

# Year 9 Science Knowledge Booklet

## Term 3

**Name:**

**Class:**

**Homework 1 Due: 11<sup>th</sup> January**

**Homework 2 Due: 25<sup>th</sup> January**

**Homework 3 Due: 8<sup>th</sup> February**





# Science Homework 1

Read all of this knowledge organiser. The work covered will be in the first knowledge quiz of the term.

## Big questions:

What are the differences between prokaryotic and eukaryotic cells?

What organelles do cells have?

Do all cells perform the same functions?

How can we see cells?

How do we calculate magnification?

What are stem cells?

How can we use stem cells?

What are chromosomes?

What is the cell cycle?

How do substances move in and out of cells (Diffusion)?

Why do organisms need exchange surfaces?

How do substances move in and out of cells (Osmosis)?

How do substances move in and out of cells via active transport?

## Key vocabulary

<b>Cell</b>	The building block of living things.
<b>Nucleus</b>	Controls the activities of the cell. Contains chromosomes made of DNA.
<b>Cytoplasm</b>	Jelly-like contents of the cell where many chemical reactions take place.
<b>Cell membrane</b>	A thin layer around the cell that controls the movement of substances in and out of the cell.
<b>Cell wall</b>	Rigid layer outside the cell membrane of a <b>plant</b> (cellulose), fungi (chitin) or a <b>bacterial</b> (peptidoglycan) cell.

<b>Chloroplast</b>	Small disc in the cytoplasm of <b>plants</b> containing chlorophyll.
<b>Active Transport</b>	The movement of particles against a concentration gradient using energy transferred during respiration.
<b>Mitochondria</b>	The site of aerobic respiration in plant and animal cells.
<b>Specialised cell</b>	A cell that has a structure well suited to its function.
<b>Prokaryote</b>	A small simple cell that contains no membrane bound organelles.
<b>Eukaryote</b>	A unicellular or multicellular organism that has a nucleus.
<b>Phloem</b>	A type of plant tissue which transports dissolved sugars around the plant.
<b>Xylem</b>	A type of plant tissue which transports water and mineral ions around the plant.
<b>Stem cell</b>	An undifferentiated cell that can become specialised into any <b>type</b> of cell.
<b>Diffusion</b>	The spreading out of particles from an area <b>of high concentration</b> to an area <b>of low concentration</b> .
<b>Osmosis</b>	The movement of water molecules across a partially permeable membrane from a dilute solution to a more concentrated solution.
<b>Ribosome</b>	Site of protein synthesis.
<b>Mitosis</b>	A form of cell division which produces 2 identical daughter cells.
<b>Permanent vacuole</b>	Fluid-filled area in plant cell containing sap.
<b>Chromosome</b>	A long molecule of DNA found in the nucleus, which carries genes.
<b>Resolution</b>	Ability of a microscope to distinguish between 2 points.

## What are the differences between prokaryotic and eukaryotic cells?

There are two types of cells:

1. Eukaryotic cells make up multicellular organisms such as animals, plants and fungi.
2. Prokaryotes are single celled organisms comprised of only cytoplasm such as bacteria.
3. Prokaryotic cells, such as bacteria, are far smaller than eukaryotic cells such as plant, animals and fungal cells.
4. On top of their difference in size there are other notable differences in the structures of these two types of cell.

## What organelles do cells have?

Animal cells:

Ribosomes, mitochondria, cytoplasm, nucleus, cell membrane.

Plant cells:

Cell wall, vacuole, chloroplast, nucleus, ribosomes, cell membrane, cytoplasm, mitochondria.

## Do all cells perform the same functions?

In a **single-celled organism** the one cell has to do **ALL** of the jobs.

In **multicellular organisms**, the tasks that need to be complete can be shared out between many, **specialist cells**.

## How can we see cells?

**Magnification** is the degree to which the size of an image is larger than the image itself.

**Resolution** is the degree to which it is possible to distinguish between two objects that are very close together.

## How do we calculate magnification?

- 1 Kilometre (Km) = 1000 metre (m)
- 1m = 100cm
- 1cm = 10mm
- 1mm = 1000 micrometres ( $\mu\text{m}$ )
- 1 $\mu\text{m}$  = 1000 nanometres (nm)
- 1 nm =  $1 \times 10^{-9}$  m

# Science Homework 2



Try to answer all of these key knowledge questions. Then check your answers using the last page. These are some of the questions that will be in the knowledge quizzes and the end of term tests.

