Science paper 1 revision resource

In this document you will find resources that will help prepare students for their science paper 1 mocks which will begin week commencing 19th Jun. (exam board AQA)

- The paper 1 assessments are 1:15h for combined science and 1:45 for triple students.
- Please use the review lessons and note down any topics your are struggling with. Please then go over the corresponding lesson.
- Effective revision strategies include manipulating the information and recalling it regularly to reinforce the learning. To help with this I have included the knowledge organisers and revision questions which can help with quizzing and therefore retention. Revision guides can also be used and bought on wisepay.
- Students should then use past paper questions which can be found on Cognito or AQA to support their learning. I have also provided links to Seneca and save my exams

Seneca: https://senecalearning.com/en-GB/

Cognito: https://cognitoedu.org/home.html

Save my exams: https://www.savemyexams.co.uk/gcse/

B1.1 Cell Biology

Review lessons

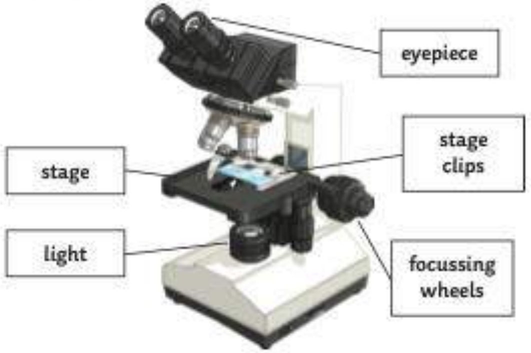
Biology cells review 1 https://continuityoak.org.uk/Lessons? r=1949
Biology cells review 2 https://continuityoak.org.uk/Lessons? r=1950

Cell Biology Knowledge Organiser – Foundation and Higher

Required Practical

Microscopy Required Practical

- Includes preparing a slide, using a light microscope, drawing any observations – use a pencil and label important observations.



Osmosis and Potato Practical

- Independent variable – concentration.
- Dependent variable – change in mass.
- Control variable – volume of solution, temperature, time, surface area of the potato.

The potato in the sugar solution will lose water and so will have less mass at the end; the potato in the pure water solution will gain water.

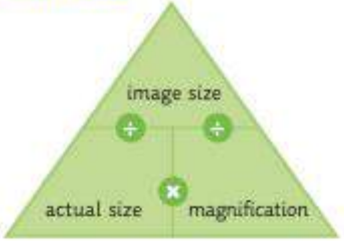
Specialised Cells

When a cell changes to become a specialised cell, it is called differentiation.

Specialised Cell	Function	Adaptation
sperm	To get the male DNA to the female DNA.	Streamlined head, long tail, lots of mitochondria to provide energy.
nerve	To send electrical impulses around the body.	Long to cover more distance. Has branched connections to connect in a network.
muscle	To contract quickly.	Long and contain lots of mitochondria for energy.
root hair	To absorb water from the soil.	A large surface area to absorb more water.
phloem	Transports substances around the plant.	Pores to allow cell sap to flow. Cells are long and joined end-to-end.
xylem	Transports water through the plant.	Hollow in the centre. Tubes are joined end-to-end.

Equations and Maths

Equation



Maths Skills

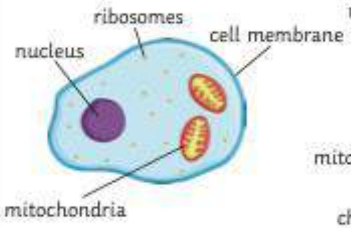
Conversions:
Micrometres to millimetres: divide by 1000.

Standard Form:
$0.003 = 3 \times 10^{-3}$

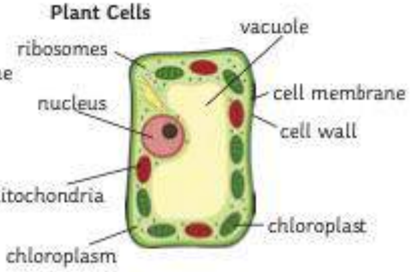
$5.6 \times 10^{-3} = 0.0056$

Prokaryotic and Eukaryotic Cells

Animal Cells



Plant Cells

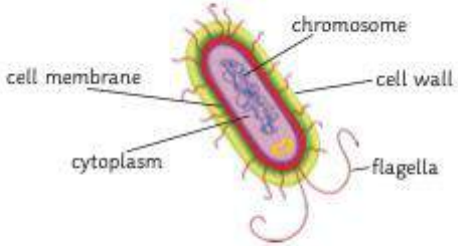


Plant and animal cells have similarities and differences:

	Animal	Plant
nucleus	✓	✓
cytoplasm	✓	✓
chloroplast	X	✓
cell membrane	✓	✓
permanent vacuole	X	✓
mitochondria	✓	✓
ribosomes	✓	✓
cell wall	X	✓

Bacterial Cells

Bacterial cells do not have a true nucleus, they just have a single strand of DNA that floats in the cytoplasm. They contain a plasmid.

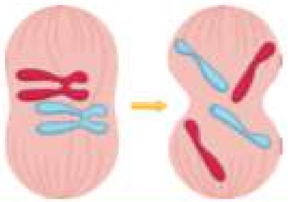


Chromosomes and Mitosis

In the nucleus of a human cell there are 23 pairs of **chromosomes**. Chromosomes contain a double helix of **DNA**. Chromosomes have a large number of genes.

The **cell cycle** makes new cells.

Mitosis: DNA has to be **copied/replicated** before the cell carries out mitosis.



Key Vocabulary

active transport
alveoli
chromosome
diffusion
eukaryotic
gas exchange
mitosis
multicellular
osmosis
prokaryotic
undifferentiated
replicated
specialised
villi

Stem Cells

Embryonic stem cells are **undifferentiated** cells, they have the potential to turn into any kind of cell.

Adult stem cells are found in the bone marrow, they can only turn into some types of cells e.g. blood cells.

Uses of stem cells:

- Replacing faulty blood cells;
- making insulin producing cells;
- making nerve cells.

Some people are against stem cell research.

For Stem Cell Research	Against Stem Cell Research
Curing patients with stem cells - more important than the rights of embryos.	Embryos are human life.
They are just using unwanted embryos from fertility clinics, which would normally be destroyed.	Scientists should find other sources of stem cells.

Stem Cells in Plants

In plants, stem cells are found in the **meristem**. These stem cells are able to produce clones of the plant. They can be used to grow crops with specific features for a farmer, e.g. **disease resistant.**

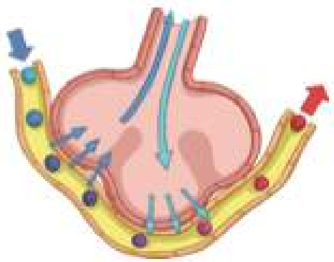
Exchange – Humans

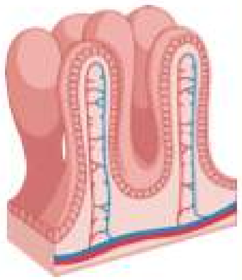
Multicellular organisms have a large surface are to volume ratio so that all the substances can be exchanged.

Gas exchange: Lungs

The alveoli are where gas exchange takes place.

They have a large surface area, moist lining, thin walls and a good blood supply.



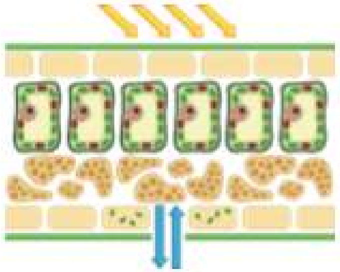


Villi: Small Intestine

Millions of villi line the small intestine increasing the surface area to absorb more digested food.

They are a single layer of cells with a good blood supply.

Exchange in Plants

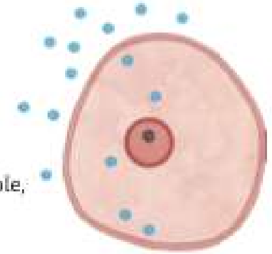


The surface of the leaf is flattened to increase the surface area for more gas exchange by diffusion.

Oxygen and water vapour diffuse out of the stomata. Guard cells open and close the stomata, controlling water loss.

Key Processes

Diffusion is the spreading out of particles from an area of higher concentration to an area of lower concentration.

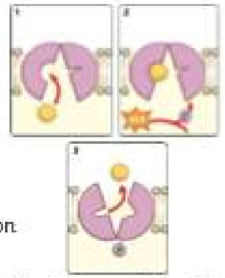


Cell Diffusion

Cell membranes are semi-permeable, only small molecules can get through.

Osmosis is the movement of water molecules across a partially permeable membrane from a region of higher concentration to a region of lower concentration.

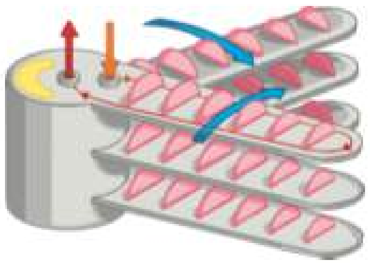
Active transport is the movement of substances against the concentration gradient. This process requires energy from respiration.



Active Transport in Cells

Exchange in Fish

Fish have a large surface area for gas exchange. These are called **gills.** Water enters the fish through the mouth and goes out through the gills. The oxygen is transported from the water to the blood by **diffusion**. Carbon dioxide diffuses from the blood to the water. Each gill has **gill filaments** which give the gills a large surface area. **Lamellae** cover each gill filament to further increase the surface area for more gas exchange. They have a **thin surface layer** and **capillaries** for good blood supply which helps with diffusion.



a

Draw and label a typical plant cell.

Which organelle is:

- the site of anaerobic respiration?

____

- the site of protein synthesis?

____

- the site of photosynthesis?

____

b

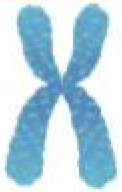
How many chromosomes does:

- a human skin cell contain?

____

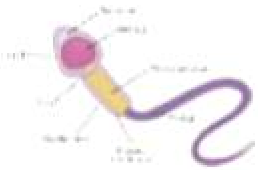
- a human gamete contain?

____



c

Sperm cells are specialised cells. Explain how the acrosome helps the sperm cell to carry out its function.



____
____
____
____

d

Draw and label the parts of a typical bacterial cell.

e

Why do cells undergo mitosis?

____

What happens to the cell during:

- interphase?

____
____
____

- mitosis?

____
____
____
____
____
____

f

What are 'embryonic' stem cells?

____
____

Name 2 medical conditions that could be treated with embryonic stem cells in the future.

1. _______________
2. _______________

g

Describe how to prepare an uncontaminated culture of bacteria using the aseptic technique.

____
____
____

h

Diffusion is:

- [ ] The movement of water particles from a high water concentration to a lower water concentration across a partially permeable membrane.
- [ ] The spreading out of the particles of any gas, or liquid from an area of high concentration to an area of lower concentration.
- [ ] The movement of particles from a low concentration to a higher concentration.

i

Name 3 substances that are transported into or out of animal cells by diffusion:

1. _______________
2. _______________
3. _______________

j

List 5 important keywords from this unit.

1. _______________
2. _______________
3. _______________
4. _______________
5. _______________

k

Describe an advantage of using therapeutic cloning to treat disease.

____
____
____

o

What is osmosis?

____
____
____

l

Light microscopes have objective lenses.
What is the purpose of the objective lens?

____

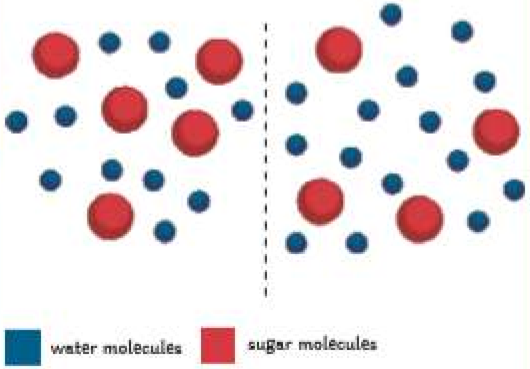
m

Name the tubes that transport water up the stem of a plant.

____

n

On the diagram below, draw an arrow to show the direction of the net movement of water molecules.



o

My main areas for improvement in this unit are:

____
____
____

Draw and label a typical animal cell. a

Which organelle is:
- the site of aerobic respiration?
- controls the movement of substances in and out of the cell?
- contains the genetic information?

An elephant sperm cell contains 28 chromosomes. How many chromosomes would be in an elephant: b
- liver cell?
- ovum?

Root hair cells are specialised cells. Describe how the root hair cell is adapted to carry out its function. c

A bacterium can divide once every 20 minutes. A piece of chicken was contaminated with 5 bacteria; how many bacteria will there be on the chicken after 3 hours? d

Describe how active transport is used by: e
- plants
- animals

Describe 3 ways that exchange surfaces are adapted to their function. f

1.
2.
3.

Describe 2 ways in which active transport is different to diffusion. g

1.
2.

Where in the body are adult stem cells found and how do they differ from embryonic stem cells? h

The unit 'centimetres' is written as 'cm'. What do each of the following units represent? i

mm:

µm:

nm:

pm:

Plants can be cloned from meristem cells. Give two advantages of cloning plants. j

List 5 important keywords from this topic. k

1.
2.
3.
4.
5.

Electron microscopes have better resolution than light microscopes. What does 'resolution' mean? l

State 2 factors that affect the rate of diffusion. m

1.
2.

Write each of the following numbers in standard form. n

2500;

0.003;

4 200 000;

0.00000006;

Which has a bigger 'surface area to volume' ratio, an elephant or a mouse? o

What is the equation for calculating the magnification of an image? p

Why do some people object to embryonic stem cell research? q

How do prokaryotic cells differ from eukaryotic cells? r

My main areas for improvement in this unit are: s

B1.2 Organisation

Review lessons

Organisation review 1 https://continuityoak.org.uk/Lessons?r =3352
Organisation review 2 https://continuityoak.org.uk/Lessons?r =1748

AQA GCSE Biology (Combined Science) Unit 2: Organisation

Principles of Organisation

cell	tissue	organ	organ system	organism
Cells are the basic building blocks of all living things.	A group of cells with a similar structure and function is called a tissue.	An organ is a combination of tissues carrying out a specific function.	Organs work together within an organ system.	Organ systems work together to form whole living organisms.

Food Tests (Required Practical)

What are you testing for?	Which indicator do you use?	What does a positive result look like?
sugar	Benedict's reagent	Once heated, the solution will change from blue-green to yellow-red.
starch	iodine	Blue-black colour indicates starch is present.
protein	biuret	The solution will change from blue to pink-purple.
lipid	sudan III	The lipids will separate and the top layer will turn bright red.

Effect of pH on the Rate of Reaction of Amylase (Required Practical)

Iodine is used to test for the presence of **starch**. If starch is present, the colour will change to blue-black.

The **independent variable** in the investigation is the pH of the buffer solution.

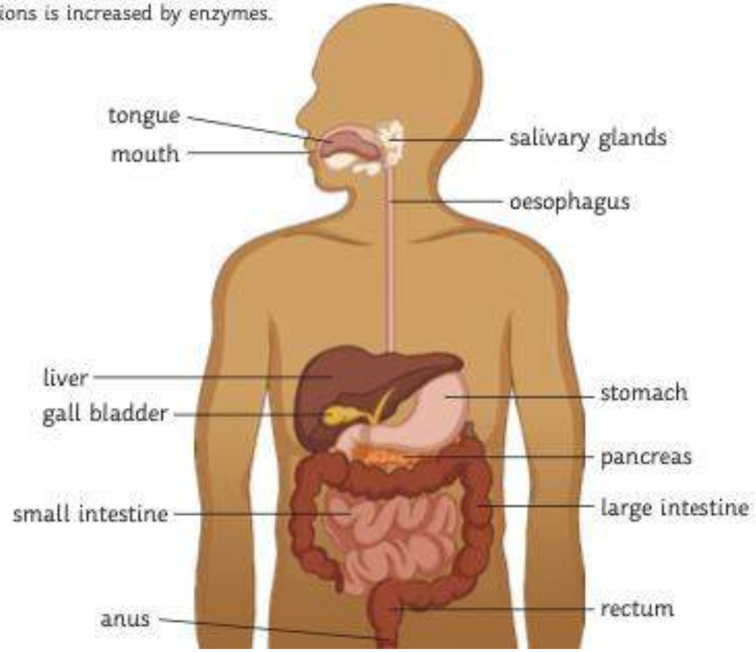
The **dependent variable** in the investigation is the time taken for the reaction to complete (how long it takes for all the starch to be digested by the amylase).

Method:

1. Use the marker pen to label a test tube with the first value of pH buffer solution (pH 4) and stand it in the test tube rack.
2. Into each well of the spotting tiles, place a drop of iodine.
3. Using a measuring cylinder, measure $2cm^3$ of amylase and pour into the test tube.
4. Using a syringe, measure $1cm^3$ of the buffer solution and pour into the test tube.
5. Leave this to stand for five minutes and then use the thermometer to measure the temperature. Make a note of the temperature.
6. Add $2cm^3$ of starch solution into the test tube, using a different measuring cylinder to measure, and begin a timer (leave the timer to run continuously).
7. After 10 seconds, use a pipette to extract some of the amylase/starch solution, and place one drop into the first well of the spotting tile. Squirt the remaining solution back into the test tube.
8. Continue to place one drop into the next well of the spotting tile, every 10 seconds, until the iodine remains orange.
9. Record the time taken for the starch to be completely digested by the amylase by counting the wells that were tested positive for starch (indicated by the blue/black colour change of the iodine). Each well represents 10 seconds of time.
10. Repeat steps 1 to 8 for pH values 7 and 10.

The Digestive System

The purpose of the digestive system is to break down large molecules into smaller, soluble molecules, which are then absorbed into the bloodstream. The rate of these reactions is increased by enzymes.



AQA GCSE Biology (Combined Science) Unit 2: Organisation

Enzymes

An enzyme is a biological **catalyst**; enzymes speed up chemical reactions without being changed or used up.

This happens because the enzyme lowers the **activation energy** required for the reaction to occur. Enzymes are made up of chains of amino acids folded into a globular shape.

Enzymes have an **active site** which the **substrate** (reactants) fits into. Enzymes are very specific and will only catalyse one specific reaction. If the reactants are not the complimentary shape, the enzyme will not work for that reaction.

Enzymes also work optimally at specific conditions of pH and temperature. In extremes of pH or temperature, the enzyme will **denature**. This means that the bonds holding together the 3D shape of the active site will break and the active shape will deform. The substrate will not be able to fit into the active site anymore and the enzyme cannot function.

Enzyme	Reactant	Product
amylase	starch	sugars (glucose)
protease	protein	amino acids
lipase	lipid	glycerol and fatty acids

The products of digestion are used to build new carbohydrates and proteins and some of the glucose is used for respiration.

Bile is produced in the **liver** and stored in the gall bladder. It is an **alkaline** substance which **neutralises** the hydrochloric acid in the stomach. It also works to **emulsify** fats into small droplets. The fat droplets have a higher **surface area** and so the rate of their digestion by lipase is increased.

The Heart and Blood Vessels

The **heart** is a large muscular organ which **pumps blood** carrying oxygen or waste products around the body. The **lungs** are the site of **gas exchange** where oxygen from the air is exchanged for waste carbon dioxide in the blood. Oxygen is used in the **respiration** reaction to release energy for the cells and carbon dioxide is made as a waste product during the reaction.

glucose + oxygen ⟶ carbon dioxide + water + [energy]

		
vein	artery	capillary

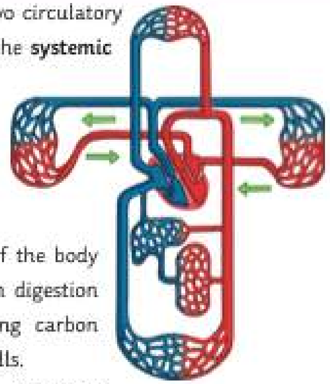
The three types of blood vessels, shown above, are each adapted to carry out their specific function.

Capillaries are narrow vessels which form networks to closely supply cells and organs between the veins and arteries. The walls of the capillaries are only **one cell thick**, which provides a short **diffusion pathway** to increase the rate at which substances are transferred.

The table below compares the structure and function of arteries and veins:

	Artery	Vein
direction of blood flow	away from the heart	towards the heart
oxygenated or deoxygenated blood?	oxygenated (except the pulmonary artery)	deoxygenated (except the pulmonary vein)
pressure	high	low (negative)
wall structure	thick, elastic, muscular, connective tissue for strength	thin, less muscular, less connective tissue
lumen (channel inside the vessel)	narrow	wide (with valves)

The Heart as a Double Pump



The heart works as a **double pump** for two circulatory systems; the **pulmonary** circulation and the **systemic** circulation.

