Science Knowledge Organisers

Year 11 PC3 (February Exams)

Biology Paper 2

Chemistry Paper 1

Physics Paper 2

Kettering science Academy

What is a 'knowledge organiser'?

A knowledge organiser is simply a collection of the all of the information which your teacher would like you to be able to **recall** from a particular topic. That means that it **does not have everything on it** for a unit of study but it does have **the most essential things to learn.**

A knowledge organiser has lots of facts and definitions on it. Did you know that there is as many new words in studying science as there is in studying a language?

A knowledge organiser does **not develop skills**, so good revision will involve **lots of practice questions** as well as learning the content of these organisers.

What do I do with it?

For most of us, the first thing that we learned at school in reception was our phonics sounds. We learned them by repetition – seeing them again and again until the association between the sound and the image stuck. We need to do the same thing with these knowledge organisers!

Your teacher will probably be using knowledge organisers as you are taught. They will be referred to in class and you should have regular small tests on what you have learned.

Our knowledge organisers are deliberately broken into small lesson sized chunks for you to learn. Typically a teacher may ask you to 'learn box 2 and 3' for a homework.

By the time you come to an assessment – an exam or test – you should already be familiar with the knowledge organisers and already know some of it. They can then be relearned as a part of the revision and assessment preparation procedure.

Retrieval Practice

A key part of learning anything is the act of trying to remember. In class, your teacher will be helping you to do this by asking lots of questions and setting quizzes. **The more often you try to remember something the more likely you are to remember it**. With knowledge organisers you can achieve the same thing at home.

Why are we doing this?

Research has shown that **the more you know** the **more you can learn.** By being able to recall the facts, you are able to understand more complicated ideas because you **already know what the key words mean.** You will also already have a set of ideas in your mind that the new ideas can connect to (this is often referred to as a **schema**).

What are the best techniques for memorising using a knowledge organiser?

READ COVER WRITE

Make sure you are working somewhere quiet and that you have something to write with and some paper. Focus on learning on part of the knowledge organiser only, for example box one. Read through it carefully several times. When you think you've got it, cover over the knowledge organiser and write it all down. Then check what you've been able to remember. Read the bits that you could not recall, cover and write again.

TEST ME

Once you have learned the sections, its time to see if you can remember larger amounts.

Ask a friend or family member to test you on the content of the knowledge organiser page. They don't need to be experts – only to say whether you have remembered it correctly.

TEST EACH OTHER

If you are revising with class mates, testing each other is great. By doing this you are thinking about what you need to know when you are answering questions but also when you are checking to see if your class mate is right. This works well on video calls!

MAKING FLASH CARDS

Some students find making flash cards really helps. You are thinking about what needs to be learned as you write! But don't fall into the trap of writing them and never using them! Once written they should be used regularly – you can test yourself with them or test each other!

Spaced Learning

All of the techniques work best when they are done **little and often**. Aim to repeat something you have learned a week – studies have shown that once you learn something, if you see it again after a week recall is better long term. Then again after a month… and so on.

Application

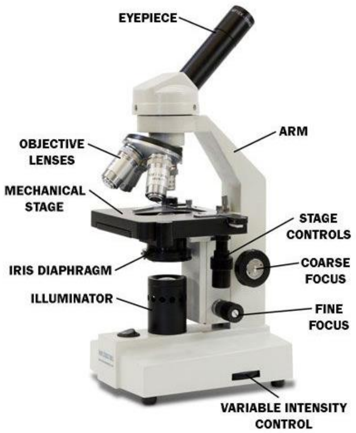
Once you have memorised some of the information, or have made a good start, it's a good idea to start trying to **use that knowledge**. Websites like **Seneca** and **Educake** provide great banks of questions for this.

B1: Biology key concepts

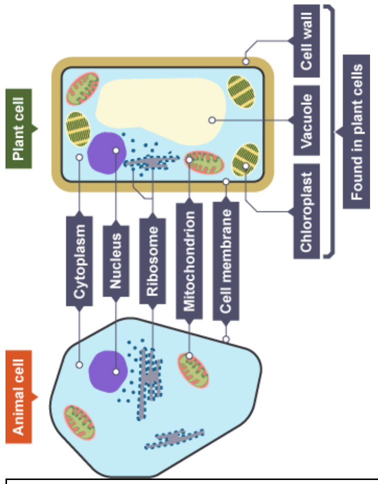
Lesson sequence

1. Microscopes
2. Plant and animal cells
3. Measuring cells
4. Core practical: using microscopes
5. Specialised cells
6. Bacterial cells
7. Digestive enzymes
8. How enzymes work
9. Factors affecting enzymes
10. Core practical: enzymes and pH
11. Cell transport
12. Core practical: osmosis in potatoes

1. Microscopes	
***Magnification**	The number of times bigger something appears under a microscope.
***Eyepiece lens**	The lens on a microscope that you look through.
***Objective lens**	The lens at the bottom of a microscope. There are normally three you can choose from.
***Total magnification**	Eyepiece lens x objective lens.
****Resolution**	The smallest distance between two points so that they can still be seen as two separate points.
****Stains**	Dyes added to microscope slides to show the details more clearly.
****Milli**	Thousandth, $1x10^{-3}$ (a millimetre is a thousandth of a metre).
****Micro**	Millionth, $1x10^{-6}$ (a micrometre is a millionth of a metre).
****Nano**	Billionth, $1x10^{-9}$ (a nanometre is a billionth of a metre).
****Pico**	Trillionth, $1x10^{-12}$ (a picometre is a trillionth of a metre).



2. Plant and animal cells	
***Cell**	The basic structural unit of all living things (the building blocks of life).
***Parts of an animal cell**	Cell membrane, cytoplasm, nucleus, ribosomes, mitochondria.
***Parts of a plant cell**	Cell membrane, cytoplasm, nucleus, ribosomes, mitochondria, cell wall, permanent vacuole, chloroplasts.
***Cell membrane**	Controls what enters and leaves the cell.
***Cytoplasm**	A jelly-like substance where chemical reactions take place.
***Nucleus**	Contains DNA and controls the cell.
***Ribosome**	Produces proteins.
***Mitochondria**	Releases energy by aerobic respiration.
***Cell wall**	Protects and supports the cell, made of cellulose.
***Permanent vacuole**	Stores sap and helps to support the cell.
***Chloroplast**	Where photosynthesis happens, contains chlorophyll.



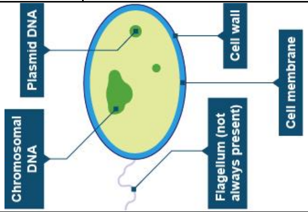
3. Measuring cells	
***Micrograph**	A picture produced by a microscope.
***Light microscope**	A microscope that uses light, can magnify up to 1500 times.
****Electron microscope**	A microscope that uses electrons to produce an image, can magnify up to 1,000,000 times.
****Actual size of a cell**	Actual size = measured size / magnification
****Convert mm to µm**	Micrometres (µm) = millimetres (mm) x 1000

4. Core practical – using microscopes (CP1)	
***CP1 – key question**	What do cells look like under a light microscope?
***CP1 – Prepare the slide**	Collect the cells you are studying and place them on the slide. Add a drop of stain and cover with a cover slip.
***CP1 – Select lens**	Choose between the 4x, 10x and 40x objective lenses.
***CP1 – Place slide in microscope**	Place slide on microscope stage, adjust the coarse focus until the lens is just touching the slide.
***CP1 – Rough focus**	Looking through the eyepiece, slowly adjust the coarse focus until you see a rough image.
***CP1 – Fine focus**	Looking through the eyepiece, slowly adjust the fine focus until you see a sharply focussed image.
***CP1 – Record the image**	Draw what you see, label any cell parts you can recognise and repeat with different objective lenses.
***CP1 - Results**	As you increase the magnification of the objective lens, the cells appear larger and more detailed.

5. Specialised cells	
****Small intestine cell**	**Job:** To absorb small food molecules produced during digestion. **Adaptations:** Tiny folds called microvilli that increase their surface area.
****Sperm cell**	**Job:** Fertilise an egg and deliver male DNA. **Adaptations:** A tail to swim, mitochondria to give energy for swimming, an acrosome to break through the egg's jelly coat, haploid nucleus with only half the total DNA.
****Egg cell**	**Job:** To be fertilised by a sperm and then develop into an embryo. **Adaptations:** Jelly coat to protect the cell, many mitochondria and nutrients to provide energy for growth, haploid nucleus with only half the total DNA.
****Ciliated epithelial cell**	**Job:** To clear mucus out of your lungs (and other internal surfaces). **Adaptations:** Small hairs on the surface – called cilia – which wave to sweep mucus along.

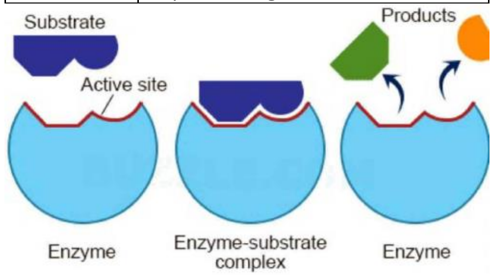
6. Bacterial cells	
***Parts of a bacterial cell**	**All bacteria:** Cell membrane, cell wall, cytoplasm, ribosomes, chromosomal DNA, plasmid DNA **Some bacteria:** flagellum.
****Chromosomal DNA**	Large piece of DNA containing most genes.

****Plasmid DNA**	Small loops of DNA containing a few genes.
****Flagellum**	A tail used for movement.
****Eukaryotic cells**	Cells with a nucleus.
****Prokaryotic cells**	Cells without a nucleus.
*****Standard form**	A way of writing numbers in terms of powers of ten. E.g. $0.015 = 1.5 \times 10^{-2}$ $0.000458 = 4.56 \times 10^{-4}$ The index of ten (the 'minus' number) tell you which decimal point to start on.



7. Digestive enzymes	
***Digestion**	Breaking large food molecules down into ones small enough to absorbed by the small intestine.
***Catalyst**	A substance that speeds up a chemical reaction without being used up.
***Enzyme**	A protein that works as a catalyst to speed up the reactions in our cells.
***Digestive enzymes**	Enzymes that break large food molecules down into smaller ones.
****Amylase**	**Where found:** saliva, small intestine **What it does:** breaks down starch into simple sugars such as maltose
****Lipase**	**Where found:** small intestine **What it does:** breaks down fats into fatty acids and glycerol
****Protease**	**Where found:** stomach (pepsin), small intestine (trypsin) **What it does:** breaks down proteins into amino acids

8. How enzymes work	
***Substrate**	The chemical(s) that an enzyme works on.
***Active site**	An area of an enzyme with the same shape as the substrate.
****Lock and key mechanism**	The substrate moves into the active site and reacts to form the products. The products leave the active site so another substrate can then enter and so on.
****Specificity**	Each enzyme can only work on one substrate because the shape of the active site has to match.
***Denature**	When the shape of the active site changes shape so the enzyme stops working.



9. Factor affecting enzymes	
***Optimum temperature**	The temperature when an enzyme works fastest (about 37°C for human enzymes).
****Changing the temperature**	**Increasing to optimum**: rate increases because particles move faster **Increasing past optimum:** rate decreases as enzyme denatures
***Optimum pH**	The pH when enzymes work fastest (around pH 6-8 for most human enzymes)
****Changing pH**	Rate decreases as you move away from the optimum because the enzyme denatures.
****Increasing substrate concentration**	At first the rate increases, but then it levels out as the enzyme is working as fast as possible.

10. Core practical – enzymes and pH (CP2)	
***CP2 – key question**	How does the rate that amylase works change as you change the pH?
***CP2 – Prepare your reactants**	Place starch solution, amylase solution and pH 7 buffer into separate test tubes and warm them in a water bath at 40°C
***CP2 – Prepare your dropping tile**	Place a few drops of iodine solution into each well of a spotting tile.
***CP2 – Start the reaction**	Mix reactants together, start the stop watch and keep the mixture warm in the water bath.
***CP2 – Test for starch**	Remove a small amount of mixture and place in a well on the spotting tile.
***CP2 – Record your results**	Repeat the test until the mixture does not go black (no starch). Record the time.
***CP2 – Vary the pH**	Repeat with different pH buffers from pH 3 to pH 10
***CP2 – Results**	The amylase works fastest around pH 7 and more slowly at pH high or lower than this.

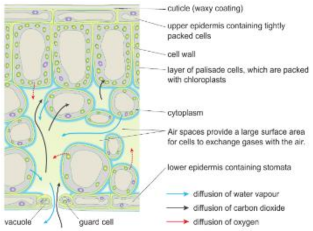
11. Cell transport	
***Concentration**	The number of particles in a given volume (the strength of a solution).
****Concentration gradient**	The difference in concentration between two neighbouring areas.
***Diffusion**	The movement of particles from high to low concentration (down a concentration gradient).
***Diffusion examples**	**Lungs:** oxygen into blood, carbon dioxide out of blood **Leaf:** carbon dioxide into leaf, oxygen out of leaf.
****Partially permeable membrane**	A membrane that allows some molecules but not others to pass through it (like a cell membrane).
****Osmosis**	The movement of water across a partially permeable membrane from high water/low solute conc to low water/high solute conc.
****Osmosis examples**	Water into plant roots, water in/out of any cells.
***Active transport**	Using energy to move substances from low to high concentration (up a concentration gradient).
***Active transport examples**	Minerals being absorbed into plant roots.