Key knowledge question	Answer
What is a cell?	
What is the function of the flagellum?	
What two structures are found in eukaryotic cells but not found in prokaryotic cells?	
What three structures that are found in plant cells and not animal cells?	
What structure allows things to enter and leave the cell?	
What is a stem cell?	
What is the function of a sperm cell?	
What is the function of a root hair cell?	
What is the function of a nerve cell?	
What are unspecialised cells in a plant cell called?	
What is mitosis?	
What does diffusion mean?	
What diffuses in and out of leaf cells?	
What is osmosis?	
What is active transport?	
Which process released the energy needed for active transport?	
What is the name of the structure which carries molecules across the cell membrane during active transport?	
Name one food molecule absorbed into epithelial cells by active transport	
Which organelle is prevalent (more common) in cells that carry out active transport more frequently?	
Why do epithelial cells have many mitochondria?	

**What are stem cells?**

Stem cells are undifferentiated cells of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation.

**How can we use stem cells?**

- Meristems contain stem cells. These differentiate into any type of plant cell. They do this throughout the plants life
- Stem cells are used to create clones of plants quickly and cheaply.
- Therapeutic cloning
- Cloning

**What are chromosomes?**

Unit of inheritance that are made out of DNA, they determine our physical characteristics.

**What is the cell cycle?**

A cell that is actively dividing goes through a series of stages called the cell cycle. The cycle involves the growth of the cell and the production of new cell components and division for growth, repairing tissue and replacing cells. The cell cycle has 3 main phases: interphase, mitosis and cytokinesis

**Mitosis** = A form of cell division in which genetically identical cells are produced from the parent cell.

Each new cell contains 46 chromosomes (in humans).

During mitosis, the double chromosomes are pulled apart as each new set of 46 chromosomes moves to opposite ends of the cell. Two nuclei then form. The cytoplasm and cell membrane then divides and two identical cells are produced.

**How do substances move in and out of cells (Diffusion)?**

**Diffusion** is the name we give to the movement of particles down a concentration gradient.

The movement of particles of a gas, or any substance in solution, resulting in the net movement of particles from an area of high concentration to an area of low concentration.

## Why do organisms need exchange surfaces?

Exchange surfaces are tissues specialised for the exchange of substances in the body and are adapted for this function.

Some common features of an exchange surface are the following:

1. A large surface area over which exchange can take place
2. A thin membrane or being thin to provide a short diffusion path
3. In animals, an efficient blood supply moves the diffusing substances away from the exchange surface to maintain a steep concentration gradient.
4. In animals, being ventilated makes gas exchange more efficient by maintaining a steep concentration gradient.

## How do substances move in and out of cells via osmosis?

**Osmosis** = The net movement of water molecules from a dilute solution to a more concentrated solution through a partially permeable membrane. It is a passive process like diffusion as it doesn't require energy from respiration. These membranes are called 'partially permeable' as they only let certain types of particles pass through.

- Osmosis in plant and animals cells is different because of their different structures.
- Plant cells can take on lots of water because of the tough cell wall which resists bursting.
- Animal cells can burst if they take on too much water- they have no cell wall.
- If animal cells lose lots of water they shrink.
- When plant cells lose lots of water they become plasmolysed- the vacuole pulls away from the cell membrane. This does not shrink the overall cell.

**How do substances move in and out of cells via active transport?**

Active transport is an **active** process, this means substances are moved **against** their concentration, from an area of low concentration to an area of high concentration.

Active transport results in the pumping of nitrate ions against their concentration gradient from the soil into the root hair cells.

We need to absorb nutrients from food to survive (ie glucose).

These nutrients transport from the gut to the blood.

- Higher concentration of nutrients in the gut compared to the blood, they DIFFUSE to the blood.
- Lower concentration of nutrients in the gut compared to the blood, they use ACTIVE TRANSPORT to move into the blood.

**WHAT DOES THIS MEAN?**

Glucose can be taken into the blood by active transport against the concentration gradient. Then the glucose can be transported to the cells to be used in respiration.

In humans, an example of active transport is the active absorption of glucose from your gut and kidney tubules into your blood. This is often done against a large concentration gradient.

