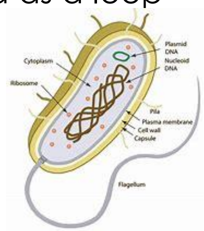
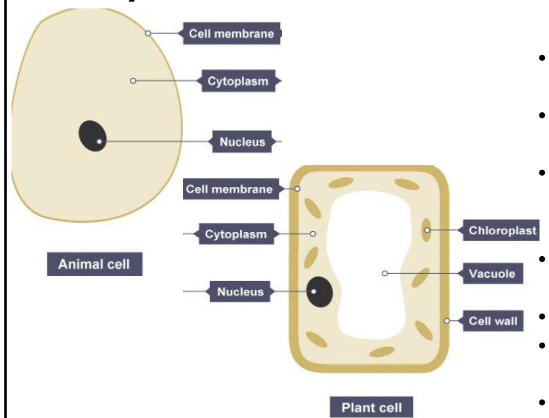
GCSE Science - B1 Cell Biology - Knowledge Organiser

Prokaryotic cells 1

- Bacterial cells
- Have cytoplasm, cell membrane and cell wall
- Do not have a nucleus
- DNA found as a loop - plasmid



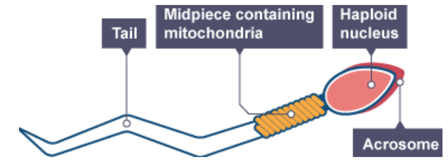
Eukaryotic cells 2



- **Nucleus**: contains genetic information. Controls the activities of the cell.
- **Cell membrane:** Controls what goes in/out of the cell.
- **Cytoplasm:** where chemical reactions happen.
- **Chloroplasts:** absorbs light energy so the plant can make food.
- **Permanent Vacuole:** contains liquid to keep the cell rigid.
- **Cell wall:** strengthens the cell.
- **Mitochondria** – Releases energy from respiration
- **Ribosome** – Makes protein

Cell specialisation 3

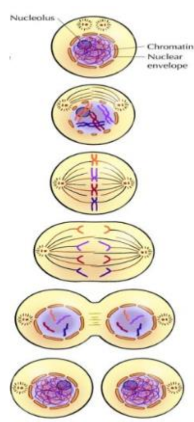
- Specialised cells have a particular function
- Identify the **adaptation** and **explain** how it allows the cell to perform its function
- **Sperm cell:** Tail – swim to egg, Lots of mitochondria – requires lots of energy



Cell division – Mitosis – (Growth and repair) 4

Chromosomes are made of DNA and carry a large number of genes. Found in pairs. **23 pairs** in each human cell. **The cell cycle:**

1. Cell **grows** to increase the number of sub-cellular structures, e.g. mitochondria and ribosomes
2. DNA **replicates**
3. Chromosomes line up on the equator
4. Spindle fibres **pull chromosomes apart** so one copy is at each end of the cell
5. **Nucleus divides**
6. Cytoplasm and cell membrane divides to form **two identical cells**

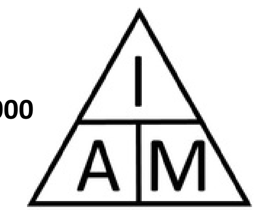


Microscopy – Required Practical 5

Maths skills:

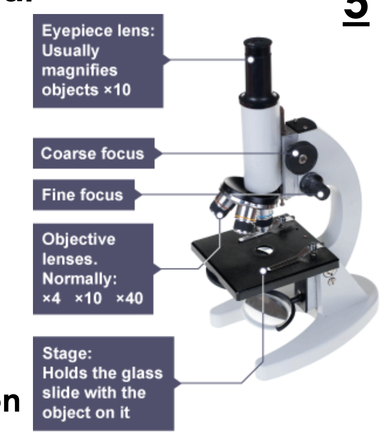
1,000 µm = 1mm

µm → mm divide by 1000



- Increasing magnification makes an image bigger
- Does not "zoom in"

Remember:
A = Actual size
I = Image size
M = Magnification



Stem cells 6

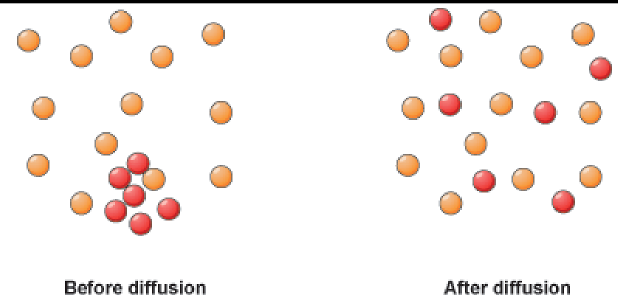
- Stem cells are **undifferentiated cells** which are capable of **differentiating into many types of cell**
- Stem cells from **human embryos** can be cloned and made to differentiate into different types of human cell
- Stem cells from **adult bone marrow** can form blood cells
- Treatment from stem cells may help **paralysis and diabetes**
- **Meristem tissue** in plants can differentiate into any type of plant cell

Stem cell applications 7

- An embryo is produced with the **same genes as the patient**
- Stem cells from the embryo are **not rejected** by the patient's body so may be used for medical treatment
- **Risk of viral infection**
- Stem cells from meristems in plants can be used to produce clones of plants quickly and economically
- Rare plants can be **cloned to protect from extinction**
- Crop plants with **resistance to disease can be produced in large numbers**

GCSE Science - B1 Cell Biology - Knowledge Organiser

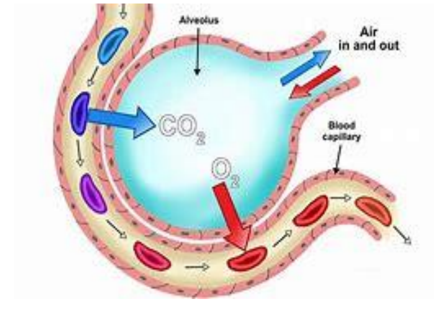
Diffusion **1**



- Transport of substances **down a concentration gradient**
- Gases
- Liquids – except water
- **High to Low concentration**
- **Passive process** – No energy required

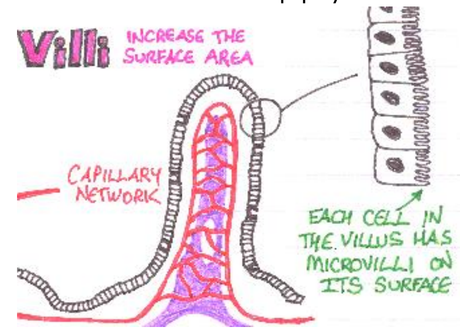
Diffusion - Contexts **2**

- Gas exchange
- Digestion
- Respiration



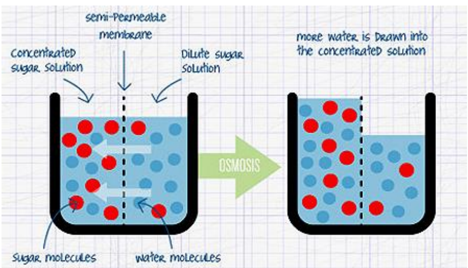
Diffusion - Adaptations **3**

- E.g. alveoli/microvilli
- Large surface area
- Short diffusion pathway
- Good blood supply



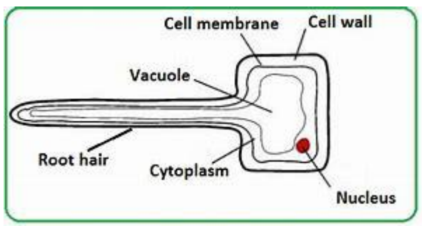
Osmosis **4**

- Movement of water molecules from a more dilute to concentrated solution



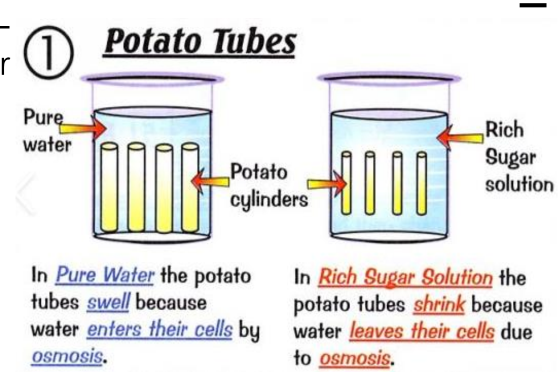
Osmosis - Adaptations **5**

- **Root hair cell:** large surface area, absorbs more water



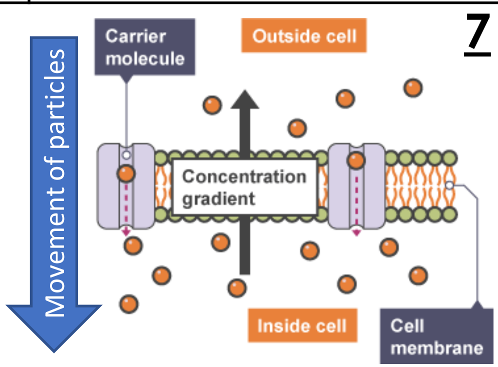
Osmosis – Required practical **6**

- **Independent variable** – Concentration of sugar solution
- **Dependent variable** – Change in mass of potato
- **Control variables** – Volume of sugar solution, time in sugar solution

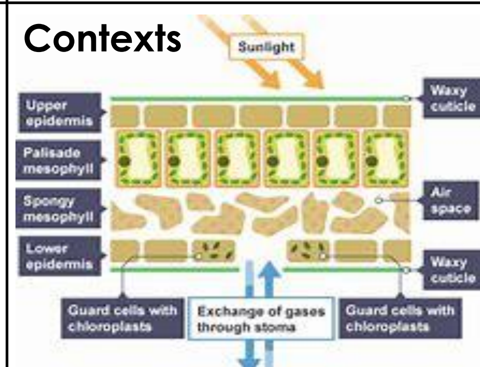


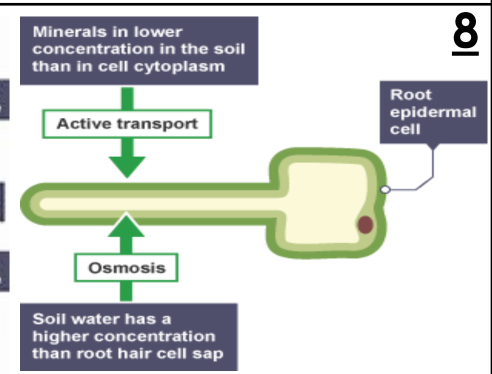
Active transport **7**

- Transport of substances against a concentration gradient
- **Low to High concentration**
- **Requires energy** released from respiration



