THE DUSTON SCHOOL
Knowledge itself is power
TDS 4-19

Year 10 Science Knowledge Booklet

Term 4

Name:	Class:

Year 10 Knowledge and Pillars Test Timetable and Workbook Deadlines		
1st March	C2	C2 H p118-131 F p107-117
15th March	P2	P2 H p205-218 F p180-193
29th March	C2/P2	C3 H p132-140 F p118-122

Science Homework 1

Complete the section of the homework workbook identified on the front of this Knowledge organiser and learn the key knowledge questions and answers ready for the knowledge quiz.

Big questions:

How are different salts made?

What practical steps are needed to make a soluble salt?

Why can you drink some acids but not others?

What reactions are used to determine the reactivity series?

What is the difference between a neutralisation and a redox reaction?

How can chemical equations be represented more simply?

How can metals be extracted from their compounds?

Do we always produce a metal during electrolysis ?

Key vocabulary

Acid	A substance that dissolves in water to release H^+ ions (the acid ion) It has a pH less than 7
Base	A substance that reacts with an acid, neutralising it. It has a pH more than 7
Alkali	A soluble base. It dissolves in water releasing OH^- ions (the alkaline ion)
Strength	Measure of how much the acid has split into its ions (ionised)
Concentration	Measure of the number of particle per unit of volume in a solution. Units g/dm^3
Neutralisation	Reaction between a acid and a base to produce salt and water (and carbon dioxide if base was metal carbonate
Reduction	In terms of oxygen → Loss of oxygen In terms of electrons → Gain of electrons
Oxidation	In terms of oxygen → gain of oxygen In terms of electrons → Loss of electrons
Electrolysis	Process where electricity is used to split a compound back into its elements
Electrode	Point of contact between a solution and wires in electrical circuit. Graphite typically used as high melting point and good electrical conductivity.

How are different salts made?

Salts are made when acids react with different substances, including metals, bases and alkalis

Metal + acid → Salt + hydrogen E.g Sodium + hydrochloric acid → Sodium chloride + hydrogen

Base + acid → Salt + water E.g Calcium oxide + nitric acid → Calcium nitrate + water

Metal carbonate + acid → Salt + water + carbon dioxide

e.g Lithium carbonate + sulphuric acid → Lithium sulfate + water + carbon dioxide

Alkali + acid → Salt + water E.g Lithium hydroxide + hydrochloric acid → Lithium chloride + water

To name the salt, need to know the metal / metal part of the base and what acid is used.

The metal part never changes its name, the acid changes its name based on

Name of acid	Chemical formula	Ions the acid splits into
Hydrochloric acid	**HCl**	**H^+ Cl^-**
Nitric acid	**HNO_3**	**H^+ NO_3^-**
Sulfuric acid	**H_2SO_4**	**$2H^+$ SO_4^{2-}**

If asked to write the formula of the salt, the positive charges of the metal must cancel the negative charge on acid part of salt

<u>Key ions Positive ions</u>

Group 1 → M^+ Group 2 → M^{2+} Group 3 → M^{3+}

<u>Key negative ions</u>

Chloride → Cl^- Nitrate → NO_3^- Sulfate → SO_4^{2-}

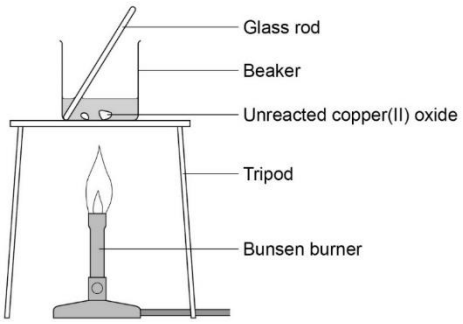
For example Sodium sulfate with be Na_2SO_4 as Sodium is in group 1, so two Na^+ ions are needed to cancel the SO_4^{2-}.

What practical steps are needed to make a soluble salt?