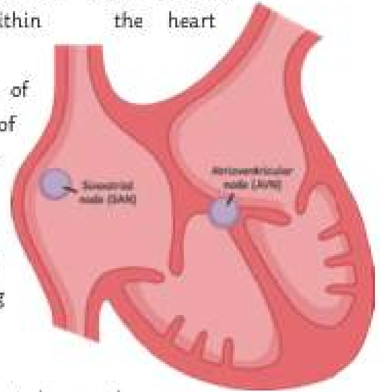
The pulmonary circulation serves the lungs and bring deoxygenated blood to exchange waste carbon dioxide gas for oxygen at the **alveoli**.

The systemic circulation serves the rest of the body and transports oxygen and nutrients from digestion to the cells of the body, whilst carrying carbon dioxide and other waste away from the cells.

The systemic circulation flows through the whole body. This means the blood is flowing at a much higher pressure than in the pulmonary circuit.

The Heart as Pacemaker

The rate of the heart beating is very carefully, and automatically, controlled within the heart itself.



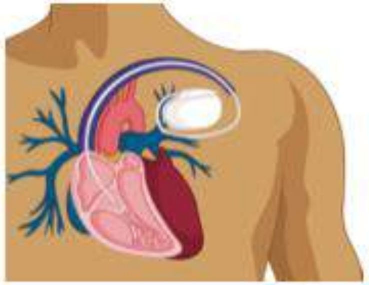
Located in the muscular walls of the heart are small groups of cells which act as pacemakers. They produce electrical impulses which stimulate the surrounding muscle to contract, squeezing the chambers of the heart and pumping the blood.

The **sino-atrial node (SAN)** is located near the right atrium and it stimulates the atria to contract.

The **atrio-ventricular node (AVN)** is located in between the ventricles and stimulates them to contract.

AQA GCSE Biology (Combined Science) Unit 2: Organisation

Artificial pacemakers can be surgically implanted into a person if their heart nodes are not functioning correctly.



Coronary Heart Disease

Coronary heart disease is a condition resulting from **blockages** in the **coronary arteries**. These are the main arteries which supply blood to the heart itself and they can become blocked by build-up of **fatty deposits**.

In the UK and around the world, coronary heart disease is a major cause of many **deaths**.

The main symptoms can include **chest pain**, **heart attack** or **heart failure**. Yet, not all people suffer the same symptoms, if any at all.

Lifestyle factors can increase the risk of a person developing coronary heart disease.

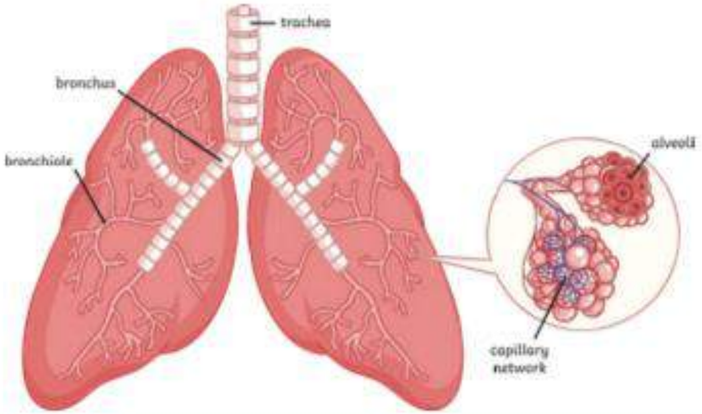
Diet – a high-fat diet (containing lots of saturated fat) can lead to higher cholesterol levels and this cholesterol forms the fatty deposits which damage and block the arteries.

Smoking – chemicals in cigarette smoke, including nicotine and carbon monoxide, increase the risk of heart disease. Carbon monoxide reduces the amount of oxygen which can be transported by the red blood cells and nicotine causes an increased heart rate. The lack of oxygen to the heart and increased pressure can lead to heart attacks.

Stress – prolonged exposure to stress or stressful situations (such as high pressure jobs) can lead to high blood pressure and an increased risk of heart disease.

Drugs – illegal drugs (e.g. ecstasy and cannabis) can lead to increased heart rate and blood pressure, increasing the risk of heart disease.

Alcohol – regularly exceeding unit guidelines for alcohol can lead to increased blood pressure and risk of heart disease.



Blood

Blood is composed of red blood cells (erythrocytes), white blood cells and platelets, all suspended within a plasma (a tissue).

The **plasma** transports the different blood cells around the body as well as carbon dioxide, nutrients, urea and hormones. It also distributes the heat throughout the body.

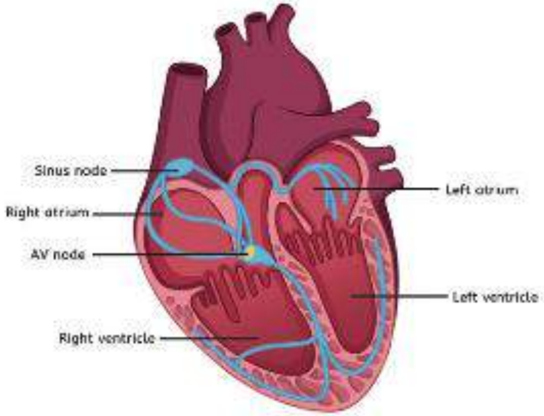
Red blood cells transport oxygen attached to the haem group in their structure. It has a biconcave shape to increase surface area and does not contain a nucleus so it can bind with more oxygen molecules.

White blood cells form part of the immune system and ingest pathogens and produce antibodies. **Platelets** are important blood clotting factors.

at the lungs

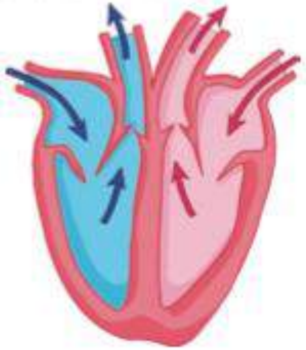
haemoglobin + oxygen ⟷ oxyhaemoglobin

at the cells



The **right atrium** receives deoxygenated blood via the **vena cava**. It is then pumped down through the valves into the right ventricle. From here, it is forced up through the **pulmonary artery** towards the **lungs** where it exchanges carbon dioxide for oxygen. The oxygenated blood then enters the **left atrium** via the **pulmonary vein** and down into the left ventricle. The muscular wall of the **left ventricle** is much thicker so it can pump the blood more forcefully out of the heart and around the entire body, via the **aorta**.

The blood only flows in **one direction**. This is because there are **valves** in the heart which close under pressure and prevent the backward flow of blood.



Plant Tissues, Organs and Systems

Leaves are plant organs and their main function is to absorb sunlight energy for use in **photosynthesis**. Within the cells are small organelles called **chloroplasts** which contain a green pigment called **chlorophyll**. This is the part of the plant which absorbs the sunlight and where photosynthesis occurs.

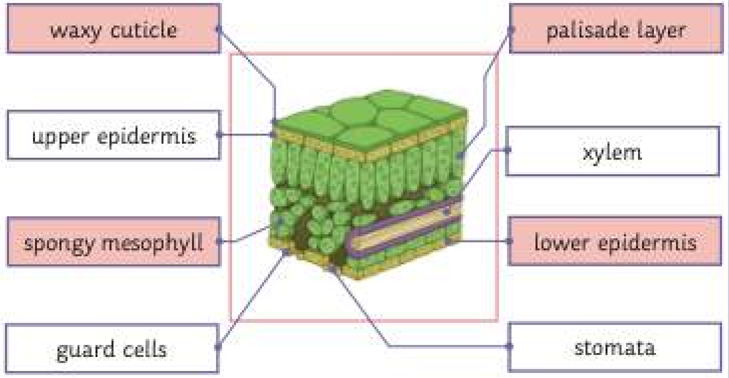
sunlight

carbon dioxide + water ⟶ oxygen + glucose

Leaves are adapted to carry out their function. Leaves are typically flat and thin with a large **surface area**. This means they have a maximum area to absorb the sunlight and carbon dioxide. The **thin** shape reduces the distance for **diffusion** of water and gases.

Leaves contain vessels called xylem and phloem. The **xylem** transport water and dissolved minerals toward the leaves. The **phloem** transport glucose and other products from photosynthesis around the plant.

The large **air spaces** between the cells of the spongy mesophyll layer allow for the diffusion of gases. **Carbon dioxide** enters the leaves and **oxygen** exits the leaves.



The **guard cells** are specially adapted cells located on the underside of the leaf. They are positioned in pairs, surrounding the **stomata** (a small opening in the epidermis layer). The guard cells change shape to open and close the stomata, controlling the rate of **gas exchange** in the leaf.

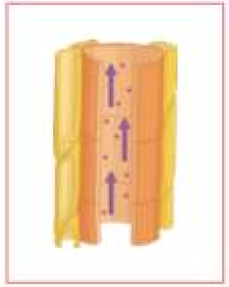
Root Hair Cells

Plants absorb water by **osmosis** through the root hair cells of the roots. Dissolved in the water are important minerals for the plant's growth and development, which are absorbed by **active transport**.

The **root hair cells** are adapted to their function with the following features:

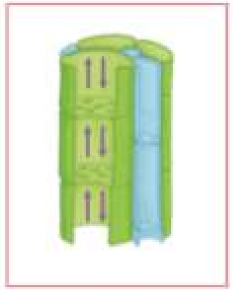
- Finger-like projection in the membrane increases the **surface area** available for water and minerals to be absorbed across.
- The narrow shape of the projection can squeeze into small spaces between soil particles, bringing it closer and reducing the distance of the **diffusion pathway**.
- The cell has many **mitochondria**, which release energy required for the active transport of some substances.

Xylem and Phloem



Xylem vessels transport **water** through the plant, from roots to leaves. They are made up of **dead**, lignified cells, which are joined end to end with no walls between them, forming a long central tube down the middle. The movement of the water, and dissolved minerals, along the xylem is in a **transpiration** stream.

Xylem vessels also provide **support** and **strength** to the plant structure. They are found in the middle of roots so they aren't crushed within the soil. They are found in the middle of the stem to provide strength and prevent bending. In the leaves, they are found in **vascular bundles** alongside the phloem and can be seen as the veins which network across the leaf.



Phloem vessels transport **food** such as dissolved sugars and glucose from photosynthesis. The food is transported around the plant to where growth is occurring (root and shoot tips), as well as to the organs which store the food. The transport occurs in **all directions** throughout the plant. The cells making up the phloem tube are **living**, with small holes in the walls where the cells are joined.

Transpiration and Translocation

Transpiration is the loss of water, by **evaporation** and **diffusion**, from the leaves of the plant. Water is a cohesive molecule and as it evaporates, there is less water in the leaf, so water from further back moves up to take its place. This, in turn, draws more water with it. This is the **transpiration stream**.

Transpiration occurs naturally as there is a tendency for water to diffuse from the leaves (where the concentration is relatively high) to the air around the plants (where the concentration is relatively low), via the **stomata**.

Environmental factors can change the rate at which transpiration occurs:

- Increased **light intensity** will increase the rate of transpiration because light stimulates the stomata to open. The leaf will also be warmed by the sunlight.
- Increased **temperature** will cause the water to evaporate more quickly and so increase the rate of transpiration.
- Increased **humidity** (moisture in the air) will reduce the rate of transpiration. Whereas if the air becomes drier, the rate increases. A greater concentration gradient will increase the rate of diffusion.
- If the **wind speed** increases, then the rate of transpiration also increases. This is because as the water surrounding the leaves is moved away more quickly, the concentration gradient is increased.
- If the **water content** in the soil is decreased, then the rate of absorption in the roots decreases. This causes the stomata to become flaccid and close, reducing transpiration. If the loss of turgor affects the whole plant, then it will wilt.

a

Complete the table below.

Enzyme	Site of Production	Substrate	Products
amylase			glucose
pepsin		protein	
lipase	pancreas		

b

The diagram below shows the 'lock & key' model of enzyme function. Label the diagram using the following words:

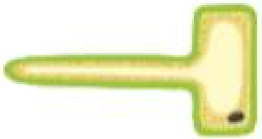
enzyme, active site, substrate, products, enzyme-substrate complex

c

Describe how to carry out the test for reducing sugars.

d

Describe how this root hair cell is adapted for the efficient uptake of water and mineral ions.



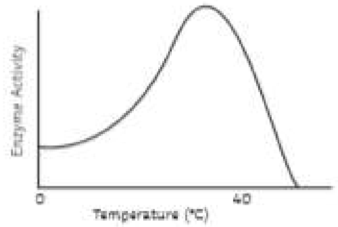
e

Place the following structures in order from smallest to largest:

cell, organ, nucleus, tissue, organism

f

Use the graph below to describe how temperature affects enzyme function.



g

Enzymes are described as being 'specific' to a substrate. What does this mean? Use a labelled diagram to help your explanation.

h

Describe how to test for protein

i

Bile is made in the liver and stored in the gall bladder. Explain how bile helps digestion.

j

Transpiration is:

- The movement of water molecules from a high water concentration to a lower water concentration across a partially permeable membrane. ☐
- The evaporation and diffusion of water from the leaves of a plant. ☐
- The movement of glucose molecules around the plant. ☐

k

Name 3 factors that affect the rate of transpiration.

1.
2.
3.

l

List 5 important keywords from this unit.

1.
2.
3.
4.
5.

m

Why are enzymes referred to as 'biological catalysts'?

n

What is the function of phloem tissue?

o

From which part of the human digestive system is nutrients absorbed into the bloodstream?

p

Where in the plant is meristem tissue located?

q

The xylem tissue is composed of hollow tubes strengthened by lignin. What is the function of xylem tissue?

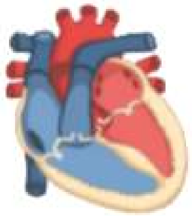
r

Describe how to test for starch.

s

My main areas for improvement in this unit are:

Label the following blood vessels on the diagram of the heart: aorta, vena cava, pulmonary artery, pulmonary vein. a



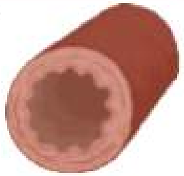
Label the following parts on the diagram below: trachea, bronchi, bronchiole, alveolus. b

Describe how smoking tobacco affects: c

Adults

Unborn babies

Describe how the structure of an artery is related to its function. d



In coronary heart disease, layers of fatty material build up inside the coronary arteries. Explain how this can lead to a 'heart attack'. e

Stents can be used to treat coronary heart disease. Give one advantage and one disadvantage of using stents. f

Advantage

Disadvantage

Describe 3 lifestyle factors that can impact a person's physical and mental wellbeing. g

1.
2.
3.

Why does the left ventricle have a thicker, more muscular wall than the right ventricle? h

Name the four main components of the blood and describe their function. i

1.
2.
3.
4.

What is a 'carcinogen'? Give an example. j

List 5 important keywords from this unit. k

1.
2.
3.
4.
5.

Explain how an infection with a microorganism could lead to the development of other, non-communicable diseases. l

Describe how a faulty heart valve will affect a person's health. m

Describe 3 ways that the lungs are adapted for gaseous exchange. n

1.
2.
3.

A problem with heart transplants is rejection of the donor heart. What is 'rejection'? o

Name the group of cells that controls the resting heart rate. p

What are 'statins'? q

What is the difference between a benign and a malignant tumour? r

My main areas for improvement in this unit are: s

B1.3 infection and response

Review lessons

Biology infection and response review 1
https://continuityoak.org.uk/Lessons ?r=1278

Biology review 2 https://continuityoak.org.uk/Lessons
?r=1277

Biology infection and response review (triple)
https://continuityoak.org.uk/Lessons ?r=9312

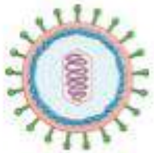
Infection and Response Knowledge Organiser – Foundation and Higher

Communicable Disease

Pathogens are **microorganisms** that enter the body and cause communicable disease (infectious). Plants and animals can be infected by them.

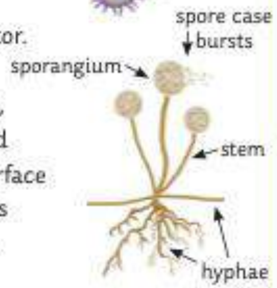
Bacteria are small cells that can reproduce very quickly in the body. They produce **toxins** that make you feel ill, damaging your cells and tissues.

Viruses are much smaller than bacteria; they can also reproduce quickly in the body. Viruses live inside your cell where they replicate. They then burst out of the cell, releasing new viruses.



Protists are eukaryotes (multicellular). Some are parasites which live on or inside other organisms, often carried by a vector.

Fungi are sometimes single celled, others have hyphae that grow and penetrate human skin and the surface of plants. They can produce spores which can spread to other plants.



How Pathogens Are Spread

Pathogens can be spread in many ways, for example:

Water – by drinking dirty water, e.g. cholera.

Air – carried by air and breathed in, e.g. influenza.

Direct contact – touching contaminated surfaces including the skin, e.g. athlete's foot.

Viral Diseases

Measles is spread by droplets of liquid from sneezes and coughs etc., symptoms include a red rash on the skin and a fever. Measles can be serious or even fatal, it can lead to pneumonia. Most people are vaccinated against measles when they are very young.

HIV is spread by sexual contact or exchanging body fluids. HIV can be controlled be antiviral drugs; this stops the viruses replicating. The virus attacks the cells in the immune system. If the immune system is badly damaged, the body cannot cope with other infections. This is the late stage and is called aids.

Tobacco mosaic virus affects plants, parts of the leaves become discoloured. This means plants cannot carry out photosynthesis; this will affect the plants growth.

Fungal and Protist Diseases

Fungal

Rose black spot shows as black spots on the leaves of the plant, this means less photosynthesis occurs. As a result, the plant does not grow as well. It is spread by the wind or the water. They can be treated by using fungicides and taking the leaves off the infected plant.

Protists

Malaria is caused by a protist, mosquitoes are the vectors. They become infected when they feed on an infected animal. The protist is inserted into the blood vessel. Malaria can cause fever, it can also be fatal.

Bacterial Diseases

Salmonella bacteria causes food poisoning. Symptoms include fever, stomach cramps, vomiting and diarrhoea. The symptoms are caused by the toxins produced by the bacteria. Food contaminated with salmonella can give you food poisoning. Most poultry in the UK will have had a vaccination against salmonella.

Gonorrhoea is a sexually transmitted bacterial disease, passed on by sexual contact. Symptoms include pain when urinating and thick yellow/green discharge from the vagina or penis. To prevent the spread, people should be treated with antibiotics and use a condom.

How to prevent the spread:

Being hygienic –

washing hands thoroughly.

Destroying vectors –

killing vectors by using insecticides or destroying their habitat.

Isolation –

isolating an infected person will prevent the spread.

Vaccination –

people cannot develop the infection and then pass it on.

Infection and Response Knowledge Organiser – Foundation and Higher

Fighting Diseases

Defence System

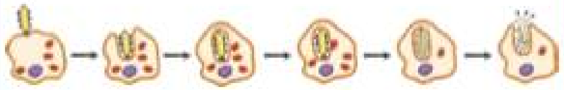
1. The skin acts as a barrier to pathogens.
2. Hairs and mucus in your nose trap particles.
3. The trachea and bronchi secrete mucus to trap pathogens. They also have cilia which move backwards and forwards to transport the mucus towards the throat. This traps any pathogens and the mucus is usually swallowed.
4. The stomach contains hydrochloric acid to kill any pathogens that enter the body via the mouth.

The Immune System

This kills any pathogens that enter the body.

White blood cells:

- **Phagocytosis** is when white blood cells engulf pathogens and then digest them.
- They produce **antitoxins** to neutralise the **toxins**.
- They also produce **antibodies**. Pathogens have **antigens** on their surface, antibodies produced by the white blood cells lock on to the antigen on the outside of the pathogen. White blood cells can then destroy the pathogens. Antibodies are specific to one antigen and will only work on that pathogen.



Vaccinations

Vaccinations have been developed to protect us from future infections. A vaccination involves an injection of a **dead** or **weakened** version of the pathogen. They carry antigens which cause your body to produce antibodies which will attack the pathogen. If you are infected again, the white blood cells can produce antibodies quickly.

