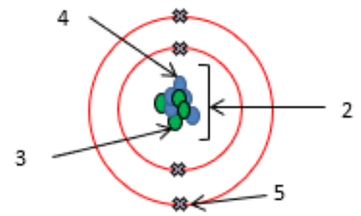
Science: GCSE Atomic Structure and Radiation

1. Structure of the atom

	Key word	Definition
1	Atom	The smallest possible piece of an element. Has a radius of 0.1nm (or 1x10-10m)
2	Nucleus	The centre of an atom. Contains protons and neutrons
3	Proton	A positively charged particle found in the nucleus
4	Neutron	A neutral particle found in the nucleus. Has no charge
5	Electron	A negatively charged particle found in energy levels (shells) around the nucleus

Sub-atomic particle	Relative atomic mass	Charge
Proton	1	+1
Neutron	1	0
Electron	~0	-1

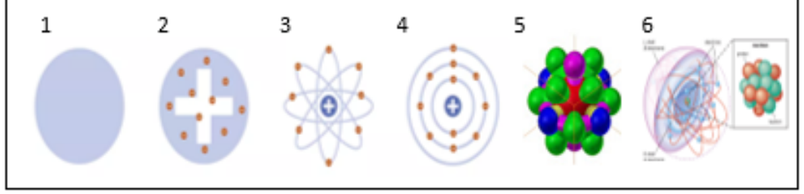


2. Key Words

Atomic number	Number of protons in the nucleus of an atom
Atomic mass	Total number of protons **and** neutrons in the nucleus of an atom
Isotope	Different forms of the same element with the same number of protons, but different numbers of neutrons

3. Discovery of the Atomic Model

	Model	Discovery
1	Solid sphere	Dalton stated that the atom was the smallest particle and it could not be broken up further
2	Plum Pudding Discovery of the electron	JJ Thompson stated that the atom was a cloud of positive charge with negatively charged electrons randomly dotted around the cloud.
3	Nuclear model Discovery of a positively charged nucleus	Rutherford conducted experiments with gold foil that proved that the atom contained a positively charged nucleus with the electrons randomly around the outside of the nucleus
4	Planetary Model (Bohr) Discovery that electrons orbit the nucleus on energy levels called 'shells'	Bohr stated that electrons orbited around the nucleus like planets around the sun and that there were different numbers of shells in different elements
5	Quantum Model Discovered that electrons are found in clouds of probability called orbitals	Schrodinger stated that electrons do not orbit the nucleus but move around in waves and it is impossible to know the exact location of an electron.
6	Modern Atomic Model Discovery of the neutron	Chadwick discovered the neutron in the nucleus which helped to explain the atomic mass of an atom.



Challenge Questions

1	What needs to be taken before the count rate can be measured?
2	What safety precautions should a teacher take when demonstrating radioactive sources to the class?
3	Explain why isotopes of large elements are generally radioactive.
4	Explain why a radioactive source with a short half-life is used as tracers in the body?

Science: GCSE Atomic Structure and Radiation

4. Radiactivity Key Words

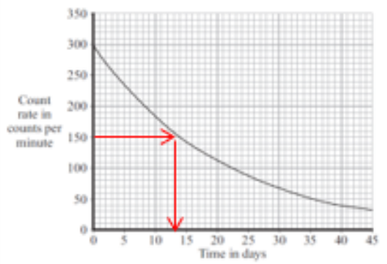
Background radiation	Radiation that is found in the environment such as from rocks, cosmic rays and fallout from nuclear weapons testing
Becquerel (Bq)	Units for measuring the radioactivity of a source
Count rate	The speed at which a radioactive source decays (gives out radiation)
Unstable atom	An atom that a very large nucleus with a high neutron to proton ration meaning that radiation is emitted from the nucleus
Geiger counter	Instrument used to measure radioactivity of a substance

5. Types of Radiation

Type of radiation	Symbol	Structure and charge	Range and penetration	Ionising power
Alpha	α	2 protons and 2 neutrons from the nucleus Charge = +2	Travels up to 5cm in air, blocked by paper and skin	High
Beta	β	Fast moving electron from the nucleus Charge = -1	Most travel up to 15cm in air, blocked by a thin sheet of aluminium	Medium
Gamma	γ	High energy wave Charge = 0	Can travel at the speed of light so can travel vast distances. Stopped by 1m thick concrete or thick lead plates	Low

6. Half-Life

The half-life of a radioactive source is the time it takes for the count rate to decrease by half.



1. The starting count rate is 300, so half of that is 150.
2. You find 150 on the y-axis and read across to the line.
3. Then read down from the line to calculate the time.