12. Core practical – osmosis in potatoes (CP3)	
***CP3 – Prepare potatoes**	Cut six similar pieces of potato, blot them dry and weigh them.
***CP3 – Run the experiment**	Place each potato piece in a test tube with sucrose (sugar) solutions with concentrations from 0% to 50%
***CP3 – Record results**	Blot each potato piece dry and re-weigh it.
***CP3 – Calculate percentage mass change**	% change = (final value – starting value) / starting value x 100
***CP3 – Results**	Potato in weaker sucrose solutions gain mass because water enters potatoes by osmosis, those in stronger solutions lose mass as water leaves by osmosis.

B6: Plant Structures and their Functions

1. Photosynthesis

Photosynthesis	How plants produce glucose using the energy from light.
Photosynthesis equation	Carbon dioxide + water → glucose + oxygen
Chloroplast	Part of a plant cell where photosynthesis happens.
Chlorophyll	A green pigment that enables photosynthesis by trapping the energy in light.
Glucose	Sugar formed by photosynthesis.
Starch	As soon as they are made, glucose molecules are joined together into long chains to form starch.
Sucrose	Starch is be broken down into sucrose to be transported around the plant.
Uses of sucrose	Sucrose is converted into: - Glucose for respiration - Starch for storage - Other molecules for growth
Endothermic	Reactions where the products have more energy than the reactants. Photosynthesis is an exothermic reaction.
Leaf adaptations	To do more photosynthesis, leaves have: a large surface area, a waxy cuticle, palisade cells, a spongy layer, stomata.
Large surface area	Allows the leaf to absorb more light.
Waxy cuticle	A waxy coating that stops water evaporating from the leaf.
Palisade cells	Tall cells in a leaf with many chloroplasts for lots of photosynthesis.

Stomata (singular = stoma)	Microscopic pores in the bottom of the leaf that allow carbon dioxide in and oxygen and water vapour out.
Stomata structure	Each stoma is surrounded by two guard cells that can swell to open it or shrink to close it.
How stomata work	During the day, the stomata open to allow gas exchange. At night the stomata close. Stomata also close during dry spells to stop water loss.
Leaf Structure	

2. Factors That Affect Photosynthesis

Limiting factor	A factor that holds back the rate of photosynthesis when in short supply. Carbon dioxide concentration, light intensity and temperature
Carbon Dioxide and Photosynthesis	To start with, increasing CO_2 levels will increase the rate of photosynthesis. Eventually further increases have no effect because they are no longer the limiting factor.
Light Intensity and Photosynthesis	To start with, increasing light intensity will increase the rate of photosynthesis because they. Eventually increasing it further has no effect as they are no longer limiting.
Temperature and photosynthesis	Increasing temperature towards the optimum increases the rate as particles move faster and collide more. Increasing past the optimum decreases rate as enzymes denature.

Inverse square law	$I_{new} = \frac{I_{orig} \times d_{orig}^2}{d_{new}^2}$
Linear Relationship	A relationship between two variables shown by a straight line on a graph.
Direct Proportion	A linear relationship in which a change in a variable occurs with an equal percentage change in another variable.

3. Core Practical

Key Question	How does light intensity affect the rate of photosynthesis?
Method	Measure the pH of solutions with algal balls in at different distances away from a light source.
Dependent Variable	Change in pH/hour (rate of photosynthesis)
Independent Variable	Distance of algal balls from light source.
Control Variables	Number/size of algal balls, volume of indicator solution, temperature (tank of water is placed between light source and jars with algal balls to absorb heat).
Results	The closer to the light source the greater the rate of photosynthesis (and greater final pH).
Explanation	The closer to the light source the algal balls are, the greater the light intensity and the greater the level of photosynthesis.

4. Absorbing Water and Mineral Ions

Water	In plants, used for carrying dissolved mineral ions, keeping cells rigid, cooling leaves and photosynthesis.
Root hair cells	**Role:** To quickly absorb water and minerals from soil **Adaptations:** A long hair which increases their surface area & thin cell wall for fast water absorption.
Diffusion	Movement from a high concentration to low until equilibrium is reached.

Osmosis	Movement of a solvent from high to low concentrations across as semi-permeable membrane.
Diffusion in roots	Water diffuses along the cell walls around the outside of each cell until it reaches the xylem.
Osmosis in roots	Water travels from cell to cell across cell membranes by osmosis until it reaches the xylem.
Minerals in the soil	Plants absorb minerals from soil such as nitrates, phosphates and potassium.
Absorbing minerals	Plants absorb minerals by active transport because their concentration is low.

5. Transpiration and Translocation

Transpiration	The movement of water into a plant's roots, up its stem and evaporating out of the leaves.
Xylem	Hollow tubes that carry water from the roots, up the stem to the leaves.
Xylem Adaptations	Hollow dead cells to let water pass, no walls between neighbours to allow water through, rings of lignin to make them strong.
Factors increasing transpiration	Air movement (wind), dryer air (low humidity), higher temperatures
Potometer	Equipment used to measure rate of transpiration.
Translocation	The movement of sucrose (sugar) around a plant through the phloem.
Phloem	Tissue that transports sucrose around plants, made of sieve tubes and companion cells.
Sieve tubes	Cells in phloem with a large channel running through them to carry sucrose solution.
Companion cells	Cells in phloem that sit next to the sieve tubes and pump sucrose into the sieve tubes- lots of mitochondria for active transport

B7: Animal coordination, control and homeostasis

1. Hormones

Hormone	A chemical messenger that changes the way a part of the body works.
Endocrine Gland	Parts of the body that produce and secrete hormones.
Target Organ	Part of the body affected by a hormone/hormones.

Hormones and Glands

Endocrine Gland	Hormone
Adrenal gland	Adrenaline
Testes	Testosterone
Thyroid gland	Thyroxine
Ovaries	Oestrogen Progesterone
Pituitary gland	FSH LH Growth hormone
Pancreas	Insulin Glucagon

2. Hormonal Control of Metabolic Rate

Metabolic Rate	The rate at which the body uses the energy stored in food.
Thyroxine	**Role:** To control your metabolic rate. **Endocrine gland:** Thyroid gland **Target organ:** Most of the body
Negative Feedback	The way the body responds to high levels of something by bringing them down, and low levels by bringing them up, both back to normal.
Negative feedback and the metabolic rate	1) Low levels of thyroxine stimulates production of TRH in hypothalamus 2) This causes the release of TSH from the pituitary gland 3) TSH causes the thyroid to produce thyroxine 4) Normal levels of thyroxine inhibitsthe release of TRH and the production of TSH
Adrenaline	**Role:** To prepare the body for fight or flight **Endocrine gland:** Adrenal glands **Target organ:** Heart (beats faster and stronger), blood vessels going to muscles (get wider), blood vessels going to organs (get narrower), liver (releases glucose)

3. Menstrual Cycle

Menstrual Cycle	An average of 28 day cycle that prepares a woman's body for pregnancy.
Ovulation	The release of an egg cell by an ovary
Fertilisation	When the nuclei of a sperm cell fuses with the nuclei of an egg cell to form a zygote.
Menstrual Cycle: Days 1-5	Menstruation (a period): the lining of the uterus breaks down and leaves the body through the vagina. **Progesterone low. Oestrogen low.**
Menstrual Cycle: Days 6 – 12	Waist measurement ÷ hip measurement Better method of measuring abdominal fat which is linked with cardiovascular disease.
Menstrual Cycle: Days 13 – 15	Ovulation happens
Menstrual Cycle Days 16 – 28	The uterus lining continues to thicken and would be able to accept an embryo if fertilisation happens. **Progesterone high**

Barrier Contraception	Contraception which makes an obstruction, stopping the sperm from reaching the egg. Eg **condom, cervical cap**
Hormonal Contraception	Contraception which uses the release of hormones to disrupt the menstrual cycle preventing pregnancy. Eg **'the pill', implants**

4. Hormones and the menstrual cycle

Egg Follicle	A layer of tissue surrounding each of the immature eggs in the ovaries.
Oestrogen	Causes the release of FSH and the thickening of the uterus lining. High oestrogen levels cause LH release.
FSH	Causes one follicle to develop and mature the egg cell within it.
LH	Causes ovulation when the egg is released from the follicle.
Corpus luteum	The is what the follicle becomes after ovulation, and releases progesterone. It breaks down over two weeks.
Progesterone	Maintains the thickness of the uterus lining, inhibits FSH release. Falling levels trigger ovulation.
Assisted Reproductive Technology	(ART)Using hormones and other methods to increase the chance of pregnancy.
Clomifene therapy	Clomifene increases the levels of FSH and LH to make egg successful ovulation more likely.
In vitro fertilisation (IVF)	Sperm is extracted from a man, and eggs from a woman. The eggs are fertilised in a laboratory and one or more is placed into the uterus.

5. Control of blood glucose

Homeostasis	Maintaining constant conditions in the body, such as temperature or blood glucose concentration.
Blood Glucose Concentration	The concentration (amount) of glucose in the blood. Both too high and too low are dangerous.
Glycoen	A stored form of glucose made by joining glucose molecules together in long chains.
Insulin	**Role:** To reduce blood glucose concentration **Endocrine gland:** Pancreas **Target organ:** Liver and muscles which convert glucose into glycogen.
Glucagon	**Role:** To increase blood glucose concentration **Endocrine gland:** Pancreas **Target organ:** Liver and muscles which convert glycogen back into glucose.

6. Type 1 & Type 2 Diabetes

Diabetes	A disease in which the body cannot quickly reduce blood glucose concentrations after eating.
Type 1 Diabetes	Diabetes caused when a person's pancreas can't produce insulin. **Treat with insulin injections**
Type 2 Diabetes	Diabetes caused when a person becomes **insulin resistant**. Treat with **controlled diet, exercise or medication**
Risk Factors for Type 2 Diabetes	Obesity and inactivity (lack of exercise).
Measuring Obesity	Body mass index above 30: $BMI = \frac{mass\ (kg)}{height\ (m)^2}$ High waist:hip ratio $waist{:}hip = \frac{waist}{hip}$

Lesson	Memorised?
1.Hormones	
2. Hormonal Control of Metabolic Rate	
3. Menstrual Cycle	

4. Hormones and Menstrual Cycle	
5. Control of blood glucose	
6. Diabetes	

B8: Exchange and Transport in Animals

1. Efficient Exchange & Transport

Substances Needed	Oxygen, glucose and nutrients are needed by the body.
Waste Products	Carbon dioxide, urea.
Transport	Moving substances around the body.
Exchange	Moving substances in and out of our cells.
Diffusion	The way substances move in and out of cells – they diffuse from high to low concentration.
Increasing Diffusion	High surface area, thin surfaces
Surface Area: Volume Ratio	Surface area ÷ volume A higher ratio means there is more surface area, so substances can diffuse in and out of cells more quickly.
Alveoli	**Role:** Air sacs in lungs where CO_2 and O_2 are exchanged **Adaptations:** millions of them gives a high surface area, good blood supply maintains a high concentration gradient, thin walls increases diffusion

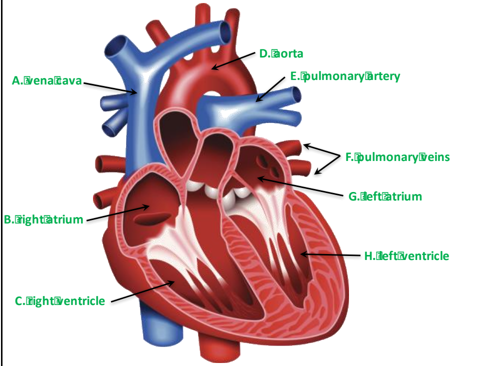
2. Circulatory System

Circulatory System	Your heart, arteries, capillaries and veins which work together to pump blood around the body.
The Role of Blood	To carry oxygen and nutrients to our cells and take waste products away.
Arteries	**Role:** Carry blood away from the heart **Adaptations:** Thick muscle walls to withstand the high pressure, elastic fibres to stretch as pressure increases during a pulse.
Capillaries	**Role:** To exchange nutrients and waste between the blood and cells. **Adaptations:** Thin walls to increase diffusion, many of them to give a high surface area.
Veins	**Role:** To carry blood towards the heart **Adaptations:** Thin walls because pressure is low, wide because blood is moving slowly, valves so blood flows right way.
Components of Blood	Plasma, red blood cells, white blood cells, platelets.
Plasma	A straw-coloured liquid that carries the blood cells and dissolved substances such as urea, carbon dioxide and glucose.
Red Blood Cells	Erythrocytes Contain haemoglobin to carry oxygen around the body.
White Blood Cells	Fight pathogens. **Phagocytes** – engulf ('eat') pathogens. **Lymphocytes** – produce antibodies to attack pathogens.
Platelets	Small fragments of cells that help the blood to clot when you are cut.