Pros	Cons
Helps to control communicable diseases that used to be very common.	They don't always work.
Epidemics can be prevented.	Some people can have a bad reaction to a vaccine – however, that is very rare.

Fighting Disease – Drugs

Painkillers relive the pain and symptoms, but do not tackle the cause.

Antibiotics kill the bacteria causing the problem, but do not work on viruses. Viruses are very difficult to kill because they live inside the body cells.

Developing Drugs

There are three main stages in drug testing:

Pre-clinical testing:

1. Drugs are tested on human cells and tissues.
2. Testing carried out on living animals.

Clinical testing:

3. Tested on healthy human volunteers in clinical trials. Starts with a very low dose, then tested on people with the illness to find the optimum dose.

Placebo is a substance that is like the drug, but does not do anything.

Placebo effect is when the patient thinks the treatment will work even though their treatment isn't doing anything.

Blind trial is when the patient does not know whether they are getting the drug or the placebo.

Double-blind trial is when both the doctor and the patient do not know whether they are getting the drug.

Drugs from Plants

Chemicals produced by plants to defend themselves can be used to treat human diseases or help with symptoms.

Drug	Plant/Microorganism
aspirin	willow
digitalis	foxglove
penicillin	mould - penicillium

New drugs are now made by chemists, who work for the pharmaceutical industry, in laboratories.

Key Vocabulary

antibodies
antigens
antitoxins
bacteria
blind trial
double-blind
fungus
microorganism
phagocytosis
placebo
protist
toxins
vaccination
vector
virus

a

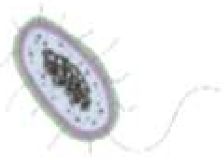
Write a definition for each type of disease and give two examples.

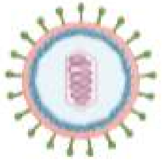
communicable disease:

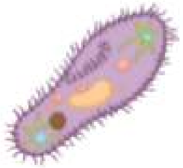
non-communicable disease:

b

Label the pathogens below that cause infectious diseases.







c

Name three ways that pathogens are spread and give at least one example.

d

How do pathogens cause disease? Fill in the gaps.

________ reproduce rapidly by ________. They may produce ________ that damage tissues and make us feel ill.

________ take over the cells of your body. They live and rapidly ________ inside, this causes cell damage.

e

Simple hygiene measures are one of the most effective ways of preventing the spread of pathogens. List 5 ways we can be more hygienic below:

f

List three other methods for preventing the spread of pathogens.

g

Salmonella

What type of pathogen is it caused by?

What are the symptoms?

How is it spread?

What can we do about it?

h

Measles

What type of pathogen is it caused by?

What are the symptoms?

How is it spread?

What can we do about it?

i

Tobacco Mosaic Virus

What type of pathogen is it caused by?

What are the symptoms?

How is it spread?

What can we do about it?

j

Explain how your skin prevents microorganisms getting into your body.

k

Gonorrhoea

What type of pathogen is it caused by?

What are the symptoms?

How is it spread?

What can we do about it?

l

HIV

What type of pathogen is it caused by?

What are the symptoms?

How is it spread?

What can we do about it?

m

Explain how the respiratory system is adapted to reduce the entry of microorganisms.

n

Malaria
What type of pathogen is it caused by?

What are the symptoms?

How is it spread?

What can we do about it?

o

Rose Black Spot
What type of pathogen is it caused by?

What are the symptoms?

How is it spread?

What can we do about it?

p

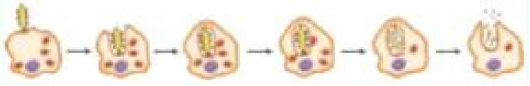
Describe how vaccinations prevent illness.

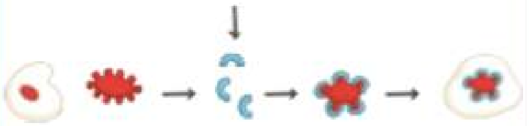
q

Explain how the digestive system is adapted to reduce the entry of microorganisms.

r

Describe each role of a white blood cell and explain how it protects you against disease.





s

Tick the correct boxes.

	Treat Symptoms	Kills Bacteria	Kills Viruses
painkillers			
antibiotics			

t

Define the following terms:

vaccine: ___

antigen: ___

antibody: ___

herd immunity: ___

u

Fill in the missing words:

The use of ___ has greatly reduced the deaths from infectious ___ diseases. However the evolution of strains that are ___ to antibiotics is a concern.

___ are specific which means they ___.

v

State where the following drugs were discovered.

The heart drug digitalis: ___

The painkiller aspirin: ___

The antibiotic penicillin: ___

Who discovered penicillin? ___

Why is it difficult to discover new medicines?

w

Where do most new drugs now come from?

What has to happen before a drug can be used?

x

Describe each process of drug testing.

preclinical testing: ___

clinical trials: ___

double-blind trials: ___

B1.4 Bioenenergetics

Review lessons

Photosynthesis review
https://continuityoak.org.uk/Lessons ?r=1220

bioenergetics review 1
https://continuityoak.org.uk/Lessons ?r=1227

Photosynthesis

Photosynthesis is a chemical reaction which takes place in plants. It converts **carbon dioxide** and **water** into **glucose** and **oxygen**. It uses **light** energy to power the chemical reaction, which is absorbed by the green pigment **chlorophyll**. This means that photosynthesis is an example of an **endothermic** reaction. The whole reaction takes place inside the **chloroplasts** which are small organelles found in plant cells.

Plants acquire the carbon dioxide via diffusion through the **stomata** of their leaves. The water is absorbed from the soil through the **roots** and transported to the cells carrying out photosynthesis, via the **xylem**.

The glucose made in photosynthesis is used for respiration, stored as starch, fat or oils, used to produce cellulose or used to produce amino acids for protein synthesis.

The Rate of Photosynthesis and Limiting Factors

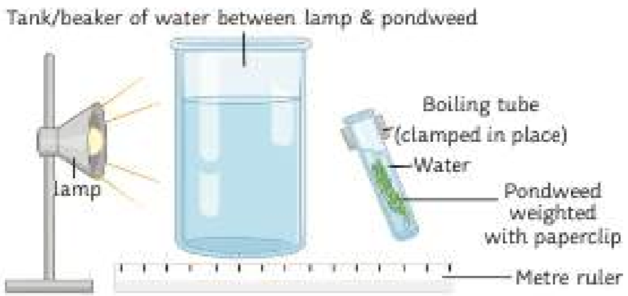
A **limiting factor** is something which stops the photosynthesis reaction from occurring at a faster rate. **Temperature**, **light intensity** and **carbon dioxide** level are all limiting factors.

Increasing the temperature of the surroundings will increase the rate of reaction, but only up to around 45°C. At around this temperature, the enzymes which catalyse the reaction become denatured.

Increasing the light intensity will increase the rate of reaction because there is more energy to carry out more reactions. Increasing the carbon dioxide concentration will also increase the rate of reaction because there are more reactants available.

The Effect of Light Intensity on the Rate of Photosynthesis (RPI)

The amount of light a plant receives affects the rate of photosynthesis. If a plant receives lots of light, lots of photosynthesis will occur. If there is very little or no light, photosynthesis will stop.



Method

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

The **independent** variable was the light intensity.

The **dependent** variable was the amount of bubbles produced. Counting the bubbles is a common method, but you could use a gas syringe instead to more accurately measure the volume of oxygen produced.

The **control** variables were same amount of time and same amount of pondweed. A bench lamp is used to control the light intensity and the water in the test tube containing the pondweed is monitored with a thermometer to monitor and control the temperature.

Interaction of Limiting Factors (HT only)

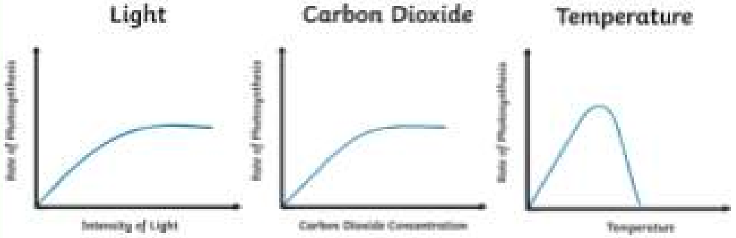
The limiting factor for the reaction will depend on the environmental conditions.

For example:

At night, light intensity is the limiting factor.

In winter, temperature is the limiting factor.

In other conditions, carbon dioxide is usually the limiting factor.



From the graph, you can see that increasing one of the factors will also increase the rate of reaction, but only for so long before it plateaus. This is because another factor will have then become the limiting factor. E.g. you could increase the supply of carbon dioxide, but if there is not enough chlorophyll to absorb the sunlight, then the sunlight will become the limiting factor instead.

Greenhouse Economics (HT only)

To grow plants in the most suitable conditions, a greenhouse can be used.

A greenhouse traps the sun's radiation as heat inside the greenhouse, so that temperature is not a limiting factor for the rate of photosynthesis.

Artificial lighting can be installed in the greenhouse to provide constant light energy and prevent light intensity being a limiting factor.

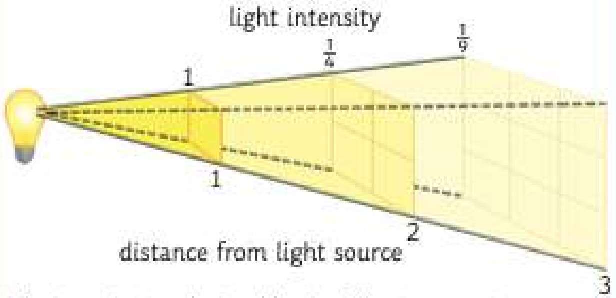
A paraffin heater can be used in the greenhouse to not only maintain a suitable temperature, but the by-product of the combustion off the paraffin is carbon dioxide.

Enclosing the crops in a greenhouse and regulating all the conditions in this way can be expensive; however, it is often outweighed because the harvest of the crop is much healthier, faster-grown crops. Furthermore, the enclosed conditions mean that disease and pests can be easily controlled and prevented.

Inverse Square Law and Light Intensity

The **inverse square law** is used to describe the light intensity at different distances from the source.

The inverse square law states that: **the intensity of light is inversely proportional to the square distance from the source.**



Light intensity is calculated by the following equation:

$$\text{light intensity} \propto \frac{1}{\text{distance}^2}$$

- The symbol, ∝, means 'is proportional to'.
- Distance is measured in metres, m.

In other words, if an object is moved twice as far away from the light source, the light intensity received is reduced to just one quarter.

Worked example:

If the light source is 10cm from a plant, calculate the light intensity reaching the plant.

$1 \div (\text{distance}^2)$

$1 \div (0.10 \times 0.10)$

$1 \div 0.01$

= **100 arbitrary units**

If the light source is moved 25cm from the plant, calculate the light intensity reaching the plant.

$1 \div (\text{distance}^2)$

$1 \div (0.25 \times 0.25)$

$1 \div 0.0625$

= 16 arbitrary units

Respiration

Respiration is the chemical reaction which occurs inside the **mitochondria** of all living cells to release energy for living functions and processes, e.g. movement, warmth and building larger molecules for growth and repair. The reaction is **exothermic**, meaning that energy is released to the surroundings.

Respiration can be either **aerobic** (using oxygen) or **anaerobic** (without using oxygen).

glucose + oxygen → carbon dioxide + water + energy

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

In anaerobic respiration, the glucose is not completely oxidised. This means that there is less energy released than in aerobic respiration.

glucose → lactic acid + energy

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

In plants and yeast, anaerobic respiration makes some different products. The reaction is also called fermentation and is used in bread-making and beer-brewing.

glucose → ethanol + carbon dioxide + energy

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

Effect of Exercise

When a person exercises, their body (specifically their **muscles**) need much more energy. To release more energy, the amount of respiration reactions occurring has to increase.

The **heart** pumps faster and the **breathing** rate and breath volume all increase to supply more **oxygen** to the muscles via the bloodstream.

If the muscles are not receiving enough oxygen to keep up the demand needed by the respiration reactions, then **anaerobic** respiration begins to occur. This incomplete oxidation of the glucose produces **lactic acid**, which can build up in the muscles and results in an **oxygen debt**.

After long periods of exercise, the muscles can become fatigued and stop contracting. You might experience a pain commonly called a **stitch**.

Metabolism

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

Energy released during respiration is used during metabolic processes to synthesise new molecules:

- Glucose is converted to starch, glycogen and cellulose.
- Glycerol and three fatty acids are joined to form a lipid molecule.
- Glucose and nitrate ions are joined to form amino acids.
- Amino acids are joined to form proteins.
- Excess proteins are broken down and released as urea during excretion.

Respiration itself is also a process which is included in metabolism.

Oxygen Debt (HT only)

During vigorous exercise, the body can begin to carry out **anaerobic respiration** and produces **lactic acid**.

Lactic acid is transported via the bloodstream to the **liver**. The liver converts the lactic acid back into **glucose**. However, **oxygen** is needed to carry out this reaction.

The **oxygen debt** is the amount of the oxygen required by the body to convert the built-up lactic acid back into glucose and remove it from the respiring cells.

1

Complete the word equation for photosynthesis.

____

________ + ________ → ________ + ________

2

Write the name of each chemical next to its formula. Which elements make up each chemical?

CO_2 ______________________________

H_2O ______________________________

O_2 ______________________________

$C_6H_{12}O_6$ ______________________________

3

Choose the correct answer:

Photosynthesis is an exothermic/endothermic reaction.

Fill in the blanks:

In photosynthesis, ________ is transferred from the ___________ to the ________ by ________.

4

Name five ways the glucose produced in photosynthesis could be used.

____

____

____

____

____

____

Fill in the blanks:

To produce ________ , plants also need ________ ions that are absorbed from the soil.

5

How does the rate of photosynthesis affect the biomass of a plant?

____

____

6

Explain how the amount of chlorophyll in a leaf affects the rate of photosynthesis.

____

____

Give two reasons there may be less chlorophyll in the leaf.

____

____

____

____

7

Explain how farmers manipulate the environment of their crops to help them make a profit.

____

____

____

____

____

____

____

____

____

____

____

____

____

____

8

Fill in the gaps:

As the distance of the light from the plant __________, the light intensity __________. This is called an __________ relationship.

The light intensity changes in inverse proportion to the square of the distance.

You would write this as:

______________ α

If you double the distance between the light and the plant, how much will the light intensity fall by?

____

9

Respiration is an exothermic/endothermic reaction that takes place in the mitochondria of cells.

The more active a cell is, the more mitochondria it needs. Name two cell types that have lots of mitochondria.

____

____

Respiration transfers __________ into a form we can use for living processes.

Respiration can take place __________ (using oxygen), or __________ (without oxygen).

10

Explain what happens to your muscles during long periods of vigorous activity.

____

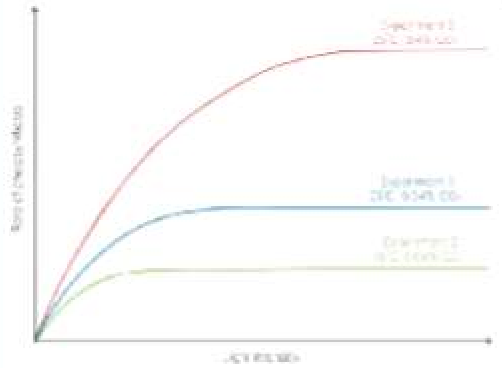
____

____

____

____

11



Compare the graphs for experiments 1 and 2, explain what they tell you about the rate of photosynthesis.

____

____

Now compare these graphs with experiment 3, explain what this tells you about the rate of photosynthesis.

____

____

Describe how light intensity affected the rate of photosynthesis.

____

____

____

____

12

Complete the word equation for aerobic respiration.

______ + ______ → __________ + ______

Complete the formula equation for aerobic respiration.

________ + ______ → ________ + ______

13

What happens to the waste lactic acid produced during anaerobic respiration?

What is the oxygen debt?

How does your body clear the oxygen debt?

14

Explain what happens to your breathing rate when you exercise.

15

Complete the word equation for anaerobic respiration in plant and yeast cells.

________ → ________ + ________

What is anaerobic respiration in yeast called?

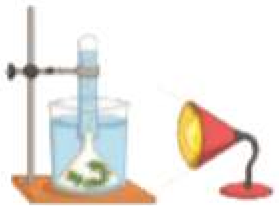
Why does this process have economic importance?

16

Explain what happens to your heart rate when you exercise.

17

The illustration shows a method for investigating the effect of light intensity on photosynthesis.



How could you measure the rate of photosynthesis using this equipment?

What is the independent variable in this experiment and what additional equipment would you need to measure it?

We often add a heat shield to the apparatus shown, what is the purpose of this?

18

When does anaerobic respiration happen?

Complete the word equation for anaerobic respiration in muscles.

________ → ________

Why is anaerobic respiration not as efficient as aerobic respiration?

19

Respiration is an exothermic/endothermic reaction that takes place in the mitochondria of cells.

The more active a cell is, the more mitochondria it needs. Name two cell types that have lots of mitochondria.

Respiration transfers ________ into a form we can use for living processes.

Respiration can take place ________ (using oxygen), or ________ (without oxygen).

20

What happens to the waste lactic acid produced during anaerobic respiration?

What is the oxygen debt?

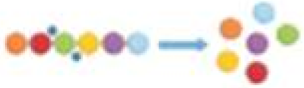
How does your body clear the oxygen debt?

21

The illustrations show the macromolecules in the foods that we eat. Complete the labels to identify the molecules they are broken down into.

carbohydrates → ________

→ ________



proteins → ________

What do the small dots on each of the macromolecules above represent?

Why is respiration important in this process?

22

Explain what happens to your heart rate when you exercise.

23

Give three reasons why organisms need energy.

24

What is metabolism?

Metabolism includes the synthesis of new molecules. Complete the sentences to identify some of the molecules that are made in plant and/or animal cells.

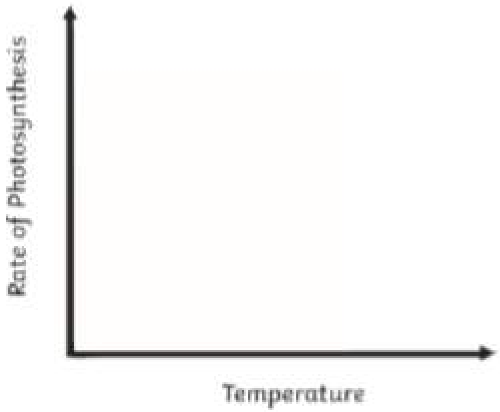
1. Glucose is converted to ________ , ________ and ________ .
2. Glycerol and ________ molecules of fatty acid are used to form ________ .
3. Glucose and ________ ions are used to form ________ , which are used to form ________ .

What happens to excess proteins in the body?

25

Draw a line on the graph to show how temperature affects the rate of photosynthesis.

Temperature

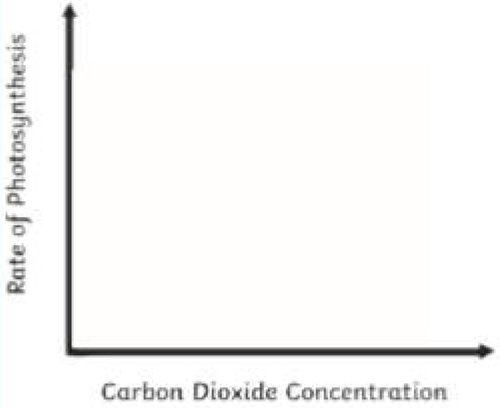


Explain how temperature affects the rate of photosynthesis.

26

Draw a line on the graph to show how carbon dioxide affects the rate of photosynthesis.

Carbon Dioxide



Describe how carbon dioxide affects the rate of photosynthesis.

27

Draw a line on the graph to show how light intensity affects the rate of photosynthesis.

Light

Describe how light intensity affects the rate of photosynthesis.

C1.1 Atomic structure and the periodic table

Review lessons

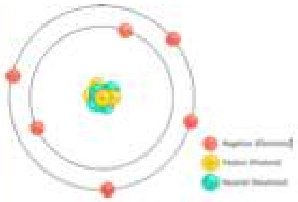
Atomic structure review
https://www.youtube.com/watch?v=bgyuXU97jaI

Atomic Structure and the Periodic Table – Foundation and Higher

Atoms

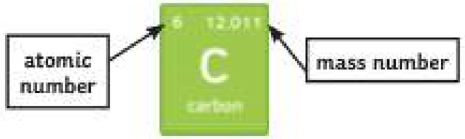
Contained in the nucleus are the **protons** and **neutrons**. Moving around the nucleus are the **electron** shells. They are negatively charged.

