

Paper 1

Revision Booklet

2025-2026



The John Roan School
The best in everyone™
Part of United Learning

Resources:

- 1) Cognito Video Links
- 2) Knowledge Organiser
- 3) Quizzes



Exam content:

Topic / Skill	Cognito video links
B1 Cells	Cell structure - https://youtu.be/qHkUOIC8Nbo Kingdom's of life - https://youtu.be/Xzy4Ze93G3g Microscopy - https://youtu.be/PB97svr7Ye8 Light and electron microscopes - https://youtu.be/PAzs3Ooex5k Units of conversion - https://youtu.be/rJrR8h-DtA Mitosis - https://youtu.be/RHyZVmbiA78 Stem cells - https://youtu.be/fp5H3SslskQ Specialised cells and differentiation - https://youtu.be/LNLz7mswPkQ Stem cells in medicine - https://youtu.be/5IN2NrGBOYY Diffusion - https://youtu.be/lxHmJaXOzP4 Osmosis - https://youtu.be/vCJVXYmXkzM Active transport - https://youtu.be/tM0bGaaQ2jY Surface area to volume ratio - https://youtu.be/GC7phTfotpE Exchange surfaces - https://youtu.be/GXGNR1NCPjE
B2 Organisation	Cell organisation - https://youtu.be/MB6mE6weCS4 Enzymes - https://youtu.be/gUncqL1ul8Q Factors affecting enzyme activity - https://youtu.be/n9He_FK6nao Balanced diet - https://youtu.be/dN7c2JniR8U Digestive enzymes - https://youtu.be/6jz9WvfKDVc Digestive system - https://youtu.be/vMI46qGQMDw Food tests - https://youtu.be/13H1urX3gxl Lung and gas exchange - https://youtu.be/B44n2SMLv-s The heart - https://youtu.be/zU90AkcTJEs Blood vessels - https://youtu.be/AISQEs694qY Blood - https://youtu.be/81w0BXg7QJA Cardiovascular disease - https://youtu.be/UN5BIPfMUkg Health and disease - https://youtu.be/thAyrNpD77A Risk factors for non-communicable diseases - https://youtu.be/iy-47a68P60 Cancer - https://youtu.be/B5VHRKBI4PY Plant cell organisation - https://youtu.be/oT4jvKRYBjA Transpiration and translocation - https://youtu.be/9FTafxbwHQ
B3 Infection and response	Communicable disease intro - https://youtu.be/dbd5iydu3EY Viruses - https://youtu.be/m0o8mhu9Arg Bacteria - https://youtu.be/Z5c8lVXDiqc Protists and fungi - https://youtu.be/2Fh-2wpvhHQ Immune systems and defence - https://youtu.be/63XExOKWrqg Vaccinations and immunisation - https://youtu.be/23fQscOSqVU Drugs and medicine - https://youtu.be/r_5GM3_u0Wo Developing new medicines - https://youtu.be/w3ykU52K-Hw
B4 Bioenergetics	Photosynthesis - https://youtu.be/X81OlkeuHJw Factors affecting photosynthesis - https://youtu.be/J0KxRX3fyol Aerobic and anaerobic respiration - https://youtu.be/U4WwWuVZSe4 Exercise - https://youtu.be/PthdswsrM3Y
C1 atomic structure and the periodic table	Atoms - https://youtu.be/fN8kH9Vvgo0 Elements, isotopes and relative atomic mass - https://youtu.be/iyCLDHG1PCA Compounds, molecules and mixtures - https://youtu.be/jBDr0mHyc5M

	Balancing equations - https://youtu.be/qquOFYOpdl0 Filtration and crystallisation - https://youtu.be/vi_SJBnxmHo Distillation - https://youtu.be/eQlnHr9g6lo History of the atom - https://youtu.be/sG6QoLxwIw4 Electronic structure - https://youtu.be/EBKwG25hRPE Development of the periodic table - https://youtu.be/IdS9roW7IzM Metals and non-metals - https://youtu.be/Rc2JBp91V7o Group 1 - https://youtu.be/dZGDUKQa_6g Group 7 and group 0 - https://youtu.be/HT1zAPQIBAQ
C2 bonding, structure and properties of matter	Formation of ions - https://youtu.be/PCZtnbxtXqE Ionic bonding - https://youtu.be/6DtrrWA5nkE Ionic compounds - https://youtu.be/kShlflsvWbQ Covalent bonding - https://youtu.be/5l_1jRGSr9E Types of covalent structures - https://youtu.be/d2ogZgGmMDY Diamond and graphite - https://youtu.be/tGH0mXCcEFU Graphene and fullerenes - https://youtu.be/4ZEtS5qLOHs Metallic bonding - https://youtu.be/b1y2Q6YX1bQ States of matter - https://youtu.be/hkBrw2fG75U
C3 quantitative chemistry	Relative formula mass - https://youtu.be/it_fmQu5ivg Moles and mass - https://youtu.be/wPGVQu3UXpw Calculating mass in reactions - https://cognitoedu.org/coursesubtopic/c2-gcse-aqa-h-c_3.11 Conservation of mass - https://youtu.be/M-De2IMayco limiting reactants - https://youtu.be/TKDOyR7WKQQ
C4 chemical changes	Acids and bases - https://youtu.be/vt8fB3MFzLk Strong and weak acids - https://youtu.be/_gYBbzqrmE Neutralisation reactions - https://youtu.be/lBjwMcHUyBY Reactivity series and displacement reactions - https://youtu.be/2i5Lm7BMtpo Separating metals from metal oxides - https://youtu.be/gvNuMpxqG7Q Redox reactions - https://youtu.be/jyvcVjrZnJA Electrolysis intro - https://youtu.be/iINOpROacf0 Electrolysis of aluminium oxide - https://youtu.be/hOrGNtIN3sg Electrolysis of aqueous solutions - https://youtu.be/GrgYXk_NCec
C5 Energy Changes	Exothermic and endothermic reactions - https://youtu.be/dstRL5xB0Sk Bond energies - https://youtu.be/it0HGXhxD-s
P1 Energy	Energy stores and systems - https://youtu.be/JGwDCeYRYo Kinetic energy - https://youtu.be/WrFCHt21kVA Gravitational potential energy - https://youtu.be/rNS-W7k0jts Specific heat capacity - https://youtu.be/4rT7-5yE4pQ Conservation of energy - https://youtu.be/H6D_ViW0Ch4 Conduction, convection and radiation - https://youtu.be/Eizsm5V8c_c Reducing unwanted energy transfers - https://youtu.be/43XCqAN53Sg Power and work done - https://youtu.be/kCJUzdCBOK0 Efficiency - https://youtu.be/7hcv_mxA-g Energy resources intro - https://youtu.be/AOhQ4gi4Ng8 Fossil fuels and nuclear energy - https://cognitoedu.org/coursesubtopic/p2-gcse-aqa-h-c_1.16 Wind and solar - https://youtu.be/loJicGutYZg Geothermal power - https://youtu.be/OPI-2B29btU Biofuels - https://youtu.be/DsCCM6JSmaA Hydroelectric and tidal power - https://youtu.be/oRFZvbHI4Ck
P2 Electricity	Circuits introduction - https://youtu.be/R3hdaLpq2AA

	Potential difference equation and IV graphs - https://youtu.be/hRojfU77c38 Charge, current and time - https://youtu.be/TIHW5hEoaAw Components - https://youtu.be/AQawCNla5Fg Series circuits - https://youtu.be/ZQurBlu35Fo Parallel circuits - https://youtu.be/iNFXtjt5mul National grid - https://youtu.be/VTAFjhO1HNo AC and DC currents - https://youtu.be/EY_EphcrpDI Plugs and wires - https://youtu.be/2g8SusMrX_o Fuses and Earthing - https://youtu.be/S8lB2kxT1n0
P3 Particle model of matter	Particle model and states of matter - https://youtu.be/OTksau0_VoI Density - https://youtu.be/pgGzVdau1Bw Specific latent heat - https://youtu.be/3itqmCtmJPc Factors affecting gas pressure - https://youtu.be/9PwzPDJ7GYc
P4 Atomic structure	Development of the model of the atom - https://youtu.be/Q8y4x5EEIm8 Atomic structure, isotopes and electron shells - https://youtu.be/KwOHJbE4Tro Alpha, beta and gamma radiation - https://youtu.be/KwOHJbE4Tro Nuclear decay equations - https://youtu.be/CaYoDxWxww8 Radioactive decay and half-life - https://youtu.be/zXw2cOSBB8E

Science specific top tips:

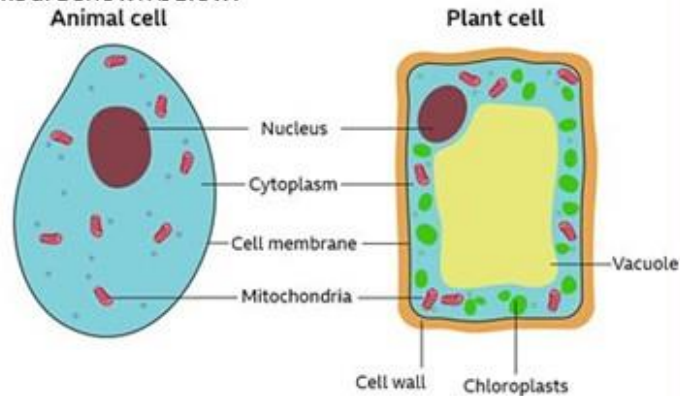
- 1) Make sure all graphs and diagrams are drawn in pencil
- 2) Line of best 'fit' is either a straight line or a smooth curve. Roughly half the points should be on either side of the line of best fit
- 3) Remember, we do not use the word **amount** in science, instead we use *volume*, *concentration* or *mass* depending on the question
- 4) When calculating the mean make sure you do **NOT** include any anomalies
- 5) After calculations, make sure you use the correct units
- 6) When describing just say 'what you will see'
- 7) When explaining you are giving reasons as to why something happens



B1 – Cell Biology

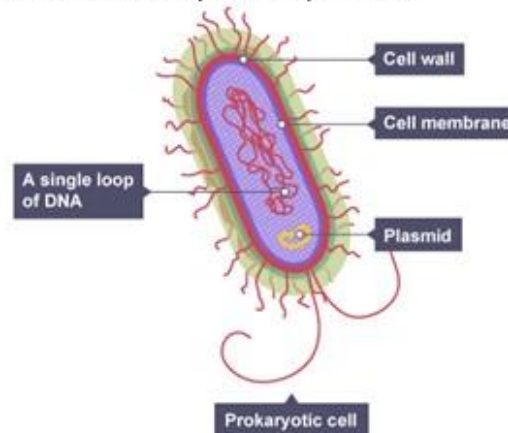
Eukaryotic Cells

They have a nucleus to contain the chromosomes. These can be animal, plant or fungus or protist cells. Animal and plant cells are shown below.



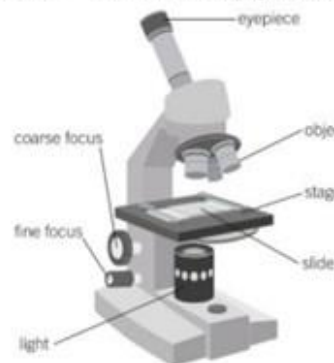
Prokaryotic Cells

They do not have a nucleus, they are usually a lot smaller and may contain plasmids.



Cell		Features
Animal	Sperm	High number of mitochondria Ribosomes that make enzymes in the head
	Nerve	Long Lots of branches (dendrites)
	Muscle	High number of mitochondria High Number of ribosomes Store glycogen
Plant	Xylem	Walls thickened with lignin to strength the cells into a tube
	Phloem	Sections between cells called sieves to help transport substances like dissolved sugars
	Root hair	Large surface area Lack of chloroplasts Large vacuole

RP1 – Microscopy; Observing Plant Cells



Preparing the slide:

1. Place a thin layer of onion membrane on a glass slide with forceps.
2. Use a drop of iodine to stain the cells.
3. Gently place a glass cover slip over the same and tap carefully to remove air bubbles.

Viewing the slide:

1. Place the slide on the stage and turn on the light.
2. Select the lowest magnification objective lens.
3. Look through the eyepiece and turn the coarse focus until the image can be seen.
4. Turn the fine focus until a clear image is formed.
5. Change the objective lens to another with a higher magnification and turn the fine focus re-focus the image.

Microscopes

The development of microscopes of the last 200 years has allowed us to study cells and the structures inside them in more and more detail.

Light Microscope	Electron Microscope
Low resolution Low magnification Cheap	High resolution High magnification Expensive

Calculating Magnification

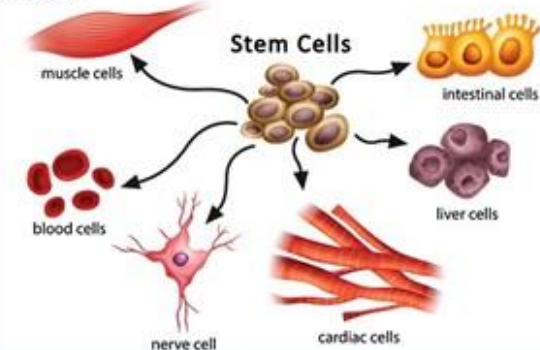
Units for image and actual size may need to be converted before using the equation below.

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}}$$

$\text{mm} \rightarrow \mu\text{m}$ $\times 1000$
 $\mu\text{m} \rightarrow \text{mm}$ $\div 1000$

Cell Differentiation

As an organism develops, cells differentiate to form different types of cells. This is an example in animals.

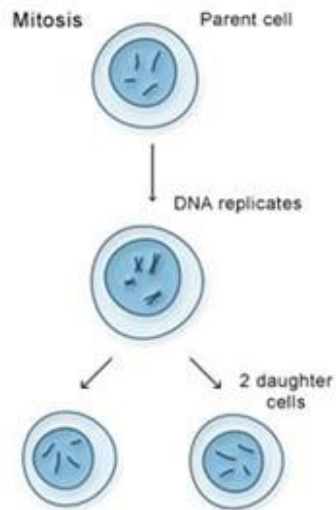


B1 – Cell Biology

<ol style="list-style-type: none"> 1. Name the three cell parts (organelles) found in a plant cell but not in an animal cell. 2. How can you identify an eukaryotic cells from its structure? 3. What is the role of a ribosome? 4. Which organelle releases energy through respiration? 5. What is the role of the cell wall? 	<ol style="list-style-type: none"> 1. What structures are only found in prokaryotic cells? 2. Which are larger; prokaryotic or eukaryotic cells? 3. What feature do some bacterial (and some animal) cells have that enable it to move? 	<ol style="list-style-type: none"> 1. How is a root hair cell specialised? 2. Why would a cell contain more mitochondria than usual? 3. Describe the structure of phloem cells. 4. How are nerve cells specialised? 5. Why does a sperm cell require a lot of mitochondria? 6. How are xylem cells specialised?
<ol style="list-style-type: none"> 1. Which part of a light microscope is the glass slide placed on? 2. Which objective lens is selected first to produce a magnified image of a sample? 3. What is used to stain plant cells? 4. What is place on top of the slide, sample and stain? 5. What part of the microscope is used to focus the image and make it clear? 	<ol style="list-style-type: none"> 1. What are the advantages of using a electron microscope for viewing cells? 2. Convert 2.3mm into μm. 3. How would we calculate the actual size of a cell using the image size and magnification? 4. Convert 570μm into mm. 	<ol style="list-style-type: none"> 1. What does cell differentiation mean? 2. How is plant cell differentiation different to animal cells differentiation?

B1 – Cell Biology

Mitosis

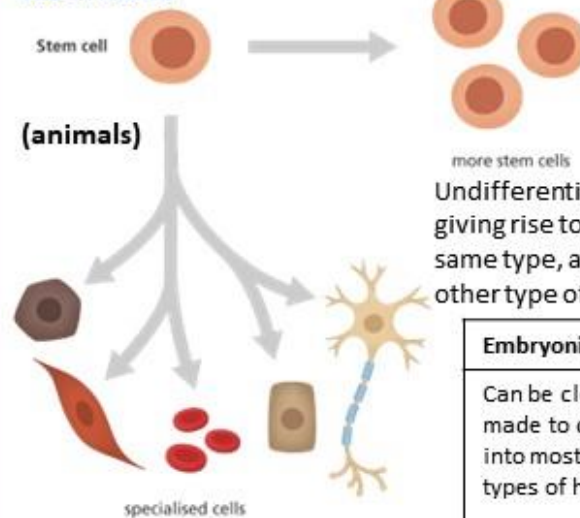


Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as ribosomes and mitochondria. **The DNA replicates** to form two copies of each chromosome.

In mitosis one set of chromosomes is pulled to each end of the cell and the **nucleus divides**.

Finally the **cytoplasm and cell membranes divide** to form two identical cells.

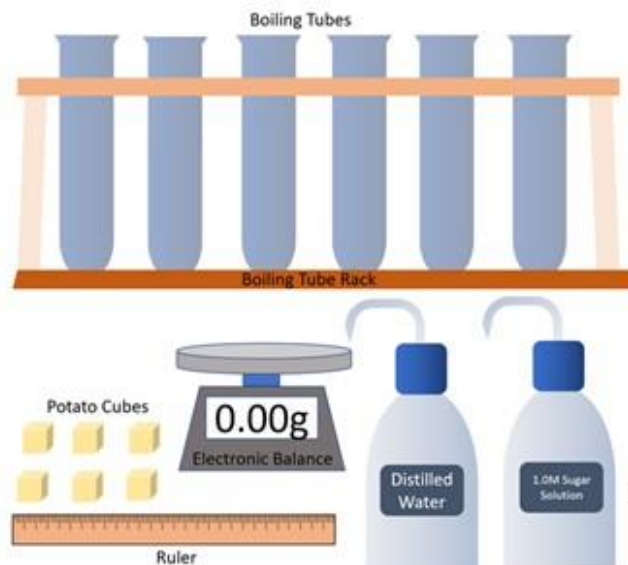
Stem Cells



Undifferentiated cells are capable of giving rise to many more cells of the same type, and can differentiate into other type of cells.

Embryonic	Adult	Meristems
Can be cloned and made to differentiate into most different types of human cells	Bone marrow stem cells can form many types of cells including blood cells.	Can differentiate into any type of plant cell, throughout the life of the plant.

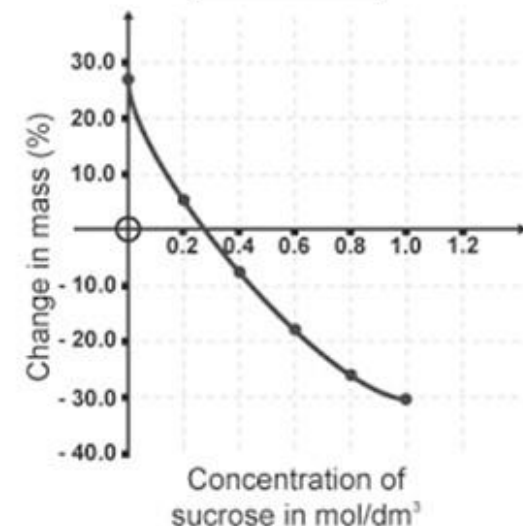
RP2 – Osmosis: The concentration of surrounding solution affects mass of plant tissue



1. Use a cork borer to create 5 cylinders of plant tissue (usually potato) and cut them all to the same length.
2. Measure the mass of each piece using a top pan balance and the length of each piece with a ruler. Record in a table.
3. Measure out 100cm³ of each concentration of salt/sugar solution into labelled boiling tubes.
4. Place each piece of potato into a boiling tube for 24 hours.
5. Remove the pieces and blot with a paper towel.
6. Measure the mass of each piece using a top pan balance and the length of each piece with a ruler. Record in a table.
7. Calculate the percentage change in mass.

$$\% \text{ change in mass} = \frac{\text{change in mass (g)}}{\text{initial mass of potato (g)}}$$

Results Graph



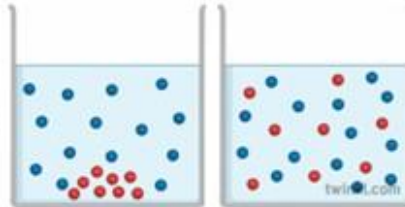
B1 – Cell Biology

- | | |
|---|---|
| <ol style="list-style-type: none">1. What has to be replicated (copied) before the cell can divide?2. What happens in the third stage of mitosis?3. What word is used to describe the similarity of the two cells formed? | <ol style="list-style-type: none">1. Where type of organism contains meristems?2. What is a stem cell?3. Which type of animal stem cell can only become a small number of different cells rather than any type of cell? |
|---|---|
-
1. What piece of equipment is used to ensure the surface area of each piece of potato is the same?
 2. What piece of equipment is used to measure the mass before and after the experiment?
 3. What happens to pieces of potato in dilute (high water concentration) solutions?
 4. What should be done with the pieces of potato after then have been removed from the solution but before their mass is measured?