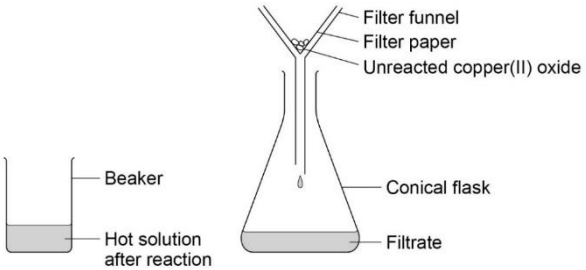
A pure sample of a soluble salt can be obtained from the reaction between an insoluble base e,g a metal oxide and an acid.

The order of the steps can be remembered using the acronym WAFER

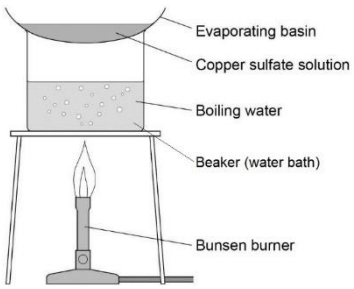
W → Warm the acid ***To increase rate of reaction***
A → Add the (insoluble) base to EXCESS ***To ensure all the acid has reacted***
F → Filter the resulting solution ***To remove the excess base***
E → Evaporate to the crystallisation point ***To remove the solvent***
R → Remove from heat, and allow the rest of the water to evaporate ***Get larger crystals and not powder***



W **A**



F



E **R**

Why can you drink some acids but not others?

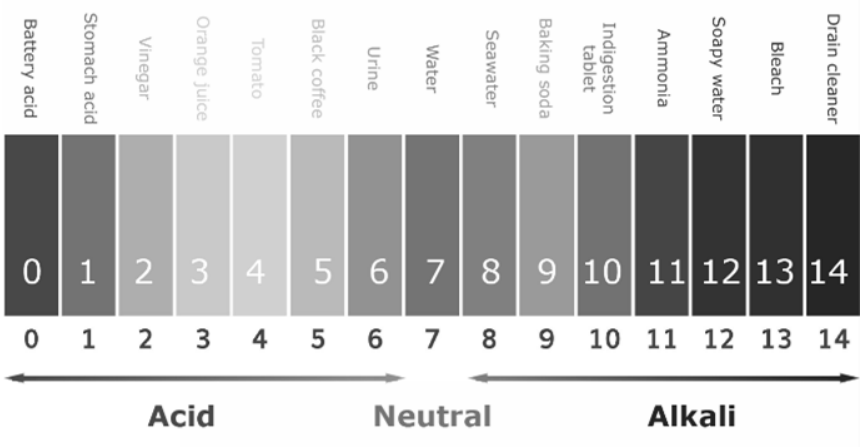
Not all acids are the same however, some acids and alkalis are **stronger** that others.

Strength of acids → Depends of how easily **IONISED** the acid is. This is where it **splits** into $\mathbf{H^+}$ ions and the negatively charged ion left over forms the salt

Strong acids → Completely ionise in solution. Examples include hydrochloric acid, sulphuric acid and nitric acid

Weak acids → Partially ionise in solution. Examples include ethanoic acid,

With the acids in solution, we cannot directly see the acids ionising, so we have to use the pH scale to identify the strength of the acids.



Key features

Neutral → pH 7

Acid → Less than 7 (strong 0-2)

Alkali → More than 7 (strong 12-14)

Strength is not the same as concentrated. Concentrated mean a larger number of particles per unit volume While dilute means per particles per unit volume.

The concentration can be increased by adding more mass of the solute to same volume

The concentration can be decreased by adding more solvent ie water to the solution.

A pH increase of 1 means the solution is 10x less concentrated

What reactions are used to determine the reactivity series?

When metals react, they are oxidised, meaning they LOSE electrons, forming positive ions.

The more reactive the metal, the more easily they lose electrons.

The reactivity series lists metals in order of most reactive to least reactive based on reactions with water, acid and oxygen.