Particle	Relative Mass	Charge
proton	1	+1
neutron	1	0
electron	Very small	-1



Overall, atoms have no charge; they have the same number of protons as electrons. An ion is a charged particle - it does not have an equal number of protons to electrons.

Atomic Number and Mass Number



Elements

Elements are made of atoms with the same atomic number. Atoms can be represented as symbols.

N = nitrogen **F** = fluorine **Zn** = zinc **Ca** = calcium

Isotopes – an isotope is an element with the **same number of protons** but a **different number of neutrons**. They have the same atomic number, but different mass number.

Isotope	Protons	Electrons	Neutrons
$^{1}_{1}H$	1	1	1 - 1 = 0
$^{2}_{1}H$	1	1	2 - 1 = 1
$^{3}_{1}H$	1	1	3 - 1 = 2

Compounds – a compound is when two or more elements are chemically joined. Examples of compounds are carbon dioxide and magnesium oxide. Some examples of formulas are CO_2, NaCl, HCl, H_2O, Na_2SO_4. They are held together by chemical bonds and are difficult to separate.

Equations and Maths

To calculate the relative atomic mass, use the following equation:

relative atomic mass (A_r) =

$$\frac{\text{sum of (isotope abundance} \times \text{isotope mass number)}}{\text{sum of abundances of all isotopes}}$$

Balancing Symbol Equations

There must be the same number of atoms on both sides of the equation:

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

C = 1

O = 4

H = 4

Chemical Equations

A chemical reaction can be shown by using a **word equation.**

e.g. magnesium + oxygen → magnesium oxide

On the left-hand side are the reactants, and the right-hand side are the products.

They can also be shown by a **symbol equation.**

e.g. $2Mg + O_2 \rightarrow 2MgO$

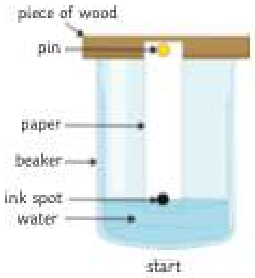
Equations need to be **balanced,** so the same number of atoms are on each side. To do this, numbers are put in front of the compounds.

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

Mixtures, Chromatography and Separation

Mixtures – in a mixture there are no chemical bonds, so the elements are easy to separate. Examples of mixtures are air and salt water.

Chromatography – to separate out mixtures.



Filtration – to separate solids from liquids.

Evaporation – to separate a soluble salt from a solution; a quick way of separating out the salt.

Crystallisation - to separate a soluble salt from a solution; a slower method of separating out salt.

Separating out salt from rock salt:

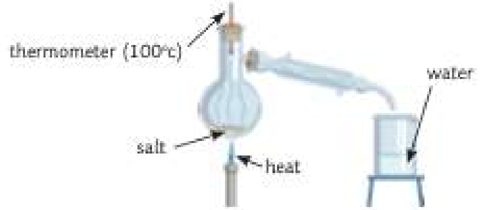
1. Grind the mixture of rock salt.
2. Add water and stir.
3. Filter the mixture, leaving the sand in the filter paper
4. Evaporate the water from the salt, leaving the crystals.

Atomic Structure and the Periodic Table – Foundation and Higher

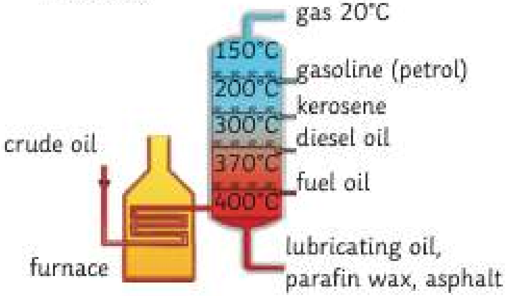
Distillation

To separate out mixtures of liquids.

1. **Simple distillation** – separating a liquid from a solution.



2. **Fractional distillation** – separating out a mixture of liquids. Fractional distillation can be used to separate out crude oil into fractions.



Metals and Non-metals

They are found at the **left** part of the periodic table. Non-metals are at the **right** of the table.

Metals

Are strong, malleable, good conductors of electricity and heat. They bond metallically.

Non-Metals

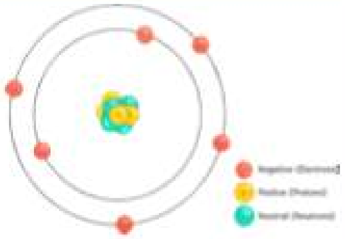
Are dull, brittle, and not always solids at room temperature.

History of the Atom

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

Electronic Structure

Electrons are found in shells. A maximum of two in the most inner shell, then eight in the 2nd and 3rd shell. The inner shell is filled first, then the 2nd then the 3rd shell.



Group 7 Elements and Noble Gases

Halogens

The halogens are **non-metals**: fluorine, chlorine, bromine, iodine. As you go down the group they become less reactive. It is harder to gain an extra electron because its outer shell is further away from the nucleus. The melting and boiling points also become higher.

Noble Gases

The **noble gases** (**group 0** elements) include: **helium**, **neon** and **argon**. They are un-reactive as they have full outer shells, which makes them very stable. They are all colourless gases at room temperature.

The boiling points all increase as they go down the group – they have greater intermolecular forces because of the increase in the number of electrons.

Development of the Periodic Table

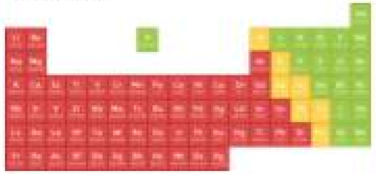
In the early 1800s, elements were arranged by atomic mass. The periodic table was not complete because some of the elements had not been found. Some elements were put in the wrong group.

Dimitri Mendeleev (1869) left gaps in the periodic table. He put them in order of **atomic mass**. The gaps show that he believed there was some undiscovered elements. He was right! Once found, they fitted in the pattern.

The Modern Periodic Table

Elements are in order of **atomic mass/proton number**. It shows where the metals and non-metals are. **Metals** are on the **left** and **non-metals** on the **right**. The **columns** show the **groups**. The **group number** shows the number of **electrons** in the **outer shell**. The rows are **periods** – each period shows another full shell of electrons.

The periodic table can be used to predict the reactivity of elements.



Alkali Metals

The alkali metals (**group** 1 elements) are soft, very reactive metals. They all have **one electron** in their **outer shell**, making them **very reactive**. They are **low density**. As you go down the group, they become more reactive. They get bigger and it is easier to lose an electron that is further away from the nucleus.

They form ionic compounds with non-metals.

They react with water and produce hydrogen.

E.g.

lithium + water → lithium hydroxide + hydrogen

$2Li + 2H_2O \rightarrow 2LiOH + H_2$

They react with chlorine and produce a metal salt.

E.g.

lithium + chlorine → lithium chloride

$2Li + Cl_2 \rightarrow 2LiCl$

They react with oxygen to form metal oxides.

a

Draw and label an atom. Include labels for the following: neutron, proton, electron.

True or false?

1. The radius of an atom is 0.1nm
2. Most of the mass is in the shell of the atom.

b

Fill in the table to show the charges and mass of the components of an atom.

Name	Charge	Relative Mass
proton		
neutron		
electron		

What is the overall charge of an atom?

Positive

Negative

No charge

c

A compound is 2 or more ____________, chemically ____________.

Which of the following are compounds?

Put a ring round them.

oxygen, salt water, magnesium oxide, sodium chloride, nitrogen

Why have you circled the ones you have?

____

____

d

What are the symbols for the following elements?

Element	Symbol
oxygen	
lithium	
sodium	
potassium	
helium	
carbon	
magnesium	

e

Complete the following diagram for sodium, include the atomic number and the atomic mass number.

Na

What is the mass number?

How do you calculate neutron number?

f

Isotopes are elements with a different number of ____________ but the same number of ____________, e.g. carbon 12 and carbon 14.

How can you use isotopes to calculate the relative atomic mass? Write down the equation.

g

Complete and balance the following equations. What is the name of the compound formed?

$Mg + O_2 \rightarrow MgO$

____

$Be + S \rightarrow BeS$

____

$Be + F_2 \rightarrow$

____

$K + Cl_2 \rightarrow$

____

h

Mixtures

Write the definition of a mixture. Give two examples.

____

____

____

____

____

i

Name the compounds and the elements they contain.

NaCl - ______________________________

MgO - ______________________________

MgS - ______________________________

FeS - ______________________________

j

What is the ratio of the elements in the following compounds?

e.g. CaO = 1:1

NaCl >

$MgCl_2$ >

lithium fluoride >

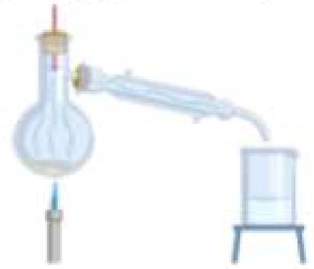
K_2O >

sodium hydroxide >

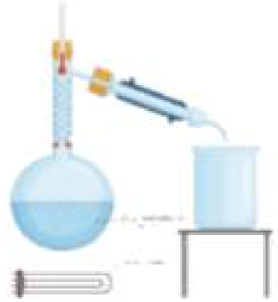
k

Separating Mixtures

What are the following separation techniques?



____



____

What separation technique would you use to separate out different inks in pens?

____

How can salt be collected using the process of crystallisation?

____

____

Sand and water can be separated by using a process called

____

Describe, in 4 steps, how to collect salt from rock salt.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

a

Complete the electronic structure diagrams for:

oxygen

magnesium

b

Describe why the noble gases are so unreactive.

The boiling points of the noble gases increase/decrease as you go down the group. (delete the wrong answer) Can you explain your answer?

c

Describe what happens to the reactivity of the alkali metals as you go down the group.

Why?

Complete the word and symbol equation for sodium reacting with water:

sodium + water → sodium hydroxide + ________

Na + ________ → NaOH + ________

d

List 3 halogens

________ ________ ________

How many electrons do they have in their outer shell?

Describe how the reactivity changes as you go down the group.

Write balanced symbol equations for the following reactions:

bromine + potassium iodide

chlorine + sodium iodide

fluorine + potassium chloride

e

Underline the properties of metals and circle the properties of non-metals:

Strong, low density, malleable, dull, good conductors of heat and electricity, high melting and boiling point, brittle, not good conductors of electricity.

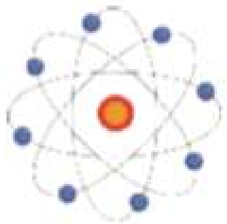
f

James Chadwick discovered the...
(underline the correct answer)

proton

neutron

electron



g

Complete the following dot and cross diagrams for:

NaCl

MgO

h

Complete word equations for the following reactions:

sodium + chlorine →

lithium + iodine →

potassium + bromine →

i

How are the groups arranged in the periodic table?

How can you tell that the alkali metals are very reactive?

How can you tell the noble gases are unreactive?

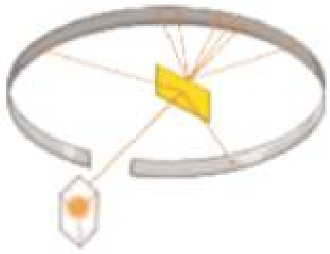
j

Describe the plum pudding model of the atom. Draw a diagram.

Why did scientists believe this model?

k

Describe what the alpha scattering experiment showed scientists.



l

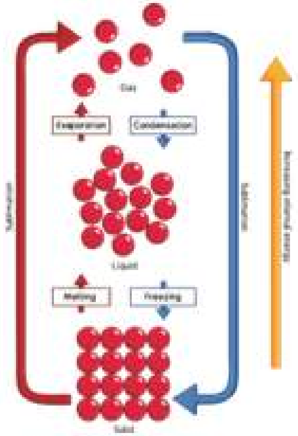
Niels Bohr discovered that

Why did Mendeleev leave gaps in the periodic table?

What happened to some of the gaps he left?

C1.2 Bonding, structure and the properties of matter

- Chemistry Bonding topic review 1 https://continuityoak.org.uk/Lessons?r=1278
- Chemistry Bonding topic review 2 https://continuityoak.org.uk/Lessons?r=1277



The three states of matter are **solid, liquid and gas**.

For a substance to change from one state to another, **energy** must be **transferred**.

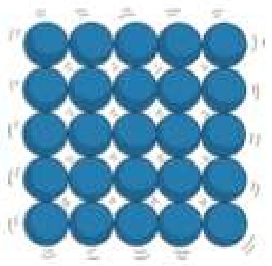
The particles gain energy. This results in the breaking of some of the **attractive forces** between particles during melting.

To evaporate or boil a liquid, more energy is needed to overcome the remaining chemical bonds between the particles.

Note the difference between **boiling** and **evaporation**. When a liquid **evaporates**, particles **leave the surface** of the liquid **only**. When a liquid **boils**, **bubbles** of gas form **throughout** the liquid before rising to the surface and escaping.

The amount of energy needed for a substance to change state is dependent upon the **strength** of the **attractive forces** between particles. The **stronger** the **forces of attraction**, the **more energy** needed to **break them apart**. Substances that have strong attractive forces between particles generally have **higher melting and boiling points**.

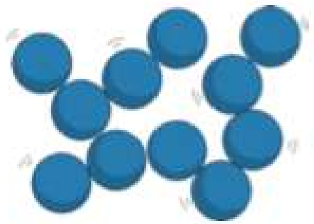
Solid



The particles in a **solid** are arranged in a regular pattern. The particles in a solid **vibrate** in a fixed position and are tightly packed together. The particles in a solid have a **low amount of kinetic energy**.

Solids have a **fixed shape** and are unable to flow like liquids. The particles **cannot be compressed** because the particles are very close together.

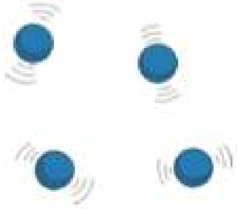
Liquid



The particles in a **liquid** are randomly arranged. The particles in a liquid are able to **move around** each other. The particles in a liquid have a **greater amount** of **kinetic energy** than particles in a **solid**.

Liquids are able to **flow** and can take the shape of the container that they are placed in. As with a solid, liquids **cannot be compressed** because the particles are close together.

Gas



The particles in a **gas** are randomly arranged. The particles in a gas are able to **move around very quickly** in all directions. Of the three states of matter, gas particles have the **highest amount** of **kinetic energy**.

Gases, like liquids, are able to **flow** and can fill the container that they are placed in. The particles in a gas are **far apart** from one another which allows the particles to move in any direction.

Gases can be **compressed**; when squashed, the particles have empty space to move into.

Limitations of the Particle Model (HT only)

The chemical bonds between particles are not represented in the diagrams above.

Particles are represented as solid spheres – this is not the case. Particles like atoms are mostly empty space. Particles are not always spherical in nature.

State Symbols

In chemical equations, the three states of matter are represented as symbols:

solid **(s)**
liquid **(l)**
gas **(g)**
aqueous **(aq)**

Aqueous solutions are those that are formed when a substance is dissolved in water.

Identifying the Physical State of a Substance

If the given temperature of a substance is **lower** than the **melting point**, the physical state of the substance will be **solid**.

If the given temperature of the substance is **between** the **melting point and boiling point**, the substance will be a **liquid**.

If the given temperature of the substance is **higher** than the **boiling point**, the substance will be a **gas**.

AQA GCSE Chemistry (Combined Science) Unit 2: Bonding, Structure and Properties of Matter

Formation of Ions

Ions are charged particle. They can be either positively or negatively charged, for example Na^+ or Cl^-.

When an element loses or gains electrons, it becomes an ion.

Metals **lose** electrons to become **positively charged**.

Non-metals **gain** electrons to become **negatively charged**.

Group 1 and 2 elements **lose** electrons and group 6 and 7 elements **gain** electrons.

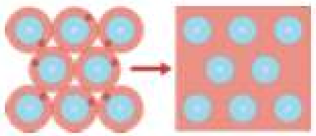
Group	Ions	Element Example
1	+1	$Li \rightarrow Li^+ + e^-$
2	+2	$Ca \rightarrow Ca^{2+} + 2e^-$
6	-2	$Br + e^- \rightarrow Br^-$
7	-1	$O + 2e^- \rightarrow O^{2-}$

Metals and Non-metals

Metals are found on the **left-hand side** of the **periodic table**. Metals are strong, shiny, malleable and good conductors of heat and electricity. On the other hand, non-metals are brittle, dull, not always solids at room temperature and poor conductors of heat and electricity. **Non-metals** are found on the **right-hand side** of the **periodic table**.

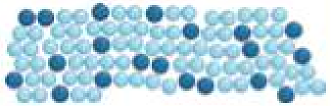
Metallic Bonding

Metallic bonding occurs between **metals only**. Positive metal ions are surrounded by a **sea of delocalised electrons**. The ions are tightly packed and arranged in rows.



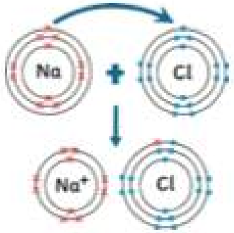
There are strong electrostatic forces of attraction between the positive metal ions and negatively charged electrons.

Pure metals are too soft for many uses and are often mixed with other metals to make alloys. The mixture of the metals introduces different-sized metal atoms. This **distorts the layers** and **prevents them from sliding over one another**. This makes it harder for alloys to be bent and shaped like pure metals.



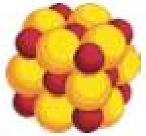
Ionic Bonding

Ionic bonding occurs between a metal and a non-metal. Metals lose electrons to become positively charged. Opposite charges are attracted by electrostatic forces – an ionic bond.



Ionic Compounds

Ionic compounds form structures called giant lattices. There are **strong electrostatic forces of attraction** that **act in all directions** and act between the **oppositely charged ions** that make up the giant ionic lattice.



Properties of Ionic Compounds

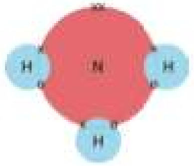
- High melting point – lots of energy needed to overcome the electrostatic forces of attraction.
- High boiling point
- **Cannot conduct electricity** in a **solid** as the ions are not free to move.
- Ionic compounds, when **molten** or in **solution**, can **conduct electricity** as the ions are free to move and can carry the electrical current.

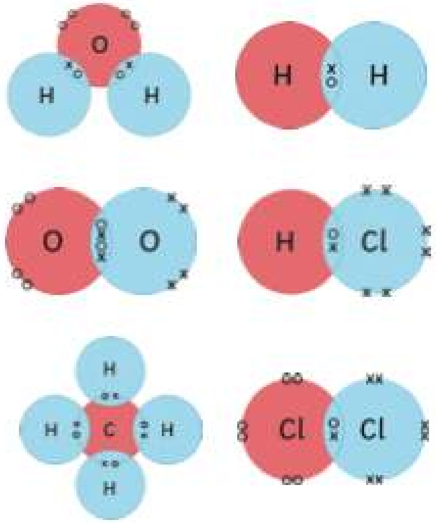
Covalent Bonding

Covalent bonding is the sharing of a pair of electrons between atoms to gain a full outer shell. This occurs between **non-metals only**. Simple covalent bonding occurs between the molecules below. Simple covalent structures have **low melting and boiling points** – this is because the **weak intermolecular forces** that hold the molecules together break when a substance is heated, not the strong covalent bonds between atoms. They **do not conduct electricity** as they do not have any free delocalised electrons.

Dot and cross diagrams are useful to show the **bonding** in **simple molecules**. The **outer electron shell** of each atom is represented as a **circle**, the circles from each atom overlap to show where there is a **covalent bond**, and the electrons from each atom are either drawn as **dots or crosses**. There are **two different types** of **dot and cross diagram** – one with a circle to represent the outer electron shell and one without.

You should be able to draw the dot and cross diagrams for the following simple covalent structures: chlorine, oxygen, nitrogen, water, ammonia, hydrogen chloride and methane.

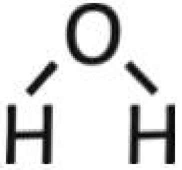




AQA GCSE Chemistry (Combined Science) Unit 2: Bonding, Structure and Properties of Matter

Structural Formulae

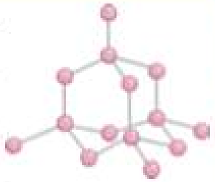
In this type of diagram, the element symbol represents the type of atom and the straight line represents the covalent bonding between each atom.