B1 – Cell Biology

Diffusion

- Substances move a higher concentration of that substance (red particles pictured) to where there is a lower concentration of that substance. (High → Low)
- This happens because of the random movement of the particles in a fluid (liquid or gas).



- There are ways the rate of diffusion can be changed:
 - the difference in concentrations (concentration gradient)
 - the temperature
 - the surface area of the membrane

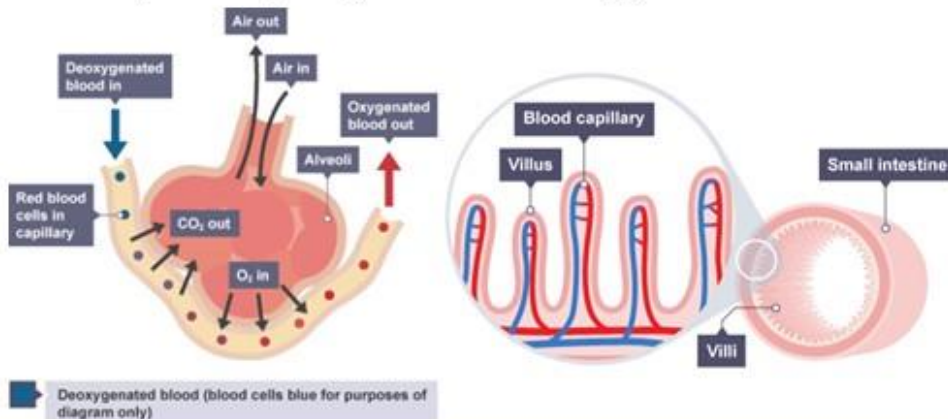
1 cm	2 cm	3 cm
SA = 6 cm ²	SA = 24 cm ²	SA = 54 cm ²
Vol = 1 cm ³	Vol = 8 cm ³	Vol = 27 cm ³
SA:Vol = 6:1	SA:Vol = 3:1	SA:Vol = 2:1



Examples

Alveoli in the lungs and villi in the small intestine are both structured in similar ways so diffusion can happen at a high rate (fast).

- having a large surface area
- a membrane that is thin, to provide a short diffusion path
- (in animals) having an efficient blood supply

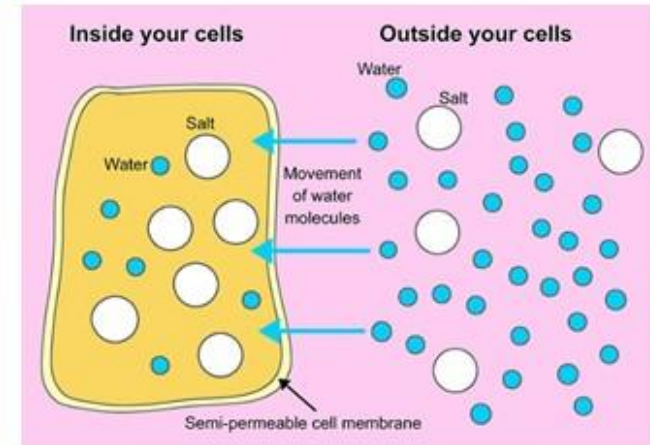


Osmosis

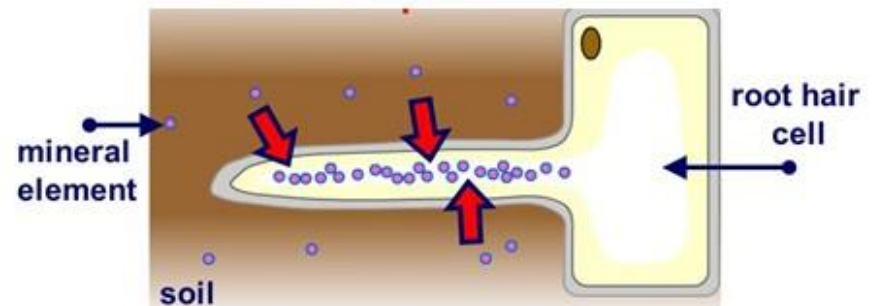
Water may move across cell membranes via osmosis.

Osmosis is the diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane (H → L).

Partially permeable means small molecules can move through but large molecules cannot.



Active Transport



- Active transport is moving substances against the concentration gradient (L → H) so requires energy. This energy comes from respiration.
- This means that cells that carry out a lot of active transport (root hair cells, epithelial cells on villi in the small intestine) contain a lot of mitochondria.

B1 – Cell Biology

1. What factors affect the rate of diffusion?

-
-
-

2. Give an example in animals where diffusion would take place?

3. How are structures in organisms adapted for efficient diffusion?

-
-
-

4. Do substances move from a low concentration to a high concentration

1. What substance is being transported by osmosis?

2. What does partially permeable mean?

1. How is active transport different to diffusion?

2. Give an example of where active transport happens often in organisms.

3. Why do cells that carry out active transport often have a lot of mitochondria?

B2 – Organisation

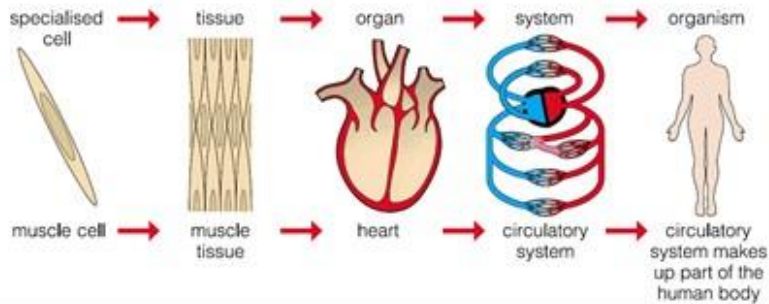
Levels of Organisation

Cells = basic building blocks of all living organisms.

A tissue = group of cells with a similar structure and function.

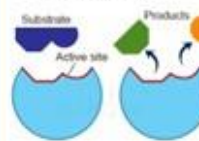
Organs = aggregations of tissues performing specific functions.

Organ systems = organs organised to form organisms.

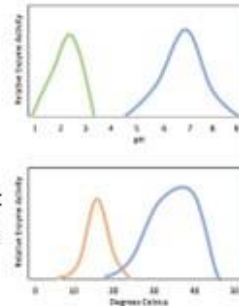


Enzymes

- Biological catalysts
- Digestive enzymes speed up the break down of insoluble food molecules
- Specific shape active site that matches substrate



Enzymes work best at certain temperatures or pH depending on their role.



Bile

The liver makes an **alkaline** solution called bile. Stored by the gall bladder.

Has two jobs:

- Emulsifies fats
- Neutralises stomach acid.



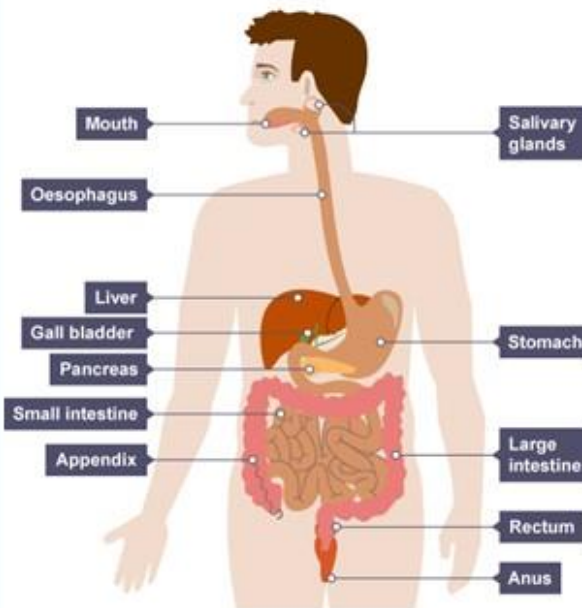
Digestive Enzymes

Starch $\xrightarrow{\text{amylase}}$ Glucose

Protein $\xrightarrow{\text{protease}}$ Amino Acids

Fats $\xrightarrow{\text{lipase}}$ Fatty acids + Glycerol

Digestive System



Organ	Function
Mouth	Teeth and tongue to chew food.
Salivary Glands	Releases saliva containing enzymes.
Oesophagus	Muscle tube to squeeze food along.
Stomach	Contains enzymes and hydrochloric acid. Is made of muscle to churn food. Hydrochloric acid kills bacteria in food
Small Intestine	Where digestion is completed and soluble food particles (glucose, amino acids, fatty acids, glycerol) are absorbed
Large Intestine	Absorbs water.
Liver	Produces bile.
Gall Bladder	Stores bile.
Pancreas	Releases enzymes.

Where are the enzymes?

Enzyme	Salivary glands	Stomach	Pancreas	Small intestine
Amylase	X		X	X
Protease		X	X	X
Lipase			X	X

RP3 – Food Tests

Summaries of the four food tests.

Protein Add Biuret's reagent Positive test; Blue solution turns Purple	Starch Add Iodine Positive test; solution turns from orange to Black
Fats Add Ethanol and water Positive test – solution turns Cloudy	Glucose Add Benedict's and heat Positive test blue solution turns Brick red

Water Bath

B2 – Organisation

1. What is an organ system?
2. What are group of cells with a similar structure and function?
3. Give an example of an organ.
4. Put these into order, starting with the smallest:
tissue cell organ system organ

1. What is an enzyme?
2. What is the name of the part of the enzyme that the substrate fits into?
3. Give two factors that affect how enzymes work

1. Where is bile made?
 2. Where is bile stored?
 3. What are the two jobs of bile?
1. Which enzyme breaks down starch?
 2. What are the products of fat digestion?
 3. What are proteins made of?

1. Where are the salivary glands found?
2. What is the job of the oesophagus?
3. What is the job of the pancreas (in digestion)?
4. What is the job of the small intestine?
5. What is the function of the hydrochloric acid in the stomach?

1. Where is lipase released from?
2. Which enzyme is released in the stomach?
3. Which enzyme is found in the mouth?

1. Which two chemicals are added to test for fats?
2. What is the colour change when Biuret is added to a food containing protein?
3. Which test needs to be placed in a water bath?

B2 – Organisation

The effect of pH on the rate of reaction of amylase

1. Add 2cm³ amylase solution, 2cm³ of starch solution and 2cm³ of pH2 buffer to a water bath (37°) in separate test tubes. Wait 10 minutes.
2. While waiting, add 2 drops of iodine solution to each well on the spotting tile.
3. Once the solutions in the water bath have reached 37° pour the amylase and PH2 buffer into the starch solution.
4. Immediately take a sample with a pipette and add to the first well of the spotting tile.
5. Repeat step 4 every 30 seconds until there is no colour change when testing with iodine solution.
6. Repeat steps 1-5 with pH4, pH6, pH8 and pH10 buffers.



Blood Vessels



Arteries

- Blood carried away from heart
- Thick muscular and elastic walls = withstands high pressure
- Small lumen = maintains high pressure



Capillaries

- Walls only one cells thick = shorter diffusion pathway
- Lumen just bigger than red blood cell
- Blood flows very slowly
- Diffusion takes place here

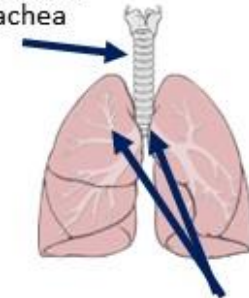


Veins

- Blood carried back to heart
- Thin walls as blood is low pressure
- Large lumen – lower resistance for blood passing through
- Valves prevent backflow

Respiratory System

The lungs have two jobs – to get oxygen into the blood and remove carbon dioxide

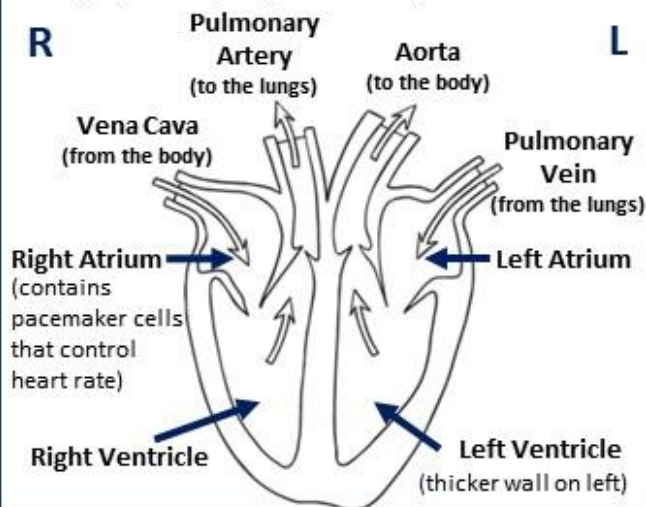


bronchi

Structures that cannot be seen on this diagram are the **alveoli** and **capillary network** – see 'unit 1 - diffusion'.

The Human Heart

Double pump because - left side pumps to whole body, right side pumps to the lungs.



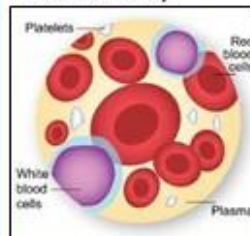
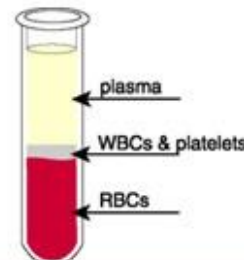
Blood – 4 components

Red blood cells – contain haemoglobin to carry oxygen. More detail... →

White blood cells – fight pathogens (see unit 3 – infection and response).

Platelets – cell fragments that clot blood.

Plasma – liquid part that transports cells, cell fragments and dissolved substances (salts, urea, CO₂, hormones...)

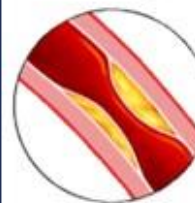


Red Blood Cells (RBCs)

- Contain chemical 'haemoglobin'.
- This reacts/ binds with oxygen to be carried around the body.
- RBCs are ~8µm (relative small animal cell) allows them to fit through capillaries
- Bi-concave disc shape for large SA:V



Coronary Heart Disease (CHD)



- Coronary arteries supply heart muscle with blood (containing glucose and oxygen for respiration)
- Can become narrowed/blocked by fatty deposits if cholesterol high, reducing blood flow.
- Reduced muscle contraction in heart

B2 – Organisation

The effect of pH on the rate of reaction of amylase

1. What temperature should the water bath be set at for the affect of pH on amylase practical?
2. What is the name of the chemical used to test for the presence of starch?
3. What is the independent variable in the investigation?

1. Which blood vessels contain valves?
2. Which vessels carry blood under very high pressure?
3. In which blood vessels does diffusion take place?
4. Which blood vessels have thick muscular walls?
5. Which vessels have a wide lumen?

1. What is the name of the tube that connects the throat to the lungs?
2. What is the name of the tubes that enter each lung?
3. What are the two jobs of the lungs?

1. Which blood vessel returns blood to the heart from the lungs?
2. Which blood vessel carries blood away from the heart towards the body?
3. Which ventricle wall is thicker?
4. Where are pacemaker cells found?
5. Why is the heart known as a double pump?

1. Name the two types of cells in blood.
2. What are platelets?
3. What do platelets do?
4. Name 3 substances plasma might have dissolved in it?

1. What chemical is found inside red blood cells?
2. What is the 3D shape of RBCs called? What is the advantage of this shape?

1. What do coronary arteries do?
2. What can block coronary arteries?
3. What will happen to the heart if they become blocked?

B2 – Organisation

Heart Disease Treatment – Statins vs Stents

Statins	Stents
<ul style="list-style-type: none"> Medication to be taken everyday Lowers blood cholesterol Does not work immediately 	<ul style="list-style-type: none"> Mesh tube to be inserted into artery to hold it open Surgery required Works immediately



Faulty Valves

- Valves in veins and the heart prevent backflow of blood
- Faulty valves = don't open or close fully
- Can be replaced with man-made valves or transplants from donors



faulty



healthy

Cancer

Uncontrolled cell growth

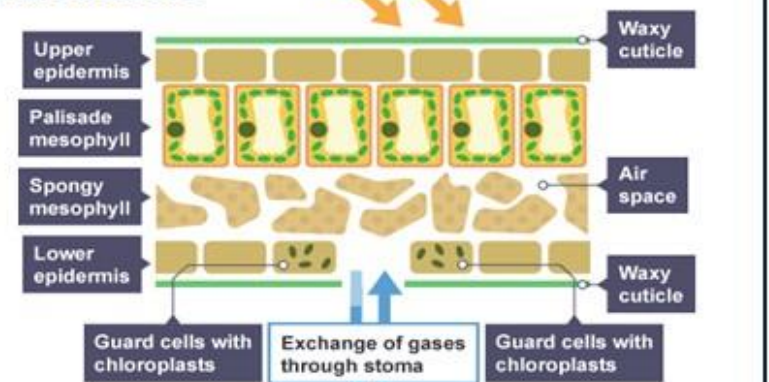
Benign tumours = abnormal cells, contained in one area, in a membrane, do not invade other parts of body.

Malignant tumours = cancer cells, not in a capsule, invade neighbouring tissue, and spread into blood and form secondary tumours.

Risk Factors

Lifestyle factors can have be risk factors for certain diseases. E.g. obesity is a risk factor for type 2 diabetes, or drinking and smoking while pregnant affects the development of the foetus.

Leaf Structure

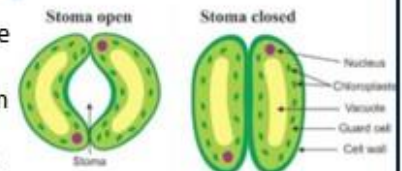


Stomata

Tiny pores on the underside of the leaf.

Allow oxygen and CO₂ to diffuse in and out

Guard cells surround the stomata and can open and close the pore

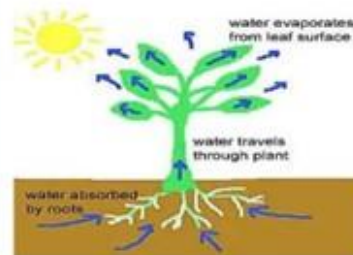


Interaction of Diseases

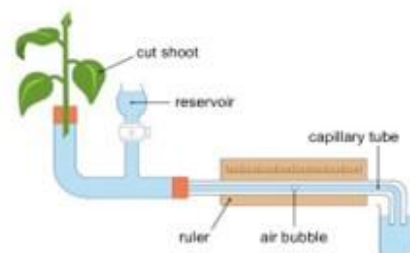
- Defects in the immune system - individual is more likely to suffer from infectious diseases.
- Viruses can trigger cancers, e.g. HPV can trigger cervical cancer.
- Immune reactions caused by pathogens can trigger allergies such as asthma or rashes
- Severe physical ill health can lead to depression and other mental illness.