Glucose is needed for respiration so it is important to get as much as possible from the gut.



Key knowledge question	Answer
What is a cell?	The smallest unit of an organism.
What is the function of the flagellum?	Aids movement of the cell - often towards the nutrients.
What two structures are found in eukaryotic cells but not found in prokaryotic cells?	Membrane-bound organelles and the nucleus.
What three structures that are found in plant cells and not animal cells?	Cell wall, chloroplast and vacuole
What structure allows things to enter and leave the cell?	Cell membrane
What is a stem cell?	A specialised cell that has the ability to differentiate into any type of cell
What is the function of a sperm cell?	It has a tail so that it can swim towards an egg cell to fertilise it.
What is the function of a root hair cell?	To absorb minerals and water from the soil to the roots.
What is the function of a nerve cell?	To carry electrical nerve impulses around the body.
What are unspecialised cells in a plant cell called?	Meristem
What is mitosis?	A type of cell division
What does diffusion mean?	Diffusion is the movement of particles from a higher concentration to a lower concentration.
What diffuses in and out of leaf cells?	Carbon dioxide and oxygen
What is osmosis?	The net movement of water particles in a dilute solution, to a more concentrated solution through a partially permeable membrane.
What is active transport?	An active process where substances are moved against a concentration gradient from an area of lower concentration to high concentration.
Which process released the energy needed for active transport?	Respiration releases energy in the form of ATP, this is required for active transport to take place.
What is the name of the structure which carries molecules across the cell membrane during active transport?	A protein carrier which spans the cell membrane.
Name one food molecule absorbed into epithelial cells by active transport.	Sugar/glucose
Which organelle is prevalent (more common) in cells that carry out active transport more frequently?	Mitochondria
Why do epithelial cells have many mitochondria?	They require energy (respiration).

**Big questions: What is the link between atomic structure and the periodic table?**

What's the difference between elements, compounds and mixtures?

What are atoms made up of?

How did scientists prove the structure of the atom?

How are electrons arranged in an atom?

How are elements ordered in the periodic table?

Why are group 1 metals unusual?

Why is there a trend in reactivity in group 1?

Why are group 7 so reactive and how do they interact with each other?

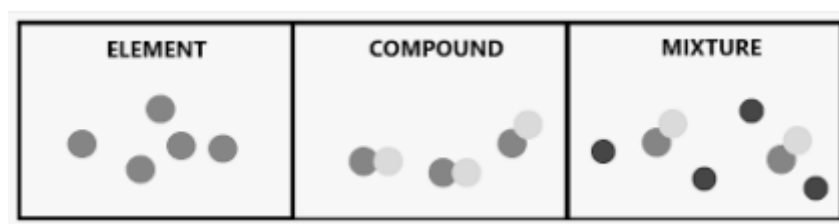
Why are Group 0 unreactive?

**Key vocabulary**

<b>Atom</b>	The smallest part of an element that can exist.
<b>Element</b>	One type of atom.
<b>Compound</b>	Two or more elements chemically combined in fixed proportions.
<b>Mixture</b>	A substance with two or more elements or compounds not chemically combined together.
<b>Separation techniques</b>	Physical processes that are used to separate mixtures into their constituent parts.
<b>Melting</b>	The change of state from a solid to a liquid.
<b>Boiling</b>	The change of state from a liquid to a gas.
<b>Filtration</b>	A separation technique to separate an insoluble solid from a liquid.
<b>Crystallisation</b>	A separation technique to separate a solute (soluble solid) from a solvent. Heat to evaporate off water, cool to crystallise..
<b>Distillation</b>	A separation technique to separate two liquids with different boiling processes. It involves heating to evaporate and separate, and cooling to condense and collect.
<b>Chromatography</b>	A separation technique to separate solvents in a fluid.
<b>Proton</b>	A subatomic particle with a positive charge, mass of 1, and located in the nucleus.
<b>Neutron</b>	A subatomic particle with a neutral (0) charge, mass of 1, and located in the nucleus.
<b>Electron</b>	A subatomic particle with a negative charge, very small / negligible mass, and located in electron shells / energy levels orbiting the nucleus..

