Name:

5.1.1.5 – Size & Mass of Atoms

Date / /

Keywords

- ❑ Atom
- ❑ Radius
- ❑ Nucleus
- ❑ Protons
- ❑ Neutrons
- ❑ Electrons
- ❑ Shells
- ❑ Mass Number
- ❑ Atomic Number
- ❑ Element
- ❑ Isotope

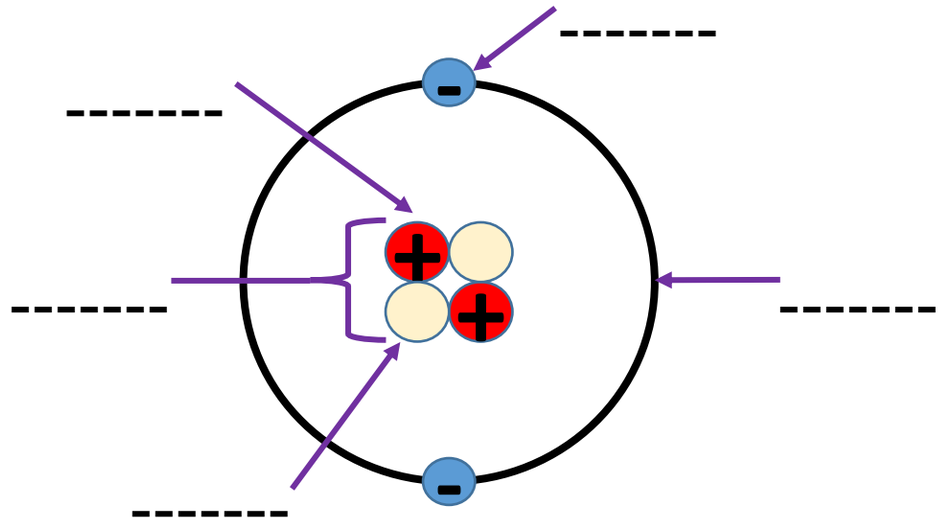
1. Starter: How small is an atom?

2. How small is an atom?

An atom has a _____ of about _____

nm stands for _____

3. Label the atom using the keywords



4. How small is the nucleus of the atom?

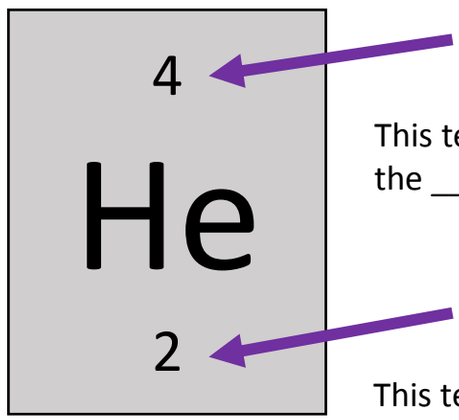
- The radius of the _____ is less than ___/_____ of the atom.

  This means the atom is mostly _____ _____.

- However, almost all of the _____ of the atom comes from the nucleus.

  This means almost all of the mass comes from the _____ and _____.

5. Atomic Number & Mass Number



This tells us the _____ of the atom which comes from the _____ + _____ in the nucleus

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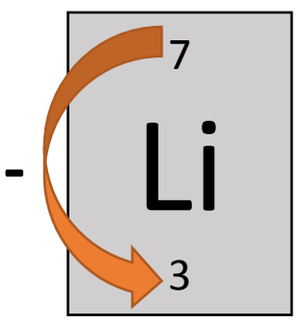
This tells us the number of _____ in the nucleus which is the same as the number of negative _____.

6. How to work out the number of neutrons.

We can work out the number of neutrons by subtracting the _____ _____ from the _____ _____.



Work out the number of neutrons in lithium:

7 – 3 = ____ Neutrons.

7. Work out the number of protons, neutrons and electrons for each element:

4 He 2	Protons _____ Neutrons _____ Electrons _____	7 Li 3	Protons _____ Neutrons _____ Electrons _____	31 P 15	Protons _____ Neutrons _____ Electrons _____
23 Na 11	Protons _____ Neutrons _____ Electrons _____	20 Ne 10	Protons _____ Neutrons _____ Electrons _____	80 Br 35	Protons _____ Neutrons _____ Electrons _____

8. Work out the number of protons, neutrons and electrons for each element:

35 Cl 17	Protons _____ Neutrons _____ Electrons _____	37 Cl 17	Protons _____ Neutrons _____ Electrons _____

Q1. Why are they the same element?

Both are the element _____ as they both have ____ protons.

Q2. What is the same about them?

They have the same number of _____ and _____

Q3. What is different about them?

They have different numbers of _____, this makes them _____

9. Isotopes

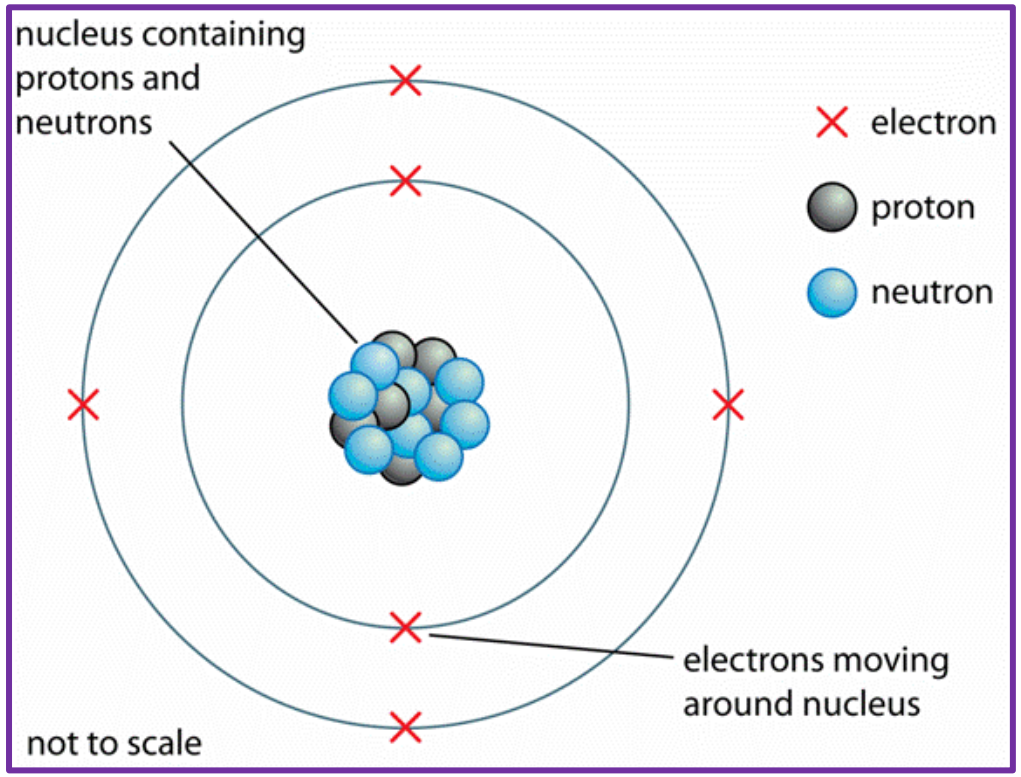
Elements with the same number of _____ and _____, but different numbers of _____ are called _____.

Feedback

18

The Size & Mass of atoms

5.1.1.5

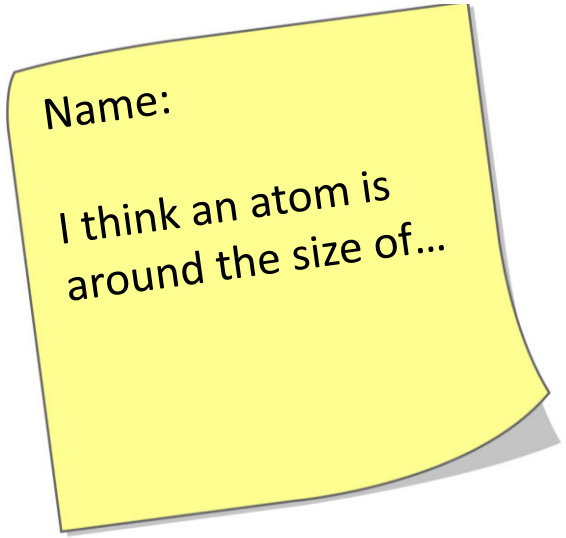


5.1.1.5 - Students should be able to:

- State that atoms a very small, with a radius of 0.1 nm
- Explain that the nucleus of an atom is even smaller = 1/10,000 the radius of the atom.
- Describe how almost all of the mass of the atom is concentrated in the nucleus with the protons and neutrons.
- Define mass number and atomic number.
- State that the element is defined by the atomic number.
- Calculate the number of protons, neutrons and electrons in an atom.
- Explain what isotopes of an element are.

How small is an atom?

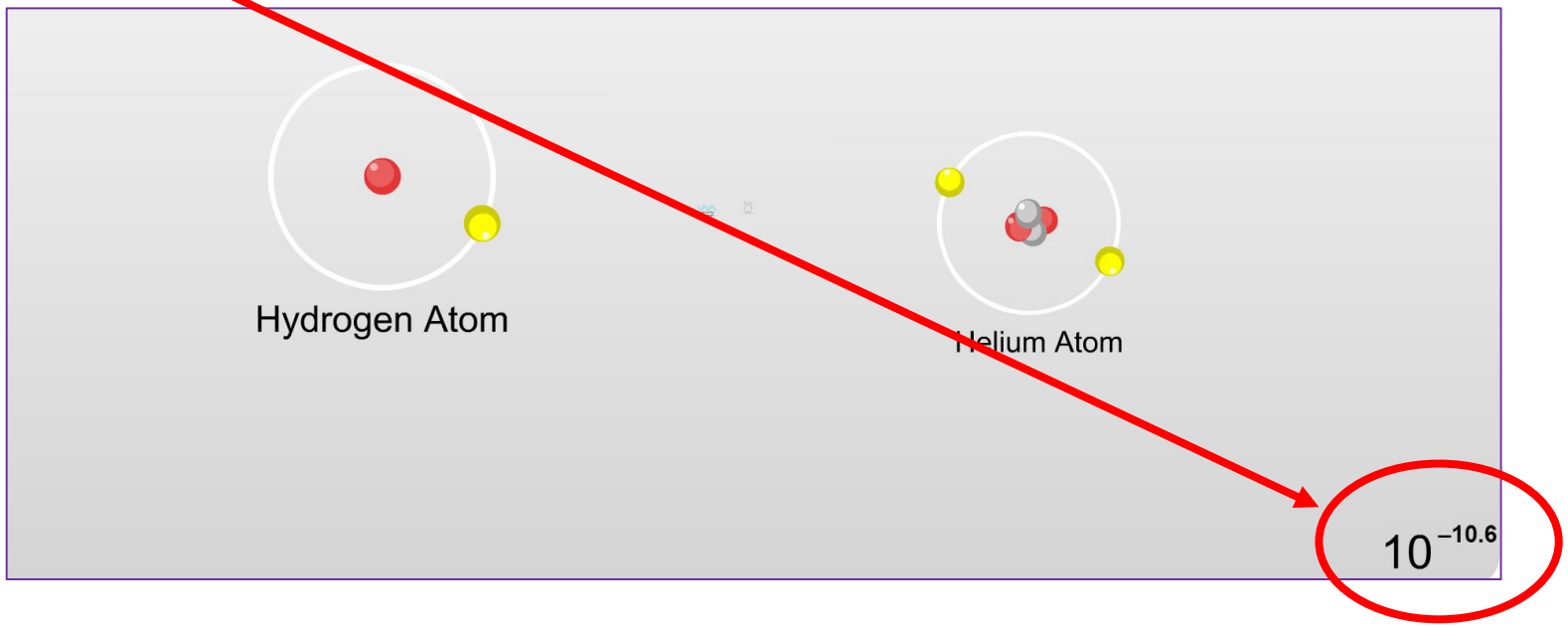
- Write down how small you think an atom is on a post-it.
- You could use a comparison to another object….
- Or you could use units, e.g. meters… (m)



The Scale of the Universe 2

How small is an atom?

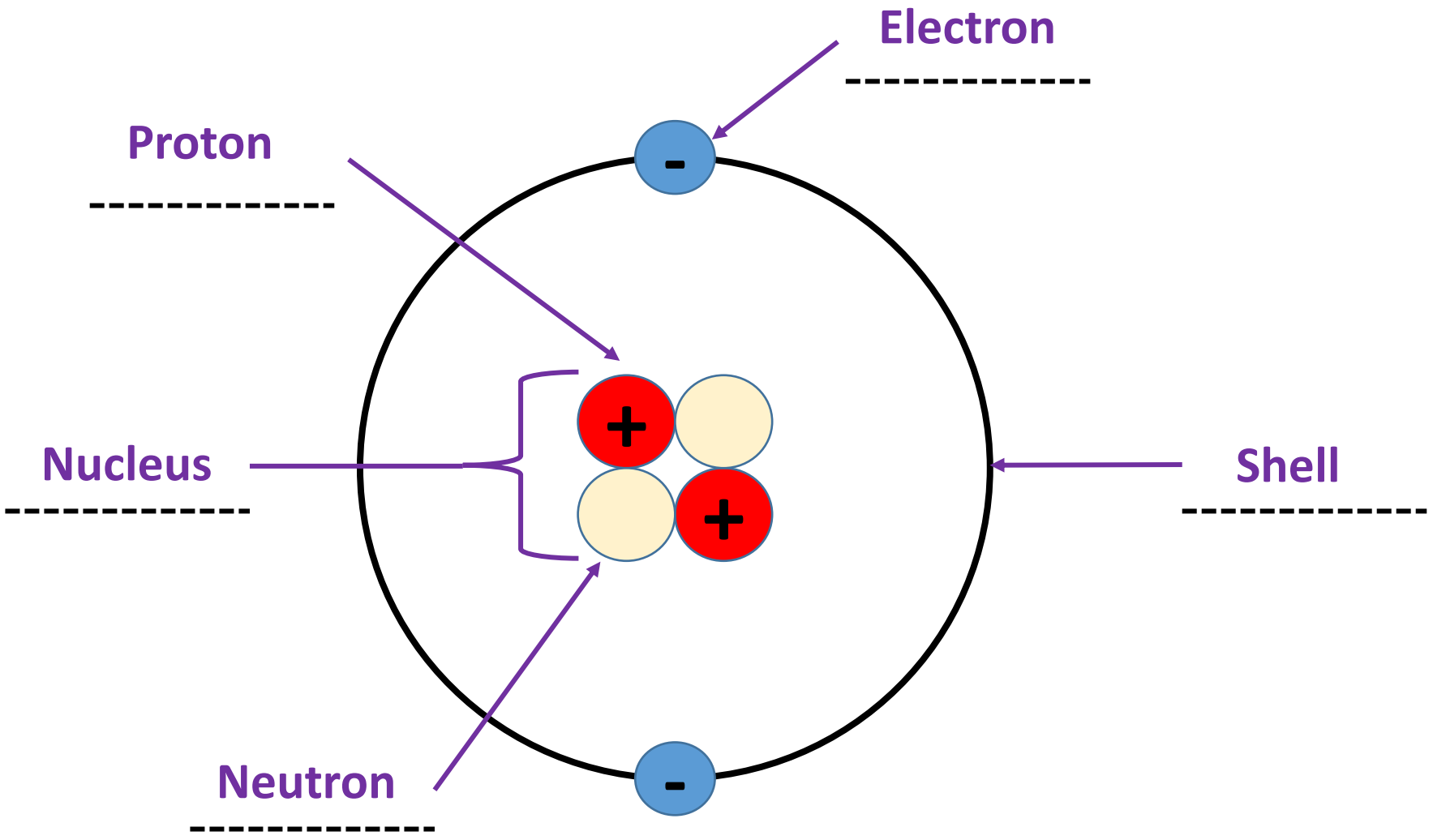
- Atoms are very small, they have a **radius** of about **0.1 nm**
- That's 1×10^{-10} m !



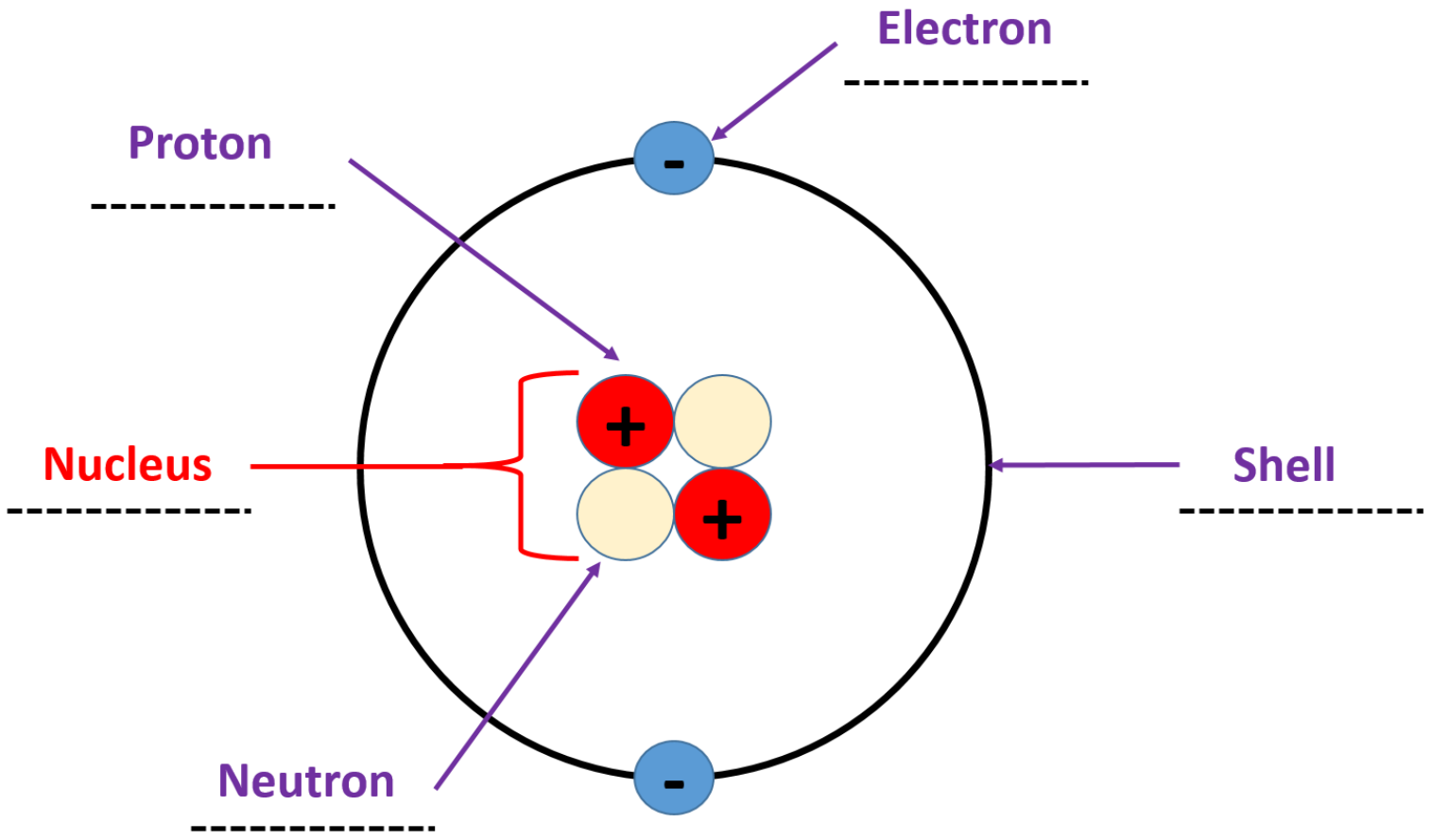
Task: Label the atom

Keywords

1. Proton
2. Neutron
3. Electron
4. Nucleus
5. Shell

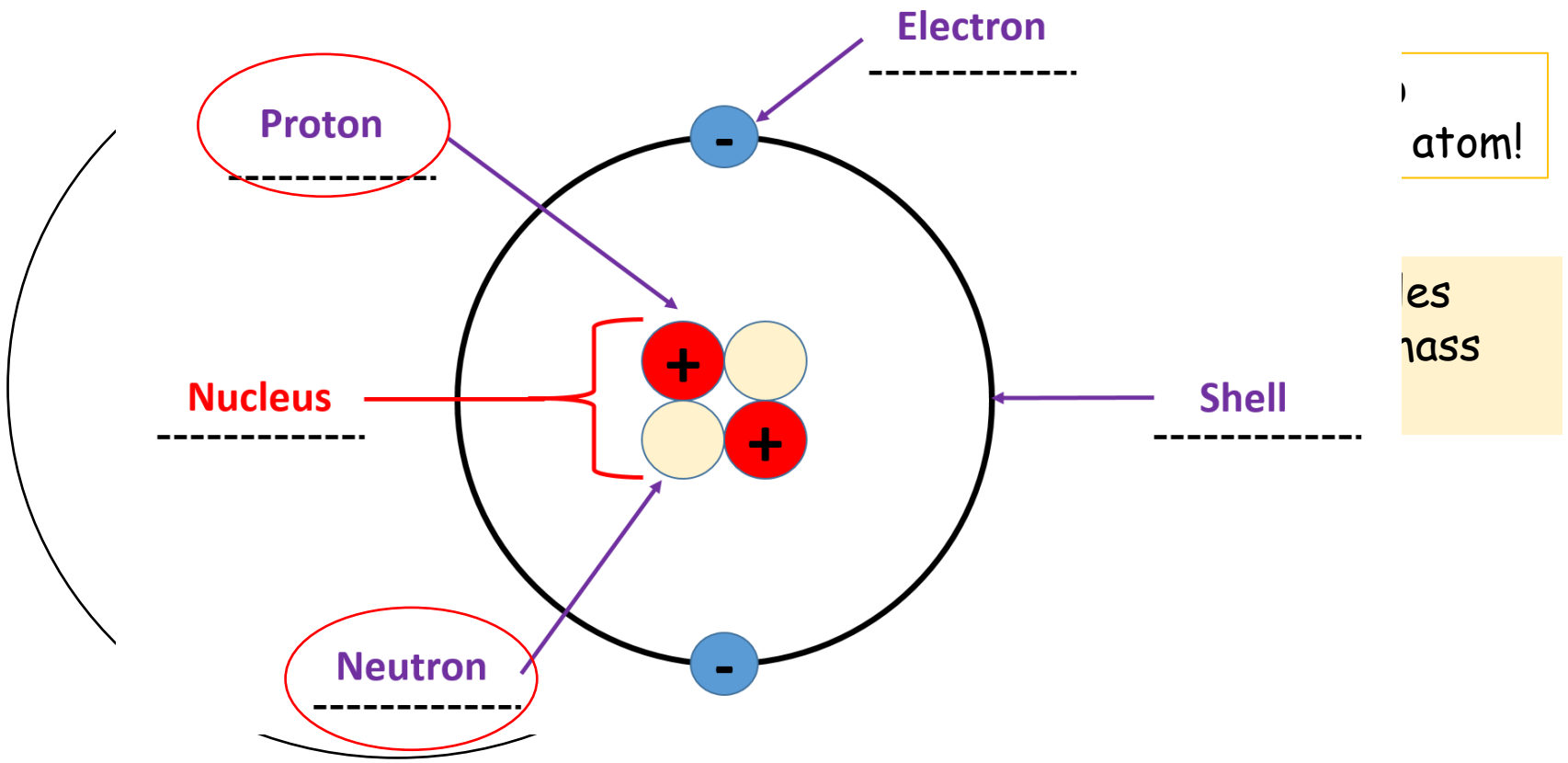


How big is the nucleus compared with the whole atom?