So for this graph, the half-life is 15 days. This means that every 15 days the count rate will decrease by half.
In 60 days the count rate will be 18.75Bq

7. Half-life Equations (HT)

Alpha decay	When an alpha particle is emitted from the nucleus 2 protons and 2 neutrons are given out. This means the atomic number will decrease by 2 and the atomic mass will decrease by 4.

$$^{235}_{92}U \longrightarrow {}^{231}_{90}Th + {}^{4}_{2}He$$

beta decay	When a beta particle is emitted from an atom, 1 neutron changes into a proton. This means the atomic number will increase by 1 and the atomic mass will stay the same.

$$^{235}_{92}U \longrightarrow {}^{235}_{93}Np + {}^{0}_{-1}e$$

Science: GCSE Atomic Structure and the Periodic Table

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6	Shell	Energy levels surrounding the nucleus of the atom

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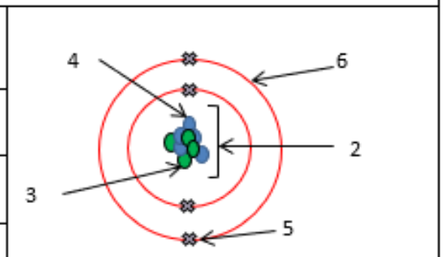

2. Key Words

Atomic number	Number of protons in the nucleus of an atom
Atomic mass	Total number of protons **and** neutrons in the nucleus of an atom
Isotope	Different forms of the same element with the same number of protons, but different numbers of neutrons
Ion	A charged atom that forms when electrons are lost or gained

3. Discovery of the Atomic Model

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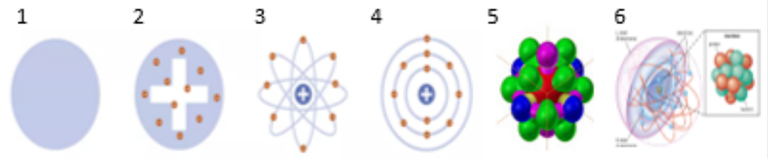


4. Properties of metals and non-metals

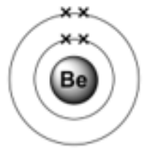
Metals	Non-Metals
High density, sonorous, malleable, shiny, conducts heat and electricity	Low density, brittle, dull, poor conductors of heat and electricity

Science: GCSE Atomic Structure and the Periodic Table

5. Electron configuration diagrams

Rules	1. Do not draw protons and neutrons in the nucleus 2. Use small x's to show electrons 3. Only 2 electrons can fit on the 1st shell, then 8 on 2nd, 8 on 3rd 4. Draw the electrons from the nucleus outward

Beryllium



Sodium

6. The Periodic Table

Developed by Mendeleev, who arranged the elements in order of atomic mass. He left gaps for undiscovered elements and predicted their properties. When these predictions proved correct, Mendeleev's periodic table was widely accepted.

Arrangement	Elements are placed in order based on atomic number
Groups	**The columns downwards:** Elements in each group have similar properties and electronic configurations
Periods	**The rows across:** Elements in the same period have the same number of shells.
Transition metals	Highlighted in yellow are the transition metals of the periodic table. These elements can form more than one type of ion.

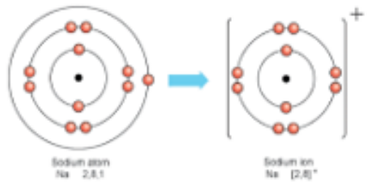
7. Patterns in the periodic table

Group	Name	Elements	Key feature	Patterns
1	Alkali metals	Li, Na, K, Rb, Cs, Fr	Contains 1 electron on the outer shell	Reactivity increases down the group and atom gets bigger
7	Halogens	F, Cl, I, Br	Contain 7 electrons on the outer shell	Reactivity decreases down the group and atom gets bigger
0	Nobel Gases	He, Ne, Ar, Kr, Xe, Rn	All atoms have a full outer shell	Unreactive elements **(inert)**

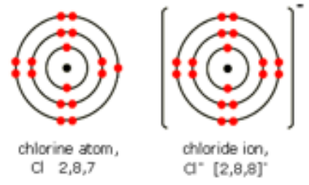
8. Forming ions

Rules	**Positively** charged ions have lost electrons from the outer shell **Negatively** charged ions have gained electrons from the outer shell

Sodium (Na^+)



Chlorine (Cl^-)



Challenge Questions

1	Draw an electron configuration diagram for Fluorine and calculate the number of protons, neutrons and electrons.
2	Compare the plum pudding model to the Bohr model of the atom
3	Explain how Rutherford's gold foil experiments disproved the plum pudding model
4	Explain in detail the patterns in reactivity for group 1 and 7.

