Y9 Atomic Structure and the Periodic Table

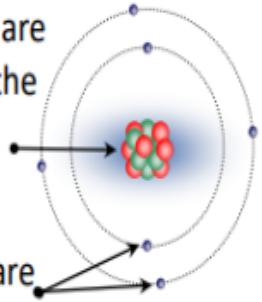
An **atom** is the smallest part of an element that cannot be broken down chemically.

An **element** is made up of one type of atom and is found in the Periodic Table.

A **compound** consists of 2 or more different types of atoms chemically joined together and are difficult to separate.

A **mixture** is made up of two or more elements **NOT** chemically joined together. They can be separated easily.

Protons and neutrons are found in the nucleus



Electrons are found in shells

Particle	Mass	Charge
proton	1	+1
neutron	1	0
electron	almost 0	-1

Properties of metals and non-metals

Metals

- normally good **conductors of heat** and **electricity**
- **shiny** when cut
- **Malleable**
- **dense** and **sonorous**
- most have **high melting points**

Non-Metals

Often have properties the opposite of metals

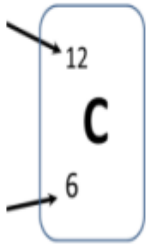
- **low boiling points**, so are gases at room temperature
- **poor conductors** of **electricity and heat**
- **dull** in appearance
- **low density**
- **brittle** and **not sonorous**

Keywords

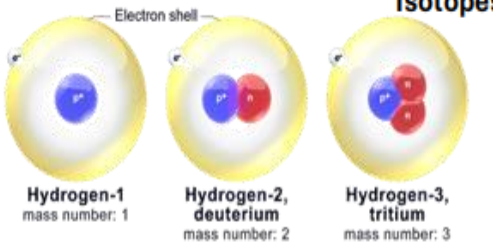
- Periodic Table
- Element
- Groups
- Periods
- Alkali Metals
- Transition Metals
- Halogens
- Noble Gases
- Atoms
- Electrons
- Protons
- Neutrons
- Nucleus
- Electron Shells
- Properties

Mass number = Number of protons + neutrons

Atomic number or proton number = Number of protons



Isotopes



Isotopes are different forms of elements that have the **same** number of protons, but **different** number of neutrons.

The **relative atomic mass** of an element is an average value that takes account of the abundance of the isotopes of the element.

The **number of electron** is always equal to the **number of protons** for a given element. Atoms have no overall charge.

Atoms are very small. Their radius is 1×10^{-10} m.
The radius of the nucleus is 1/10 000 the size of an atom.

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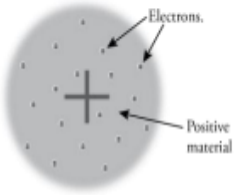
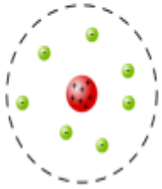
Atomic Model Development

- New experimental evidence and technology may lead to scientific models being changed.
- Before the electron was discovered, atoms were thought to be tiny solid spheres that could not be divided.

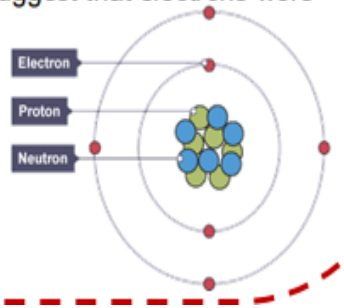
- When JJ Thomson discovered the electron, he modified the atomic model to the Plum Pudding Model.



- The Plum Pudding model suggested the atom to be a solid positive sphere with negative electrons embedded throughout it.
- Rutherford's Alpha Scattering Experiment led to the conclusion that the mass of an atom is concentrated at the centre (nucleus) and that the nucleus was positively charged.
- The Nuclear Atomic model replaced the Plum Pudding Model.

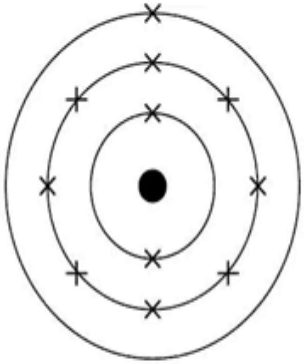


- Neils Bohr adapted the nuclear model to suggest that electrons were held at specific distances from the nucleus, creating the Planetoid Model.
- Further experiments identified neutrons as a particle found within the nucleus.