How small is the nucleus compared with the whole atom?

The radius of a nucleus is less than 1/10,000 of the atom!



Recap

- Atoms are very small.
- The radius of an atom is 0.1nm (small!)
- The radius of the nucleus is 1/10,000 the radius of the atom (even smaller!)
- Almost all the mass of the atom comes from its tiny nucleus.
- The nucleus contains protons and neutrons.

Atomic number & Mass number

On the periodic table we find elemental symbols like this:

There are two numbers, one above the other below:

Mass number

The largest number is called the "**mass number**"

This number tells us the **mass** of an atom of this element.

4

Q. Where does almost all the mass of the atom come from?

The nucleus!

He

Q. What particles were in the nucleus?

Protons & Neutrons!

Q. So what does the mass number also tells us?

2

The sum of (protons + neutrons)

Mass number

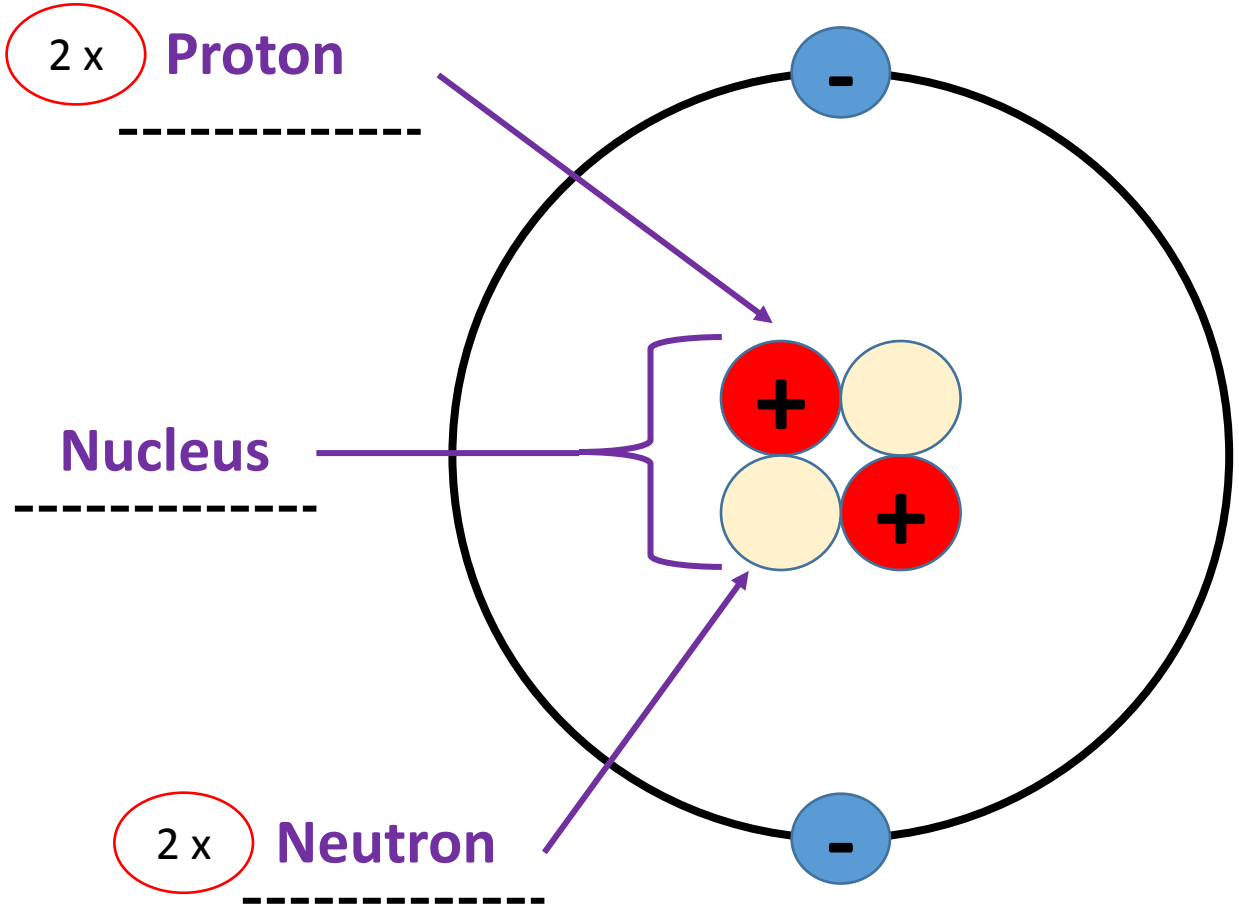
2 protons + 2 neutrons = mass number of 4

So why is Helium's mass number = 4?

4

He

2

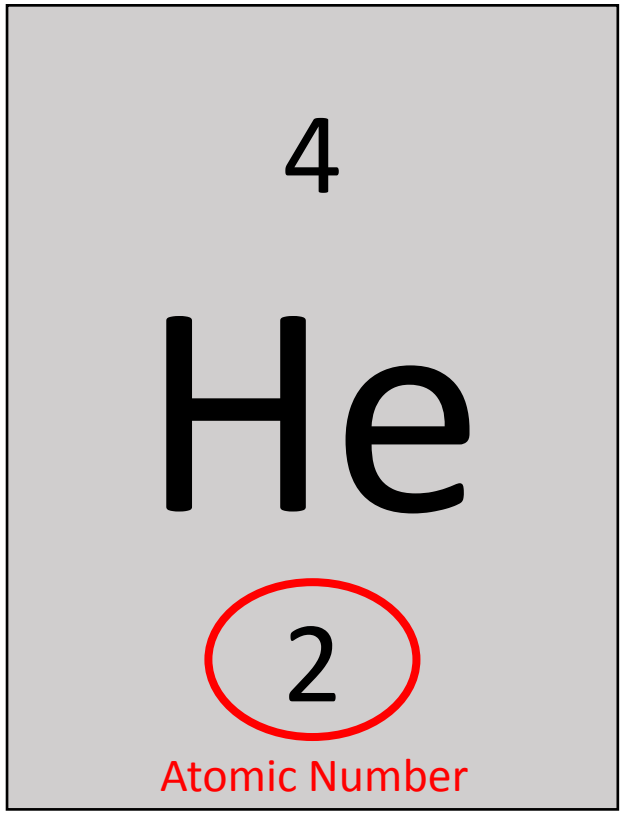


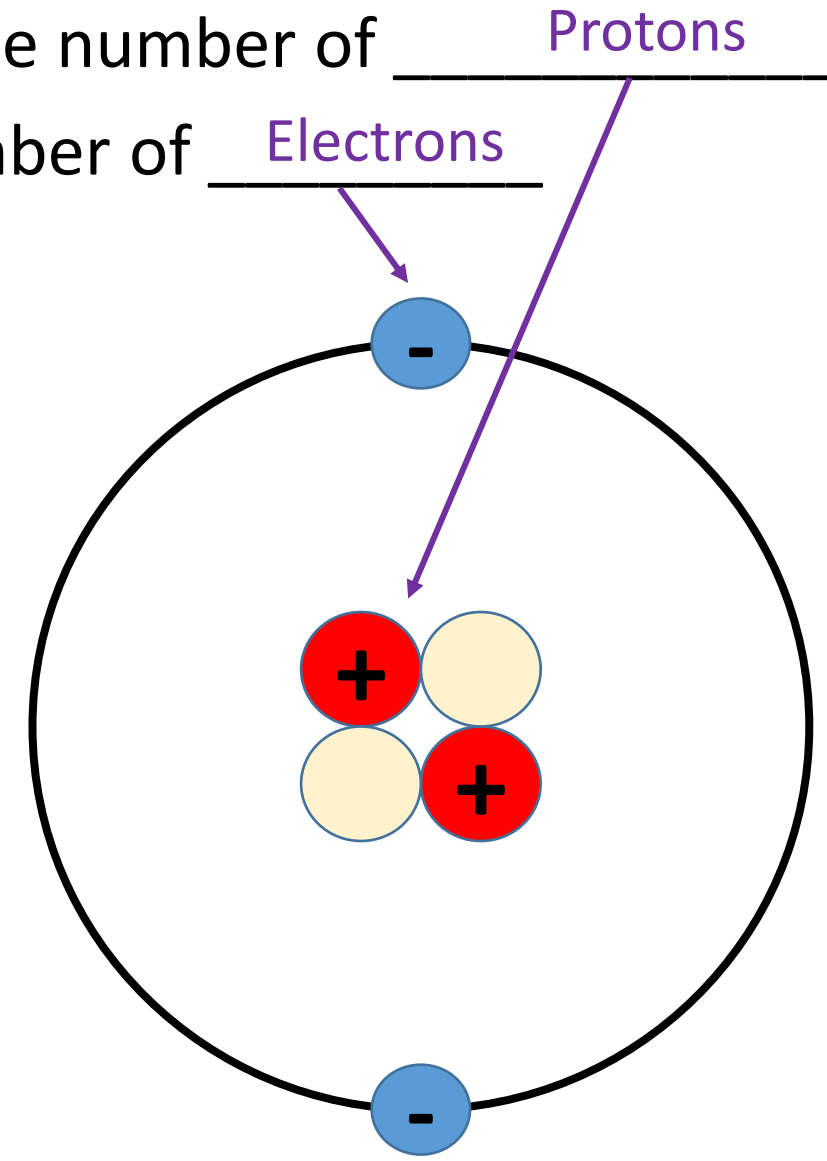
Mass Number Recap

- Almost all the mass of an atom comes from the nucleus.
- The nucleus contains protons and neutrons.
- When you add up the numbers of protons and neutrons you get the mass of the atom!
- This is called the "**Mass number**"

Atomic Number

- The atomic number tells us the number of Protons
- Which is the same as the number of Electrons





Atoms have an equal number of positive protons and negative electrons. This is so the atom has no overall electrical charge.

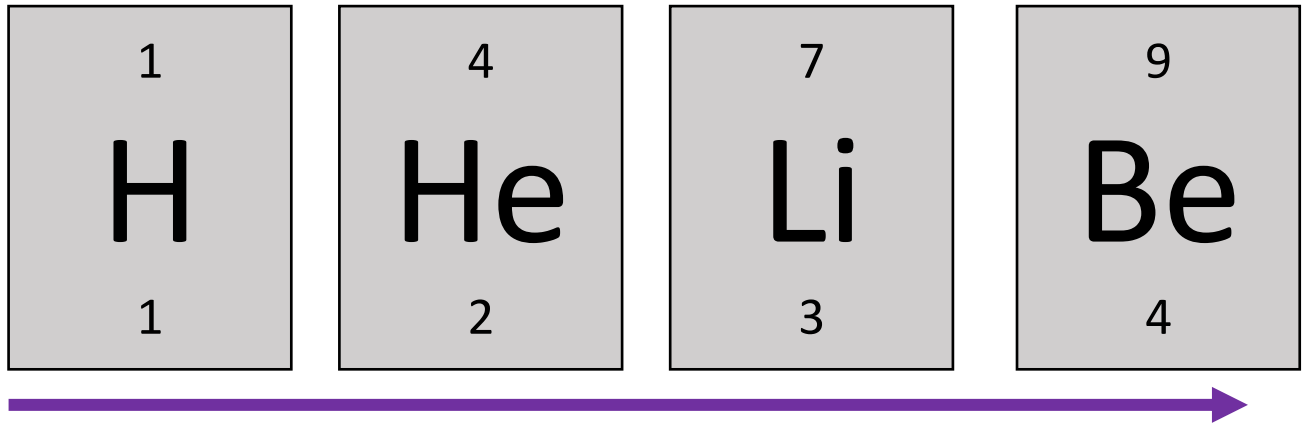
Look at the periodic table, what do you notice about

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
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated						

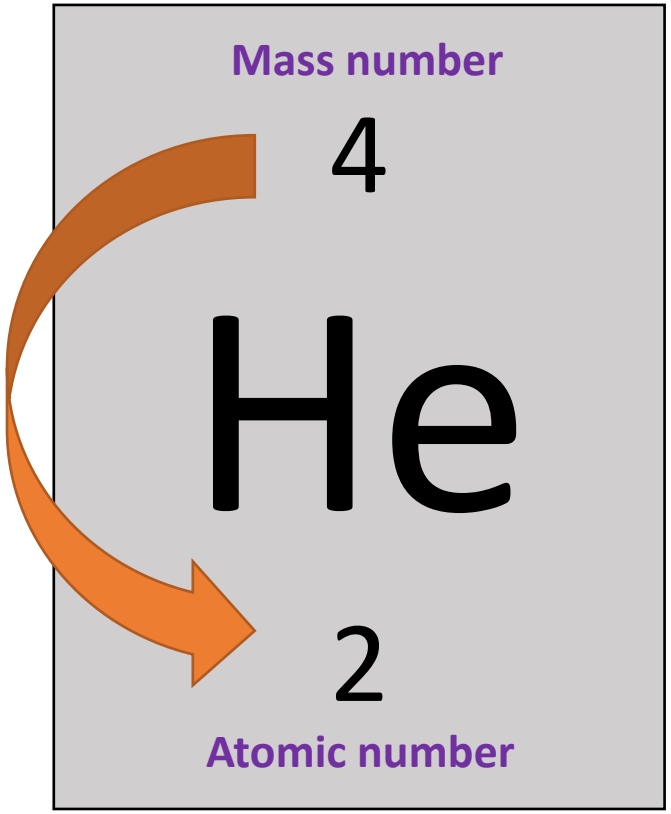
Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Key fact!



- The number of protons defines the element!
- Elements are arranged on the periodic table in order of their atomic numbers.
- If you change the number of protons (atomic number) you change the element!



Mass number

Protons + Neutrons

So how do we work out the number of neutrons?

Mass number – atomic number = number of neutrons.

4 – 2 = 2 neutrons.

Atomic number

Protons

Practice: Protons, Neutrons and Electrons

Key maths skill

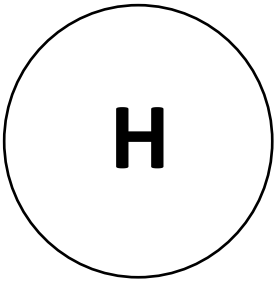
4 He 2	Protons 2 Neutrons 2 Electrons 2	
7 Li 3	Protons 3 Neutrons 4 Electrons 3	
31 P 15	Protons 15 Neutrons 16 Electrons 15	
23 Na 11	Protons 11 Neutrons 12 Electrons 11	
20 Ne 10	Protons 10 Neutrons 10 Electrons 10	
80 Br 35	Protons 35 Neutrons 45 Electrons 35	

Calculate protons, neutrons and electrons for both.

35 Cl 17		37 Cl 17	
	Protons 17		Protons 17
	Neutrons 18		Neutrons 20
	Electrons 17		Electrons 17

ISOTOPES

A version of an element with a <u>different number of neutrons</u>,
but the same number of protons and electrons.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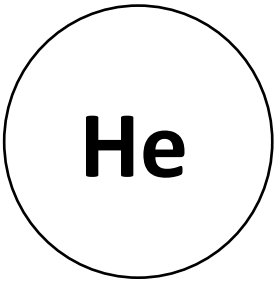
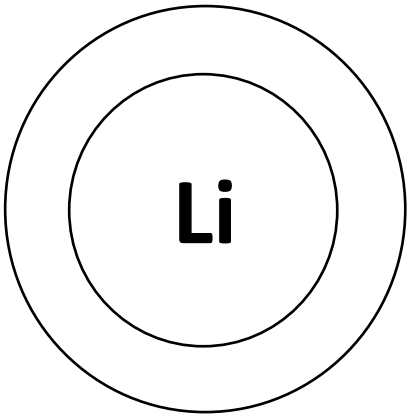
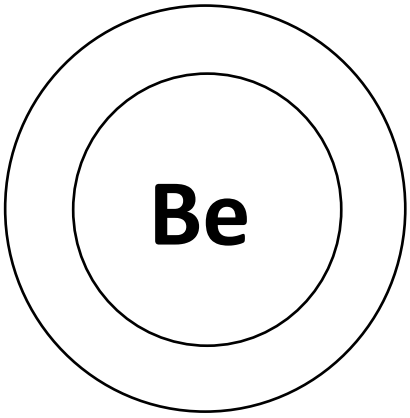
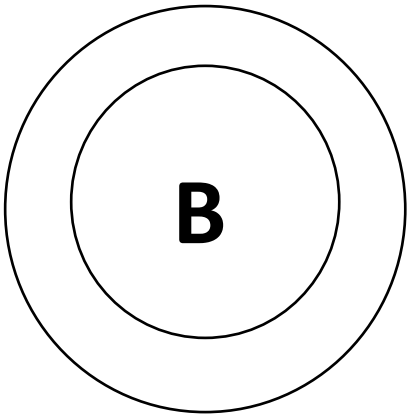

He


Li


Be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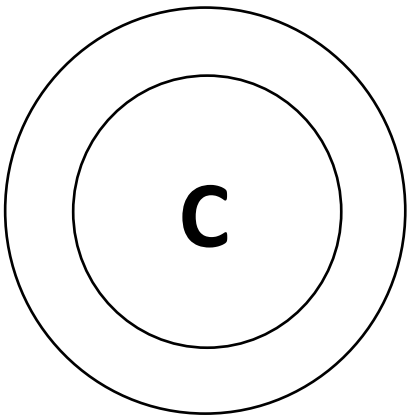
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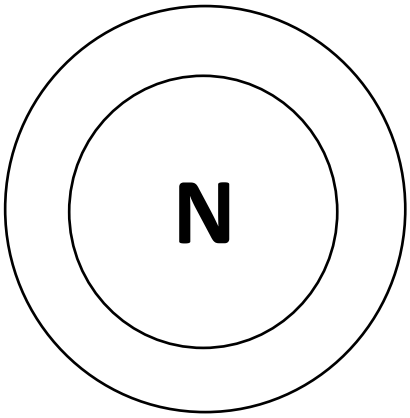
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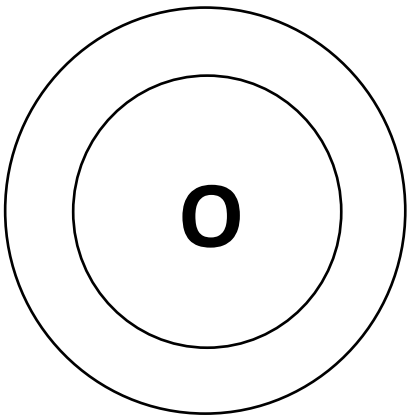
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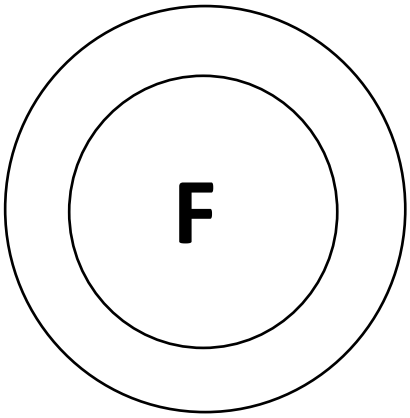
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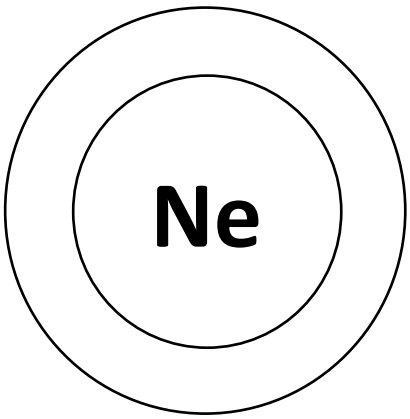
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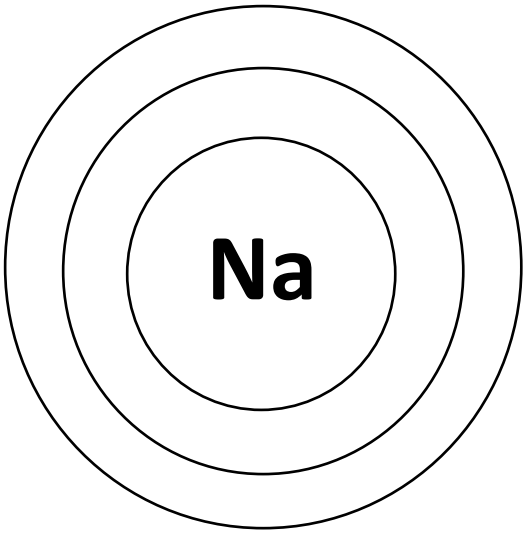
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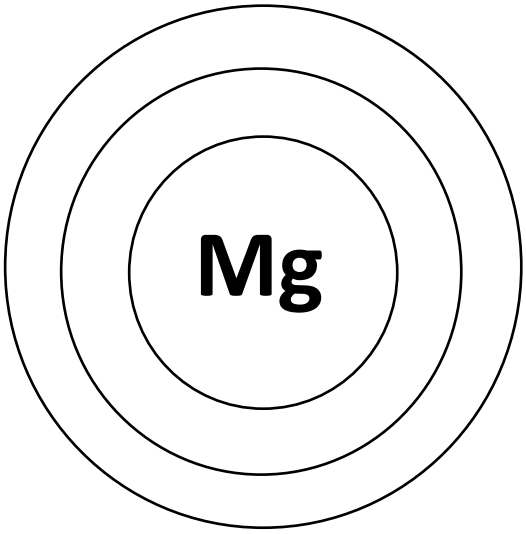
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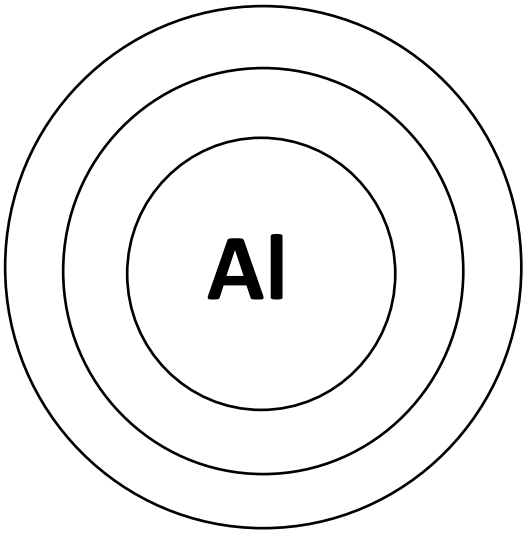
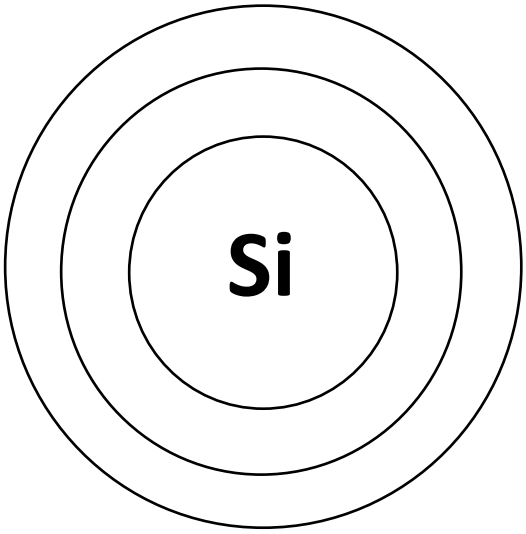