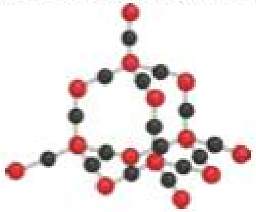
The structure of small molecules can also be represented as a 3D model.

Giant Covalent Structure – Diamond

Each **carbon** atom is **bonded** to **four** other carbon atoms, making diamond very strong. Diamond has a high melting and boiling point. **Large** amounts of **energy** are needed to break the strong covalent bonds between each carbon atom. Diamond **does not conduct** electricity because it has **no free electrons**.

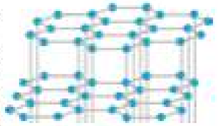


Silicon dioxide (silicon and oxygen atoms) has a similar structure to that of diamond, in that its atoms are held together by **strong covalent bonds**. Large amounts of energy are needed to break the strong covalent bonds therefore silicon dioxide, like diamond, has a high melting and boiling point.



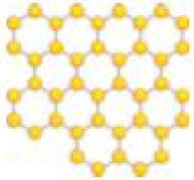
Giant Covalent Structure – Graphite

Graphite is made up of layers of **carbon** arranged in **hexagons**. Each carbon is bonded to **three** other carbons and has **one free delocalised electron** that is able to move between the layers. The layers are held together by weak intermolecular forces. The layers of carbon can slide over each other easily as there are no strong covalent bonds between the layers. Graphite has a high melting point because a lot of energy is needed to break the covalent bonds between the carbon atoms. Graphite can **conduct** electricity.



Giant Covalent Structure – Graphene

Graphene is one layer of graphite. It is very **strong** because of the covalent bonds between the carbon atoms. As with graphite, each carbon in graphene is bonded to three others with one **free delocalised electron**. Graphene is able to **conduct electricity**. Graphene, when added to other materials, can make them even stronger. Useful in electricals and composites.



Nanoscience

Nanoscience refers to structures that are **1–100nm** in size, of the order of a few hundred atoms. Nanoparticles have a **high surface area to volume ratio**. This means that smaller amounts are needed in comparison to normal sized particles. As the side length of a cube decreases by a factor of 10, the surface area to volume ratio increases approximately

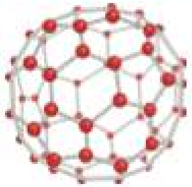
Name of Particle	Diameter
nanoparticle	1–100nm
fine particles ($PM_{2.5}$)	100–2500nm
coarse particles (PM_{10})	2500–10000nm

Polymers

Polymers are long chain molecules that are made up of many smaller units called **monomers**. Atoms in a polymer chain are held together by **strong covalent bonds**. Between polymer molecules, there are **intermolecular forces**. Intermolecular forces **attract** polymer chains towards each other. Longer polymer chains have stronger forces of attraction than shorter ones therefore making stronger materials.

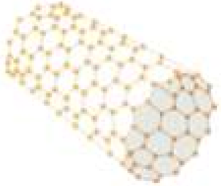
Fullerenes and Nanotubes

Molecules of carbon that are shaped like hollow tubes or balls, arranged in hexagons of five or seven carbon atoms. They can be used to **deliver drugs into the body**.



Buckminsterfullerene has the formula C_{60}

Carbon Nanotubes are tiny carbon cylinders that are very long compared to their width. Nanotubes can conduct electricity as well as strengthening materials without adding much weight. The properties of carbon nanotubes make them useful in electronics and nanotechnology.



Possible Risks of Nanoparticles

As nanoparticles are so **small**, it makes it possible for them to be inhaled and enter the lungs. Once inside the body, nanoparticles may **initiate harmful reactions** and toxic substances could bind to them because of their large surface area to volume ratio. Nanoparticles have many applications. These include medicine, cosmetics, sun creams and deodorants. They can also be used as catalysts.

Modern nanoparticles are a relatively new phenomenon therefore it is difficult for scientists to truly determine the risks associated with them.

The three types of chemical bonding are... **a**

1. ______
2. ______
3. ______

Describe the movement and arrangement of subatomic particles in each of the above.

1. ______
2. ______
3. ______

Draw a dot and cross diagram for the following ionic bonding: **b**
sodium chloride

Which four groups are more likely to make ions?

______

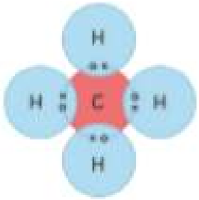
Describe the bonding in ionic compounds **c**

______

Why can ionic compounds conduct electricity when in solution?

______

Using this example, draw dot and cross diagrams for H_2O, NH_3 and O_2 **d**



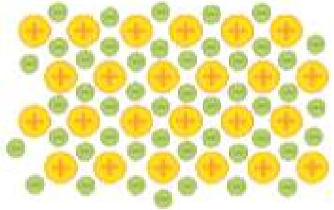
1. H_2O

2. NH_3

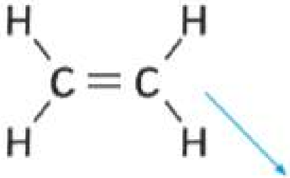
3. O_2

Describe how metals conduct heat and electricity. Use the diagram to help explain. **e**

______



Complete the polymer diagram for the following monomer. **f**



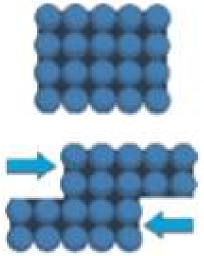
What is a monomer?

______

What is a polymer?

______

Properties of metals and alloys. **g**



Describe how the 2 pictures are different to each other.

______

Why are some alloys harder than pure metals?

______

Match up the following with the state symbol. **h**

solid	(g)
liquid	(l)
gas	(s)
solution	(aq)

What happens to the intermolecular forces when a liquid turns into a gas?

______

Describe the changes of state during: **i**

evaporation:

______

condensation:

______

melting:

______

Small molecules form substances with **high/low** boiling points because they have **strong/weak** intermolecular forces. **j**

They **do/do not** conduct electricity because they do not have any free electrons.

My main areas for improvement are: **k**

______

a

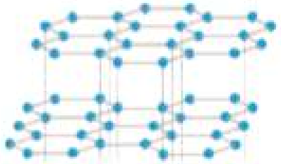
Draw a diagram of the structure of diamond.

Why is this structure so strong? Choose the correct answer.

1. Many strong ionic bonds.
2. Many strong covalent bonds.
3. Many strong metallic bonds.

b

What is this a diagram of?



Explain why it can conduct electricity and heat.

____

c

The topic I understand the most in this unit is

____

____

____

____

The topic I need to work on is

____

____

____

____

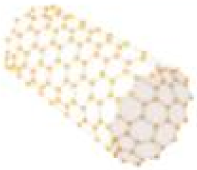
d

This is a carbon ____________.

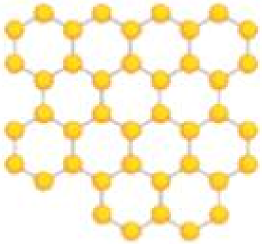
It has high ____________

strength, high ____________

and ____________ conductivity.



e



____________ is a single layer of graphite.

Why is this material so strong?

____

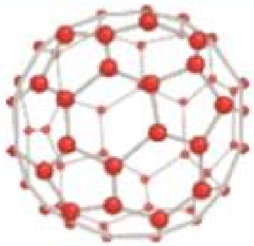
____

Where is this product used?

____

____

f



What is this structure?

____

How many carbon atoms are there?

a) 20 b) 30 c) 40 d) 50 e) 60

g

Explain the differences and similarities between silicon dioxide and diamond.

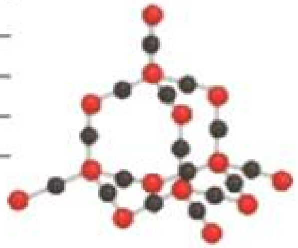
____

____

____

____

____



h

What are the formulas for the following?
Match up the answers.

Iron (II) oxide	$Fe(OH)_3$
Iron (II) hydroxide	FeO
Iron (III) oxide	Fe_2O_3

i

How many:

mm in 1m? ____________

m in 1mm? ____________

What are the abbreviated units for the following:

metre; ____________

centimetre; ____________

millimetre; ____________

nanometre; ____________

micrometre. ____________

j

Compare diamond and graphite.
Describe the structure, hardness and conductivity.

____

____

____

____

____

____

k

My main areas for improvement are:

____

____

____

____

____

____

____

C1.3 Quantitative chemistry

- Chemistry Quantitative chemistry (Higher) https://continuityoak.org.uk/Less ons?r=574
- Chemistry Quantitative chemistry (foundation) https://continuityoak.org.uk/Less ons?r=9098
- Chemistry Quantitative chemistry (Triple) https://continuityoak.org.uk/Less ons?r=9586

AQA GCSE Chemistry (Combined Science) Unit 5.3: Quantitative Chemistry Knowledge Organiser - Higher

Conservation of Mass

No atoms can be created or made during a chemical reaction, so the mass of the reactants will equal the mass of the product.

Reactions can be shown as a word or symbol equation.

magnesium + oxygen → magnesium oxide

$Mg + O \rightarrow MgO$

Symbol equations should also be balanced; they should have the same number of atoms on each side.

$2Mg + O_2 \rightarrow 2MgO$

Relative Formula Mass

The relative formula mass (M_r) is the sum of all the relative atomic masses (A_r) of the atoms in the formula.

Examples:

HCl

A_r of H = 1

A_r of Cl = 35.5

M_r of HCl = 1 + 35.5 = 36.5

H_2SO_4

A_r of H = 1

A_r of S = 32

A_r of O = 16

M_r of H_2SO_4 = (1 × 2) + 32 + (16 × 4)

M_r of H_2SO_4 = 2 + 32 + 64

M_r of H_2SO_4 = 98

Calculating Percentage Mass of an Element in a Compound

percentage mass of an element in a compound =

$$A_r \times \frac{\text{number of atoms of that element}}{M_r \text{ of the compound}}$$

Find the percentage mass of oxygen in magnesium oxide.

A_r of magnesium = 24 A_r of oxygen = 16

M_r of MgO = 24 + 16

= 40

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

Conservation of Mass

Show that mass is conserved in a reaction.

$2Mg + O_2 \rightarrow 2MgO$

(2 × 24) + (2 × 16) → 2(24 + 16)

48 + 32 → 2 × 40

80 → 80

Total M_r on the left-hand side of the equation is the same as the M_r on the right-hand side.

Calculate the mass of the product.

6g of magnesium reacts with 4g of oxygen:

6 + 4 = 10g of magnesium oxide

Concentration of Solutions

Concentration is the amount of a substance in a specific volume of a solution. The more substance that is dissolved, then the more concentrated the solution is.

It is possible to calculate the concentration of a solution with the following equation:

concentration (g/dm^3) = mass (g) ÷ volume of solvent (dm^3)

The equation can be rearranged to find the mass of the dissolved substance:

mass (g) = concentration (g/dm^3) × volume (dm^3)

During a reaction the mass can change. If one of the reactants is a gas, the mass can go up.

E.g.

magnesium + oxygen → magnesium oxide

Oxygen from the air is added to the magnesium (making the product) which will be heavier in mass.

If one of the products is a gas, the mass can go down.

E.g.

sodium carbonate → sodium oxide + carbon dioxide

When sodium carbonate is thermally decomposed, carbon dioxide gas is produced and released into the atmosphere.

The Mole

The Avogadro constant, 6.02×10^{23}, is the number of molecules of a substance that make up one mole of that substance.

Iron has an A_r of 56, so 1 mole of iron has a mass of 56g.

Oxygen (O_2) gas has an M_r of 32, so 1 mole of oxygen has a mass of 32g.

Ammonia (NH_3) has an M_r of 17, so 1 mole of ammonia has a mass of 17g.

$$\text{number of moles} = \frac{\text{mass in g (of an element or compound)}}{M_r \text{ (of the element or compound)}}$$

Moles and Equations

Write a balanced symbol equation for the reaction in which 5.6g of iron reacts with 10.65g of chlorine to form iron chloride.

Work out the M_r of all the substances.

A_r of Fe = 56 and A_r of Cl = 35.5

Divide the mass of each substance by its M_r to calculate how many moles of each substance reacted or produced.

moles Fe = 5.6/56 = 0.1

moles Cl = 10.65/35.5 = 0.3

Divide by the smallest number of moles

$Fe = \frac{0.1}{0.1} = 1$ $\quad$ $Cl = \frac{0.3}{0.1} = 3$

Write down the balanced symbol equation.

Fe + 3Cl

Chlorine exists as Cl_2 so the whole thing must be multiplied by 2.

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$

Limiting Reactions

If one reactant gets used up in a reaction before the other, then the reaction will stop. The reactant that has been used up is limiting.

If you halve the amount of reactant then the amount of product will also be halved.

Concentrations of Solutions

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

Concentration = mass ÷ volume
(g/dm^3) (g) (dm^3)

Can be rearranged to find mass dissolved:

mass = concentration x volume
(g) (g/dm^3) (dm^3)

$1000cm^3 = 1dm^3$
$cm^3 \rightarrow dm^3$ = divide by 1000.

Calculating mass in a given volume

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

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

$96g/dm^3$ means 96g in every 1000cm
↓
25c m^3

How do we get from 1000 to 25? (÷40)

Do the same to the other side (÷40)
↓
2.4g

Moles and Equations (HT only)

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

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

Step	Example
Write the equation for the reaction (unbalanced)	$Na + O_2 \rightarrow Na_2O$
write down the mass or % given in the question	$18.4 + 6.4 \rightarrow 24.8$
Write the mass of one mole of each element or compound	23 32 62 (e.g 18.4 ÷ 23)
Divide the mass given in question by the mass of one mole	0.8 0.2 0.4
Turn the answers into whole number simple ratio	8 2 4 (cancel down) 4 1 2
Put the numbers into the equation	$4Na + O_2 \rightarrow 2Na_2O$

Calculating reacting masses (HT)

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

Step	Calculation
Write the balanced equation	$2Ca + O_2 \rightarrow 2CaO$
Write the masses of each substance	$80 + 32 \rightarrow 112$
Write down the given mass in the question.	11.2
Work out the 'scale' factor (ie what did you have to do to the original number to get to the desired mass	÷ 10
Do the same to the other side	8g

Limiting Reactants (HT only)

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

a

Mass of the ___________ must always equal the mass of the ___________.

Balance the following:

$H_2 + O_2 \longrightarrow H_2O$

$Na + Cl_2 \longrightarrow NaCl$

$Br_2 + \quad KI \longrightarrow I_2 + \quad KBr$

$N_2 + \quad H_2 \longrightarrow \quad NH_3$

b

Complete the following sentences

The relative formula mass is the (_____) of a compound.

It is the sum of the _________ atomic masses (A_r) of the atoms.

Calculate the relative formula mass for the following. Show your working out.

A_r of C = 12
A_r of H = 1
A_r of O = 16
A_r of N = 14

Example:
CO_2
12 + (16 × 2)
12 + 32
= 44

H_2O

CH_4

NH_4NO_3

c

When a gas is produced during a reaction, why might the mass go down?

____

____

____

Write the equation for when magnesium reacts with oxygen.

____

What happens to the mass of the product from the question above?

____

____

____

d

$$\% \text{ mass} = \frac{A_r \times \text{number of atoms} \times 100}{M_r \text{ of the compound}}$$

Using the equation above, calculate the % mass of sodium (Na) in NaCl.

A_r of Na = 23

A_r of Cl = 35.5

e

Use the A_r values below to calculate the molar mass of these elements. Don't forget the units.

E.g. A_r of sodium = 23, one mole = 23g

A_r of K = 39

A_r of F = 19

A_r of O = 16

A_r of Mg = 24

potassium

fluorine (Fl_2)

oxygen (O_2)

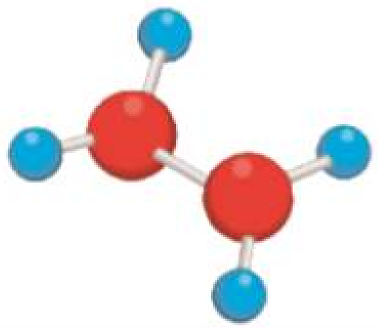
magnesium

f

What is the equation to calculate the number of moles for a pure substance.

moles = ___________________

Rearrange the equation to calculate the mass.



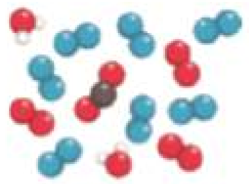
g

What unit are chemical amounts measured in?

1. cm
2. m/s
3. moles

Avogadro's constant is...

1. 6.03 × 10^{23} per mole
2. 6.02 × 10^{23} per mole
3. 6.05 × 10^{23} per mole

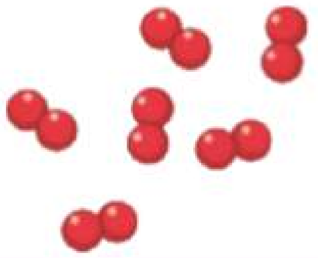


h

What mass of nitrogen is in 92g of NO_2?

A_r of N = 14

A_r of O = 16



i

Using the equation

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

What mass of NaCl would be produced from 2.5 grams of sodium carbonate?

A_r of Na = 23

A_r of H = 1

A_r of Cl = 35.5

A_r of O = 16

A_r of C = 12

j

What is the mass of solute when the concentration of a solution is 4mol/dm³ and the volume is 600cm³?

k

concentration (gm/dm³) = $\frac{\text{mass of solute}}{\text{volume}}$

Using the equation above, calculate the following:

The mass of a solute is 60g and the volume is 0.5dm³, what is the concentration?

l

Rearrange the following equation to find volume.

concentration (mol/dm³) = $\frac{\text{mass of solute}}{\text{volume}}$

m

Why, in some reactions, are the reactants in excess?

n

Define concentration.

Draw a diagram to show a solution with a low concentration and a solution with a high concentration

o

Convert the following measurements in cm³ to dm³.

1. 15cm³
2. 60cm³
3. 90cm³
4. 0.5cm³

I understand the following topic:

I need to work on the following topic:

C1.4 Chemical changes

- Chemistry Chemical changes review https://continuityoak.org.uk/Lessons?r=7598
- Chemistry Chemical changes review https://continuityoak.org.uk/Lessons?r=7605
- Chemistry Chemical changes review (Higher) https://continuityoak.org.uk/Less ons?r=7612

AQA GCSE Chemistry (Combined Science) Unit 4: Chemical Changes Knowledge Organiser

The Reactivity Series

Here's a mnemonic to help you learn the order:

purple (potassium)
slime (sodium)
can (calcium)
make (magnesium)
a (aluminium)
careless (carbon)
zebra (zinc)
insane (iron)
try (tin)
learning (lead)
how (hydrogen)
camels (copper)
surprise (silver)
gorillas (gold)

potassium
sodium
calcium
magnesium
aluminium
carbon →
zinc
iron
tin
lead
hydrogen →
copper
silver
gold
platinum

The reactivity series is a league table for metals. The more reactive metals are near the top of the table with the least reactive near the bottom. In chemical reactions, a more reactive metal will displace a less reactive metal.

Reactions of Metals with Water

Metals, when reacted with water, produce a metal hydroxide and hydrogen.

lithium + water → lithium hydroxide + hydrogen

$2Li + 2H_2O \rightarrow 2LiOH + H_2$

The more reactive a metal is, the faster the reaction.

Reactions of Metals with Dilute Acid

Metals, when reacted with acids, produce a salt and hydrogen.

Sodium + hydrochloric acid → sodium chloride + hydrogen

$2Na + 2HCl \rightarrow 2NaCl + H_2$

Metals that are below hydrogen in the reactivity series **do not** react with dilute acids.

Reactions of Acids

The general formula for the reaction between an acid and a metal is:

acid + metal → salt + hydrogen

For example: hydrochloric acid + sodium → sodium chloride + hydrogen

$2HCl + 2Na \rightarrow 2NaCl + H_2$

When an acid reacts with an alkali, a neutralisation reaction takes place and a salt and water are produced.

The general formula for this kind of reaction is as follows:

acid + alkali → salt + water

hydrochloric acid + sodium hydroxide → sodium chloride + water

$HCl + NaOH \rightarrow NaCl + H_2O$

Naming Salts

The first part comes from the metal in the metal carbonate, oxide or hydroxide. The second part of the name comes from the acid that was used to make it.

Acid Used	Salt Produced
hydrochloric	chloride
nitric	nitrate
sulfuric	sulfate

For example, sodium chloride.