<b>Nucleus</b>	The centre of an atom, containing protons and neutrons, and with positive charge.
<b>Plum Pudding model</b>	A model describing the atom as a ball of positive charge with electrons embedded into it (proposed by Thomson).
<b>Nuclear model</b>	The current model of the atoms with a positive nucleus (containing protons and neutrons) and electrons orbiting in shells / energy levels.
<b>Atomic number</b>	The number of protons in an element. (Atoms of different elements have different numbers of protons).
<b>Relative atomic mass</b>	The number of protons and neutrons of an element. An average mass value that takes into account of the abundance of isotopes of the element.
<b>Isotope</b>	The same element with a different mass number due to a different number of neutrons.
<b>Periodic table</b>	A table in which elements are arranged so elements with similar properties occur at regular intervals (periodicity).
<b>Noble Gases</b>	Unreactive gases found in Group 0 of the periodic table.
<b>Alkali metals</b>	Reactive metals found in Group 1 of the periodic table.
<b>Halogens</b>	Reactive non-metals found in Group 7 of the periodic table.
<b>Properties</b>	Physical or chemical characteristics of a substance.

**What's the difference between elements, compounds and mixtures?**



All substances are made of **atoms**. An atom is the smallest part of an element that can exist.

Atoms of each element are represent by a chemical symbol,

e.g. O is an atom of Oxygen

Na is an atom of Sodium.

An **element** is one type of atom.

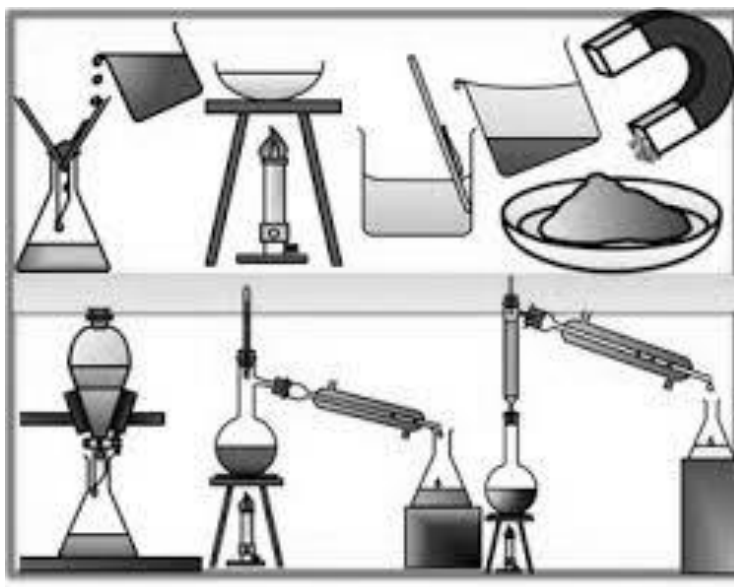
There are about 100 different elements, which re displayed in the periodic table.

**Compounds:**

- are made up from two or more elements chemically bonded in fixed proportions.
- are made in chemical reactions.
- Can be separated into elements in chemical reactions.

**Mixtures**

- Consist of two or more element or compounds not chemically combined together.
- The chemical properties of each substance in the mixture are unchanged.
- Mixtures can be separated by physical processes.



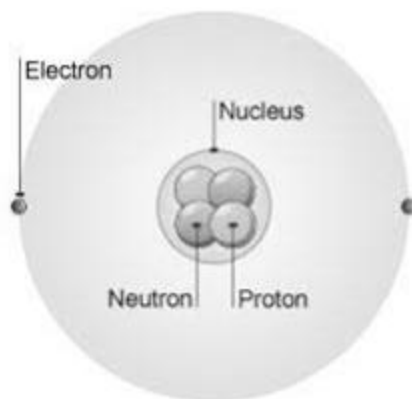
Separation techniques are physical processes, they do not include chemical reactions and no new substances are made. Techniques for separating mixtures include: Filtration

- Crystallisation
- Simple distillation
- Fractional distillation
- Chromatography
-

## What are atoms made up of?

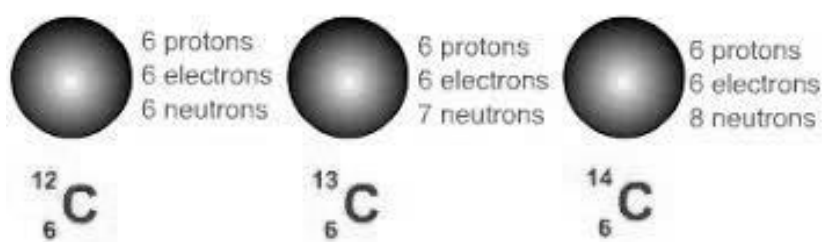
Atoms are made up from 3 sub-atomic particles. The proton, neutron and electron, which have different charges and masses.