Al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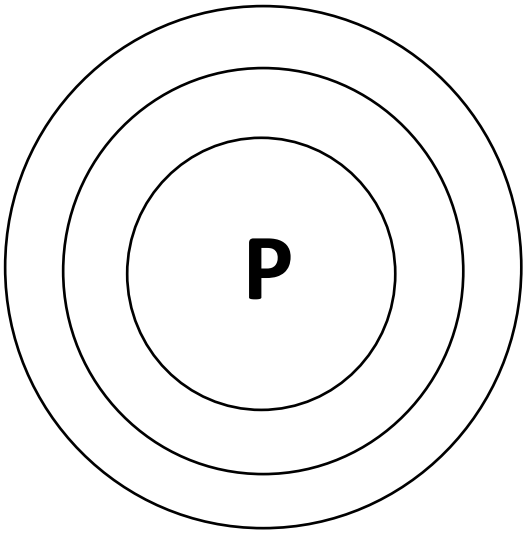
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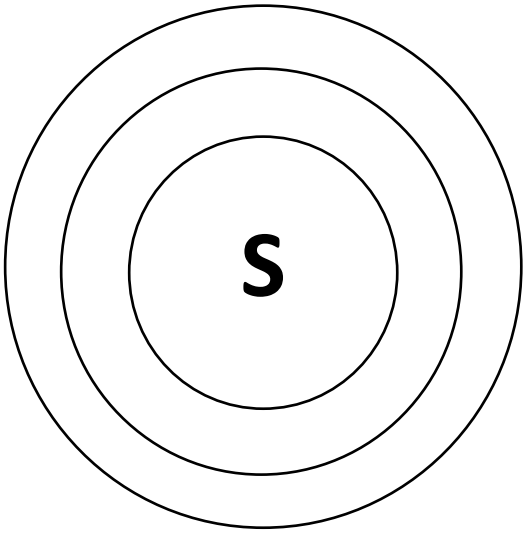
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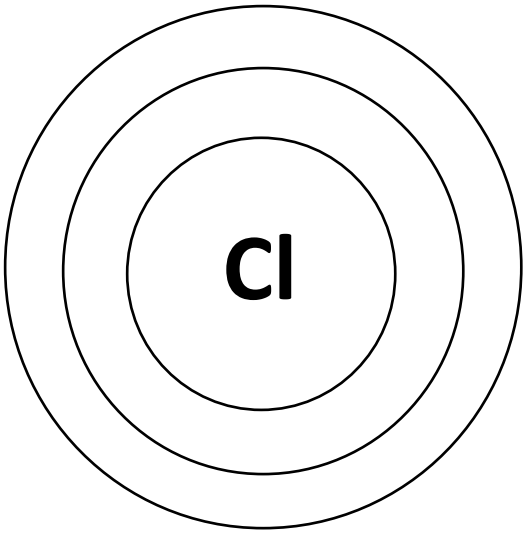
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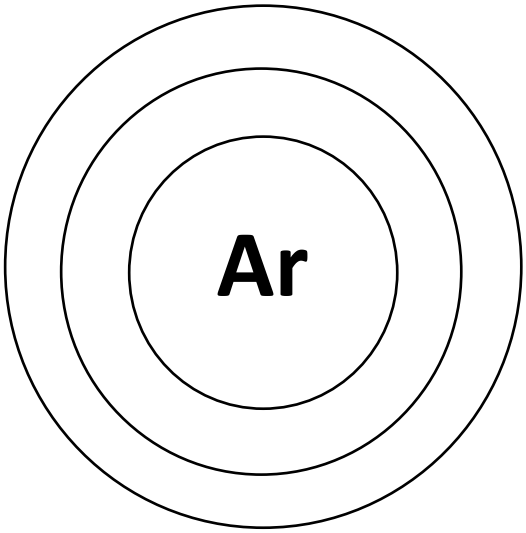
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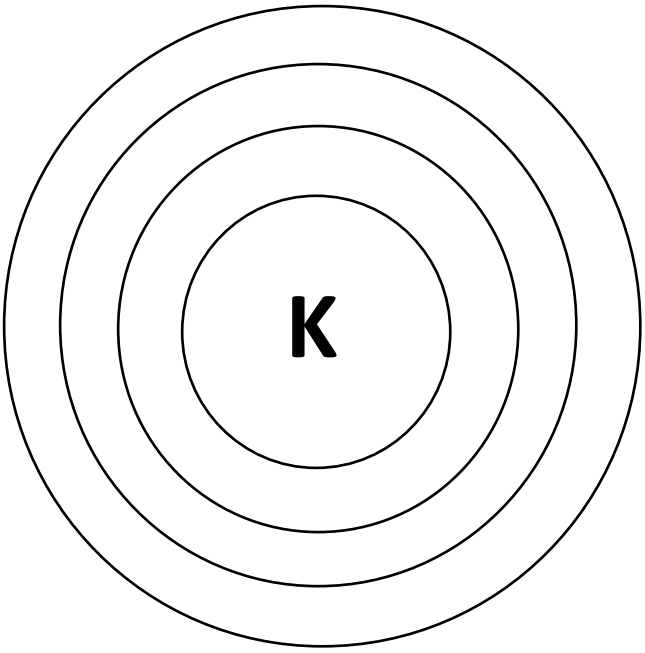
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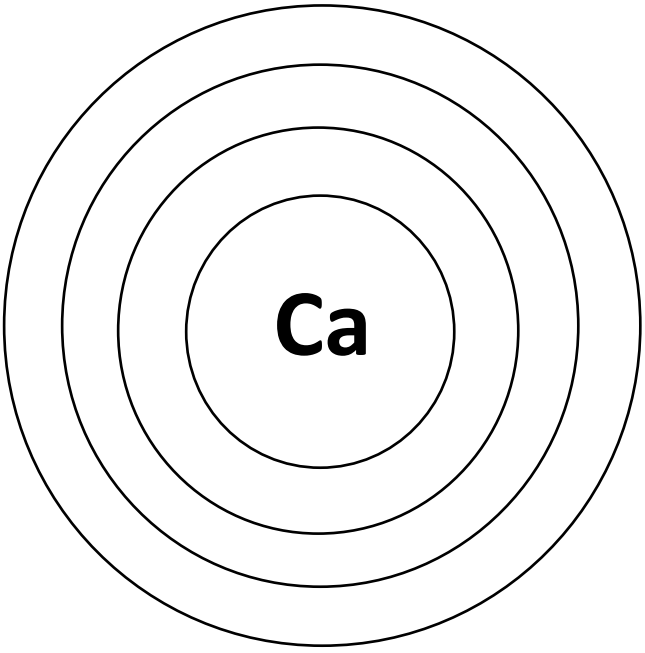
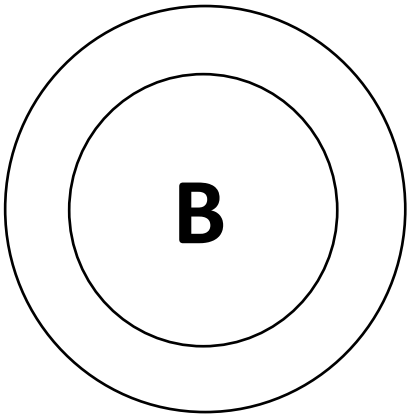

Ca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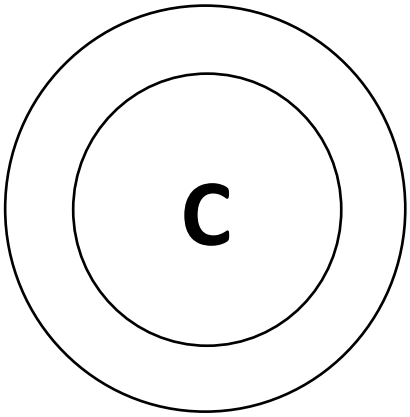

C

Electron configuration Name:

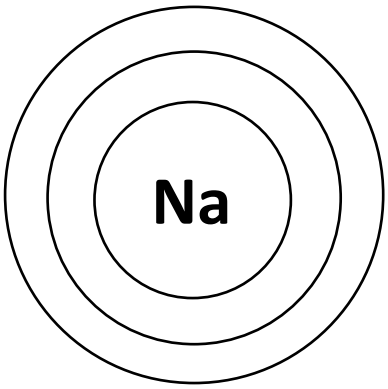
The golden rules:

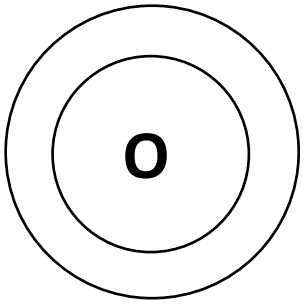
First you need to count the number of _____, you can get this from the element's _____ _____.

The first shell can take a maximum of _____ electrons.

All other shells can take up to _____ electrons.

Draw the electron configuration for sodium (Na) and Oxygen (O):
Sodium has 11 electrons, Oxygen has 8 electrons.





___, ___, ____ ____, ___

How elements are arranged on the periodic table

Lithium (Li), Sodium (Na) and Potassium (K) are all in group ____ because they all have ____ electron in their outer shells.

Beryllium (Be), Magnesium (Mg) and calcium (Ca) are all in group ____ because they all have ____ electron in their outer shells.

Fluorine (F), Chlorine (Cl) and Bromine (Br) are all in group ____ because they all have ____ electron in their outer shells.

Helium (He), Neon (Ne) and Argon (Ar) are all in group ____ because they all have ____ electron in their outer shells.

Elements in the same group _____ similarly because they have the same number of _____ in their outer shells.

Elements in group ___ are very _____ because they have _____ outer shells.

Electron configuration Name:

The golden rules:

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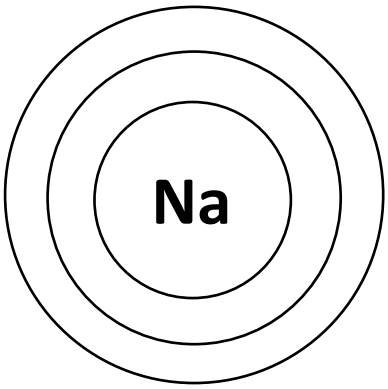

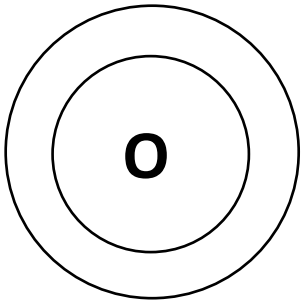

___, ___, ____ ____, ___

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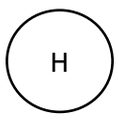
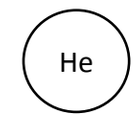
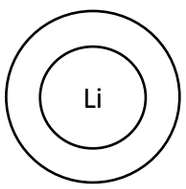
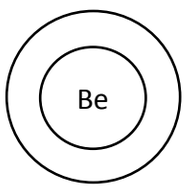
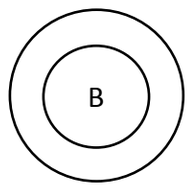
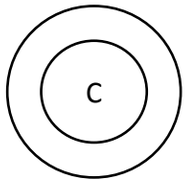
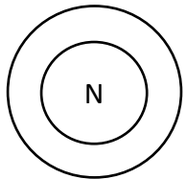
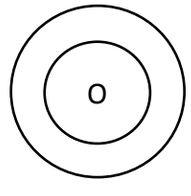
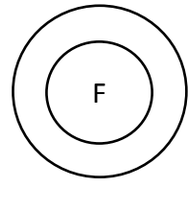
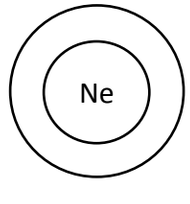
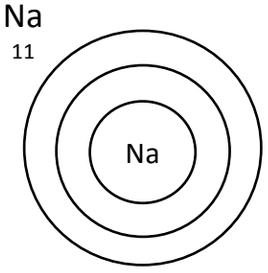
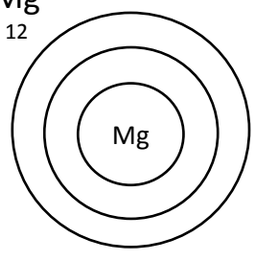
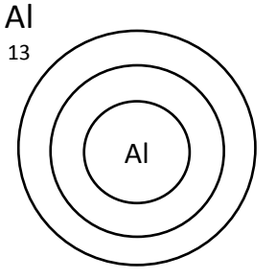
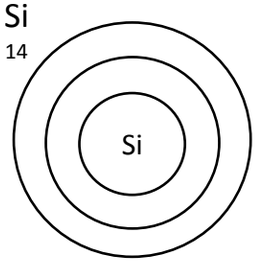
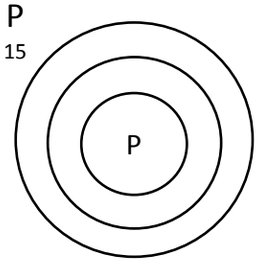
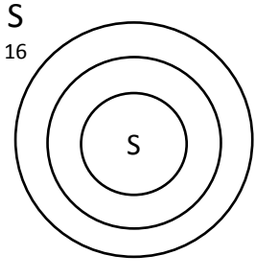
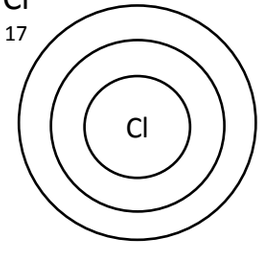
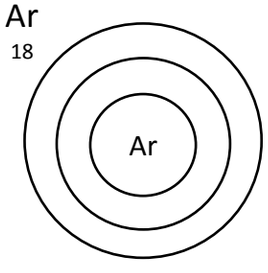
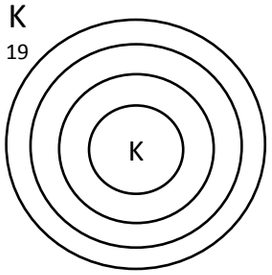
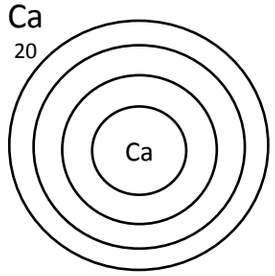
Elements in the same group _____ similarly because they have the same number of _____ in their outer shells.

Elements in group ___ are very _____ because they have _____ outer shells.

Name: _____ | **5.1.1.6 - Electronic Structure** | Class: _____ Date: ____/____/_____

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
Period 1	1 H 1  ___							4 He 2  ___
Period 2	7 Li 3  ___,___	9 Be 4  ___,___	11 B 5  ___,___	12 C 6  ___,___	14 N 7  ___,___	16 O 8  ___,___	19 F 9  ___,___	20 Ne 10  ___,___
Period 3	23 Na 11  ___,___,___	24 Mg 12  ___,___,___	27 Al 13  ___,___,___	28 Si 14  ___,___,___	31 P 15  ___,___,___	32 S 16  ___,___,___	35.5 Cl 17  ___,___,___	40 Ar 18  ___,___,___
Period 4	39 K 19  ___,___,___, ___	40 Ca 20  ___,___,___,___						

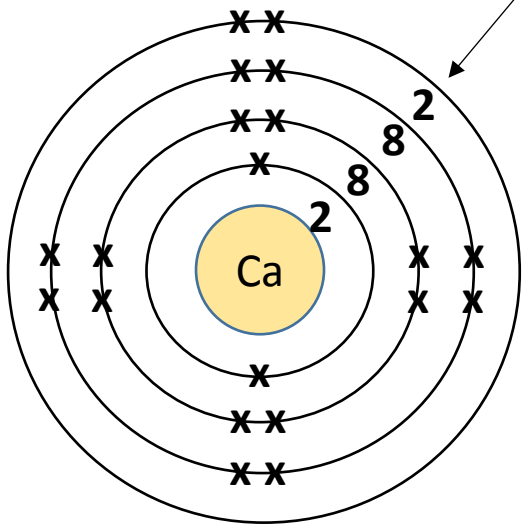
- Electrons are represented by _____
- Electrons will occupy the lowest available _____ _____.
- The first shell takes a maximum of _____ electrons.
- All other shells take a maximum of _____ electrons.
- The groups go _____ in vertical columns.
- The group number tells us how many electrons are in the _____ _____.
- This means elements in the same group have similar _____.
- The periods go _____ the periodic table.
- The period number tells us how many _____ there are.
- Elements in group 0 are very _____ because they have full _____ _____.

Electron Configurations

Only lizards say nuculus. Don't be a lizard!

Negative electrons orbit the positive nucleus in electron shells. The first shell can take up to 2 electrons, all of the other shells take up to 8.

2, 8, 8…. Etc.

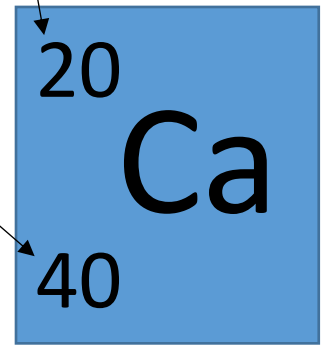


Remember successive shells can take up to 8 electrons. As we have already filled 18 in the first 3 shells, there is only 2 left for the outside.

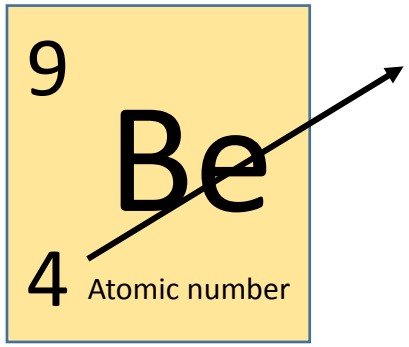
The Smallest number is the atomic number. This tells us how many protons there are. So in a neutral atom, the number of electrons should be the same.

The largest number is the atomic mass, it tells us the combined number of protons and neutrons.

To work out the number of neutrons:
atomic mass – atomic number.

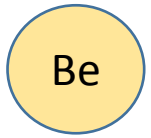


Electron configuration work through 1

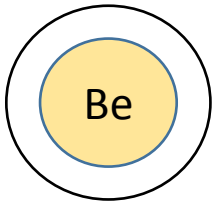


4 positive protons, so in a neutral atom: 4 negative electrons.

1. Draw nucleus

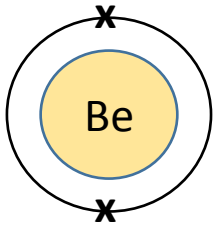


2. Draw 1st shell

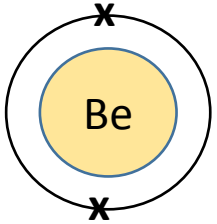


3. Fill with e^-

(first shell takes 2)

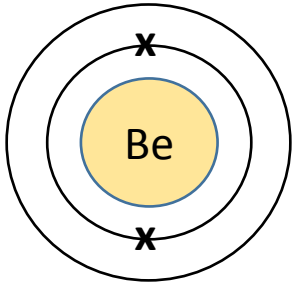


4. Count how many e^- you have left.

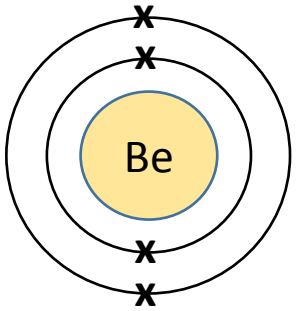


2/4 =
2 left

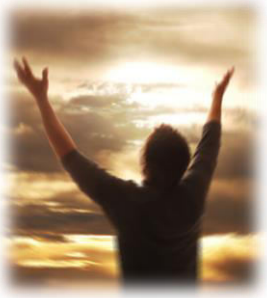
5. Draw next shell



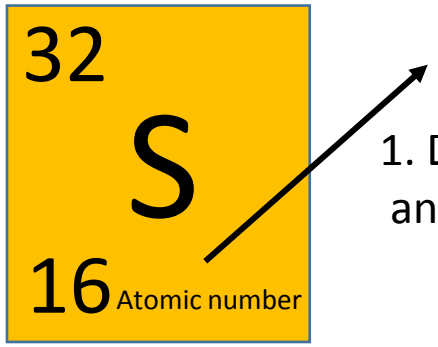
6. Add remaining e^-



7. Rejoice!

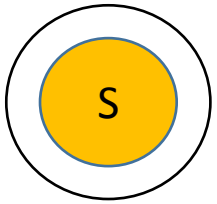


Electron configuration work through 2



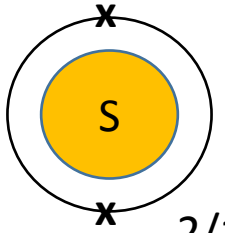
16 positive protons, so in a neutral atom: 16 negative electrons.