3. The Heart

Heart	A double pump that pumps blood: **Right side**: to lungs **Left side**: around the whole body
Atria (Atriums)	The two chambers at the top of the heart. Right: receives blood from body Left: receives blood from lungs
Ventricles	The two chambers at the bottom of the heart Right: pumps blood to lungs Left: pumps blood to body
Valves	Prevent blood from flowing from the ventricles back to the atria
Vena Cava	Carries blood from the body into the right atrium.
Pulmonary Artery	Carries blood from the right ventricle to the lungs.
Pulmonary Vein	Carries blood from the lungs to the left atrium.
Aorta	Carries blood from the left ventricle to the body.
Cardiac Output	Cardiac output = stroke volume x heart rate
Increasing Cardiac Output	Stronger heart beats (higher stroke volume), higher heat rate.

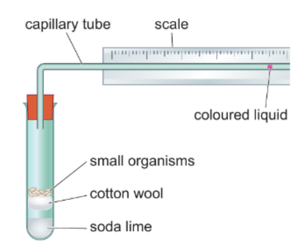
Structure of the Heart



4. Respiration

Respiration	An exothermic reaction carried out in all living cells to release energy from food molecules such as glucose.
Aerobic Respiration	The main type of respiration, which takes place in mitochondria and uses oxygen.
Aerobic Equation	glucose + oxygen → carbon dioxide + water
Anaerobic Respiration	A form of respiration that releases less energy but extremely quickly. Takes place in the cytoplasm.
Anaerobic Equation	Glucose → lactic acid
Role of Anaerobic Respiration	To provide an energy boost during intense exercise when aerobic respiration alone isn't enough.
Lactic Acid	A poison that builds up in muscles during anaerobic respiration leading to muscle tiredness and cramp.
Excess Post Exercise Oxygen Consumption	We continue to breathe heavily and have a high heart rate after exercise to get lots of oxygen to the muscles to oxidise harmful lactic acid to CO_2 and H_2O.

5. Core Practical

Key Question	How does temperature affect the rate of respiration in small animals?
Method	Place some soda lime (absorbs CO_2) into the test tube put a protective layer of cotton wool over it, add ten maggots, insert in bung with capillary tube and put in water bath to adjust for 5 mins. Dab open end of capillary tube into red dye and start timing.
Equipment	**B** a simple respirometer
Record Results	Every five minutes for fifteen minutes, measure the distance travelled by the food colouring.
Vary the Temperature	Repeat the experiment in water baths set to different temperatures.
Results	The higher the temperature, the faster the animals respire.

B9: Ecosystems and Material Cycles

1. Ecosystems

Resources	Something that an organism needs to stay alive such as food, water and space.
Ecosystem	An area in which all the living organisms and non-living factors in an area form a stable relationship.
Population	A group of one species living in the same area.
Community	All the different organisms living and interacting with one another in a particular area.
Interdependent	When organisms in an area need each other for resources (such as food and shelter).
Habitat	The place in which an organisms lives.
Abundance	A measure of how common something is.
Quadrat	A square frame used to take a sample of organisms in a given area.
Population Size	$= \text{number of organisms in all quadrats} \times \frac{\text{total size of area where organism lives}}{\text{total area of quadrats}}$
Food Chain	A diagram that uses arrows to show the flow of energy through organisms that depend on each other for food.
Food Web	A diagram of interlinked food chains showing the feeding relationships in a community.

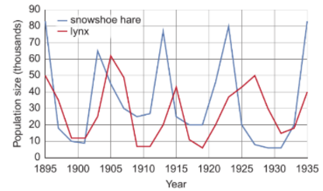
2. Abiotic Factors and Communities

Distribution	The places in which a certain organism can be found in an area.
Abiotic Factors	Non-living components in an ecosystem that can influence where organisms live e.g. temperature , light
Adaptations	The features of an organism that enable it to do a certain function.
Drought	A lack of water. Most organisms cannot survive in a drought.
Temperature	Affects the distribution of organisms. All organisms have adaptations that suit them to life at specific temperatures.
Temperature Changes	Long-term rises or falls may change the distribution of organisms.
Light	Essential for plants and algae to grow- limited 30m below the ocean surface and in dense forests.
Pollutants	A substance that harms living organisms when released into their environment.
Pollution	Harm caused to the environment, such as by adding poisonous substances or abnormally high amounts of substances into the air.
Belt Transect	A line in an environment along which samples are taken to measure the effect of an abiotic factor on the distribution of organisms.

3. Core Practical

Key Question	How do abiotic factors affect the abundance of low-growing plants?
Method	Use a quadrat to measure the abundance of plants at different distances along a belt transect as an abiotic factor changes (such as from the shaded area under a tree to the open unshaded area).
Dependent Variable	The abundance of plants.
Independent Variable	Distance along belt transect / named abiotic factor (light)
Control Variables	Time/day of sampling to control other abiotic factors. Quadrat size used. Person measuring abundance.
Results	Moving from the shaded area into the unshaded area the abundance of plants would increase.
Explanation	In the shaded area there is more competition for light, decreasing the abundance of the plants.

4. Biotic Factors and Communities

Biotic Factors	Living components (the organisms) in an ecosystem.
Competition	When organisms need the same resources as each other so they struggle against each other to get those resources.
Predation	When one animal species kills and eats another animal species.
Predator-Prey Cycle	
Biodiversity	The variety of species in an area.
Yellowstone National Park	• 1926 wolves became extinct • Then the number of elk increased rapidly (due to reduced predation) • Reduced food for other herbivores such as beavers • 1995 wolvers reintroduced • Reduced elk numbers • Increased beaver numbers who change ecosystems and increase biodiversity

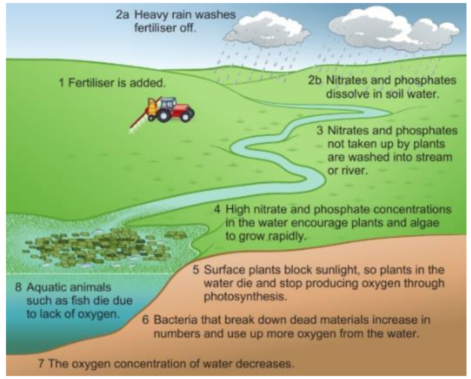
5. Parasitism and Mutualism

Parasitism	A feeding relationship in which a parasite benefits and its host is harmed.
Parasite	An organism that lives on or in a host and takes food from it while it is alive.
Host	The individual that is being lived on/in by a parasite.
Parasitism examples	Tapeworms and humans Head lice and humans
Mutualism	A relationship between individuals of different species where they both benefit.
Mutualism examples	Flowers and insects (flowers get pollinated, insects get food). Coral polyps and algae (algae get a place to live safely and the polyps get food from the algae who can photosynthesise).

6. Biodiversity and Humans

Overfishing	Taking more fish from a population than are replaced by the fish reproducing so that the population falls over time.
Fish Farming	Growing fish in a contained area, usually to supply humans with food.
Indigenous / Native	Species that have always been in an area.
Non-Indigenous	Species that have been introduced to an area where they haven't been before.

Eutrophication

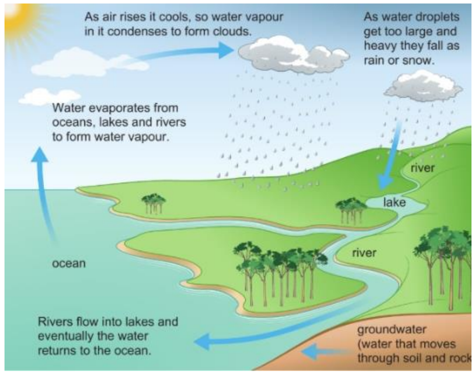


7. Preserving Biodiversity

Reforestation	Planting new forests where old forests have been cut down.
Conservation	The protection of an area or species to prevent damage.

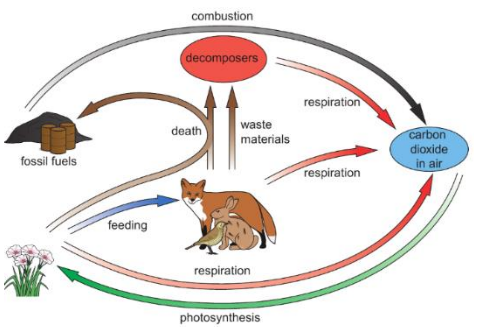
Endangered	An area or species that is at great risk of destruction / extinction.
Kielder Forest Conservation	• Reforestation of conifer and broad leaved trees (with areas of open space left). • Nesting platforms built for the ospreys. • Grey squirrels caught and killed, to help protect the indigenous red squirrels.
Captivity	Keeping something in unnatural surroundings, such as animals in a zoo.
Threats to Tigers	The dense forest they live in is being cut down and people hunt tigers for fur and other body parts.
Conservation of Tigers	They are being bred in captivity to increase population numbers. Their habitats are being rebuilt and protected too.
Importance of Biodiversity	Areas with higher biodiversity can recover faster from natural disasters. We use plants and animals for food and as a major source of medicines- it is important we try to preserve as many species as we can.

8. The Water Cycle



Water Cycle	A sequence of processes by which water moves through abiotic and biotic parts of an ecosystem.
Potable	Suitable for drinking.
Desalination	A process that produces potable water by removing the salt from sea water.
Distillation	A process that separates a liquid from a mixture by evaporating it and then condensing it.

9. The Carbon Cycle



Carbon Cycle	A sequence of processes by which carbon moves from the atmosphere, through living and dead organisms, into sediments and into the atmosphere again.
Decay	A process in which complex substances in dead plant and animal biomass are broken down by decomposers into simpler substances.
Decomposers	An organism that feeds on dead material, causing decay.
Fossil Fuels	A fuel formed from the dead remains of organisms over millions of years. Coal, oil, natural gas

Respiration

Glucose + Oxygen ⟶ Carbon dioxide + Water

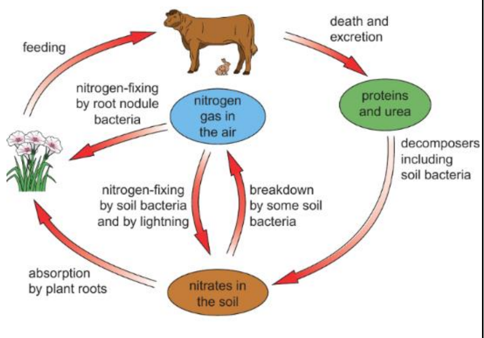
$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

Photosynthesis

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

carbon dioxide + water ⟶ glucose + oxygen

10. The Nitrogen Cycle

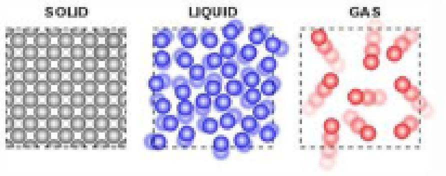


Nitrogen Cycle	A sequence of processes by which nitrogen moves from the atmosphere through living and dead organisms, into the soil and back to the atmosphere.
Nitrates	A compound that contains nitrogen in the form of a nitrate ion.
Nitrogen-Fixing Bacteria	Bacteria that can take nitrogen from the atmosphere and convert it into more complex nitrogen compounds such as ammonia.