The reactions can be compared by visual observations, such as how violent the effervescence (bubbling) is, how much the temperature changes by) or whether a displacement reaction has taken place

MOST REACTIVE OF COMMONLY USED METALS

Potassium

Sodium

Lithium

Calcium

Magnesium

Aluminium

Carbon (above this electrolysis MUST be used to extract)

Zinc

Iron

Hydrogen (below this unreactive that exist as metal

Copper

Silver

Gold

LEAST REACTIVE OF COMMONLY USED METALS

Displacement reactions → Where the more reactive element takes the place of a less reactive element in a compound

What is the difference between a neutralisation and a redox reaction?

Neutralisation reactions occur when acids react with bases or alkalis. The H^+ in the acid reacts with the base to form water. Essentially the reaction involves transfer of a H^+, there is NO transfer of electrons

When metals react with acids, or other substances, electrons are transferred instead. This is known as a redox reaction. REDOX → Reduction and oxidation

Reduction → Loss of oxygen (look in equation for reactant that had oxygen in chemical formula that has less oxygen's in product)

Oxidation → Gain of oxygen (look in equation for reactant that has more oxygen in product in chemical formula)

Example: $2Fe_2O_3 + 3C \rightarrow 3CO_2 + 4Fe$

Reduced → Fe_2O_3 as it produced iron so has lost oxygen

Oxidised → C as it has produced CO_2 showing it has gained oxygen

How can chemical equations be represented more simply?

Redox reactions can be identified by looking at what has gained or lost electrons instead of oxygen

The key acronym here is OIL_e RIG_e (pronounced Oily Rigy)

Oxidation is Loss of Electrons

Reduction is Gain of Electrons

To identify this more easily we can use half equations. Half equations on involve the element that is being oxidised and reduced, and the electrons.

To balance

1) Balance the atoms first
2) Count up the charges (don't forget numbers in front)
3) Balance the charge by adding electrons to the more positive side

Example

$H^+ \rightarrow H_2$ *Balance the atoms first, add another H^+ to balance the hydrogens*

$2H^+ \rightarrow H_2$ Count up the charges (2+ on the left, 0 on right) Left hand side more positive by 2 so add 2 electrons on the left

$2H^+ + 2e^- \rightarrow H_2$ H^+ has gained electrons so it has been reduced

Ionic equations

This is where spectator ions are removed from the equation. Spectator ions are those that aren't involved in the reaction, they remain in solution (aq) and don't change charge

To find spectator ions →

Look what is aqueous both sides of the equation,

Split those aqueous into ions (CHARGES !)

Cross out any that are same both side

Rewrite equation

E.g $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2\ (aq)} + H_{2\ (g)}$

$Mg_{(s)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow Mg^{2+}_{(aq)} + 2Cl^-_{(aq)} + H_{2\ (g)}$