1. Draw nucleus and the 1st shell



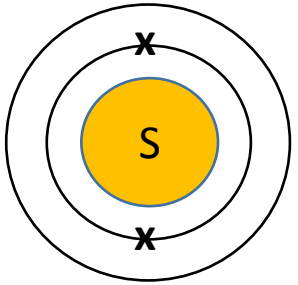
2. Fill with e-

(first shell takes 2)



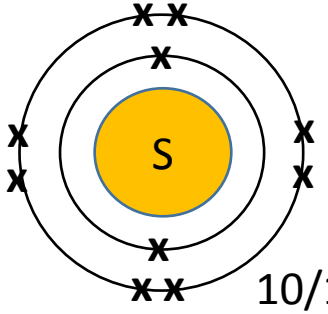
2/16 e-

3. Draw next shell



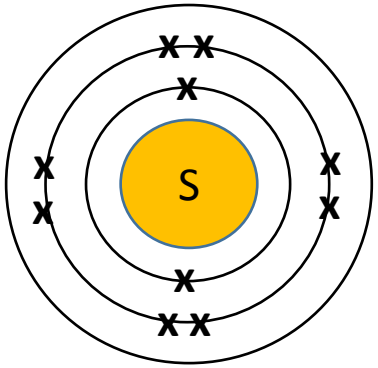
4. Fill with e-

(takes up to 8)



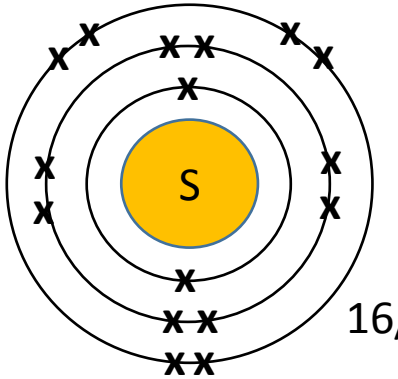
10/16 e-

5. Draw next shell



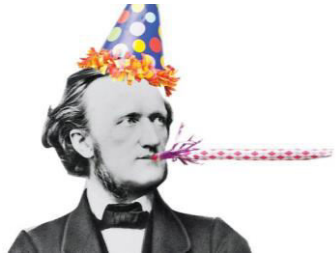
6. Fill with remaining e-

(takes up to 8, but we have 6 left)

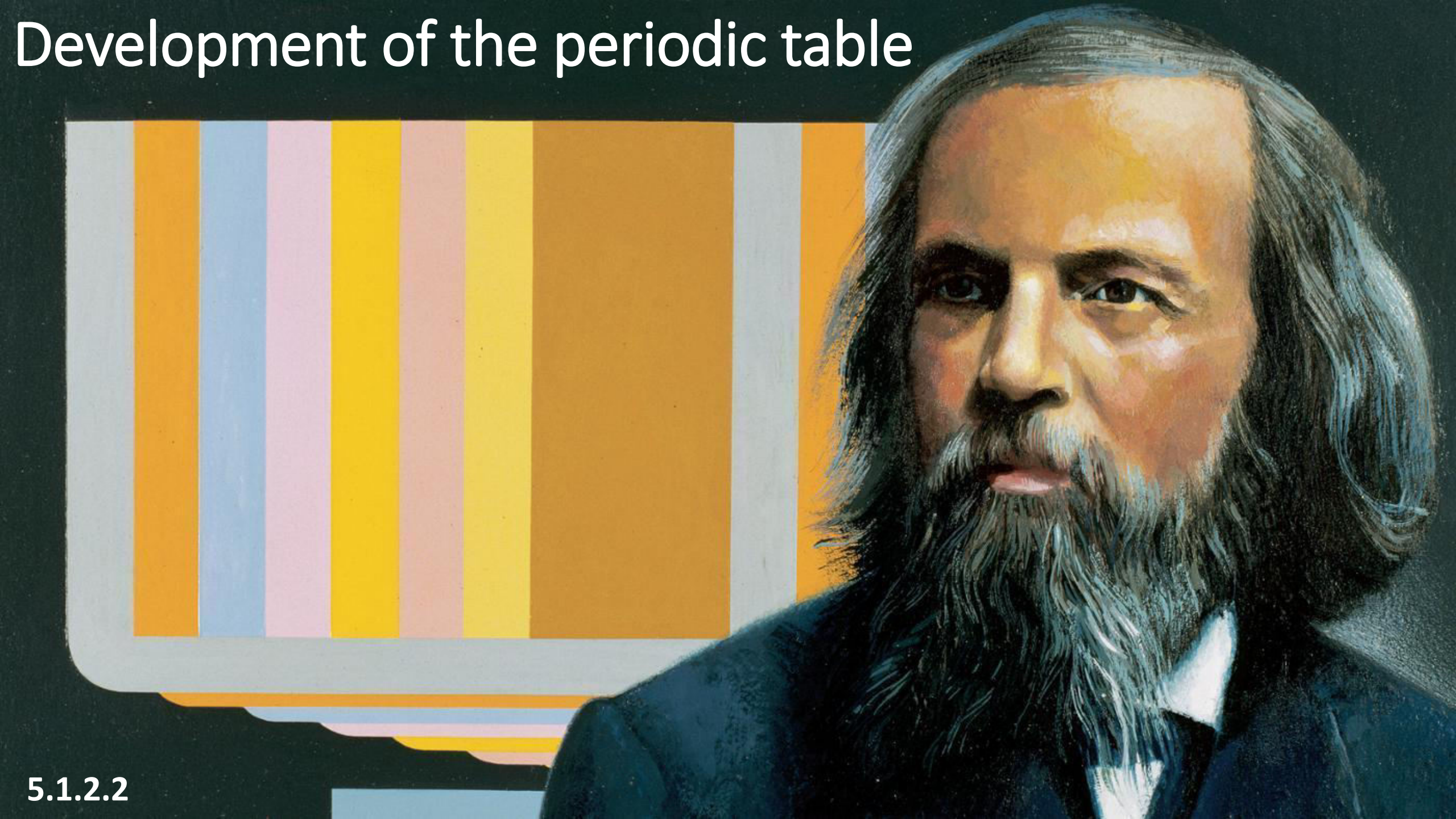


16/16 e-

7. Celebrate!



Development of the periodic table



5.1.2.2

The modern periodic table

- https://www.youtube.com/watch?v=6rdmpx39PRk#t=39
- http://www.rsc.org/periodic-table

Discussion

Hydrogen simplest element – 1 proton.

We arrange elements on the modern periodic table in order of their atomic numbers (number of protons).

Research Task – Development of the periodic table

Key writing skills

1. How is the modern periodic table arranged?

2. Before the discovery of protons, neutrons and electrons, how was the periodic table arranged?

   - What was the key issue with this arrangement?

3. How did Mendeleev fix the issues with early periodic tables?

4. How did knowledge of isotopes help to explain why the original order of atomic weights was not always correct?

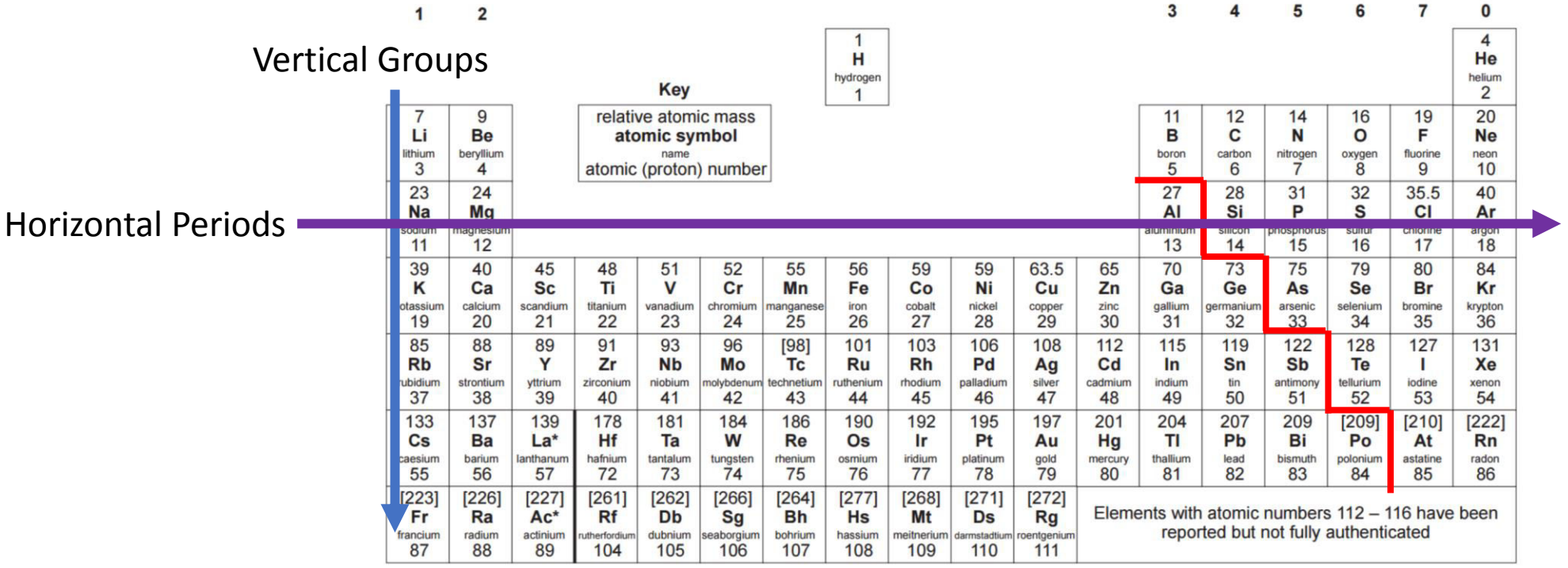
The Modern Periodic Table

- Elements on the modern periodic table are arranged **in order of their atomic number.**
- The atomic number is the **number of protons** an element has, where every element has a different number of protons.
- The elements are also arranged in terms of their **electronic structure and properties.**

  - Elements in the same vertical group have the same number of outer shell electrons and therefore have similar properties.

  - Elements in the same period (going across) have the same number of electron shells.

- **Metals and non-metals are also separated**, as shown by the red "staircase" division line.



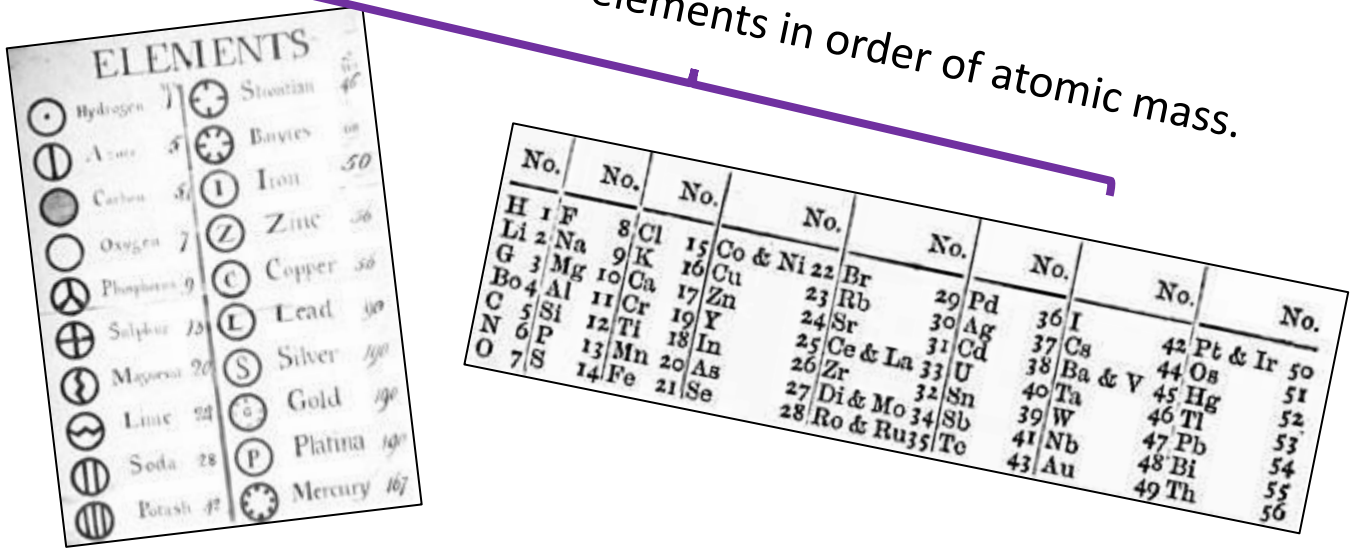
Key points

- Arranged by atomic number
- Groups (similar properties)
- Periods
- Metals & Non-metals

Early Periodic Tables

- Before the discovery of protons, neutrons and electrons, scientists tried to classify the elements in order of their atomic mass.
- The early periodic tables were incomplete (many elements were missing!) as many elements had not yet been discovered.
- Because they followed atomic mass, elements were **not** placed in groups of elements with similar properties.
- The metals & the non-metals got mixed up too.

Early periodic tables arranged elements in order of atomic mass.



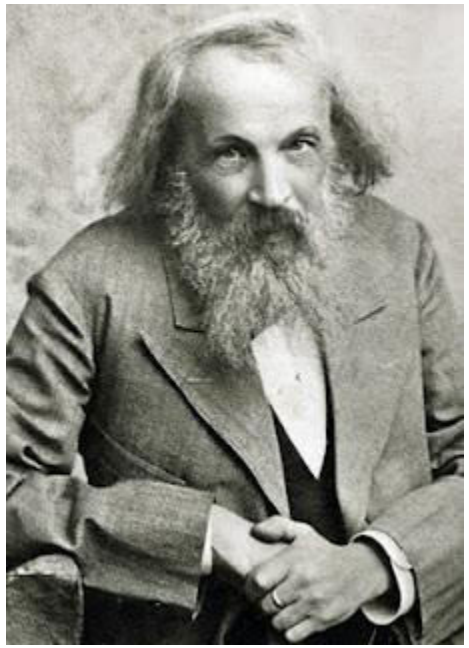
Key points

- Arranged by atomic mass.
- Incomplete
- Many elements hadn't been discovered.
- No groups of elements with similar properties.
- Metals & non-metals mixed together.

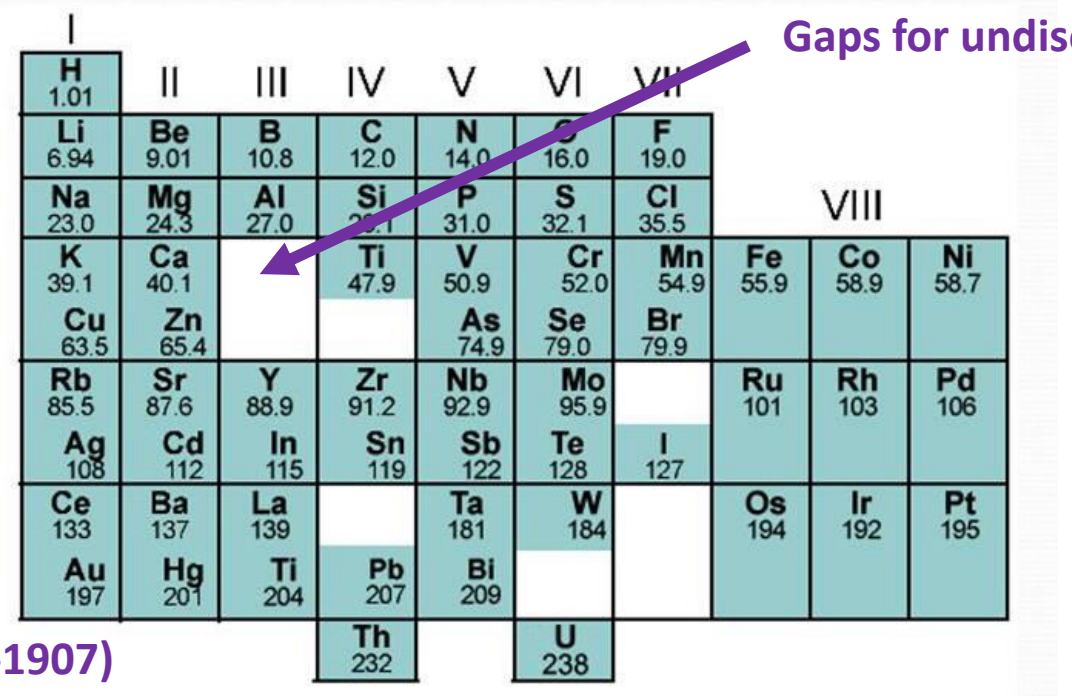
Mendeleev's Periodic Table

- The problem with previous periodic tables was that elements were placed in the wrong groups, because the order of atomic mass was strictly followed.
- Mendeleev fixed this by leaving gaps in his groups for undiscovered elements.
- This meant that when a new element was discovered, it could be grouped with other elements that had similar properties – fitting the pattern!

Mendeleev



Russian Chemist (1834-1907)



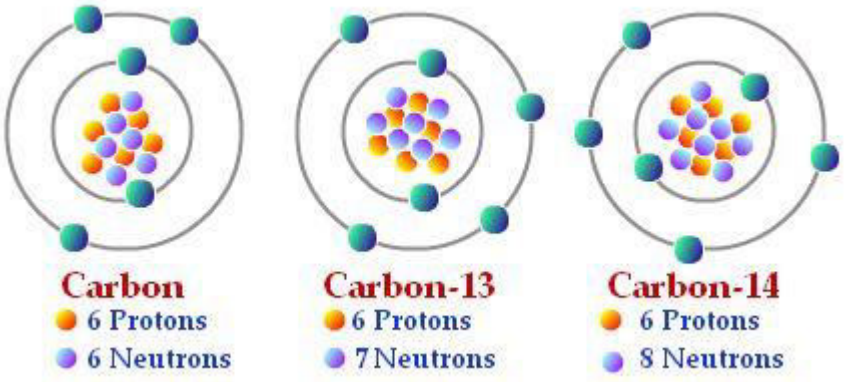
Key points

- Mendeleev
- Grouped elements by properties.
- Left gaps for undiscovered elements.
- Newly discovered elements fit their predicted properties – so fit the pattern.

Isotopes – Why arranging in order of atomic mass didn't work!

- Elements come in different isotopes.
- All isotopes of an element have the same number of protons and electrons but a different number of neutrons.
- This changes the atomic mass of the element.
- For instance, carbon has 15 isotopes each with different atomic masses.
- If you tried to arrange elements in order of atomic mass, the isotopes would spoil the order.

Carbon has many isotopes, each with a different atomic mass.



This means you cannot arrange elements in order of atomic mass, because elements wouldn't fit the pattern of properties in their groups.

Kahoot

https://play.kahoot.it/#/k/8bad371b-b948-4588-b974-36a8b92bd9ca

Extended Writing Task

- Describe the differences between the early periodic tables and our current periodic table.
- Explain why the periodic table has changed throughout the years.

Teacher guidance

- Use questioning to create mind map on the whiteboard as essay plan.
- Ensure students read back their responses before handing to peer assessor.
- Get students to peer assess on key points and highlight where they have included key info.
- Improve answers in green pen.
- If you are teaching this more than once, please scan a WAGOLL and upload to G-Drive

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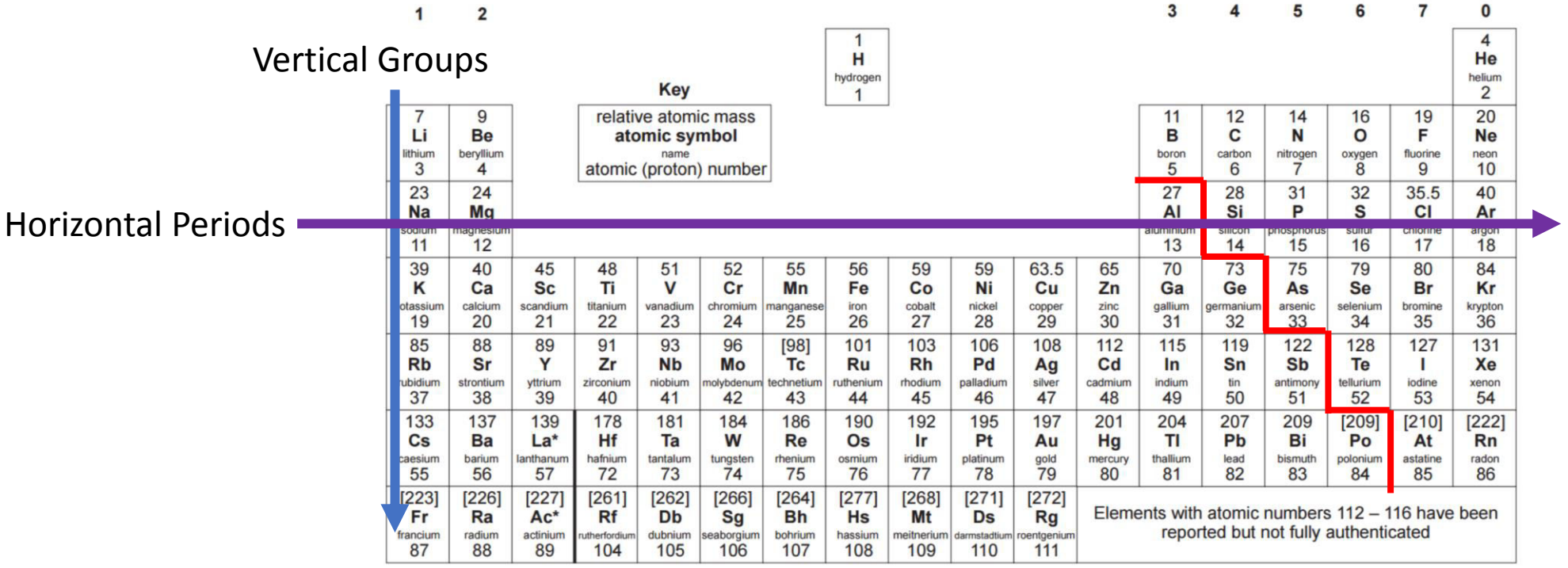

Key points

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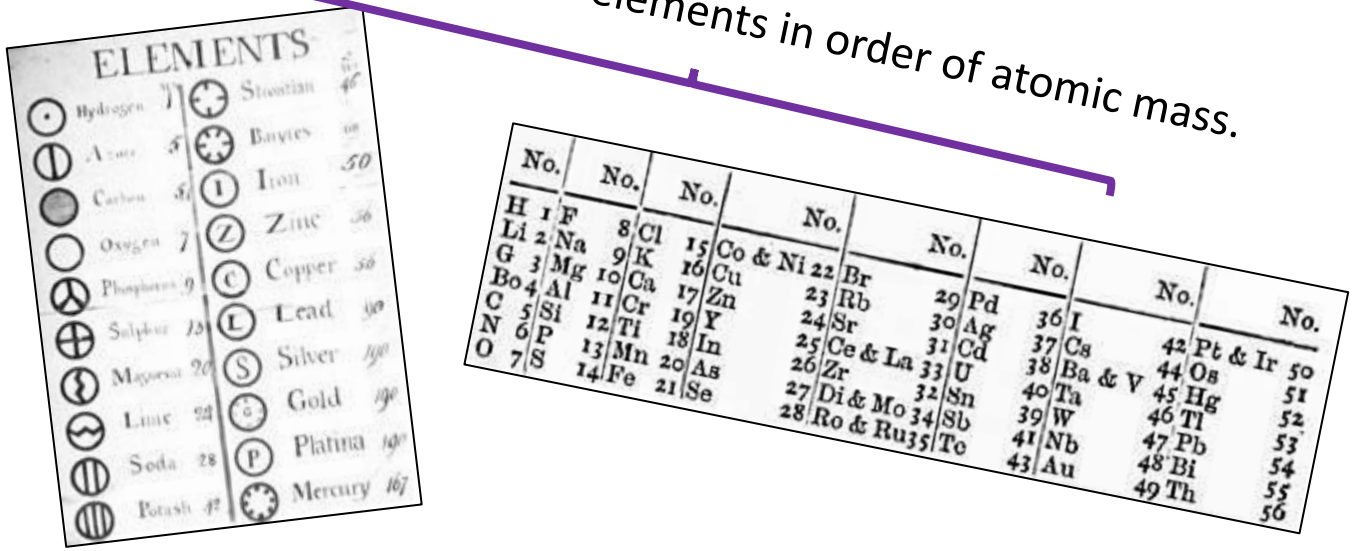
Early periodic tables arranged elements in order of atomic mass.