Contexts **8**





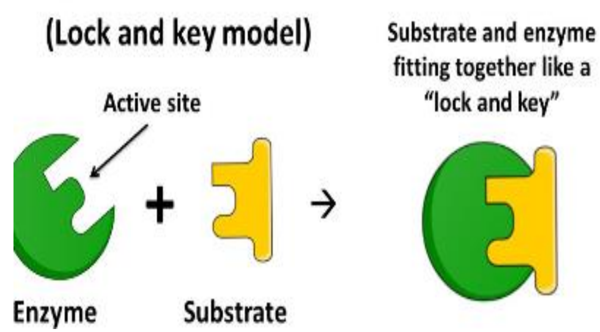
GCSE Science – B2 Organisation – Knowledge Organiser

Enzymes 1

- **Amylase** – Breaks down carbohydrate to starch
- **Lipase** – Breaks down lipids to glycerol and fatty acids
- **Proteases** – Break down protein to amino acids
- **Bile** – Made in the liver. Emulsifies fats to provide larger surface area for enzyme action

Enzyme action 2

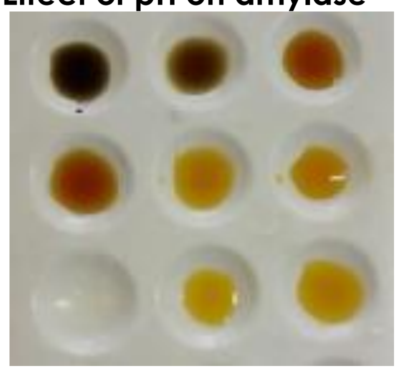
Active site – Where substrate binds.
Complimentary shape
When denatured bonds holding active site break – **changes shape**
Substrate can longer bind



Food tests – RP 3

- **Test for sugars –** Benedict's solution – **Blue → orange/red**
- **Test for protein –** Biuret – **Blue → purple**
- **Test for starch –** Iodine – **Yellow → blue/black**

Required practical – Effect of pH on amylase 4



Step 1) Place 2 drops of iodine in each dimple within the spotting tile.

Step 2) Select a starch solution to test, and add three drops of amylase to the starch solution. Whilst doing this, start a stop watch.

Step 3) Using a new pipette, collect one drop of starch and amylase solution every 30 seconds and place it in one of the dripping trays.

Step 4) Does the solution turn black or not? If the iodine turns black then amylase hasn't completely broken up the starch, if the iodine stays the same colour then the amylase has completed its reaction.

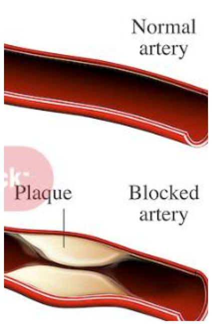
Health issues – risk factors 5

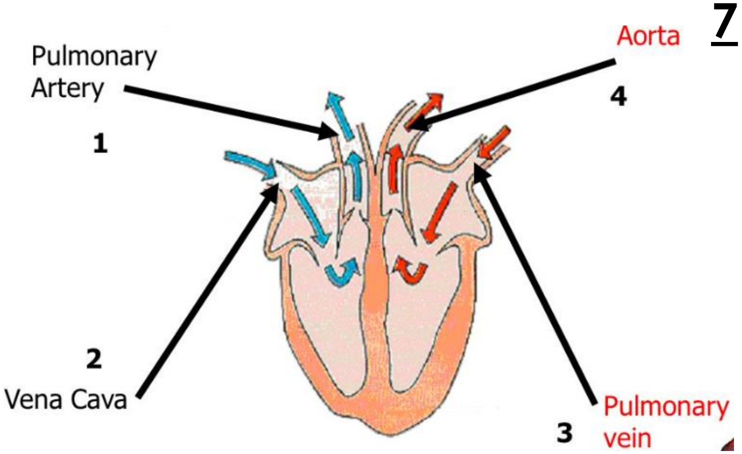
- Diet
- Smoking
- Lack of exercise
- Obesity
- Alcohol
- Carcinogens – cause cancer
- **Cancer** – changes in cells that cause uncontrollable growth and division

Coronary Heart Disease 6

- Build of fatty material in artery leads to **narrowing**
- **Reduces blood flow** to heart
- **Lack of oxygen** for heart muscles to respire
- **Treatment –**
- **Statins** – lower cholesterol
- **Stents** – keep artery open

The heart 7



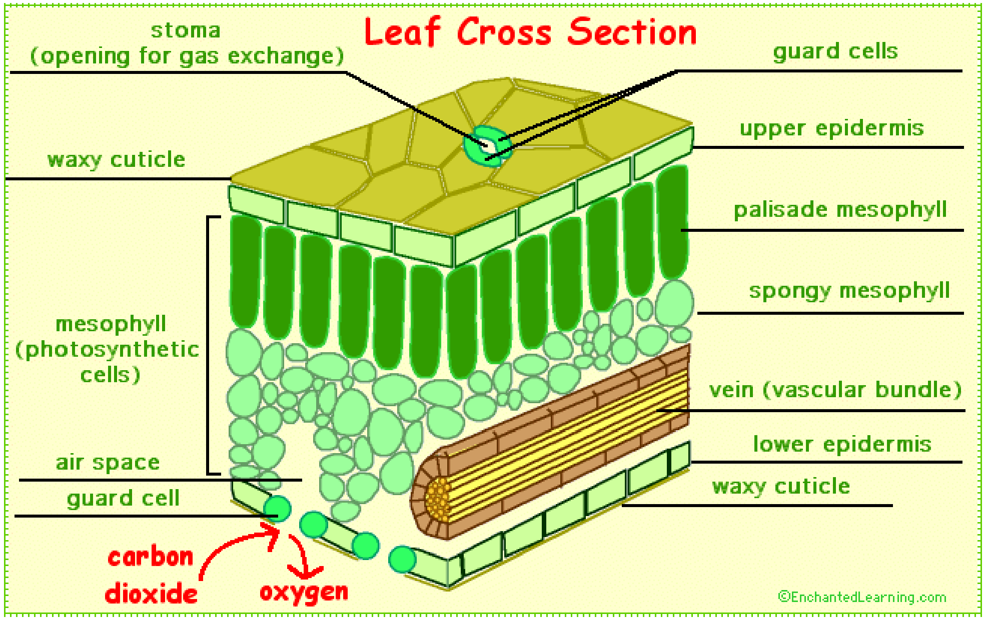


8

Blood vessel	Artery	Vein	Capillary
Direction of blood flow	Away from heart	To the heart	
Lumen size	Small lumen	Large lumen	Very small
Muscle thickness	Thick layer of muscle – high pressure	Thin layer of muscle – low pressure	No muscle layer
Outer wall	Thick outer wall	Thin outer wall	Single layer of cells

GCSE Science – B2 Organisation – Knowledge Organiser

Plant tissues 1

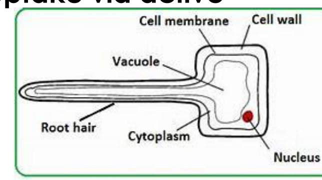


- **Epidermal tissue** – Waxy cuticle – prevents water loss
- **Palisade mesophyll** – Adapted to absorb light – lots of chloroplasts containing chlorophyll, cells packed tightly together
- **Spongy mesophyll** – Cells packed loosely for efficient gas exchange, cells covered in thin layer of water for gases to dissolve in and they move into and out of cells

- **Xylem** – transports water and minerals up the plant stem – strengthened by lignin
- **Phloem** – transports sugars (sucrose) produced by photosynthesis around the plant for growth
- **Meristem tissue** – Found at root and shoot tips for growth

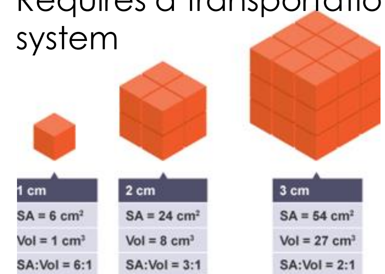
Root hair cells 2

Large surface area - absorb more water via osmosis
Thin cell wall – short diffusion pathway
No chloroplasts
Mineral uptake via active transport



SA:Vol ratio 3

- Larger organisms have a smaller SA:Vol ratio
- Requires a transportation system



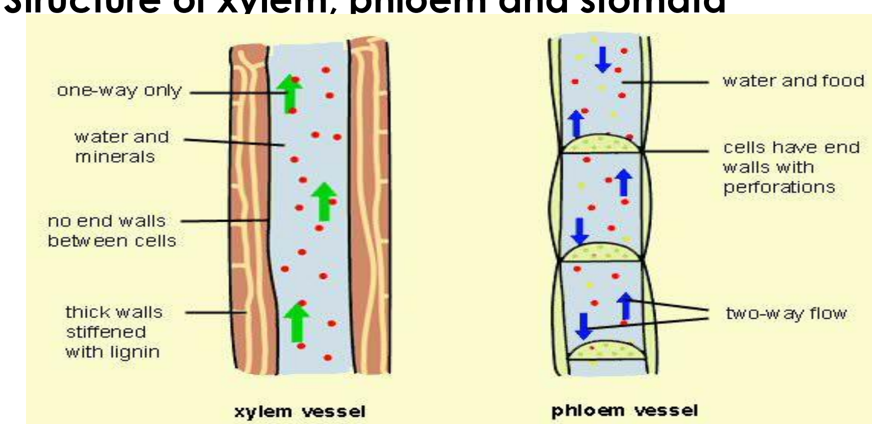
Transpiration 4

- **Water diffuses out of the leaf via the stomata**
- Water is drawn from the xylem to replace this water, this is the **Transpiration stream**
- Xylem are hollow tubes **strengthened by lignin**
- **Rate decreased by humidity**
- **Rate increased by temperature, air movement and light intensity**

Translocation 5

- Glucose produced from photosynthesis is **converted to sucrose**
- Transported in phloem vessels
- **Transported to leafs and roots for growth**
- Sucrose moves through elongated cells through holes in the end walls

Structure of xylem, phloem and stomata 6



GCSE Science - B3 Infection and Response - Knowledge Organiser

Communicable diseases 1

Pathogens are microorganisms that cause infectious disease.

Pathogens may be viruses, bacteria, protists or fungi.

They may infect plants or animals and can be spread by direct contact, by water or by air.

How to prevent the spread

Being hygienic- *washing hands thoroughly*
Killing vectors – *killing vectors by using insecticides or destroying the habitat*
Isolation- *isolating an infected person will prevent the spread*
Vaccination- *people cannot develop the infection and pass it on*

Viral diseases 2

Measles symptoms include fever & a red skin rash and can be fatal if complications arise. For this reason most young children are vaccinated against measles. The measles virus is spread by inhalation of droplets from sneezes and coughs.