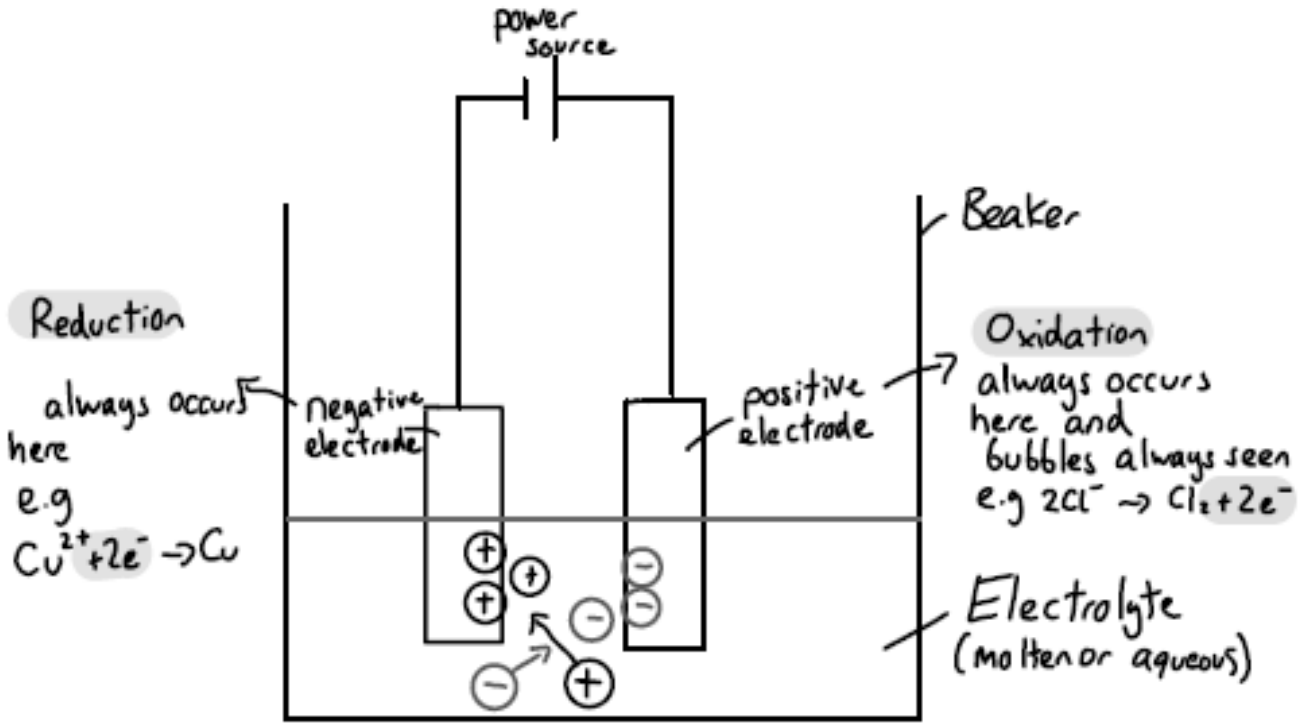
$Mg_{(s)} + 2H^+_{(aq)} + \cancel{2Cl^-_{(aq)}} \rightarrow Mg^{2+}_{(aq)} + \cancel{2Cl^-_{(aq)}} + H_{2\ (g)}$

$Mg_{(s)} + 2H^+_{(aq)} \rightarrow Mg^{2+}_{(aq)} + H_{2\ (g}$

How can metals be extracted from their compounds?

When an ionic compound is molten or dissolved in water, the giant ionic lattice is broken down and the ions are free to move (mobile). The molten mixture or aqueous solution (electrolyte) can conduct electricity as the charges can move to the oppositely charged electrode transferring energy.

A simple set up for electrolysis is shown below



To reform the element, negative ions lose electrons so are oxidised (losing electrons oxidation)

To reform the element, positive ions gain electrons so are reduced (gaining electrons reduction)

Do we always produce a metal during electrolysis ?

If you want to guarantee forming the metal, then the electrolyte needs to be the MOLTEN compound, and not aqueous.

Aqueous means dissolved in water, and water can split into ions: $H_2O \rightarrow H^+ + OH^-$

Reactive metals easily lose electrons, it is difficult to force them into accepting the electrons lost back. If there is a less reactive element (Hydrogen in this case) that can accept them instead, then Hydrogen will be reduced, forming H_2 gas. The metal ions stay in solution (forming a metal hydroxide solution

Ion	**In aqueous solutions**	**In molten compounds**
Metals **MORE** reactive than Hydrogen	Hydrogen gas is produced at negative electrode	The metal is produced on the negative electrode
Metals **LESS** reactive than Hydrogen	The metal is produced on the negative electrode	The metal is produced on the negative electrode
Halide ion (Cl^- Br^- I^-)	Halogen gas (Cl_2 Br_2 I_2) at positive electrode	Halogen gas (Cl_2 Br_2 I_2) at positive electrode
Hydroxide ions	Oxygen gas at positive electrode	X
Any other negative ion (sulfate, nitrate)	Oxygen gas at positive electrode	X

Science Homework 2

Complete the section of the homework workbook identified on the front of this Knowledge organiser and learn the key knowledge questions and answers ready for the knowledge quiz.