Transpiration

Movement of water through plant from roots to leaves, driven by evaporation through the stomata



Measuring transpiration



Record the distance the bubble of air moves along the scale during set amount of time to calculate volume of water uptake per minute.

Transpiration	Translocation
Movement of water from roots to leaves	Movement of dissolved sugars from leaves all round the plant
Xylem - hollow tubes strengthened by lignin.	Phloem – tubes of elongated cells.
One way system – roots to leaves.	Two way system – sugars taken to wherever they are needed.

Increasing the rate of transpiration

- Higher temperature
- Lower humidity
- Higher light intensity
- Higher air movement

B2 – Organisation

1. How do stents treat CHD?
2. How do statins treat CHD?
3. Give an advantage of using stents rather than statins to treat CHD

1. What is the job of a valve?
2. How can faulty valves be treated?

1. What is a benign tumour?
2. Why do benign tumours not spread?
3. How can malignant tumours spread?
4. Name a disease linked with obesity

1. What are the cells called that surround the stomata?
2. What is the job of the stomata?
3. What the top layer of a leaf called?
4. Which tissue in a leaf has air spaces?
5. Which layer in the leaf contains cells with lots of chloroplasts?

1. Give an example of when cancer can be triggered by a virus.
2. Give an example of an immune reaction that can be triggered by a pathogen

1. What is transpiration?
2. What is translocation?
3. Which tissue carries out translocation?
4. Name 2 conditions that affect the rate of transpiration.
5. Describe how to investigate the rate of transpiration.

B3 – Infection and Response

Communicable Diseases – diseases caused by a pathogen

Disease	Pathogen	Symptoms	Spread by	Prevent spread	Treatment
Salmonella	Bacteria	Fever, cramps, vomiting, diarrhoea	Contaminated food	Vaccinating poultry, cooking food thoroughly	Antibiotics or management of symptoms
Gonorrhoea	Bacteria	Yellow/green discharge, pain when urinating	Sexual Contact	Using barrier protection, e.g. condoms	Antibiotics
Measles	Virus	Red rash and fever	Breathing in droplets from coughs/sneezes	Vaccination	No cure – only management of symptoms
HIV	Virus	Flu-like symptoms, develops into AIDS	Sexual contact	Using barrier protection, e.g. condoms	Antiretroviral drugs
Tobacco Mosaic Virus (plants)	Virus	'Mosaic' pattern of discolouration on the leaves	Soil	Destroy infected plants	No treatment
Rose Black Spot (plants)	Fungus	Black spots on leaves	Wind or water	Remove and destroy infected leaves	Fungicides
Malaria	Protist	Recurrent episodes of fever	Insect bites (mosquitoes)	Mosquito nets, insect repellent	Antimalarial drugs

Antibiotics & Painkillers

Antibiotics = kill bacteria (specific antibiotic for specific bacteria) **THEY DO NOT KILL VIRUSES** e.g. penicillin

Antibiotics cannot kill viruses because viruses live inside cells

Painkillers = stop pain (don't kill microbes, just help with symptoms) e.g. paracetamol

Development of Drugs

Testing for:

- Safety
- Efficacy (does it work)
- Dosage (how much is needed)

Stage	Description
1	Tested on cells and tissues. Side effects? Efficacy?
2	Tested on animals. Side effects?
3	Clinical trials = tested on humans. 1 st health volunteers, 2 nd patients with the illness. Dosage gradually increased to optimum.

Non-specific Defence Systems

Trachea & Bronchi

Cilia cells (small hair-like projections from cells) and mucus (produced by goblet cells) trap pathogens.

Nose

Hairs and mucus trap pathogens before entering lungs.

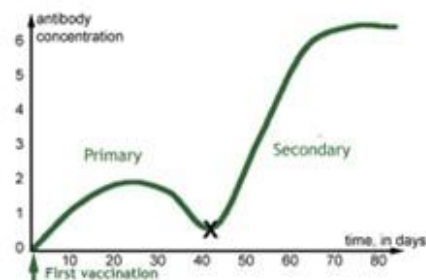
Stomach

Contains hydrochloric acid to kill pathogens that have been eaten.

Skin
If damaged, repairs itself (scabs)

Vaccination

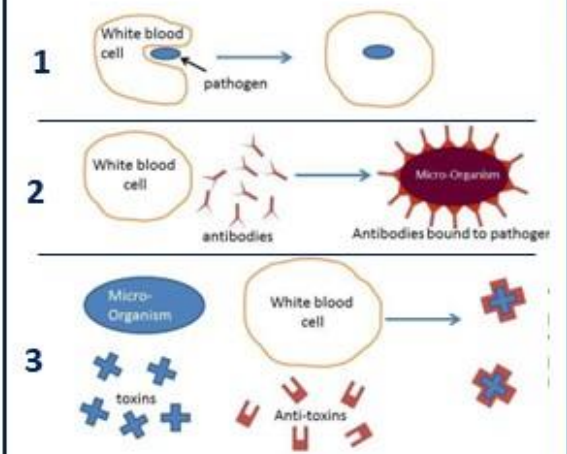
- Introducing small quantities of dead or inactive forms of pathogen into the body.
- Stimulates WBCs to produce antibodies.



- If same pathogen returns (X), WBCs remember how to make the right antibodies.
- They make MORE antibodies, MORE QUICKLY, and they stay in body for LONGER.

White Blood Cells (WBCs)

1. Phagocytosis – engulfing the pathogen
2. Producing antibodies – specific to the antigen
3. Producing antitoxins – to neutralise toxins



B3 – Infection and Response

1. What is a communicable disease?
2. What are the symptoms of gonorrhoea?
3. Which type of pathogen causes rose black spot?
4. How is measles spread?
5. How can we prevent the spread of malaria?
6. What is the **treatment** for salmonella?
7. How is salmonella spread?
8. How can HIV be treated?

1. What is the only type of pathogen antibiotics can kill?
2. What do painkillers do?
3. Why can antibiotics NOT kill viruses?

1. What are clinical trials?
2. What are the three things we test for before a drug can be used by the public?
3. What is the first stage of drug testing?
4. What are drugs tested on in preclinical trials?

1. What is in a vaccination?
2. Why do the white blood cells respond more quickly the second time they come into contact with a pathogen?
3. How does vaccination prevent us from becoming infected with the same pathogen in the future?

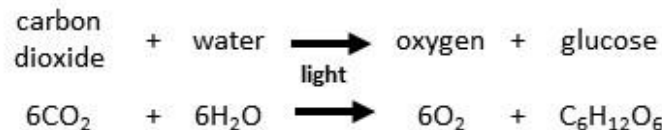
1. How are the trachea and bronchi help prevent infection?
2. What does the stomach contain to prevent infections?

1. What is phagocytosis?
2. What do antibodies attach to?
3. How do antitoxins make us feel better?

B4 – Bioenergetics

Photosynthesis

Endothermic chemical reaction that takes place in chloroplasts in leaves that produces glucose and oxygen from carbon dioxide and water



What do plants do with the glucose?

- Stored as starch
- Stored as fats and oils
- For making cellulose (for cell walls)
- For respiration
- For making amino acids (along with nitrates from soil)

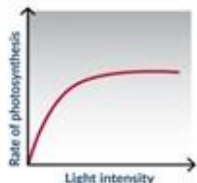
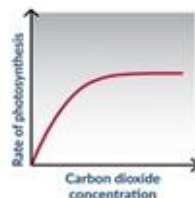
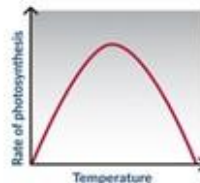
Testing the leaf for starch:

- Boil the leaf for 5 minutes to soften
- Put into heated ethanol to remove chlorophyll (turn off Bunsen burner!)
- Spread leaf on a white tile
- Add iodine
- In the places that contain starch the iodine will turn blue/black
- In a variegated leaf, only the parts containing chlorophyll turn blue black
- This shows chlorophyll is essential for photosynthesis

Factors that affect the rate of photosynthesis

- Light
- Temperature
- CO_2 concentration

Whichever one is in the shortest supply is called the **limiting factor** – as it is the one limiting the rate of photosynthesis

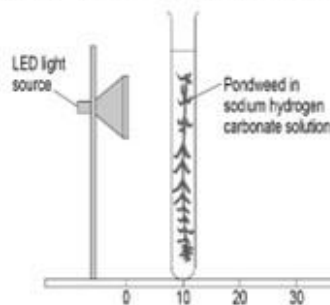


Increased light intensity increases the rate, but only up to a point, when CO_2 or temperature become limiting

Increased CO_2 conc increases the rate, but only up to a point, when light or temperature become limiting

Increased temperature increases the rate, but only up to a point, then the enzymes are denatured & rate drops

RP5 – Effect of light intensity on rate of photosynthesis



Independent variable: distance between lamp and plant (or light intensity)

Dependent variable – number of bubbles per second / rate of photosynthesis

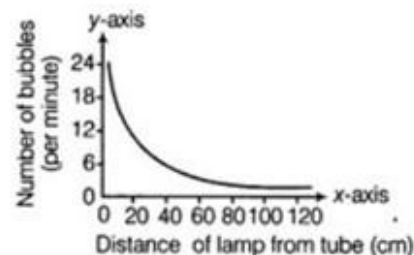
Controls – temperature of solution, piece of pondweed

1. Measure 10cm length of pondweed and cut with scissors.
2. Place into beaker of 250ml NaHCO_3 solution. (this provides CO_2)
3. Place lamp 10cm away from pondweed – turn on lamp and leave for 2 minutes to adjust to light intensity.
4. Count number of bubbles produced in 60 seconds and record in table.
5. Repeat steps 3 and 4 for lamp distances of 20cm – 50cm at 10cm intervals.
6. Keep the temperature of the solution the same (LED light is used to not give off heat)

Inverse Square Law (HT only)

As distance of the lamp doubles the light intensity of the plant quarters $I = \frac{1}{d^2}$

Typical results:



As the **distance** between the lamp and the pondweed **increases**, the **number of bubbles per minute decreases**

B4 – Bioenergetics

Photosynthesis

1. What are the two reactants for photosynthesis?
2. What are the two products?
3. Where in a cell does this reaction happen?
4. Name two uses of glucose produced in photosynthesis.
5. What else is needed for plants to produce amino acids?
6. What chemical is used to test for starch?
7. Which parts of the leaf contain starch in a variegated leaf?



RP5 – Effect of light intensity on rate of photosynthesis

1. What is the independent variable in this investigation?
2. What needs to be kept the same?
3. What is the dependent variable?
4. Why is an LED lamp used rather than a regular lamp?
5. Why is sodium hydrogen carbonate solution used?
6. What is a good range and interval for the distance measurements?
7. Why is the plant left for 2 minutes every time the lamp is moved?
8. Describe the relationship between distance and the number of bubbles per minute

Factors that affect rate of photosynthesis

1. What are the three main factors that affect the rate of photosynthesis?
2. What is a 'limiting factor'?
3. Why does increasing the temperature above a certain point cause the rate to drop?
4. Describe the effect of increasing the concentration of CO_2 on the rate of photosynthesis

B4 – Bioenergetics

Respiration

Respiration is a chemical reaction that happens in the mitochondria of cells to release energy from glucose.

There are two types – Aerobic and Anaerobic.

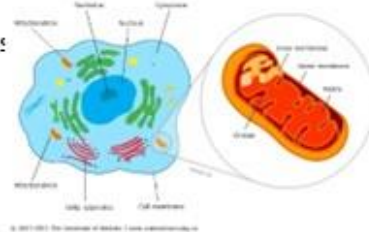
Aerobic: - with oxygen

oxygen + glucose → carbon dioxide + water



Organisms need energy for:

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



Exercise

During exercise, more energy is needed so that muscles can keep contracting. This means more respiration is needed.

Increased breath depth -

Get more oxygen into blood per breath and remove CO_2

Increased heart rate -

Get more oxygenated blood to muscles.

Increased breathing rate -

Get oxygen into blood quickly.



Heart beats harder -

more blood is pumped with every beat.

During intense exercise, there is just not enough oxygen getting into the body. The muscles start to respire anaerobically.

The build up of lactic acid can cause cramp/stitch.

(HT ONLY) When exercise is over, the lactic acid has to be oxidised to CO_2 and H_2O . The amount of oxygen needed to do this is called the oxygen debt

Anaerobic respiration

Respiration without oxygen

In animal cells = glucose → lactic acid

In plant/yeast cells = glucose → ethanol + carbon dioxide

In yeast, this is fermentation and is used in brewing and baking



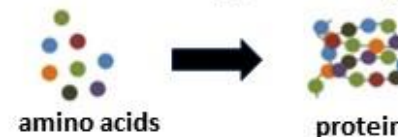
	Aerobic	Anaerobic
Oxygen used?	Yes	No
Waste products	CO_2 and H_2O	Lactic acid (animals) Ethanol + CO_2 (plants/yeast)
Energy released	Lots	Much less

Metabolism

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

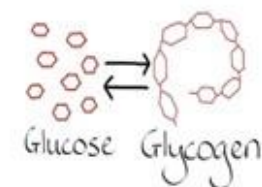
The 'metabolic rate' is the rate at which all of these reactions take place.

An example of a reaction = making proteins using amino acids from digestion.



More examples:

- glucose → glycogen (in muscles/liver)
- respiration
- protein → urea
- glycerol and fatty acids → fats



B4 – Bioenergetics

Respiration

1. What is respiration?
2. Where does respiration take place?
3. What does aerobic mean?
4. Give two uses for the energy released from respiration
5. What are the two types of respiration?
6. What are the reactants in respiration?
7. Write the equation for respiration below

Exercise

1. Describe two changes to breathing during exercise
2. Why does breathing need to change during exercise?
3. What happens to heart rate during exercise?
4. When does anaerobic respiration happen?
5. Which chemical builds up in muscles during anaerobic respiration?

Anaerobic respiration

1. What is anaerobic respiration?
2. What is 'fermentation'?
3. What are the waste products of anaerobic respiration in humans?
4. What are the waste products of anaerobic respiration in plants and yeast cells?
5. Which type of respiration releases most energy?

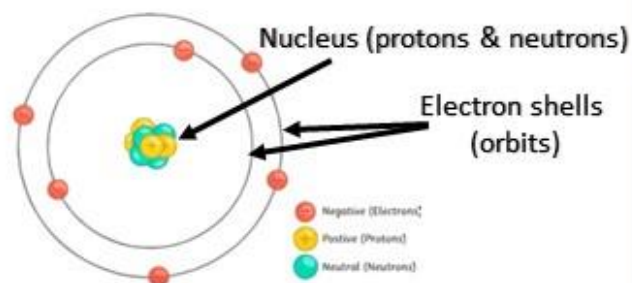
Metabolism

1. What is the metabolic rate?
2. Give two examples of metabolic reactions other than respiration
3. What is glucose stored as in muscles?
4. What are fats made of?

C1 – Atomic Structure and The Periodic Table

Atoms

- Made up of **protons**, **electrons** and **neutrons**.



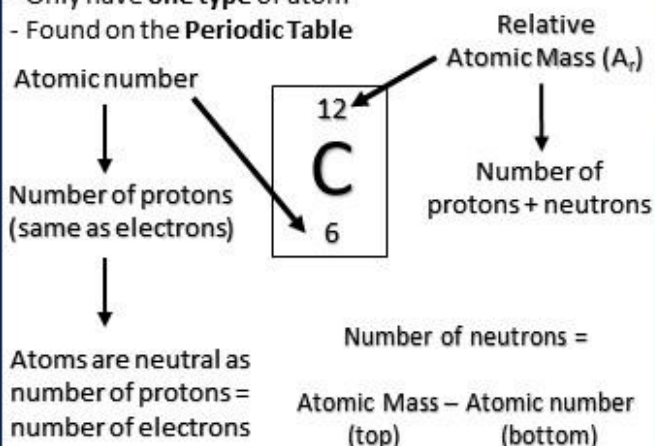
Subatomic particle	Relative Mass	Charge
Proton	1	Positive
Neutron	1	Neutral
Electron	Very small	Negative

Atoms have a radius of about 0.1nm (1×10^{-10} m)

Radius of nucleus = about 1×10^{-14} m

Elements

- Only have **one type** of atom
- Found on the **Periodic Table**



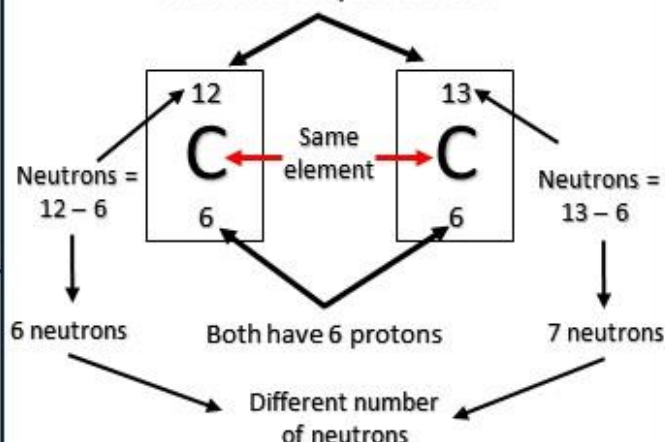
Compounds

- Two or more elements **chemically combined**.
- Formed by chemical reactions
- For example: CO_2 H_2O CH_4 HCl NaCl

Isotopes

Isotope = atoms of the **same element** which have the **same number of protons**, but a **different number of neutrons**.

These are isotopes because..



Chemical Equations

- Shown by using a **word equation**.
e.g. magnesium + oxygen → magnesium oxide

Left of the arrow = **reactants**
Right of the arrow = **products**.

- Also can be shown by a **symbol equation**
e.g. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

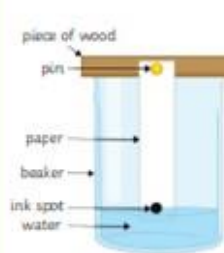
Mixtures and Separation

Mixtures – two or more elements or compounds **not** chemically joined.

This means the different components of the mixture can be separated by physical methods (below)

E.g. air is a mixture mainly made of nitrogen, oxygen and carbon dioxide.

Chromatography
to separate out mixtures (usually liquids) (e.g. colours in ink)



Evaporation
To quickly separate soluble solids from a solution. (e.g. salt and water)



Filtration
To separate insoluble solids from liquids (e.g. sand and water)



Crystallisation
To slowly separate a soluble salt from a solution. (e.g. copper sulfate crystals)



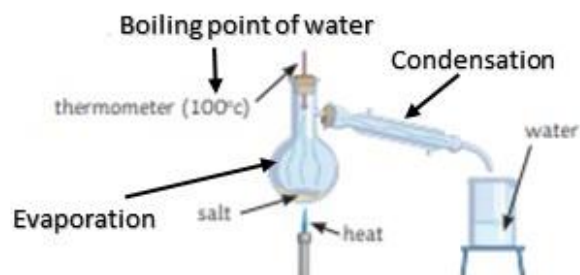
C1 – Atomic Structure and The Periodic Table

<ol style="list-style-type: none"> 1. Name the three subatomic particles. 2. Which two subatomic particles are found in the nucleus of an atom? 3. What is the mass of a proton? 4. What is the radius of an atom? 5. What is the radius of the nucleus of an atom? 	<ol style="list-style-type: none"> 1. Define the word compound. 2. Give three examples of compounds. 	<ol style="list-style-type: none"> 1. Is air an element, compound or mixture? Why? 2. What is chromatography used to separate? 3. What can be separated using filtration? 4. Give an example of a mixture that can be separated using filtration. 5. What is evaporation used to separate? 6. Give an example of a mixture that can be separated using evaporation.
<ol style="list-style-type: none"> 1. Where are elements found? 2. What does the relative atomic mass of an element show? 3. What does the atomic number show? 4. How do you calculate the amount of neutrons? 	<ol style="list-style-type: none"> 1. What is an isotope? 2. Why are the two elements below isotopes? (use the numbers of subatomic particles) <div style="display: flex; justify-content: space-around; align-items: center; margin: 20px 0;"> <div style="border: 1px solid black; padding: 5px; text-align: center;"> ¹⁴ N ₇ </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> ¹⁵ N ₇ </div> </div>	
	<ol style="list-style-type: none"> 1. Where do you find the reactants in a chemical reaction? 2. Where do you find the products in a chemical reaction? 	

