Year 9 End of year revision

9BP: Plants and photosynthesis

Photosynthesis
- Plants make their own food (for energy) in a process called **photosynthesis**.
- Photosynthesis helps keep:
  - levels of oxygen high;
  - levels of carbon dioxide low.

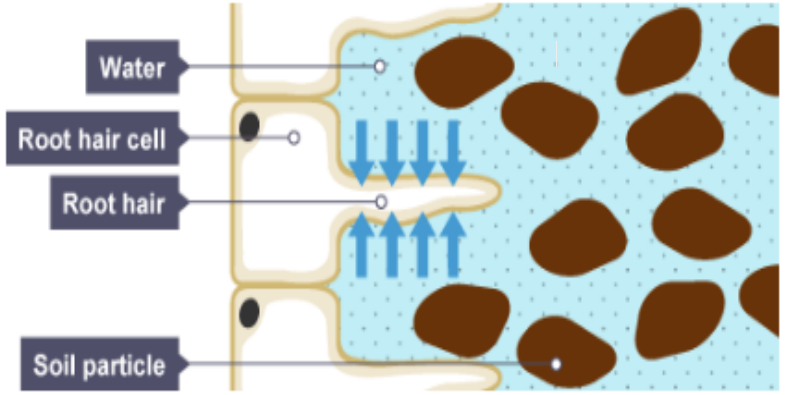
- Photosynthesis takes place in the **chloroplasts.**
- Chloroplasts contain **chlorophyll** which absorbs the energy transferred by light waves for photosynthesis

The equation for photosynthesis is:

carbon dioxide + water → glucose + oxygen

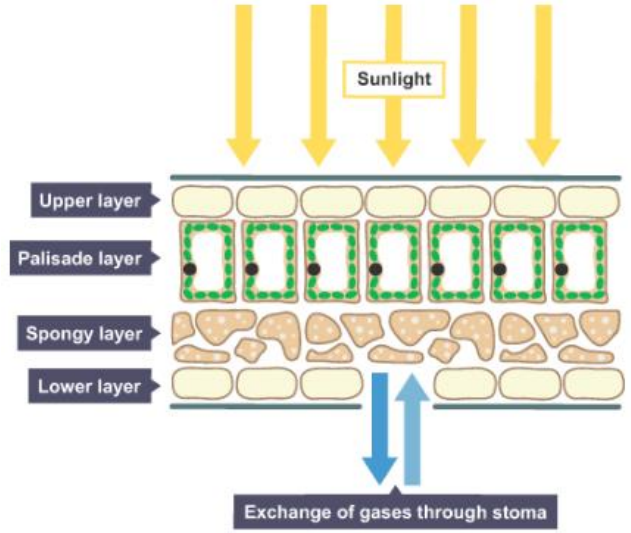
These are the things that plants need for photosynthesis:
- **carbon dioxide** – absorbed through their leaves;
- **Water** - from the ground through their roots;
- **light** (a source of energy) - from the Sun.

These are the things that plants make by photosynthesis:
- **Oxygen** - released into the air from the leaves;
- **Glucose**:
  - turned into **starch** and plant oils, used as an energy store;
  - This energy is released by **respiration**;
  - Used to make **cellulose** for cell walls.



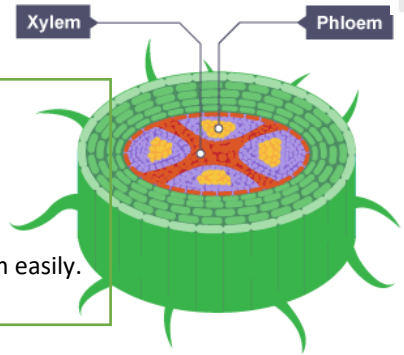
Water is absorbed into the roots by a process called **osmosis**, which does not use energy.
Minerals are absorbed into the roots by a process called **active transport,** which uses energy.

Feature of plant leaf	Function
Thin	Short distance for carbon dioxide to diffuse into the leaf
Waxy Layer	Prevents water loss by **evaporation**
Palisade cells	Contain a lot of **chloroplasts** to absorb light
Chloroplasts contain chlorophyll	Absorbs light
Stomata	Allows carbon dioxide to diffuse into the leaf (and oxygen to diffuse out)
Guard cells	Open/close stomata depending on conditions
Network of tubes (xylem & phloem)	Transports water (xylem) and food (phloem)



A cross-section through a leaf showing its main parts

Water
- Water is absorbed through the roots, by **osmosis**;
- It is transported through tubes (**xylem**) to the leaf;
- The roots contain cells called a **root hair cells:**
  - They increase the **surface area**
  - They have **thin walls to** let water pass into them easily.
  - They **do not** contain chloroplasts.



Respiration v photosynthesis
Photosynthesis:

carbon dioxide + water → glucose + oxygen

Aerobic respiration is:

glucose + oxygen → carbon dioxide + water

The equation for photosynthesis is the **opposite** of the equation for aerobic respiration.
- **Photosynthesis**:
  - **produces** glucose and oxygen;
  - **uses** carbon dioxide and water;
- **Respiration**:
  - **produces** carbon dioxide and water;
  - **uses** glucose and oxygen;

Food security and pollination
- **Pollination** is the transfer of pollen from one plant to another;
- Pollen can be transferred by **insects** or by **wind**;
- Insects that pollinate plants help us produce our food.
- Our food supply depends on plants:
  - Our food made of, and from plants;
  - The animals we eat feed on plants.

Carbon dioxide
- Enters leaf by **diffusion** through the **stomata**.
- **Guard cells** control the size of the stomata
- Stomata closes in **hot**, **windy** or **dry** conditions.
- Spongy layer has gaps between cells;
  - Allows carbon dioxide to **diffuse** to other cells in the leaf;
  - Allows oxygen produced in photosynthesis diffuse out of the leaf.

Photosynthesis

1. Write the missing words

- Plants make their own food (for energy) in a process called _____.
- Photosynthesis helps keep:
  - levels of oxygen _____;
  - levels of carbon dioxide _____.

2. Where does photosynthesis takes place?

3. Name the green chemical inside chloroplasts?

4. What is the function of this green chemical?

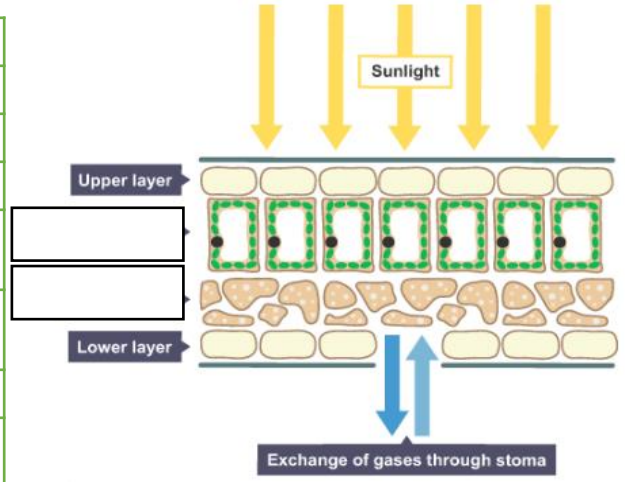
5. Write the word equation for photosynthesis

6. Name the 3 things needed for photosynthesis

7. Describe 3 ways plants use glucose made from photosynthesis

Feature of plant leaf	Function
	Short distance for carbon dioxide to diffuse into the leaf
Waxy Layer	
Palisade cells	
Chloroplasts contain chlorophyll	
	Allows carbon dioxide to diffuse into the leaf (and oxygen to diffuse out)
	Open/close stomata depending on conditions
Network of tubes (xylem & phloem)	

9BP: Plants and photosynthesis



A cross-section through a leaf showing its main parts

Water

1. Name the cells found in the roots?
2. Describe how root hair cells are adapted for water absorption?
3. Name the cell structure missing from root hair cells

Food security and pollination

1. What is pollination?
2. Which group of organisms are involved in pollination?
3. How else can pollen be transferred?
4. Explain why pollination is important?

1. What is absorbed by the roots? By which process is this absorbed into the roots?
2. Name the process by which minerals are absorbed into the roots?

3. How is the process mentioned in question 2 different from the process mentioned in question 1?

Respiration v photosynthesis

1. Write the word equation for respiration
2. How is photosynthesis different to respiration?
3. Which process uses carbon dioxide and water?
4. Which process uses glucose and oxygen?

Carbon dioxide

1. State the 3 weather conditions that closes the stomata
2. Name the gases that diffuse through the spongy layer
3. In which direction does the carbon dioxide diffuse?
4. In which direction does the oxygen diffuse?

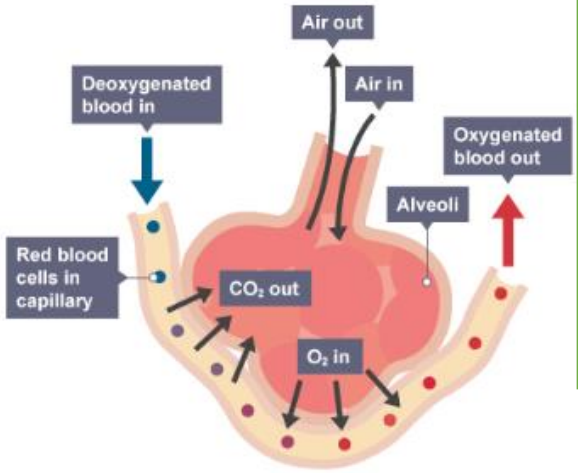
The human gas exchange system

- Oxygen is needed for respiration;
- Carbon dioxide produced in respiration needs to be removed;

Gas exchange is moving oxygen from the air into the blood, and removing waste carbon dioxide from the blood into the air.