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
<u>You tube channels:</u>
Fuse school
Ted talks
Free science lessons
Primrose Kitten

Key knowledge question	**Answer**
In terms of oxygen, what is meant by reduction?	Loss of oxygen
In terms of electrons, what is meant by oxidation?	Loss of electrons
What acid must be used in preparation of Calcium nitrate?	Nitric acid
What process is used to separate an insoluble solid from a solution?	Filtration
What process is used to extract a salt from a salt solution?	Evaporation
Give 1 reason why graphite is a suitable electrode in electrolysis?	High melting point / good conductor of electricity / unreactive
Why does electrolysis not work for a solid salt?	Ions are fixed / not mobile
During electrolysis of sodium chloride solution, what is produced at negative electrode?	Hydrogen gas
During electrolysis of copper sulfate solution, what is produced at the positive electrode?	Oxygen gas

Science Homework 3

Complete the final section of the homework workbook identified on the front and learn the key knowledge questions and answers for all of the areas covered in this knowledge organiser ready for the end of term test.

Big questions:

- **What are atoms made of?**
- **How was the structure of the atom discovered?**
- **What is nuclear radiation?**
- **What are the properties of the nuclear radiations?**
- **How do we write decay equations?**
- **How long do sources stay radioactive?**
- **What is the difference between irradiation and contamination?**
-

Key vocabulary

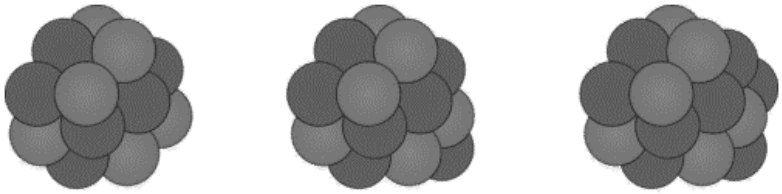
Alpha particle	A helium nucleus (two protons, two neutrons) emitted from some unstable nuclei during radioactive decay.
Alpha scattering experiment	An experiment carried out by Rutherford and others that showed that the atom has a nucleus.
Atomic structure	The atoms of an element are made of smaller, sub-atomic, particles. The number and arrangement of these particles is the atomic structure of the element.
Background radiation	Ionising radiation emitted by natural and man-made sources that is at a constant low level all over the Earth.
Beta particle	A fast moving electron emitted from the nucleus of some unstable nuclei during radioactive decay. Created by the decay of a neutron into a proton and electron.
Decay equation	A symbol equation representing the decay of a nucleus. Show the changes happening in the nucleus of radioactive isotopes.
Gamma ray	A photon (particle) of high energy electromagnetic radiation emitted from some unstable nuclei during radioactive decay.
Half Life	The time taken for one half of all remaining undecayed nuclei to decay. A measure of how long a sample will stay radioactive.
Ionising Radiation	Potentially harmful radiation emitted from the nucleus of an unstable isotope that can cause ionisation of other atoms.
Irradiation and contamination	Potentially harmful exposure to radiation either by radiation passing through (irradiation) or being in contact with radioactive material (contamination)
Isotope	Version of the same element with the same number of protons but different number of neutrons.
Radioactive decay	When an unstable isotope of an element undergoes a change in its nucleus and emits ionising radiation.

- **What are atoms made of?**

Atoms consist of a nucleus of protons and neutrons surrounded by electrons.

Isotopes of an element have the same number of **protons** and different number of **neutrons**. They have the same **Atomic number** and different **Mass number**.

Eg. Isotopes of carbon.



Carbon-12
98.9%
6 protons
6 neutrons

Carbon-13
1.1%
6 protons
7 neutrons

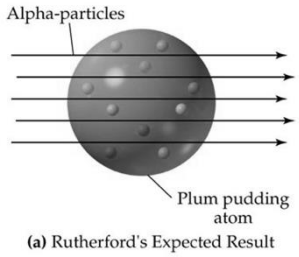
Carbon-14
<0.1%
6 protons
8 neutrons

- **How was the structure of the atom discovered?**
  Rutherford's alpha scattering experiment led to the modern model of the atom.