SUB-ATOMIC PARTICLE	Location	Charge	Mass
Proton	In nucleus	Positive (+1)	1
Neutron	In nucleus	Neutral (0)	1
Electron	In shells	Negative (-1)	Very small



Some elements have **isotopes**. These are the same type of element but with a different mass number due to a different number of neutrons.

Diagram to show the Isotopes of Carbon:



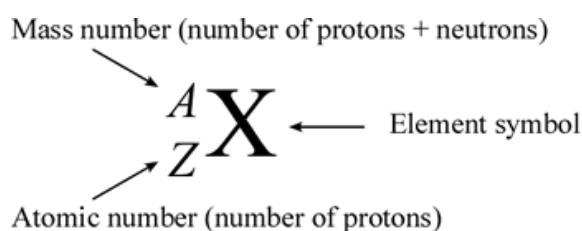
<https://s-cool.co.uk/gcse/chemistry/radioactivity/revise-it/introduction>

Every atom has a relative atomic number, the atomic number is the number of protons.

Since the overall charge of an atom is zero the atomic number informs of the number of electrons.

The relative atomic mass is the number of protons and neutrons in an atom.

The number of neutrons is the difference between the mass number and the atomic number.

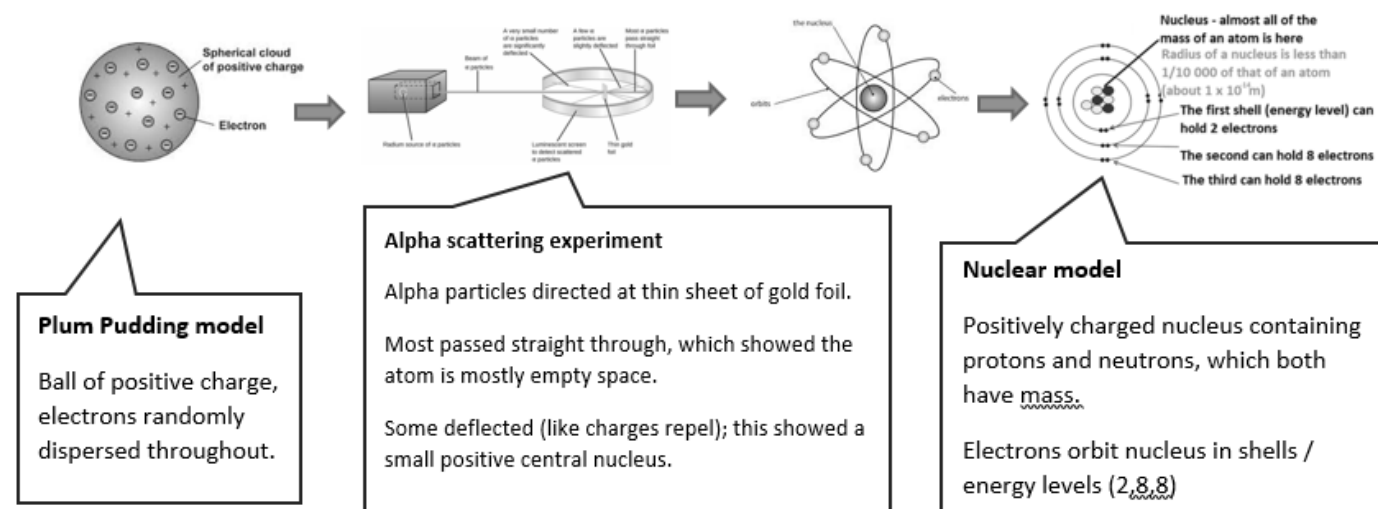


E.g.  ${}^{23}_{11}\text{Na}$  Sodium has 11 protons, 11 electrons and (23-11) 12 neutrons.