C1 – Atomic Structure and The Periodic Table

Distillation

Simple distillation – separating a liquid from a solution.



- Liquid is heated to boiling point and evaporates
- Vapours travel up into the condenser
- Condenser has cold water around it.
- Vapours cool and condense (turn back into a liquid).

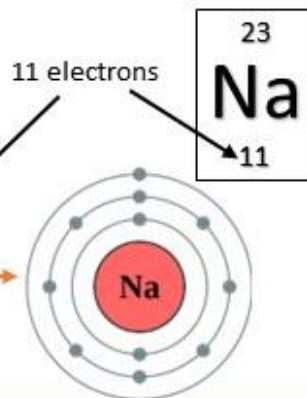
Electronic Structure

- Electrons are found on shells (orbits) orbiting the nucleus.
- There is a maximum number of electrons allowed on each shell:

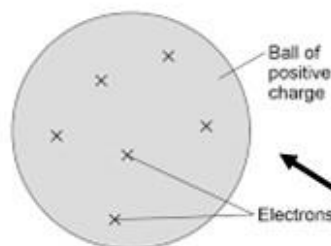
First shell = 2 electrons
Second shell = 8 electrons
Third shell = 8 electrons.

1st shell = 2
2nd shell = 8
3rd shell = 1

Total = 11 electrons



Plum pudding model



Differences to nuclear model

- Ball of positive charge (no protons)
- No nucleus
- No neutrons
- Evenly distributed mass

Rutherford tested the plum pudding model

History of the atom

Scientist	Time	Discovery
John Dalton	Start of the 19 th century	Atoms were first described as solid spheres.
JJ Thomson	1897	Plum pudding model – atom is a ball of + charge with electrons scattered
Ernest Rutherford	1909	Alpha scattering experiment - mass concentrated at the centre, only the nucleus is + charged. Most of the atoms is empty space.
Niels Bohr	Around 1911	Electrons are in shells orbiting the nucleus
James Chadwick	Around 1940	Discovered that there are neutrons in the nucleus.

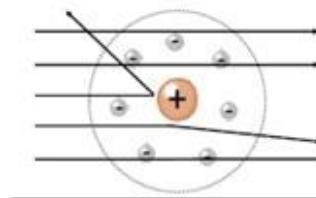
Rutherford's scattering experiment

alpha particles are positively charged

Fired at gold foil

some alpha particles are deflected/repelled

most alpha particles passed straight through



What happened?

Conclusions made

Observation	Conclusion
Most of the particles passed straight through	Most of the atom is empty space
Some were deflected to the sides	The particles had passed close by a positive charge
A very small number were repelled straight back	The alpha particles had approached the nucleus straight on. the tiny number told him that the positive charge is in a very small dense core

C1 – Atomic Structure and The Periodic Table

1. What two changes of state occur in distillation?
2. What temperature would the thermometer show when distilling salt and water?
3. Why does the water vapour condense in the condenser?

1. Who suggested the plum pudding model?
2. State three differences between the nuclear model and the plum pudding model.
3. What did Niels Bohr discover?
4. What did James Chadwick discover?
5. Put the particles into order of discovery:
proton electron neutron

1. Where are electrons found?
2. How many electrons can be placed in the first, second and third shells?
3. Which number on the element shows the number of electrons?

1. Who conducted the scattering experiment?
2. What was fired at gold leaf during the scattering experiment?
3. Only a tiny number of the alpha particles were deflected, what did this show about the atom?
4. Some particles went straight through, what did this show about the atom?

C1 – Atomic Structure and The Periodic Table

Development of the Periodic Table

John Newlands – Law of Octaves

- Elements ordered by **atomic weight**.
- Noticed a pattern with every eighth element.
- Some elements placed inappropriately – metals and non-metals grouped together.
- Rejected by other scientists.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru

John Newlands' Law of Octaves

Dimitri Mendeleev

- Still ordered by atomic weight
- Left gaps for **undiscovered elements**
- Could predict properties of undiscovered elements.
- Some elements didn't fit pattern—switched them to keep pattern of **similar properties**.

[illegible]

Dimitri Mendeleev left gaps for undiscovered elements

Eventually, knowledge of isotopes explained why elements could not be ordered by atomic weight.

The Modern Periodic Table

- Ordered by **atomic (proton) number**.

Columns = groups

Group number = number of electrons in outer shell.

Elements in each group have similar properties.

Rows = periods

Period number = number of electron shells the atom has.

metals

non-metals

Periodic Table of Elements

1	2																	3	4	5	6	7	8	
1	H																	He						
2	Li	Be																	B	C	N	O	F	Ne
3	Na	Mg																	Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
7	Fr	Ra	Ac																					

Group 0 (Noble Gases)

- Full outer shell – unreactive as they don't need to lose or gain any electrons

As you go down...

- Boiling point increases
- More electron shells
- Bigger atoms
- More intermolecular forces
- More energy needed to break forces.

Group 1 (alkali metals)

- Similar properties as all have 1 electron in outer shell.
- All lose one electron in reactions to form $1+$ ions
- Soft, grey, shiny metals
- Stored in oil as would react with oxygen in air.
- When placed in water they produce an alkali (hence alkali metals) and hydrogen gas

E.g. Lithium + water $\rightarrow$ lithium hydroxide + hydrogen

Reactivity of Group 1

Li
Na
K
Rb
Cs
Fr

As you go down the group...

- Elements are more reactive because:
 - More electron shells
 - Outer electron = further from nucleus and more shielded by the other shells
 - The electrostatic force of attraction between outer electron and nucleus is weaker
 - Easier for outer electron to be lost

Group 7 (Halogens)

- 7 electrons in outer shell – all react similarly
- All gain one electron when they react to form 1- ions
- Form molecules (e.g. Cl_2 , F_2)
- Non-metals.
- A more reactive halogen can replace a less reactive halogen in a reaction (**displacement**)

Reactivity of Group 7

F
Cl
Br
I
At

As you go down the group...

- Elements are **less** reactive because:
- More electron shells
- Outer shell is further from nucleus and is **more shielded** by the other shells
- The electrostatic force of attraction between free electron and nucleus is **weaker**
- Harder to attract an electron into the outer shell.

C1 – Atomic Structure and The Periodic Table

- | | | | |
|--|---|--|--|
| <ol style="list-style-type: none"> 1. Who created the 'Law of Octaves'? 2. How were the elements ordered in old versions of the periodic table? 3. How did Dimitri Mendeleev order his elements? 4. Why did Mendeleev leave gaps in his periodic table? 5. The knowledge of what eventually explained why elements could not be ordered by atomic weight? | <ol style="list-style-type: none"> 1. State 2 properties of Group 1 metals. 2. Why are they known as the alkali metals? 3. Are they reactive or unreactive? 4. As you go down the group, what happens to the reactivity of elements? 5. Explain your answer to Q4. | | |
| <ol style="list-style-type: none"> 1. How are elements ordered in the modern periodic table? 2. Groups are rows or columns? 3. What does group number show? 4. What does period number show? | <table border="1"> <tr> <td data-bbox="913 826 1326 1367"> <ol style="list-style-type: none"> 1. What are elements in group 0 known as? 2. Why are these elements unreactive? 3. What happens to boiling point as you go down group 0? </td> <td data-bbox="1326 826 2040 1367"> <ol style="list-style-type: none"> 1. How many electrons do the halogens have in the outer shell? 2. What type of element are they? 3. State the trend in reactivity as you go down group 7. 4. Explain your answer to Q4. </td> </tr> </table> | <ol style="list-style-type: none"> 1. What are elements in group 0 known as? 2. Why are these elements unreactive? 3. What happens to boiling point as you go down group 0? | <ol style="list-style-type: none"> 1. How many electrons do the halogens have in the outer shell? 2. What type of element are they? 3. State the trend in reactivity as you go down group 7. 4. Explain your answer to Q4. |
| <ol style="list-style-type: none"> 1. What are elements in group 0 known as? 2. Why are these elements unreactive? 3. What happens to boiling point as you go down group 0? | <ol style="list-style-type: none"> 1. How many electrons do the halogens have in the outer shell? 2. What type of element are they? 3. State the trend in reactivity as you go down group 7. 4. Explain your answer to Q4. | | |

C2 – Bonding, structure, and the properties of matter

Formation of Ions

- **Ions** = a charged particle made when atoms lose or gain electrons
- **Positive ion** = atom has lost electrons
- **Negative ion** = atom has gained electrons.

Metals form **positive ions**

Non-metals form **negative ions**

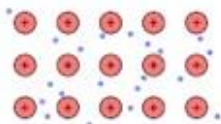
Group	Ions	Example
1	+1	$\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$
2	+2	$\text{Ca} \rightarrow \text{Ca}^{2+} + 2\text{e}^-$
6	-2	$\text{O} + 2\text{e}^- \rightarrow \text{O}^{2-}$
7	-1	$\text{Br} + \text{e}^- \rightarrow \text{Br}^-$

Lost electrons

Gained electrons

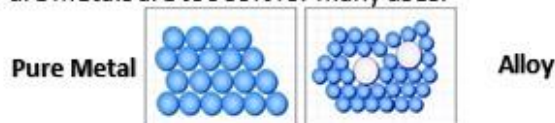
Metallic Bonding

- Happens in **metals only**.
- Positive metal ions surrounded by **sea of delocalised electrons (can move)**.
- Ions tightly packed in rows.
- Strong **electrostatic forces of attraction** between positive ions and negative electrons.



Alloys

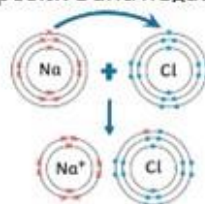
- **Alloys** = mixture of two or more metal atoms
- Pure metals are too soft for many uses.



- | | |
|-------------------|-------------------------|
| • Atoms same size | • Different sized atoms |
| • Layers slide | • Layers cannot slide |
| • Softer | • Stronger |

Ionic Bonding

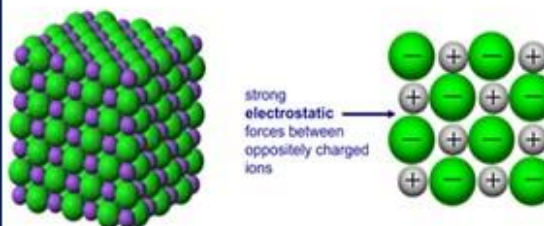
- Between a metal and non-metal.
- Metals give electrons to non-metals so both have a full outer shell.
- **Electrostatic force of attraction** between positive and negative ions.



E.g. Sodium loses one electron to become Na^+ . Chlorine gains one electron to become Cl^- . The two ions attract to form sodium chloride.

Ionic compounds

- Form **giant lattices**, as the attraction between ions acts in all directions



Properties of Ionic Compounds

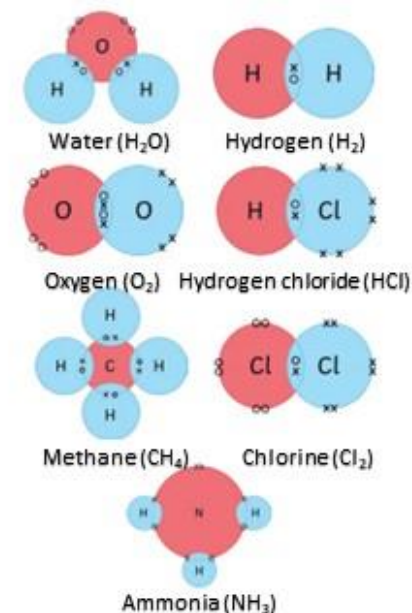
- **High melting point** – lots of energy needed to overcome electrostatic forces.
- **High boiling point**
- **Cannot conduct electricity as solid** – ions cannot move
- **Conducts electricity when molten or dissolved** – ions are free to move.

Covalent Bonding

- **Covalent bonding** = sharing a pair or pairs of electrons for a full outer shell.
- Between **non-metals only**.

Dot and cross diagrams

- Show the bonding in simple molecules.
- Uses the outer shell of the atoms
- Crosses and dots used to show electrons
- You should be able to draw the following:



Simple Covalent Molecules

- Form when all atoms have full outer shells so bonding stops
- Examples are the molecules shown above.
- Have **low melting and boiling points**
- Due to **weak intermolecular forces**
- Do not conduct electricity

C2 – Bonding, structure, and the properties of matter

1. What is an ion?
2. What happens to form a positive ion?
3. What happens to form a negative ion?
4. What type of ions are formed by:
 1. metals
 2. non-metals

1. What are metal ions surrounded by?
2. Name the type of attraction between the electrons and ions.
3. Why do metals conduct electricity?
4. What is an alloy?
5. Why are pure metals too soft for some uses?
6. Why are alloys stronger than pure metals?

1. Ionic bonding happens between..
2. What do metals give to non-metals?
3. What type of attraction is between the positive and negative ions?

4. What structure do ionic compounds form?
5. What are the melting points of ionic compounds like?
6. Why can solid ionic compounds **not** conduct electricity?
7. When can ionic compounds conduct electricity?

1. What is covalent bonding?
2. What type of atoms does covalent bonding happen between?
3. Draw dot and cross diagrams for the following:

Water (H₂O)

Methane (CH₄)

Oxygen (O₂)

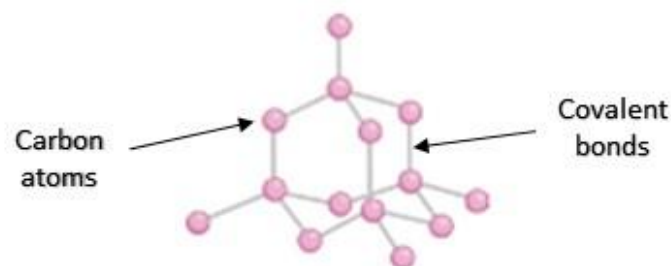
5. Do simple covalent molecules have a high/low melting point?

6. Why is this?

C2 – Bonding, structure, and the properties of matter

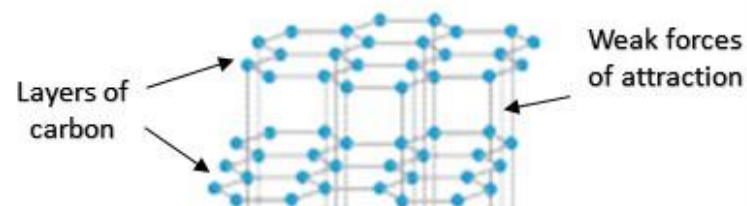
Giant Covalent Structure – Diamond

- Each carbon atom **covalently** bonded to **four** others.
- Forms a giant structure
- This makes diamond **strong** → a lot of **energy** needed to break lots of strong covalent bonds.
- **Does not conduct electricity** – has no free electrons.



Giant Covalent Structure – Graphite

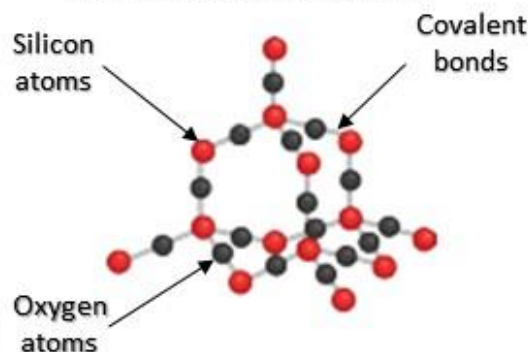
- Layers of **carbon** arranged in **hexagons**.
- Each carbon bonded to **three** other carbons.
- Leaves **one delocalised electron** → moves to carry electrical charge **throughout** structure.



- Layers held together by **weak forces**
- Layers can **slide** over each other easily
- Makes graphite **soft/slippy** → good lubricant.
- Has **high melting point** as has many strong covalent bonds.

Silicon Dioxide

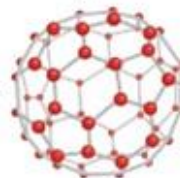
- Similar structure to diamond
- Giant covalent structure.
- Lots of **strong covalent bonds**.
- These require lots of **energy** to break.
- High melting and boiling points.



Fullerenes and Nanotubes

- Molecules of carbon shaped into hollow tubes or balls.
- Used to **deliver drugs into body**

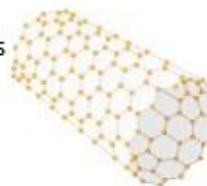
Buckminsterfullerene
Formula = C₆₀



- **Carbon nanotubes** = long narrow tubes
- Can conduct electricity

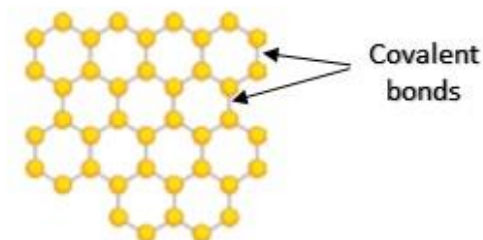
- Can strengthen materials without adding weight.

- Used in electronics and nanotechnology.



Graphene

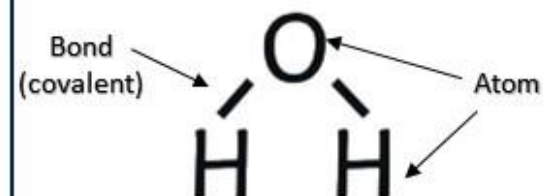
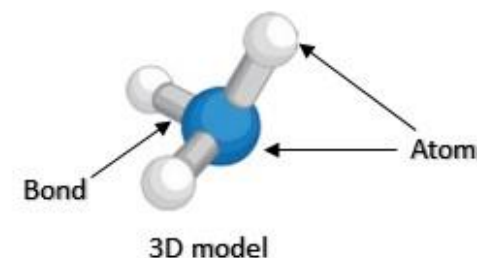
- Graphene = one layer of graphite.
- Very strong → lots of strong covalent bonds.



- Each carbon bonded to **three** others.
- One **free delocalised electron** → can move to carry **electrical current** throughout the structure.

Molecular models

- There are different ways to show a molecule other than dot and cross diagrams.



C2 – Bonding, structure, and the properties of matter

1. How many bonds do each carbon atom have in diamond?
2. What type of bonds are in diamond?
3. Why is diamond hard?
4. Why does diamond not conduct electricity?

1. What structure does silicon dioxide have?
2. Why does this structure have a high melting and boiling point?

1. What is graphene?
2. State a property of graphene.
3. How many bonds does each carbon have?
4. What does this allow graphene to do?

1. What element is graphite made from?
2. How many bonds does each carbon have?
3. Why can graphite conduct electricity?
4. What holds together the layers of graphite?
5. Why is graphite soft/slippery?
6. Does graphite have a high/low melting point?
7. Why?

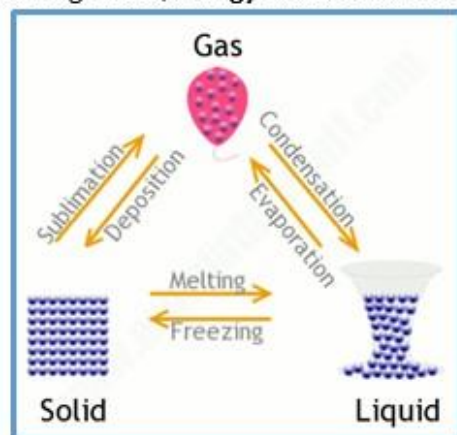
1. What can fullerenes be used for?
2. What is the formula of buckminsterfullerene?
3. State two uses of carbon nanotubes.