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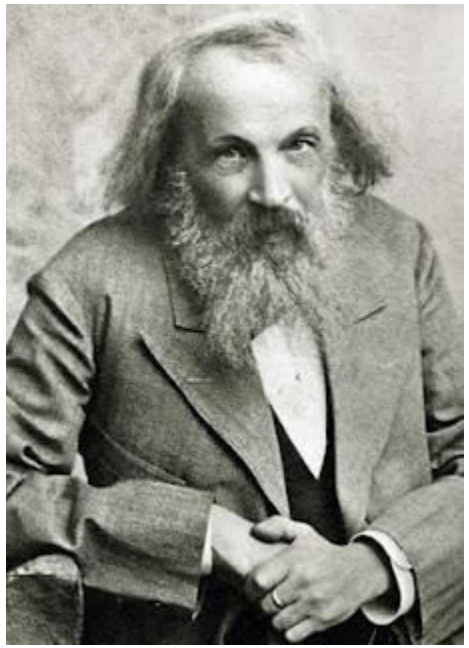
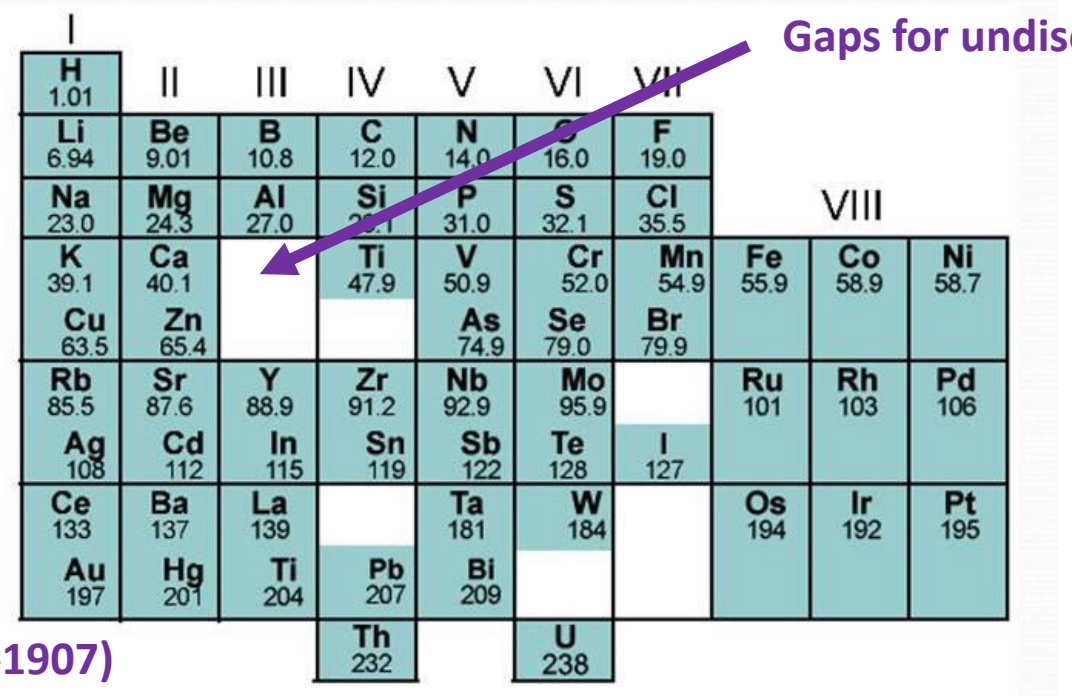
- This meant that when a new element was discovered, it could be grouped with other elements that had similar properties – fitting the pattern!

Mendeleev



Russian Chemist (1834-1907)



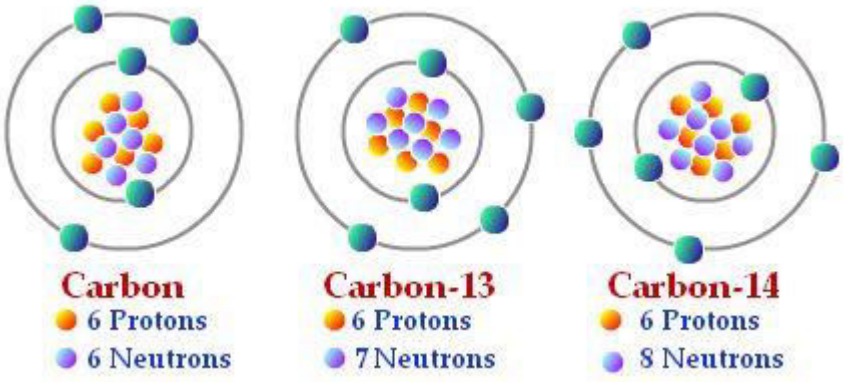
Key points

- Mendeleev
- Grouped elements by properties.
- Left gaps for undiscovered elements.
- Newly discovered elements fit their predicted properties – so fit the pattern.

Isotopes – Why arranging in order of atomic mass didn't work!

- Elements come in different isotopes.
- All isotopes of an element have the same number of protons and electrons but a different number of neutrons.
- This changes the atomic mass of the element.
- For instance, carbon has 15 isotopes each with different atomic masses.
- If you tried to arrange elements in order of atomic mass, the isotopes would spoil the order.

Carbon has many isotopes, each with a different atomic mass.



This means you cannot arrange elements in order of atomic mass, because elements wouldn't fit the pattern of properties in their groups.

Name: Date: __/__/____

History of the Periodic Table

1. Elements on the modern periodic table are put in order of their _____ _____.

2. The older "Early" periodic tables arranged elements in order of their _____ _____.

   These periodic tables were _____ as many elements had not yet been _____.

   This meant that elements were not grouped according to their _____, and the _____ and _____ were mixed up.

3. Mendeleev improved the earlier periodic tables by _____ _____ for undiscovered elements.

   This allowed him to predict the _____ of undiscovered elements.

   When new elements were discovered, he placed them in the gaps and the predicted properties were _____.
   This was _____ for his theory.

Keywords

Properties, Correct, Atomic Mass, Atomic Number, Discovered, Incomplete, Properties, Leaving Gaps, Metals, Evidence, Non-metals.

Name: Date: __/__/____

History of the Periodic Table

1. Elements on the modern periodic table are put in order of their _____ _____.

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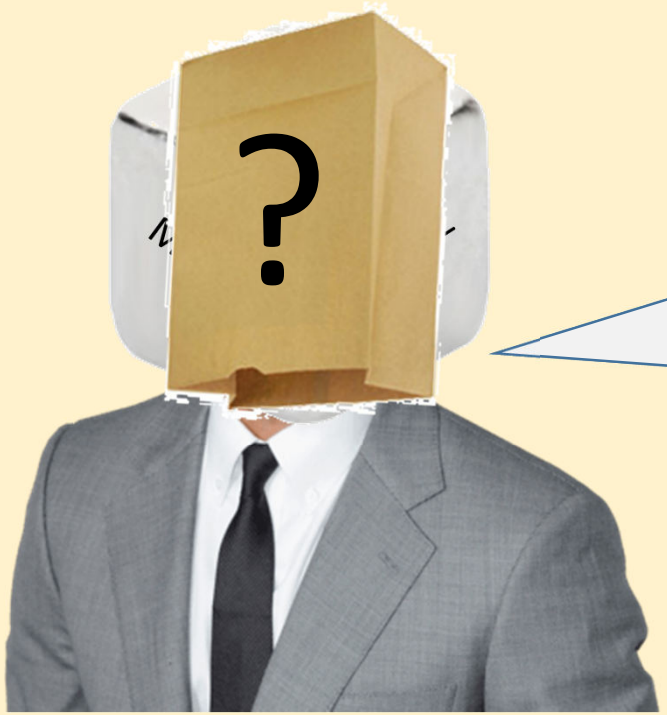
Guess Who?



I'm Lustrous (Shiny)

I'm hard!

I have a high density

I have a high melting point

I'm a great conductor of heat and electricity

Metals and Non-metals

5.1.2.3

The Big Question

Why are they called “non-metals”, instead of having their own name?

The properties of metals & non-metals

Put the properties into the correct columns.

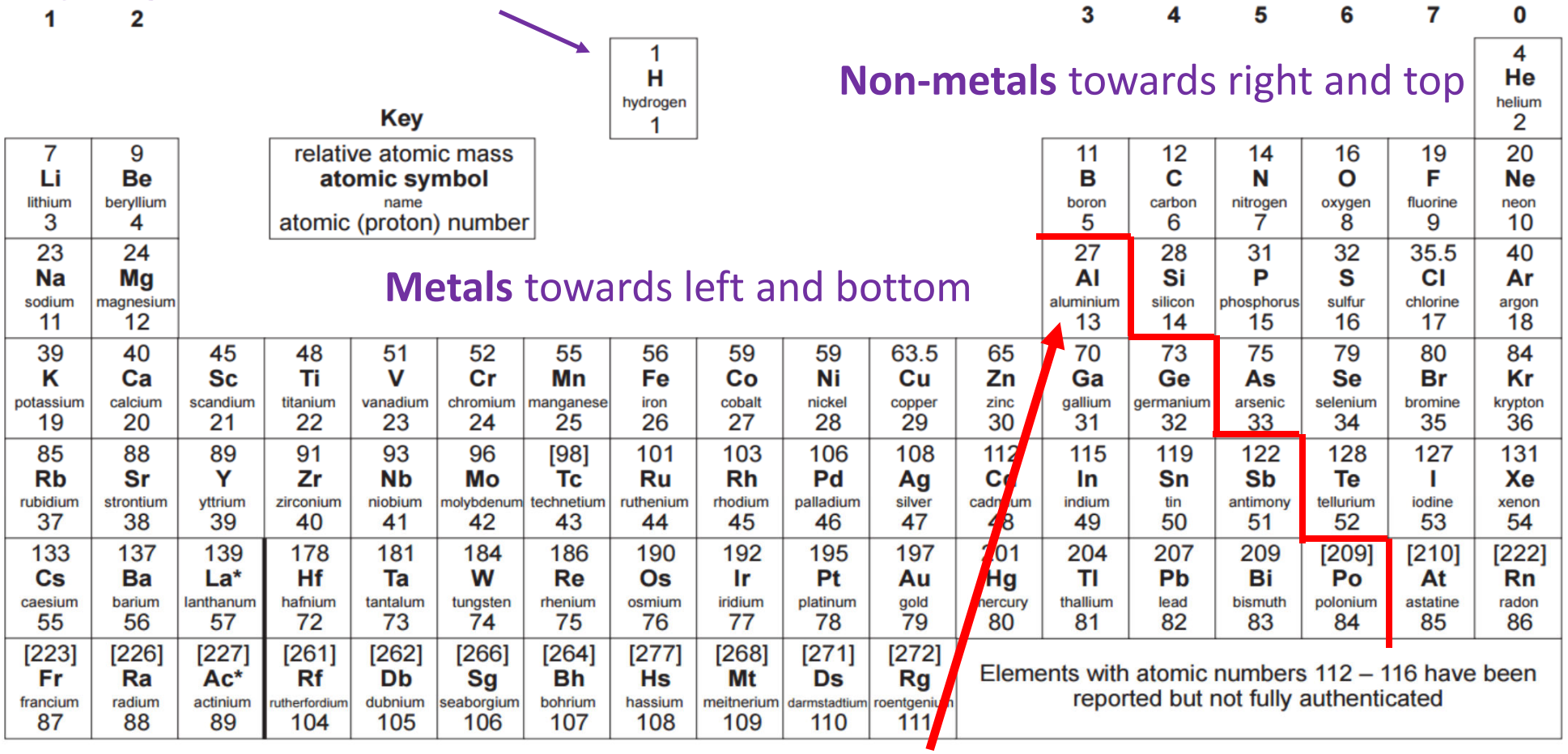
- Lustrous (Shiny)
- Strong
- Poor conductor of heat & electricity
- Weak
- Brittle
- Malleable
- Good conductor of heat
- Good conductor of electricity
- Low density
- High Density
- Solid (Except mercury)
- Can be solid, liquid or gas
- Sonorous
- Dull appearance
- Makes a dull sound

Metals	Non-metals

Metals	Non-metals
• Shiny • Solid (except mercury) • High density • Strong • Malleable • Good conductor of heat • Good conductor of electricity • Sonorous	• Dull appearance • Can be solid, liquid or gas. • Low density • Weak • Brittle • Poor conductor of heat • Poor conductor of electricity • Make a dull sound.

Where are the metals & non-metals?

Hydrogen is a non-metal!



Memory tip: Aluminium is under the stairs!

The Big Question

Why are they called “non-metals”, instead of having their own name?

Because the majority of elements are metals!

1																	0
																	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
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

H hydrogen 1

Group Discussion

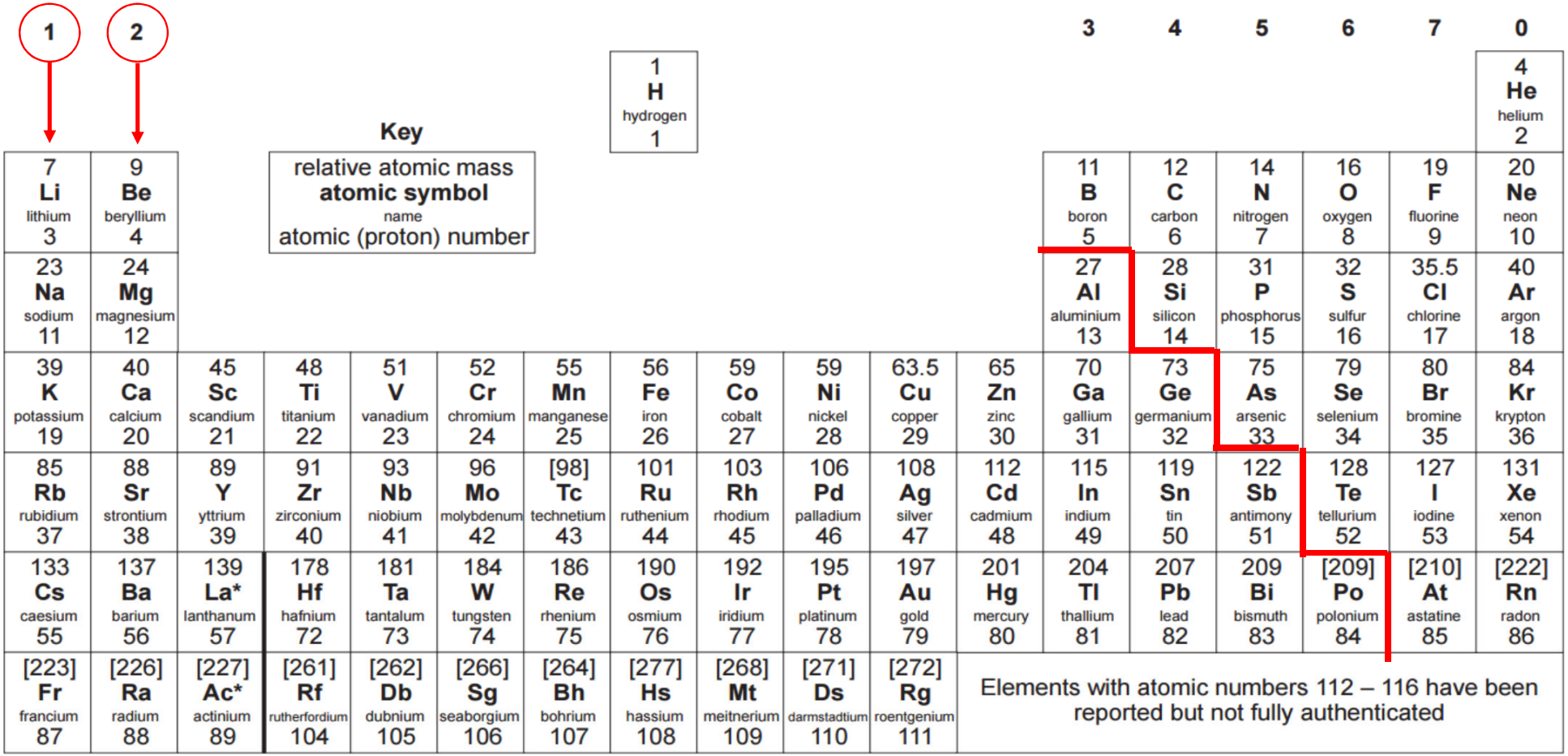
Why are the metals mostly to the left of the periodic table?

- Think in terms of their "electronic structure".
- Your group should write down one refined answer on a mini-whiteboard.

Extension
Draw the electron configurations of sodium, magnesium and aluminium.
Use this as justification for your answer.

Why are the metals mostly to the left of the periodic table?

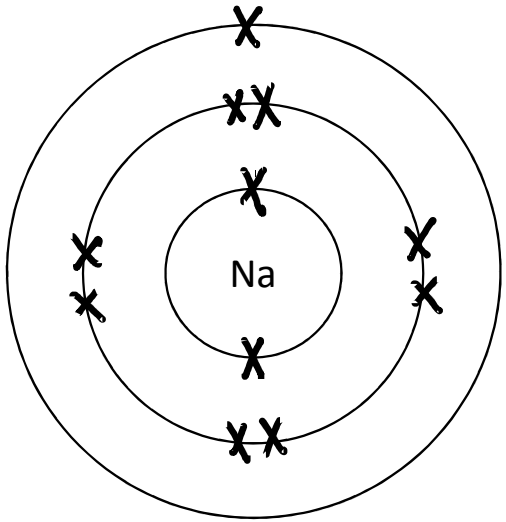
Metals don't have many electrons in their outer shells e.g. group 1 metals all have 1 electron in their outer shell.



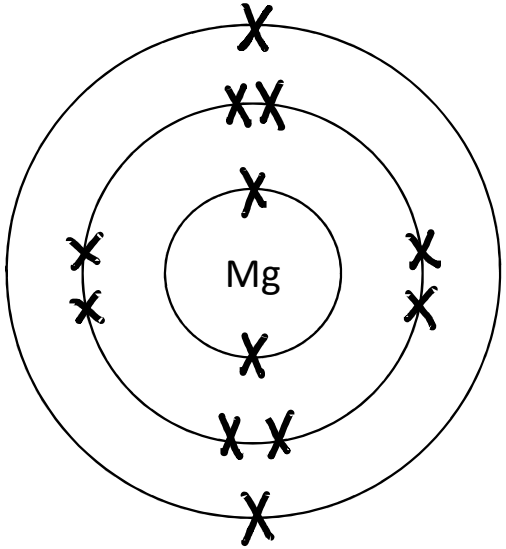
Metals don't have many electrons in their outer shells, so they are towards the left of the periodic table.

Why is this important?

Group 1

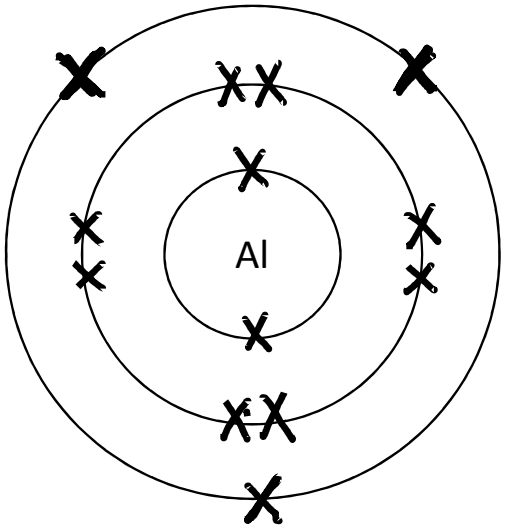


2,8,1



2,8,2

Group 3



2,8,3

Because metals are losers!