## How did scientists prove the structure of the atom?

The model of the atom has changed over time. New experimental evidence may lead to a scientific model being changed or replaced. Several scientists have contributed to the current model of the atom

Scientist	Discovery
Dalton	Spheres that cannot be divided.
Thomson	<b>Plum Pudding Model</b> Negative electrons embedded in a ball of positive charge
Rutherford	Used the alpha scattering experiment and discovered: - <b>positive nucleus</b> - atom mostly empty - electrons in shells
Bohr	<b>Electrons</b> located in different energy levels / <b>shells (2,8,8)</b>
Chadwick	<b>Neutrons</b> in nucleus



## How are electrons arranged in an atom?

Remember that in an atom the proton number = electron number.

The electrons in an atom occupy the lowest available energy levels (innermost available shells).

Shell 1 – 2 electrons  
Shell 2 – 8 electrons  
Shell 3 – 8 electrons

E.g. Sodium has a proton number and therefore an electron number of 11. So the electronic arrangement is **2, 8, 1**.

hydrogen 1							helium 2
lithium 2.1	beryllium 2.2	boron 2.3	carbon 2.4	nitrogen 2.5	oxygen 2.6	fluorine 2.7	neon 2.8
sodium 2.8.1	magnesium 2.8.2	aluminium 2.8.3	silicon 2.8.4	phosphorus 2.8.5	sulfur 2.8.6	chlorine 2.8.7	argon 2.8.8
potassium 2.8.8.1	calcium 2.8.8.2						

The electronic structure of an atom can be represented by numbers or by a diagram.

# Science Homework 3



Try to answer all of these key knowledge questions. Then check your answers using the last page. These are some of the questions that will be in the knowledge quizzes and the end of term tests.

Questions in *italics* are from older work.

Key knowledge question	Answer
Define a compound.	
What does the mass number of an atom represent?	
What are the charges of protons, neutrons and electrons?	
What are the masses of protons, neutrons and electrons?	
What is the plum pudding model of the atom?	
How did Mendeleev improve the periodic table?	
State the name of group 0, group 1 and group 7.	
What are the properties of the elements in group 0?	
How does the reactivity change in group 1?	
How do the properties of group 7 elements changes as you go down the group?	
<i>What is a cell?</i>	
<i>What is the function of the flagellum?</i>	
<i>What two structures are found in eukaryotic cells but not found in prokaryotic cells?</i>	
<i>What three structures that are found in plant cells and not animal cells?</i>	
<i>What structure allows things to enter and leave the cell?</i>	

### How are elements ordered in the periodic table?

Elements are found in the periodic table. The majority of elements are metals. Metals are found to the left and towards the bottoms of the periodic table. Non-metals are found towards the right and top of the periodic table.

In the modern periodic table elements are arranged in order of **increasing atomic (proton) number** and so that the elements with similar properties are in columns, known as groups. The table is called a periodic table because similar properties occur at regular intervals (periodicity = repeating patterns).

**Groups** – elements in the same groups (columns) have the same number of electrons in the outer shell. E.g. Group 1 has 1 outer electron, Group 7 has 7 outer electrons, and Group 0 has a full outer shell.

Elements in the same groups have similar properties because they have the same number of electrons in their outer shell.

**Periods** – elements in the same period use the same number of electron shells.

E.g. Li 2,1 uses 2 shells so is in period 2. Ca 2,8,8,2 uses 4 shells so is in period 4

Groups

1

2

</

Early periodic tables were incomplete because many elements had not been discovered.

Additionally protons, neutrons and electrons had not been discovered, so elements were not arranged in order of atomic (proton) number, atomic mass number (protons + neutrons). Early periodic tables were arranged in order of **atomic weight**.

**Mendeleev** overcame some of the problems by leaving **gaps** for elements that he thought had not been discovered and in some places changed the order based on atomic weights.

Elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.

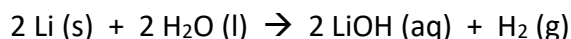


**Why are group 1 metals unusual?**

**Group 1** are called the **Alkali Metals**.

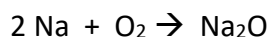
They all have 1 electron in the outer shell, lose one electron to form positive ions with a charge of +1, and therefore are highly reactive.

**metal + water → metal hydroxide + hydrogen**



Group 1 metals are less dense than water and float, they form a sphere that moves across the water on the hydrogen gas, and potassium burns with a lilac flame.