1. What are three ways that H₂O could be drawn?

C2 – Bonding, structure, and the properties of matter

States of Matter

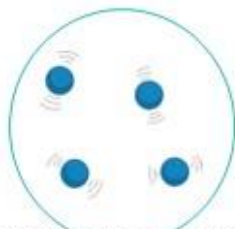
- Three states of matter: **solid, liquid & gas.**
- To change state, **energy must be transferred.**



- When heated, particles **gain energy.**
- **Attractive forces** between particles begin breaking when melting or boiling points are reached
- **Amount of energy** needed to change state depends on how strong forces are.

Gas

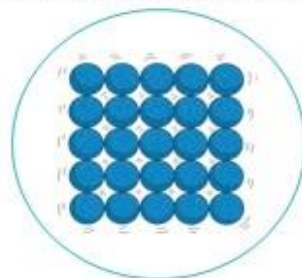
- Randomly arranged.
- Particles **move quickly** – all directions.
- Highest **amount of kinetic energy.**



- Gases are **able to flow** – fill containers
- **Can be compressed** as there is space between particles

Solid

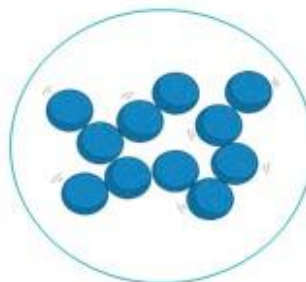
- **Regular pattern** (rows and columns)
- Particles **vibrate** in a **fixed position.**
- Particles have **low amount of kinetic energy.**



- Have a **fixed shape** – cannot flow because of strong forces of attraction between particles
- **Cannot be compressed** – particles close together.

Liquid

- Particles **randomly** arranged and touching.
- Particles can **move around.**
- **Greater amount of kinetic energy** than solid



- Liquids **able to flow** – take shape of containers.
- **Cannot be compressed** – particles are close together and cannot be pushed closer

State symbols

- States of matter shown in chemical equations:
- Solid (**s**)
- Liquid (**l**)
- Gas (**g**)
- Aqueous (**aq**)
- **Aqueous solutions** = substance dissolved in water.

Identifying Physical State of Substances

- If the temperature is **lower** than a substance's melting point – substance is **solid.**
- If the temperature is **between** the melting point and boiling point – substance is **liquid.**
- If the temperature is **higher** than the boiling point – substance is a **gas.**

Limitations of Particle Model (HT)

- No chemical bonds are shown.
- Particles shown as solid spheres – not the case, particles are mostly empty space like atoms.
- The diagrams don't show any of the forces between particles
- The diagrams are unable to show the movement of the particles.

C2 – Bonding, structure, and the properties of matter

1. What are the three states of matter?
2. What happens to particles when they are heated?
3. What happens to attractive forces when particles are heated?
4. What does the amount of energy needed to change state depend on?

1. How are gas particles arranged?
2. How do gas particles move?
3. Do particles in a gas have more or less kinetic energy than those in solids and liquids?
4. Can gases be compressed? Why?

1. How are solid particles arranged?
2. Do solid particles move?
3. Do particles in a solid have a high or low amount of kinetic energy?
4. Can solid particles flow?
5. Can solids be compressed?

1. How are liquid particles arranged?
2. Do particles in a liquid move?
3. Do the particles in a liquid have more or less kinetic energy than solids?
4. Can liquid particles flow?
5. Can liquids be compressed?

1. Where are state symbols used?
2. Write the symbols for solid, liquid, gas and aqueous.
3. What does aqueous mean?

1. If the temperature is lower than melting point, the substance is..
2. If the temperature is between melting and boiling point, the substance is..
3. When would a substance be gas?

1. State two limitations of the particle model.

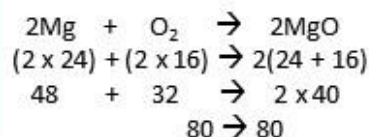
C3 – Quantitative Chemistry

Conservation of Mass

- Atoms cannot be created or destroyed during reactions.
- **Mass of reactants = mass of products.**

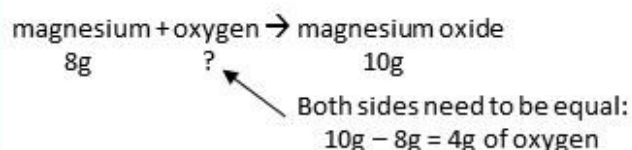
To show mass is conserved in a reaction:

M_r on the left-side must be same as the right side.



Reacting masses

Use conservation of mass to predict masses:



Percentage Mass

- Percentage mass of an element in a compound

$$\frac{\text{Mass of the element in compound}}{\text{Total mass of compound}} \times 100$$

Example Question:

Find the percentage mass of oxygen in magnesium oxide (**MgO**).

A_r of magnesium = 24 A_r of oxygen = 16

$$M_r \text{ of MgO} = 24 + 16 = 40$$

$$\% \text{ mass} = \frac{A_r}{M_r} = \frac{16}{40} = 0.4 \times 100 = 40\%$$

X 100 to make a % 40% of the mass of MgO is oxygen

Mass Changes

- Mass is always conserved in a reaction.
- Sometimes it may seem like the mass has increased/decreased.
- If a **reactant** is a gas – mass may **increase**.

magnesium + oxygen → magnesium oxide

Oxygen is in the air before it combines with magnesium – you cannot find the mass of oxygen on the balance.

It will look like the mass has increased when it is re-weighed at the end.



- If a **product** is a gas and the gas is able to escape the system – mass will **decrease**.

sodium carbonate → sodium oxide + carbon dioxide

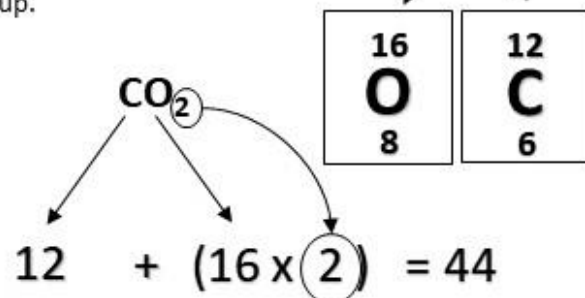


It will look like the mass has decreased as some of the atoms have been given off as gas and have escaped – so cannot be re-weighed.

Atomic mass (A_r) and Relative Formula Mass (M_r) The Mole (HT only)

- Atomic mass (A_r) is the mass number – ie the mass of one atom
- Relative formula mass (M_r) = all the **relative atomic masses (A_r)** of the atoms in a compound or molecule added up.

Example



- Avogadro constant – 6.02×10^{23}

- One mole contains 6.02×10^{23} atoms or molecules
- The mass, in g, of one mole is the A_r (if an element) or M_r if a compound or molecular element

Iron has a A_r of 56, so 1 mole of iron is 56 g and contains 6.02×10^{23} atoms of iron

Ammonia (NH_3) has an M_r of 17, so 1 mole of ammonia has a mass of 17g. and contains 6.02×10^{23} molecules of ammonia

C3 – Quantitative Chemistry

1. What is meant by conservation of mass?
2. Mass of reactants = ?
3. The M_r of the left side of an equation must be the same as..

1. How do you calculate the percentage mass of an element in a compound?
2. What do you do to convert a decimal into a percentage?

1. Should mass change in a reaction?
2. If a reactant is a gas, what will happen to the mass?
3. Why will it appear this has happened?

1. What does M_r stand for?
2. What is the relative formula mass?
3. Where can you find the relative atomic mass (A_r) of an element?

1. How many atoms are in one mole?
2. How do we know what the mass of one mole of an element is?
3. How do we know the mass of one mole of a compound?

4. If a product is a gas, what will happen to the mass?
5. Why will it appear this has happened?

C3 – Quantitative Chemistry

Concentrations of Solutions

- Concentration = mass of dissolved substance in specific volume (eg dm^3)
- More substance dissolved = more concentrated solution

$$\text{Concentration} = \frac{\text{mass}}{\text{volume}}$$

(g/dm^3) (g) (dm^3)

Can be rearranged to find mass dissolved:

$$\text{mass} = \text{concentration} \times \text{volume}$$

(g) (g/dm^3) (dm^3)

$$1000\text{cm}^3 = 1\text{dm}^3$$

$$\text{cm}^3 \rightarrow \text{dm}^3 = \text{divide by } 1000.$$

Calculating mass in a given volume

If you have a known volume of a solution of known concentration then you can calculate the mass of dissolved solid.

E.g Calculate the mass of dissolved solid in 25cm^3 of a $96\text{g}/\text{dm}^3$ solution

$96\text{g}/\text{dm}^3$ means 96g in every 1000cm^3

Do the same to the other side
($\div 40$)

↓
2.4g

↓
 25cm^3

How do we get from 1000 to 25?
($\div 40$)

Moles and Equations (HT only)

- You can use moles to help you write balanced symbol equations.

Example Question

18.4g of Sodium reacted with 6.4g of oxygen to give 24.8g sodium oxide. Use the masses to write the balanced equation.

Step	Example
Write the equation for the reaction (unbalanced)	$\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}$
write down the mass or % given in the question	$18.4 + 6.4 \rightarrow 24.8$
Write the mass of one mole of each element or compound	<div>23 32 62</div> <div>(e.g $18.4 \div 23$)</div>
Divide the mass given in question by the mass of one mole	0.8 0.2 0.4
Turn the answers into whole number simple ratio	<div>8 2 4</div> <div>(cancel down)</div> <div>4 1 2</div>
Put the numbers into the equation	$4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$

Calculating reacting masses (HT)

Example Question

Calculate the mass of calcium needed to make 11.2g Calcium oxide

Step	Calculation
Write the balanced equation	$2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$
Write the masses of each substance	<div>$80 + 32 \rightarrow 112$</div> <div style="text-align: right;">↓</div>
Write down the given mass in the question.	11.2
Work out the 'scale' factor (ie what did you have to do to the original number to get to the desired mass)	<div>$\div 10$</div> <div style="text-align: right;">↓</div>
Do the same to the other side	8g

Limiting Reactants (HT only)

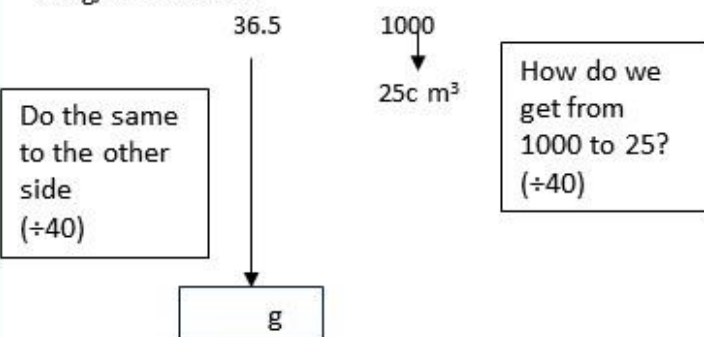
- If one reactant runs out before the other, then the reaction will stop.
- The reactant that runs out first in a reaction is known as the limiting reactant.

C3 – Quantitative Chemistry

1. What does concentration mean?
2. How can you make a solution more concentrated?
3. State the equation to calculate concentration in g/dm^3 .
4. What is the unit for volume?
5. How many cm^3 are in a dm^3 ?

Calculating mass in a given volume

1. What does 36.5g/dm^3 mean?
2. Calculate the mass of dissolved solid in 25 cm^3 of a 36.5g/dm^3 solution



Moles and Equations (HT only)

12g of magnesium (Mg) reacted with 8g of oxygen (O_2) to produce 20g magnesium oxide (MgO). Use the masses to write a balanced equation

Step	Example
Write the equation for the reaction (unbalanced)	
write down the mass or % <u>given in the question</u>	
Write the mass of one mole of each element or compound	
Divide the mass given in question by the mass of one mole	
Turn the answers into whole number simple ratio	
Put the numbers into the equation	

1. What is a limiting reactant?
2. Complete the calculation: Calculate the mass of calcium needed to make 224g of calcium oxide

Step	Calculation
Write the balanced equation	$2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$
Write the masses of each substance	
Write down the given mass in the question.	
Work out the 'scale' factor (ie what did you have to do to the original number to get to the desired mass)	
Do the same to the other side	

C4 – Chemical Changes

The Reactivity Series

- A more reactive metal will replace a less reactive metal in a compound (**displacement**)

- e.g. potassium + magnesium chloride → potassium chloride + magnesium

Potassium is more reactive than magnesium

Potassium **displaces** magnesium from the compound and takes its place.

carbon →

hydrogen →

potassium	Most Reactive ↑ ↓ Least Reactive
sodium	
calcium	
magnesium	
aluminium	
zinc	
iron	
tin	
lead	
copper	
silver	
gold	
platinum	Least Reactive

Reactions of acids with metals

- Metal + acid → salt + hydrogen

E.g. iron + sulfuric acid → iron sulfate + hydrogen

salt

To name salt:
1st name Metal
2nd name Acid used

Naming Salts

Acid used	Salt produced
Hydrochloric	Chloride
Sulfuric	Sulfate
Nitric	Nitrate

Extraction of Metals

- Extraction = remove metal from an ore or a compound.

Ore = a rock containing enough metal to make extracting metal worthwhile.

How to extract metals:

Less reactive than carbon – reduction with carbon

Reduction = loss of oxygen

E.g. iron oxide + carbon → iron + carbon dioxide

Oxygen has been removed to extract iron.

Carbon and the oxygen removed from the iron react to make carbon dioxide

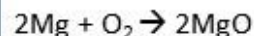
More reactive than carbon – electrolysis is used.

- Some metals are found in **native** form (not reacted, so in element form) – usually platinum and gold as **very unreactive**.

Reaction of metals with oxygen

- Metal + oxygen → metal oxide

e.g. magnesium + oxygen → magnesium oxide



Oxidation reaction as metal gained oxygen

- Oxidation = gaining oxygen

- Reduction = losing oxygen

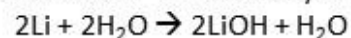
Reaction of metals with water

- Most metals don't react well with water

- Group 1 and group 2 react to form alkalis

- Metal + water → metal hydroxide + hydrogen

e.g. lithium + water → lithium hydroxide + hydrogen



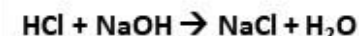
Metal hydroxides are alkaline

Reactions of acids with alkalis

- Acid + alkali → salt + water neutralisation

Hydrochloric acid + sodium hydroxide → sodium chloride + water

salt



Reactions of acids with carbonates

- Acid + carbonate → salt + water + carbon dioxide

sulfuric acid + calcium carbonate → calcium chloride + water + carbon dioxide

salt



C4 – Chemical Changes

1. What is meant by displacement?

2. Name a very reactive metal

3. Name two metals which are less reactive than hydrogen.

1. State the general equation for the reaction of metal with acid.

2. State the salts produced from hydrochloric acid, sulfuric acid and nitric acid.

1. Define extraction.

2. What is an ore?

3. How do you extract a metal less reactive than carbon?

1. State the general equation for the reaction of metal with oxygen.

2. Write a word equation for the reaction of iron with oxygen.

1. State the general equation for the reaction of acid with an alkali.

4. What is meant by reduction?

1. State the general equation for the reaction of metal with water.

5. What is meant by a 'native metal'?

2. Are hydroxides acid/alkaline?

6. Give an example of a metal found in native form.

1. State the general equation for the reaction of acid with carbonates.

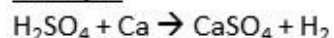
C4 – Chemical Changes

Redox Reactions (HT only)

- Redox = reduction and oxidation takes place at same time in a reaction.

- Metal + acid = redox reaction

Example



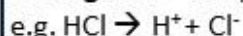
Ionic equation: $2\text{H}^+ + \text{Ca} \rightarrow \text{Ca}^{2+} + \text{H}_2$ Lost 2 electrons (oxidation)

Half equation 1: $\text{Ca} \rightarrow \text{Ca}^{2+} + 2\text{e}^-$

Half equation 2: $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ Gained 2 electrons (reduction)

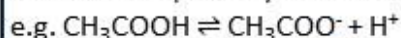
Strong/Weak Acids (HT only)

Strong acid = completely dissociates in a solution



Examples = nitric acid and sulfuric acid

Weak acid = partially dissociates in solution.



$\rightleftharpoons$ = reversible reaction

Hasn't fully turned into ions – only partially

Concentration = how much is dissolved in every cm^3

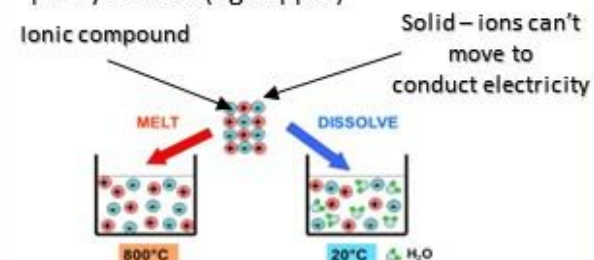
Strong/weak = how well it ionises

As **pH** decreases by 1 unit, **hydrogen ion concentration** of solution increases by factor of 10

Electrolysis

- **Splitting** up a **compound** using electricity.

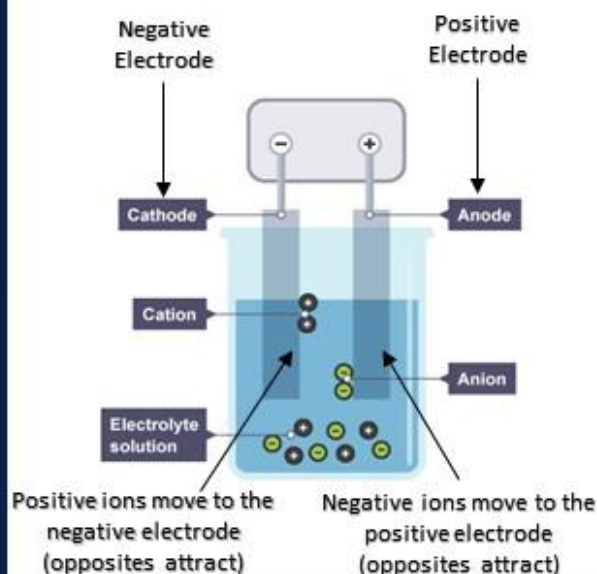
- Used to extract metals from compounds, purify metals (eg copper)



- Must be **molten** or **aqueous** (dissolved in water) to allow **ions** to **move** to the electrodes

The Process of Electrolysis

Two **electrodes** – made of **inert** material (doesn't react)



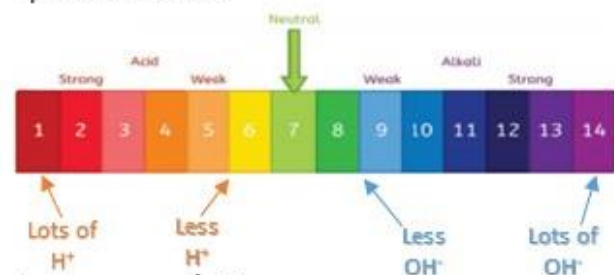
pH Scale

- Shows how acidic or alkaline solution is.

- pH 1-6 = acid

- pH 7 = neutral

- pH 8-14 = alkali

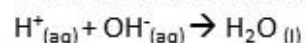


In aqueous solutions:

Acids – produce H^+ ions

Alkalis – produce OH^- ions

In neutralisation reactions:

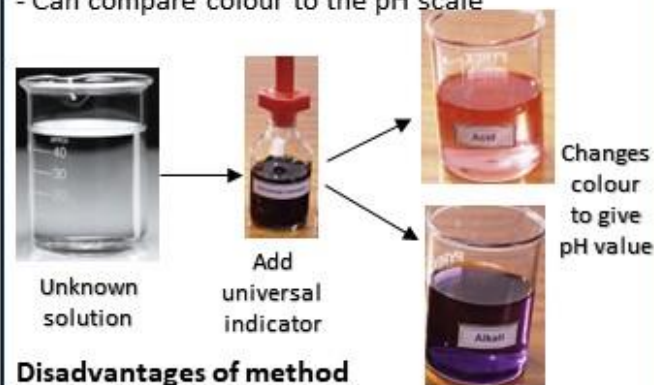


Measuring pH of a solution

- Can use **universal indicator**

- Gives the solution a colour

- Can compare colour to the pH scale



Disadvantages of method

- Colour is **subjective** – different people may see different colours

- Doesn't give an exact pH number (could use **pH probe** to make more **accurate**).