Lesson	Memorised?
1. Ecosystems	
2. Abiotic Factors and Communities	
3. Core Practical	
4. Biotic Factors and Communities	
5. Parasitism and Mutualism	
6. Biodiversity and Humans	
7. Preserving Biodiversity	
8. The Water Cycle	
9. The Carbon Cycle	
10. The Nitrogen Cycle	

CC1-SC2: States of matter, separating and purifying knowledge organiser (F)

Lesson 1 States of matter



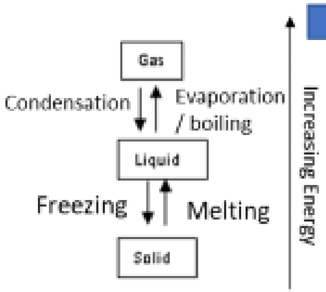
Arrangement of particles

Solid	Liquid	Gas
Ordered Neat rows	Random Some touch	Random Apart

Movement of particles

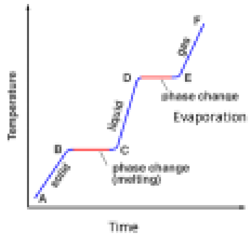
Solid	Liquid	Gas
Vibrating In fixed position	Rolling over each other	Flying around with high energy

State Changes



Sublimation is going from a solid straight to a gas

Lesson 2 Heating / Cooling curves

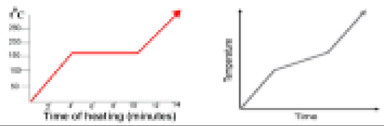


A heating or cooling curve shows how the temperature changes with time
State changes are shown as horizontal lines

Lesson 3 Mixtures

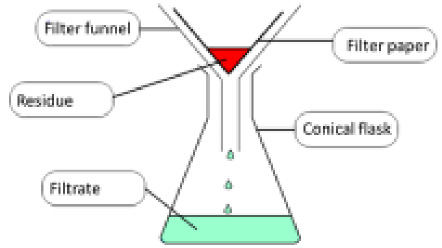
- Mixtures contain substances which are not chemically combined and they can be separated
- Pure substances have a sharp melting point
- Impure substances have a range of melting points

Pure **Impure**

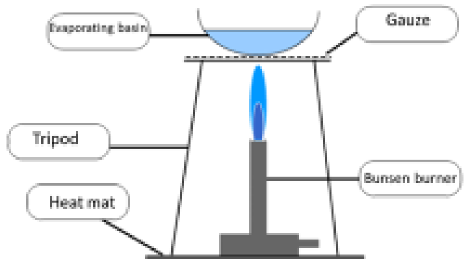


Lesson 4 Filtration and crystallisation

Filtration can be use to separate an insoluble solid from a liquid or from a solution



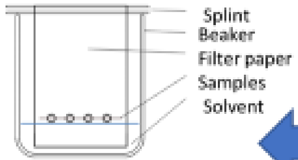
Crystallisation can be used to separate a soluble solid from a solution of that solid



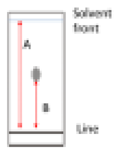
In crystallisation of a solution the **solvent** is **evaporated** from a **solution** to leave the **solute**

Lesson 5 Chromatography

Chromatography is used to separate a mixture of substances. E.g. a mixture of different dyes in an ink.



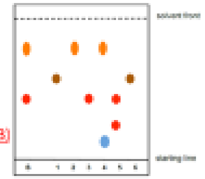
Calculating Rf values



A = Distance solvent has travelled

B = Distance substance has travelled

Rf = Distance substance has travelled (B) / Distance solvent has travelled (A)

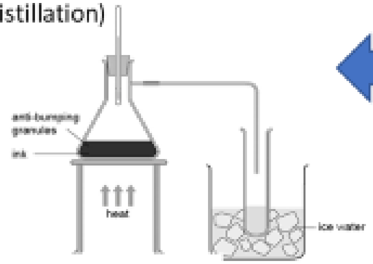


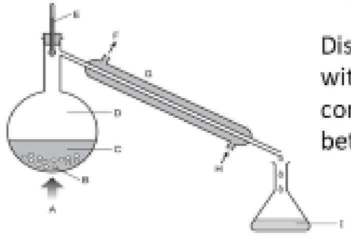
Each dot represents a dye
The same dye will travel the same distance up the paper

Lesson 6 Distillation

Distillation is used to separate a solvent from a solution or from a mixture of solvents (fractional distillation)

Simple distillation





Distillation with a condenser is better

State changes involved in distillation - boiling/evaporation and condensation

Risk Assessment

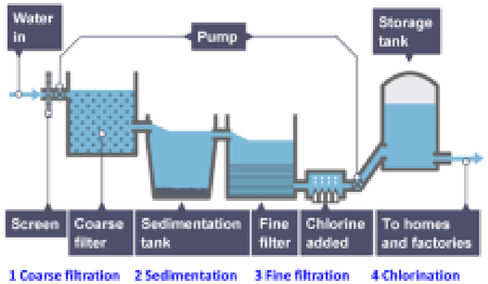
Hazard – what is dangerous e.g. Bunsen Burner
Risk – the harm it could do e.g. Hair could catch fire
Control measure – How you make it safe e.g. tie your hair back

Lesson 7 Purifying water

Water is used for many things around the home

Water is purified by:-

Course filtration – filtered to remove twigs etc.
Sedimentation – a chemical is added which makes particles sink to bottom
Fine filtration – filtered through sand
Chlorination – to kill bacteria



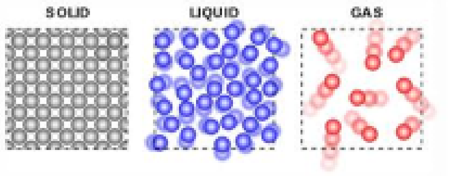
Distilled water is pure water and contains no dissolved salts.

Sea water contains dissolved sodium chloride

Mineral water contains many dissolved salts

CC1-SC2: States of matter, separating and purifying knowledge organiser (H)

Lesson 1 States of matter



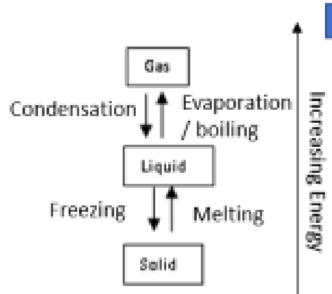
Arrangement of particles

Solid	Liquid	Gas
Ordered Neat rows	Random Some touch	Random Apart

Movement of particles

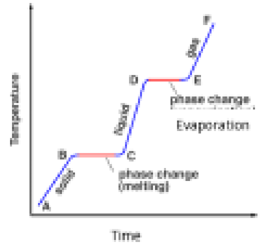
Solid	Liquid	Gas
Vibrating about fixed position	Rolling over each other	Flying around with high energy

State Changes



Sublimation is going from a solid straight to a gas

Lesson 2 Heating / Cooling curves



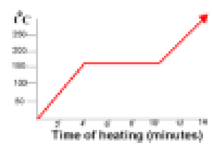
A heating or cooling curve shows how the temperature changes with time
State changes are shown as horizontal lines
During this time the energy is used to change state and not temperature

Lesson 3 Mixtures

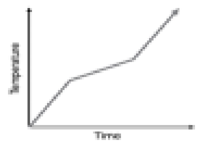
- Mixtures contain substances which are not chemically combined and they can be separated
- Pure materials contain only one substance
- Impure materials contain a mixture of substances

Pure substances have a sharp melting point
Impure substances have a range of melting points

Pure

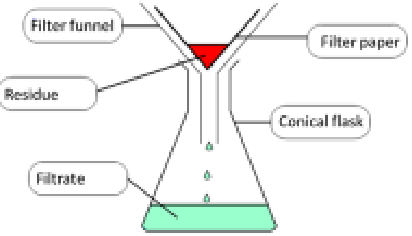


Impure



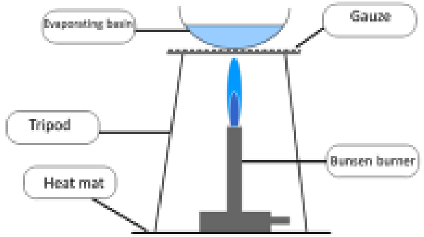
Lesson 4 Filtration and crystallisation

Filtration can be use to separate an insoluble solid from a liquid or from a solution



Filtration works because the large particles of the residue can not pass through the small gaps in the filter paper

Crystallisation can be used to separate a soluble solid from a solution of that solid

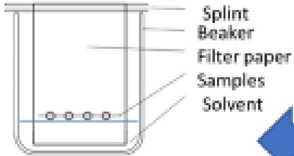


In crystallisation of a solution the **solvent** is **evaporated** from a **solution** to leave the **solute**

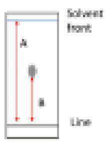
Lesson 5 Chromatography

Chromatography is used to separate a mixture of substances. E.g. a mixture of different dyes in an ink.

The mixture separates because some dyes like the solvent more and some like the paper more.



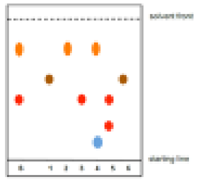
Calculating Rf values



A = Distance solvent has travelled

B = Distance substance has travelled

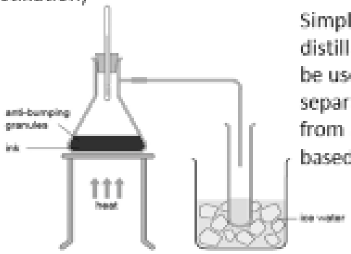
$$Rf = \frac{\text{Distance substance has travelled (B)}}{\text{Distance solvent has travelled (A)}}$$



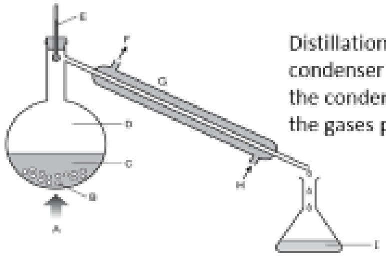
You can compare how far inks have travelled (Rf values) to analyse the dyes in an unknown mixture

Lesson 6 Distillation

Distillation is used to separate a solvent from a solution or from a mixture of solvent (fractional distillation)



Simple distillation – can be used to separate water from a water based ink



Distillation with a condenser is better as the condenser cools the gases produced

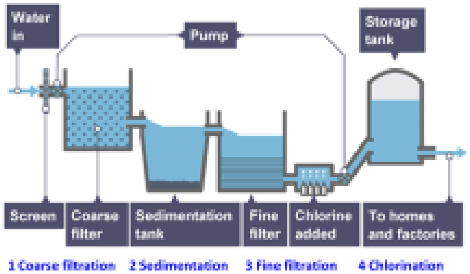
State changes involved in distillation - boiling/evaporation and condensation

Risk Assessment
Hazard – what is dangerous e.g. Bunsen Burner
Risk – the hard it could do e.g. Hair could catch fire
Control measure – How you make it safe e.g. tie your hair back

Lesson 7 Purifying water

Water is used for many things around the home and comes from a variety of sources

Water is purified to remove impurities (silt and mud, chemicals, dissolved salts)



Course filtration – filtered to remove twigs etc.
Sedimentation – a chemical is added which makes particles sink to bottom
Fine filtration – filtered through sand
Chlorination – to kill bacteria

Distilled water is pure water and contains no dissolved salts. It is used for laboratory tests.
Sea water contains dissolved sodium chloride
Mineral water contains many dissolved salts
We do not use distillation to make drinking water as it uses a lot of energy and would be expensive

C3 & 4: Atoms and the periodic table

Lesson sequence

13. Structure of atoms
14. Detailed structure of atoms
15. Isotopes
16. Mendeleev's periodic table
17. The modern periodic table
18. Electron configuration

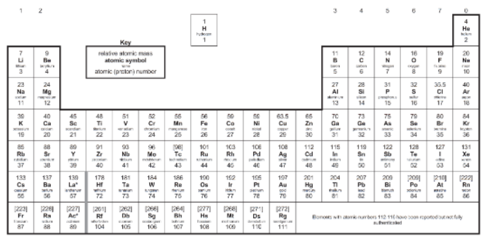
1. Structure of atoms	
***Particle**	The tiny pieces that all matter is made from.
***Atom**	The smallest independent particle. Everything is made of atoms.
****Size of atoms**	About 1 x 10^{-10} m in diameter.
****Dalton's model of atoms**	- Tiny hard spheres - Can't be broken down - Can't be created or destroyed - Atoms of an element are identical - Different elements have different atoms
***Subatomic particles**	Smaller particles that atoms are made from.
***Proton**	Mass = 1 Charge = +1 Location = nucleus
***Neutron**	Mass = 1 Charge = 0 Location = nucleus
***Electron**	Mass = 1/1835 (negligible) Charge = -1 Location = shells orbiting nucleus
***Nucleus**	Central part of an atom, 100,000 times smaller than the overall atom

2. Detailed structure of atoms	
****Alpha particle**	Small positively charged particle made of two protons and two neutrons.
****Scattering**	When particles bounce back or change direction.
****Rutherford's experiment**	Fired alpha particles at gold leaf, used a phosphor-coated screen to track where they went.
****Rutherford's results**	Most alpha particles went through, some scattered (changed direction).
****Rutherford's explanation**	Scattered particles hit a solid nucleus. Most did not hit it, therefore nucleus is small
***Atomic number**	The bottom number on the periodic table, gives the number of protons and electrons.
***Atomic mass**	The top number on the periodic table, gives the total protons and neutrons together.
***Number of protons**	The atomic number.
***Number of electrons**	The atomic number.
***Number of neutrons**	Atomic mass minus atomic number.
***Number of protons and electrons**	Equal, because each negative electron is attracted to a positive proton in the nucleus.

3. Isotopes	
****Isotopes**	Atoms with the same number of protons but different number of neutrons.
****Describing isotopes**	Mass after the name (e.g. boron-10) or superscript mass before the symbol (^{10}B).
***Nuclear fission**	Large unstable atoms break into two smaller stable ones.
****Uses of fission**	Nuclear power, nuclear weapons.
****Relative atomic mass, A_r**	The weighted average of the masses of all of the isotopes of an element.
*****Isotopic abundance**	The percentage of an element that is made of a particular isotope.
*****Calculating A_r**	- Multiply each mass by the decimal % - Add these up **Note:** (decimal % = %/100)

4. Mendeleev's periodic table	
***Dmitri Mendeleev**	Russian chemist, developed the periodic table.
***Mendeleev's periodic table**	Ordered by increasing A_r, some elements switched according to their properties.
***Chemical properties**	Includes reaction with acid and formula of oxide.
***Physical properties**	Includes melting point and density.
****Gaps in Mendeleev's periodic table**	Mendeleev left gaps where no known element fitted and predicted these would be filled with newly discovered elements.
****Eka-aluminium**	An element that Mendeleev thought would fill a gap. He predicted its properties, which matched gallium when discovered.