Electron Structure

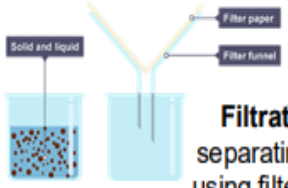
- Electrons in an atom occupy the lowest available energy level (shell).
- The electronic structure of an atom can be represented by numbers or by a diagram, as shown on the right (Sodium).
- This shows that 2 electrons fill the lowest energy level 8 the second, and one in the third energy level.



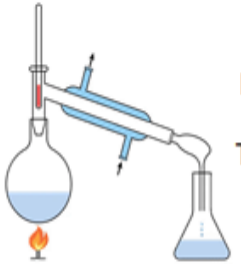
2, 8, 1

Separating Techniques

Mixtures are easily separated by the following physical processes which do not involve chemical reactions, and no new substance is made.

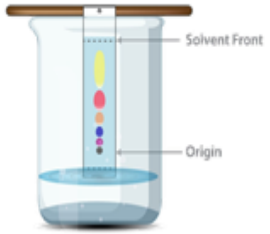


Filtration – separating solid using filter paper



Distillation – separating liquids from liquids based on different boiling points. This can be simple distillation (ink and water) or fractional distillation (crude oil)

Crystallisation – liquid is evaporated leaving a solid crystal



Chromatography – separating coloured substances (e.g. food colourings) based on molecular size.

Y9 Atomic Structure and The Periodic Table

The Periodic Table

1	2										3	4	5	6	7	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 — e.g. 1 H hydrogen 1

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

The **Periodic Table** consists of every known element.

- The modern periodic table is arranged according to increasing **atomic number**.
- It is called Periodic Table because similar properties occur at regular intervals (periodically).
- Columns of elements are called **groups** and have the same number of electrons on their outer shell.
- Groups of elements have similar properties.
- Rows of elements are called **periods** and have the same number of electron shells.

Development of the Periodic Table

- Before protons, electrons, and neutrons were discovered, scientists tried to organize the known elements.
- In the early Periodic Tables elements were largely arranged in atomic weight but the tables were largely incomplete (many elements were still undiscovered).
- Some elements were placed in the wrong groups.
- Dimitri Mendeleev overcame some of the problems by leaving gaps where he though undiscovered elements might lay. He also changed the order of some of the elements.

I	II	III	IV	V	VI	VII	VIII		
H 1.01									
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5			
K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 106
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
Au 197	Hg 201	Ti 204	Pb 207	Bi 209					
			Th 232		U 238				

- Elements that Mendeleev predicted were discovered and filled the gaps.
- When isotopes were discovered, they explained why the order of elements was not strictly according to atomic weight but atomic mass.

Y9 Atomic Structure and The Periodic Table

The Periodic Table Properties

Li Lithium
Na Sodium
K Potassium
Rb Rubidium
Cs Cesium
Fr Francium

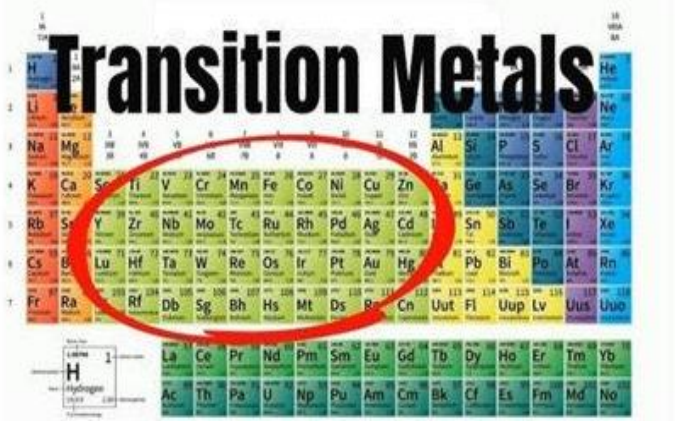
- **GROUP 1** elements are the **Alkali Metals**
- They have 1 electron on the outer shell, making them all highly reactive.
- Reactivity increases going down the group.

- **GROUP 7** elements are called the **Halogens** and are non-metals.
- They have seven electrons on their outer shell.
- Reactivity decreases going down the group.
- Relative molecular mass, melting and boiling points increase going the group.
- A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.

19 F 9 Fluorine
35 Cl 17 Chlorine
80 Br 35 Bromine
127 I 53 Iodine
210 At 85 Astatine

He
Ne
Ar
Kr
Xe
Rn

- **GROUP 0** are called the **Noble Gases** and a full outer electron shell.
- They are largely unreactive and do not easily form molecules.
- They have 8 electrons on their outer shell, except Helium that has 2.
- The boiling points increase with increasing relative atomic mass (going down the group).