C4 – Chemical Changes

- | | | |
|--|--|---|
| <ol style="list-style-type: none">1. What is a redox reaction?2. In terms of electrons, what does oxidation mean?3. In terms of electrons, what does reduction mean? | <ol style="list-style-type: none">1. Define a strong acid.2. Give an example of a strong acid.3. Define a weak acid.4. What happens to H^+ concentration as the pH value decreases by 1? | <ol style="list-style-type: none">1. What is meant by the term electrolysis?2. What is electrolysis used for?3. What must the compound be for electrolysis to take place?4. Why can solid ionic compounds not conduct electricity? |
| <ol style="list-style-type: none">1. What is the pH range for an acid?2. What is the pH range for an alkali?3. If a substance has a pH of 7, what type of substance is it?4. What ions do acids produce in solution?5. What ions do alkalis produce in a solution?6. State the ionic equation for neutralisation reactions. | <ol style="list-style-type: none">1. Describe a simple method to test the pH of an unknown solution.2. State 2 disadvantages of using universal indicator.3. How can pH be measured more accurately? | <ol style="list-style-type: none">5. What does inert mean?6. Name the positive electrode.7. Name the negative electrode.8. Why do positive ions move to the negative electrode? |

C4 – Chemical Changes – Required Practical – Preparation of soluble salts

Aim

Prepare a pure, dry sample of a soluble salt from an insoluble **oxide or carbonate**.

Equipment

- Beaker
- Measuring cylinder
- Bunsen burner and safety mat
- Filter funnel and filter paper
- Named acid (e.g. hydrochloric acid)
- Metal oxide or carbonate.
- Spatula
- Glass stirring rod

Change method
depending on reactants in
the question.

Method (example copper oxide and sulfuric acid to make copper sulfate)

1. Using measuring cylinder – 20cm³ **sulfuric acid** → beaker
2. Warm the acid gently (not boiling)
3. Using spatula add **copper oxide** to the acid and stir
4. Keep adding until no more oxide will dissolve (excess).
5. Using a filter funnel and filter paper – filter excess copper oxide.
6. Evaporate some of the filtrate using a water bath.
7. Pour remaining filtrate into an evaporating basin – leave overnight to evaporate water
8. Pat the crystals dry.



Common questions

Q1) Why do you heat the acid before adding the oxide?

A1) To speed up the reaction (particles have more energy to react).

Q2) Why is the oxide added in excess?

A2) To make sure that all the acid has been neutralised.

Q3) Why is the solution filtered?

A3) Remove any unreacted, excess solid.

Q4) Why is the solution left overnight in a warm, dry place?

A4) To evaporate excess water, to form crystals (crystallise).

Q5) Name 2 safety precautions you should take during this practical.

A5) Safety goggles and allow equipment to cool before putting away

C4 – Chemical Changes – Required Practical – Preparation of soluble salts

1. Write a method to prepare a pure, **dry** sample of copper sulfate crystals (6 marks).

Q2) Why do you heat the acid before adding the oxide?

Q3) Why is the oxide added in excess?

Q4) Why is the solution filtered?

Q5) Why is the solution left overnight in a warm, dry place?

Q6) Name 2 safety precautions you should take during this practical.

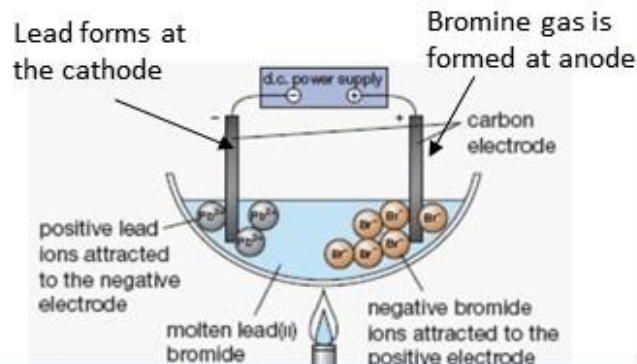
C4 – Chemical Changes

Electrolysis of Molten Ionic Compounds

Molten = melted so ions can move.

- Metal = produced at **anode**
- Non-metal = produced at **cathode**

Example: Lead Bromide - PbBr₂



Using Electrolysis to Extract Metals

- Used if metal is **too reactive** to be extracted by reduction with carbon.
- Requires **large amount of energy** to melt the compound and produce electrical current. (**expensive**)

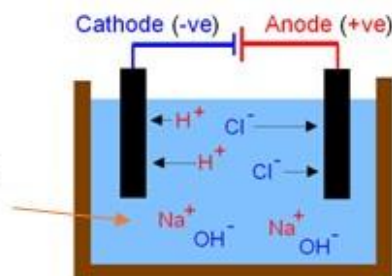
Example: Aluminium Oxide

- **Cryolite** is added – reduces the melting point (less energy needed – less expensive)
- **Carbon** used as positive electrode – needs to be replaced constantly as **oxygen** will react with it to produce CO₂ – it will degrade.

Electrolysis of Aqueous Solutions

- Compound is dissolved in water so ions can move.

When aqueous – H⁺ and OH⁻ (from H₂O) are also present along with the two ions from the compound.



- Only **one** ion is discharged at each electrode.

Anode – Non-metal or oxygen

Cathode – Metal or hydrogen

Rules

+ ANODE Attracts – ions ('Anions')	- CATHODE Attracts + ions ('Cations')
If – ions are group 7 i.e. chloride Cl ⁻ bromide Br ⁻ iodide I ⁻ Then the group 7 element is produced as a gas	If + ions (metals) are MORE REACTIVE than hydrogen K, Na, Ca, Mg, Zn, Fe Then HYDROGEN is produced
If – ions are NOT Group 7 Eg. sulphate SO ₄ ²⁻ nitrate NO ₃ ⁻ carbonate CO ₃ ²⁻ OXYGEN is produced.	If + ions (metals) are LESS REACTIVE than hydrogen Cu, Ag, Au Then the METAL is produced

Examples

Solution	Product at cathode	Product at anode
Potassium chloride	Hydrogen – because K is more reactive than H	Chlorine – as it is a halogen
Copper sulfate	Copper – as copper is less reactive than H	Oxygen – as there is no halogen

Half-Equations at Electrodes (HT only)

During electrolysis:

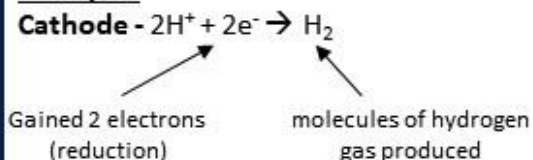
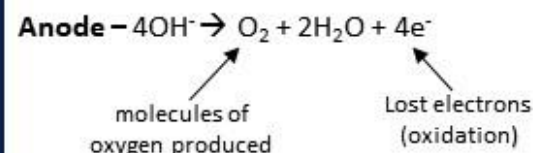
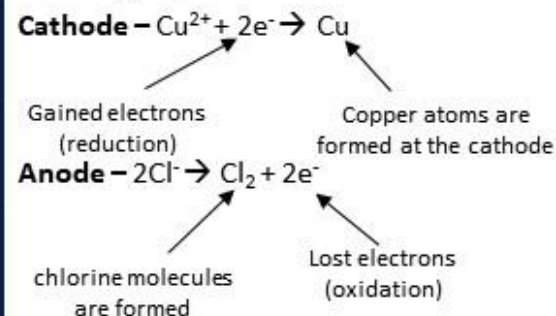
Cathode – positive ions **gain** electrons (**reduction**)

Anode – negative ions **lose** electrons (**oxidation**)

- Ions become **discharged** (lose their charge) at the electrodes to form the atoms again.

- Reactions at electrodes can be represented by half equations.

Examples



C4 – Chemical Changes

1. Why is an ionic compound melted before electrolysis takes place?
2. Metals are produced at the..
3. Non-metals are produced at the..

1. When is electrolysis used to extract a metal?
2. Why is electrolysis expensive?
3. Why is cryolite added to aluminium oxide before electrolysis?
4. Why does the positive anode need constantly replacing when electrolysing aluminium oxide?

1. Why is the compound dissolved in water before electrolysing?
2. What two ions are also present in aqueous solutions (along with the compound)?
3. Which two substances can be produced at the anode?
4. Which two substances can be produced at the cathode?
5. When would a metal be produced at the cathode?
6. When would oxygen be produced at the anode?

1. In terms of electrons, what happens at the positive electrode?
2. In terms of electrons, what happens at the negative electrode?
3. Write the half equation for the production of hydrogen.
4. Write the half equation for the production of oxygen from hydroxide ions.
5. Write the half equation for the production of copper from copper ions.
6. Write the half equation for the production of chlorine from chloride ions.

C4 – Chemical Changes – Required Practical – Electrolysis of Aqueous Solutions

Aim

To investigate the electrolysis of an aqueous solution using inert (unreactive) **electrodes**.

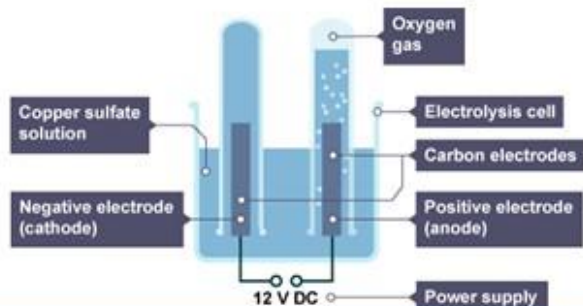
Equipment

- Beaker
- Two test tubes (or measuring cylinders)
- Graphite electrodes
- Two splints
- Aqueous solution
- DC powerpack

Change method depending on the question.

Method (example copper sulfate solution.)

1. Pour some copper sulfate solution into a beaker.
2. Place two graphite rods into the copper sulfate solution. Attach one electrode to the negative terminal of a dc supply, and the other electrode to the positive terminal.
3. Completely fill two small test tubes with copper sulfate solution and position a test tube over each electrode as shown in the diagram. **(use measuring cylinders if measuring volume of gas produced)**
4. Turn on the power supply and observe what happens at each electrode.
5. Test any gas produced with a glowing splint and a burning splint.
6. Record observations and the results of your tests.



Common questions

Q1) How do you test for hydrogen gas?

A1) Lit splint will make a squeaky pop.

Q2) How do you test for oxygen gas?

A2) Glowing splint – will relight.

Q3) Explain why copper is produced at the cathode.

A3) Copper ions are **positive**, so are attracted to the negative electrode (opposites attract). Copper is less reactive than hydrogen so is discharged. The copper ions **gain electrons** and are **reduced** to form **copper atoms**.

Q4) Why do hydrogen ions move to the cathode?

A4) Hydrogen ions are **positive** so move to the negative electrode as **opposites attract**.

Q5) Why are measuring cylinders better to collect the gas?

A5) Because they are more accurate when measuring the volume of gas produced.

C4 – Chemical Changes – Required Practical – Electrolysis of Aqueous Solutions

Q1. Draw a labelled diagram to show the equipment needed to electrolyse copper chloride.

Q2. Write a method for the electrolysis of aqueous copper chloride solution.

Q2) How do you test for hydrogen gas?

Q3) How do you test for oxygen gas?

Q4) Explain why copper is produced at the cathode.

Q5) Why do hydrogen ions move to the cathode?

Q6) Why are measuring cylinders better to collect the gas?

C5 – Energy Changes

Exothermic Reactions

- Energy transferred to the surroundings
- Temperature of the reaction mixture **increases**
- This energy is transferred **to** the surroundings

Examples include:

- Hand warmers
- Combustion reactions
- Respiration
- Neutralisation reactions
- Self-heating cans.



Exothermic

Endothermic Reactions

- Energy absorbed from the surroundings
- Temperature of reaction mixture often **decreases**
- Energy is transferred **from** the surroundings

Examples include:

- Ice packs (injuries)
- Reaction of citric acid and sodium hydrogen carbonate
- Thermal decomposition of calcium carbonate



Endothermic

Energy change of reactions (HT)

During a reaction:

- Energy is **absorbed** in order to **break** bonds in the reactants 
- Energy is **released** when bonds are **made** in the products. 

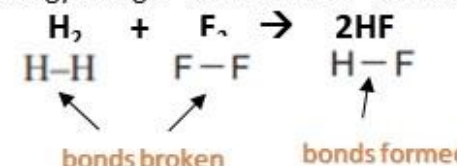
Bond energy = the amount of energy that is released when a bond is made or that is needed to break a bond

Calculating energy changes (HT)

Overall energy change = difference between energy needed to break bonds and the energy released when bonds formed.

To calculate energy change :

Energy change = bonds broken – bonds formed



Bond	Bond Energy / kJ mol ⁻¹
F—F	158
H—H	436
H—F	568

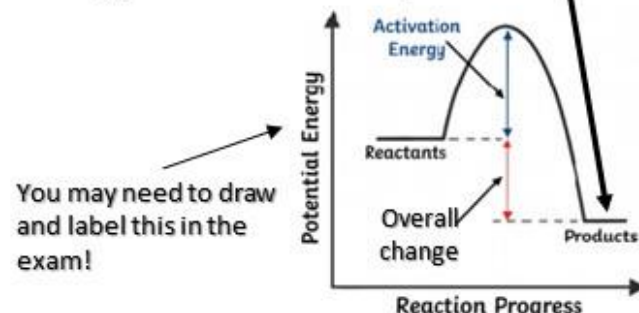
Bonds broken =	Bonds formed
436 + 158	2 x 568
593	1136

Overall energy change = 593 – 1136
= **-543 kJ/mol Exothermic**

More energy is released in bond making than is required for bond breaking.

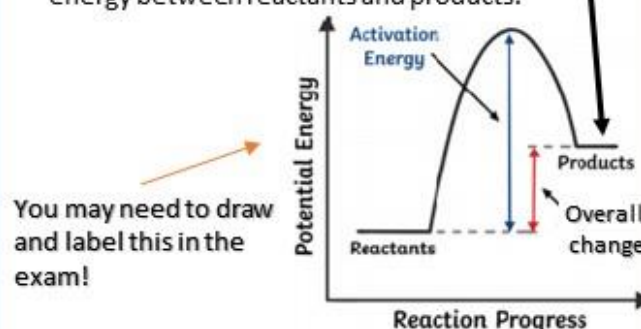
Reaction Profiles – Exothermic

- Energy level diagrams show **difference in energy** between reactants and products.
- Exothermic = Energy of products is **lower than** reactants (energy is released)
- **Activation Energy** = minimum amount of energy needed to start the reaction.
- **Energy change** = the difference in energy between reactants and products.



Reaction Profiles – Endothermic

- Energy level diagrams show **difference in energy** between reactants and products.
- Endothermic = Energy of products is **higher than** reactants (energy is absorbed)
- **Activation Energy** = minimum amount of energy needed to start the reaction
- **Energy change** = the difference in energy between reactants and products.



C5 – Energy Changes

1. Which way is energy transferred in an exothermic reaction?
2. What happens to the temperature of the reaction mixture in an exothermic reaction?
3. State two examples of exothermic reactions.

1. Which way is energy transferred in an endothermic reaction?
2. What generally happens to the temperature of the reaction mixture of an endothermic reaction?
3. State two examples of endothermic reactions.

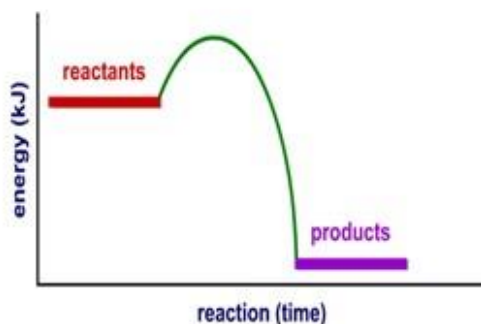
Higher Tier only

1. In terms of energy, what happens for bonds to be broken?
2. In terms of energy, what happens when bonds are formed?

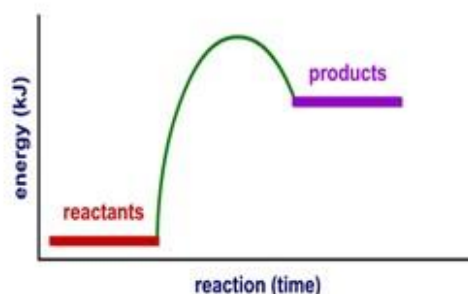
Higher Tier only

1. Define overall energy change.
2. How do you calculate energy change?
3. Why, in terms of bond breaking and making, is a reaction exothermic?
4. Why, in terms of bond making and breaking, is a reaction endothermic?

1. Define activation energy.
2. On the graph below, draw and label the :
 - overall energy change
 - activation energy



1. What does an energy level diagram show?
2. On the graph below, draw and label the :
 - overall energy change
 - activation energy



C5 – Energy Changes – Required Practical – Temperature Changes

Hypothesis

The energy change in the reaction between acid and alkali depends on the volume of alkali added.

Equipment

- Polystyrene cup and lid
- Thermometer
- 250cm³ beaker
- Measuring cylinder
- Liquid reactants



Method (example for hydrochloric acid and sodium hydroxide)

1. Using measuring cylinder to measure 30cm³ hydrochloric acid and put in polystyrene cup
2. Stand cup inside beaker to make stable.
3. Use a thermometer to measure the temperature of acid and record.
4. Using measuring cylinder – 5cm³ sodium hydroxide → polystyrene cup
5. Fit the lid and gently stir with thermometer through hole.
6. When reading stops on thermometer, record temperature in table.
7. Repeat, each time adding 5cm³ more sodium hydroxide up to a maximum of 40cm³.
8. Calculate the temperature change on each attempt.
9. Repeat the experiment 3 times and calculate a mean temperature change for each volume of sodium hydroxide.

Variables

Independent – Volume of sodium hydroxide

Dependent – Temperature change

Control – Volume of hydrochloric acid, concentration of acid, concentration of sodium hydroxide

Common questions

Q1) Why do you use a polystyrene cup and lid?

A1) Because polystyrene cups are insulators, which reduces heat loss in the experiment, making the results more accurate.

Q2) Why should you calculate the temperature change, instead of just using the final temperature?

A2) Because the initial (starting) temperature of the acid may have been different.

Q3) Why is it important to stir the mixture?

A3) To make sure all of the reactants have reacted and to get a uniform temperature.

Q4) Why is the experiment conducted 3 times?

A4) So that anomalies can be seen and removed and a mean calculated

Energy changes could also be investigated using:

1. Changing the **mass of metal** added to acid and measuring the **temperature increase**
2. Changing the **type of metal** added to acid and measuring the **temperature increase**
3. Dissolving different **masses of potassium nitrate** into water and observing the **temperature decrease**.