HIV initially causes a flu-like illness. Unless successfully controlled with antiretroviral drugs the virus attacks the body's immune cells. Late stage HIV infection, or AIDS, occurs when the body's immune system becomes so badly damaged it can no longer deal with other infections or cancers. HIV is spread by sexual contact or exchange of body fluids such as blood which occurs when drug users share needles.

Tobacco mosaic virus (TMV) is a widespread plant pathogen. It gives a distinctive 'mosaic' pattern of discolouration on the leaves which affects the growth of the plant due to lack of photosynthesis.

Bacterial diseases 3

Salmonella (food poisoning)
Symptoms include fever, abdominal cramps, vomiting and diarrhoea. The salmonella bacteria is spread in food, or on food prepared in unhygienic conditions. In the UK, poultry are vaccinated against Salmonella to control the spread.

Gonorrhoea is a sexually transmitted disease (STD) with symptoms of a thick yellow or green discharge from the vagina or penis and pain on urinating. It easily treated with the antibiotic penicillin until many resistant strains appeared. Gonorrhoea is spread by sexual contact. The spread can be controlled by treatment with antibiotics or the use of a barrier method of contraception such as a condom.

Fungal & protists diseases 4

Rose black spot is a fungal disease where purple or black spots develop on leaves, which often turn yellow and drop early. It affects the growth of the plant as photosynthesis is reduced. It is spread in the environment by water or wind. Rose black spot can be treated by using fungicides and/or removing and destroying the affected leaves

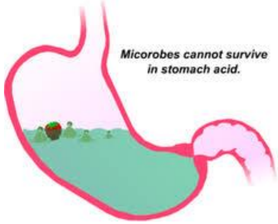
The pathogens that cause malaria are protists. The malarial protist has a life cycle that includes the mosquito. Malaria causes recurrent episodes of fever and can be fatal. The spread of malaria is controlled by preventing the vectors, mosquitos, from breeding and by using mosquito nets to avoid being bitten.

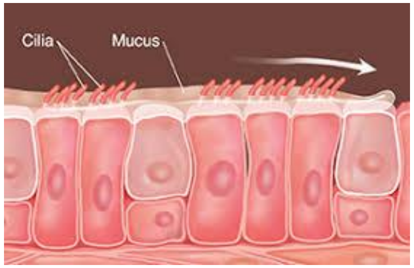
GCSE Science - B3 Infection and Response - Knowledge Organiser

Human Defence System

1

The non-specific defence systems of the human body against pathogens, including the: ***Skin*. *Nose, trachea, bronchi & stomach.***

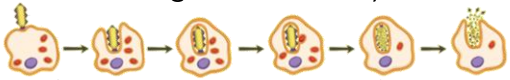




Role of the immune system

If pathogens pass the non-specific first line of defence they will cause an infection. However, the body has a second line of defence to stop or minimise this infection. This is called the immune system.

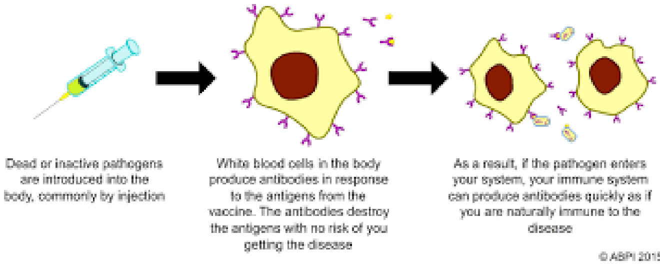
Phagocytes surround any pathogens in the blood and engulf them. They are attracted to pathogens and bind to them.



Lymphocytes recognise proteins on the surface of pathogens called **antigens**. Lymphocytes detect that these are foreign not naturally occurring within your body and produce **antibodies**. The antibodies cause pathogens to stick together and make it easier for phagocytes to engulf them.

Lymphocytes can also produce antitoxins to neutralise toxins.

Vaccinations



Fighting disease – drugs

3

Antibiotics cannot kill viral pathogens. It is difficult to develop drugs that kill viruses without also damaging the body's tissues

Painkillers and other medicines are used to treat the symptoms of disease but do not kill pathogens..

Discovery of drugs

4

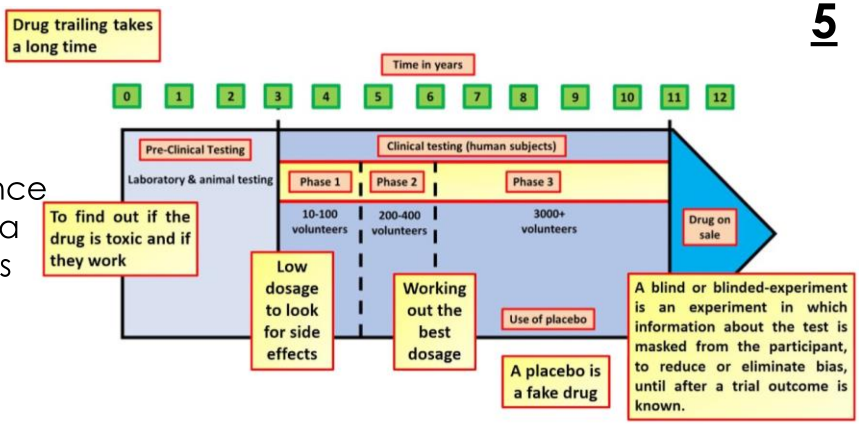
Traditionally drugs were extracted from plants & microorganisms.

- The heart drug **digitalis** originates from foxgloves.
- The painkiller **aspirin** originates from willow.
- **Penicillin** was discovered by Alexander Fleming from the Penicillium mould.

Development of drugs

5

Placebo =
An inactive substance made to resemble a drug for researchers to use as a control.



GCSE Science - B4 Bioenergetics (Photosynthesis) – Knowledge Organiser

Photosynthesis reaction 1

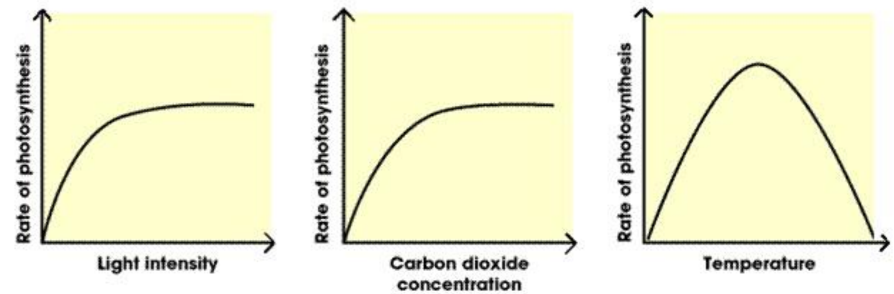
Photosynthesis

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

carbon dioxide + water ⟶ glucose + oxygen

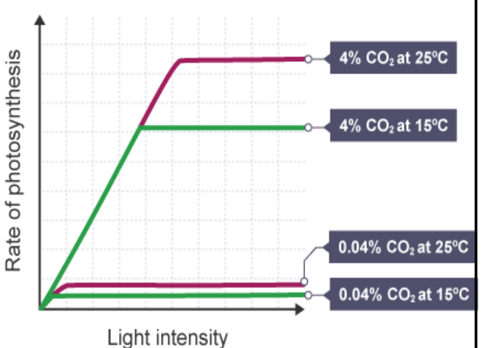
Photosynthesis is an endothermic reaction. Energy is transferred from the environment to the chloroplasts by light.

Rate of photosynthesis 2



Chlorophyll also affects the rate.
More chlorophyll = faster rate.

Factors affecting rate 3



Inverse square law for light 4

The intensity of the light from a source is inversely proportional to the square of distance from the source.

$$\text{INTENSITY} \propto \frac{1}{\text{DISTANCE}^2}$$

Greenhouses 5

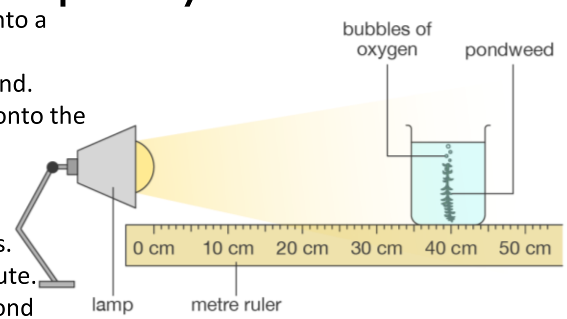
Light, temperature and CO_2 can all be controlled to get the maximum photosynthesis rate. But yields need to be balanced against increased costs.

Plants using glucose from photosynthesis 6

- used for respiration
- converted into insoluble starch for storage
- used to produce fat or oil for storage
- used to produce cellulose
- Combined with nitrates to produce amino acids

Required practical – light intensity and rate of photosynthesis 7

1. Measure 20cm^3 of sodium hydrogen carbonate solution and pour into a boiling tube.
2. Collect a 10cm piece of pond weed and attach a paper clip to one end.
3. Clamp the boiling tube, ensuring you will be able to shine the light onto the pond weed.
4. Place a meter ruler next to the pond weed.
5. Place the lamp 10cm away from the pondweed.
6. Wait 2 minutes until the pond weed has started to produce bubbles.
7. Using a stopwatch count the number of bubbles produced in a minute.
8. Repeat stages 5-7, moving the lamp 10cm further away from the pond weed each time until you have 5 different distances.
9. Repeat twice more so you have 3 readings for each distance.



Independent variable = light intensity
Dependent variable = amount of bubbles produced. To be more accurate instead of counting bubbles collect gas in a pas syringe.
Control variables = time and length of pond weed. Bench lamp used to control light intensity and a thermometer in the in the pond weed water controls the temperature.

GCSE Science - B4 Bioenergetics (Respiration) – Knowledge Organiser

Respiration 1

Occurs continuously in all living cells.
It is an **exothermic** reaction.
The energy transferred supplies all the energy needed for living processes.
Organisms need energy for:

- chemical reactions to build larger molecules
- movement
- keeping warm.

Aerobic respiration

glucose + oxygen → carbon dioxide + water + energy

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

Aerobic respiration produced a lot more energy than anaerobic respiration.

Anaerobic respiration 2

As the oxidation of glucose is incomplete in anaerobic respiration much less energy is transferred than in aerobic respiration.

glucose → lactic acid + energy

$$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3 + 2ATP$$

Anaerobic respiration in plant and yeast cells (fermentation) is used to manufacture bread and alcoholic drinks.