- The transition metals are the central block of metals on the Period Table, and all have similar properties, which are different to Group 1 metals.
- They do not show group trends like other groups.

Physical Properties

- Good conductors of heat and electricity
- Malleable (can be hammered) and ductile (can be deformed without losing their toughness)
- Very high melting points (except Mercury)
- Usually hard and tough
- High densities

Chemical Properties

- Less reactive than Alkali metals.
- Form coloured ions of different charges.
- Can be very unreactive (e.g. silver, gold, and platinum).
- Many can be used as catalysts.

Y9 Energy Resources

8 Energy Stores

 Chemical

 Elastic

 Gravitational potential

 Nuclear

 Kinetic

 Magnetic

 Thermal

 Electrostatic

Energies that are always transferred:
Light and Sound

Conservation of Energy

Energy cannot be created or destroyed. Energy can only be **stored**, usefully **transferred**, or **dissipated**.

The total energy before and after a change in a **system** is constant.

A **system** is an object or group of objects where the net energy change is 0J.

Keywords

- Energy store
- Transfer
- System
- Dissipation
- Efficiency
- Biomass
- Geothermal
- Energy
- Insulation
- Fossil Fuel
- Renewable
- Non-renewable
- Power
- Work done
- Temperature
- Thermometer

Energy Transfers

Energy is transferred when it moves from one store to another. For example, when a ball rolls down a hill, gravitational potential energy transfers to the kinetic energy store.

Reducing unwanted transfers

- Energy that is transferred to the surroundings has been dissipated.
- Insulation, lubrication, sound proofing can all reduce energy dissipation.

SOURCES OF ENERGY

Renewable: replenished as quickly as they are used

Non-renewable: Finite resources, will eventually run out.

Y9 Energy Resources

Required Practical 2:

Insulation Material Thickness method:

1: Wrap 2 layers of newspaper around small beaker and use a rubber band to keep it in place. **Do not** cover the bottom.

2: Boil 80cm^3 of water and place into the beaker.

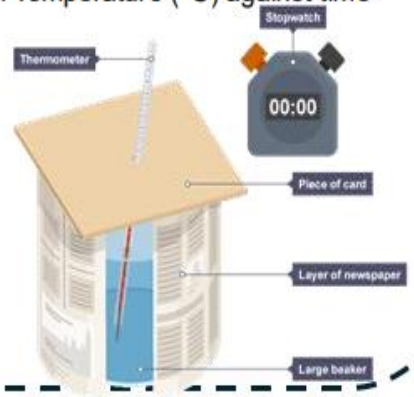
3: Add cardboard lid with hole for thermometer and record starting temperature.

4: Start the timer.

5: Record temperature every 3 minutes for 15 minutes.

6: Repeat steps 2-6 adding 2 layers of newspaper each time to a maximum of 8 layers.

7: Plot graph Temperature (°C) against time (mins).



Power

Power is the rate energy is transferred. It is measured in WATTS (W).

$$Power\ (W) = \frac{Energy\ transferred\ (J)}{time\ (s)}$$

$$Power\ (W) = \frac{Work\ done\ (J)}{time\ (s)}$$

Efficiency

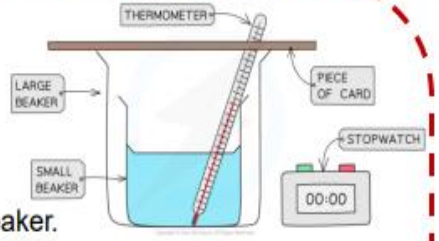
The ratio of the useful energy (or power) output from a system to its total energy (or power) input.

$$efficiency = \frac{useful\ energy\ output}{total\ energy\ input}$$

$$efficiency = \frac{useful\ power\ output}{total\ power\ input}$$

Required Practical 1

Insulation Material method:



1: Put small beaker in a large beaker.

2: Boil 80cm^3 water and place in small beaker.

3: Use a cardboard lid with a hole for the thermometer and record the starting temperature.

4: Start the timer.

5: Record temperature every 3 minutes for 15 minutes.

6: Repeat steps 2-6, placing different insulation materials between beakers.

7: Plot graph Temperature (°C) against time (mins).

Renewable energy resources

Advantages:

- Renewable
- No CO_2 gas released
- Not reliant upon Earth's natural resources

Disadvantages:

- Destroy habitats
- Many are weather dependent (wind, solar)
- Expensive to build and run

Non-renewable energy resources

Advantages:

- High energy stored
- Readily available

Disadvantages:

- Releases greenhouse gases (fossil fuels only)
- Finite (will run out)
- Makes Radioactive waste (nuclear only)