Redox Reactions (Higher Tier Only)

When metals react with acids, they undergo a redox reaction. A **redox reaction** occurs when both **oxidation** and **reduction** take place at the **same time**.

For example:

$2H^+ + Ca \rightarrow Ca^{2+} + H_2$

The ionic equation can be further split into two half equations.

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

Oxidation is loss of electrons.

$2H^+ + 2e^- \rightarrow H_2$

Reduction is gaining of electrons.

Reactions with Bases

The general formula for the reaction between an acid and a metal oxide is:

acid + metal oxide → salt + water

sulfuric acid + copper oxide → copper sulfate + water

$H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$

Reactions with Carbonates

The general formula for the reaction between an acid and a carbonate is:

acid + carbonate → salt + water + carbon dioxide

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

pH Scale

In aqueous solutions, acids produce H^+ ions and alkalis produce OH^- ions.

Neutral solutions are pH7 and are neither acids or alkalis.

For example, in neutralisation reactions, hydrogen ions from an acid react with hydroxide ions from an alkali to produce water:

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

Making Soluble Salts

1. Make a saturated solution by stirring copper oxide into the sulfuric acid until no more will dissolve.

2. Filter the solution to remove the excess copper oxide solid.

3. Half fill a beaker with water and set this over a Bunsen burner to heat the water. Place an evaporating dish on top of the beaker.

4. Add some of the solution to the evaporating basin and heat until crystals begin to form.

5. Once cooled, pour the remaining liquid into a crystallising dish and leave to cool for 24 hours.

6. Remove the crystals with a spatula and pat dry between paper towels.

Strong and Weak Acids (Higher Tier Only)

A **strong** acid **completely dissociates** in a solution. For example: $HCl \rightarrow H^+ + Cl^-$

Hydrochloric acid is able to completely dissociate in solution to form hydrogen and chloride ions.

Examples of strong acids include nitric acid (HNO_3) and sulfuric acid (H_2SO_4).

Weak acids in comparison only partially dissociate.

For example acetic acid **partially dissociates** to form a hydrogen and acetate ion.

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

The **double arrow** symbol indicates that the reaction is **reversible**. Both the forward and reverse reaction occur at the same time and the reaction never goes to completion.

The Process of Electrolysis

Electrolysis is the **splitting up** of an ionic substance using **electricity.**

On setting up an electrical circuit for electrolysis, two **electrodes** are required to be placed in the electrolyte. The electrodes are **conducting rods**. One of the rods is connected to the **positive** terminal and the other to the **negative** terminal.

The **electrodes** are **inert** (this means they do not react in the reaction) and are often made from **graphite** or platinum.

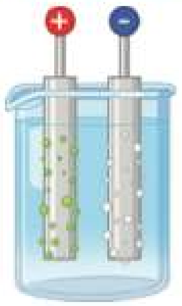
During the process of electrolysis, **opposites attract.** The positively charged ions will be attracted toward the negative electrode. The negatively charged ions will be attracted towards the positive electrode.

When ions reach the electrodes, the charges are lost and they become elements.

The **positive** electrode is called the **anode.**

The **negative** electrode is called the **cathode.**

Electrolysis of Aqueous Solutions



Gases may be given off or metals deposited at the electrodes. This is dependent on the reactivity of the elements involved.

If the metal is **more reactive** than **hydrogen** in the reactivity series, then **hydrogen** will be **produced** at the **negative cathode.** At the **positive anode,** negatively charged ions **lose** electrons. This is called **oxidation** and you say that the ions have been oxidised.

Using Electrolysis to Extract Metals

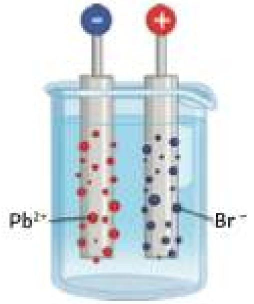
Metals are extracted by electrolysis if the metal in question reacts with carbon or if it is too reactive to be extracted by reduction with carbon. During the extraction process, large quantities of energy are used to melt the compounds.

Aluminium is manufactured by the process of electrolysis. Aluminium oxide has a high melting point and melting it would use large amounts of energy. This would increase the cost of the process, therefore molten **cryolite** is added to aluminium oxide to lower the melting point and thus reduce the cost.

Electrolysis of Molten Ionic Compounds – Lead Bromide

Lead bromide is an **ionic** substance. Ionic substances, when solid, are **not** able to conduct electricity. When molten or in solution, the ions are free to move and are able to carry a charge.

The **positive** lead ions are attracted toward the **negative cathode** at the same time as the **negative bromide** ions are attracted toward the **positive anode.**



Oxidation is the loss of electrons and reduction is the gaining of electrons. **OIL RIG** (Higher Tier Only).

We represent what is happening at the electrodes by using **half equations** (Higher Tier Only).

The lead ions are attracted towards the negative electrode. When the **lead ions** (Pb^{2+}) reach the cathode, each ion **gains two electrons** and becomes a neutral atom. We say that the lead ions have been **reduced.**

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

The bromide ions are attracted towards the positive electrode. When the **bromide ions** (Br^-) reach the anode, each ion **loses one electron** to become a neutral atom. Two bromine atoms are then able to bond together to form the covalent molecule Br_2.

$2Br^- \rightarrow Br_2 + 2e^-$

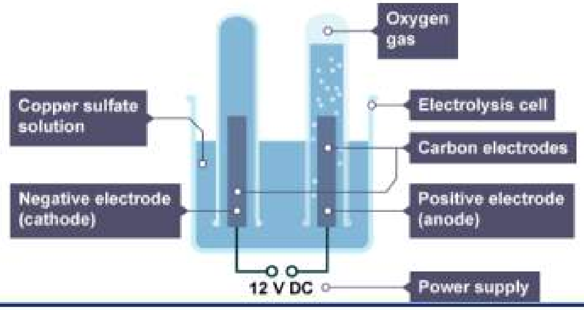
C1.4 Required practicals

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

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

Change method depending on the question.

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



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

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

Change method depending on reactants in the question.

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

a

What is an oxidation reaction?

Write an equation to show an oxidation reaction.

What is a reduction reaction?

Write an equation to show a reduction reaction.

b

Place the following metals in order of reactivity – adding the names to the symbols.

Na, Zn, Fe, Cu, Li, K, Mg, Ca

Why are hydrogen and carbon sometimes included in the reactivity series?

Place arrows on the reactivity series where hydrogen and carbon could go.

Why is gold often found in its pure state?

c

Complete the word equations.

zinc carbonate + sulfuric acid →

magnesium oxide + hydrochloric acid →

magnesium carbonate + nitric acid →

calcium carbonate + hydrochloric acid →

d

Describe what a metal reacting with an acid can tell you about the reactivity of the metal.

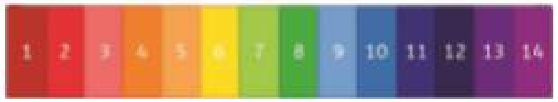
acid + metal → salt + hydrogen

e

On the pH scale, label:

strong acid;
strong alkali;
neutral;
weak acid;
weak alkali.

What does the pH show?



f

Some metals react with water to produce

Some metals react with acid to produce

g

To measure pH you can use... **(select two)**

universal indicator
Litmus paper
iodine
methylene blue
Benedict's solution
pH meter

h

Describe how to make a soluble salt from an insoluble base.

1. Choose an a__________.
2. Choose an i__________ base.
3. Warm the a__________.
4. Add the insoluble base to the acid until there is no further r__________.
5. F__________ the mixture.
6. Heat the solution to e__________ the water.
7. C__________ of salt will start to form.

i

Complete the neutralisation reaction.

acid + base → s________ + w________

H^+ (aq) + OH- (aq) → ________.

What is the pH of the products of a neutralisation reaction?

a) 1 b) 7 c) 14

j

Complete the following:

O ______________

I ______________

L ______________

R ______________

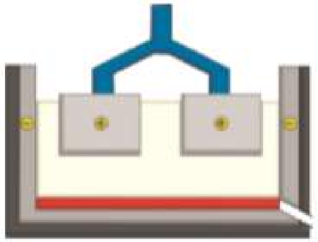
I ______________

G ______________

__________ is the loss of electrons and __________ is the gaining of electrons.

a

Describe how aluminium is extracted by electrolysis.



Why is aluminium oxide mixed with cryolite?

What is the overall equation for the electrolysis of Al_2O_3 to make aluminium and oxygen?

Why can aluminium not be extracted by carbon?

Write the equation for the reaction at the negative electrode.

Write the equation for the reaction at the positive electrode.

b

In which of the following reactions will a displacement reaction occur?

copper oxide + magnesium

magnesium oxide + iron

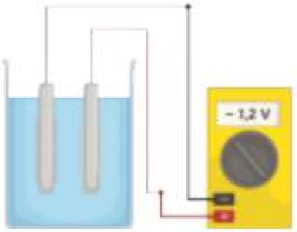
potassium oxide + zinc

zinc oxide + lithium

Why do some of them not work?

c

Describe what happens during the process of electrolysis.



d

The pH of an acid or alkali is a measure of the concentration of __________ ions.

A pH change from 4 to 2 increases H+ concentration by a factor of...

a) 10 b) 100 c) 1000

(choose the correct answer)

The pH of a strong acid is __________ than the pH of a weaker acid if they have the same __________.

Acids produce __________ in aqueous solutions.

Alkalis produce __________ in aqueous solutions.

e

In copper sulfate solution what forms at the:

cathode __________ anode __________

Why?

In sodium chloride solution what forms at the:

cathode __________ anode __________

Why?

What are the tests for:

chlorine;

hydrogen;

oxygen?

f

Strong acids are completely/partially ionised in an aqueous solution

A weak acid is completely/partially ionised in an aqueous solution.

The concentration of an acid is

g

I understand the following topic

I need to work on the following topic

C1.5 Energy changes

- Chemistry energy changes https://continuityoak.org.uk/Lessons?r=7673
- Chemistry energy changes (Triple) https://continuityoak.org.uk/Le
ons?r=9591

AQA GCSE Chemistry (Combined) Unit 5 Energy Changes Knowledge Organiser

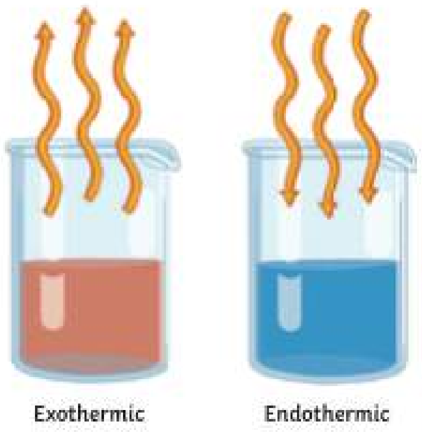
Exothermic and Endothermic Reactions

When a chemical reaction takes place, **energy** is involved. Energy is transferred when chemical **bonds are broken** and when new **bonds are made**.

Exothermic reactions are those which involve the transfer of energy **from the reacting chemicals to** the surroundings. During a practical investigation, an exothermic reaction would show an **increase in temperature** as the reaction takes place.

Examples of exothermic reactions include **combustion, respiration and neutralisation** reactions. Hand-warmers and self-heating cans are examples of everyday exothermic reactions.

Endothermic reactions are those which involve the transfer of energy **from the surroundings to** the reacting chemicals. During a practical investigation, an endothermic reaction would show a **decrease in temperature** as the reaction takes place.



Examples of endothermic reactions include the **thermal decomposition** of calcium carbonate.

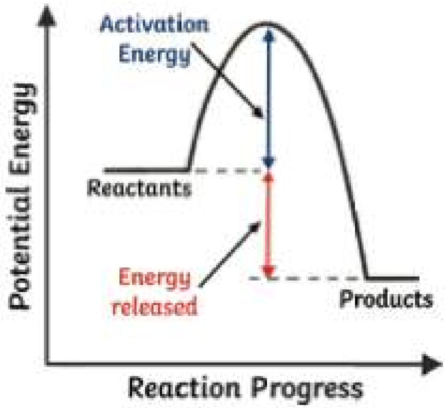
Eating **sherbet** is an everyday example of an endothermic reaction. When the sherbet dissolves in the saliva in your mouth, it produces a cooling effect. Another example is **instant ice packs** that are used to treat sporting injuries.

Reaction Profiles – Exothermic

Energy level diagrams show us what is happening in a particular chemical reaction. The diagram shows us the **difference in energy** between the reactants and the products.

In an exothermic reaction, the **reactants** are at a **higher** energy level than the products.

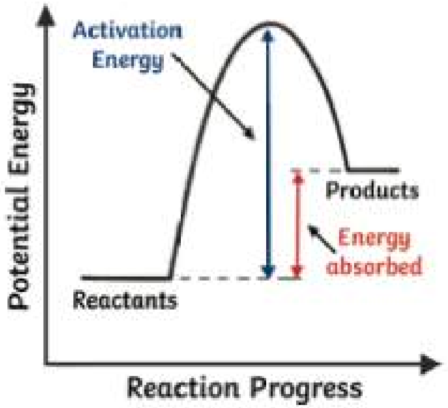
In an **exothermic** reaction, the difference in energy is **released** to the surroundings and so the **temperature** of the surroundings **increases**.



Reaction Profiles – Endothermic

In an **endothermic** reaction, the **reactants** are at a **lower** energy level than the products.

In an **endothermic** reaction, the difference in energy is **absorbed** from the surroundings and so the **temperature** of the surroundings **decreases**.



Activation Energy – the minimum amount of energy required for a chemical reaction to take place.

Catalysts – increase the rate of a reaction. Catalysts provide an alternative pathway for a chemical reaction to take place by **lowering** the activation energy.

Bond Making and Bond Breaking

In an **endothermic** reaction, energy is needed to break chemical bonds. The **energy change (ΔH)** in an endothermic reaction is **positive**.

You may also find, in some textbooks, **ΔH** referred to as the **enthalpy change**.

In an **exothermic** reaction, energy is needed to form chemical bonds. The **energy change (ΔH)** in an exothermic reaction is **negative**.

Bond energies are measured in **kJ/mol**.

Calculations Using Bond Energies (Higher Tier Only)

Bond energies are used to calculate the change in energy of a chemical reaction.

Calculate the change in energy for the reaction: $2H_2O_2 \rightarrow 2H_2O + O_2$

The first step is to write the symbol equation for the reaction. Once you have done this, work out the bonds that are breaking and the ones that are being made.

2H-O-O-H ⟶ 2H-O-H + O=O

Bond	Bond Energy kJ/mol
H-O	464
O-O	146
O=O	498

On the **left-hand side** of the equation, the **bonds are breaking.**

There are two **O-H** bonds and one **O-O** bond.

So 464 + 146 + 464 = 1074

There are two moles of H_2O_2 therefore the answer needs to be multiplied by two.

So 1074 × 2 = 2148

On the **right-hand** side of the equation, the **bonds are made.**

There are two **H-O** bonds

So 464 + 464 = 928

Two moles of H_2O are made therefore the answer needs to be multiplied by two.

So 928 × 2 = 1856

There is also one **O=O** bond with a bond energy of 498

So 1856 + 498 = 2354

ΔH = sum (bonds broken) – sum (bonds made)

ΔH = 2148 – 2354 = -206 kJ/mol

The reaction is exothermic as ΔH is negative.

Required Practical

Aim

To investigate the variables that affect temperature changes in reacting solutions, e.g. acid plus metals, acid plus carbonates, neutralisations and displacement of metals.

Equipment

- polystyrene cup
- measuring cylinder
- thermometer
- 250cm^3 glass beaker
- measuring cylinder
- top pan balance

Method

1. Gather the equipment.
2. Place the polystyrene cup inside the beaker. This will prevent the cup from falling over.
3. Using a measuring cylinder, measure out 30cm^3 of the acid. Different acids such as hydrochloric or sulfuric acid may be used. Pour this into the polystyrene cup.
4. Record the temperature of the acid using a thermometer.
5. Using a top pan balance, measure out an appropriate amount of the solid (for example, 10g) or use one strip of a metal such as magnesium.
6. Add the solid to the acid and record the temperature. You may choose to record the temperature of the acid and metal every minute for 10 minutes.

Energy changes required prac

Hypothesis

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

Equipment

- Polystyrene cup and lid
- Thermometer
- $250cm^3$ beaker
- Measuring cylinder
- Liquid reactants

Method (example for hydrochloric acid and sodium hydroxide)

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

Variables

Independent – Volume of sodium hydroxide
Dependent – Temperature change
Control – Volume of hydrochloric acid, concentration of acid, concentration of sodium hydroxide

a

In an exothermic reaction heat ________ the reaction to the surrounding environment.

The surrounding temperature ________ .

In an endothermic reaction heat ______ the chemical reaction.

The surrounding temperature ________ .

b

Circle the exothermic reactions and underline the endothermic reactions:

combustion
photosynthesis
electrolysis
neutralisation
water reacting with calcium oxide
ammonium chloride reacting with water

Name some every day uses of exothermic reactions.

Give an example of an every day use of an endothermic reaction.

c

What is activation energy?

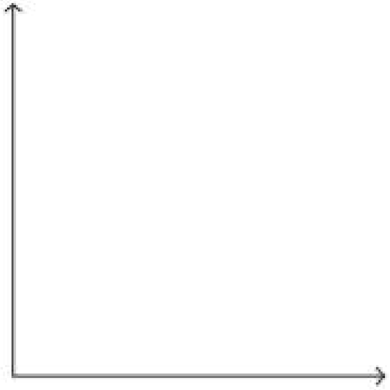
d

Describe how energy transfer can be measured in a practical.

Draw a diagram to show the practical.

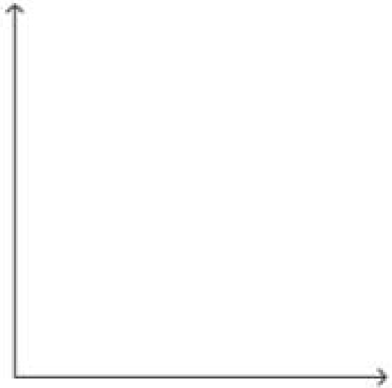
e

Sketch a reaction profile for an endothermic reaction.



f

Sketch a reaction profile for an exothermic reaction.



g

Describe the reaction profile of an endothermic reaction.

Describe the reaction profile of an exothermic reaction.

h

Use the approximate bond energies to calculate the energy change in the following reaction.

$H_2 + Cl_2 \rightarrow 2HCl$

State whether the reaction is endothermic or exothermic.

H–H = 436kJ/mol **Cl–Cl** = 243kJ/mol **H–Cl** = 432kJ/mol

P1.1 Energy

Review lessons

Topic review lesson Link Physics Energy review
https://continuityoak.org.uk/Less ons?r=2685

Required Practical

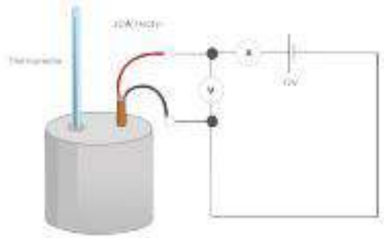
Investigating Specific Heat Capacity

independent variable – material

dependent variable – specific heat capacity

control variables – insulating layer, initial temperature, time taken

$\Delta E = m \times c \times \Delta\theta$



Method:

1. Using the balance, measure and record the mass of the copper block in kg.
2. Wrap the insulation around the block.
3. Put the heater into the large hole in the block and the block onto the heatproof mat.
4. Connect the power pack and ammeter in series and the voltmeter across the power pack.
5. Using the pipette, put a drop of water into the small hole.
6. Put the thermometer into the small hole and measure the temperature.
7. Switch the power pack to 12V and turn it on.
8. Read and record the voltmeter and ammeter readings – during the experiment, they shouldn't change.
9. Turn on the stop clock and record the temperature every minute for 10 minutes.
10. Record the results in the table.
11. Calculate work done and plot a line graph of work done against temperature.