5. The modern periodic table	
***Noble gases**	Gases that do not react: He, Ne, Ar, Kr.
****Moseley's experiment**	Fired electrons at samples of elements and measured X-rays produced.
****Moseley's results**	Energy of x-rays produced proportional to the positive charge of the element.
****Conc. from Moseley's work**	The atomic number must be the number of protons in the atoms.



****Pair reversals**	Elements (like Ar and K) that are not in order of increasing mass.
****Explaining pair reversals**	It means elements should be order elements by increasing atomic number instead.

6. Electron configuration	
***Shells**	Electrons orbit atoms in shells.
***First shell**	Holds up to two electrons.
***Second shell**	Holds up to eight electrons.
***Third shell**	Holds up to eight electrons.
***Number of electrons**	Given by the atomic number.
***Filling shells**	Fill shells from the first shell out. Move up a shell when current one is full.
***Electron configuration**	The number of electrons in each shell (e.g. Al is 2.8.3).
***Outer shell**	The last shell with any electrons in it.
****Groups**	Columns in the periodic table, tell you the number of electrons in the outer shell.
****Periods**	Rows in the periodic table, tell you the number of electron shells.

C5-7: Bonding

Lesson sequence

19. Ionic bonding
20. Ionic compounds
21. Properties of ionic compounds
22. Covalent bonding
23. Covalent structures
24. Allotropes of carbon
25. Metallic bonding
26. Classifying materials

1. Ionic bonding	
***Bond**	An attraction between two atoms that holds them together.
***Ion**	An atom that has gained a charge by gaining or losing electrons.
***Charge**	Whether an ion is positive or negative.
***Cation**	Positive ion formed by losing electrons. Formed by metal atoms.
***Anion**	Negative ion formed by gaining electrons. Formed by non-metal atoms.
****Size of charge**	The number of electrons transferred affects the size of charge: losing two electrons makes a 2+ charge, gaining three electrons makes a 3- charge.
****How many electrons are gained or lost?**	**Metals:** however many electrons are in the outer shell **Non-metals:** however many electrons are needed to fill the outer shell.
***Electrostatic force**	A force of attraction between a positive and negative particle.
***Ionic bond**	When two oppositely charged ions are held together by an electrostatic force.

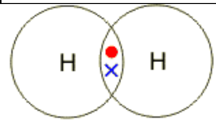
****Forming ionic bonds**	Electrons are transferred from a metal atom to a non-metal atom to form a positive metal cation and a negative metal anion. The oppositely charged ions are attracted to each other.

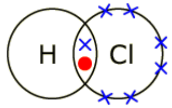
2. Ionic compounds	
***Chemical formula**	Shows the number of atoms of each element present in one ‘unit’ of a compound.
***Writing formulae**	- Each chemical symbol starts with a capital letter. - The number of each atom present is shown with a subscript number after the symbol. E.g. H_2SO_4.
****Determining ionic formulae**	- Ensure the total number of positive and negative charges balance. - Change the number of each ion present by changing the subscript numbers.
***Compound ions**	An ion made from two or more atoms that share a charge.
***Common compound ions**	Hydroxide: OH^- Nitrate: NO_3^- Sulfate: SO_4^{2-} Sulfite: SO_3^{2-} Carbonate: CO_3^{2-} Ammonium: NH_4^+
****Including compound ions in formulae**	If you need more than one, put brackets around it. E.g. $Mg(OH)_2$
***Ionic lattice**	The structure of ionic compounds: a repeating 3D pattern of alternating positive and negative ions.
****Crystal**	A piece of material with a regular shape and straight edges formed by the regular pattern of ions in an ionic lattice.

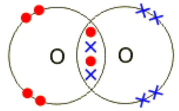
3. Properties of ionic compounds	
****Melting point of ionic compounds**	High because melting needs a lot of energy to break strong ionic bonds.
***Solubility of ionic compounds**	Many ionic compounds dissolve in water.
****Electrical conductivity of ionic compounds**	Solid: Do not conduct because ions can’t move. Liquid (molten or solution): Do conduct because ions can move.
****How ionic compounds conduct electricity**	When they are in a liquid form, the positive cations move to the negative electrode (cathode) and the negative anions move the positive electrode (anode).

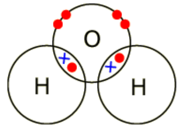
4. Covalent bonding	
***Covalent bond**	An electrostatic attraction between two atoms and a share pair of electrons.
****Double bond**	A covalent bond involving two shared pairs of electrons.
***Dot and cross diagram**	A bonding diagram showing the electrons in the outer shell of each atom, with electrons drawn as dots or crosses.
***Hydrogen, H_2**	Two overlapping circles both labelled H. One pair in the overlap.
****Hydrogen chloride, HCl**	Two overlapping circles labelled H and Cl. One pair in the overlap, 6 electrons around Cl.
****Oxygen, O_2**	Two overlapping circles both labelled O. Two pairs in the overlap, 4 electrons around each O.
****Water, H_2O**	Three overlapping circles in a line labelled H, O, H. A pair in each overlap, 4 electrons around O.
****Carbon dioxide, CO_2**	Three overlapping circles in a line labelled O, C, O. Two pairs in each overlap, 4 electrons around each O.
****Methane, CH_4**	Five circles with one in the centre labelled C and 4 labelled H around it. A pair in each overlap.

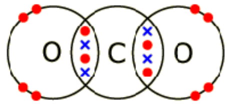
****Valency**	The number of covalent bonds an atom can form.
****Valency and groups**	Group 4 = 4 (4 electrons needed) Group 5 = 3 (3 electrons needed) Group 6 = 2 (2 electrons needed) Group 7 = 1 (1 electron needed)
****Working out molecular formulae**	Find the lowest common multiple of the valency of each atom. Use the number of an atom required to reach the LCM.

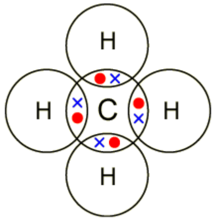








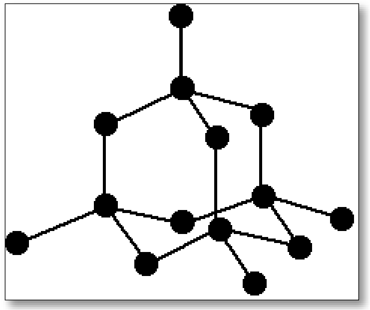


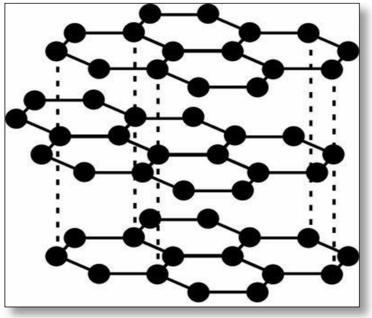


5. Covalent structures	
***Molecule**	A particle made from two or more atoms bonded together.
***Simple molecular structure**	A structure made of small molecules in which a few atoms join together to form a small particle.
****Structure of molecular substances**	Atoms in a molecule are held together by strong covalent bonds. Neighbouring molecules are held close by weak intermolecular forces.
****Intermolecular force**	A weak electrostatic force that holds two neighbouring molecules together.
****Melting point of simple molecular compounds**	Low because melting only needs a little energy to break weak intermolecular forces.
****Electrical conductivity of simple molecular compounds**	Do not conduct because there are no electrons that are free to move.
***Examples of simple molecular substances**	Hydrogen gas, oxygen gas, water, carbon dioxide, methane.
***Giant molecular structure**	A structure made of a repeating pattern of atoms covalently bonded together.
****Melting point of giant molecular compounds**	High because melting requires breaking strong covalent bonds.
****Electrical conductivity of simple molecular compounds**	Do not conduct (except graphite) because there are no electrons free to move.
***Examples of simple molecular substances**	Silicon dioxide (silica), diamond, graphite.
***Polymer**	A large molecule made of a small unit repeated many times.
***Monomer**	A small molecule that can be joined together many times to form a polymer.

6. Allotropes of carbon	
***Allotrope**	A different structural form of an element made of the same atoms just bonded together differently.
***Carbon's allotropes**	Graphite, diamond, graphene, fullerenes
****Graphite**	**Structure:** stacked sheets of carbon in a honeycomb pattern with delocalised electrons between them. **Properties:** sheets slide apart easily, excellent conductor **Uses:** lubricants
****Diamond**	**Structure:** Repeating pattern of 4 atoms bonded to 4 others. **Properties:** Extremely hard. **Uses:** Cutting tools and drills
****Graphene**	**Structure:** A single layer of atoms in a honeycomb pattern. **Properties:** Very strong, excellent conductor. **Uses:** None yet, but potentially many.
****Buckminster fullerene**	**Structure:** Ball-shaped molecules of C_{60}. **Properties:** Low melting point **Uses:** None
****Carbon nanotubes**	**Structure:** Cylinders made of carbons bonded in a honeycomb pattern. **Properties:** Very strong, excellent conductors **Uses:** Strong and flexible materials, electronics.

7. Metallic bonding	
***Structure of metals**	A lattice of positive metal ions surrounded by a cloud of delocalised electrons.
****Delocalised electrons**	Electrons that are not bound to a single atom but move freely around many.
****Metallic bonding**	The electrostatic attraction between the lattice of positive metal ions and the cloud of delocalised electrons.





****Electrical conductivity of metals**	Metals are good conductors because the electrons are free to move.
****Comparing the conductivity of metals**	Metals with more electrons in the outer shell – such as Al – are better conductors than those with fewer – such as Li – because there are more delocalised electrons that are able to move.
***Malleable**	When a substance dents when it is hit instead of shattering.
****Malleability of metals**	Metals are malleable because the atoms are arranged in regular sheets and these sheets can easily slide over each other when hit.
****Melting point of metals**	High because melting them requires breaking the strong force of attraction between the lattice of metal ions and the cloud of delocalised electrons.

8. Bonding models	
****Classifying materials**	The properties of a material can be used to determine the type of bonding in it.
****Properties of ionic compounds**	High melting point, often soluble in water, solid does not conduct electricity, liquid/solution does.
****Properties of simple molecular compounds**	Low melting point, does not conduct electricity, sometimes soluble in water.
****Properties of giant molecular compounds**	High melting point, does not conduct electricity (except graphite), insoluble in water.
****Properties of metallic compounds**	High melting point, does conduct electricity, insoluble in water.
****Bonding models**	The ideas and drawings that we use to explain the bonding of atoms.
****Problems with bonding models**	- Dot and cross diagrams make electrons seem different, they are not - Atoms appear stationary but are actually vibrating - Atoms don't appear to be touching when they actually are.

C8: Acids and alkalis

Lesson sequence

27. Acids, alkalis and indicators
28. Acids in detail (HT)
29. Bases and salts
30. Core practical – preparing copper sulfate (CP8)
31. Alkalis and balancing equations
32. Core practical – investigating neutralisation
33. Alkalis and neutralisation
34. Reactions of acids with metals and carbonates
35. Solubility

1. Acids, alkalis and indicators

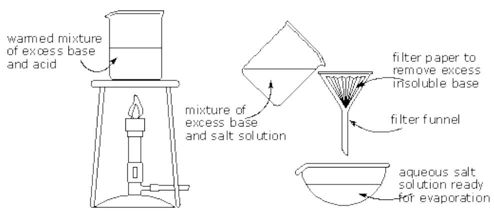
***pH scale**	A scale running from 0 to 14 that measures how acid or alkaline a solution is.
***Acid**	A solution with a pH less than 7.
Alkali	A substance with a pH greater than 7.
***Neutral**	A substance with a pH equal to 7.
***Indicator**	A substance that changes colour depending on the pH.
****Common indicators**	**Litmus:** red in acid, blue in alkali **Methyl orange:** red in acid, orange in alkali **Phenolphthalein:** colourless in acid, pink in alkali
***Universal indicator**	A mixture of several indicators that is red in strong acid, green when neutral and purple in strong alkali.
****Acids and ions**	Acids dissolve in water to produce an excess of hydrogen ions (H^+).
****Alkalis and ions**	Alkalis dissolve in water to produce an excess of hydroxide ions (OH-).
***Hydrochloric acid**	**Formula:** HCl **Hydrogen ions formed:** 1 **Anion formed:** Chloride, Cl^-
***Nitric acid**	**Formula:** HNO_3 **Hydrogen ions formed:** 1 **Anion formed:** Nitrate, NO_3^-
***Sulfuric acid**	**Formula:** H_2SO_4 **Hydrogen ions formed:** 2 **Anion formed:** Sulfate, SO_4^{2-}
*****Ions and pH**	The higher the hydrogen ion concentration the lower the pH, the higher the hydroxide ion concentration, the higher the pH.