C5 – Energy Changes**Required Practical – Temperature Changes**

1. Write a method to investigate how the volume of sodium hydroxide affects the change in temperature when reacting with hydrochloric acid (6 marks)

2. For the investigation above, name the :
Independent variable :
Dependent variable :
2 control variables :

3. Why do you use a polystyrene cup and lid instead of a beaker?

4. Why should you calculate the temperature change, instead of just using the final temperature?

5. Why is it important to stir the mixture?

6. Why do we do repeat readings?

Energy Stores

There are 8 energy stores:

Store	Stored in...
Kinetic	moving objects
Gravitational potential	objects raised above ground
Elastic potential	Stretched or compressed objects
Thermal	All objects due to particle movement
Chemical	Substances (foods, fuels) that can release energy in a chemical reaction
Nuclear	The nucleus of atoms
Magnetic	Magnets attracting or repelling
Electrostatic	Separation of charges

Conservation of energy law:

Energy is **NEVER** created or destroyed

Energy is transferred by different pathways – by heating or when work is done

When energy is transferred, some is often transferred to the environment – this is wasted or dissipated energy

Efficiency

Tells us how much of the energy is transferred usefully.

$$\text{Efficiency} = \frac{\text{Useful output energy transferred by the device}}{\text{Total input energy supplied to the device}}$$

$$\text{Efficiency} = \frac{\text{Useful power out}}{\text{Total power in}}$$

Wasted energy always ends up in the **thermal store** of the surroundings

P1 Energy

Calculating energy stores

The energy stored in a raised object can be calculated using:

$$\text{GPE} = \text{mass} \times \text{height} \times \text{gravitational field strength}$$

$$\text{GPE} = mgh$$

The energy stored in a moving object can be calculated using:

$$\text{KE} = \frac{1}{2} \text{mass} \times \text{velocity}^2$$

$$\text{KE} = \frac{1}{2} m v^2$$

Energy stored in a stretched or compressed object can be calculated using:

$$E = \frac{1}{2} \text{spring constant} \times \text{extension}^2$$

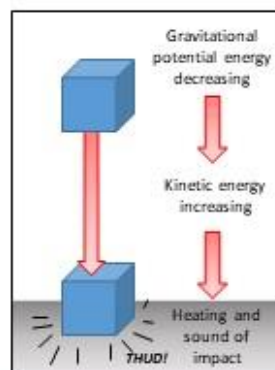
$$E = \frac{1}{2} k e^2$$

Transfers of energy:

E.g. An object above ground has GPE.

If that object falls:

1. Decreases its GPE store
2. Increases its KE store as it falls
3. Waste energy transferred to the environment by heating and sound



Specific heat capacity

The amount of energy needed to change the temperature of 1Kg of a substance by 1°C

It is calculated by:

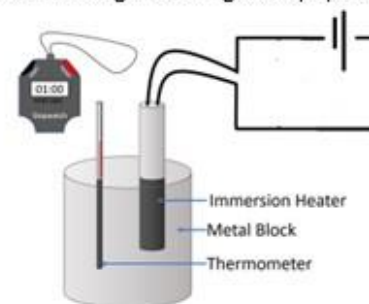
$$E = \text{specific heat capacity} \times \text{mass} \times \text{temp change}$$

$$E = \text{SHC} \times m \times \theta$$

Units for SHC are J/Kg/°C

Different materials have different specific heat capacity values.

This can be investigated using the equipment below:



- Energy is supplied to the block by the immersion heater over a fixed time period (e.g 5 mins)
- The thermometer measures the temperature of the block at the start and the end of the experiment
- The stopwatch measures the time
- If the power of the heater is known (e.g 50W) the energy transferred to the block can be found using the equation:

$$\text{Energy (J)} = \text{Power (W)} \times \text{time (s)}$$

The specific heat capacity of different materials can be investigated by:

- changing the metal (**independent variable**)
- measuring the temperature increase (**dependent variable**)
- Keeping the energy supplied, mass and insulation the same (**control variables**)

Insulating the block reduces energy transferred to the thermal store of the environment, improving accuracy

Energy Stores

Complete the table:

Store	Stored in...
kinetic	
	objects raised above ground
Elastic potential	
	All objects due to particle movement
Chemical	
	The nucleus of atoms
Magnetic	
	Separation of charges

1. What is the conservation of energy law?
2. In what two general ways is energy transferred?
3. What is wasted energy?

Efficiency

1. What is the equation to calculate efficiency?
2. Where does wasted energy end up?

1. What is the equation linking gravitational field strength, GPE, height and mass?

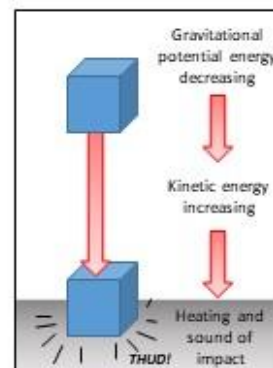
2. What is the equation linking kinetic energy, mass and velocity?

3. What quantity is found in both equations?

4. What happens to the GPE store when a raised object falls?

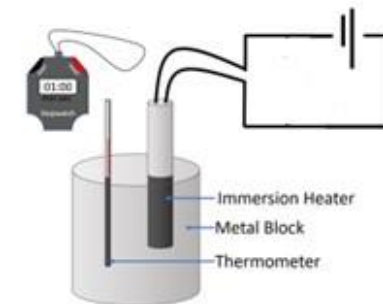
5. What happens to the KE store of a raised object when it begins to fall?

6. By which two pathways is energy transferred to the environment when an object falls?



1. What is the specific heat capacity of a substance?

2. In the hypothesis 'different metals have different specific heat capacity values' what is the independent variable?



3. What does the immersion heater do?

4. What two readings are taken using the thermometer?

5. What is a sensible time period to use for transferring energy to the block?

6. What should be put round the block?

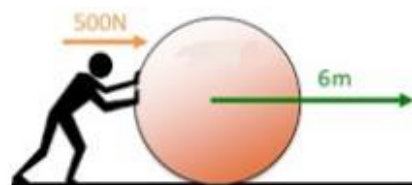
Power and work done

Work done = energy transferred

Energy transferred mechanically is calculated:

Work done = force x distance

$$W (J) = F (N) \times s (m)$$



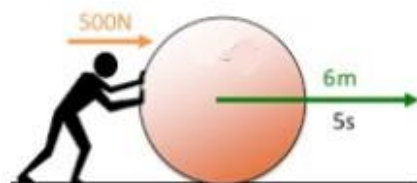
$$\begin{aligned} \text{Work done} &= 500N \times 6m \\ &= 3000 J \end{aligned}$$

Power = energy transferred per second

1 Watt = 1 Joule per second

Power = energy transferred ÷ time

$$P (W) = e (J) \div t (s)$$



$$\begin{aligned} \text{Power} &= \text{Energy} \div \text{time} \\ &= 3000 J \div 5 s \\ &= 600W \end{aligned}$$

A more powerful appliance transfers more energy per second, eg:



Reducing unwanted energy transfers

Reducing wasted energy means lower costs

Materials that conduct heat well have a high **thermal conductivity**.



Reducing energy transfers in homes

- Double glazing
- Thick walls
- Walls made of materials with low thermal conductivity
- Insulation – wall and loft

Reducing energy transfers in appliances:

- Lubrication – reduces friction
- Streamlining – reduces air resistance



Energy resources

We use energy resources for electricity generation, transport and heating

Non-renewable – ones that are being used faster than they can be replaced and will run out.

Example	+	-
Coal, oil, natural gas	Reliable method of generating electricity	Release CO ₂ which contributes to global warming
nuclear	No CO ₂ released	Produces radioactive nuclear waste

Renewable resources:

Ones that will not run out, they are being replenished as they are used

Example	+	-
Solar	No CO ₂ released	Don't work at night or well on cloudy days
wind	No CO ₂ released	Doesn't work if it isn't windy
Hydro	No CO ₂ released	Damage to habitats
Geothermal	No CO ₂ released	Only found in specific places
waves	No CO ₂ released	Damage to habitats
Biofuel	Carbon neutral	Uses crop land to grow new forests

1. What are the units for work done?
2. What are the units for force?
3. What is the equation to calculate work done during mechanical work?
4. What is the equation to calculate power?
5. What is the unit for power?
6. What is the unit for time in the power equation?
7. What is 1 Watt equivalent to?
8. How would you recognise a more powerful lightbulb?
9. What is meant by a more powerful appliance?

1. Why is reducing unwanted energy transfers from the home important?
2. What is meant by 'high thermal conductivity'?



3. Where is most of the heat lost through in a house?
4. Give two ways to reduce the heat lost through the walls of a house.

5. What does lubrication reduce?



6. What does streamlining reduce?



1. Give the three main uses for energy resources
2. What is a non-renewable energy resource?
3. Give 2 examples of non-renewable energy resources
4. Give two disadvantages of using coal and oil
5. Give one advantage to using nuclear resources to generate electricity.
6. What is a renewable energy resource?
7. Give 4 examples of renewable resources
8. Give 2 advantages of using renewable resources to generate electricity
9. Give two disadvantages of using renewable resources to generate electricity

P2 – Electricity

Current, resistance and potential difference

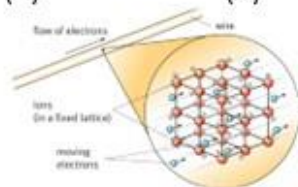
Electrical current is the flow of electrical charge.

Current is measured in amps (A), charge is measured in Coulombs (C).

The size of the current depends on the rate of the flow of charge – ie how many coulombs of charge per second.

$$Q = I t$$

Charge = Current x time
(C) (A)



Ohms Law

The current through a component depends on the potential difference and the resistance of the component.

If a component has high resistance, the current will be smaller for a given potential difference

potential difference = current x resistance

$$V = I R$$

pd is measured in volts (V), resistance in Ohms (Ω)



Hypothesis 'the length of the wire affects resistance'

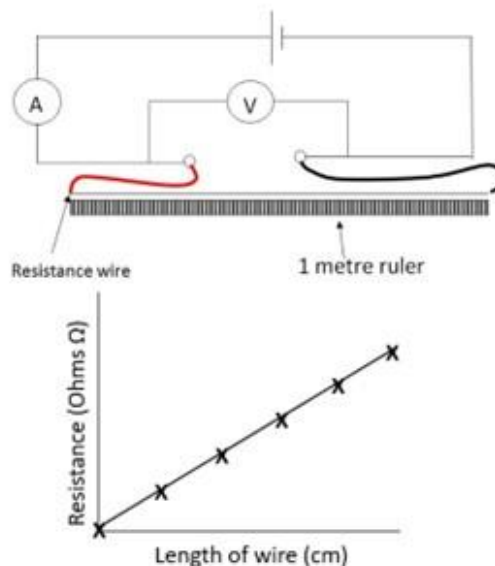
Independent variable – length of wire

Dependent variable – resistance

Control variables – type of wire, temperature of the wire, diameter of the wire

1. Set up the circuit as shown, with an ammeter in the circuit and a voltmeter connected across the wire
2. Use crocodile clips to change the length of the wire in the circuit
3. Make the wire 10cm long and read the current and pd. Switch off the current between readings or the wire will get hot, increasing the resistance.
4. Repeat for 20, 30, 40, 50 cm. (5 minimum)
5. Calculate resistance using Ohms Law $R = V/I$

Plot length of wire (IV) against resistance (DV)

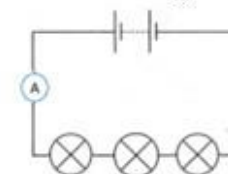


The relationship is directly proportional

Series and parallel circuits

Series circuits:

A series circuit is one single loop

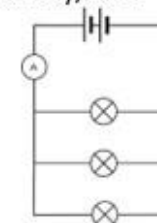


In a series circuit:

- the current is the same at all points in the circuit.
- potential difference is shared between components (equally if components are identical resistance)
- total resistance = sum of all resistors

Parallel circuits

A parallel circuit consists of more than one loop from the battery/cell.



In a parallel circuit:

- The current is shared amongst the branches
- The potential difference is the same across all components
- Resistance in the whole circuit is LESS than that of the smallest resistor

P2 – Electricity

Current, resistance and potential difference

1. What is current?
2. What is the unit for charge?
3. What is the unit for current?
4. What is the equation linking charge, current and time?
5. What is the equation linking current, potential difference and voltage?
6. If a component's resistance increases, what happens to current through that component?
7. What is the unit for resistance?

Hypothesis 'the length of the wire affects resistance'

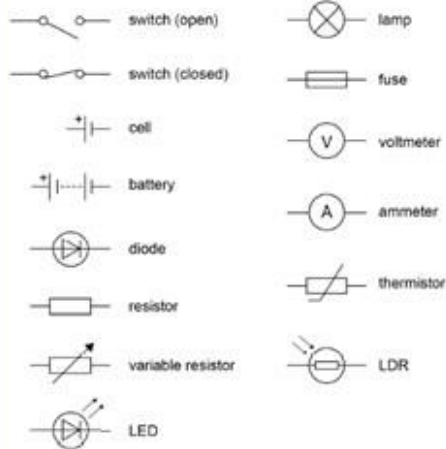
1. What is the independent variable in this investigation?
2. What is the dependent variable?
3. What is the minimum number of readings needed for a line graph?
4. What two readings are taken?
5. How is resistance calculated?
6. What sort of relationship is seen?
7. Why is it important to turn off the power in between readings?

Series and parallel circuits

1. What is a series circuit?
2. In a series circuit, the current is.....
3. How do you find total resistance in a series circuit?
4. The potential difference is shared equally among components as long as.....
5. What is a parallel circuit?
6. What is true about potential difference across all of the components in a parallel circuit?
7. How is total current calculated in parallel?
8. What is true for total resistance in a parallel circuit?

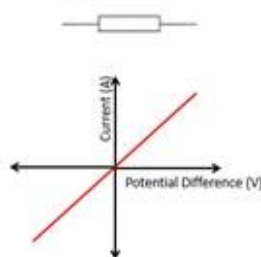
P2 – Electricity

Components

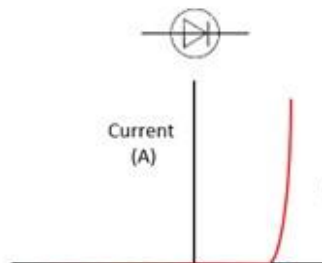


- A **diode** only allows current to flow one way in a circuit
- A **resistor** is a component that provides a fixed resistance in the circuit – e.g a $5\ \Omega$ resistor
- A **variable resistor** is a component whose resistance can be changed (e.g a dimmer switch)
- A **thermistor** is a resistor whose resistance changes with temperature – the higher the temperature the lower the resistance
- An **LDR** (light dependent resistor) has resistance that changes
- An LED (light emitting diode) is a light that only allows the flow of current one way

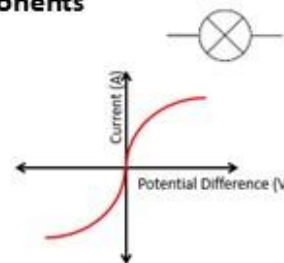
Current, potential difference and resistance for different components



A fixed (ohmic) resistor has fixed resistance
current is directly proportional to potential difference
Resistance remains constant (at constant temp)

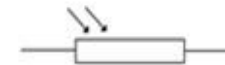


A diode very high resistance in one direction.
Only when the potential difference is positive does current flow



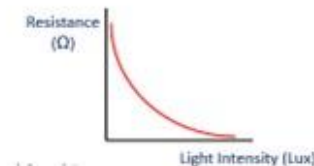
A filament bulb contains a thin wire that glows as current flows.
As the pd increases, the current initially increases.
However, at higher pd, the wire gets hot
The ions in the wire move faster and collide with the moving charges
Resistance increases, so current stops increasing

LDR

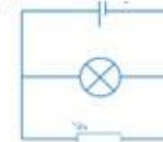


A light dependent resistor has varying resistance.

As the light intensity increases, the resistance decreases



LDRs can be used to switch on lights at night time.



In this circuit, when it is day time, the resistance in the LDR is low, so all current flows through the LDR.

As light levels fall, resistance increases, until eventually there is less resistance in the bulb than the LDR, so current flows through the bulb – switching it on.

Thermistor



As the temperature increases, the resistance in a thermistor decreases.

P2 – Electricity

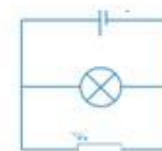
Components

Symbol	Name
	Cell
	
	fuse
	
	Voltmeter

1. Complete the table opposite
2. Which component has a resistance that decreases as light intensity increases?
3. Which component only allows current to flow one way?
4. What is a fixed resistor?

LDR

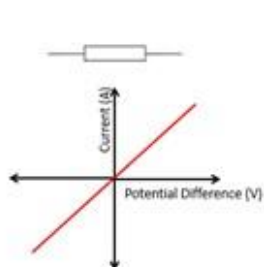
1. Draw the symbol for an LDR
2. Draw the pattern you would expect for resistance as the light intensity increases.
3. The circuit below is for a night light. What is resistance in the LDR like during the day time? (high light levels)



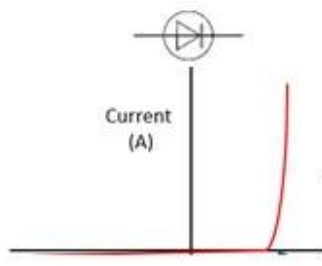
4. Why does the light switch on when it goes dark?
5. Draw the symbol for a thermistor
6. Describe the relationship between temperature and resistance in a thermistor

Current, potential difference and resistance for different components

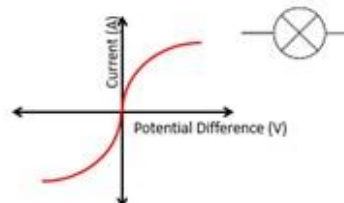
1. What readings would you need to take from a circuit to calculate resistance?



2. Describe the relationship shown



3. Why is there no current on one side of the graph?



4. What happens to current when the pd rises at first?
5. What happens to the current as the pd gets higher?
6. Why does the resistance increase at higher pd?

P2 – Electricity

Domestic use of electricity

There are two types of electrical supply – direct (DC) and alternating current (AC)

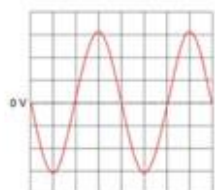
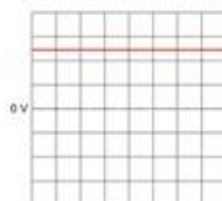
AC

The pd changes direction and magnitude, giving alternating current

The number of times the change of direction happens per second is the frequency.

UK mains is AC - **230V**

Frequency of **50 Hz**



DC

A direct pd produces current that flows in one direction

Batteries supply DC



Electrical appliances are connected using 3 core cable

- Brown – live wire, with pd of 230V
- Blue – neutral, 0V, completes the circuit
- Yellow and green – Earth wire, is at 0V unless there is a fault, when it will become live

Appliances in the home and power

Power is measured in Watts (W) or kW
Power can be calculated by using:

Power = Voltage x current

$$P = IV$$

Power = current² x resistance

$$P = I^2 R$$

Appliances transfer energy.

Energy is measured in Joules (J) or kJ

The energy transferred can be calculated by using:

Energy = charge flow x potential difference
 $E = QV$

Energy = power x time

$$E = p t$$

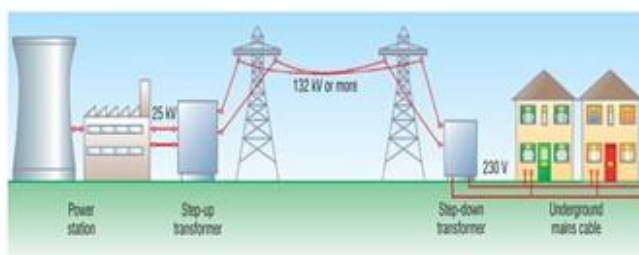
For example

A kettle transfers energy from the thermal store of the filament in the kettle to the thermal store of the water inside.

Some energy is transferred to the thermal store of the surroundings.

The National Grid

The National Grid is a system of cables and transformers connecting power stations to homes and businesses



The National Grid uses very high pd and low current.

High current causes heating in the wires and would result in large energy losses.

Step up transformers increase the pd from the power station (to around 400000V) so that low current can be used to transmit power.

This means the wires don't get hot, so less energy is lost.

Near homes and businesses, step down transformers reduce the pd to 230V for safety.