The respiratory system contains the organs that allow us to get the oxygen we need and to remove the waste carbon dioxide we do not need:

- Air passes from the mouth into the **trachea** (windpipe);
- The trachea divides into two **bronchi** - one for each lung.
- Each bronchus divides into smaller tubes called **bronchioles**.
- At the end of each bronchiole, there are air sacs (**alveoli**)
- The alveoli increase the **surface** of the lungs.



Features of the alveoli

- Increase surface area of lungs;
- Moist, thin walls (just one cell thick);
- A lot of tiny blood vessels called **capillaries**

The gases move by **diffusion** (from a **high concentration to a low concentration**):

- oxygen diffuses from the air into the blood;
- carbon dioxide diffuses from the blood into the air.

Aerobic respiration

Energy is needed for:

- growth and repair
- movement
- control of body temperature in mammals/birds

The equation for aerobic respiration is:

glucose + oxygen → carbon dioxide + water

- Glucose and oxygen react to produce carbon dioxide and water and release energy;
- It is **aerobic** respiration because oxygen is used;
- Respiration happens in all living cells, including plant and animal cells;
- Takes place in the **mitochondria** of the cell;
- Energy is released from glucose;
- **Do not** confuse respiration with breathing (which is called **ventilation**).

Anaerobic respiration

In humans:

The equation for anaerobic respiration in humans is:

glucose → lactic acid

- Lactic acid builds up in the muscles;
- Causing pain and tiredness (fatigue);
- Can lead to cramp;
- Lactic acid is broken down when you start aerobic respiration again.

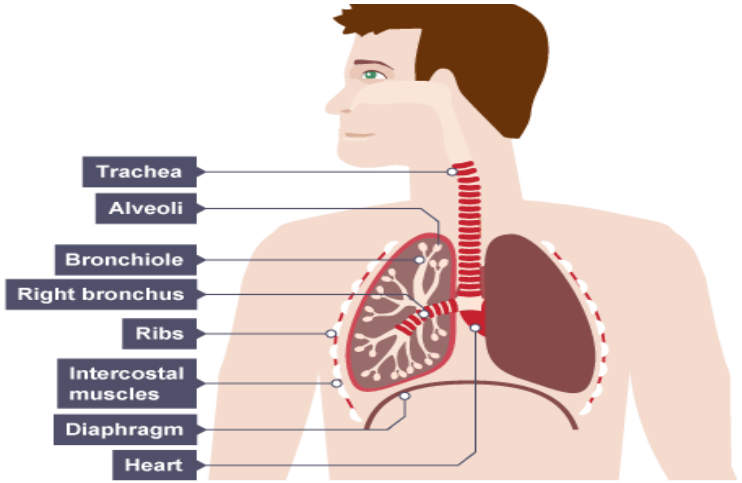
Fermentation

The equation for anaerobic respiration in yeast is:

glucose → ethanol + carbon dioxide

- Anaerobic respiration happens in microbes (eg bacteria);
- They need to release energy from glucose;
- Yeast (unicellular fungi) can carry out an anaerobic process called **fermentation;**
- Ethanol (alcohol) is produced;
- The ethanol is used to make beer and wine;
- The carbon dioxide helps bread rise.

9BB
Biological systems and processes



Ventilation

- Ventilation is another word for breathing;
- It involves movements of the **ribs**, **intercostal muscles** and **diaphragm** to move air in and out of the lungs:
- **inhale** – breathing in; **exhale** – breathing out;

	Inhaling	Exhaling
Diaphragm	Contracts and moves downwards	Relaxes and moves upwards
Intercostal muscles	Contract, moving the ribs upwards and outwards	Relax, letting the ribs move downwards and inwards
Volume of ribcage	Increases	Decreases
Pressure inside the chest	Decreases below atmospheric pressure	Increases above atmospheric pressure
Movement of air	Moves into the lungs	Moves out of the lungs

	Aerobic	Anaerobic
Needs oxygen?	Yes	No
Needs glucose?	Yes	Yes
Product(s) formed	Carbon dioxide and water	Lactic acid
Energy released	More	Less

Impact of exercise - exercise causes an increase in:

- breathing rate;
- tidal volume (volume of air breathed in/out in one breath);

Regular exercise can increase the:

- strength of the **diaphragm** and **intercostal muscles**;
- vital capacity (volume of air that can be forcibly exhaled after inhaling fully).

The human gas exchange system

1. Which gas is needed for respiration?
2. Name the gas produced in respiration needs to be removed;
3. What is gas exchange?
4. Complete the passage

- Air passes from the mouth into the _____ (windpipe);
- The trachea divides into two _____ - one for each lung.
- Each bronchus divides into smaller tubes called _____.
- At the end of each bronchiole, there are air sacs (_____)
- The alveoli increase the _____ of the lungs.

Features of the alveoli

1. Describe the features of the alveoli
2. What is diffusion?
3. In which direction does oxygen diffuse?
4. In which direction does the carbon dioxide diffuse?

Aerobic respiration

1. Write 3 ways energy is used
2. Write the word equation for aerobic respiration
3. Why is the equation in question 2 called aerobic question?
4. Where does respiration take place in cells?
5. What is released during respiration?

Anaerobic respiration

1. Write the word equation for anaerobic respiration in humans.
2. Name the chemical that builds up in the muscles during anaerobic respiration.
3. What does the build up of this chemical cause?
4. What can be done to break down this chemical built up in the muscles?
5. Write the word equation for anaerobic respiration in yeast
6. What is the name for this type of respiration?
7. Describe how ethanol and carbon dioxide is used in the food industry.

9BB
Biological systems and processes

	Inhaling	Exhaling
Diaphragm		
Intercostal muscles		
Volume of ribcage		
Pressure inside the chest		
Movement of air		

	Aerobic	Anaerobic
Needs oxygen?		
Needs glucose?		
Product(s) formed		
Energy released		

Impact of exercise

1. How does exercise affect the breathing rate and tidal volume?
2. Describe the impact of regular exercise

Smoking
Smoking is very harmful to health. Smoke contains harmful substances. These include:
- tar
- nicotine
- carbon monoxide

Tar
- causes cancer of the lungs, mouth and throat;
- coats the inside of the lungs causing coughing;
- damages the alveoli, making gas exchange difficult.

Smoke
- Cells in the trachea, bronchi and bronchioles produce **mucus**;
- Mucus traps dirt and microbes;
- Cells with **cilia** move the mucus out of the lungs;
- Smoke and tar damages the cilia;
- Smokers cough to move the mucus and are more likely to get bronchitis.

Nicotine
- Nicotine is **addictive**;
- Nicotine increases heart rate and blood pressure, and makes blood vessels narrower;
- This can lead to **heart disease**.

Carbon monoxide
- Carbon monoxide takes the place of oxygen in red blood cells;
- This reduces amount of oxygen that the blood can carry;
- It means the circulatory system has to work harder, causing heart disease.

Smoking and pregnancy
Smoking can damage the foetus during gestation. For example, it can:
- increase the risk of complications in pregnancy and birth;
- make it less likely to have a healthier pregnancy and a healthier baby
- increase the risk of stillbirth;
- make it more likely to be born too early;
- be more likely to be born underweight.

Drugs
Drugs are a substance that has an effect on the body.
They can be:
- **medicines** are drugs that treat pain or disease;
- **recreational drugs** are taken because people like the effects they have on their bodies.

- Some recreational drugs are legal, eg **caffeine**, **tobacco** & **alcohol**;
- Most recreational drugs are illegal, eg **cannabis**, **ecstasy** and **heroin**;
- Recreational drugs can be classified as a **depressant** or a **stimulant;**
- Most recreational drugs can be **addictive**.

9BB
Biological systems and processes

Asthma
- Asthma affects the bronchioles;
- Airways can become inflamed, swollen and constricted (narrowed);
- excess mucus is produced.

During an asthma attack:
- the lining of airways becomes **inflamed**;
- fluid builds up in the airways;
- muscles around bronchioles contract, which **constricts** airways.

Symptoms are:
- **wheezing**, **tight chest** and **difficulty breathing**.
- treated using drugs called **relievers** which relax and open up the airways.

Relievers are often administered using an **inhaler**, to breathe the medicine in directly into your lungs.

Stimulants
Stimulants speed up messages in the brain and along the nerves.

Legal Stimulants
- **Nicotine** and **caffeine** are legal stimulants;
- Caffeine is found in cola drinks, coffee and tea;
- Caffeine makes you feel more alert, but it can cause insomnia (difficulty in sleeping), headaches and nervousness;

Illegal Stimulants
- **Cocaine**, **ecstasy** and **amphetamines** are all illegal stimulants;
- Cocaine, ecstasy and amphetamines make you feel more energetic and confident, but damage the **liver** and **heart;**
- They cause loss of memory and concentration, and increase risk of mental illness;

Depressants
Depressants slow down messages in the brain and along the nerves;
- **alcohol**, **heroin** and **solvents** are depressants

Here are some of the typical effects depressants have on the body:
- feelings of well-being;
- lowered inhibition;
- slowed thinking;
- slowed muscular activity;
- a distorted view of the world, or hallucinations.

Long-term effects of depressants:
- damage to the liver, brain and heart;
- alcohol can cause weight gain;
- solvent abuse causes a rash around the nose and mouth;
- loss of memory and concentration;
- increased risk of mental illness.

- Any drug that is misused can cause damage to the body, as well as personal and social problems.
- Injecting drugs with syringes that someone else has used may lead to diseases such as **HIV** and **hepatitis**.

Tar

1. Describe 3 effects of Tar in the lungs

Smoke

1. What is produced by the cells in the trachea? What is it's function?
2. What moves the mucus out of the lungs?
3. What does the smoke and tar damage? What effects does this have?