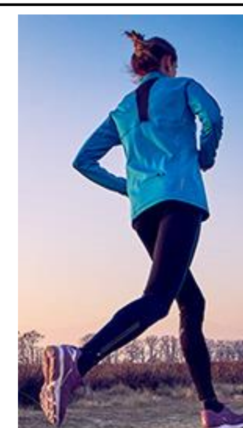
glucose → ethanol + carbon dioxide

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

Response to exercise 3

During exercise the body needs more energy so the respiration rates increase.
The heart rate, breathing rate and breath volume increase during exercise to supply the muscles with more oxygenated blood.

If insufficient oxygen then anaerobic respiration takes place in muscles, this causes lactic acid to build up. During long periods of vigorous activity muscles become fatigued and stop contracting efficiently.
Blood flowing through the muscles transports the lactic acid to the liver where it is converted back into glucose. Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells.



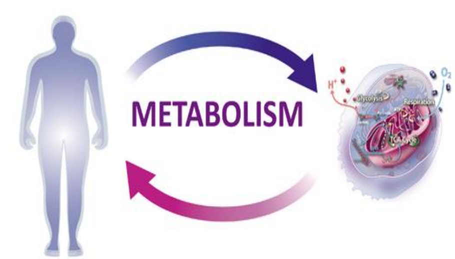
Metabolism 4

Metabolism is the sum of all the reactions in a cell or the body.

The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism that synthesise new molecules.

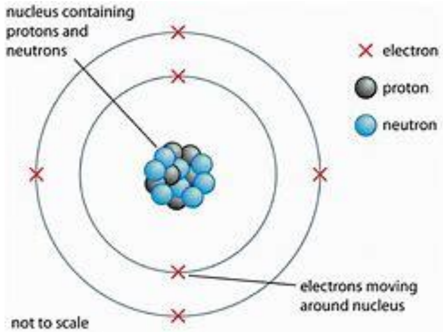
Metabolism includes:

- conversion of glucose to starch, glycogen and cellulose
- the formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids
- the use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins
- respiration
- breakdown of excess proteins to form urea for excretion.



GCSE Science - C1 Atomic Structure - Knowledge Organiser

The atom 1



- Very small – $\times 10^{-10}$m.

Elements 2

23 — Mass number

Na

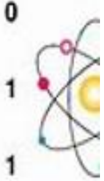
11

P = 11
E = 11
N = 12

- **Mass number** – Protons + neutrons
- **Atomic number** – Protons and electrons always balance – no overall charge

Sub-atomic particles 3

Particle	Symbol	Charge	Relative Mass
Electron	e^-	1-	0
Proton	p^+	1+	1
Neutron	n	0	1



Properties of metals 4

- High melting point
- Shiny
- Malleable
- Hard (high density)
- Conduct electricity
- Conduct heat

NON-METALS ARE THE OPPOSITE

Relative Atomic Mass 5

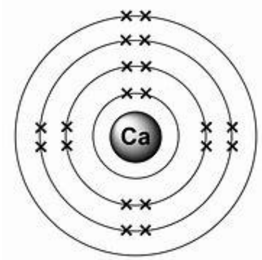
- RAM = The average value for the mass of an element
- Takes into account the abundance of the isotopes of each element

$$A_r = \frac{(mass\ 1 \times abundance\ 1) + (mass\ 2 \times abundance\ 2)}{100}$$

Electron configurations 6

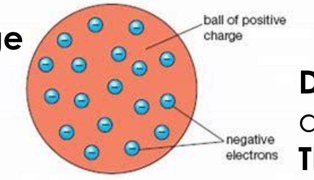
- First shell = 2
- Second shell = 8 max
- Third shell = 8 max
- Calcium = 2, 8, 8, 2

Group number = number of electrons on outer shell



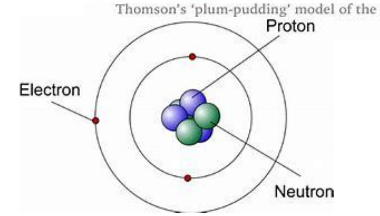
Development of the atomic model – key diagrams 7

Plum pudding –
P – ball of positive charge
E – Randomly scattered
N – No neutrons
N – No nucleus



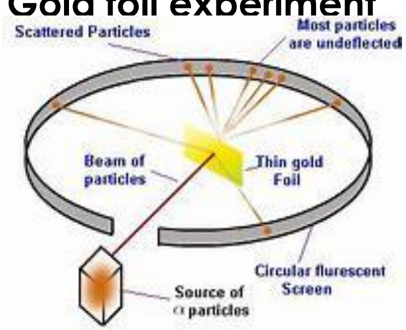
Thomson's 'plum-pudding' model of the

Nuclear Model –
P – In the nucleus
E – Orbit in shells
N – In the nucleus
N - Has a nucleus



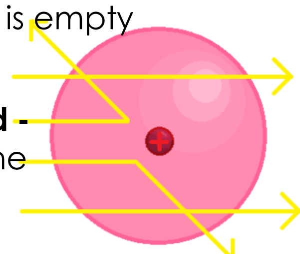
Dalton – atoms are small balls.
Thomson – plum pudding model.
Rutherford – atoms are like the solar system.
Bohr – electrons orbit atoms.

Gold foil experiment 8



Un-deflected - Most of the atom is empty space

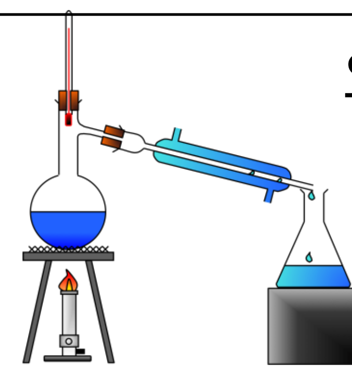
Deflected - Mass in the nucleus which is positive



Actual Result

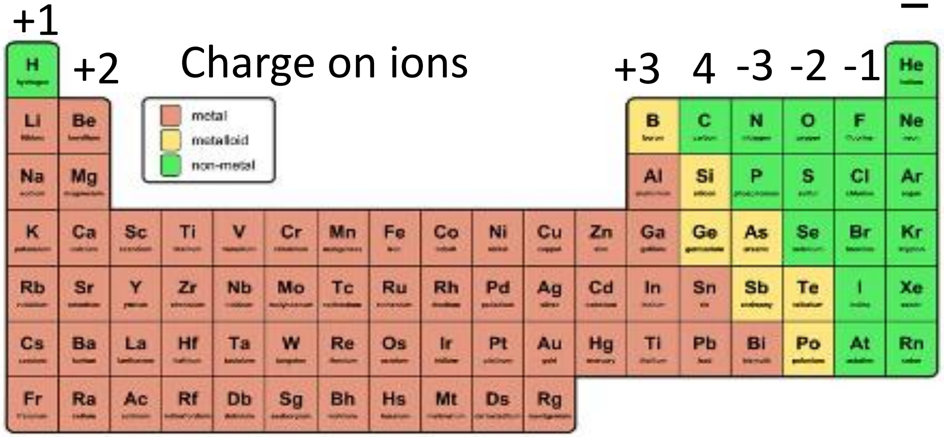
Separating mixtures. 9

- **Filtration** – insoluble solid and liquid.
- **Crystallisation** – evaporate water forms crystalline solid.
- **Distillation** – 2 liquids based on boiling point.
- **Chromatography** – pigments.



GCSE Science - C1 Atomic Structure - Knowledge Organiser

The Periodic table 1



Modern periodic table 2

- Arranged in order of atomic number
- **Group** – Column of elements that have similar chemical properties
- **Group number = number of electrons in the outer shell**
- **Period** – Row in the periodic table
- **Period = Number of shells**

Group 0 3

- Noble gases
- Unreactive / inert
- Stable arrangement of electrons
- Full outer shell
- Used in light bulbs – will not reactive with the metal filament
- Boiling point increases down the group

Group 1 5

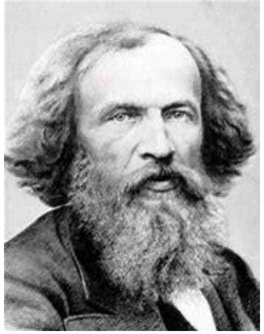
- Alkali metals,
- 1 electron in outer shell
- **More reactive as you go down the group**
- **More shielding, easier to lose outer electron**
- react with water, producing hydroxides and hydrogen gas

Group 7 6

- Halogens
- 7 electrons in outer shell
- their molecules each contain two atoms (they are diatomic)
- **Less reactive as you go down the group**
- **More shielding, harder to gain an electron**

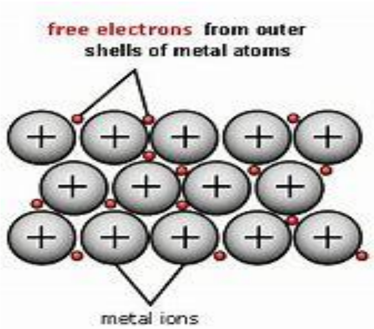
Development of the periodic table 7

- Early Periodic Table arranged by atomic weight
- **Newland** – Law of Octaves – every 8th element placed in the same group – had metals and on-metals together
- **Mendeleev** – Left gaps for undiscovered elements



Metals 8

- High melting point
- Shiny
- Malleable
- Hard (high density)
- Conduct electricity
- Conduct heat



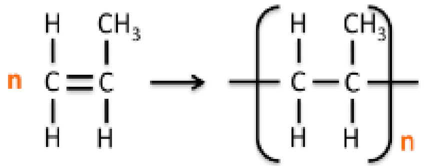
Properties of transition metals (TRIPLE ONLY) 9

- Good conductors
- High melting points
- High densities
- Very malleable and ductile
- Hard, strong
- Coloured compounds
- Used as catalysts
- Used for wires – conduct, ductile
- Used for pipes – Do not react with water

GCSE Science - C2 Structure and Bonding – Knowledge Organiser

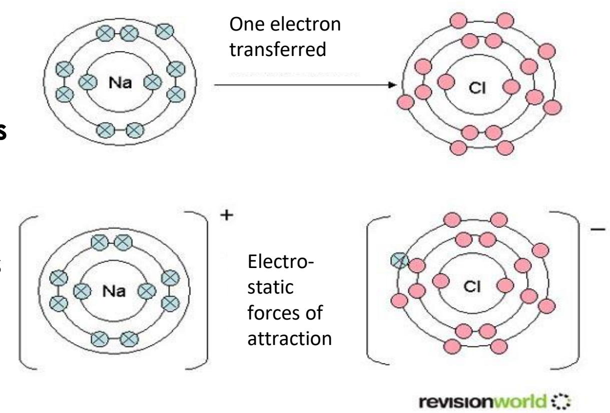
Polymers 1

- Covalent bonding
- **Monomer** – Single unit
- **Polymer** – lots of monomers joined together