2. Acids in detail (HT)

*****Concentrated solution**	A solution with a large amount of solute dissolved in a given volume.
*****Dilute solution**	A solution with a small amount of solute dissolved in a given volume.
*****pH and hydrogen ion concentration**	Every step down the pH scale is a ten-fold increase in hydrogen ion concentration and vice versa. - pH 3 to 1 = 100 times increase - pH 4 to 7 = 1000 times decrease
*****Dissociation**	When an acid dissolves in water, it splits up into positive hydrogen ions and negative anions.
*****Strong acids**	Acids that dissociate fully when dissolved in water – every single molecule splits up.
*****Weak acids**	Acids that do not fully dissociate when dissolved in water – only some molecules split up.
*****Acid examples**	**Strong:** hydrochloric, sulfuric **Weak:** ethanoic
*****Properties of strong acids**	Strong acids react more quickly than weak acids because there are more hydrogen ions available for reactions.

3. Bases and salts

***Base**	A substance that neutralises an acid to form a salt and water.
***Salt**	A compound formed from the metal cation of a base and the non-metal anion of an alkali.
***Naming salts**	Two-part names. First part = the metal from the base, second part = the anion from the acid.
***Acids and their anions**	Sulfuric acid → sulfate Nitric acid → nitrate Hydrochloric acid → chloride
****Reaction of metal oxides with acid**	Metal oxide + acid → salt + water E.g. Magnesium oxide + hydrochloric acid → magnesium chloride + water $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$
***Preparing soluble salts**	- Gently warm a beaker of acid - Add a spatula of metal oxide and stir until dissolved - Repeat until it no longer dissolves - Filter to remove excess oxide - Allow water to evaporate to produce pure crystals



Stage 1 Stage 2

4. Core practical – preparing copper sulfate (CP8)

***CP8 - Aim**	To produce crystals of copper sulfate by reacting copper oxide with sulfuric acid.
***CP8 - Setup**	Place 20 cm^3 of dilute sulfuric acid in a beaker and warm to 50 ^oC.
***CP8 – Adding excess copper oxide**	Add a spatula of black copper oxide and stir until dissolved. Repeat this process until a spatula does not fully dissolve.
***CP8 - Filtration**	Filter the solution and collect the filtrate.
***CP8 - Crystallisation**	- Place the filtrate in an evaporating basin - Heat the evaporating basin by placing above a beaker of boiling water. - Remove from heat when crystals start to form. - Leave somewhere warm to dry.
***CP8 - Results**	As the copper oxide dissolves the sulfuric acid turns blue. When there is copper oxide remaining, the solution looks black from the copper oxide floating in it. Blue diamond-shaped crystals should form.

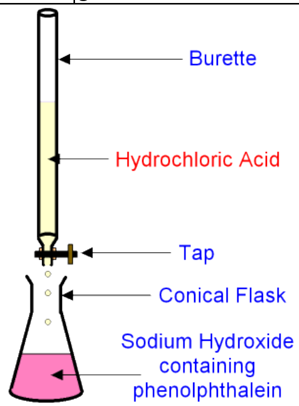
5. Alkalis and balancing equations

****Bases and alkalis**	A base is a substance that neutralises an acid to form a salt and water. An alkali is a base that is soluble in water.
***Common alkalis**	Sodium hydroxide, $NaOH$ Potassium hydroxide, KOH Calcium hydroxide, $Ca(OH)_2$
***Reaction of alkalis with acids**	Acid + alkali → salt + water Eg: Sodium hydroxide nitric acid → sodium nitrate + water $NaOH(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l)$
****Balancing equations**	- Use a tally chart to keep track of the number of atoms on each side. - Change the coefficients (the big numbers) to add more of things that are missing. - DO NOT TOUCH the little numbers

6. Core practical – investigating neutralisation (CP9)	
****pH meter**	An instrument that can measure pH more accurately than universal indicator.
***CP9 - Aim**	To see how the pH of an acid changes as you gradually add a base.
***CP9 - Setup**	Place 50 cm^3 of hydrochloric acid in a beaker and estimate its pH using a pH meter or universal indicator paper.
***CP9 – Run the experiment**	Add 0.3 g of calcium hydroxide powder, stir to dissolve and re-measure the pH. Repeat 7 more times.
***CP9 – Graph your results**	Plot a graph with mass of calcium on the x-axis and pH on the y-axis.
***CP9 - Results**	The pH will increase slowly at first, then very rapidly, then more slowly again.

7. Alkalis and neutralisation	
****Acid and alkali ions**	Acids produce hydrogen ions, H^+, alkalis produce hydroxide ions, OH^-.
****Ions and neutralisation**	The H^+ ion and OH^- ion react together to form H_2O (water).
****Producing a salt by neutralisation**	The salt is produced from the ions left over once the H^+ and OH^- ions have reacted together.
****Burette**	A tall glass tube with 0.1 cm^3 markings on it and a tap at the bottom used for accurately adding variable amounts of liquid.
****Pipette**	A piece of glassware used to very accurately measure a fixed amount of liquid.
****Titration**	A method used to find out exactly how much acid is needed to neutralise an alkali

****Titration method**	- Add alkali to beaker with a pipette - Add an alkali to the beaker - Gradually add acid from a burette - Note how much has been added at the point of neutralisation.
****Titration indicators**	Use indicators with a sharp colour change – such as phenolphthalein – rather than a gradual one such as universal.



8. Reactions of acids with metals and metal carbonates	
****Reaction of acid with metal**	Metal + acid → salt + hydrogen E.g. magnesium + hydrochloric acid → magnesium chloride + hydrogen $Mg(s) + 2HCl)aq) \rightarrow MgCl_2(aq) + H_2(_g)$
****Metal and acid observations**	- Bubbles of hydrogen gas - Metal dissolves - Warms up
*****Ionic equation**	A chemical equation that shows changes to the ions in a reaction.
*****Ionic equation for magnesium and acid**	$Mg + 2H^+ \rightarrow Mg^{2+} + H_2$
*****Spectator ion**	An ion that does not change during a chemical reaction.

*****Half-equations**	An equation that shows what happens to just one of the ions during chemical reaction. Two half-equations combine to give the overall ionic equation
*****Half-equation examples**	- $Mg \rightarrow Mg\ 2^+ + 2e^-$ - $2H^+ + 2e^- \rightarrow H_2$ Combine to give: $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$
****Reaction of metal carbonates with acid**	Carbonate + acid → salt + water + carbon dioxide E.g: Calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$
****Carbonate and acid observations**	- Bubbles of CO_2 gas - Solid carbonate dissolves
*****Carbonate and acid ionic equation**	$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

9. Solubility	
***Soluble**	When a substance can be dissolved by a liquid.
***Insoluble**	When a substance cannot be dissolved by a liquid.
****Soluble in water**	-All common sodium, potassium and ammonium salts - All nitrates - Most chlorides - Mot sulfates
****Insoluble in water**	- Silver and lead chlorides - Lead, barium and calcium sulfates - Most carbonates - Most hydroxides
***Precipitate**	A solid (insoluble) product formed by mixing two solutions. Turns the solution cloudy.

***Precipitation reaction**	A reaction that produces a solid precipitate by mixing two solutions.
****Predicting precipitation**	When mixing two solutions, swap the names of the salts around to find the possible products. If one is insoluble a precipitate forms.
****Precipitation equations**	AB + YX → AX + YB E.g: Sodium chloride + silver nitrate → silver chloride + sodium nitrate $NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$
*****Precipitation ionic equations**	Only include the ions that make the solid precipitate E.g: $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
***To prepare insoluble salts**	- Mix your two solutions - Filter the mixture - Wash the residue by pouring distilled water through the filter - Leave somewhere warm to dry

CC9: Quantitative chemistry

Kettering Science Academy

1. Relative Formula masses

Molecular formula	Gives the number of atoms of each element present in a molecule.
Empirical formula	The **simplest ratio** of the atoms of each element present in a compound.
Converting molecular to empirical formulae	Divide the number of each atom by the highest common factor of all of the atoms.
Molecular to empirical formula examples	C_4H_8 ← write the formula 4 : 8 ← write as a ratio $\frac{4}{4} : \frac{8}{4}$ ←divide by small number 1 : 2 ← simplest ratio CH_2 ← write as formula
Relative atomic mass, Ar	The mass of an atom relative to 1/12th the mass of carbon-12. No units.
Relative formula mass, Mr	The mass of one unit of a formula, found by adding the relative atomic masses of all of the atoms in it.

2. Calculating empirical formulae

Steps to calculate empirical formulae from experimental data	1) Write each element's symbol with a ratio (:) symbol between 2) Write out the amount of each element from the questions 3) Divide each amount by the A_r of the element 4) Divide each answer by the **smallest number** to get a ratio 5) Write the empirical formula
To find a molecular formula from an empirical formula	1) Calculate M_r for the empirical formula 2) Divide the M_r of the molecular formula by this number 3) Multiply the empirical formula by your answer

Empirical formula example

A compound contains 14.3% hydrogen by mass and 85.7% carbon. Determine its empirical formula.

Symbols:	C	:	H
Amounts:	85.7%		14.3%
by A_r:	85.7 ÷ 12 = 7.14		14.3 ÷ 1 = 14.3
÷ by smallest:	7.14 ÷ 7.14 = 1		14.3 ÷ 7.14 = 2
Write formula:	CH_2		

The relative formula mass of the compound is 28, determine its molecular formula.

M_r of empirical: $M_r(CH_2)$ = 12 x 1 + 1 x 2 = 14
÷ molecular M_r by empirical M_r: 28 ÷ 14 = 2
Multiply empirical formula: CH_2 x 2 = C_2H_4

3. Magnesium Oxide Experiment

Equipment	Crucible (small pot capable of withstanding high heat) Clay triangle (to put the crucible on because a gauze would melt)
Method	1) Weigh small amount of magnesium ribbon 2) Heat in a **crucible** to react with air 3) Reweigh once cool to find new mass.
Results	It gets heavier because the oxygen has been added to the solid
Analysis	Find the mass of oxygen added by doing **new mass – old mass.** **Then do the empirical formula calculation**
Magnesium Oxide	Is MgO

3. Conservation of mass

Conservation of mass	The total mass of products must equal the total mass of reactants.
Precipitation reaction	A reaction that produces An insoluble solid precipitate by mixing two solutions.
Closed system	A system in which no chemicals can enter or leave, such as a sealed test tube.
Open system	A system in which chemicals can enter or leave – such as an open test tube.
Conservation of mass in a closed system	No atoms are able to enter or leave - total mass stays the same. Example: precipitation in a closed flask.
Conservation of mass in an open system	Atoms can leave – total mass appears to change. Example: a carbonate reacting with acid producing CO_2 bubbles: the mass appears to decrease because you can't weigh the gas that goes into the air, however it is still there.

4. Calculating reacting masses

Excess reactant	Any reactant which is not used up completely in a reaction because there is more of it than needed.
Limiting reactant	Any reactant which is completely used up in a reaction. The limiting reactant determines how much product is made because it will run out of this then stop.
Stoichiometry	Means the balancing of an equation. Use the **limiting reactant** to work out how much is made from balancing.
Calculating reacting masses	1) Write out the balanced equation 2) Calculate the RFMs 3) Write the RFMs as a **ratio** 4) Divide both sides of the ratio by the RFM of the chemical you know the mass of 5) Scale up or down
Calculate concentration	Concentration = $\frac{\text{mass in g}}{\text{volume in dm}^3}$
Convert cm^3 to dm^3	$\frac{cm^3}{1000} = dm^3$

Reacting masses example

What mass of iron can be produced from 50 g of iron oxide (Fe_2O_3)?