Nicotine

1. Why is smoking difficult to give up?
2. Describe the effects of nicotine on heart rate, blood pressure and blood vessels.
3. What can the effects in question 2 lead to?

Carbon monoxide

1. What does carbon monoxide take the place of in red blood cells?
2. How does affect the amount of oxygen carried around the body?
3. What can it lead to?

Smoking and pregnancy

1. Describe 4 risks of smoking during pregnancy

Drugs

1. What are drugs?
2. Explain how medicines are different from recreational drugs?
3. Give 2 examples of legal recreational drugs
4. Give 2 examples of illegal recreational drugs?

9BB
Biological systems and processes

Asthma

1. Which part of the respiratory system is affected by Asthma?
2. Describe what happens during an asthma attack?
3. What are the symptoms of Asthma?
4. Name the drugs used to treat Asthma. Explain how they work?
5. How are these drugs administered?

Stimulants

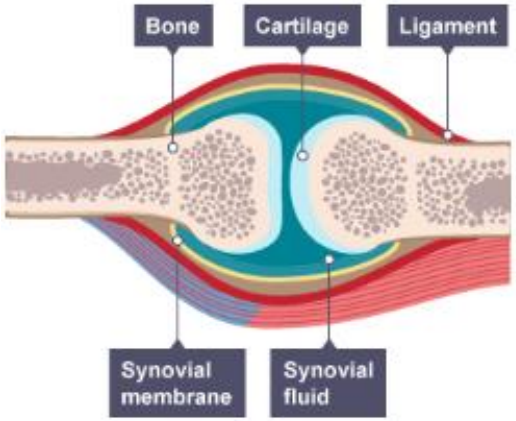
1. What is a stimulant?
2. Give 2 examples of legal stimulants
3. Give 2 examples of illegal stimulants
4. Describe the effects and causes of caffeine?
5. Describe the effects and causes of amphetamines

Depressants

1. Describe the effects of depressants on the brain and nerves
2. Describe 4 typical effects depressants have on the body.
3. Describe 4 Long-term effects of depressants

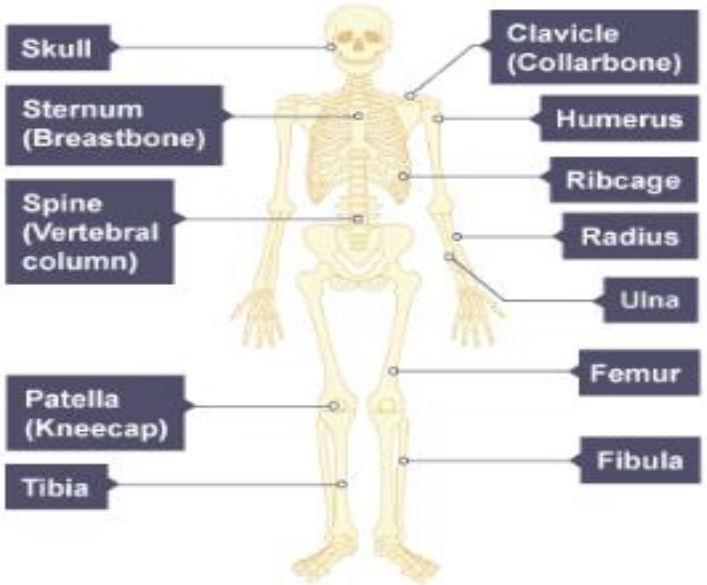
Joints

- Most joints allow parts of the skeleton to move;
- The human skeleton has joints called **synovial joints.**



The synovial joint

- The ends of the bones in a joint are covered with a tough, smooth substance called **cartilage**.
- This is kept slippery by a liquid called **synovial fluid**.
- Tough **ligaments** join the two bones in the joint;
- If two bones moved against each other, without cartilage they would eventually wear away;
- This is called **arthritis**.



The skeleton

- Bone is a living **tissue** with a blood supply.
- It is constantly being dissolved and formed
- It can repair itself if a bone is broken.
- Calcium and other minerals make bone strong but slightly flexible.

Four functions of the skeleton:

1) Support the body

The skeleton supports the body. For example, without a backbone we would not be able to stay upright.

2) Protection of vital organs

- the skull protects the brain
- the ribcage protects the heart and lungs
- the backbone protects the spinal cord

3) Movement

- Bones are linked together by joints;
- Some are **fixed joints** – eg in the skull;
- Some are **flexible joints** – eg the knee;
- Muscles move bones attached by joints.

4) Making blood cells

Two main types of blood cell:

- **red blood cells**, which carry oxygen;
- **white blood cells**, which destroy **harmful microbes** (pathogens);
- Both are made in the **bone marrow** - soft tissue inside large bones protected by the hard part of the bone around it.

Muscles and movement

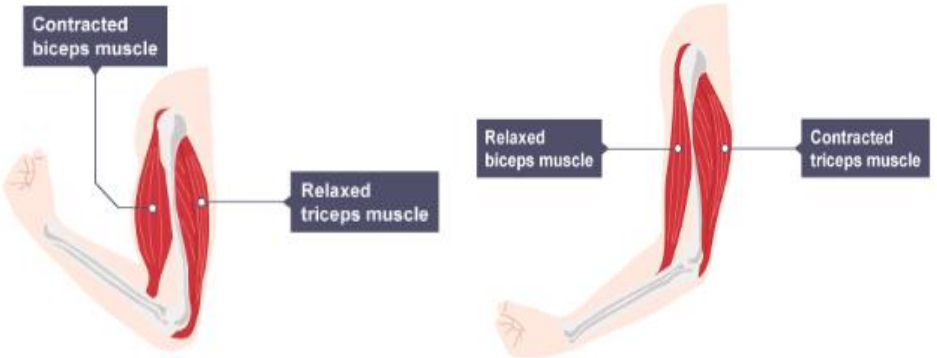
- Muscles work by getting shorter - they **contract**;
- Muscles are attached to bones by strong **tendons**.
- During muscle contraction, it pulls on the bone, moving it.

Antagonistic muscles

- Muscles can **only** pull, they **cannot push**;
- Muscles work in pairs, called **antagonistic muscles**;

Your elbow joint has two muscles that move your forearm up or down. These are the **biceps** and the **triceps:**

- to raise the forearm, the biceps contracts and the triceps relaxes;
- to lower the forearm again, the triceps contracts and the biceps relaxes.



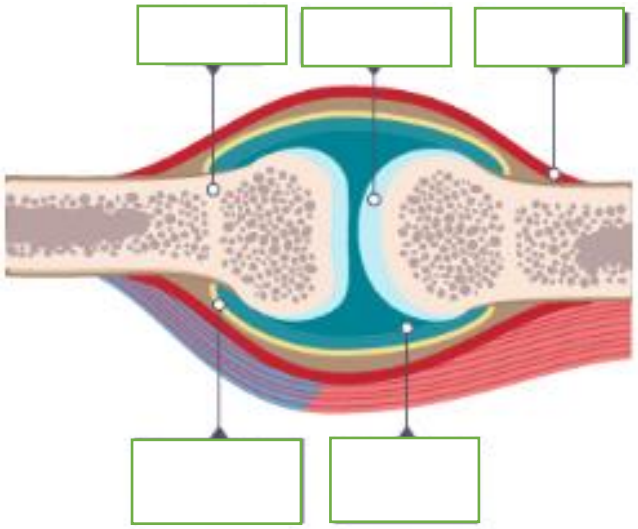
- Muscles exert a force on bones when they contract.
- You could work out the force exerted by the biceps muscle using the idea of **moments**.
- The way in which muscles and bones work together to exert forces is called **biomechanics**.

9BB
Biological systems and processes

Type of joint	Examples	Movement allowed
Hinge joint	Knee, elbow	The same as opening and closing a door, with no rotation (turning)
Ball and socket	Hip, shoulder	Back and forth in all directions, and rotation

Joints

1. What is the name given to human skeleton joints?



2. Name the tough smooth substance that is found at the ends of the bones in a joint?

3. Name the fluid that keeps the cartilage slippery?

4. What joins the two bones in the joint?

5. What would happen ff two bones moved against each other, without cartilage? What is this condition called?

The skeleton

1. State the 4 functions of the skeleton

2. Which organs does the ribcage protect?

3. What are the 2 main types of blood cells? Describe their function?

4. Where are these blood cells made?

9BB
Biological systems and processes

Muscles and movement

1. What do muscles do to work?

2. What attaches muscles to bones?

3. Describe what happens when a muscle contracts.

4. What can't muscles do?

5. What do you call muscles that work in pairs?

6. Describe how the biceps and triceps work to raise the forearm

7. Describe how the triceps and biceps work to lower the forearm

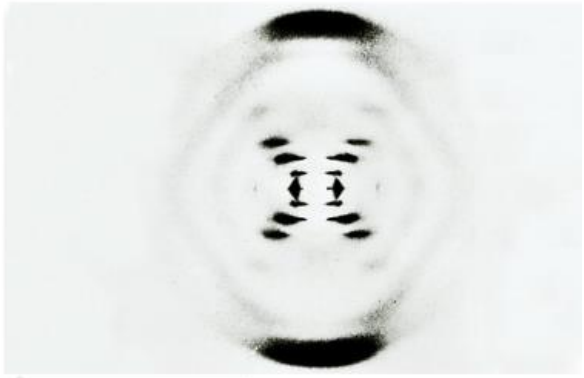
8. What do you call the way in which muscles and bones work together to exert forces?

Type of joint	Examples	Movement allowed
	Knee, elbow	
Ball and socket		

Structure of DNA
Genetic information is passed from one generation to the next.
This is called **heredity** and why we resemble our parents.

The genetic information itself is contained in a complex molecule called **DNA**.