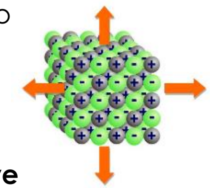
Ionic bonding 2

- Metal and non-metal
- **Transfer of electrons**
- Metal → Loses electrons forms positive ion
- Non-metal → Gains electrons forms negative ion
- **Electrostatic forces of attraction**



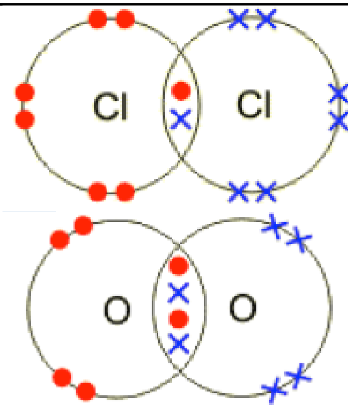
Ionic compounds 3

- Ionic lattice
- **Strong electrostatic forces** of attraction between oppositely charged ions
- **High melting point**
- Lots of **energy** to break bonds
- **Conducts when molten** or dissolved
- **Ions free to move**



Covalent structures 4

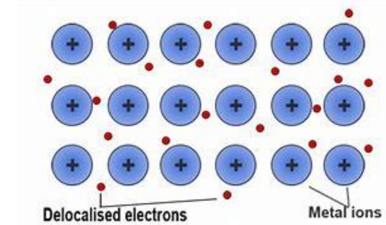
- 2 non-metals
- **Share electrons**
- **Venn diagram – dot and cross in the overlap**
- One shared pair = single bond
- Two shared pairs = Double bond
- Number of dots/crosses must add up to the group number



Covalent compounds 5

- Simple molecule
- **Weak intermolecular forces** of attraction between molecules
- **Low boiling point**
- **Little energy required to break**
- **Doesn't conduct electricity**
- No free electrons

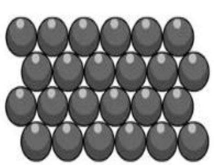
Metallic bonding 6



- **Delocalised electrons**
- **Free to carry a charge**
- Conducts thermal energy transferred by free electrons

Alloys 7

- **Pure metal**
- layers
- slide



- **Alloys** – 2 metals
- Layers distorted
- Can't slide

Nanoparticles 8

- Tiny particles **(1-100nm).**
- Able to penetrate biological tissues.
- **High surface area to volume ration so are good catalysts.**
- Concern about safety because not much is known about effects on body.

9

Diamond	Graphite	Graphene	Fullerene
4 strong covalent bonds	3 strong covalent bonds	One layer of graphite	Hexagonal ring of carbon atoms
High melting point – lots of energy to break	Lubricant – Layers of atoms slide over each other	3 strong covalent bonds	Buckminster-fullerene (C_{60})
Very hard - Used for drill bits	Delocalised electron – carries a charge	Delocalised electron – carries a charge	Carbon nanotubes - cylindrical
Does not conduct electricity	Conducts electricity	Conducts electricity	Used for nanotechnology

GCSE Science - C3 Quantitative Chemistry (COMBINED) - Knowledge Organiser

Conservation of Mass 1

- ***No atoms are lost or made during a chemical reaction:*** **Mass of the products equals the mass of the reactants.**
- **Mass changes when a reactant or product is a gas:**

Mass appears to increase during a reaction	*One of the reactants is a gas*	Magnesium + oxygen → magnesium oxide
Mass appears to decrease during a reaction	*One of the products is a gas and has escaped*	Calcium carbonate → carbon dioxide + calcium oxide

Relative Formula Mass, M_r 2

The sum of the relative atomic masses of the atoms in the numbers shown in the formula

$2Mg + O2 \rightarrow 2MgO$
48g + 32g = 80g
80g = 80g

Balancing symbol equations:
Represent chemical reactions and have the same number of atoms of each element on both sides of the equation

$H_2 + Cl_2 \rightarrow 2HCl$

Subscript · Normal script

Subscript numbers show the number of atoms of the element to its left.

Normal script numbers show the number of molecules.

Uncertainty 3

Whenever a measurement is taken, there is always some uncertainty about the result obtained.

1. Calculate the mean
2. Calculate the range of the results
3. Estimate of uncertainty in mean would be half the range.

Does the mean value fall within the range of uncertainty of the result?

Moles HT 4

Chemical amounts are measured in moles (mol).
Mass of one mole of a substance in grams = relative formula mass.
e.g. One mole of H_2O = 18g (1 + 1+ 16), One mole of Mg = 24g

Avogadro's Constant: 6.02×10^{23}

'One mole of any substance will contain the same number of particles, atoms, molecules or ions.'

6.02×10^{23} per mole:
One mole of H_2O will contain 6.02×10^{23} molecules of water
One mole of NaCl will contain 6.02×10^{23} Na^+ ions.
Calculating number of moles: *Number of moles = $\frac{\text{mass (g)}}{A_r}$ or $\frac{\text{mass (g)}}{M_r}$*

Amounts of substances in equations HT 5

Chemical reactions show the number of moles reacting and the number of moles made.
e.g.
$Mg + 2HCl \rightarrow MgCl_2 + H_2$
One mole of magnesium reacts with two moles of hydrochloric acid to make one mole of magnesium chloride and one mole of hydrogen

Calculating amounts of substances in equations HT 6

If you have a 60g of Mg, what mass of HCl do you need to convert it to $MgCl_2$?

A_r : Mg =24 so mass of 1 mole of Mg = 24g
M_r : HCl (1 + 35.5) so mass of 1 mole of HCl = 36.5g

So 60g of Mg is 60/24 = 2.5 moles

Balanced symbol equation tells us that for every one mole of Mg, you need two moles of HCl to react with it.

So you need 2.5x2 = 5 moles of HCl

You will need 5 x 36.5g of HCl= 182.5g

Limiting Reactants HT 7

In a reaction with 2 reactants, it is common to use an **excess** of one reactant to make sure that **all** of the other reactant is used up. This reactant that is completely used up is called the **limiting reactant**, as it **limits the amount of the products** that can be made.
You can **calculate the moles or mass of the products formed**.

Concentration HT 8

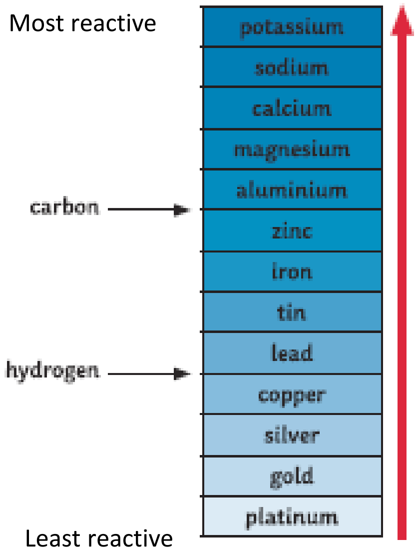
- The concentration of a solution (aq) can be measured in **g/dm³** (mass/volume)
Concentration = mass ÷ volume
- The concentration of the **solution** depends on the mass of the **solute** and the volume of the **solvent**. Increasing mass increases concentration, increasing volume decreases concentration.

Using Moles to balance equations HT 9

Remember: moles = mass ÷ M_r
- If you calculate the number of moles of each reactant and product in a reaction it will give you the **ratio of reactants and products**, so you can write the **balanced equation**.
e.g 48g of Mg reacts with 32g of O_2 to produce 80g of MgO
so: 48÷24 = **2mol of Mg**; 32÷(2x16)= **1mol of O_2**; 80÷(24+16)= **2mol of MgO**
this is a **ratio** of **2:1:2** (Mg: O_2: MgO):
2Mg + O_2 —> **2**MgO (**Balanced)**

GCSE Science - C4 Chemical Changes - Knowledge Organiser

Reactivity Series 1



Metals less reactive than carbon can be extracted from their oxides by reduction.
For example: zinc oxide + carbon → zinc + carbon dioxide.
Metals more reactive than carbon require electrolysis for extraction.
Unreactive metals, such as gold, are found in the Earth as the metal itself. They can be mined from the ground.

Reactions of metals with water: 2

Metal + Water → Metal Hydroxide + Hydrogen

Reactions of metals with dilute acid:
Metal + Acid → Salt + Hydrogen

Ores 3

Rock containing enough mineral or metal for extraction.
There must be enough mineral or metal to make a profit. Metals are usually in the form of compounds within the ore (typically metal oxides).

More Important Reactions: 4

Metal + Oxygen → Metal oxide

Thermal decomposition: breakdown of compounds using heat:
$CaCO_3$ → $CaO + CO_2$

Recycling Metals 5

Recycling is used to conserves ores, reduce energy required for extraction and minimise pollution. It also reduces the use of landfill and the destruction of habitats. Some metals cannot be reused because of damage, need for paint removal, rusting/corrosion, metal fatigue.

Displacement reactions 6

A less reactive metal is displaced from its compound by a more reactive metal.
e.g.
Tin oxide + Sodium → Sodium oxide + Tin

Extracting metals using electrolysis 7

Metals can be extracted from molten compounds using electrolysis.
This process is used when the metal is too reactive to be extracted by reduction with carbon.
The process is expensive due to large amounts of energy needed to produce the electrical current.
Example: aluminium is extracted in this way.

GCSE Science - C4 Chemical Changes - Knowledge Organiser

Redox Reactions and Ionic Half Equations (H Tier) 1

Oxidation **I**s **L**oss (of electrons)

Reduction **I**s **G**ain (of electrons)

The ionic equation for the reaction between iron and copper (II) ions is:

$Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$

The half-equation for iron (II) is:

$Fe \rightarrow Fe^{2+} + 2e^-$

The half-equation for copper (II) ions is:

$Cu^{2+} + 2e^- \rightarrow Cu$

More Acid Reactions 2

Neutralisation reactions: Acid + Alkali → Salt + Water

Acid + BASE → Salt + Water

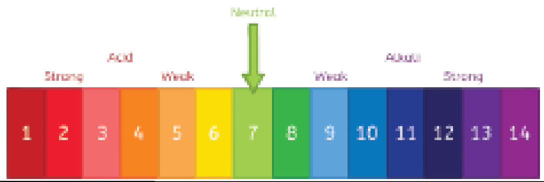
Acid + Carbonate → Salt + Water + Carbon Dioxide

Base = insoluble alkalis e.g. insoluble metal oxides and hydroxides

pH Scale 3

Acids	*Acids produce hydrogen ions (H^+) in aqueous solutions.*
Alkalis	*Aqueous solutions of alkalis contain hydroxide ions (OH^-).*

You can use universal indicator or a pH probe to measure the acidity or alkalinity of a solution against the pH scale.