$2Fe_2O_3 + 3C$	→	$4Fe + 3CO_2$
320	:	224
$\frac{320}{320}$	:	$\frac{224}{320}$
1	:	0.7
1 × 50	:	0.7 × 50
50g	:	**35g**

RFM calcs: **2 Fe_2O_3:** 2 x (2 x 56 + 3 x 16) = 320
4 Fe: 4 x 56 = 224

5. Moles (HIGHER ONLY)

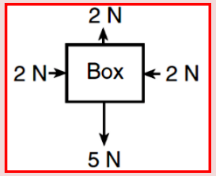
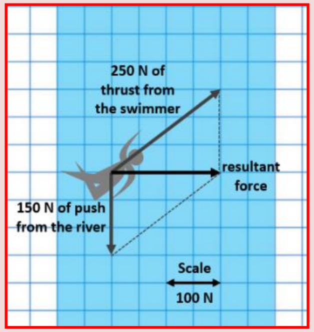
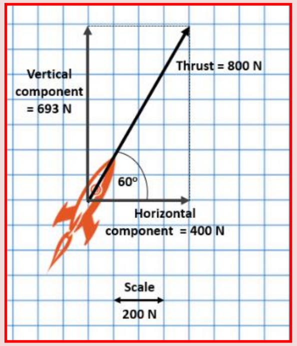
Moles	Measures **amount of substance** – one mole of any chemical is the same amount.
One mole is…	The Avogadro number of particles (atoms, ions or molecules)
One mole is also…	The mass in grams of its relative formula mass.
Avogadro's constant	6.02×10^{23}: the number of atoms/molecules present in one mole of a substance.
Calculating moles from mass	moles = $\frac{\text{mass}}{\text{relative formula mass}}$
Calculating moles from a number of particles	Quantity in moles = $\frac{\text{no.particles}}{6.02 \times 10^{23}}$
Calculating the number of particles from moles	No. particles = moles x 6.02×10^{23}

Lesson	Memorised?
1. Relative Formula Masses	
2. Calculating Empirical Formulae	
3. Conservation of mass	
4. Reacting masses	
5. Moles	

P7/8 Energy and Forces and their Effects

1. Work and Power	
Energy	Needed to make things happen or change.
Joules	The units of energy, symbol = J.
Kilojoules	1000 J, symbol = kJ.
Work Done	The energy transferred by a force.
Calculating Work Done	Work done = force x distance E = F x d Work done = joules Force = newtons Distance = metres
Power	The rate of energy transfer.
Watts, W	The unit of power: 1 W = 1 joule per second
Calculating Power	Power = work done / time P = E / t Power = watts Work done = joules Time = seconds

2. Contact & Non-Contact Forces	
Contact Force	A force that acts when two objects touch.
Contact Force Examples	Normal contact force, friction, upthrust, air resistance.
Normal Contact Force	Force that acts at right angles to a surface as a reaction to a force on that surface.
Non-contact Force	A force that acts at a distance.
Non-contact Force Examples	Gravity, magnetism, electrostatic force.
Action-Reaction Forces	If, A applies an action force to B, B applies a reaction force of same size and opposite direction to A.
Force Field	The area around an object where its force can affect other objects.
Magnetic Field	The area of magnetic force around a magnet.
Magnet	Attracts magnetic materials (iron, nickel, cobalt) and attracts or repels other magnets.
Electric Field	The area of electrostatic force around an object charged with static electricity.
Vectors	Arrows that show size and direction.

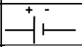
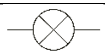
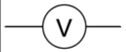
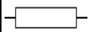
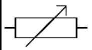
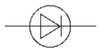
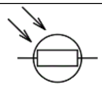
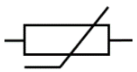
3. Vector Diagrams (HIGHER ONLY)	
Free Body Diagram	A diagram showing all the forces on an object. 
Vector Diagram Arrows	Arrows showing the size and direction of a force – must be drawn to scale.
Scale Diagram	Diagram drawn on graph paper to find the size of forces.
Resultant Force	The force left over when forces acting in opposite directions are cancelled out.
Resultant Force Diagram	Draw correct arrows for two forces, add lines to make a parallelogram. Resultant force = the diagonal of the parallelogram.
Resultant Force Diagram	
Resolving Forces	Breaking a force up into its horizontal and vertical components.
Component Forces	The vertical and horizontal forces that a diagonal force is made from.
Resolving Forces Diagram	Draw a correct force arrow, add arrows for vertical and horizontal component forces.
Resolving Forces Diagram	

Lesson	Memorised?
1. Work and Power	
2. Contact & Non-Contact Forces	
3. Vector Diagrams	

CP9 Electricity and Circuits

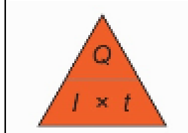
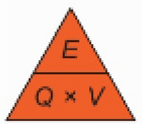
Lesson sequence

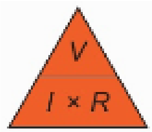
36. Electrical circuits
37. Current and potential difference
38. Current, charge and energy
39. Current, resistance and potential difference
40. More about resistance
41. Core practical – investigating resistance (CP15)
42. Transferring energy
43. Electrical power
44. Using electricity
45. Electrical safety

Circuit symbols	
Switch	
Cell	
Battery	
Lamp	
Ammeter	
Voltmeter	
Resistor	
Variable resistor	
Diode	
LDR	
****Thermistor**	

1. Electrical circuits	
Delocalised electrons	Electrons that are free to move between many different atoms.
Conventional current	The flow of positive charge from the positive terminal towards the negative terminal (goes in the opposite direction to electrons).
Electron flow	Electrons flow from the negative terminal towards the positive terminal.
Series circuit	A circuit in which there is only one path for the current to flow.
Parallel circuit	A circuit with multiple paths for the current to flow.

2. Current and Potential Difference	
Amperes, A	The unit of measurement for current. Amps for short.
Ammeter	Used for measuring current. Connected in **series** to measure the current **passing through** a component or circuit.
Potential difference	Also called voltage. This is what pushes electrons around a circuit.
Volts, V	The unit of measurement for potential difference.
Voltmeter	Used for measuring potential difference. Connected in **parallel** to measure the potential difference **across** a component or circuit.
Current in series circuits	The **same** at all points in the circuit.
Current in parallel circuits	**Less** on the branches than at the battery. Current on branches adds up to that at the battery.
Potential difference in series circuits	Potential difference is **shared** between the components on a circuit. It adds up to be the same as the battery.
Potential difference in parallel circuits	Potential difference is the **same** across each branch as it is across the battery.

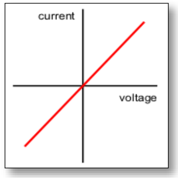
3. Current, charge and energy	
Charge	The amount electricity that has flowed through a circuit.
Coulombs, C	The unit of measurement for charge.
Current, I	The number of coulombs of charge that flows past a point each second. 1 amp = 1 coulomb per second
Calculating charge	Charge = current x time Q = I x t Q is charge (C) I is current (A) T is time = (s) 
Voltage, V	The amount of energy transferred by each coulomb of charge. One volt = 1 joule per coulomb.
Calculating energy	Energy = charge x potential difference E = Q x V E is energy (J) Q is charge (C) V is potential difference (V) 

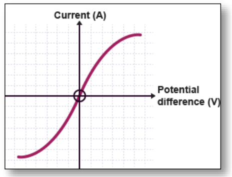
4. Current, resistance and potential difference	
Resistance	The difficulty with which current passes through materials.
Ohms, Ω	The unit of measurement for resistance.
High/low resistance	Higher resistance → better insulator→ lower current Lower resistance →better conductor→ higher current
Changing current	Higher voltage → higher current Higher resistance → lower current
Calculating resistance 	Current = potential difference / resistance I = V / R I is current (A) V is potential difference (V) R Is resistance (Ω) Note: This equation is normally written as V = IR.

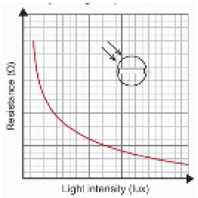
Resistors	Circuit components with differing resistance to control how much current flows to parts of a circuit.
Resistors in series	Total resistance is the sum of all of the resistors.
Voltage and resistors in series	Voltage is shared in proportion to the resistance. The resistor with more resistance takes more of the voltage. Calculate this using V=IR.
Resistors in parallel	Think about each branch of the circuit as a different series circuit. Resistors on different branches do not affect each other. The total resistance of resistors in parallel will always be **less** than resistors in series.

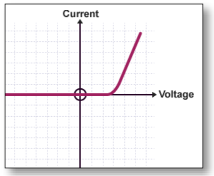
5. More about resistance

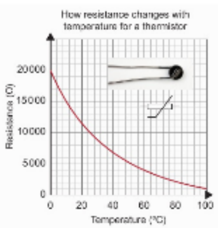
LDR	Light-dependent resistor. High resistance in dark, low resistance in light.
Thermistor	High resistance when cold, low resistance when hot.
Diode	High resistance in one direction, low resistance in the other.
Filament lamp	High resistance causes the filament to heat up, producing light.
Resistor graph	Current increases in direct proportion to voltage (straight line going through the origin (0,0)).
Filament lamp graph	Current increases as voltage increases, but levels out eventually as resistance increases with temperature.
Diode graph	Graph slopes up with a positive voltage but stays at 0 with a negative voltage.











6. Core practical CP15 Investigating resistance

CP15 - Aim	To explore how resistance changes in different circuits.
CP15 - Investigating resistance	Set up a circuit with an ammeter, resistor and voltmeter across the resistor. Vary the voltage and record voltage and current.
CP15 - Investigating series circuits	Set up a series circuit with an ammeter, two bulbs and voltmeters across each bulb and the power supply. Vary the voltage and record all readings
CP15 - Investigating parallel circuits	Set up a parallel circuit with two bulbs and ammeters on each branch and by the power supply, and voltmeters across each bulb and the powers supply. Vary voltage, record all readings.
CP15 - Results	Resistor – doubling voltage doubles current Series circuit – voltage at bulbs half of that at power supply Parallel circuit – voltage at bulbs equal to power supply, current half that at power supply

7. Transferring energy

Calculating energy transfer	Energy = current x potential difference x time E = I x V x t Energy (J) Current (A) Potential difference (V) Time (s)
Resistance and energy transfer	Electrons flowing through wires collide with atoms and lose energy. This energy is transferred to heat.

Electrical energy dissipation	When electrical energy is transferred to the surroundings as wasted heat energy by resistance.
How to reduce resistance	Use thicker wires, use shorter wires, use lower-resistance metals, reduce the temperature.

8. Electrical power

Power	The rate of energy transfer.
Watts, W	The unit of power: 1 W = 1 joule per second
Power and work done	$P = \frac{E}{t}$ P is power (W) E is work done (J) t is time (s)
Power, current and voltage	$P = I \times V$ P is power (W) I is current (A) V is the potential difference (V)
Power, current and resistance	$P = I^2 \times R$ P is power (W) I is current (A) R is resistance (Ω)

9. Using electricity

Mains electricity	The electricity supplied from wall sockets.
National grid	The systems of power lines and sub-stations that distributes electricity from power stations to homes and businesses.
Heaters	Transfer energy from electrical to thermal.
Motors	Transfer energy from electrical to kinetic.
Direct current	Current that flows in one direction.
Alternating current	Current that switches direction many times each second.
Frequency of mains current	Mains current alternates (switches direction) 50 times each second. The frequency is 50 Hz.

10. Electrical safety

Live wire	Brown, bottom right, 230 V, connects the appliance to the power station.
Neutral wire	Blue, bottom left, 0 V, completes the circuit.
Earth wire	Green and yellow, top, 0 V. Connects the appliance to the ground so current can flow there in the event of a short circuit.
Fuse	A thin metal wire that melts and breaks the circuit if there is too much current.
Circuit breaker	Breaks the circuit if too much current flows.
Advantages of circuit breakers	Quicker than fuses, just need switching - not replacing.

Lesson	Memorised?
Circuit symbols	
1.Electrical circuits	
2. Current and potential difference	
3. Current, charge and energy	
4. Current, resistance & potential difference	
5. More about resistance	
6. Core practical CP15 investigating resistance	
7. Transferring energy	
8. Electrical power	
9. Using electricity	
10. Electrical safety	

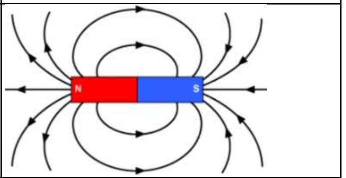
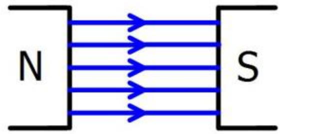
Reducing resistance (HIGHER AND TRIPLE ONLY)

Reducing resistance	Use a low resistance metal for the wires. Make the wire thicker. Cool the wires so ions do not vibrate as much.

P10 Magnetism and the Motor effect / P11 Electromagnetic Induction

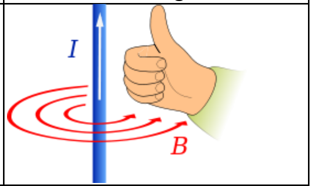
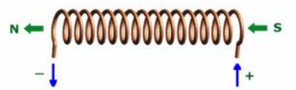
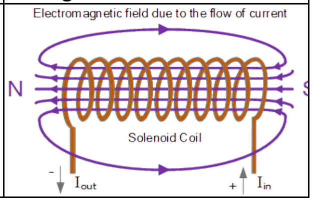
Kettering Science Academy

P10a Magnets and magnetic fields

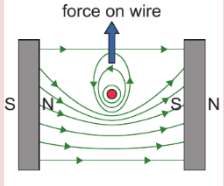
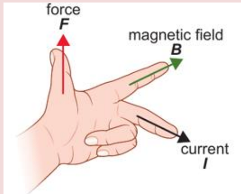
Magnet	An object that has its own magnetic field around it.
Permanent magnet	A magnet that is always magnetic such as a bar magnet.
Temporary magnet	A magnet that is not always magnetic, such as an electromagnet or an induced magnet.
Induced magnet	A piece of magnetic material that becomes a magnet because it is in the magnetic field of another magnet.
Uses of magnets	Motors, loud speakers, generators, door locks, knife holders.
Magnetic field	The area of magnetic force around a magnet where it can affect magnetic materials or induce a current.
Magnetic field lines	Magnetic field lines are a visual tool used to represent magnetic fields.
Bar magnet field shape	
Uniform magnetic field shape	
Magnetic field direction	From North to South.