OSER

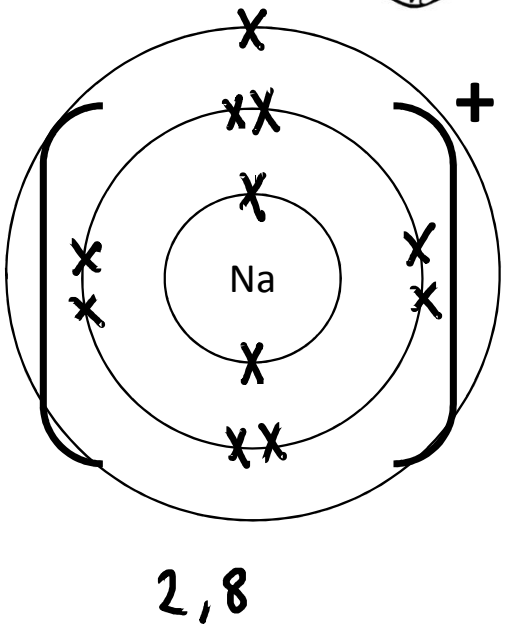
When elements react, they want to achieve full outer shells

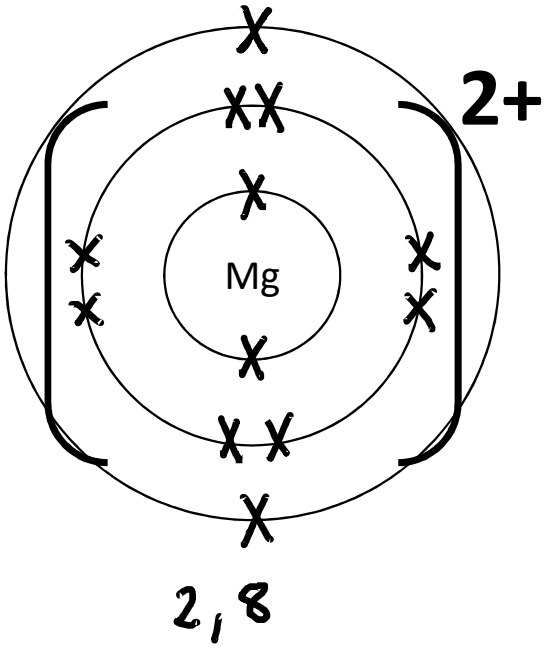
When elements react, they want to achieve full outer shells

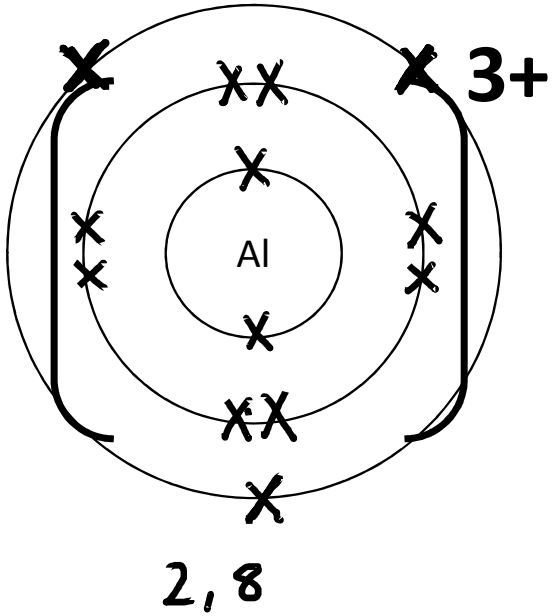
Metals form POSITIVE ions

What's the easiest way for metals to achieve full outer shells?

Metals  OSE their outer shell electrons when they react to achieve a full outer shell

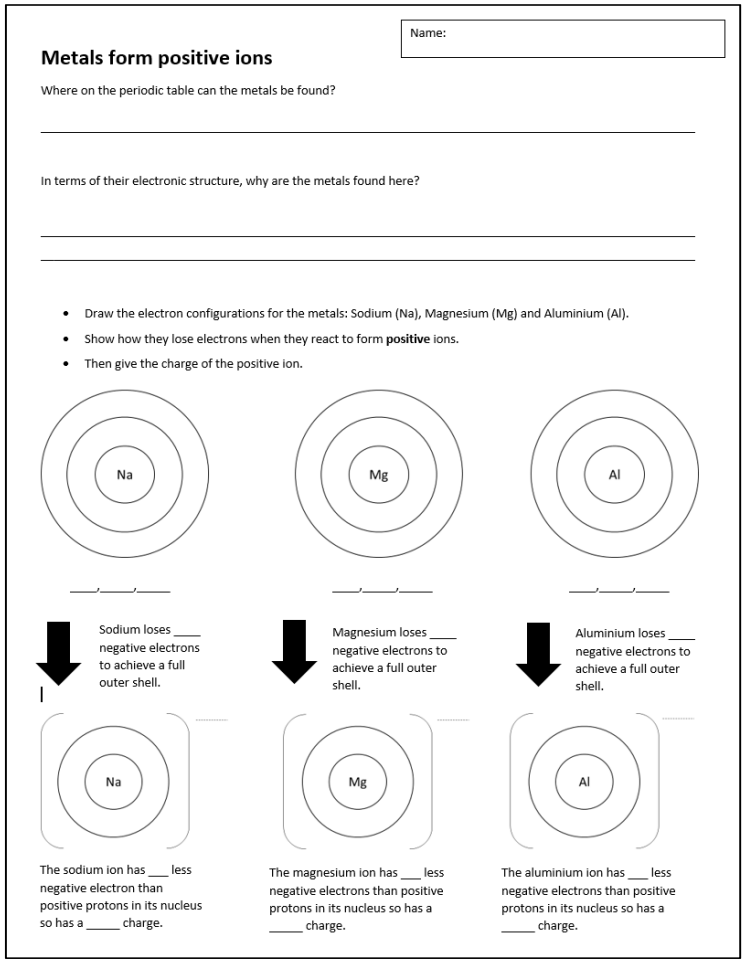






Your choice:

Support



Name:

Metals form positive ions

Where on the periodic table can the metals be found?

In terms of their electronic structure, why are the metals found here?

- Draw the electron configurations for the metals: Sodium (Na), Magnesium (Mg) and Aluminium (Al).
- Show how they lose electrons when they react to form **positive** ions.
- Then give the charge of the positive ion.

Na ___,___,___

Sodium loses ____ negative electrons to achieve a full outer shell.

Na

The sodium ion has ___ less negative electron than positive protons in its nucleus so has a _____ charge.

Mg ___,___,___

Magnesium loses ____ negative electrons to achieve a full outer shell.

Mg

The magnesium ion has ___ less negative electrons than positive protons in its nucleus so has a _____ charge.

Al ___,___,___

Aluminium loses ____ negative electrons to achieve a full outer shell.

Al

The aluminium ion has ___ less negative electrons than positive protons in its nucleus so has a _____ charge.

If you think you don't need support:

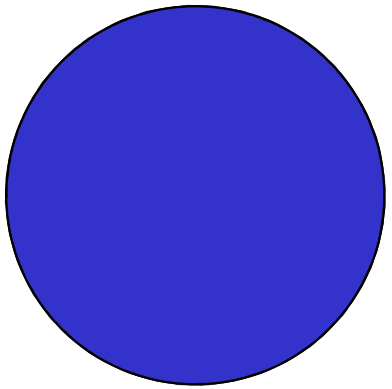
1. Write a short paragraph to explain why metals form positive ions.
2. How can the charge of a metal ion be easily worked out by looking at the periodic table?
3. Draw the electron configuration for Potassium and then draw its ion and give its charge.
4. Draw the electron configuration for Calcium and then draw its ion and give its charge.

Self Assess

You're the teacher!

- In twos/threes, prepare a short explanation of how to draw electron configuration for the ion of a metal (of your choice)
- How do you work out its charge?
- You will explain your working to the class and draw on the whiteboard.

5 minutes



Name:

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Where on the periodic table can the metals be found?

_____

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_____

_____

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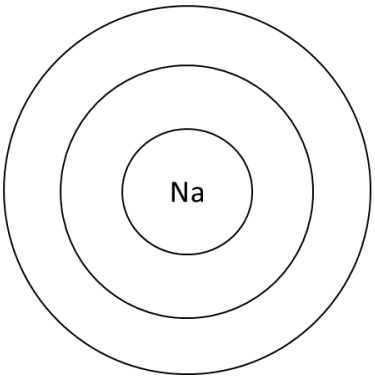
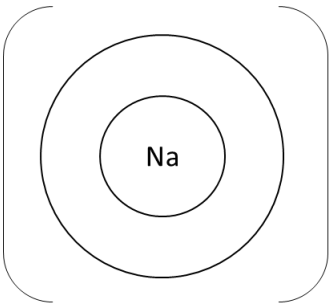
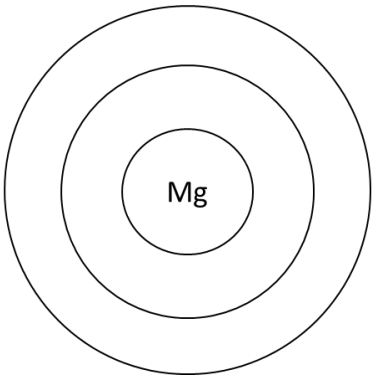


____,_____,_____

Sodium loses ____ negative electrons to achieve a full outer shell.

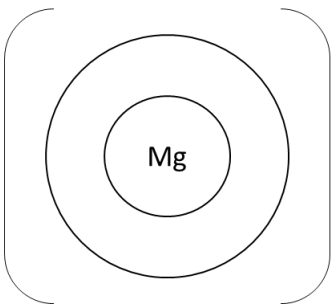


The sodium ion has ___ less negative electron than positive protons in its nucleus so has a _____ charge.

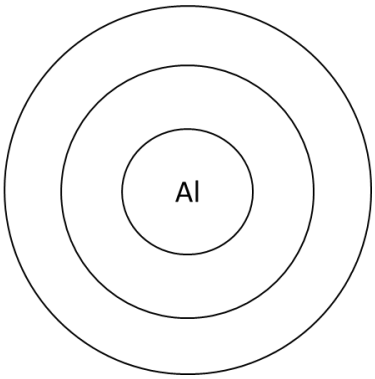


____,_____,_____

Magnesium loses ____ negative electrons to achieve a full outer shell.

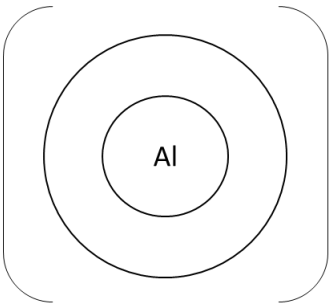


The magnesium ion has ___ less negative electrons than positive protons in its nucleus so has a _____ charge.



____,_____,_____

Aluminium loses ____ negative electrons to achieve a full outer shell.



The aluminium ion has ___ less negative electrons than positive protons in its nucleus so has a _____ charge.

The properties of metals & non-metals

Metals	Non-metals

- Lustrous (Shiny)
- Strong
- Poor conductor of heat & electricity
- Weak
- Brittle
- Malleable
- Good conductor of heat
- Good conductor of electricity
- Low density
- High Density
- Solid (Except mercury)
- Can be solid, liquid or gas
- Sonorous
- Dull appearance
- Makes a dull sound

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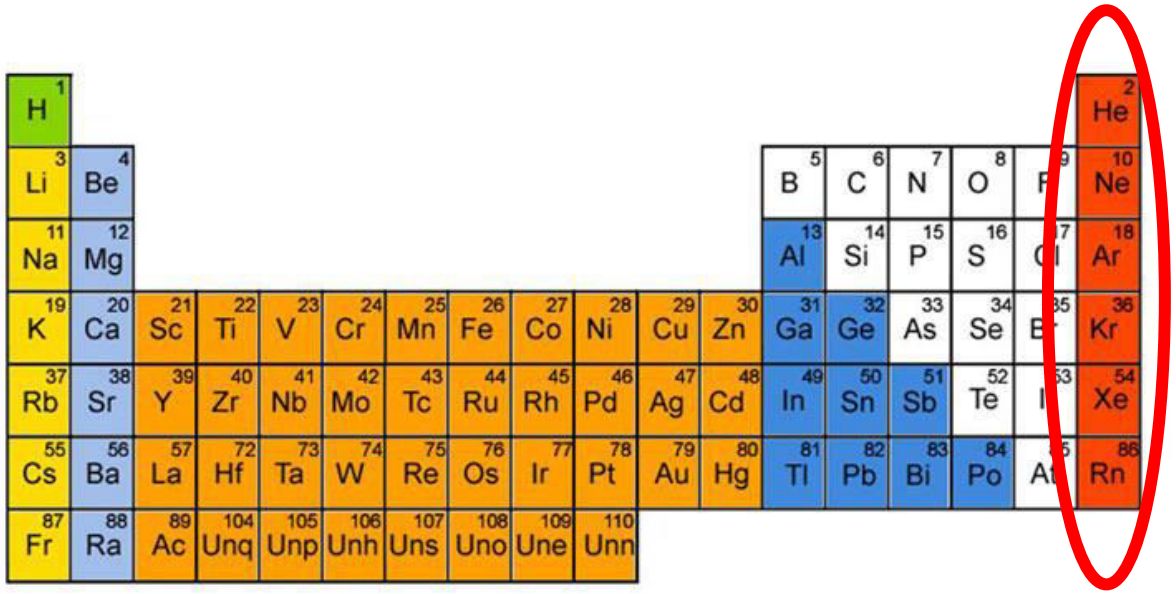
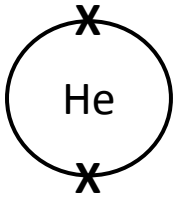
Group 0 – The Noble Gases

5.1.2.4

Starter: Draw the electron configurations of the noble gases: Helium (He), Neon (Ne) and Argon (Ar)

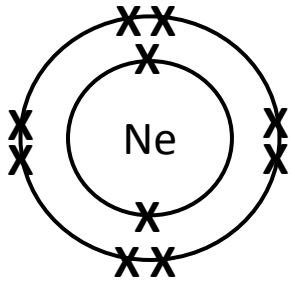


4
He
2



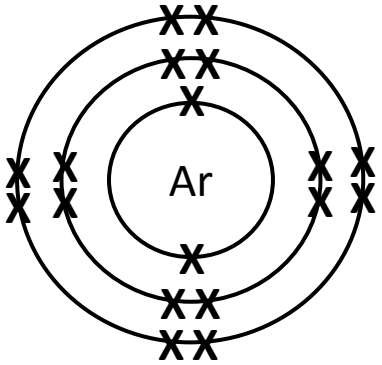
2

20
Ne
10



2, 8

40
Ar
18



2, 8, 8

FULL OUTER SHELLS

Complete the mind map by listening to the experts

Group 0
The Noble Gases

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

Don't form molecules because their full outer shell gives them a "stable electron arrangement"

Very unreactive because they have full outer shells.

Helium (He) is used in party balloons.

Neon (Ne) is used in advertising signs e.g. Vegas!

Argon (Ar) is used in lightbulbs to stop the filament reacting with oxygen.

Krypton (Kr) is used in lasers designed for laser eye surgery.

Graph Skills – Complete the graph to show the trend in boiling points down group 0.

Noble Gas	Boiling Point (°C)
He	-268.6
Ne	-245.7
Ar	-188.3
Kr	-151.5
Xe	-106.4
Rn	-61.5

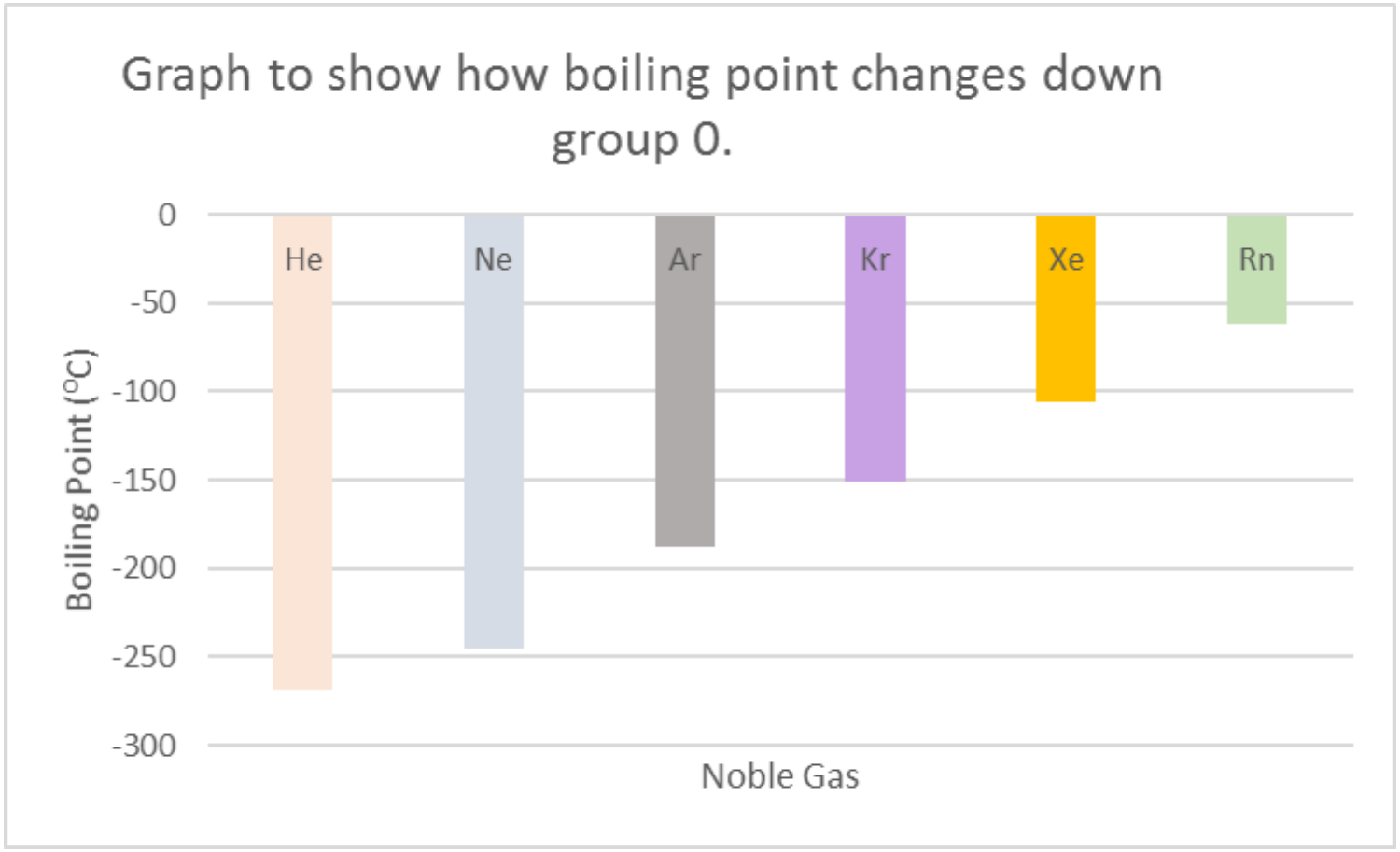
Before you begin, what type of data is this?

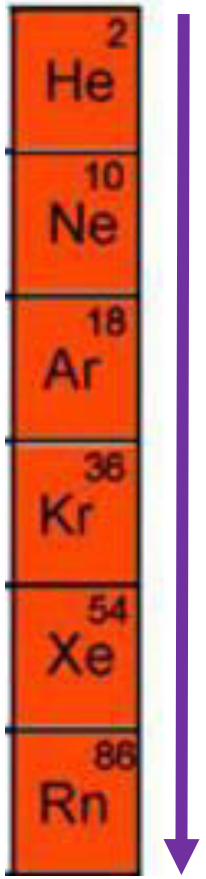
CATEGORIC

Therefore, what type of graph should you draw?

BAR GRAPH

Be careful with the scale, this is the highest temperature!

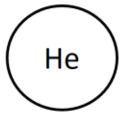




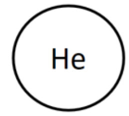
Conclusion

As you go down group 0, the boiling points increase.

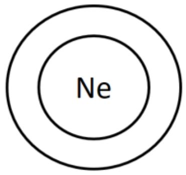
4
He
2



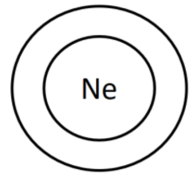
4
He
2



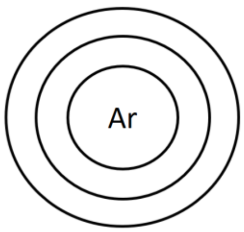
20
Ne
10



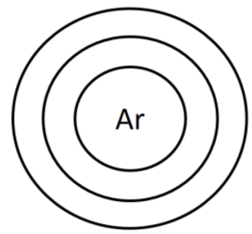
20
Ne
10



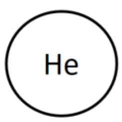
40
Ar
18



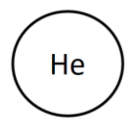
40
Ar
18



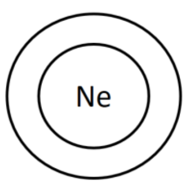
4
He
2



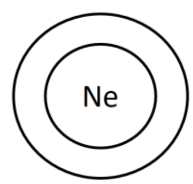
4
He
2



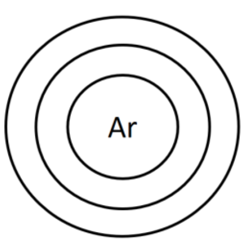
20
Ne
10



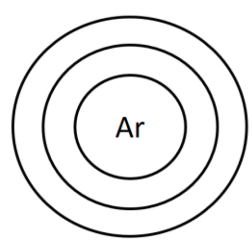
20
Ne
10



40
Ar
18



40
Ar
18



Low Density

- The density of a substance is how heavy it is for its size.
- The alkali metals all have low densities (as far as metals go, they are quite light).
- The first three alkali metals (Li, Na & K) are all less dense than water – this is why they float on the surface.

Li, Na & K float on the surface of water because they are **less dense** than water.

Reactions with Water

- The alkali metals react with water to form a hydroxide (which makes the solution alkaline) and hydrogen gas.