Scientists worked out the structure of DNA in the 1950s. Rosalind Franklin made 'X-ray diffraction' images of DNA.



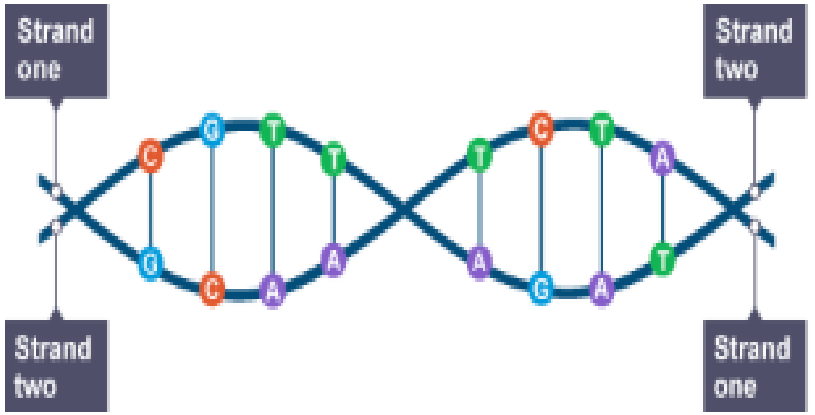
An X-ray diffraction image of DNA

James Watson and Francis Crick used information from one of her images to work out a model for the structure of DNA.

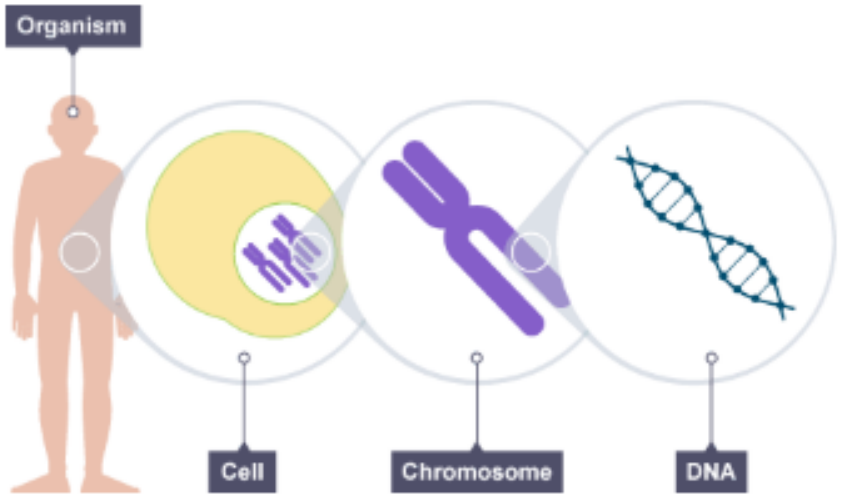
Work by Maurice Wilkins, a colleague of Franklin, supported their model.

Watson and Crick were able to work out how DNA was arranged.
They worked out that:
- DNA has two strands;
- the strands are twisted to form a **double helix;**
- the strands are held together by **bonds** between **base pairs**.

Key terms	Definition
Base Pair	the pair of nitrogenous bases that connects the (complementary) strands of DNA;
Bond	the chemical link that holds molecules together;
Chromosome	strands of DNA;
DNA	Deoxyribonucleic acid. The chemical carrying the genetic code;
Double helix	the shape of DNA molecule, two strands twisted in a spiral;
Gene	a section of DNA which we inherit from our parents, and which controls part of a cell's chemistry (protein production);
Heredity	genetic information that determines an organism's characteristics, passed on from one generation to another.
Nucleus	controls what happens inside the cell, and contains chromosomes



A DNA molecule showing its base pairs, G–C and A–T



Each cell with a nucleus contains chromosomes, which are made from DNA

9BB
Biological systems and processes

Chromosomes, DNA and genes
The DNA in all of your cells is approximately two metres long, except for:
- Red blood cells which have none;
- Sperm or eggs only have about one metre.

- It is coiled into structures called chromosomes.
- Chromosomes are found in the nucleus of each cell.

- Human body cells each contain **23 pairs of chromosomes**;
- Half of which are from each parent;
- Human gametes (eggs and sperm) each contain 23 chromosomes;
- When an egg is fertilised by a sperm, it becomes a cell with 23 pairs of chromosomes;
- We each have half of our chromosomes and DNA come from each parent;
- DNA makes up genes, which makes up chromosomes.
- One copy of all your chromosomes is called your **genome**.

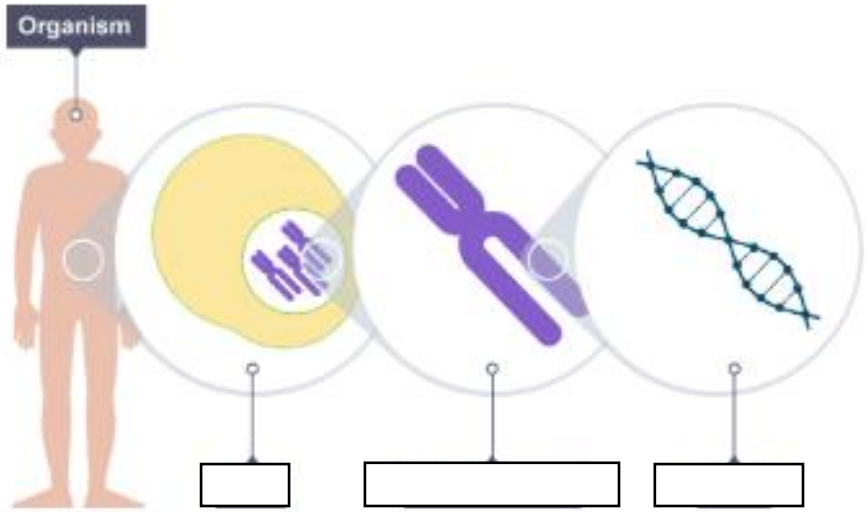
Structure of DNA

1. What does the term ‘hereditary’ mean?
2. What do you call the complex molecule that holds the genetic information?
3. Name the type of images of DNA produced by Rosalind Franklin.
4. Name the scientists who used the image to work out a model for the structure of DNA

Structure of DNA

1. What were the 3 main features of DNA discovered by Watson and Crick?

Key terms	Definition
	the pair of nitrogenous bases that connects the (complementary) strands of DNA;
	the chemical link that holds molecules together;
Chromosome	
	Deoxyribo**n**ucleic **a**cid. The chemical carrying the genetic code;
Double helix	
Gene	
Heredity	
Nucleus	



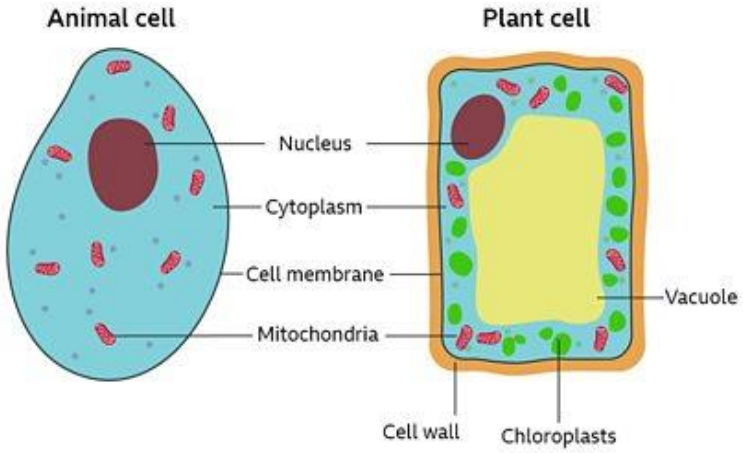
9BB
Biological systems and processes

Chromosomes, DNA and genes

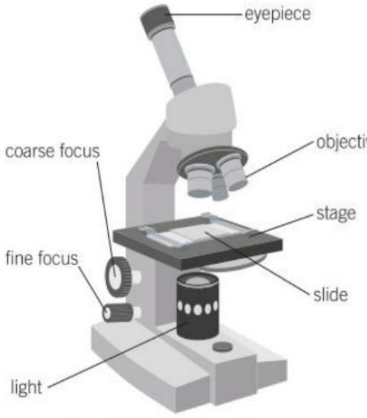
1. Name the cell in the human body that does not contain DNA.
2. What do you call the coiled DNA structures?
3. Where are chromosomes found?
4. How many pairs of chromosomes are there in each body cell?
5. How many chromosomes are found in a human gamete?
6. How do human inherit these pairs of chromosomes?
7. How do gametes gain 23 pairs of chromosomes?
8. What is a genome?