Equations

$E = \frac{1}{2}mv^2$

$E_p = mgh$

$E_e = \frac{1}{2}ke^2$

$\Delta E = m \times c \times \Delta\theta$

$P = \frac{E}{t}$

$P = \frac{W}{t}$

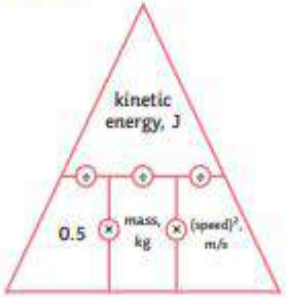
Kinetic and Potential Energy Stores

Movement Energy

kinetic energy = $\frac{1}{2}$ x mass × speed^2

$$E_k = \frac{1}{2}mv^2$$

(J) (kg)(m/s)

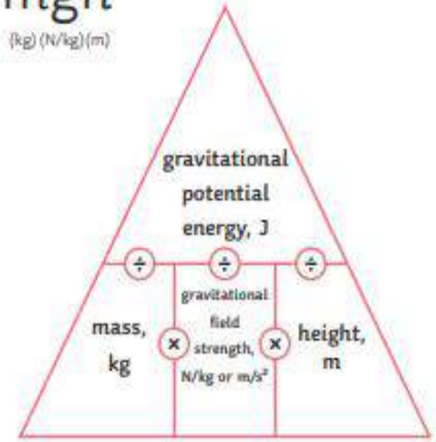


When something is off the ground, it has gravitational potential energy

gravitational potential energy = mass x gravitational field strength x height

$$E_p = mgh$$

(J) (kg) (N/kg) (m)



When an object falls, it loses gravitational potential energy and gains kinetic energy.

Stretching an object will give it elastic potential energy.

elastic potential energy = $\frac{1}{2}$ × spring constant × extension^2

$$E_e = \frac{1}{2}ke^2$$

(J) (N) (m)

Transferring Energy by Heating

Heating a material transfers the energy to its thermal energy store - the temperature increases.

E.g. a kettle: energy is transferred to the thermal energy store of the kettle. Energy is then transferred by heating to the waters thermal energy store. The temperature of the water will then increase.

Some materials need more energy to increase their temperature than others.

change in thermal energy = mass × specific heat capacity × temperature change

$$\Delta E = m \times c \times \Delta\theta$$

(J) (kg) (J/kg°C) (°C)

Specific heat capacity is the amount of energy needed to raise the temperature of 1kg of a material by 1°C.

Energy Stores and Systems

Energy Stores	
kinetic	Moving objects have kinetic energy.
thermal	All objects have thermal energy.
chemical	Anything that can release energy during a chemical reaction.
elastic potential	Things that are stretched.
gravitational potential	Anything that is raised.
electrostatic	Charges that attract or repel.
magnetic	Magnets that attract or repel.
nuclear	The nucleus of an atom releases energy.

Energy can be transferred in the following ways:

mechanically – when work is done;

electrically – when moving charge does work;

heating – when energy is transferred from a hotter object to a colder object.

Conservation of Energy

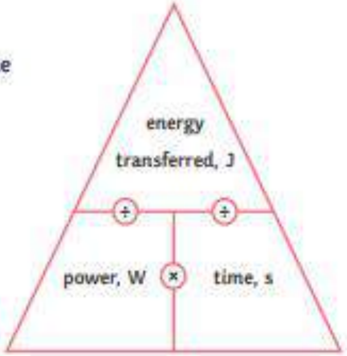
Energy can never be created or destroyed, just transferred from one form to another. Some energy is transferred usefully and some energy gets transferred into the environment. This is mostly wasted energy.

Power

Power is the rate of transfer of energy – the amount of work done in a given time.

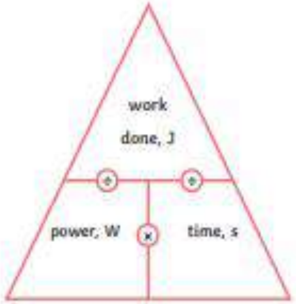
power = energy transferred ÷ time

P (W) = E (J) ÷ t (s)



power = work done ÷ time

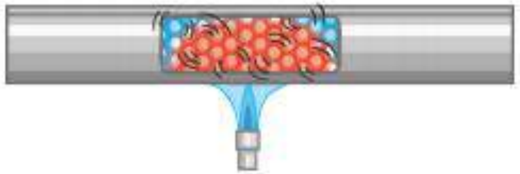
P (W) = W (J) ÷ t (s)



Energy Transfer

Lubrication reduces the amount of friction. When an object moves, there are frictional forces acting. Some energy is lost into the environment. Lubricants, such as oil, can be used to reduce the friction between the surfaces.

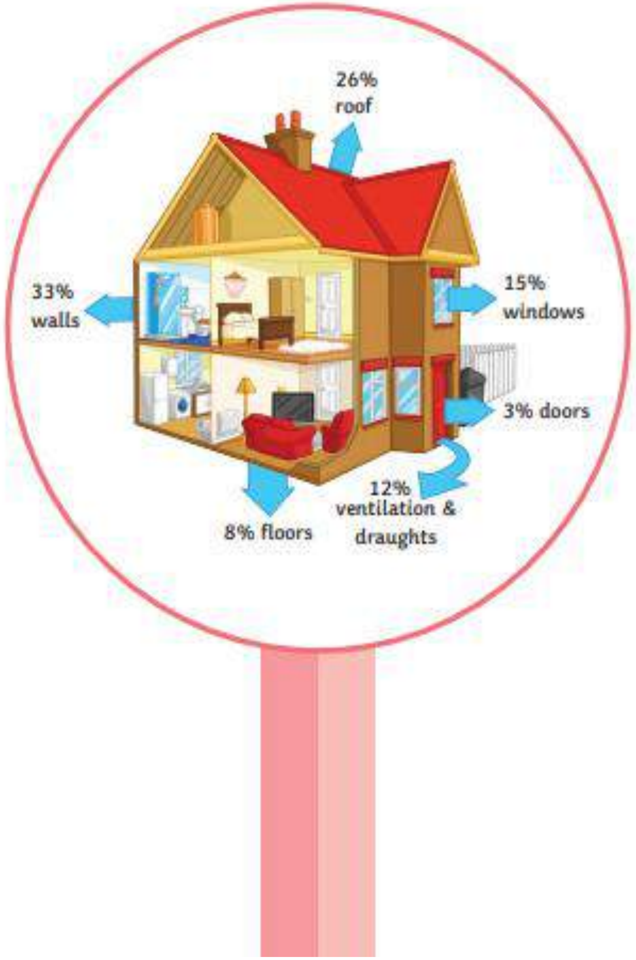
Conduction – when a solid is heated, the particles vibrate and collide more, and the energy is transferred.



Convection – when a liquid or a gas is heated, the particles move faster. This means the liquid or gas becomes less dense. The denser region will rise above the cooler region. This is a convection current.

Insulation – reduces the amount of heat lost. In your home, you can prevent heat loss in a number of ways:

- thick walls;
- thermal insulation, such as:
- loft insulation (reducing convection);
- cavity walls (reduces conduction and convection);
- double glazing (reduces conduction).



a

Describe what a system is.

b

Describe energy store changes for the following objects:

A football that has been kicked upwards.

A squash ball hitting a wall.

A car accelerating.

A car decelerating.

Bringing water to the boil.

c

What is the equation linking kinetic energy, mass and speed?

Write the units for the following:

kinetic energy: ____________

mass: ____________

speed: ____________

List some examples of objects with kinetic energy stores.

d

What is the equation linking elastic potential energy, spring constant and extension?

Write the units for the following:

elastic potential energy: ____________

spring constant: ____________

extension: ____________

List some examples of objects with elastic potential energy stores.

e

What is the equation linking gravitational potential energy, mass, gravitational field strength and height?

Write the units for the following:

gravitational potential energy: ____________

mass: ____________

gravitational field strength: ____________

height: ____________

List some examples of objects that have gravitational potential energy stores.

f

What is the equation linking change in thermal energy, mass, specific heat capacity and temperature change?

Write the units for the following:

change in thermal energy: ____________

specific heat capacity: ____________

Write a definition for specific heat capacity.

g

Define Power.

Write a definition for specific heat capacity.

Write the units for the following:

power: ____________

energy transferred: ____________

time: ____________

work done: ____________

An LED bulb has a power rating of 8W, a halogen bulb has a power rating of 28W but they both have a similar brightness. What is the difference?

The power output of a hairdryer is 2000W. How much energy is transferred per second?

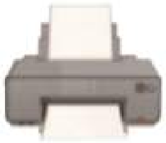
a

What is the law of conservation of energy?

Define dissipation.

b

For the following situations, name the useful energy transfers and the type of energy that is dissipated to the surroundings (wasted):



picture on a television screen.

useful:

energy dissipated as:

printer

useful:

energy dissipated as:

mobile phone

useful:

energy dissipated as:

c

For the following situations, suggest methods to reduce unwanted energy transfers and what the unwanted energy transfers are.
Hot water stored in a tank.

Moving parts in a car.

d

Describe how thermal conductivity of a material affects how it transfers energy by conduction.

e

How is energy lost from a building? What factors affect this?

f

What is the equation linking efficiency, useful output energy transfer and total input energy transfer?

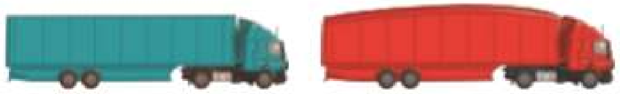
What is the equation linking efficiency, useful power output and total power input?

When energy is transferred in a closed system, what happens to the total amount of energy?

How can the efficiency of an energy transfer be increased?

g

Which lorry is more energy efficient and why?



h

List the main energy resources.

i

Define renewable and non-renewable energy resources.

j

For the energy resources that you have listed, write an R next to those that are renewable and N next to those that are non-renewable.

Except for oil, all energy resources are used for electricity generation. Which are used for heating?

k

My main areas for improvement are:

l

Energy Resource	Enviromental Impact	Reliability of Output
Coal		
Oil		
Gas		
Nuclear		
Biofuel		
Wind		
Hydroelectricity		
Geothermal		
Tidal		
Waves		
Solar		

P1.2 Electricity

Review lessons

Physics electricity review https://continuityoak.org.uk/Lessons?r=8648

Physics electricity review 2 https://continuityoak.org.uk/Lessons?r=8690

Required Practical

Investigating Resistance in a Wire

Independent variable: length of the wire.

Dependent variable: resistance.

Control variables: type of metal, diameter of the wire.

Conclusion: As the length of the wire increases, the resistance of the wire also increases.

Investigating Series and Parallel Circuits with Resistors

Independent variable: circuit type (series, parallel).

Dependent variable: resistance.

Control variables: number of resistors, type of power source.

Conclusion: Adding resistors in series increases the total resistance of the circuit. In a parallel circuit, the more resistors you add, the smaller the resistance.

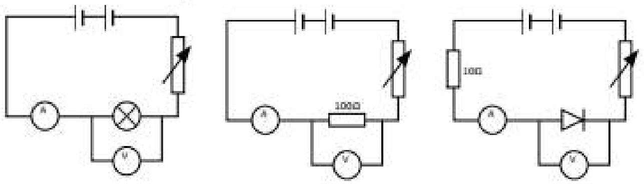
Investigating I-V Relationships in Circuits (Using a filament bulb, ohmic conductor, diode.)

Independent variable: potential difference/volts (V).

Dependent variable: current (A).

Control variable: number of components (e.g. 1 filament bulb, 1 resistor), type of power source.

Set up the circuits as shown below and measure the current and the potential difference.



Draw graphs of the results once collected.

Equations and Maths

Equations

Charge:	$Q = It$
Potential difference:	$V = IR$
Energy transferred:	$E = Pt$
Energy transferred:	$E = QV$
Power:	$P = VI$
Power:	$P = I^2R$

Maths

1kW = 1000W

0.5kW = 500W

Charge

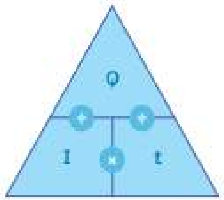
Electric current is the flow of electric charge. It only flows when the circuit is complete.

The **charge** is the current flowing past a point in a given time. Charge is measured in **coulombs (C)**.

Calculating Charge

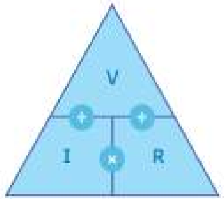
charge flow (C) = current (A) × time (s)

$Q = It$



potential difference = current x resistance

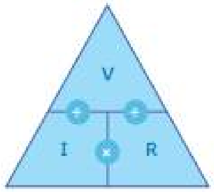
V (V) = I (A) × R (Ω)



Resistance

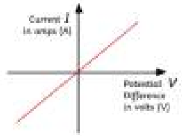
voltage (V) = current (A) × resistance (Ω)

$V = IR$

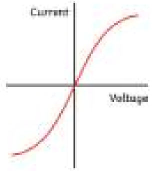


Graphs of I-V Characteristics for Components in a Circuit

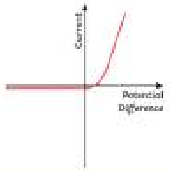
1. **Ohmic conductor**: the current is directly proportional to the potential difference - it is a straight line (at a constant temperature).



2. **Filament lamp**: as the current increases, so does the temperature. This makes it harder for the current to flow. The graph becomes less steep.



3. **Diode**: current only flows in one direction. The resistance is very high in the other direction which means no current can flow.

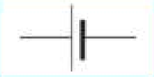
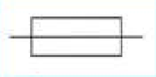
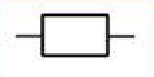
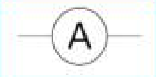
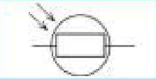
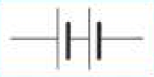
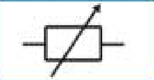
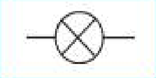
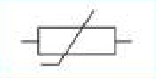
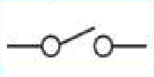
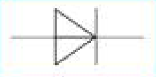


Current and Circuit Symbols

Current: the flow of electrical charge.

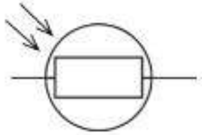
Potential difference (voltage): the push of electrical charge.

Resistance: slows down the flow of electricity.

cell		closed switch		fuse	
resistor		ammeter		LDR	
battery		voltmeter		LED	
variable resistor		bulb		thermistor	
open switch		diode			

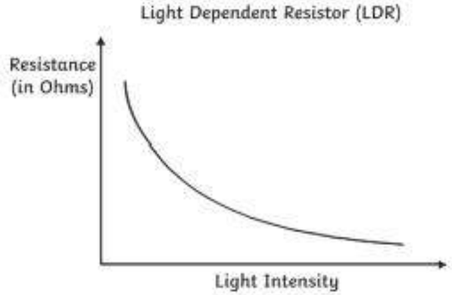
Circuit Devices

LDR – Light Dependent Resistor

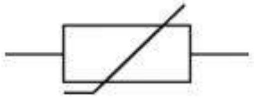


An LDR is dependent on light intensity. In bright light the resistance falls and at night the resistance is higher.

Uses of LDRs: outdoor night lights, burglar detectors.

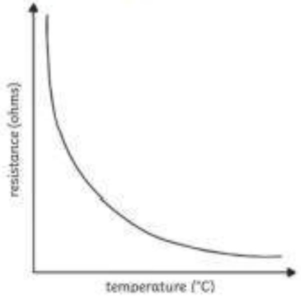


Thermistor



A thermistor is a temperature dependent resistor. If it is hot, then the resistance is less. If it becomes cold, then the resistance increases.

Uses of thermistors: temperature detectors.



Series and Parallel Circuits

Series Circuits

Once one of the components is broken then all the components will stop working.

Potential difference – the total p.d. of the supply is shared between all the components.

$V_{total} = V_1 + V_2$

Current – wherever the ammeter is placed in a series circuit the reading is the same.

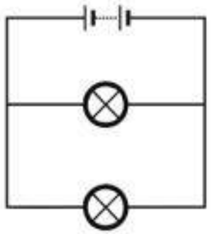
$I_1 = I_2 = I_3$

Resistance – In a series circuit, the resistance will add up to make the total resistance.

$R_{total} = R_1 + R_2$

Parallel Circuits

They are much more common - if one component stops working, it will not affect the others. This means they are more useful.



Potential Difference – this is the same for all components.

$V_1 = V_2$

Current – the total current is the total of all the currents through all the components.

$I_{total} = I_1 + I_2 + I_3$

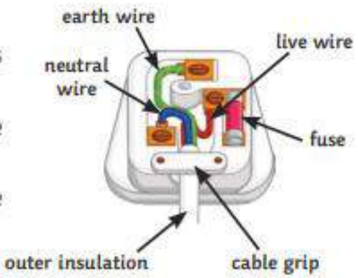
Resistance – adding resistance reduces the total resistance.

Electricity in the Home

AC – alternating current. Constantly changing direction - UK mains supply is 230V and has a frequency of 50 hertz (Hz).

DC – direct current. Supplied by batteries and only flows in one direction.

Cables – most have three wires: live, neutral and earth. They are covered in plastic insulation for safety.



Live wire – provides the potential difference from the mains.

Neutral wire – completes the circuit.

Earth wire – protection. Stops the appliance from becoming live. Carries a current if there is a fault.

Touching the live wire can cause the current to flow through your body. This causes an electric shock.

Energy Transferred – this depends on how long the appliance is on for and its power.

energy transferred (J) = power (W) × time (s) $E = Pt$

Energy is transferred around a circuit when the charge moves.

energy transferred (J) = charge flow (C) × potential difference (V) $E = QV$

power (W) = potential difference (V) × current (A) $P = VI$

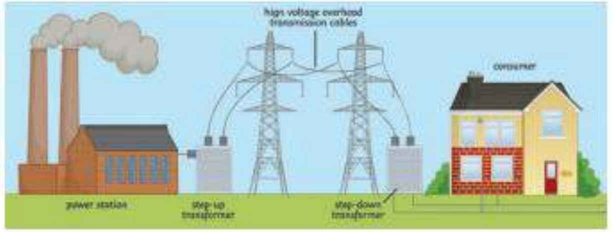
power (W) = current² (A) × resistance (Ω) $P = I^2R$

The National Grid

The National Grid is a system of cables and transformers. They transfer electrical power from the power station to where it is needed. Power stations are able to change the amount of electricity that is produced to meet the demands. For example, more energy may be needed in the evenings when people come home from work or school. Electricity is transferred at a low current, but a high voltage so less energy is being lost as it travels through the cables.

Step-up transformers – increase the voltage as the electricity flows through the cables.

Step-down transformers – decrease the potential difference to make it safe.



a

Draw the symbol diagrams for:

cell	resistor
battery	variable resistor
lamp (bulb)	ammeter
fuse	voltmeter
LED	diode
LDR	thermistor

b

What is electric current?

____

State the equation that links charge, current and time.

____

Write the symbols and units for the following:

charge: ______________________________

current: ______________________________

time: ______________________________

c

A charge of 12A flows through an electric cooker for 1 hour. How much charge has been used?

____

____

State the equation that links current, potential difference and resistance. Remember to include units.

____

A voltmeter reading is 3V and the resistance is 2Ω. What is the current?

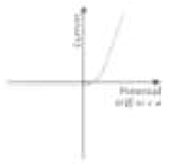
____

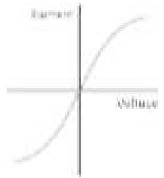
____

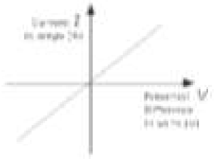
d

Use the components stated below to identify the potential difference/current graphs:

filament lamp, diode, ohmic conductor

__________ 

__________ 

__________ 

State Ohm's law.

____

____

____

____

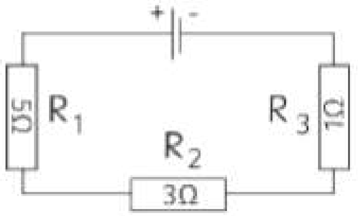
e

Complete the table.

Type of Circuit	Potential Difference Shared or the Same?	Current Same or Split?
series		
parallel		

For the circuit below, calculate the total resistance.

____



On the diagram, draw where a voltmeter could be positioned to measure the voltage through one of the components.

f

Complete the following sentences.

For a thermistor: as the temperature increases, the resistance __________

Used in: __________

For an LDR: as the light intensity increases, the resistance __________

Used in: __________

g

State the two different types of electricity supply.

1. ______________________________

2. ______________________________

The UK mains supply has an AC supply of -____V and frequency of ____Hz.

h

Label the diagram of the three pin plug.

What is the purpose of:

the neutral wire?

____

____

the live wire?

____

____

the earth wire?

____

____

a

Complete the energy transfers for the following electrical appliances.

mains-powered kettle:

electrical → t________ + s________

hairdryer:

e________ → k________ + t________ + s________

toaster

________ → ________ + ________

b

What is the equation linking energy transferred, power and time?