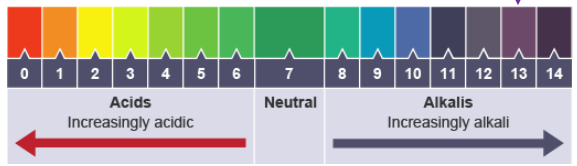
$$2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2\ (g)}$$

sodium + water → sodium hydroxide + hydrogen

- Universal indicator turns purple in alkaline solutions.

- The hydrogen gas can be tested for by using a lit splint, it will give a squeaky pop sound if hydrogen is present.

The hydroxide formed makes the solution alkaline, which turns universal indicator purple.

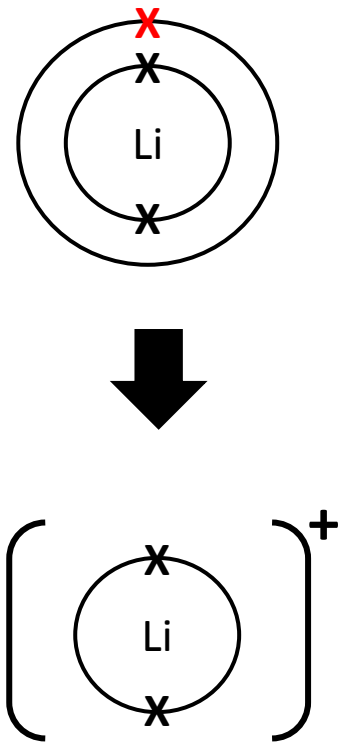


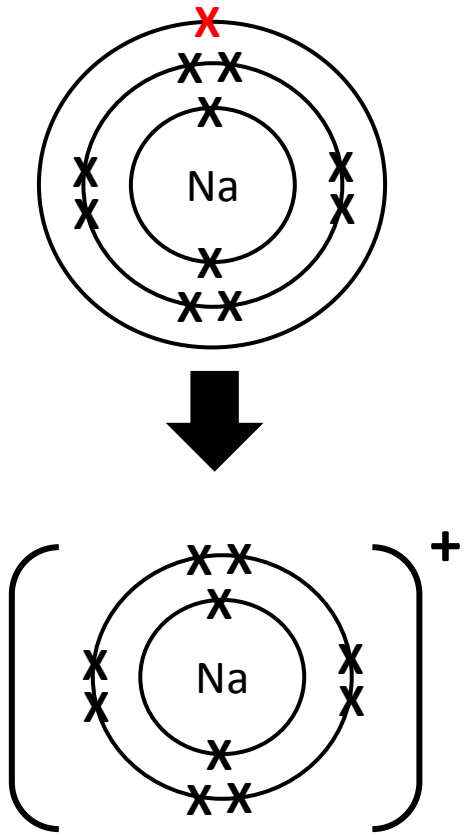
Reactivity – Down the Group

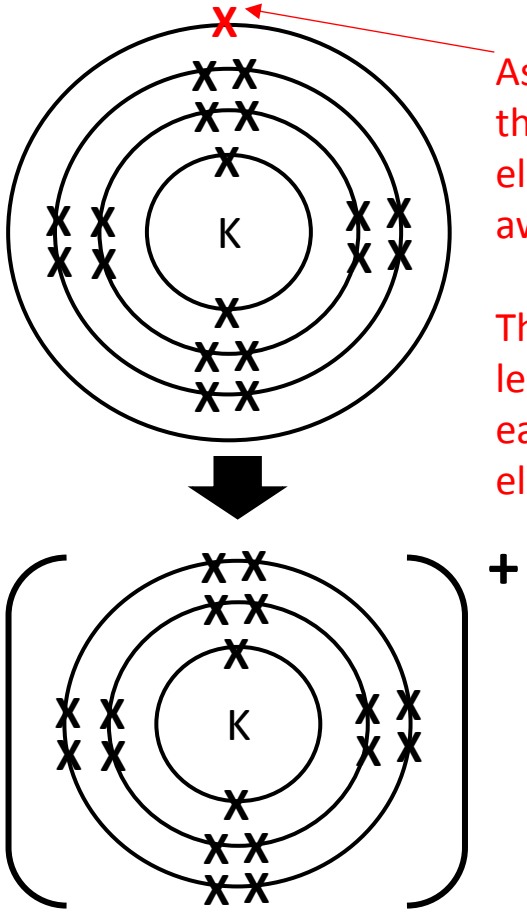
1 In group 1, the further down the group an element is, the more reactive it is.

Grade 9: This is because the further from the nucleus the outer electron is, the more easily the electron is lost!

7	**Li** lithium 3
23	**Na** sodium 11
39	**K** potassium 19
85	**Rb** rubidium 37
133	**Cs** caesium 55
[223]	**Fr** francium 87







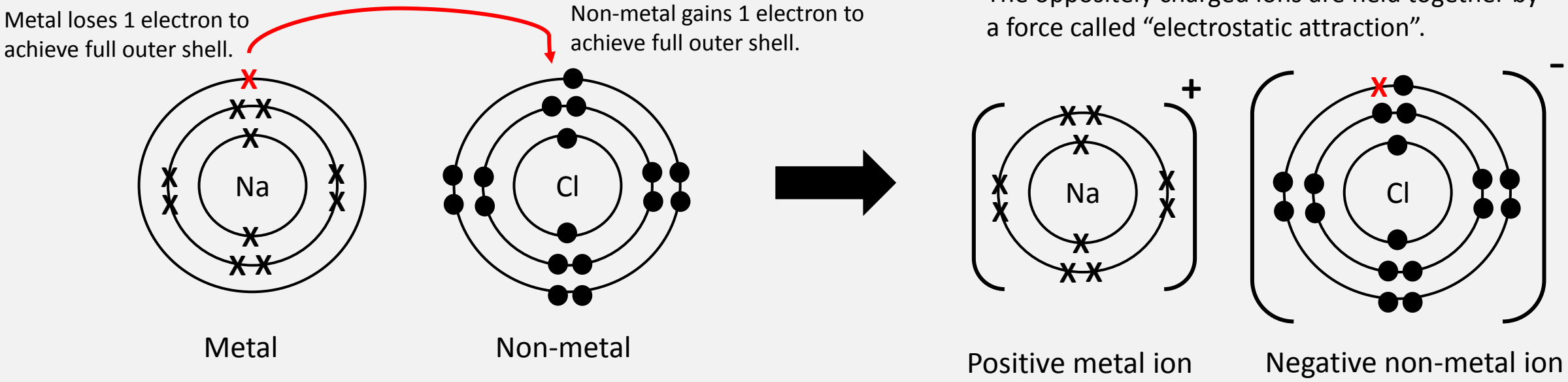
As you go down the group, the outer electron gets further away from the nucleus.

This means it experiences less attraction so is more easily lost when the element reacts.

Ionic Compounds

- When group 1 elements react with non-metals, they form ionic compounds.
- The metal ion formed has a charge of +1, as it loses 1 electron to achieve a full outer shell.
- The ionic compound formed is always white.
- The ionic compound will dissolve easily in water to form a colourless solution.

Formation of an ionic compound



Group 1 – The Alkali Metals

5.1.2.5

Starter: Place your bets:

Alkali Metal	Rank in order of reactivity (1-3)
Lithium (Li)	
Sodium (Na)	
Potassium (K)	

Gather around for teacher demo

Group 1 – The Alkali Metals

1
7 **Li** lithium 3
23 **Na** sodium 11
39 **K** potassium 19
85 **Rb** rubidium 37
133 **Cs** caesium 55
[223] **Fr** francium 87

Group 1 – The Alkali Metals

- Elements in group 1 of the periodic table are known as alkali metals.
- They all have low densities (the first three are less dense than water!)
- They react with water to form hydrogen gas.
- Also, when they react with water, they form “metal hydroxides” – this makes the water into an alkaline solution.
- The further down the group you go, the more reactive the alkali metal.
- Alkali metals also react with non-metals to form “ionic compounds”
- The ionic compounds formed are white solids that easily dissolve in water to form colourless solutions.

Questions – The alkali Metals

1. What are the key properties of the alkali metals? – (Grade 5)
2. What do the alkali metals react with? – (Grade 5)
3. Why are they called “alkali” metals? – (Grade 6)
4. Explain how we can test for hydrogen gas. (Grade 6)
5. Give the word and symbol equation for the reaction of an alkali metal with water. (Grade 7)
6. Draw a diagram to illustrate the reaction of a group 1 element with a group 7 element to form an ionic compound. (Grade 8)
7. Explain the trend in reactivity going down group 1, include an annotated illustration to aid your response. (Grade 9)

Low Density

- The density of a substance is how heavy it is for its size.
- The alkali metals all have low densities (as far as metals go, they are quite light).
- The first three alkali metals (Li, Na & K) are all less dense than water – this is why they float on the surface.

Li, Na & K float on the surface of water because they are **less dense** than water.

Reactions with Water

- The alkali metals react with water to form a hydroxide (which makes the solution alkaline) and hydrogen gas.

$$2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2\ (g)}$$

sodium + water → sodium hydroxide + hydrogen

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- The hydrogen gas can be tested for by using a lit splint, it will give a squeaky pop sound if hydrogen is present.

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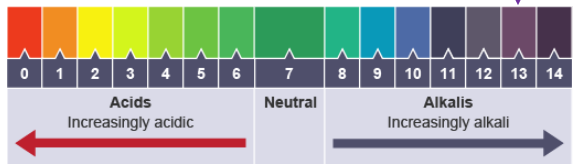

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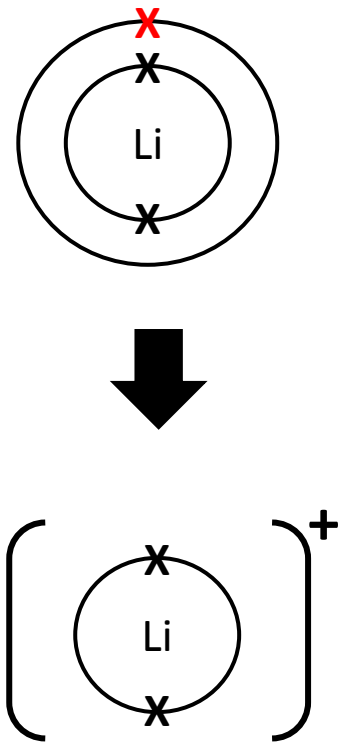
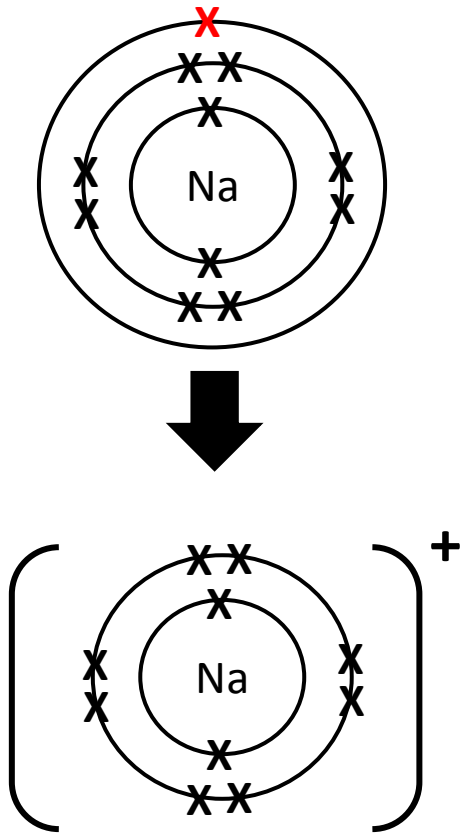
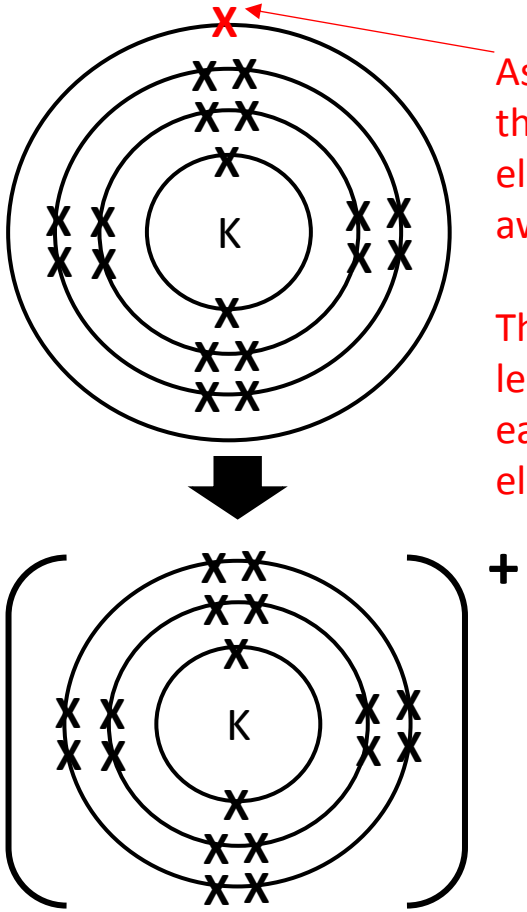






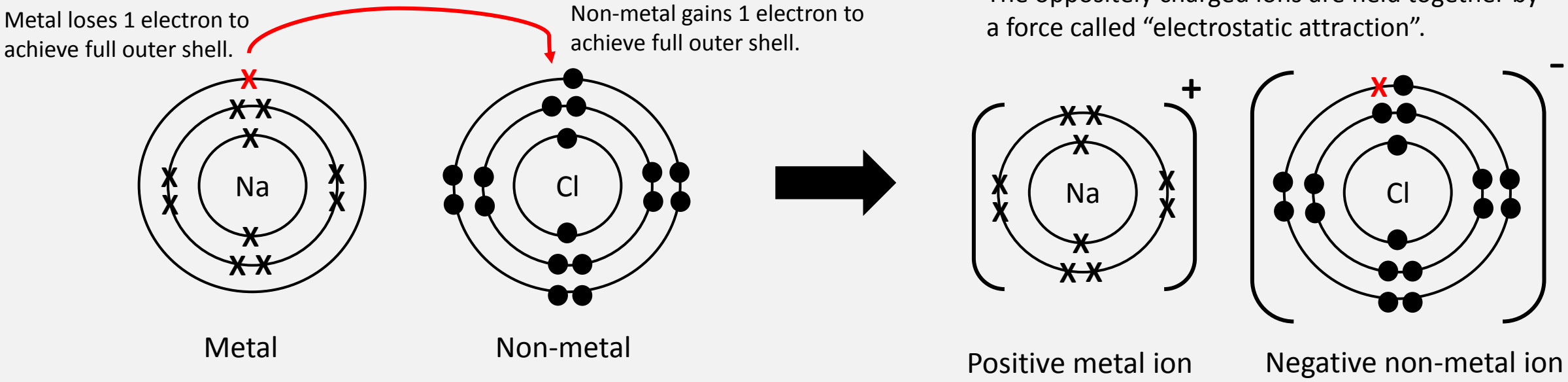
As you go down the group, the outer electron gets further away from the nucleus.

This means it experiences less attraction so is more easily lost when the element reacts.

Ionic Compounds

- When group 1 elements react with non-metals, they form ionic compounds.
- The metal ion formed has a charge of +1, as it loses 1 electron to achieve a full outer shell.
- The ionic compound formed is always white.
- The ionic compound will dissolve easily in water to form a colourless solution.

Formation of an ionic compound



Quiz – Write your answers as a numbered list.

Q1.

- How do we know that the first three alkali metals are less dense than water?

Q2.

- What type of compounds are formed when alkali metals react with non-metals?

Q3.

- What is the charge of the ion formed when an alkali metal reacts?

Q4.

- Why do metals form positive ions?

Q5.

- When an alkali metal reacts with water, a _____ is formed. This makes the solution alkaline.

Q6.

- What gas is formed when an alkali metal reacts with water?

Q7.

- What colour are the ionic compounds formed, when a group 1 element reacts with a non-metal?

Q8.

- What is a key property of ionic compounds?

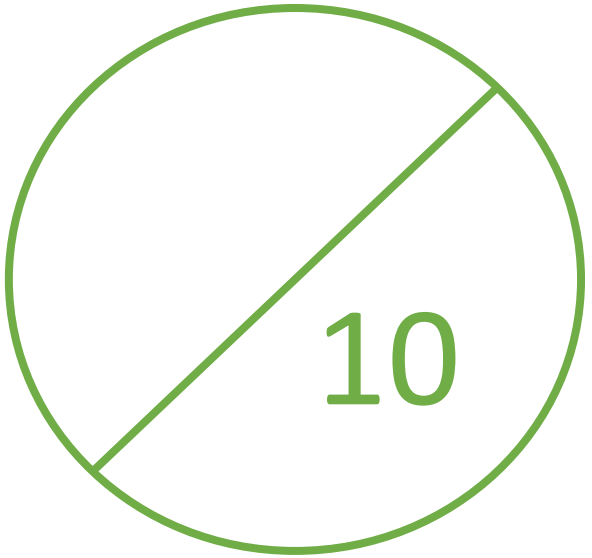
Q9.

- What trend occurs, as you go down group 1?

Q10.

- Why do elements become more reactive as you go down group 1?

Quiz – Mark your answers and give yourself a score out of ten.



Q1.

- How do we know that the first three alkali metals are less dense than water?

Because they float on the surface of water.

Q2.

- What type of compounds are formed when alkali metals react with non-metals?

Ionic compounds

Q3.

- What is the charge of the ion formed when an alkali metal reacts?

+ 1

Q4.

- Why do metals form positive ions?

To achieve a full outer shell.

Q5.

- When an alkali metal reacts with water, a _____ is formed. This makes the solution alkaline.

hydroxide

Q6.

- What gas is formed when an alkali metal reacts with water?

Hydrogen Gas (H_2)

Q7.

- What colour are the ionic compounds formed, when a group 1 element reacts with a non-metal?

White

Q8.

- What is a key property of ionic compounds?

Dissolve in water to give colourless solutions.

Q9.

- What trend occurs, as you go down group 1?

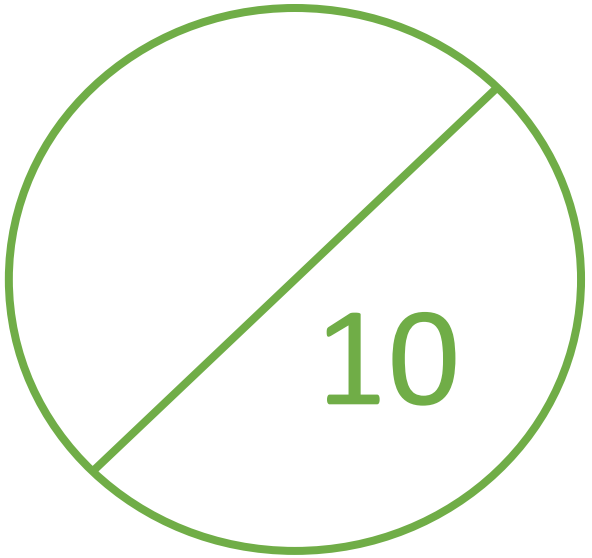
Reactivity increases

Q10.

- Why do elements become more reactive as you go down group 1?

As you go down the group, the outer shell electron is further away from the nucleus, so is more easily lost.

Quiz – Mark your answers and give yourself a score out of ten.



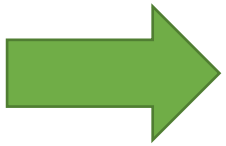
Application

- **There is a choice of exam questions:**

Grade 5

Grade 7

Grade 9



Attempt the exam question then self assess using the mark scheme

Success Criteria – Group 7 – The Halogens

- ❑ Highlight group 7 on the periodic table and state that the elements in group 7 are known as the halogens.
- ❑ Explain that group 7 elements form “diatomic” molecules consisting of a pair of atoms bonded together.
- ❑ Describe how group 7 elements react with metals to form ionic compounds.
- ❑ Illustrate how when group 7 elements react with metals, they gain electrons to form ions with a -1 charge.
- ❑ Explain how group 7 elements bond with other non-metals to form molecular compounds.
- ❑ Explain the trend in melting and boiling point in group 7 and link to relative molecular mass.
- ❑ Explain why group 7 elements become less reactive as you go down the group.
- ❑ Explain displacement reactions involving group 7 elements.

Group 7 – The Halogens

- The Halogens can be found in group 7 of the periodic table.
- The elements in group 7 are Fluorine (F), Chlorine (Cl), Bromine (Br) iodine (I) and Astatine (At).
- All of the Halogens are **non-metals.**

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									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
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
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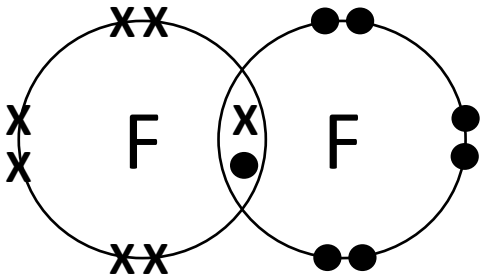
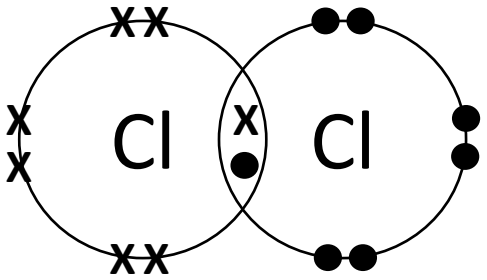
Group 7
The Halogens.

Diatomic Molecules

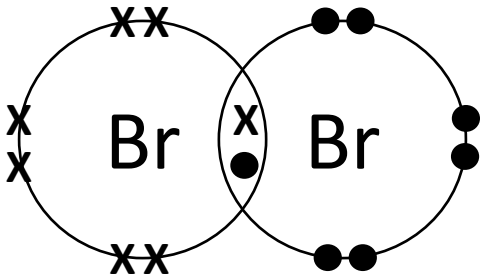
- The elements in group 7 all exist naturally as diatomic (two atom) molecules.
- The elements in group 7, all have 7 electrons in their outer shells.
- The easiest way for them to complete their outer shells is to form covalent bonds (share electrons) with another atom of the same element.
- This is why diatomic molecules form.