Eukaryotic Cells

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



RP1 – Microscopy; Observing Plant Cells



Preparing the slide:

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

Viewing the slide:

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

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

Microscopes

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

Calculating Magnification

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

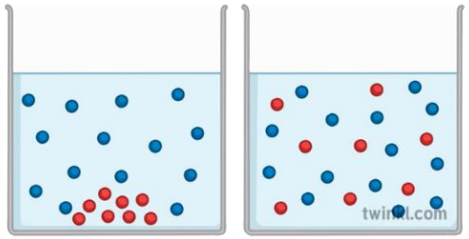
$$magnification = \frac{image\ size}{actual\ size}$$

mm → µm **x 1000**
µm → mm **÷1000**

Diffusion

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

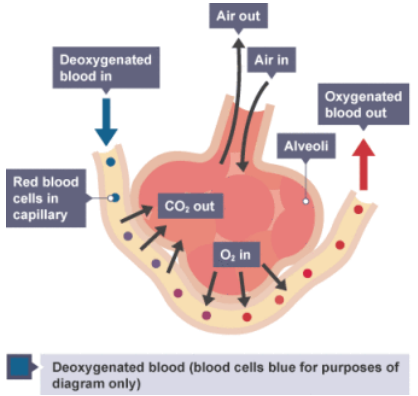
- There are ways the rate of diffusion can be changed:
  - the difference in concentrations (concentration gradient)
  - the temperature
  - the surface area of the membrane

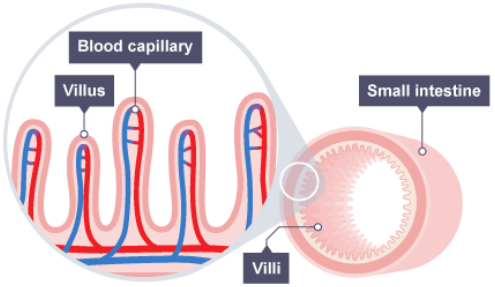


Examples

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

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





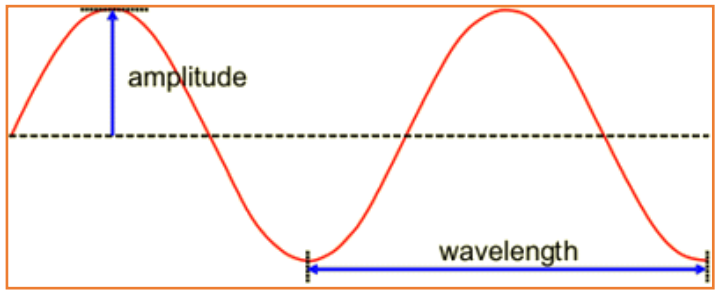
1. Name the three cell parts (organelles) found in a plant cell but not in an animal cell.
2. How can you identify an eukaryotic cells from its structure?
3. What is the role of a ribosome?
4. Which organelle releases energy through respiration?
5. What is the role of the cell wall?

1. Which part of a light microscope is the glass slide placed on?
2. Which objective lens is selected first to produce a magnified image of a sample?
3. What is used to stain plant cells?
4. What is place on top of the slide, sample and stain?
5. What part of the microscope is used to focus the image and make it clear?

1. How is a root hair cell specialised?
2. Why would a cell contain more mitochondria than usual?
3. Describe the structure of phloem cells.
4. How are nerve cells specialised?
5. Why does a sperm cell require a lot of mitochondria?
6. How are xylem cells specialised?

1. What are the advantages of using a electron microscope for viewing cells?
2. Convert 2.3mm into µm.
3. How would we calculate the actual size of a cell using the image size and magnification?
4. Convert 570µm into mm.

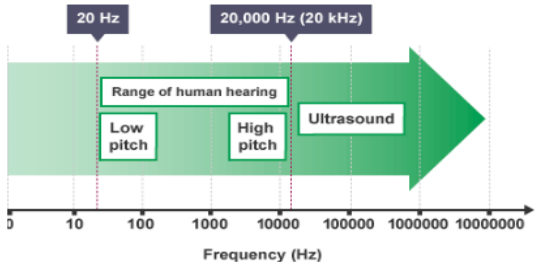
1. What factors affect the rate of diffusion?
   -
   -
   -
2. Give an example in animals where diffusion would take place?
3. How are structures in organisms adapted for efficient diffusion?
   -
   -
   -
4. Do substances more from a low concentration to a high concentration



- **Amplitude:** the maximum height of the wave from its resting position:
  - the greater the amplitude, the louder the sound
- **Wavelength:** the distance between two **crests** (tops) next to each other (or any other two identical point on waves next to each other)
- **Frequency:** the number of **waves per second** (**Hertz** - **Hz**): the higher the frequency, the closer together the waves are, the higher the pitch

Ultrasound

Human beings can generally hear sounds as low as 20 Hz and as high as 20,000 Hz (20 kHz**).**



Ultrasound is:

- any sound with a frequency of **more than 20,000 Hz.**
- Too high pitched for humans to hear
- Other animals (eg dogs, cats and bats) can hear it.
- Ultrasound can be used to check on the health of unborn babies, clean jewellery and in physiotherapy.

Types of waves

All waves transfer energy from place to place.

There are two types of wave: **longitudinal** and **transverse**:

Longitudinal waves

Sound waves are **longitudinal waves.**

The vibrations are **parallel to the direction of travel.**

Transverse waves

Light waves (and water waves) are **transverse waves.**

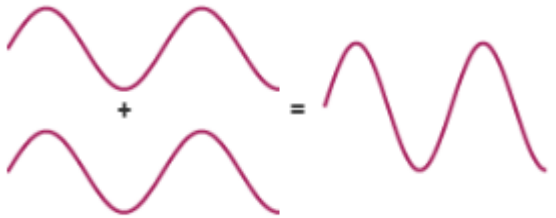
The vibrations are **perpendicular to the direction of travel**.

Water waves

- Water waves move with a transverse motion
- The **undulations** (up and down movement) are at 90° to the direction of travel.
- Water waves, like all waves, can be **reflected**, **refracted** and **diffracted**.

Superposition is where two waves meet and they affect each other: **adding** or **cancelling**.

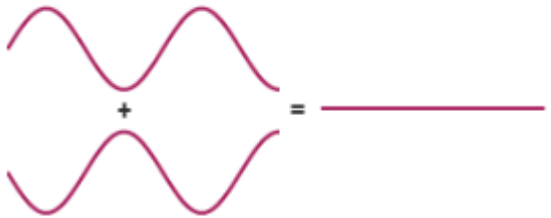
Adding (constructive interference)



If two waves meet each other **in step**, they add together and reinforce each other. They produce a much higher wave, a wave with a greater **amplitude**.

Cancelling (destructive interference)

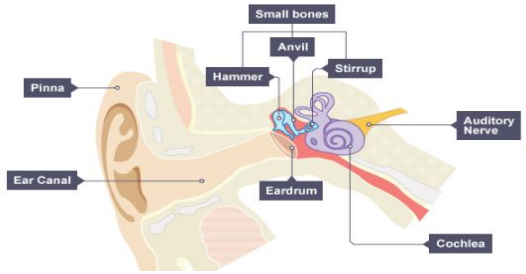
If two waves meet each other **out of step**, they cancel out.



9PS Sound

Ears

- An ear has an **eardrum**, connected to **three small bones**
- Vibrations in air make the eardrum vibrate
- which in turn vibrates the three small bones (called **ossicles**) to a spiral structure called the **cochlea**
- Signals are passed from the cochlea to the brain
- through the **auditory** nerve.

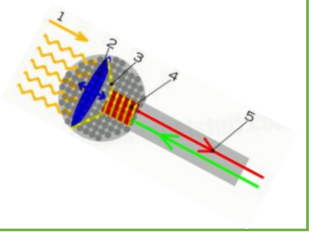


Reflection

- Sound waves can reflect off surfaces
- These reflections as heard as **echoes**
- **Hard, smooth surfaces** are good at reflecting sound (more echoes)
- **Soft, rough surfaces** are good at absorbing sound (less echoes)

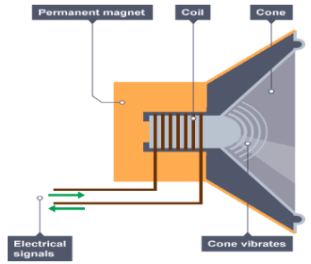
Microphones

- Microphones contain a **diaphragm**, which does a similar job to an eardrum
- The vibrations in air make the diaphragm vibrate. These vibrations are changed to electrical impulses.



Loudspeakers

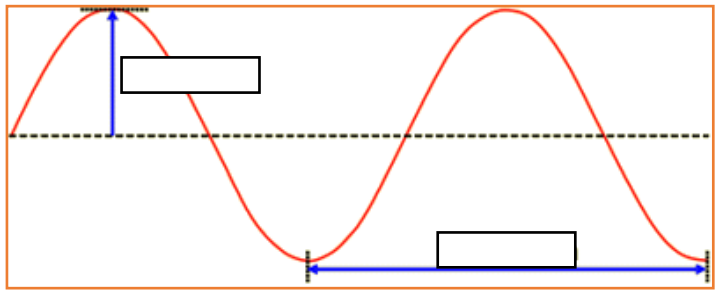
- Loudspeakers work by converting electrical current into vibrations
- This moves the cone which creates the sound waves.



The speed of sound is **340 m/s**

Properties of sound waves

- When something vibrates, it produces sound
- These sound waves are carried by vibrating particles
- Sound can only travel through solids, liquids or gases
- They cannot travel through empty space (a **vacuum**).



1. In the above diagram, label the amplitude and wavelength

2. what is frequency?

Ultrasound

1. State the frequency for human hearing

2. Explain why humans cannot hear ultrasounds

3. Describe 2 ways ultrasound is used

Types of waves

1. What do waves transfer?

2. Write down the 2 types of waves

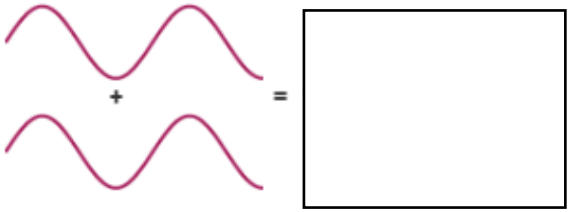
3. Write the definitions of the 2 types of waves

Water waves

1. What is a transverse wave?

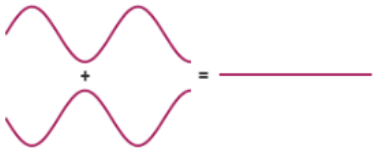
2. What is superposition? What effects does this have?

3. Complete the diagram below to show how the resulting wave will look like



4. For the above diagram, state how this affects the amplitude

5. Look at the diagram below:



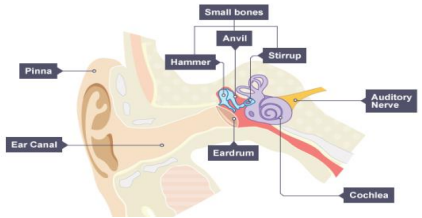
Describe what has happened.

