more reactive than chlorine)

(c) Explain, in terms of electrons, why fluorine is the most reactive element in Group 7. (3)

Outer shell electron is closer to the nucleus in fluorine, so there is a stronger attraction and it is easier to gain an electron.

GROUP 1

Group 1 metals are also known as **THE ALKALI METALS**

They all react in the same way because they all have **1 electron in their outer shell**.

1	2											3	4	5	6	7	0
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	?	?	?						

GROUP 1

metal oxide (dull)

metal (shiny)

Task: Use the pictures above to write down as many properties of alkali metals as you can remember in a bubble map.

Properties of alkali metals

Challenge – How are alkali metals different to other metals?

GROUP 1

Shiny when cut

Very reactive with water and air (so stored in oil)

Low densities (float on water)

Properties of alkali metals

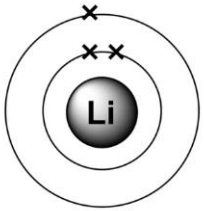
Low melting and boiling points

Very soft (can be cut with a knife)

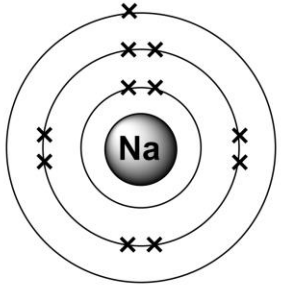
Other metals are usually unreactive, very dense, hard (cannot be cut with a knife) and have high melting points and boiling points.

GROUP 1

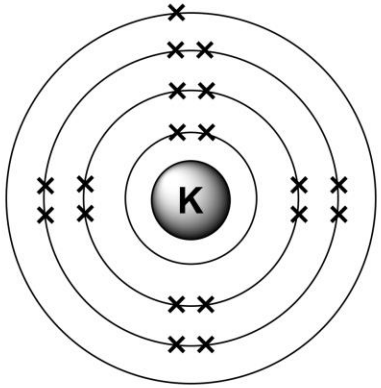
Reactivity INCREASES as you go down group 1



2, 1



2, 8, 1



2, 8, 8, 1

In potassium, the outer shell is ***further away from*** the nucleus.

This means there is a ***weaker*** attraction between the nucleus and the outer electrons.

This makes it ***easier*** for potassium to ***lose*** an electron, so ***potassium is more reactive.***

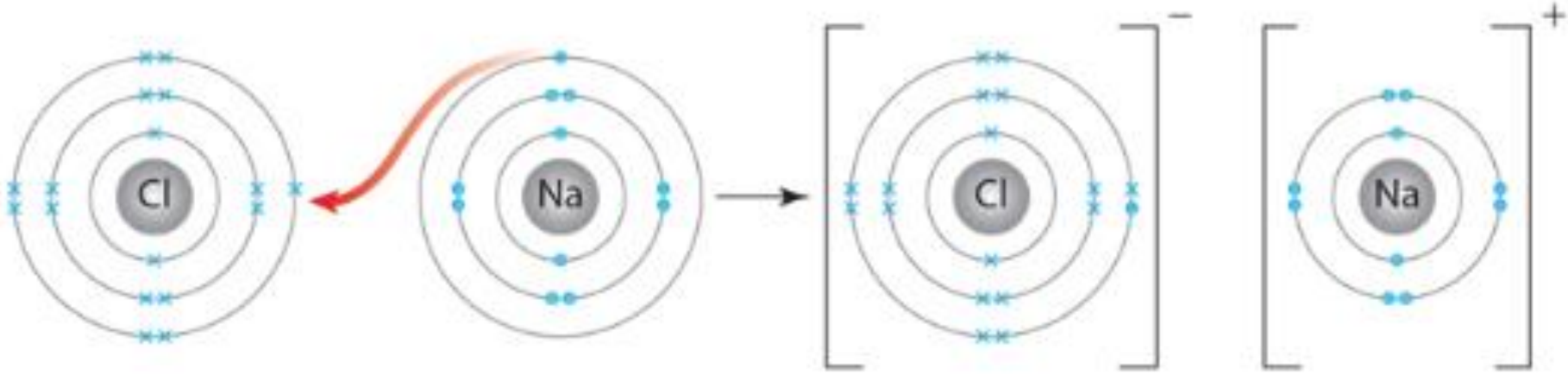
Challenge – *Why do group 1 metals usually react with group 7 elements?*

LO: **Explain** patterns in reactivity of group 1 metals.

GROUP 1

REACTIVITY OF THE ALKALI METALS

Challenge – *Why do group 1 metals usually react with group 7 elements?*



The sodium atom transfers its outer electron to the chlorine atom.

This forms NaCl (salt!)

Exam practice

A student was investigating the reaction of lithium and water.

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

(i) The lithium floated on the water.
State **two** other observations that the student would **see** during the reaction.

(2)

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

$$2\ Li(s) + \_\_\_\_\_\ H_2O(l) \longrightarrow \_\_\_\_\_\ LiOH(aq) + H_2(g)$$

(2)

(iii) All Group 1 metals have similar reactions with water.
State why, in terms of electronic structure.

(1)

(iv) The electronic structure of a potassium atom is 2, 8, 8, 1
Draw a diagram to show the electronic structure of a potassium ion.
Show the charge on the potassium ion.

(2)

(v) Potassium is more reactive than sodium.
Explain why, in terms of electronic structure.

(3)

Exam practice

A student was investigating the reaction of lithium and water.

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

(i) The lithium floated on the water.
State **two** other observations that the student would **see** during the reaction.

(2)

any **two** from:

- bubbles / effervescence / fizzing
  ignore hydrogen / gas produced
- lithium disappears / gets smaller
  allow dissolves
  *do **not** allow melts / burns*
- lithium moves on the surface of the water
  ignore floats
- (universal indicator) turns blue / purple

Exam practice

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

$2\ Li(s) + \underline{\ 2\ } H_2O(l) \longrightarrow \underline{\ 2\ } LiOH(aq) + H_2(g)$

(2)

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

State why, in terms of electronic structure.

(1)

all have 1 electron in their outer shell / energy level

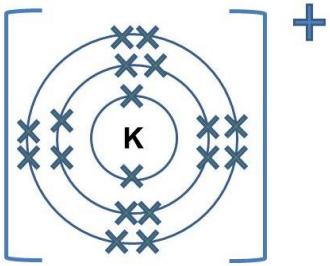
allow have the same number of electrons in their outer shell / energy level

Exam practice

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

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

Show the charge on the potassium ion. **(2)**



(v) Potassium is more reactive than sodium.

Explain why, in terms of electronic structure. **(3)**

because (in potassium) the outer shell electron is further away from the nucleus **or** because potassium atoms are larger than sodium atoms

therefore the outer shell electron is less strongly attracted to the nucleus **or** is more shielded from the attraction of the nucleus and so the outer shell electron in potassium is more easily lost