In neutralisation reactions, hydrogen ions react with hydroxide ions to produce water:

$H^+ + OH^- \rightarrow H_2O$

Strong and weak acids (H Tier) 4

Strong acids	*Completely ionised in aqueous solutions e.g. hydrochloric, nitric and sulfuric acids.*
Weak acids	*Only partially ionised in aqueous solutions e.g. ethanoic acid, citric acid.*
Hydrogen ion concentration	*As the pH decreases by one unit (becoming a stronger acid), the hydrogen ion concentration increases by a factor of 10.*

Naming salts 5

Acid Used	Salt Produced
hydrochloric	chloride
nitric	nitrate
sulfuric	sulfate

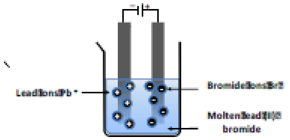
First part comes from the metal in the compound, second from which acid it reacted with.

Half equations (H tier) 6

You can display what is happening at each electrode using half-equations:

At the cathode: Pb2+ + 2e-→Pb

At the anode: 2Br-→Br2+ 2e-



Basic electrolysis 7

Positive
Anode
Negative
Is
Cathode

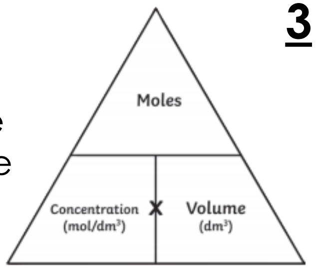
Process of electrolysis	*Splitting up using electricity*	When an ionic compound is melted or dissolved in water, the ions are free to move. These are then able to conduct electricity and are called electrolytes. Passing an electric current though electrolytes causes the ions to move to the electrodes.
Electrode	*Anode Cathode*	The positive electrode is called the anode. The negative electrode is called the cathode.
Where do the ions go?	*Cations Anions*	Cations are positive ions and they move to the negative cathode. Anions are negative ions and they move to the positive anode.

Making Soluble Salts RP. 1

1. Make a saturated solution by stirring copper oxide into the sulfuric acid until no more will dissolve.
2. Filter the solution to remove the excess copper oxide solid.
3. Half fill a beaker with water and set this over a Bunsen burner to heat the water. Place an evaporating dish on top of the beaker.
4. Add some of the solution to the evaporating basin and heat until crystals begin to form.
5. Once cooled, pour the remaining liquid into a crystallising dish and leave to cool for 24 hours.
6. Remove the crystals with a spatula and pat dry between paper towels

Titration RP (Chem only). 3

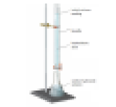
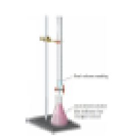
Using the results from a titration experiment, it is possible to calculate the concentration of a solution or the volume of solution required to neutralise an acid or alkali.



Calculating the chemical quantities in titrations involving concentrations in mol/dm³ and in g/dm³ (HT ONLY): $2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$ It takes 12.20cm³ of sulfuric acid to neutralise 24.00cm³ of sodium hydroxide solution, which has a concentration of 0.50mol/dm³. *Calculate the concentration of the sulfuric acid in g/dm³* 0.5 mol/dm³ x (24/1000) dm³ = 0.012 mol of NaOH	The equation shows that 2 mol of NaOH reacts with 1 mol of H_2SO_4, so the number of moles in 12.20cm³ of sulfuric acid is (0.012/2) = 0.006 mol of sulfuric acid *Calculate the concentration of sulfuric acid in mol/ dm³* 0.006 mol x (1000/12.2) dm³ =0.49mol/dm³ *Calculate the concentration of sulfuric acid in g/ dm³* H_2SO_4 = (2x1) + 32 + (4x16) = 98g 0.49 x 98g = 48.2g/dm³

Titration RP (Chem only). 2

Titrations are used to work out the precise volumes of acid and alkali solutions that react with each other.

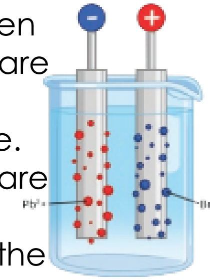
	1. Use the pipette to add 25 cm³ of alkali to a conical flask and add a few drops of indicator. **Indicator: methyl orange. Turns from orange to red upon neutralisation**
	2. Fill the burette with acid and note the starting volume. Slowly add the acid from the burette to the alkali in the conical flask, swirling to mix.
	3. Stop adding the acid when the end-point is reached (the appropriate colour change in the indicator happens). Note the final volume reading. Repeat steps 1 to 3 until you get consistent readings.

Electrolysis of aqueous solutions and molten ionic compounds. 4

At the negative electrode	Metal will be produced on the electrode if it is less reactive than hydrogen. Hydrogen will be produced if the metal is more reactive than hydrogen.
At the positive electrode	Oxygen is formed at positive electrode. If you have a halide ion (Cl^-, I^-, Br^-) then you will get chlorine, bromine or iodine formed at that electrode.

The ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved.

Lead bromide is an ionic compound. Ionic compounds, when solid, are not able to conduct electricity. When molten or in solution, the ions are free to move and are able to carry a charge. The positive lead ions are attracted toward the negative cathode at the same time as the negative bromide ions are attracted toward the positive anode.



Aluminium is manufactured by electrolysis from aluminium oxide which has a very high melting point. It takes large amount of energy and money to turn it molten. Therefore CRYOLITE is added to aluminium oxide to lower the melting point and reduce cost.

OIL RIG (Higher Tier Only).

We represent what is happening at the electrode by using half equations.

Lead ions reduced (gain e-):

$Pb^2 + 2e \rightarrow Pb$

Bromide ions reduced (lose e-):

$2Br\ Br_2 + 2e$

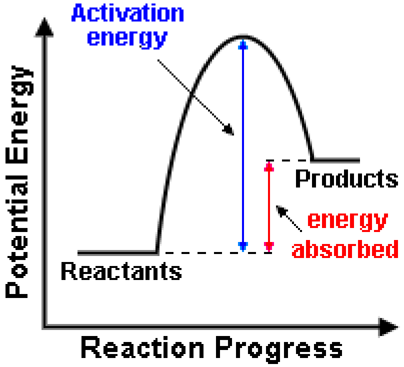
Oxidation Is Loss (OIL)

Reduction Is Gain (RIG)

GCSE Science - C5 Energy Changes - Knowledge Organiser

Endothermic reactions 1

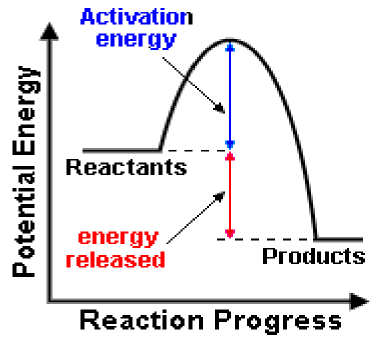
- Takes in energy from the surroundings
- **Temperature of the surroundings decreases**
- Examples:
- Thermal decomposition
- Citric acid + Sodium hydrogencarbonate
- Sports injury packs



Endothermic reaction

Exothermic reactions 2

- Transfers energy to the surroundings
- **Temperature of the surroundings increases**
- Examples:
- Combustion
- Oxidation reactions
- Neutralisation reactions
- Hand warmers



Exothermic reaction

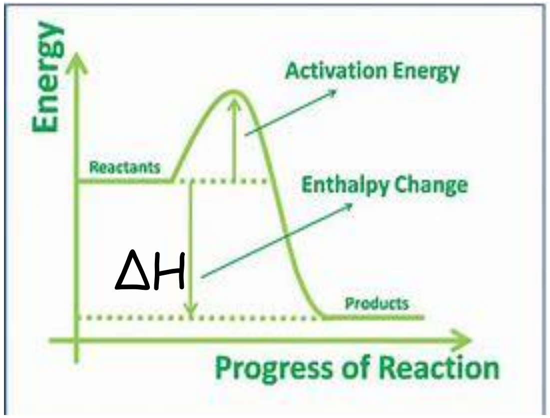
Reaction profiles 3

Activation energy – The minimum amount of energy that particles require to react

ΔH – Overall energy change

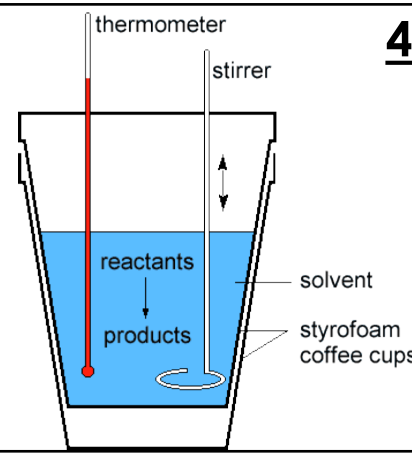
+ ΔH = Endothermic

- ΔH = Exothermic



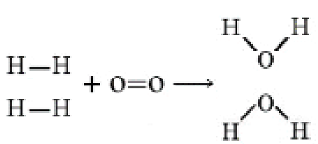
Required practical 4

- Styrofoam cup reduces energy transfer
- **Independent – Reactants**
- **Dependent – Temperature change**
- **Improvements** – add a lid to reduce energy loss
- Add a stirrer to ensure reactants fully mixed



Bond enthalpy calculations (HT only) 5

Example: Calculate the enthalpy change when water is formed from H_2 and O_2.