Ears

1. What is connected to the 3 small bones in the ear?

2. What causes the ear drum vibrate?

3. Describe how vibrations of the ear drum leads to signals passed to the brain



9PS Sound

Reflection

1. How are sound reflected sound waves heard?

2. What type of surface is good at reflecting sound?

3. What type of surface is good at absorbing sound?

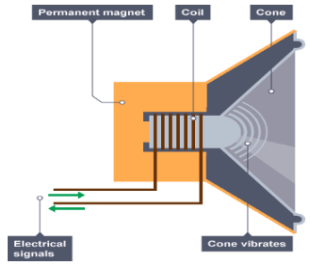
Microphones

1. What do all microphones have that is similar to an ear drum?

2. Describe how the diaphragm works

Loudspeakers

1. Describe how loud speakers work



Properties of sound waves

1. Describe the properties of sound

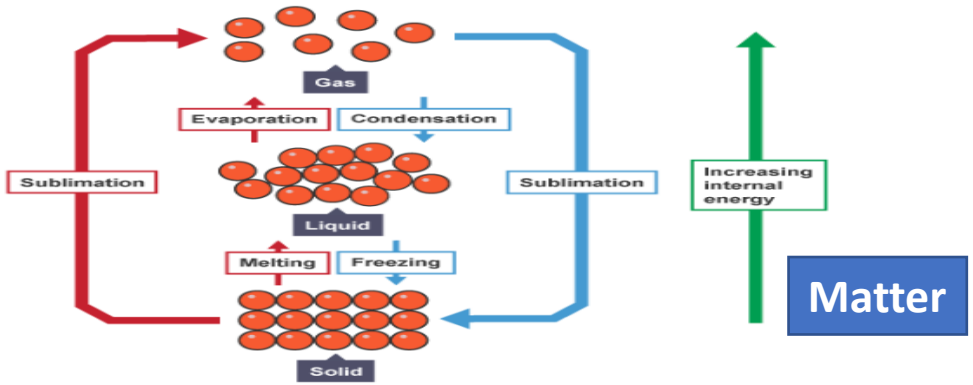
Change of state

- Substances can change state, usually when they are heated or cooled;
- State changes are **reversible** – eg ice can be melted and then frozen again;
- No new elements or compounds are formed.

The closeness, arrangement and motion of the particles in a substance change when it changes state:

	Solid	Liquid	Gas
Closeness	All touching	Mostly touching	Far apart
Arrangement	Ordered	Random	Random
Motion	Vibrate, fixed position	Move freely	Move freely (faster than liquids)
Density	Decreasing density ---------->		
Internal energy	Increasing internal energy ---------->		

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



Matter

Pressure in fluids

- A **fluid** is a liquid or gas.
- All fluids can change shape and flow from place to place.
- Fluids exert pressure at 90° to surfaces – we say that it acts normal to the surface.

Brownian motion

- Gas particles move very quickly;
- Air particles move at 500 m/s on average at room temperature;
- Particles collide with each other very frequently;
- They change direction randomly when they collide;
- Their random motion because of collisions is called **Brownian motion**.

Diffusion

- Diffusion is the **movement of particles from an area of high concentration to an area of low concentration.**
- Diffusion does not happen in solids – only fluids (liquids and gases);
- Particles in a solid can only vibrate and cannot move from place to place.
- Diffusion is driven by differences in concentration;
- No diffusion will take place if there is no difference in concentration from one place to another;
- Diffusion in liquids is slower than diffusion in gases because the particles in a liquid move more slowly.

Explaining diffusion in a smelly gas

- When a perfume is released into in a room, the perfume particles mix with the particles of air;
- The particles of perfume are free to move quickly in all directions;
- They eventually spread through the whole room **from an area of high concentration to an area of low concentration**;
- This continues until the concentration of the perfume is the same throughout the room;
- The particles will still move, even when the perfume is evenly spread out.

Diffusion and temperature

Diffusion is faster if the fluid (gas or liquid) is hotter.

Atmospheric pressure

The atmosphere exerts a pressure on you, and everything around you.

Atmospheric pressure changes with altitude. The higher you go:

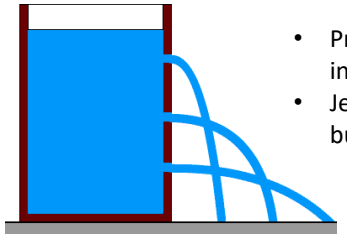
- the lower the weight of the air above you;
- the lower the atmospheric pressure.

Pressure in liquids

Just like the atmosphere, liquids exert pressure on objects.

The pressure in liquids changes with depth. The deeper you go:

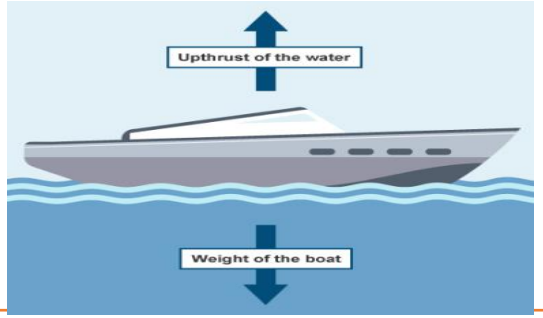
- the greater the weight of liquid above
- the greater the liquid pressure



- Pressure in a liquid increases with depth;
- Jet from the bottom of the bucket travels further.

Floating and sinking

- Liquid pressure is exerted on surfaces of objects in liquids;
- This causes **upthrust**;
- When an object sinks, the pressure increases and so the upthrust increases;
- It will continue to sink if weight is greater than maximum upthrust;
- When and object floats, the upthrust is **equal and opposite** to the object's weight.



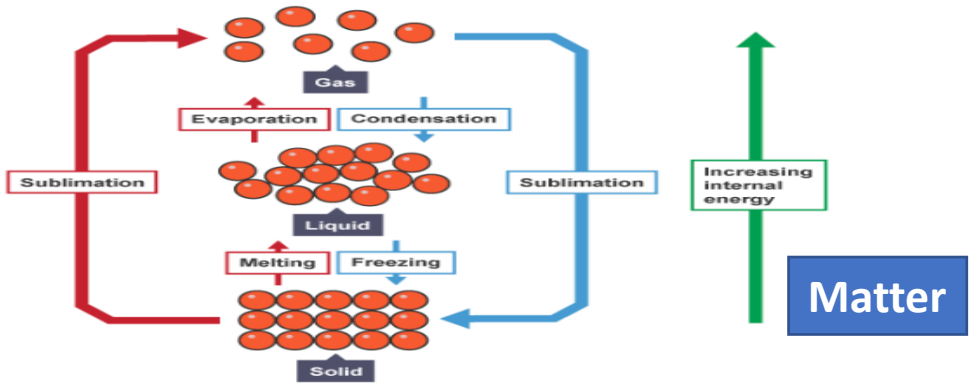
Change of state

1. Write down the 3 key facts relating to changes of state

2. Complete the table below:

	Solid	Liquid	Gas
Closeness			
Arrangement			
Motion			
Density			
Internal energy			

$$\text{density} = \frac{\square}{\square}$$



Pressure in fluids

1. What is a fluid?

2. How does a fluid exert pressure?

Brownian motion

1. Describe Brownian Motion

Diffusion

1. What is diffusion?

2. For diffusion to take place, what must there be?

3. In which states of matter can diffusion take place?

4. Explain why particles in a solid cannot diffuse?

5. State one way you can increase the speed of diffusion

Explaining diffusion in a smelly gas

1. Explain how perfume will diffuse throughout the room when released

Atmospheric pressure

1. Describe how pressure changes with altitude

Pressure in liquids

1. Describe how pressure changes with depth of liquid

2. Explain your answer to question 1

Floating and sinking

1. Name the force exerted by liquids on the surface of all objects

2. Describe what happens to pressure as an object sinks

3. Using weight and upthrust, explain why objects will either float or sink

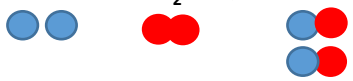
Word equations to symbol equations:

- replace names of each substance symbols or formula
- use numbers to balance the equation

Example:

copper + oxygen → copper oxide

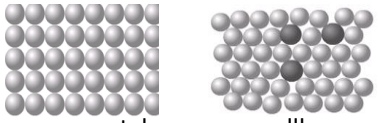
2Cu + O_2 → 2CuO



Two copper atoms (2Cu) react with **one oxygen molecule (O_2)** to produce **two units of copper oxide (2CuO)**

Typical properties of metals	
Appearance	Shiny
State at room temperature	Solid (except mercury, a liquid)
Density	High
Strength	Strong
Malleable or brittle	Malleable
Conduct heat?	Good
Conduct electricity?	Good
Magnetic material	**Only** iron, cobalt & nickel
Sound when hit	Make a ringing sound (**sonorous**)

Pure metals Vs Alloy



pure metal

allloy

The rows of atoms in a pure metal can slide over each other easily.
In an alloy, the different sized atoms disrupt the layers so the atoms can't slide.
This makes alloys more useful than pure metals.

Bases v alkalis

A **base** is a substance that can react with acids and **neutralise** them. Many bases are insoluble in water. If a base does dissolve in water it is called an **alkali**

Bases are usually:

- **metal oxides**, such as copper oxide
- **metal hydroxides**, such as sodium hydroxide, or
- **metal carbonates**, such as calcium carbonate

General word equations for neutralisation reactions:

Metal oxide + acid → salt + water
Metal hydroxide + acid → salt + water
Metal carbonate + acid → salt + carbon dioxide + water

The lab test for carbon dioxide

Bubble the gas through lime water and watch for it turn from colourless to a cloudy milky colour.