Thompson' plum pudding:

- Electrons scattered throughout.
- Positive charge spread everywhere.

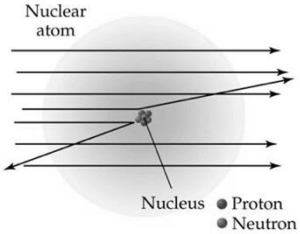
Expect alpha particles to pass through mostly undeflected.



(a) Rutherford's Expected Result

Rutherford's results:

- Many alpha particles pass through – must be lots of empty space.
- Some deflected through big angles – positive charge is in one place.



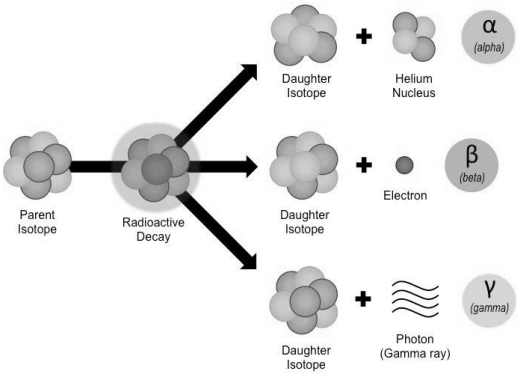
(b) Rutherford's Actual Result

Rutherford concludes: nucleus in the centre, electrons on outside.

- **What is nuclear radiation?**

In **alpha decay** a nucleus loses two protons and two neutrons.

- Mass number down by 4
- Atomic number down by 2



In **beta decay** a neutron becomes a proton and an electron. The electron is emitted. It is the beta particle.

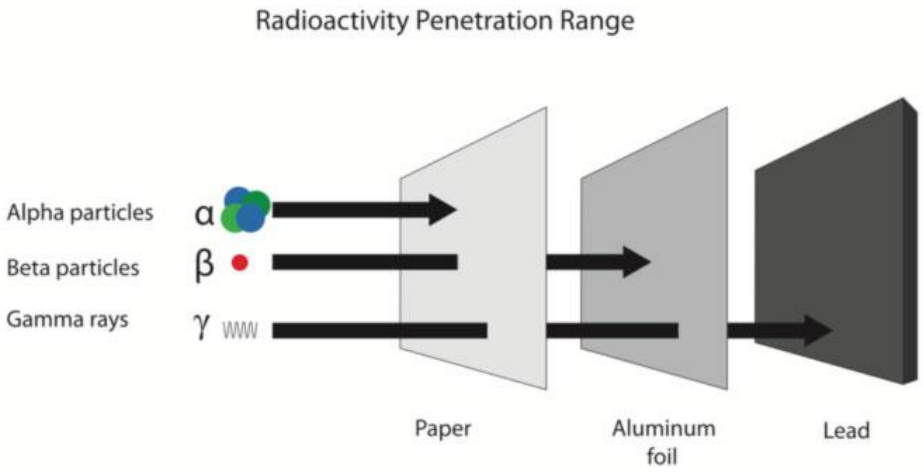
- Mass number stays the same
- Atomic number goes up by 1

In **gamma decay** a photon of high energy electromagnetic radiation is emitted. The nucleus is unchanged.

- **What are the properties of the nuclear radiations?**

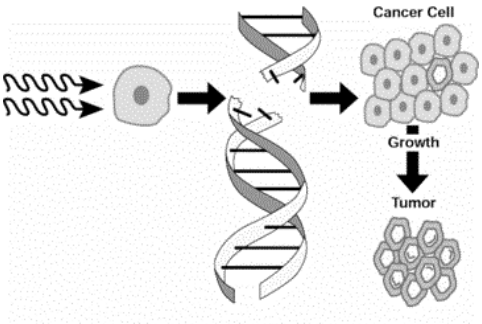
The penetrating power is a measure of how difficult it is to stop a radiation.

Alpha radiation has a low penetrating power. Beta is greater and gamma radiation is the most penetrating.