____

what are the units for:

energy? __________

power? __________

time? __________

c

Most devices have a power rating. Describe the relationship between the power rating and the changes in stored energy when a device is used.

____

____

____

____

d

Explain how a fuse works.

____

____

____

Calculate the current flowing through a 2kW electric fire at a potential difference of 230V.

____

e

State the equation that links power, current and potential difference.

____

A 2.4kW kettle is connected to the mains power supply (230V). Calculate the current through the kettle.

You will need to rearrange your equation above.

____

____

____

____

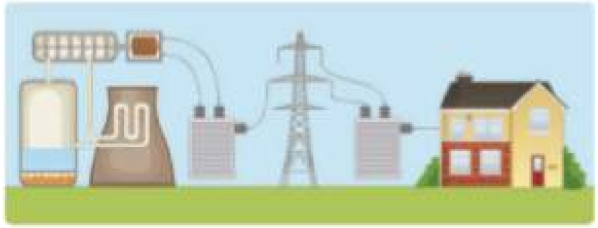
f

True or false:

- The current in a circuit can be altered by a variable resistor. __________
- A voltmeter is connected in parallel with a component. __________
- An ammeter is connected in parallel with a component. __________

g

Label the national grid diagram.



Give two examples of when the demand for electricity is likely to be high.

1. ____
2. ____

h

Why is energy transferred at such high voltage in cables?

____

____

____

____

Describe how the following work:

step-up transformer.

____

step-down transformer.

____

i

Describe an experiment to show how the length of a wire affects its resistance.

____

____

____

____

____

____

____

____

P1.3 Particle model

Review lessons

Physics Particle model of matter review
https://continuityoak.org.uk/L essons?r=1869

Required Practical

Measuring the density of a regularly shaped object:

- Measure the mass using a balance.
- Measure the length, width and height using a ruler.
- Calculate the volume.
- Use the density (ρ = m/V) equation to calculate density.

Measuring the density of an irregularly-shaped object:

- Measure the mass using a balance.
- Fill a eureka can with water.
- Place the object in the water - the water displaced by the object will transfer into a measuring cylinder.
- Measure the volume of the water. This equals the volume of the object.
- Use the density (ρ = m/V) equation to calculate density.

Density

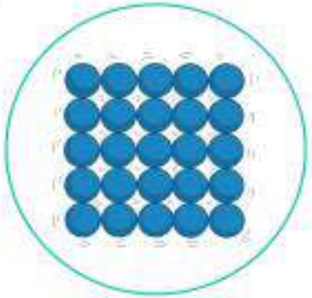
Density is a measure of how much mass there is in a given space.

Density (kg/m^3) = mass (kg) ÷ volume (m^3)

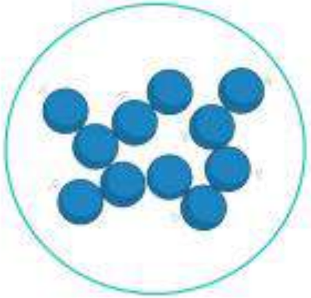
A more dense material will have more particles in the same volume when compared to a less dense material.

Particles

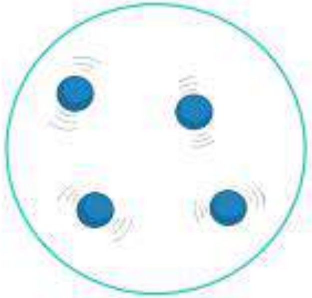
Solids have strong forces of attraction. They are held together very closely in a fixed, regular arrangement. The particles do not have much energy and can only vibrate.



Liquids have weaker forces of attraction. They are close together, but can move past each other. They form irregular arrangements. They have more energy than particles in a solid.



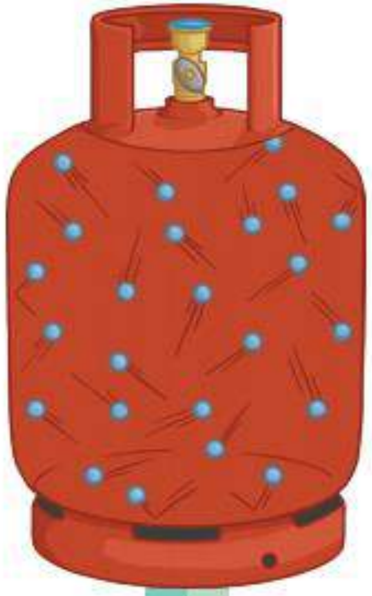
Gases have almost no forces of attraction between the particles. They have the most energy and are free to move in random directions.



Particles

Gas particles can move around freely and will collide with other particles and the walls of the container. This is the pressure of the gas.

If the temperature of the gas increases, then the pressure will also increase. The hotter the temperature, the more kinetic energy the gas particles have. They move faster, colliding with the sides of the container more often.



Density

The density of an object is 8050kg/m^3 and it has a volume of 3.4m^3 - what is its mass in kg?

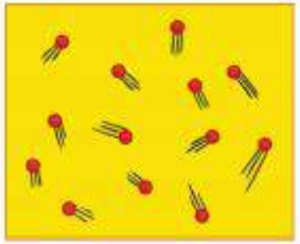
8050 = mass ÷ 3.4

8050 × 3.4 = mass

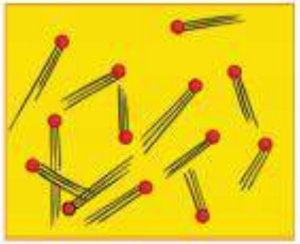
27 370kg

Internal Energy

Particles within a system have kinetic energy when they vibrate or move around. The particles also have a potential energy store. The total internal energy of a system is the kinetic and potential energy stores.



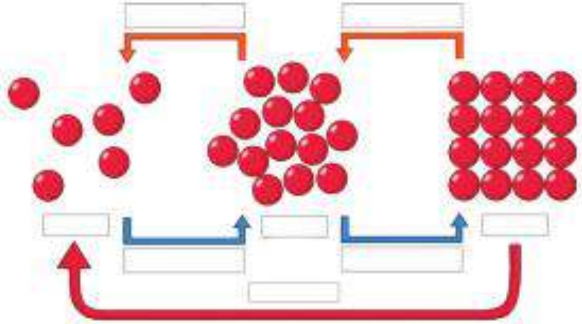
Low Temperature



High Temperature

If the system is heated, the particles will gain more kinetic energy, so increasing the internal energy.

Changing State

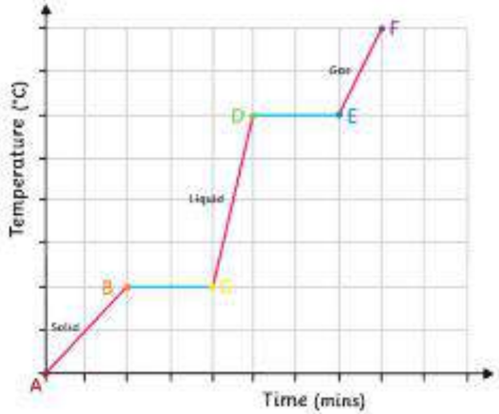


If a system gains more energy, it can lead to a change in temperature or change in state. If the system is heated enough, then there will be enough energy to break bonds.

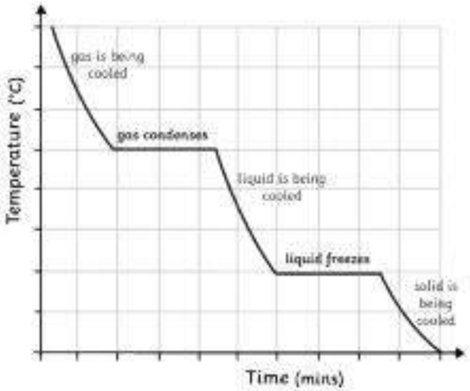
When something changes state, there is no chemical change, only physical. No new substance is formed. The substance will change back to its original form. The number of particles does not change and mass is conserved.

Specific Latent Heat

Energy is being put in during melting and boiling. This increases the amount of internal energy. The energy is being used to break the bonds, so the temperature does not increase. This is shown by the parts of the graph that are flat.



When a substance is condensing or freezing, the energy put in is used to form the bonds. This releases energy. The internal energy decreases, but the temperature does not go down.



The energy needed to change the state of a substance is called the latent heat.

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

- solid ⟶ liquid - specific latent heat of **fusion**
- liquid ⟶ gas - specific latent heat of **vaporisation**

Specific Latent Heat Equation

The amount of energy needed/released when a substance of mass changes state.

energy (E) = mass (m) × specific latent heat (L)

$E = mL$

a

What is the equation linking density, mass and volume?

b

Write the symbols and units for the following:

density:

mass:

volume:

c

Draw the particle models for solids, liquids and gases.

d

Describe the three states of matter in terms of structure, shape and movement of the particles.

solid -

liquid -

gas -

e

Why is a change of state referred to as a physical change and not a chemical change?

f

Describe the displacement technique used to determine the volume of an irregularly shaped object.

g

When substances change state, their mass is conserved. What does this mean?

Describe how to determine the volume of a regularly shaped object.

h

What is an internal system?

i

Define internal energy.

j

List some factors that affect the increase of temperature of a system.

k

Explain the differences in density of solids, liquids and gases.

l

Define specific heat capacity.

m

What is the equation linking change in thermal energy, mass, specific heat capacity and temperature?

n

Write the units and symbols for the following:

energy:

mass:

specific heat capacity:

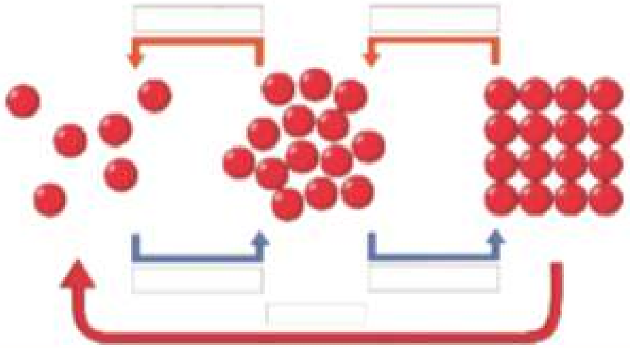
temperature change:

o

After a long journey, the temperature of a car tyre increases. What is the effect on the gas particles within the tyre?

p

Label the diagram with the terms used for changes of state.



a

Define latent heat.

b

What is the equation linking energy for a change of state, mass and specific latent heat?

Write the symbol and unit for the following:

specific latent heat: ______

c

Describe the difference between specific latent heat of fusion and specific latent heat of vaporisation.

d

Distinguish between specific heat capacity and specific latent heat.

e

What is the equation that links pressure and volume?

List the symbols and units for the following:

pressure: ______

volume: ______

f

Explain the effect of an increase in temperature on the pressure of a gas in a container.

g

For the heating and cooling curve (shown in section J), what are the terms used to describe the changes of state for:

B → C ______

D → E ______

E → D ______

C → B ______

h

What is happening to the particles between A-B, C-D and E-F?

How are kinetic energy of particles and temperature related?

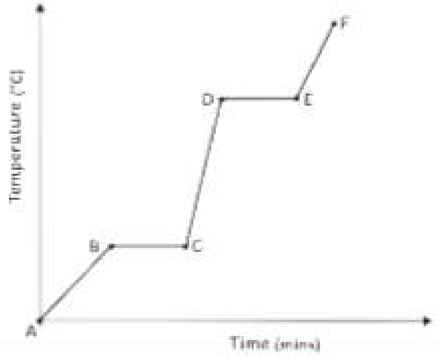
i

Using the diagram, explain the effect of an increase of volume on pressure.

(a) High pressure (b) Low pressure

j

What are the states of matter for the diagonal sections of the graph? Add labels to the graph below.



k

When work is done on a gas, what effect is there on the internal energy of the gas?

l

When work is done on a gas what effect can there be on the temperature of the gas?

m

Using the image above, explain what happens to:

a) The internal energy of the gas within the tyre:

b) The energy of the particles:

c) The temperature of the gas:

n

My main areas for improvement in this topic are:

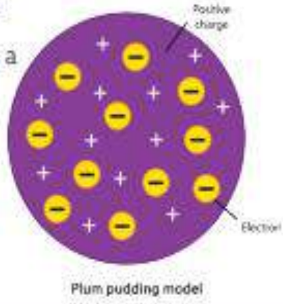
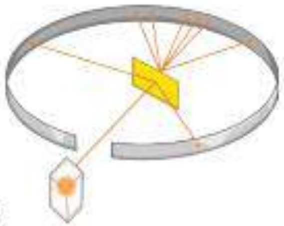
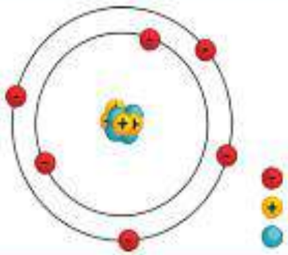
P1.4 Atomic structure

Review lessons

Physics atomic structure review 1 https://continuityoak.org.uk/Lessons?r=9680

Physics atomic structure review 2 https://continuityoak.org.uk/Lessons?r=9683

Developing the Model of the Atom

Scientist	Time	Contribution
John Dalton	Start of 19th century	Atoms were first described as solid spheres.
JJ Thomson	1897	Thomson suggested the plum pudding model – the atom is a ball of charge with electrons scattered within it.  Plum pudding model
Ernest Rutherford	1909	Alpha Scattering experiment – Rutherford discovered that the mass is concentrated at the centre and the nucleus is charged. Most of the mass is in the nucleus. Most atoms are empty space. 
Niels Bohr	Around 1911	Bohr theorised that the electrons were in shells orbiting the nucleus. 
James Chadwick	Around 1940	Chadwick discovered neutrons in the nucleus.

Isotopes

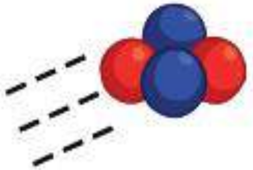
An isotope is an element with the same number of protons but a different number of neutrons. They have the same atomic number, but different mass numbers.

Isotope	Protons	Electrons	Neutrons
$^{1}_{1}H$	1	1	0
$^{2}_{1}H$	1	1	1
$^{3}_{1}H$	1	1	2

Some isotopes are unstable and, as a result, decay and give out radiation. Ionising radiation is radiation that can knock electrons off atoms. Just how ionising this radiation is, depends on how readily it can do that.

Alpha

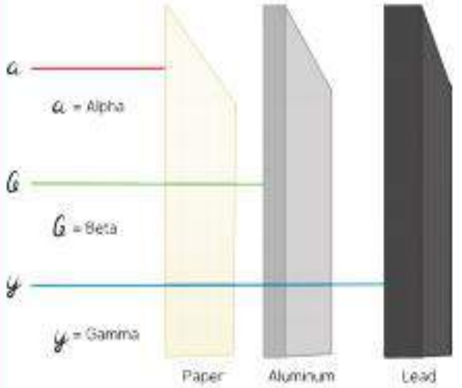
Alpha radiation is an alpha particle emitted from the nucleus of a radioactive nuclei. It is made from two protons and two neutrons. They can't travel too far in the air and are the least penetrating – stopped by skin and paper. However, they are highly ionising because of their size.



Beta

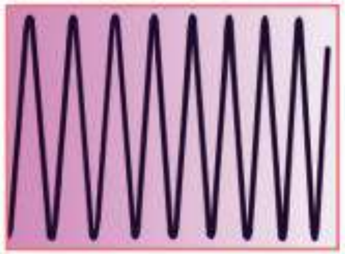
Beta radiation is a fast moving electron that can be stopped by a piece of aluminium. Beta radiation is emitted by an atom when a neutron splits into a proton and an electron.

$^{0}_{-1}e$



Gamma

A gamma wave is a wave of radiation and is the most penetrating – stopped by thick lead and concrete.



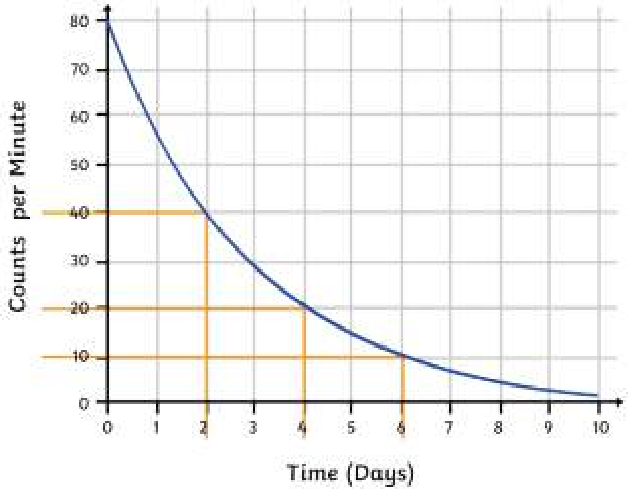
Half-life

The half-life is the time taken for the number of radioactive nuclei in an isotope to halve.

Radioactivity is a random process – you will not know which nuclei will decay. Radioactive decay is measured in becquerels Bq. 1 Bq is one decay per second.

Radioactive substances give out radiation from their nucleus.

A graph of half-life can be used to calculate the half-life of a material and will always have this shape:



Judging from the graph, the radioactive material has a half-life of two days.

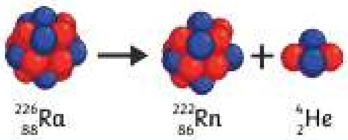
Irradiation

Irradiation occurs when materials are near a radioactive source. The source is sometimes placed inside a lead-lined box to avoid this.

People who work with radioactive sources will sometimes stand behind a lead barrier, be in a different room or use a remote-controlled arm when handling radioactive substances.

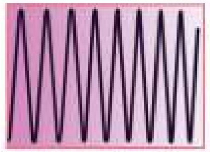
Alpha Decay Equations

An alpha particle is made of two protons and two neutrons. The atomic number goes down by two and its mass number decreases by four.



Gamma rays

There is no change to the nucleus when a radioactive source emits gamma radiation. It is the nucleus getting rid of excess energy.



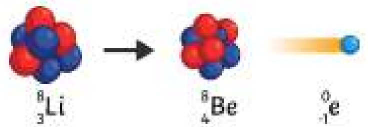
Contamination

When unwanted radioactive atoms get onto an object, it is possible for the radioactive particles to get inside the body.

Protective clothing should be worn when handling radioactive material.

Beta Decay Equations

A neutron turns into a proton and releases a an electron. The mass of the nucleus does not change but the number of protons increases.



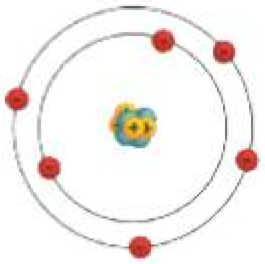
Alpha radiation is more dangerous inside the body. It is highly ionising and able to cause a lot of damage. Outside the body it is less dangerous because it cannot penetrate the skin.

Beta radiation is less dangerous inside the body as some of the radiation is able to escape. Outside the body it is more dangerous as it can penetrate the skin.

Gamma radiation is the least dangerous inside the body as most will pass out and it is the least ionising. Gamma is more dangerous outside the body as it can penetrate the skin.

a

Complete the diagram below to show where in an atom you would find the protons, neutrons and electrons.



____

____

____

Explain why atoms have no overall charge.

____

____

b

Complete the sentences by deleting the incorrect answer.

Most of the mass of an atom is concentrated in the nucleus/electron shells. The radius of the nucleus is 1000/10 000 times smaller/larger than the radius of the atom.

The element sodium is shown below.

$$^{11}_{23}Na$$

Sodium has the following number of...

protons: __________

neutrons: __________

electrons: __________

c

Two isotopes of carbon are shown below:

$$^{12}_{6}C \qquad ^{14}_{6}C$$

Define the term isotope.

____

____

Explain why alpha radiation would not be used as a medical tracer.

____

____

Explain the effect that half-life has on the choice of medical tracer.

____

____

d

Describe the plum pudding model of the atom.

____

____

e

Radioactive decay is the process of the nucleus emitting ionising radiation.

The unit for radioactivity is...

____

Explain the term count rate.

____

Name the piece of equipment used to determine count rate.

____

Name three safety precautions to be taken when handling a radioactive source.

1. _______________
2. _______________
3. _______________

f

State the difference between irradiation and contamination.
keywords: exposed, radioactive, contaminated, harmful

____

____

____

____

____

Complete the following equation for the alpha decay of uranium-234:

$$^{234}_{92}U \rightarrow Th + He$$

Complete the following equation for the beta decay of lead-214:

$$^{214}_{82}Pb \rightarrow Bi + e$$