Acids and metals

Acids react with most metals to produce a salt and hydrogen. This is the general word equation :

metal + acid → salt + hydrogen

The lab test for hydrogen

Place **lighted splint** put in the test tube and listen for the gas to burn with a squeaky pop

Naming salts

Hydro**chloric** acid → metal **chlorides**
Sulfuric acid → metal **sulfates**
Nitric acid → metal **nitrates**

Calculating relative formula mass

Formula mass is calculated by adding together the mass number of each atom in a compound's chemical formula.

E.g. $MgCl_2$ **A_r Mg = 24** **A_r Cl = 35.5**

Formula mass = 24 + (2 x 35.5) = 95

There are 2 chlorines in the chemical formula

Reactivity Series

The **reactivity series** is a list of elements in order of their reactivity:

Potassium — **Most reactive**
Sodium
Calcium
Magnesium
Aluminium
Carbon
Zinc
Iron
Tin
Lead
Hydrogen
Copper
Silver
Gold
Platinum — **Least reactive**

If a metal loses its outer electrons more easily, it will be more reactive.

Reactivity

Extracting copper from copper oxide

Copper is so unreactive, it does not react with cold or hot water, so it is used for water pipes

To extract copper:

- mix **copper oxide** powder with **carbon powder**;
- heat the mixture strongly in a **crucible**;
- keep the lid on the crucible, to stop carbon reacting with oxygen in the air;
- the **carbon dioxide** formed in the reaction escapes into the air;
- let the crucible cool down, you tip the mixture into cold water.
- brown copper sinks to the bottom, leaving unreacted powder suspended in the water.

These equations represent the reaction:

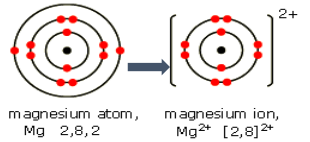
copper oxide + carbon → copper + carbon dioxide

$2CuO + C \rightarrow 2Cu + CO_2$

Why do metals react?

Metals react because they want to gain a full outer shell and become stable. They do this by losing their outer electron(s) to become positively charged ions

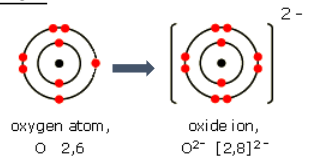
For example:
Magnesium loses its 2 outer electrons to become a +2 ion



Why do non-metals react?

Non-metals react because they want to gain a full outer shell and become stable. They do this by gaining electrons into their outer shell to become negatively charged ion.

For example:
Oxygen gains 2 electrons into its outer shell to become a -2 ion



Displacement Reactions:

This is when a more reactive metal **displaces** a less reactive metal from its compound.

For example:

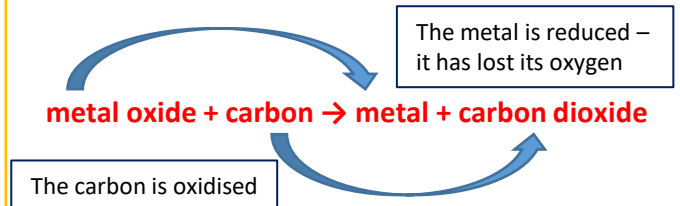
magnesium + copper sulfate → magnesium sulfate + copper

If the more reactive metal is already in the metal compound, nothing happens. For example:

magnesium sulfate + copper → no reaction

Carbon and metal extraction

Some metals can be extracted from their metal oxides using carbon **if the metal is less reactive than carbon**.



This works for **zinc**, **iron**, **tin**, **lead** and **copper** because they all less reactive than carbon.

Word equations to symbol equations:

1. Use the number of particles to balance the symbol equation

copper + oxygen → copper oxide

__Cu + O_2 → __CuO

Typical properties of metals	
Appearance	
State at room temperature	
Density	
Strength	
Malleable or brittle	
Conduct heat?	
Conduct electricity?	
Magnetic material	
Sound when hit	

Pure metals Vs Alloy

1. Draw the particle diagrams of a pure metal and alloy

pure metal allloy

2. Describe the particle arrangement of a pure metal

3. Explain why alloys do not have layers

Bases v alkalis

1. What is a base?

2. Write down the 3 types of bases

3. Write down the general word equations using all the bases in question 2

4. Describe the test for carbon dioxide gas

Acids and metals

1. Write the general word equation for metals and acid reaction

2. Describe the test for hydrogen gas

Naming salts

Hydro**chloric** acid → metal _____

Sulfuric acid → metal _____

Nitric acid → metal _____

Calculating relative formula mass

1. Calculate the relative formula mass of **$MgCl_2$**. Show all your working out

Reactivity

Reactivity Series

1. what is the reactivity series?

2. explain why some metals are more reactive than others?

Extracting copper from copper oxide

1. Explain why copper is used for water pipes?

2. Describe the process of extracting copper from copper oxide

Why do metals react?

1. What must metals do in order to react?

2. what charge do metals form when they react?

Why do non-metals react?

1. What must non-metals do in order to react?

2. what charge do non-metals form when they react?

Displacement Reactions:

1. What is a displacement reaction?

2. magnesium + copper sulfate → magnesium sulfate + copper

Look at the reaction above. Explain why magnesium displaces copper from copper sulfate

Carbon and metal extraction

1. Explain why some metals can be extracted using carbon

2. Name all the metals that can be extracted using carbon

3. When carrying out extraction of metals using carbon, which element is oxidised, and which is being reduced?

9CE Energetics and rates

Rate of reaction

Reacting particles must **collide** with a minimum amount of energy **(activation energy)** for a chemical reaction to happen.

How quickly a reaction happens is called the **rate of reaction,** and always involves a **time measurement.**

We can **increase reaction rate** by:

1) **Increasing the concentration of liquid reactants** as it **increases the frequency of collisions**
2) **Increasing the surface area of solid reactants** as it **increases the frequency of collisions**
3) Using a **catalyst** as it **decreases the energy that particles need to collide with for a successful reaction**

Some ways to measure the rate of a reaction

- Time taken for a reactant to disappear
- Time taken for the reaction mixture to change colour
- Measure the number of bubbles produced in a certain time
- Measure the volume of gas produced in a certain time.
- Measure the change in mass in a certain time

Exothermic and Endothermic reactions

- **Exothermic** reaction - **releases** energy to the surroundings.
- Causes a **rise** in temperature (**positive** temperature change)

- **Endothermic** reaction - **take in** energy from the surroundings.
- Causes a **drop** in temperature (**negative** temperature change)

Catalysts

- Speed up reactions
- Are not used up during reactions
- Are chemically unchanged after the reaction completes
- Work by reducing the energy needed to start a reaction (**activation energy**).

In industry, using catalysts often results in **lower temperature** being used in industry, **saving money** and **cutting** the **use of fossil fuels** and their subsequent **emissions**

Car exhausts have **catalytic converters**.

- They reduce amount of toxic gases released
- They contain platinum and rhodium as catalysts.

Oxidation

In oxidation reactions, a substance **gains oxygen**. Metals and non-metals can take part in oxidation reactions (be **oxidised**).

Examples:

- Magnesium reacts with oxygen to produce magnesium oxide

magnesium + oxygen → magnesium oxide

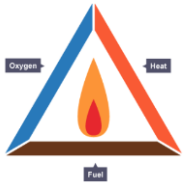
$2Mg + O_2 \rightarrow 2MgO$

- Carbon reacts with oxygen to form carbon dioxide:

carbon + oxygen → carbon dioxide

$C + O_2 \rightarrow CO_2$

Combustion



- **Combustion** is another name for burning fuels.
- It is an **exothermic** reaction
- It is an example of an **oxidation** reaction.

Complete combustion

- **Fuels** contain **hydrocarbons** which react with oxygen when they **burn**
- With enough oxygen, **complete combustion** happens:
  - the hydrogen atoms combine with oxygen to make water vapour, H_2O
  - the carbon atoms combine with oxygen to make carbon dioxide, CO_2
  - the **maximum amount of energy** is released.

The equations for the complete combustion of **methane.**

methane + oxygen → water + carbon dioxide

$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$

Incomplete combustion

- **H**appens when there is **not enough oxygen.**
- Water vapour and carbon dioxide are still produced;
- Two other products are also produced:
  - **carbon monoxide**, CO; colourless toxic gas.
  - particles of **carbon** (soot/smoke); causes breathing problems.
- the **maximum amount of energy** is **NOT released.**

Thermal Decomposition

This is the **breaking down of a substance using heat**, to form two or more products.

Many **metal carbonates** take part in thermal decomposition reactions.

For example, copper carbonate:

- copper carbonate is green; copper oxide is black.

copper carbonate → copper oxide + carbon dioxide

$CuCO_3 \rightarrow CuO + CO_2$

Other metal carbonates decompose in the same way. When they do, they follow this equation:

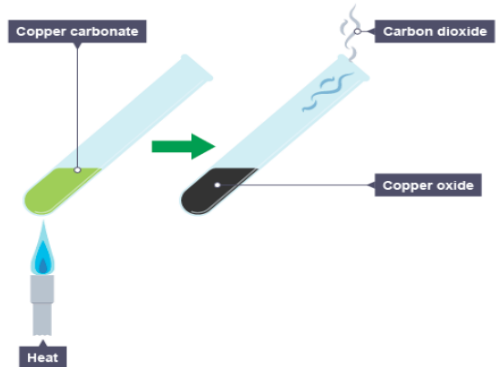
metal carbonate → metal oxide + carbon dioxide

For example, calcium carbonate:

calcium carbonate → calcium oxide + carbon dioxide

$CaCO_3 \rightarrow CaO + CO_2$

Thermal decomposition is an example of an **endothermic** reaction. Energy must be supplied **constantly** for the reaction to keep going.