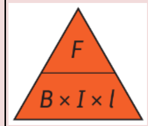
Earth's magnetic field	The North Pole is a magnetic south pole (because it attracts the north of bar magnet).
Magnetic materials	A material, such as iron, steel, nickel and cobalt that is attracted to a magnet.
Plotting compass	A small compass used to find the shape of a magnetic field.

P10b Electromagnetism

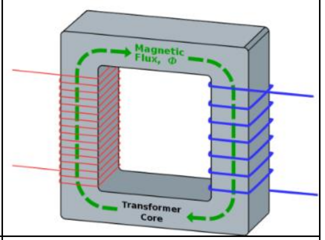
Electromagnetism	Is the study of the electromagnetic force.
Magnetic effect	A current flowing through a wire causes a magnetic field.
Wire magnetic field shape direction (right hand rule)	
Wire magnetic field strength	Stronger nearer the wire and with higher current.
Solenoid	A coil of wire with current running through it. 
Electromagnet	A magnet made using a coil of wire with electricity flowing through it.
Solenoid magnetic field shape	
Solenoid magnetic field direction	From north (negative side) to south (positive side).
Stronger magnetic field of a solenoid	The magnetic field of a solenoid can be made stronger by putting a piece of iron (an iron core) inside the coil or increasing the current.

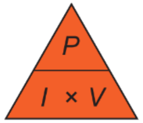
Higher only P10c Magnetic forces

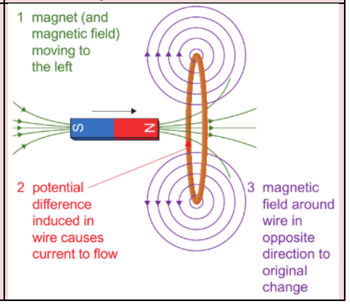
Motor effect	The force experienced by a wire carrying a current that is placed in a magnetic field.
Two magnetic fields interaction	 When the wire carrying a current is put between the magnets, the two fields interact to produce a force.
Direction of force from motor effect	Fleming's left-hand rule – index finger points in direction of magnetic field, middle finger points from + to – current, thumb points in direction of force. 
Force from motor effect is greatest when…	Magnetic field and electric field are at right angles, wire is longer, current is greater, magnet is stronger.
Magnetic flux density, B	The strength of a magnetic field.
Newtons per amp metre (N / A m)	Units of magnetic flux density.
Tesla, T	Same as newtons per amp metre.

Calculating forces from the motor effect	Force = Magnetic flux density x current x Length F = B x I x L  Force (F) = newton (N) Magnetic flux density (B) = tesla (T) Current (I) = amp (A) Length (L) = metre (m)

P11a Transformers

Transformer	A device that can change the voltage of an electricity supply.
Electromagnetic induction	A process that creates a current in a wire when the wire is moved relative to a magnetic field, or when the magnetic field around it changes.
Induce	To create. For example, a wire in a changing magnetic field has a current induced in it.
Transformer structure	
Coils	Primary coil electricity in, secondary coil electricity out.
How transformers work	Current passing through the primary coil induces a current in the secondary coil of higher voltage and lower current (or vice versa).
Conservation of energy in transformers	If the voltage increases, the current decreases, so energy is conserved since: Power = current x voltage

Conservation of energy in transformers	The power supplied to a transformer in the primary coil must be equal to the power transferred away from the secondary coil.
Electrical power	The amount (rate) of energy transferred per second. The units are watts (W). Electrical power = Current x Voltage P = I x V  Power (P) = watt (W) Current (I) =amp (A) Voltage (V) = volt (V)
Transformer calculations	Primary coil voltage x primary coil current = secondary coil voltage x secondary coil current $V_p \times I_p = V_s \times I_s$ Voltage (V) = volt (V) Current (I) = amp (A)

P11b Transformers and energy	
National grid	The system of cables and transformers that transfers electricity from power stations to homes and businesses.
Transmission lines	The wires (overhead or underground) that take electricity from power stations to towns and cities.
Voltage in the national grid	Power station = 25 kV Overhead cables = 400 kV Factories = 33 kV Homes = 230 V
Step-up transformer	Increase voltage and decreases current.
Step-down transformer	Decrease voltage and increases current.
Higher only	
Factors affecting the potential difference induced in a transformer	- the number of turns in a coil of wire - how fast the magnetic field changes or moves past the coil
Transformers and current	Transformers only work with alternating current.
Alternating current	Current whose direction changes many times each second.
Primary coil voltage VS Secondary coil voltage	The potential difference (voltage) is greater in the primary coil if it has more turns than the secondary coil.
Induced voltage (current) in a loop of wire	

Lesson	Memorised?
P10a Magnets and magnetic fields	
P10b Electromagnetism	
P10c Magnetic forces	
P11a Transformers	
P11b Transformers and energy	

P12-13: Particle model, forces and matter

1. Particles and density

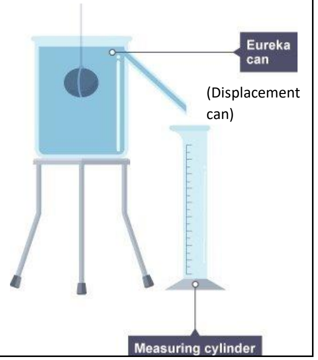
State of matter	Solid, liquid or gas.
Changes of state	Melting: solid → liquid Freezing: liquid → solid Evaporation: liquid → gas Condensation: gas → liquid Sublimation: solid → gas Deposition: gas → solid
Solid	Particles touching, neatly ordered, vibrating around a fixed point.
Liquid	Particles touching, random order, moving slowly.
Gas	Particles widely spaced, random order, moving fast.
Changing state	Increasing temperature gives particles more (kinetic) energy, allowing them to break the forces of attraction.
Density	The mass of 1 m^3 of a substance. Units = kg / m^3 (but could be g / cm^3)
Density and state	Solid > liquid > gas, due to particles being closer together.
Density calculations	Density = mass / volume ρ = m / v Density = kilograms per cubic metre Mass = kilograms Volume = metres cubed

2. Core practical – investigating densities

Core Practical - Aim	To measure the density of some solids and liquids
Core Practical – Density of liquids	Place a measuring cylinder on a balance and zero it. Add some liquid and record the mass and volume, Repeat with different liquids.

Core Practical – Density of solids

Record the mass of a solid object. Fill a displacement can and place the object in it, catching the water in a measuring cylinder. Record the volume collected.



3. Energy and changes of state

Thermal energy and motion	The hotter an object is, the faster its particles are moving (**more kinetic energy**).
Temperature	A measure of the average kinetic energy of the particles.
Temperature vs thermal energy	A very small hot object has less thermal energy than a very large cold object, because thermal energy is the energy of all the particles added up.
Thermal energy depends on…	Temperature, mass, material.
Specific heat capacity, Q	The amount of energy required to increase the temperature of 1 kg of a substance by 1 °C.
Specific latent heat of evaporation	The amount of energy required to change 1 kg of a substance (at its boiling point) from liquid to gas.
Specific latent heat of melting	The amount of energy required to change 1 kg of a substance (at its melting point) from solid to liquid.
Heating curve (see back of sheet)	

4. Energy calculations

Temperature change calculations	Thermal energy change = mass x specific heat capacity x temperature change $\Delta Q = m \times c \times \Delta T$ Thermal energy change = J Mass = kg Specific heat capacity = J / kg Temp change = °C
State change calculations	Thermal energy = mass x specific latent heat Q = m x L Thermal energy = J Mass = kg Specific latent heat = J / kg

5. Core practical – investigating water

Core Practical - Aim	To investigate the temperature change as ice melts, and measure specific heat capacity of water.
Core Practical – Melting ice	Place some ice in a boiling tube, measure the temperature then place the tube in a beaker of hot water from a kettle, kept warm by Bunsen, and measure temperature every 60s until fully melted.
Core Practical – Melting ice results	Temperature rises steadily at first but levels out during melting.
Core Practical – finding the specific heat capacity	Place a polystyrene cup on a balance, zero it, mostly fill with water then measure the mass. Measure the temp. Use an immersion heater connected to a Joulemeter to warm the water for 5 minutes and measure the temperature again.
Core Practical - problems	Heat energy moves! Use **insulation** and **lids** to stop this happening

6. Gas temperature and pressure

Gas pressure	Every time a gas particle hits a surface it pushes with a small force; gas pressure is the sum of these forces.
Increasing gas pressure	Gas pressure increases with temperature and number of particles.
Increasing temp increases gas pressure	Temp ↑ = particle speed ↑. particle speed ↑= more collisions particle speed ↑= harder collisions so gas pressure ↑
Pascals, Pa	The unit of pressure: 1 Pa = 1 N / m^2
Absolute zero, 0 K	The coldest possible temperature when particles completely stop moving.
Kelvins	Measures temperatures relative to absolute zero: 0 K = absolute zero.
Kelvins and degrees Celsius	A kelvin is the same size as a degree Celsius, but 0 K = -273°C, 273 K = 0 °C
Converting K to °C	subtract 273 (add 273 to go °C to K)
Gas pressure and temp	Gas pressure is directly proportional to temperature in K.

6a. Pressure and Volume (triple only)

Pressure and volume	Reducing volume (squeezing) increases pressure. Increasing volume reduces pressure.
Pressure volume explanation	Volume ↓ Collisions with side of container ↓ Pressure ↑
PV calculations	$P_1 \times V_1 = P_2 \times V_2$ P_1 = pressure at start (Pa) V_1 = volume at start (m^3) P_2 = pressure at end (Pa) V_2 = volume at end (m^3)
Bicycle pump (HT)	A force moves through a distance So work is done So energy is transferred to heat So the pump gets hotter

7. Bending and stretching

Elastic distortion	When something returns to its original shape after force is applied.

Inelastic distortion	When something doesn't return to its original shape after force is applied.
Extension	The increase in length of a spring when a force is applied.
Direct proportion	Doubling A doubles B, a graph of B vs A **straight line through the origin**.
Metal spring force vs extension	**DIRECTLY PROPORTIONAL** while it is **ELASTIC** Until high forces when **NON-LINEAR**
Rubber band Force vs extension	**NON-LINEAR**

8. Core practical – investigating springs

Core Practical - Aim	To explore how increasing the force affects the extension of a spring.
Core Practical - Setup	Suspend a spring or rubber band from a clamp stand and fix a metre ruler in place so the '0' is level with the bottom of the spring/band.
Core Practical – Measurements	Hang a 100 g (1 N) mass from the rubber band / spring, and measure the extensions. Repeat up to 1 kg.
Core Practical - Variations	Repeat with different springs or wires or other materials
Core Practical - Calculations	Calculate spring constant as: Spring constant = force / extension

9. Extensions and energy transfers

Spring constant	A measure of the strength of a spring: units = N/m
Spring constant and graphs	The spring constant is the gradient of a graph of force vs extension.

Force and extension calculations	Force = spring constant x extension F = k × X Force = N Spring constant = N/m Extension = m
Extension is greater when…	Force is higher, spring constant is lower
Work done	The energy transferred by a force.
Spring energy calculations	Energy transferred in stretching = ½ x spring constant x extension^2 E = ½ x k x X^2 Energy = J Spring constant = N / m Extension = m

10. Pressure in Fluids (triple only)

Atmospheric pressure pattern	High at sea level, low further up because less weight of air pushing down (as in any fluid)
Pressure in fluids	Pressure from fluid + pressure from air
Force from pressure	Acts 'normal' (90º) to any surface in the fluid
Pressure Calculation	Pressure = Force/Area P= F / A Pressure = N/m^2 or Pa Force = N Area = m^2
Factors affecting fluid pressure	• Depth • Fluid density … because these change the **weight** of fluid above
Pressure examples	- snow shoe big area to reduce pressure and stop sinking - pin, decrease area, increase pressure - submarine, thick walls to cope with increased pressure

11. Pressure in Fluids (triple only) (H only)

Pressure at different depths calculation	Pressure = density × gravity × height P = ρ × g × h P = pressure (N/m^2 or Pa) ρ = density (kg/m^3) g = gravity (N/kg) normally 10 h = height (m)
Upthrust	- experienced by an object when partly or fully submerged - equal to the weight of the fluid displaced
Object Floats	When upthrust equals weight. Density of object is less than fluid
Object Sinks	When upthrust is smaller than weight. Density of object is greater than fluid