STEP 1 Bonds Broken

2 x (H-H) = 2 x 436 = 872

1 x (O=O) = 498

Total = 872 + 498 = 1370

STEP 2 Bonds Made

4 x (O-H) = 4 x 464 = 1856

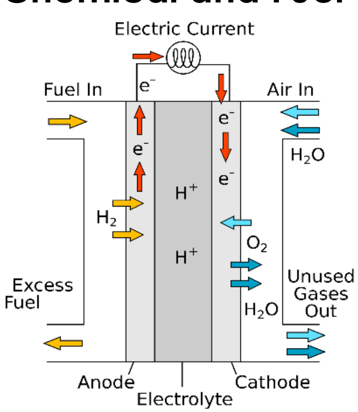
STEP 3

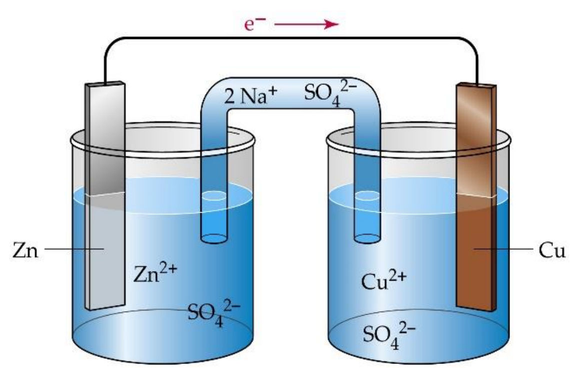
Enthalpy change = bonds broken – bonds made

= 1370 – 1856 = -486

Bond	Bond Enthalpy
H-H	436
H-O	464
O=O	498

Chemical and Fuel cells (Chemistry only) 6

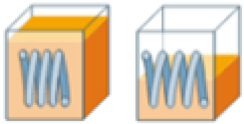




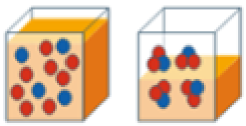
GCSE Science - P1 Energy - Knowledge Organiser

Energy Stores
- Gravitational potential
- Magnetic
- Internal thermal
- Chemical
- Kinetic
- Electrostatic
- Elastic potential
- Nuclear
- As one store empties, another store is filled by the same amount
- **Conservation of energy**
- **Energy usually wasted as thermal energy**

Energy pathways
- Mechanical
- Internal thermal
- Radiation
- Electrostatic



elastic



chemical

Energy Transfers in a System
- Energy can be **transferred usefully, stored or dissipated**, but cannot be created or destroyed
- **Dissipation is reduced by lubrication or Insulation**
- Rate of cooling of a building is affected by the thickness and thermal conductivity of the walls

Power

Power is the rate at which energy is transferred or the rate at which work is done

Power = Energy Transferred / Time

Power = Work Done / Time

Efficiency

Is a measure of useful energy output of a system

Efficiency = useful output energy / total input energy

Efficiency = useful power output / total power input

Kinetic Energy

Kinetic energy stores describe the energy that an object has because it is moving. It is calculated using the formula:

Kinetic Energy = 0.5 x mass x (speed)^2

Elastic Potential Energy

Elastic potential energy stores describe the energy that is stored in a spring when you squash or stretch it. **Elastic Potential Energy = 0.5 x spring constant x (extension)^2**

Assuming the limit of proportionality has not been exceeded.

Gravitational Potential Energy

Gravitational potential energy stores describe the energy that is stored in an object because of its position above the ground

g.p.e = Mass x Gravitational Field Strength x Height

Objects with mass have weight due to gravitational field strength.

Weight = Mass x Gravitational Field Strength

This means that: **g.p.e = Weight x Height**

Change in Thermal Energy

Thermal energy stores describe the energy a substance has because of its temperature

Change in Thermal Energy = Mass x Specific Heat Capacity x Temperature Change

The specific heat capacity of a substance is the amount of energy required to raise the temperature of 1kg of the substance by 1°C.

Quantity	Symbol	Unit
Kinetic Energy	E_k	J
Elastic Potential Energy	E_e	J
Gravitational Potential Energy	E_p	J
Change in Thermal Energy	ΔE	J
Energy Transferred	E	J
Work Done	W	J
Mass	m	Kg
Speed	v	m/s
Spring Constant	k	N/m
Extension	e	m
Height	h	m
Gravitational Field Strength	g	N/kg
Weight	w	N
Specific Heat Capacity	c	J/kg°C
Temperature Change	$\Delta\theta$	°C
Power	P	W
Time	t	s

Energy source	Renewable	Non-renewable
Advantages		
Disadvantages		

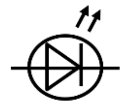
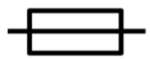
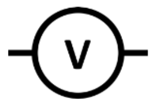
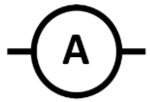
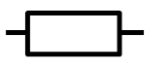
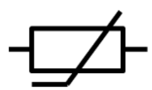
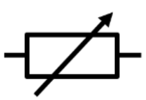
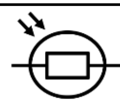
GCSE Science - P1 Energy - Knowledge Organiser

Renewable Energy: Resources that are replenished at the same rate as they are used.

Non Renewable Energy: Resources that are replenished slower than the rate as which they are used.

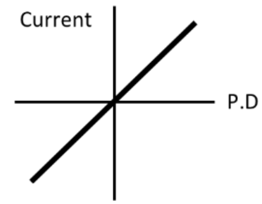
Energy Resource	Description	Renewable/ Non Renewable	Way Used	Reliability	Environmental Impact
Fossil Fuel	Coal, oil and natural gas that are extracted from the Earth and burned.	**Non-Renewable**	Transport, electricity generation and heating.	Reliable	Produce greenhouse gases.
Nuclear Fuel	Energy from atoms. Uranium is a nuclear fuel and transfers energy when the nucleus splits in two.	**Non-Renewable**	Electricity generation.	Reliable	No greenhouse gases, but radioactive waste is made.
Biofuel	A fuel taken from living or recently living things. An example of a biofuel is animal waste.	**Renewable**	Transport, electricity generation and heating.	Reliable	It is carbon neutral.
Wind	The force of wind turns blades and a generator at the top of a narrow tower.	**Renewable**	Electricity generation.	Unreliable as when there is no wind they don't work.	Unsightly and make a noise. Don't produce greenhouse gases.
Hydroelectricity	Can be generated when rainwater collects behind a reservoir and flows downhill. This turns a turbine.	**Renewable**	Electricity generation.	Affected by droughts if the reservoirs dry up.	Large reservoirs of water needed and habitats can be flooded to do this. Don't produce greenhouse gases.
Geothermal	Water is pumped under the Earth and turns to steam. This turns a turbine to turn a generator.	**Renewable**	Electricity generation and heating.	Reliable	Doesn't produce greenhouse gases.
Tidal	Water is trapped from high tide behind a barrage and then released into the sea through turbines.	**Renewable**	Electricity generation.	Reliable	Affect river estuaries and the habitats of animals. Don't produce greenhouse gases.
Solar	Transfers energy from the Sun using solar panels. They can be used to generate electricity or heat water.	**Renewable**	Electricity generation and heating.	No energy produced at night and affected by windy weather.	Cover large areas to generate enough power. Don't produce greenhouse gases.
Water Waves	The waves make a floating generator move up and down to generate electricity.	Renewable	Electricity generation.	Affected by storms and don't make a constant supply of electricity.	Can spoil the coastline and affect habitats. Don't produce greenhouse gases.

GCSE Science - P2 Electricity - Knowledge Organiser

Component	Symbol	Component	Symbol
Open Switch		LED	
Closed Switch		Lamp	
Cell		Fuse	
Battery		Voltmeter	
Diode		Ammeter	
Resistor		Thermistor	
Variable Resistor		LDR	

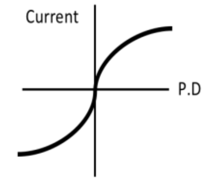
Resistors

- The current through an ohmic conductor (at a constant temperature) is **directly proportional** to the potential difference across the resistor.



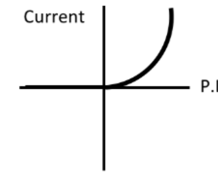
Filament Lamp

The resistance increases as the temperature increases.



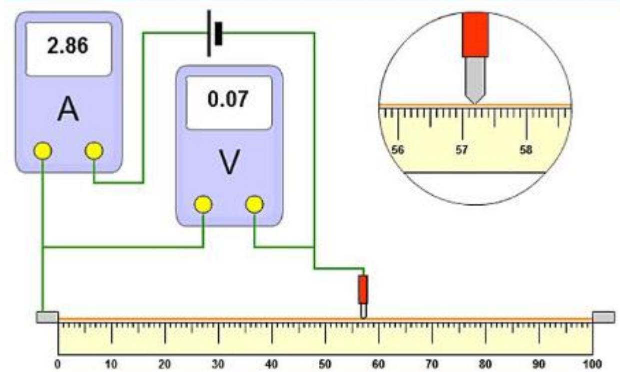
Diode

The **current flows in one direction only**. The diode has a very high resistance in the reverse direction.



Required practical

- **Independent variable** – Length of wire
- **Dependent variable** – current and PD to calculate resistance
- **Control variable** – Width of wire/ type of metal



Current, Resistance and Potential Difference

- **The current depends on the resistance and the potential difference**
- The greater the resistance of the component the smaller the current for a given potential difference

Potential Difference = Current x Resistance
V=IR

Series Circuits

- **Current is the same** at any point in the circuit
- The total **potential difference of the power supply is shared** between the components.
- Total resistance is the **sum of the resistance of each component**: *R* **total = *R*1 + *R*2**

Parallel Circuits

- The **potential difference is the same**
- **Current is shared** between each branch
- Total resistance of two resistors is less than the resistance of the smallest individual resistor.

Thermistors and Light Dependent Resistors

- Resistance of a thermistor **decreases as the temperature increases**.
- The resistance of an LDR **decreases as light intensity increases.**

Electrical Charge and Current

- Circuit must include a source of potential difference.
- Electric current is a flow of electrical charge.
- **The size of the electric current is the rate of flow of electrical charge.**

Charge Flow = Current × Time

Quantity	Symbol	Unit
Charge	Q	C
Current	I	A
Time	t	s
Potential Difference	V	V
Resistance	R	Ω

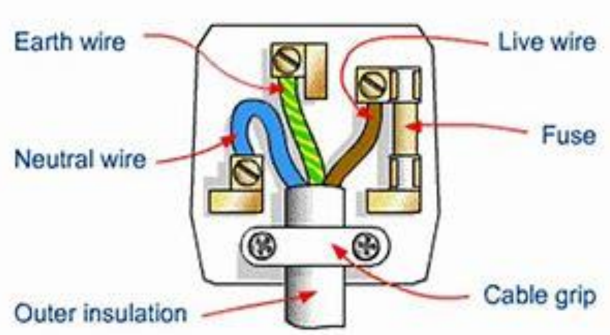
GCSE Science - P2 Electricity - Knowledge Organiser

Direct and Alternating Potential Difference
Mains electricity is an ac supply. In the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V.

Mains electricity
Most electrical appliances are connected to the mains using three-core cable. The insulation covering each wire is colour coded for easy identification:

- **Live Wire – Brown – Carries current**
- **Neutral Wire – Blue – Completes the circuit**
- **Earth Wire – Green and Yellow Stripes - safety wire to stop the appliance becoming live.**

The earth wire is at 0 V, it only carries a current if there is a fault.



Energy Transfers in Everyday Appliances
The amount of energy an appliance transfers depends on how long the appliance is switched on for and the power output of the appliance.

Energy Transferred = Power x Time

Energy Transferred = Charge x Potential Difference

Often the power of a domestic appliance is measured in kW. There are 1000W in 1kW.

Quantity	Symbol	Unit
Energy Transferred	*E*	J
Power	*P*	W
Charge	*Q*	C
Potential Difference	*V*	V
Current	*I*	A
Resistance	*R*	Ω

Power
The rate of energy transfer (power) in any circuit is related to the potential difference across the circuit and the current through it.