Identification tests

Lime water – colour change from colourless to **cloudy when carbon dioxide**
Glowing splint – will relight when placed in **oxygen.**
Blue cobalt chloride paper– colour change from blue to pink with **water**
Cobalt chloride paper – colour change from blue to pink with **water**

Conservation of mass

Atoms are not destroyed nor created during chemical reactions, so in any reaction:

Total mass of reactants = total mass of products

9CE Energetics and rates

Rate of reaction

1. What must particles do to start a chemical reaction?

2. What does term 'rate' mean in terms of a chemical reaction?

3. Describe and explain 3 ways of increasing the rate of a reaction?

3. Describe 3 ways of measuring the rate of a reaction

Exothermic and Endothermic reactions

1. what is an exothermic reaction

2. what happens to the surrounding temperature in an exothermic reaction?

3. what is an endothermic reaction?

4. what happens to the surrounding temperature in an endothermic reaction?

Catalysts

1 . What is a catalyst?

2. How does it speed up a reaction?

3. Describe the advantages of using a catalyst in chars and industries

Oxidation

1. what is an oxidation reaction?

2. magnesium + oxygen → magnesium oxide
For the above reaction, which element has become oxidised?

3. **carbon + oxygen →** _____ _____

Identification tests

1. Describe the test for carbon dioxide gas

2. Describe the test for water

Combustion

1. what is combustion?

2. what type of reaction is a combustion reaction?

3. what do all fuels contain?

4. write down the products of complete combustion reaction

4. write down the products of incomplete combustion

5. Describe how complete combustion is different to incomplete combustion

Thermal Decomposition

1. what is thermal decomposition?

2. Name a type of substance that will undergo thermal decomposition

3. write down the general word equation for thermal decomposition of metal carbonates

4. complete the following word equation:
copper carbonate → _____ **+** _____

5. complete the following word equation:
calcium carbonate → _____ **+** _____

6. explain why thermal decomposition is an exothermic reaction?

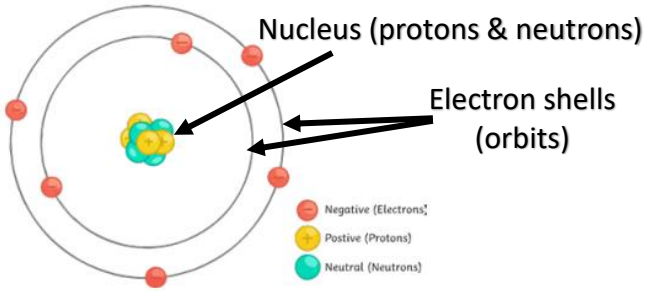
Conservation of mass

1. what is meant by the term 'conservation of mass?'

C1 – Atomic Structure and The Periodic Table

Atoms

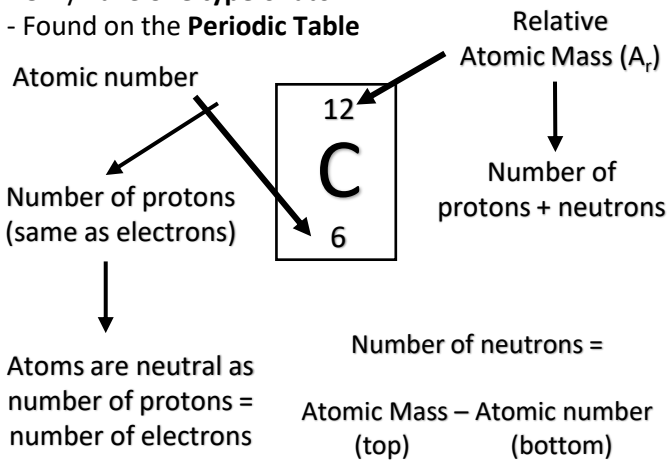
- Made up of **protons, electrons** and **neutrons**.



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

Elements

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

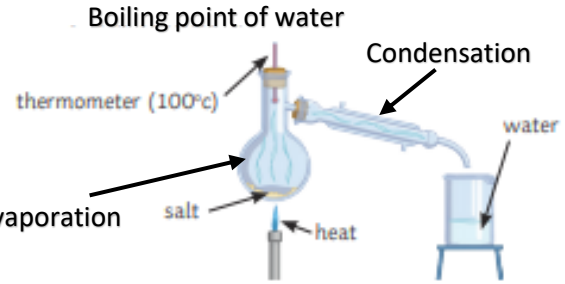


Compounds

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

Distillation

Simple distillation – separating a liquid from a solution.



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

Chemical Equations

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

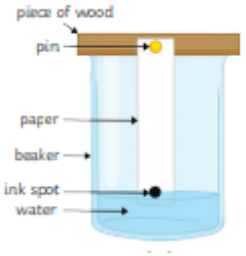
Left of the arrow = **reactants**
Right of the arrow = **products.**

- Also can be shown by a **symbol equation**
e.g. $2Mg + O_2 \rightarrow 2MgO$

Mixtures and Separation

Mixtures – two or more elements or compounds **not** chemically joined.
This means the different components of the mixture can be separated by physical methods (below)
E.g. air is a mixture mainly made of nitrogen, oxygen and carbon dioxide.

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



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

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

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

C1 – Atomic Structure and The Periodic Table

1. Name the three subatomic particles.
2. Which two subatomic particles are found in the nucleus of an atom?
3. What is the mass of a proton?
4. What is the radius of an atom?

1. Where are elements found?
2. What does the relative atomic mass of an element show?
3. What does the atomic number show?
4. How do you calculate the amount of neutrons?

1. Define the word compound.
2. Give three examples of compounds.

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

1. Where do you find the reactants in a chemical reaction?
2. Where do you find the products in a chemical reaction?

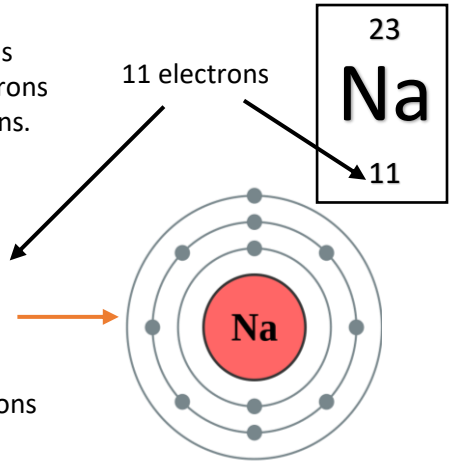
1. Is air an element, compound or mixture? Why?
2. What is chromatography used to separate?
3. What can be separated using filtration?
4. Give an example of a mixture that can be separated using filtration.
5. What is evaporation used to separate?
6. Give an example of a mixture that can be separated using evaporation.

C1 – Atomic Structure and The Periodic Table

Electronic Structure

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

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

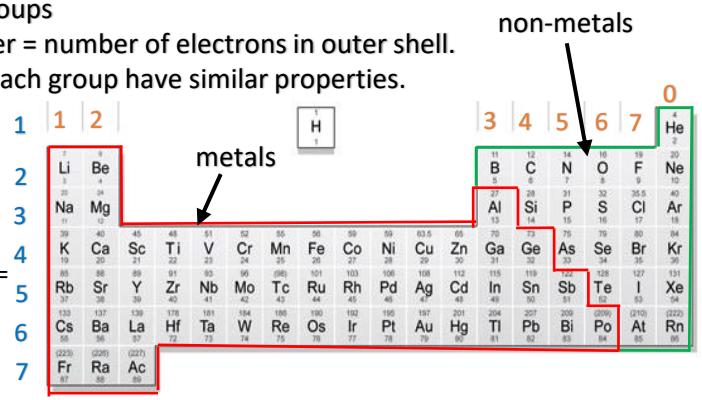


Total = 11 electrons

The Modern Periodic Table

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

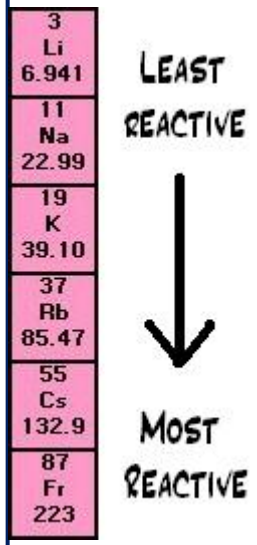
Columns = groups
Group number = number of electrons in outer shell.
Elements in each group have similar properties.



Group 1 (alkali metals)

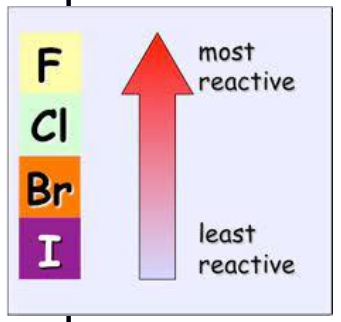
- Similar properties as all have 1 electron in outer shell.
- All lose one electron in reactions to form 1+ ions
- Soft, grey, shiny metals
- Stored in oil as would react with oxygen in air.
- When placed in water they produce an alkali (hence alkali metals) and hydrogen gas

E.g Lithium + water → lithium hydroxide + hydrogen



Group 7 (Halogens)

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



C1 – Atomic Structure and The Periodic Table

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

1. How are elements ordered in the modern periodic table?
2. Groups are rows or columns?
3. What does group number show?
4. What does period number show?

1. State 2 properties of Group 1 metals.
2. Why are they known as the alkali metals?
3. Are they reactive or unreactive?
4. As you go down the group, what happens to the reactivity of elements?

1. How many electrons do the halogens have in the outer shell?
2. What type of element are they?
3. State the trend in reactivity as you go down group 7.