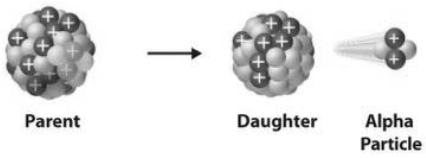
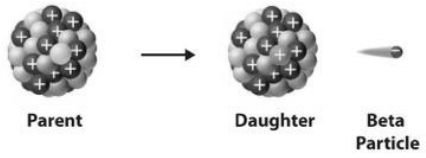
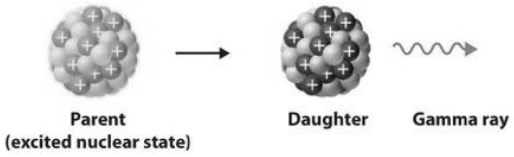


Nuclear radiations (alpha, beta, gamma) can cause **ionisation** (knock electrons out of other atoms).

This can damage human DNA and lead to cell damage or mutation that can lead to cancer.



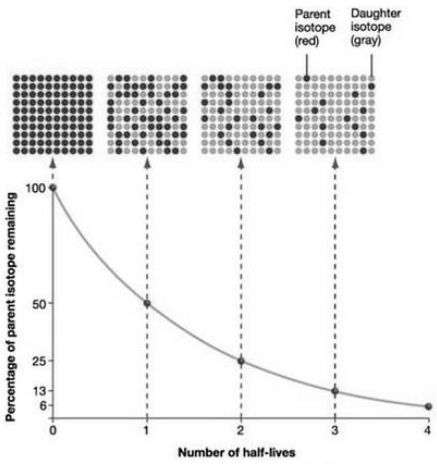
- **How do we write decay equations?**

Decay Type	Radiation Emitted	Generic Equation	Model
Alpha decay	$^{4}_{2}\alpha$	$^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}X' + {}^{4}_{2}\alpha$	
Beta decay	$^{0}_{-1}\beta$	$^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}X' + {}^{0}_{-1}\beta$	
Gamma emission	$^{0}_{0}\gamma$	$^{A}_{Z}X^{*} \xrightarrow{\text{Relaxation}} {}^{A}_{Z}X' + {}^{0}_{0}\gamma$	

- **How long do sources stay radioactive?**

Half life is: the time taken for the number of un-decayed atoms to fall by half. Equal to time for radioactive count to fall by half.

- Doesn't matter where you start counting – half life always the same.
- Half life for different isotopes very different.
- Half life useful for aging fossils and rocks – eg. carbon dating



- **What is the difference between irradiation and contamination?**

Contamination – you have a radioactive source material on you or in you.

Irradiation - ionising radiation strikes you or passes through you.

Key knowledge question	**Answer**
Which model of the atom consists of a sphere of positive charge with electrons embedded inside?	Sphere (ball) of positive charge, (negative) electrons scattered throughout
Give two features of the Plum Pudding model of the atom	Positive charge concentrated in the centre (nucleus), (negative) electrons around the outside
Give two features of the Rutherford nuclear model of the atom	Orbiting the nucleus (in energy levels/shells)
Where are electrons found in the nuclear model of the atom?	$^{4}_{2}He$ or a helium nucleus or 2 protons and 2 neutrons
Describe an alpha particle	$^{0}_{-1}e$ or a fast moving/high energy electron
Describe a beta particle	$^{0}_{0}$? or a high energy/frequency electromagnetic wave
Describe gamma	alpha, beta, gamma and neutron decay
State 3 type of nuclear radiation	the time taken for the activity to halve
Define half-life	contamination
What term means getting radioactive source on your skin, clothes or an object?	irradiation
What term means being exposed to the radiation emitted from a radioactive source?	mass number decreases by 4, atomic number decreases by 2
How do the mass number and atomic number change when a nucleus emits an alpha particle?	mass number stays the same, atomic number increases by 1

AQA

The Periodic Table of Elements

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	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[294] Ts tennessine 117	[294] Og oganesson 118

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

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

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