**metal + oxygen → metal oxide**



Reactivity in Group 1 increases going down the group. This is because lower down the group the elements:

- have a larger atomic radius
- the outer electron is a greater distance from the nucleus
- there is a weaker force of attraction between the positive nucleus and outer electron
- the outer electron is lost more easily so the atom is more reactive.

**Why are group 7 so reactive and how do they interact with each other?**

**Group 7** elements are the **Halogens**.

They have 7 electrons in the outer shell.

They are highly reactive as they only need to gain one electron to form a negative ion (-1).

They exist as di-atomic molecules with two atoms covalently bonded together.

	<b>State at room temperature</b>	<b>Colour</b>
<b>Chlorine</b>	Gas	Green
<b>Bromine</b>	Liquid	Orange
<b>Iodine</b>	Solid	Grey

Trends going down the group:

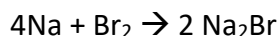
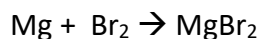
- relative molecular mass increases
- melting point and boiling point increases
- the reactivity increases going down the group.

Reactivity decreases going down Group 7 because:

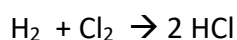
- the elements have a larger atomic radius
- the outer electron is a greater distance from the nucleus
- there is a weaker force of attraction between the positive nucleus and outer electron
- the outer electron is gained less easily so the element is less reactive.

Halogen reactions:

**Metal + Halogen → Metal Halide**



**Hydrogen + Halogen → Hydrogen Halide**



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

E.g. Chlorine + Silver Bromide → Silver chloride + Bromine

**Why are Group 0 unreactive?**

**Group 0** are called the **Noble Gases**.

They are all unreactive. This is because they all have a full outer shell or electrons.

E.g. He – 2, Ne – 2,8, Ar – 2,8,8

The trends going down the group are:

- atomic radius increases
- atomic mass increases
- boiling point increases
  - this is because larger molecules have bigger intermolecular forces between them, which required more energy to break them, and hence a higher boiling point.

**How to get the most out of your knowledge organiser:**

- To get the most use out of the knowledge organisers you should be learning sections and then self-testing.
- There are several different things you can do
  - Look, cover, write, check, correct
  - Read through the organisers
  - Mind maps
  - Key spellings
  - Make a glossary
  - Missing out key words
  - Questions/answers answers/questions
  - Flash cards
  - Revision clock learning
  - Mnemonics

**Science Learning Tools and wider study:**

The Oak Academy – Online Science lessons

BBC Bitesize science

You tube channels:

Fuse school

Ted talks

Free science lessons

Primrose Kitten

Shows on Netfilx

Our planet

Tiny creatures

A life on our planet

Key knowledge question	Answer
Define a compound.	Compounds contain two or more elements chemically combined (bonded) in a fixed ratio
What does the mass number of an atom represent?	The number of protons and neutrons
What are the charges of protons, neutrons and electrons?	Protons have a positive charge, neutrons have a neutral charge, electrons have a negative charge
What are the masses of protons, neutrons and electrons?	Protons and neutrons have a mass of 1. Electrons mass is very small / negligible / 0.0005
What is the plum pudding model of the atom?	The plum pudding model of the atom is a ball of positive charge with negative electrons embedded in it.
How did Mendeleev improve the periodic table?	He left gaps so elements were in the same group as elements with the same properties
State the name of group 0, group 1 and group 7.	Group 0 = The noble gases      Group 1 = The alkali metals Group 7 = The halogens
What are the properties of the elements in group 0?	They are unreactive, do not easily form molecules and have low boiling points.
How does the reactivity change in group 1?	In Group 1, the reactivity of the elements increases as you go down the group.
How do the properties of group 7 elements change as you go down the group?	As you go down group 7 reactivity decreases, boiling point increases and melting point increases
<i>What is a cell?</i>	The smallest unit of an organism.
<i>What is the function of the flagellum?</i>	Aids movement of the cell - often towards the nutrients.
<i>What two structures are found in eukaryotic cells but not found in prokaryotic cells?</i>	<i>Membrane-bound organelles and the nucleus.</i>
<i>What three structures are found in plant cells and not animal cells?</i>	<i>Cell wall, chloroplast and vacuole</i>
<i>What structure allows things to enter and leave the cell?</i>	<i>Cell membrane</i>