P2 – Electricity

Domestic use of electricity

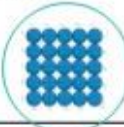
1. What are the two types of current?
2. What type of power supply produces DC current?
3. What are the two differences between AC and DC current?
4. What is the pd of the UK mains supply?
5. What is the frequency of UK mains supply?
6. What colour is the live wire in UK plugs?
7. What is the purpose of the blue wire in UK plugs?
8. When does the yellow and green wire carry a current?

The National Grid

1. What is the National Grid?
2. What sort of pd does the National Grid use to transmit electrical power?
3. What is used to increase the pd from the power station?
4. What is used to reduce the pd near homes and businesses?
5. Why is such a high pd used?

Appliances in the home and power

1. What is the equation linking current, potential difference and power?
2. What is the equation linking current, resistance and power?
3. What two factors affect how much energy an appliance transfers?
4. What is the equation linking energy, power and time?
5. What are the units for power?
6. What is the equation linking charge, energy and potential difference?
7. What are the units for energy?

State	Pattern	Energy and movement	Forces between particles
Solid 	Ordered and all touching	Vibrate around fixed positions	Strong forces between particles
Liquid 	Random and touching	Move around randomly	Weaker than in a solid
Gas 	Random and far apart	Move around randomly	Weak forces of attraction

Particle model of matter

Models	+	-
Particle diagrams	Easy to see/draw arrangement	<ul style="list-style-type: none"> Can't see the forces between particles Particles look like flat circles rather than 3D spheres Movement isn't shown
Kinetic models (eg marbles or animations)	Easy to see particle arrangement Can see the movement of particles	Can't see forces between particles

Density

Density is mass per cm^3

It can be calculated using:

$$\text{Density} = \text{mass} \div \text{volume}$$

$$\rho = m \div V$$

Required practical – measuring the density of different materials.

For regular solids :

Mass measured by **top pan balance**

Volume measured by measuring **length x breadth x height**

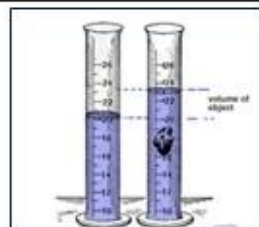
For irregular solids:

Mass measured by **top pan balance**

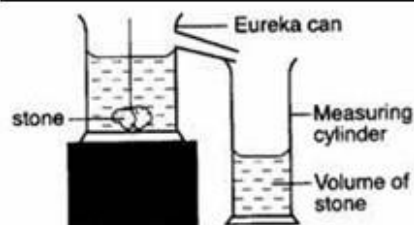
Volume measured by **displacement of water**

This means putting the object into water and measuring the volume of water 'pushed out'

Measure the volume of small objects by putting them into a measuring cylinder with 100cm^3 water in



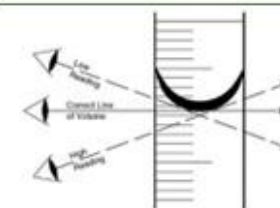
Measure the volume of larger objects by putting them into a full eureka can and catching and measuring the water that is displaced



Zero error



Read the meniscus!



Required practical continued : Density of liquids

- Find the mass of an empty measuring cylinder using a top pan balance.
- Pour a known volume (100ml) of liquid into the measuring cylinder.
- Use the meniscus to measure the volume of the liquid accurately. This is the volume.
- Now measure the mass of the measuring cylinder + the liquid combined.
- Subtract the mass of the empty measuring cylinder and this is the mass of the liquid.

$$\text{Density} = \text{mass} \div \text{volume.}$$

Particle model

1. Describe the arrangement of the particles in a solid, a liquid and a gas
2. Describe the movement of the particles in a solid, a liquid and a gas
3. In which state of matter are the forces between the particles the weakest?
4. In which state of matter are the forces between the particles the strongest?
5. Give one advantage of using particle diagrams to show the different states of matter
6. Give three disadvantages of using particle diagrams to show the different states of matter
7. Give two advantages of using kinetic models to show the different states of matter
8. Give one disadvantages of using kinetic models to show the different states of matter

Density

1. Give the formula that links density, mass and volume?
2. Give a unit for density
3. Which piece of equipment is used to measure mass of an object?
4. What type of error is it if a balance reads 0.03g when nothing is resting on it?
5. What term is used to describe when water is pushed out of the way by a solid object?
6. Name two pieces of equipment that could be used to measure the volume of an irregular object
7. What three measurements do you need to calculate the volume of a regular object?

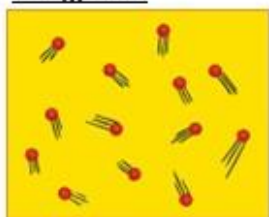
Internal energy

The temperature of any substance is related to the average speed of its particles.

The internal energy of a system is the total kinetic energy and the potential energy of the particles

The particles in a system vibrate or move around because they have energy in their kinetic energy stores

The faster a particle moves, the greater its kinetic energy store



Low Temperature



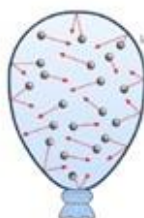
High Temperature

The particles also have energy in their potential energy stores due to their position.

As particles move further apart, their potential energy stores increase

Gas pressure

The particles in a gas are in constant random motion
They collide with the walls of their container
This exerts a force on the container.



The more energy the particles have, the higher the temperature.

An increase in temperature of a gas causes the particles to move further apart.

If this is not possible, because of the container, then there is an increase in pressure.

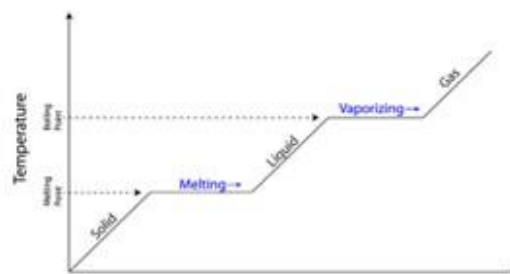
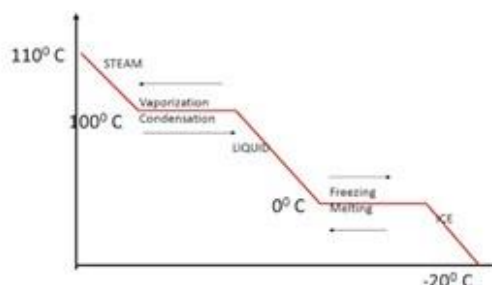
Heating and cooling

When the internal energy of a substance changes, then either :

- The temperature of the substance changes
- The state of the substance changes

This can be seen by plotting the temperature change during heating or cooling.

Heating a solid would give us a graph that looks like this:



- The temperature stays the same.
- This is when a change of state is happening – for example melting.
- The energy transferred is not increasing the mean particle speed – it is increasing the potential energy of the particles.

When the line is increasing (heating) or decreasing (cooling)

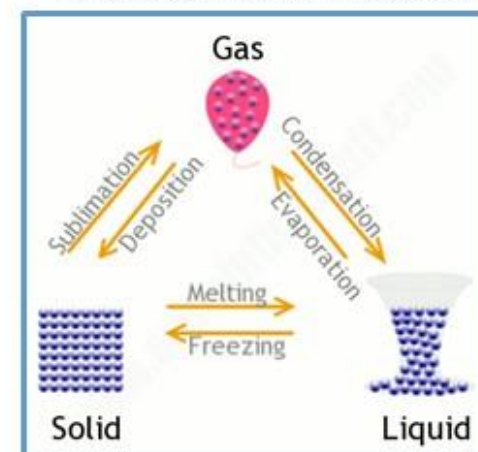
- The temperature is increasing / decreasing
- The kinetic energy store is increasing / decreasing
- Average particle speed is increasing / decreasing

Specific latent heat

Specific latent heat is the amount of energy needed to change 1kg of a substance from one state to another without changing the temperature.

Specific latent heat will be different for different materials.

- Energy needed to change 1kg of Solid → liquid - specific latent heat of fusion
- Energy needed to change 1kg of Liquid → gas - specific latent heat of vaporisation



The amount of energy needed to change 1Kg of a material is found by the equation:

$$\text{Energy} = \text{mass (kg)} \times \text{specific latent heat (L)}$$

latent heat (L)

$$E = m \times L$$

Specific heat capacity

This is the amount of energy needed to change the temperature of 1Kg of a substance by 1°C
It is calculated by:

$$E = \text{specific heat capacity} \times \text{mass} \times \text{temp change}$$

$$E = \text{SHC} \times m \times \theta$$

Internal energy

1. What two stores of energy make up internal energy?
2. Which energy store is linked with particle movement?
3. Which energy store increases if the particles in a substance move further apart?
4. What happens to the temperature when the kinetic store of the particles increases?

Gas pressure

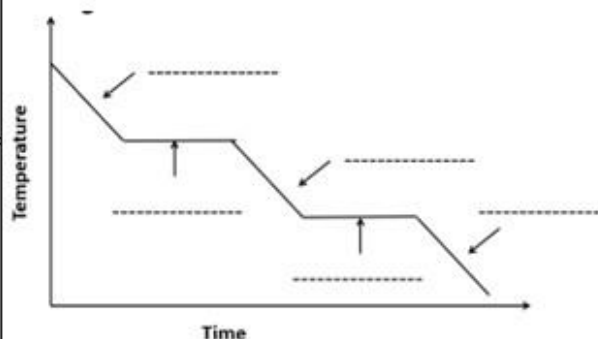
1. What causes gas pressure?
2. What happens to the temperature of a gas if the kinetic energy store of the particles increases?
3. What happens to the space between particles in a gas as it heats up?
4. If the volume of the gas is kept constant, what happens to the pressure?

Heating and cooling

1. What two things can happen to a substance when the internal energy changes?

2. Label the graph below using the words given:

liquid, gas, solid, condensing, freezing

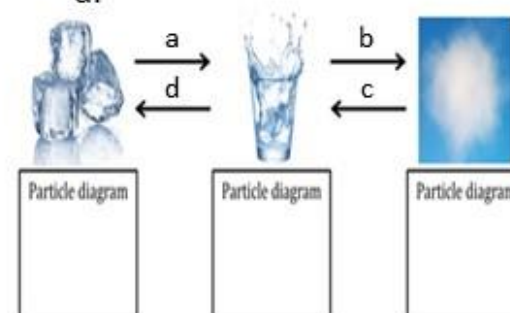


3. What is happening to temperature when the line is flat on a heating or cooling curve?
4. What is happening to the substance when the line is flat?

Specific latent heat

1. What is specific latent heat?
2. What is the term given to the amount of energy needed to change 1kg of a liquid into a solid?
3. What is the specific latent heat of vaporisation?

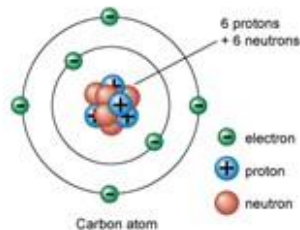
4. Label the changes of state below
 - a.
 - b.
 - c.
 - d.



5. Draw the particle diagrams in the boxes

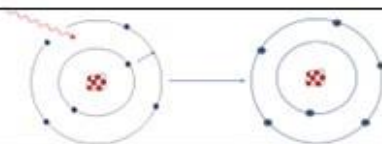
P4 – Atomic Structure

Atoms

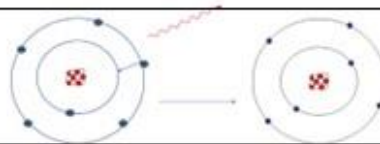


- Atoms are tiny – around 10^{-10}m
- There is a positive nucleus made of protons and neutrons
- Electrons orbit in shells or energy levels
- The nucleus is 10,000 x smaller than the atom (4 orders of magnitude) so around 10^{-14}m

Electrons can move further away or closer to the nucleus



If EM waves (eg UV /light) are **absorbed** electrons can move up energy levels



If EM waves are **emitted** by the atom, then electrons move closer to the nucleus

How the atomic model developed:

The atomic model has developed over time, when new evidence was discovered.



Atoms were first thought to be tiny spheres that could not be divided



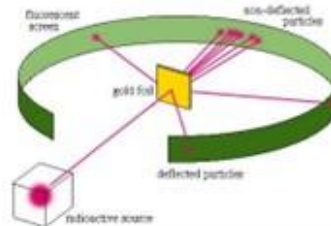
JJ Thomson then discovered the electron
Led to the plum pudding model
Atoms a cloud of positive charge with electrons randomly scattered



Rutherford discovered the positive charge is very small and in the nucleus
This discovery was from the Gold leaf experiment



Chadwick discovered neutrons
Bohr discovered the electrons orbit in shells



Rutherford's experiment:

Alpha particles fired at gold leaf
Most went straight through
Some deflected to the side
Some came straight back
This told him that most of the atom was empty space and that the positive charge was in a tiny nucleus

- Atoms of the same element have the same number of protons.
- This is the atomic (proton number)
- In an atom, the number of electrons is equal to the number of protons.
- The total number of protons and neutrons is called the mass number

(Mass number) 23
(Atomic number) 11 **Na**

Sodium has :

11 protons
11 electrons
12 neutrons (23-11)

Isotopes

Isotopes are atoms with same number of **protons**, but different numbers of **neutrons** (different mass number)

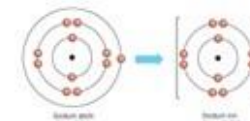
E.g.



These two isotopes both have 8 protons
One has 8 neutrons (16-8)
One has 10 neutrons (18 - 8)

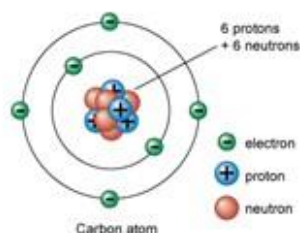
Ions

If atoms lose one or more outer electrons, they turn into positive ions

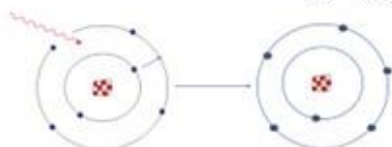
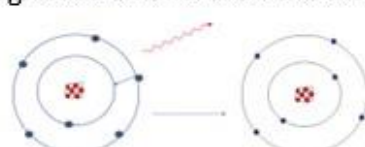


P4 – Atomic Structure

Atoms



1. What is the size of an atom?
2. What is in the nucleus?
3. What is the size of the nucleus?
4. How many orders of magnitude smaller than the atom is nucleus?



4. What can cause electrons to move further from the nucleus?

5. What can cause electrons to move closer to the nucleus?

1. What do all atoms of the same element have in common?
2. What does the bottom number on the elements in the periodic table represent?
3. What does the mass number show?
4. What is the number of electrons in an atom equal to?

1. What causes scientific ideas to change and develop?

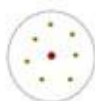


2. What was the thinking about atoms initially?



3. Which particle was discovered by JJ Thomson?

4. Where is the positive charge in this model?

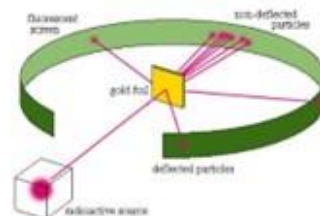


5. Where is the positive charge in this model?



6. Who discovered neutrons?

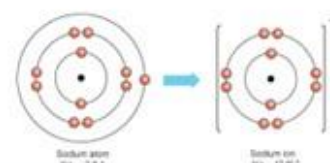
7. What was the discovery that Bohr made?



Rutherford's experiment:

1. What did Rutherford fire at gold leaf?
2. What happened to most of them?
3. What two conclusions did he come to?

5. What is an isotope?
6. What is an ion?
7. What type of ions are formed when atoms lose electrons?



P4 – Atomic Structure

Nuclear radiation

If an isotope is **unstable**, then **particles** and **energy** are emitted from the nucleus.

There are 3 main types :

Radiation	What is it?	How far does it travel?	Ionising power	Penetrating power
Alpha α	2 protons and 2 neutrons	A few cm	Strong	Stopped by paper
Beta β	A fast moving electron	Metres	Medium	Stopped by aluminium
Gamma γ	An electromagnetic wave	kilometres	Weak	Takes thick concrete or lead to stop it

Neutrons can also be emitted from the nucleus.

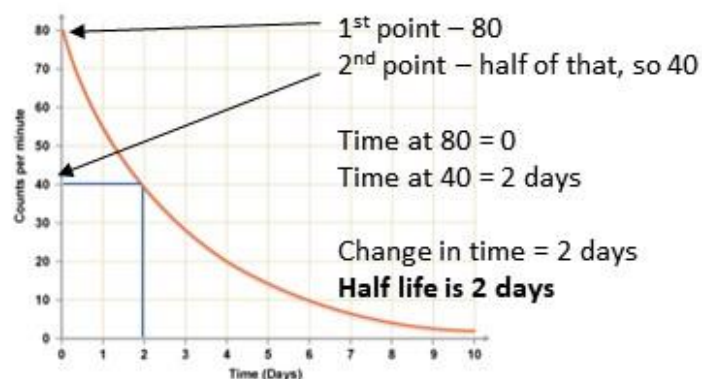
Half life

Radioactive decay is random.

The half life of an isotope is the time it takes for half of the atoms in the sample to decay OR for the count rate to fall by half

Half life is calculated from a graph by reading two points off the y axis – one value being half the other.

Read the corresponding change in time.



Isotopes are selected for use depending on their properties and half life – e.g. a medical tracer needs to have a short half life so it isn't in the body for very long

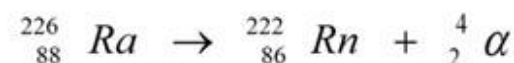
Alpha decay:

An unstable nucleus gives out 2 protons and 2 neutrons

An alpha particle is written as: ${}^4_2\alpha$

So when a particle gives out alpha radiation, it loses 2 from the proton number and 4 from the mass number

E.g



Beta decay:

In an unstable nucleus, a neutron changes into a proton and an electron.

The electron is fired out as the beta particle

Beta particles are written as ${}^0_{-1}\beta$ or ${}^0_{-1}e$

The proton number increases

The mass number stays the same



The emission of a gamma ray **does not change the nucleus**

Irradiation is the exposure to alpha, beta or gamma radiation

Contamination is the presence of radioactive atoms on materials.

P4 – Atomic Structure

Nuclear radiation

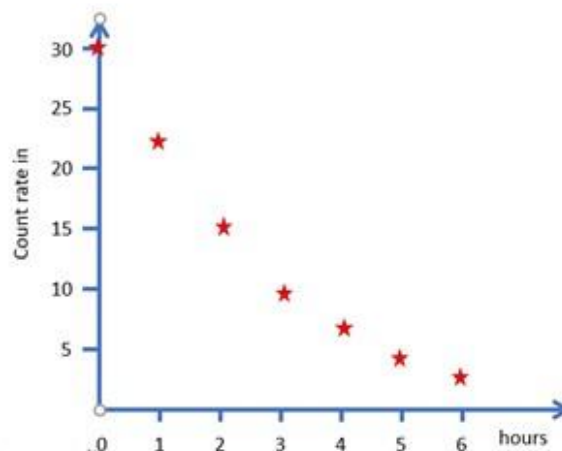
1. Why do atoms give out particles or energy from the nucleus?
2. Which radiation is the most strongly ionising?
3. What is an alpha particle made of?
4. Which radiation is the most difficult to stop?
5. Which radiation is a fast moving electron?
6. Which radiation can only travel a few cm?

Alpha decay:

1. How is an alpha particle written?
2. What happens to the proton number of an atom when alpha decay happens?
3. What happens to the mass number when alpha decay happens?
4. What happens in the nucleus during beta decay?
5. How is a beta particle written?

Half life

1. What is half life?
2. What is the unit missing from the Y axis on the graph opposite?
3. Draw a line of best fit onto the graph
4. What sort of half life would you want in an isotope being used as a medical tracer?



6. What happens to the proton number during beta decay?
7. What happens to the mass number during beta decay?
8. What is irradiation?
9. What is contamination?