Power = Potential Difference x Current

Power = (Current)^2 x Resistance

National Grid
- A system of cables and transformers that links power stations to consumers
- **Step-up transformers increase the potential difference** from the power station before reaching the cables.
- **Increasing the potential difference decreases the current, meaning less energy is wasted as heat**
- The transmission **cables have a low resistance**, meaning less energy is wasted as heat.
- **This increases the efficiency** of the National Grid.
- **Step-down transformers decrease the potential difference.** This must happen before the supply reaches consumer for safety.
- **For domestic homes the potential difference is decreased to 230V**.

Static electricity (TRIPLE)
- When insulating materials are rubbed together they become electrically charged
- **Negatively charged electrons are rubbed off one material onto another**
- The material that lost electrons becomes positively charged
- The material that gains electrons becomes negatively charged

GCSE Science - P3 Particle Model of Matter - Knowledge Organiser

Quantity	Symbol	Unit
Density	ρ	kg/m^3
Mass	m	kg
Volume	V	m^3
Change in Thermal Energy	ΔE	J
Specific Heat Capacity	c	J/kg°C
Temperature Change	$\Delta\theta$	°C
Energy	E	J
Specific Latent Heat	L	J/kg
Pressure	p	Pa
Volume	V	m^3
Constant	*constant*	

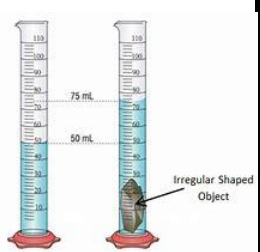
Pressure in gases (TRIPLE)
Increasing the volume of a gas, at a constant temperature, leads to a decrease in pressure

Constant = Pressure x Volume

Density
Density is the measure of the mass per unit volume of a substance.

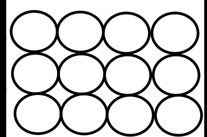
Density = Mass/Volume

Measuring the Density of a Solid Object
For an irregular shaped object lower it into a measuring cylinder partly filled with water and record the displacement. This is the volume.

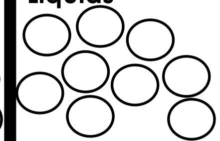


Internal Energy
- Is the energy that is **stored inside a system**.
- Internal energy is the **total kinetic and potential energy** of all the particles
- When heated, the energy stored by the particles increases.
- This will **raise the temperature of the system or will cause a change in state.**

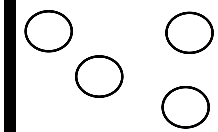
Solids



Liquids



Gases



Particle Motion in Gases
- The **temperature of the gas is related to the average kinetic energy** of the molecules.
- Changing the temperature of a gas, changes the pressure exerted by the gas.
- The **pressure of a gas on a solid surface is caused by the impact** of the gas particles with the surface.
- When a **gas is heated the particles gain kinetic energy** and so pressure increases.

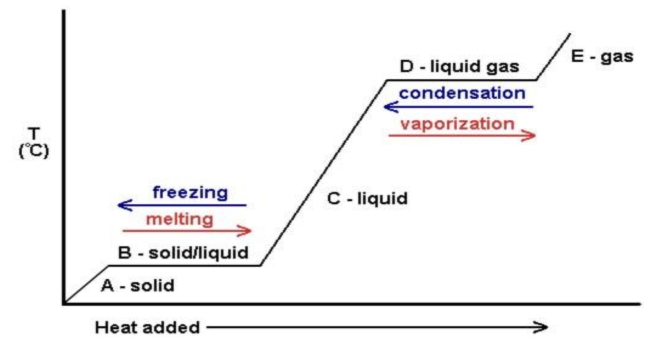
Particles in a Liquid
- **Weaker forces of attraction** between the particles
- Not held together in a regular structure,
- **When heated**, particles obtain enough energy to **break forces of attraction and become a gas**.

Particles in a Solid
- Particles are arranged in a **regular structure.**
- There are **strong forces of attraction** between the particles and they **vibrate about fixed positions.**
- When heated, **particles energy increases and vibrate more.**
- If the solid is heated up enough, it will melt.

Temperature Change
The specific heat capacity of a substance is the amount of energy required to raise the temperature of 1kg of the substance by 1°C

Change in Thermal Energy = Mass x Specific Heat Capacity x Temperature Change

Changes in State



Changes of Heat and Specific Latent Heat
- The specific latent heat of a substance is the amount of **energy required to change the state of one kilogram of the substance** with no change in temperature

energy for a change of state = mass × specific latent heat

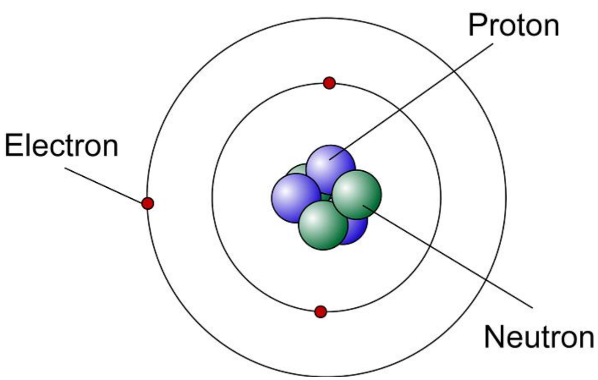
- **Specific latent heat of fusion is the change of state from solid to liquid**
- **Specific latent heat of vaporisation is the change of state from liquid to vapour.**

Increasing the Pressure of Gases (TRIPLE)
Doing work on a gas increases internal energy of the gas and causes an increase in temperature. E.G. if a tyre is inflated with a pump there would be work done so the internal energy of the gas increases which causes an increase of the temperature of the gas.

GCSE Science - P4 Atomic Structure - Knowledge Organiser

The Structure of an Atom

Atoms have a radius of about 1×10^{-10} m.

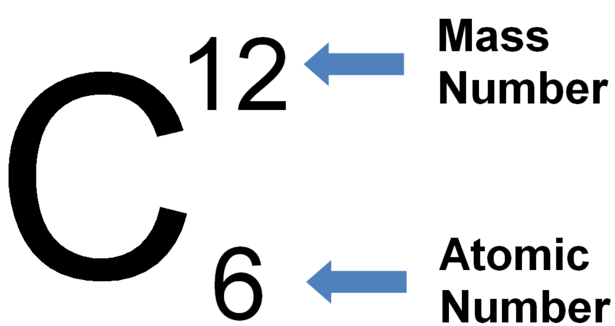


- In an atom the number of electrons is equal to the number of protons in the nucleus and atoms have no overall electrical charge.

Particle	Mass (amu)	Charge
Proton	1	+1
Neutron	1	0
Electron	0	-1

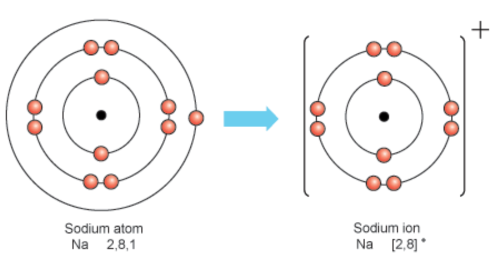
Mass Number and Atomic Number

- The atomic mass is the total number of protons and number of neutrons.
- Atomic number is the number of protons in an atom



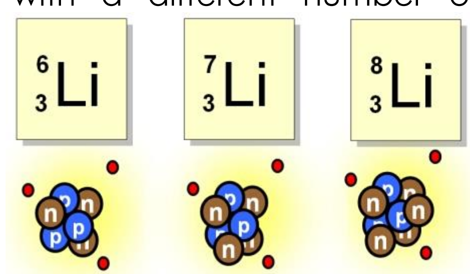
Ions

A positive ion can be created is an atom loses one or more electrons.



Isotopes

An isotope is an atom of the same element with a different number of neutrons.



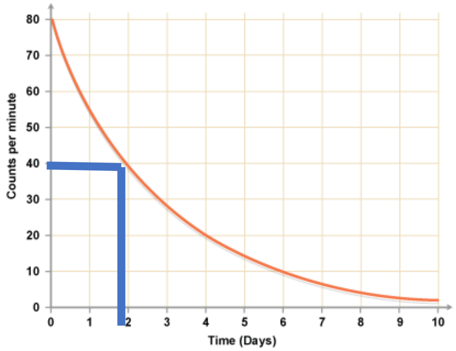
Development of the Model of the Atom

- Dalton suggested that atoms were tiny spheres that could not be divided.
- JJ Thompson then discovered the electron. He also suggested the Plum Pudding Model.
- Then due to results from the alpha particle scattering experiment the nuclear model of the atom was suggested.
- Niels Bohr suggested that electrons orbit the nucleus at specific distances and then James Chadwick proved the existence of neutrons.

Nuclear model	Plum pudding
Protons in nucleus	Positive ball of charge
Electrons in shells	Electrons randomly scattered
Neutrons in nucleus	No neutrons
Nucleus present	No Nucleus

GCSE Science - P4 Atomic Structure - Knowledge Organiser

Half-Life
The time it takes for the number of nuclei of the isotope in a sample to halve, or the time it takes for the count rate to fall to half its start level.



Radioactive Decay and Nuclear Radiation

- Some atomic nuclei are unstable.
- A nucleus can give out radiation in order to become more stable.
- This is a random process called radioactive decay.
- The nuclear radiation emitted can be in the form of alpha, beta or gamma radiation.

Gamma Decay
The emission of a gamma ray does not cause the mass or the charge of the nucleus to change.

Contamination
Contamination is the unwanted presence of materials containing radioactive atoms ending up on other materials.

Irradiation
Irradiation is the process of exposing an object to nuclear radiation. The irradiated object does not become radioactive.

Alpha Decay
An alpha particle (helium nucleus) is emitted from the nucleus.

$$^{219}_{86}\text{radon} \longrightarrow {}^{215}_{84}\text{polonium} + {}^{4}_{2}\text{He}$$

The $^{4}_{2}\text{He}$ is the symbol for the alpha particle. Notice that the mass number and atomic number are balanced on each side.

Beta Decay
A beta particle (electron) is emitted from the nucleus when a neutron turns into a proton.

$$^{14}_{6}\text{carbon} \longrightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}\text{e}$$

The $^{0}_{-1}\text{e}$ is the symbol for the beta particle. Notice that the mass number and atomic number are balanced on each side. The element has mutated because it now has an extra proton.

Radiation	Symbol	Consists of..	Blocked By..	Range in Air	Ionising Power
Alpha	α	2 neutrons and 2 protons	Paper	5cm	High
Beta	β	High speed electron	Thin Aluminium	1m	Medium
Gamma	γ	Electromagnetic Radiation	Thick Lead/ Concrete	Infinite	Low