F_2 – Diatomic molecule of the element fluorine



Cl_2 – Diatomic molecule of the element chlorine



Br_2 – Diatomic molecule of the element bromine

Reactions with metals

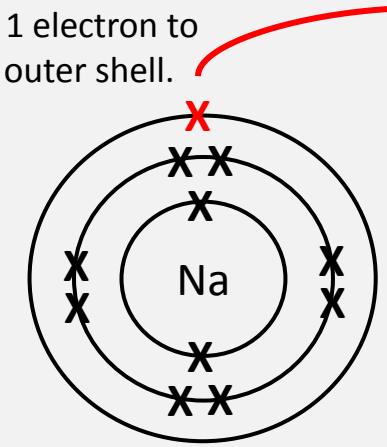
Non-metals gain electrons!

- The halogens react with metals to form ionic compounds.
- The halogen forms a "halide ion" with a charge of -1.
- As it reacts, it gains an electron to complete its outer shell, hence the charge of -1.

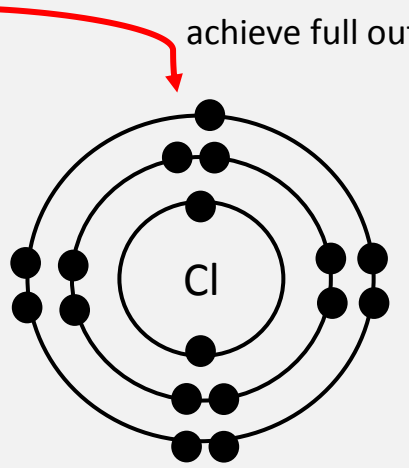
Formation of an ionic compound

Metal loses 1 electron to achieve full outer shell.

Non-metal halogen gains 1 electron to achieve full outer shell.

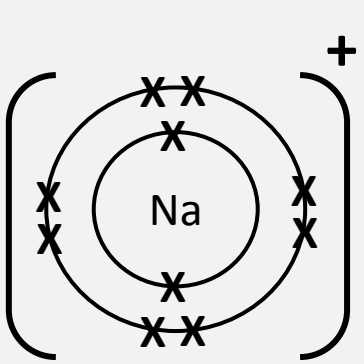


Metal

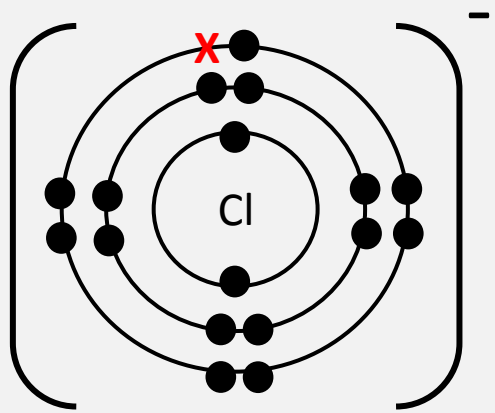


Non-metal Halogen

Ionic compound is formed, where metal has a +1 charge, non-metal has a -1 charge. The oppositely charged ions are held together by a force called "electrostatic attraction".



Positive metal ion

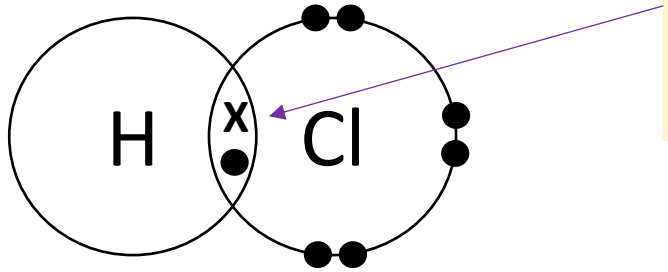


Negative non-metal "halide" ion

React with other non-metals to form molecular compounds

- The elements in group 7 will also react with other non-metals.
- When they do this, they form "molecular compounds"
- A molecule is when non-metals bond together.

This is a compound because It contains atoms of different elements bonded together.



This compound has **covalent** bonding because the non-metal atoms share electrons to form a bond.

It is a **molecular compound** because the bond is between non-metals.

HCl – Hydrochloric acid
a molecular compound formed when chlorine reacts with hydrogen.

Trends in melting & boiling point

- As you go down group 7, the “relative molecular mass” of the diatomic molecules increases.
- The “relative molecular mass” is simply the atomic mass of both atoms in the molecule added together.
- As relative molecular mass increases, so does the melting and boiling point.
- So as you go down group 7, melting and boiling point increases.

Melting & Boiling points increase as you go down group 7

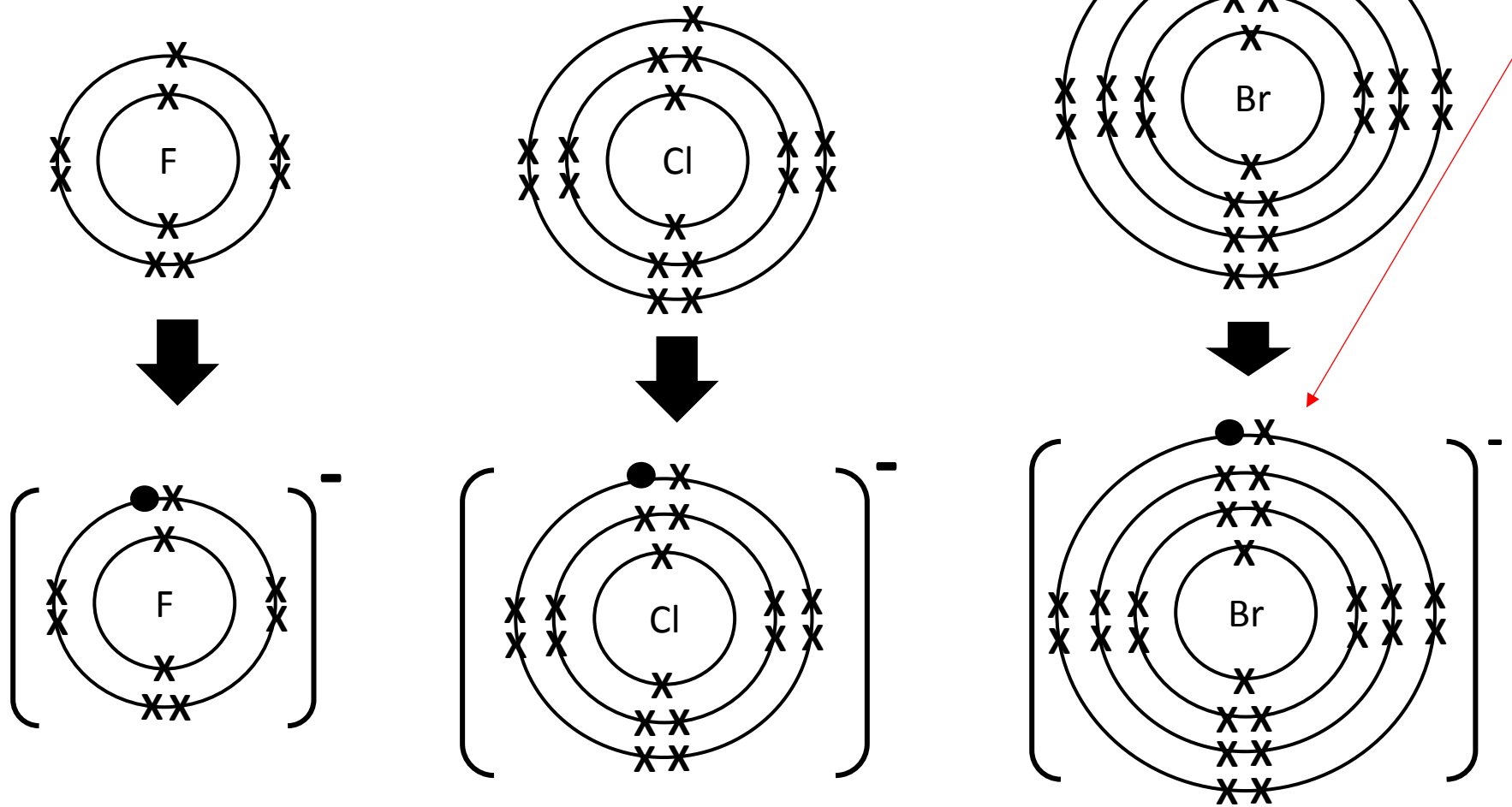
Formula	Relative Molecular Mass (g/mol)	Melting Point (°C)	Boiling Point (°C)
F_2	38	- 220	- 188
Cl_2	71	- 101	- 35
Br_2	160	- 7.2	58.8
I_2	254	114	184

Reactivity – Down Group 7

- When non-metals react, they gain electrons to complete their outer shells.
- As you go down group 7, reactivity decreases.
- This is because the outer electrons are further away from the nucleus.
- This means an electron is less easily gained.

7

19 **F** fluorine 9	
35.5 **Cl** chlorine 17	
80 **Br** bromine 35	
127 **I** iodine 53	
[210] **At** astatine 85	



As you go down the group, the outer electrons get further away from the nucleus.

This means they experience less attraction so it is harder to gain an electron when the element reacts.

This means reactivity decreases down the group.

Displacement

- A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.
- Aqueous (aq) means dissolved in water.

Salt — More reactive halogen

$$2\ KBr + Cl_2 \rightarrow 2\ KCl + Br_2$$

potassium bromide + chlorine → Potassium chloride + bromine

Bromine has been displaced and chlorine has replaced it in the compound.

Salt — More reactive halogen

$$2\ KCl + F_2 \rightarrow 2\ KF + Cl_2$$

potassium chloride + fluorine → Potassium fluoride + chlorine

Chlorine has been displaced and fluorine has replaced it in the compound.

Group 7 – The Halogens

5.1.2.6

Starter: Use symbols from the periodic table to make the longest word you can.

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

Group 7 – The Halogens

Q. What type of elements are the Halogens?

Non-metals

1	2											3	4	5	6	7	0
																	4 **He** helium 2
7 **Li** lithium 3												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												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							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
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated						

Let’s make a movie

- Each group has an information pack and set of resources.
- It’s your job to make a short film/presentation about the properties of group 7 elements.
- Your group should have the following roles:

  - **Researcher** (To gather and interpret the information)
  - **Script writer** (To work with the researcher to produce a script)
  - **Presenter** (To be on camera)
  - **Producer** (To make resources to include in your video)
  - **Director** (To direct how the film should be laid out)

Success Criteria – Group 7 – The Halogens

- ❑ Highlight group 7 on the periodic table and state that the elements in group 7 are known as the halogens.
- ❑ Explain that group 7 elements form “diatomic” molecules consisting of a pair of atoms bonded together.
- ❑ Describe how group 7 elements react with metals to form ionic compounds.
- ❑ Illustrate how when group 7 elements react with metals, they gain electrons to form ions with a -1 charge.
- ❑ Explain how group 7 elements bond with other non-metals to form molecular compounds.
- ❑ Explain the trend in melting and boiling point in group 7 and link to relative molecular mass.
- ❑ Explain why group 7 elements become less reactive as you go down the group.
- ❑ Explain displacement reactions involving group 7 elements.

Group 7 – The Halogens

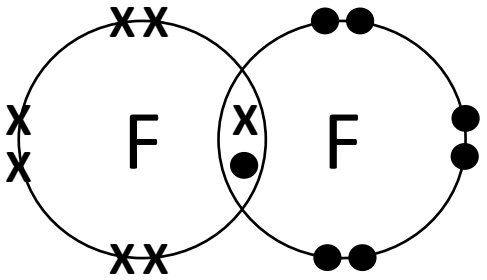
- The Halogens can be found in group 7 of the periodic table.
- The elements in group 7 are Fluorine (F), Chlorine (Cl), Bromine (Br) iodine (I) and Astatine (At).
- All of the Halogens are **non-metals.**

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									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
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated						

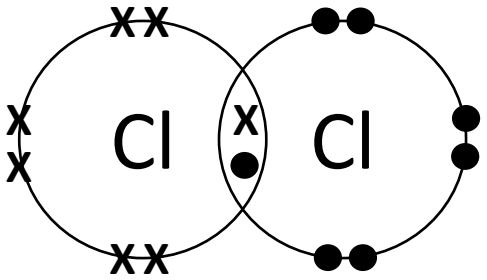
Group 7
The Halogens.

Diatomic Molecules

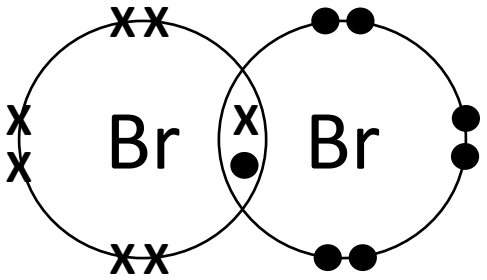
- The elements in group 7 all exist naturally as diatomic (two atom) molecules.
- The elements in group 7, all have 7 electrons in their outer shells.
- The easiest way for them to complete their outer shells is to form covalent bonds (share electrons) with another atom of the same element.
- This is why diatomic molecules form.



F_2 – Diatomic molecule of the element fluorine



Cl_2 – Diatomic molecule of the element chlorine



Br_2 – Diatomic molecule of the element bromine

Reactions with metals

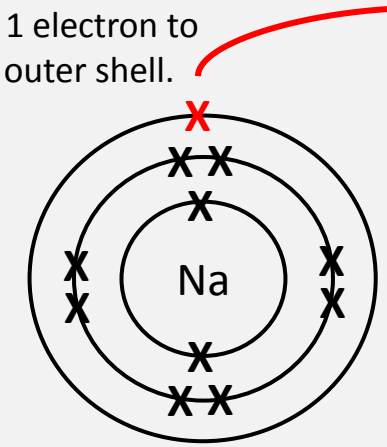
Non-metals gain electrons!

- The halogens react with metals to form ionic compounds.
- The halogen forms a "halide ion" with a charge of -1.
- As it reacts, it gains an electron to complete its outer shell, hence the charge of -1.

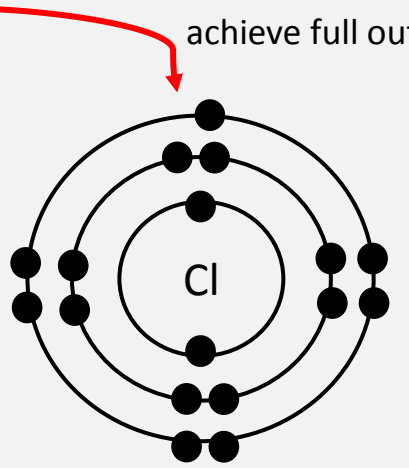
Formation of an ionic compound

Metal loses 1 electron to achieve full outer shell.

Non-metal halogen gains 1 electron to achieve full outer shell.

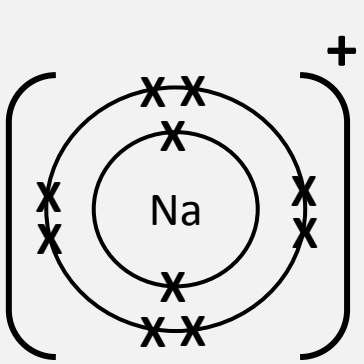


Metal

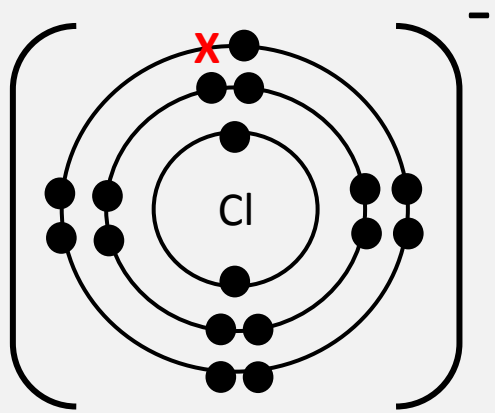


Non-metal Halogen

Ionic compound is formed, where metal has a +1 charge, non-metal has a -1 charge. The oppositely charged ions are held together by a force called "electrostatic attraction".



Positive metal ion

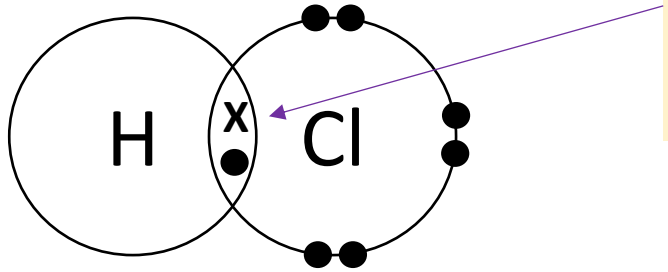


Negative non-metal "halide" ion

React with other non-metals to form molecular compounds

- The elements in group 7 will also react with other non-metals.
- When they do this, they form "molecular compounds"
- A molecule is when non-metals bond together.

This is a compound because It contains atoms of different elements bonded together.



This compound has **covalent** bonding because the non-metal atoms share electrons to form a bond.

It is a **molecular compound** because the bond is between non-metals.

HCl – Hydrochloric acid
a molecular compound formed when chlorine reacts with hydrogen.

Trends in melting & boiling point

- As you go down group 7, the “relative molecular mass” of the diatomic molecules increases.
- The “relative molecular mass” is simply the atomic mass of both atoms in the molecule added together.
- As relative molecular mass increases, so does the melting and boiling point.
- So as you go down group 7, melting and boiling point increases.

Melting & Boiling points increase as you go down group 7

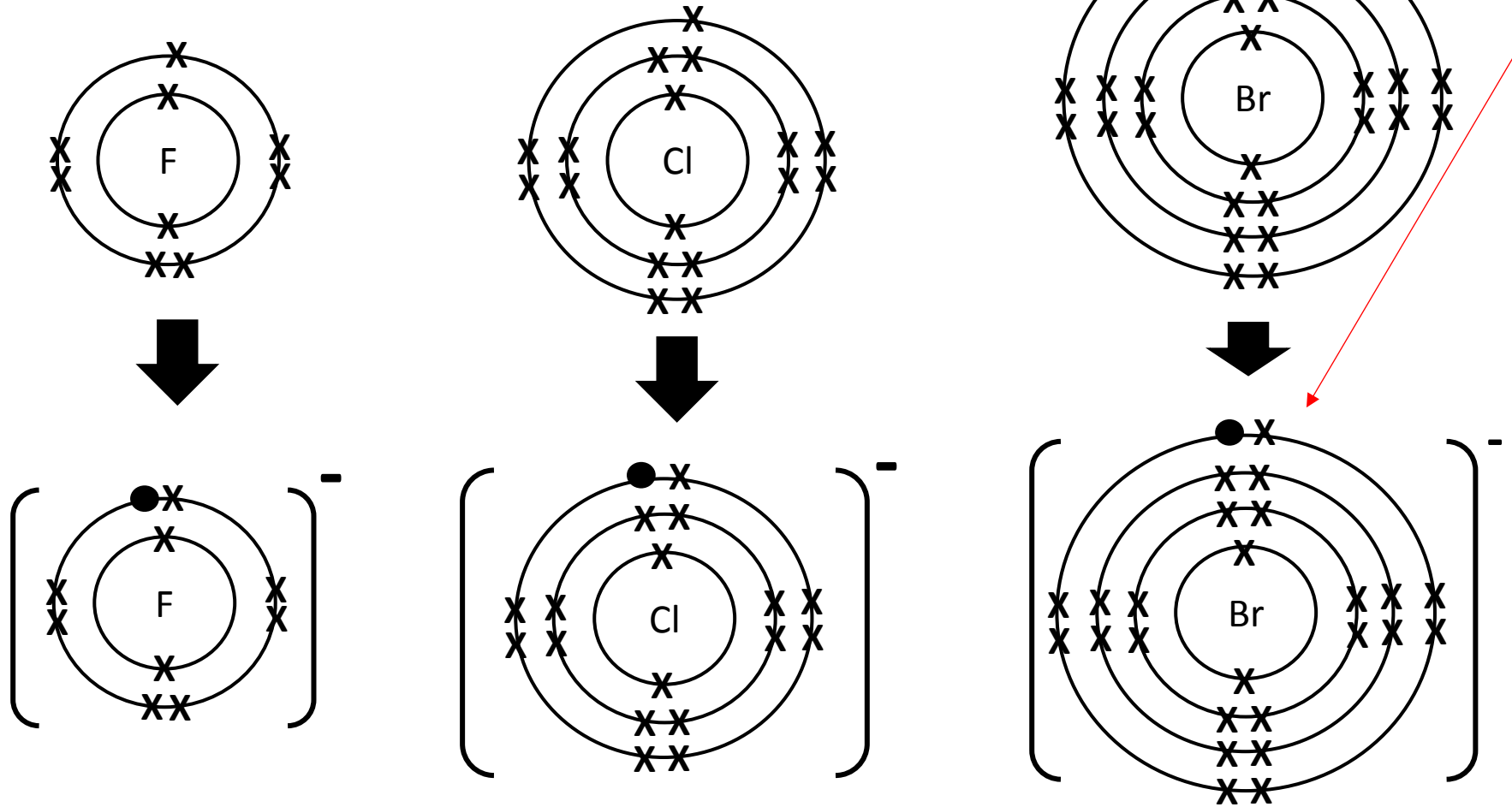
Formula	Relative Molecular Mass (g/mol)	Melting Point (°C)	Boiling Point (°C)
F_2	38	- 220	- 188
Cl_2	71	- 101	- 35
Br_2	160	- 7.2	58.8
I_2	254	114	184

Reactivity – Down Group 7

- When non-metals react, they gain electrons to complete their outer shells.
- As you go down group 7, reactivity decreases.
- This is because the outer electrons are further away from the nucleus.
- This means an electron is less easily gained.

7

19 **F** fluorine 9	
35.5 **Cl** chlorine 17	
80 **Br** bromine 35	
127 **I** iodine 53	
[210] **At** astatine 85	



As you go down the group, the outer electrons get further away from the nucleus.

This means they experience less attraction so it is harder to gain an electron when the element reacts.

This means reactivity decreases down the group.

Displacement

- A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.
- Aqueous (aq) means dissolved in water.

Salt — More reactive halogen

$$2\ KBr + Cl_2 \rightarrow 2\ KCl + Br_2$$

potassium bromide + chlorine → Potassium chloride + bromine

Bromine has been displaced and chlorine has replaced it in the compound.

Salt — More reactive halogen

$$2\ KCl + F_2 \rightarrow 2\ KF + Cl_2$$

potassium chloride + fluorine → Potassium fluoride + chlorine

Chlorine has been displaced and fluorine has replaced it in the compound.