Science: GCSE Infection and Response

1. Key Words

Key word	Definition
Communicable disease	Disease than can be passed spread by a pathogen
Pathogen	Microbe that causes a disease
Protist	Group of microbes that have features of plants, animals and fungi.
Transmission	The method by which a pathogen is spread
Vector	Type of transmission where an organism that carries a pathogen but is not affected by it. e.g. rats

2. Communicable diseases

Pathogen	Disease	Symptoms	Treatment	Prevention
Bacteria	Salmonella (food poisoning)	Vomiting, diarrhoea, fever	Antibiotics	Good hygiene, cook food thoroughly
	Gonorrhoea	Yellow mucus from penis or vagina, pain when urinating	Antibiotics	Use a condom when having sex
Virus	HIV	Flue like symptoms, decreased immunity, lesions	Anti-retroviral drugs	Use a condom when having sex, do not share needles
	Measles	Fever, red rash on chest and face	Painkillers	Vaccination
	Tobacco Mosaic Virus (TMV) - Plants	Yellowing leaves stunted growth	Remove infected leaves and burn	Keep away from infected plants
Fungi	Rose Black Spot - Plants	Black spots on leaves and stunted growth	Fungicides	Keep away from infected plants

3. Malaria

- Malaria is a disease caused by the protist *Plasmodium*
- It is transmitted by female mosquitos when they bite a human
- It causes a fever and flu like symptoms that can be fatal.
- It can be treated using drugs that kill the parasite.

Method of prevention	How it works
Mosquito Nets	Meshing is too small for mosquitoes to pass through
Draining swamp land	Reduces breeding grounds for mosquitoes and therefore reduces the mosquito population
Anti-malarial drugs	Kills the parasite during its developmental stage in the liver and red blood cells
Insect repellent	Discourages mosquitoes from biting the person

4. External body defences (non specific)

1	Skin	Layers of dead skill cells provide a barrier. Antiseptic oils are secreted on to the skin that kill pathogens
2	Nose	Cilia cells line the nose, throat and lungs. Mucus covering these cells traps the pathogens and the hairs on the upper surface of the cells sway back and forth to sweep the mucus to the nose or to the throat to be swallowed
3	Mouth	The stomach contains strong hydrochloric acid, this kills pathogens that are swallowed.
4	Cuts	Platelets in the blood clump together at the site of a cut, these for a carrier at the cut called a scab.

Science: GCSE Infection and Response

5. Internal body defences (specific)

Lymphocyte	White blood cell that makes and releases antibodies
Phagocyte	White blood cell that engulf and digests pathogens
Antigen	Unique protein marker on the pathogen
Antibody	Protein that attaches to an antigen to prevent growth and the release of toxins
Toxin	Poison released by a pathogen that induces symptoms
Antitoxin	Protein that binds to toxins to prevent them from being absorbed in to the body tissues

6. Vaccines

Vaccines are used to provide immunity against viral infections

Stage	Description
1	Small amount of WEAKENED or DEAD pathogen is injected in to the blood
2	White blood cells respond and start to make antibodies to kill the pathogen
3	Antibodies remain in the blood
4	If re-infected the levels of antibodies drop and the white blood cells make the antibodies QUICKLY to fight of the pathogen

7. Antibiotics and Painkillers

Antibiotics	ONLY used to treat bacterial infections. Interferes with the bacterial production or attacks the cell walls of the cell
Painkillers	ONLY treats the symptoms of a disease, it does not kill the pathogen
Antibiotic resistance	Where a bacteria evolves to no longer be killed by an antibiotic

8. Drug development

Drug	Chemical that has a physiological effect on the body
Toxicity	How poisonous or deadly the drug is
Efficacy	How well a drug works
Dose	The volume or mass of a drug that is needed to cause an effect
Placebo	A pill or liquid that does not contain the drug, e.g a sugar pill
Double blind trials	A method of testing a drug where neither the doctors nor the patients know who has taken the drug or placebo. (Prevents bias)

Why are drug trials conducted?

1. To ensure the drug is not toxic
2. To check for the side effects of the drug
3. To establish an effective dose
4. To assess the effectiveness of a drug compared to those currently on the market.

Stages of a drug trial

Pre-clinical	Drugs are tested on tissues and animals to check for toxicity
Clinical trials stage 1	Small group of healthy volunteers (<10) with a small dose compared to the placebo. Check for toxicity and side effects
Clinical trials stage 2	Group of 100 – 300 healthy volunteers taking a range of doses compared to a placebo. Check for side effects and possible dose
Clinical trials stage 3	Group of 1000-3000 patients. Compared against drugs already available. Check the efficacy of the drug for its intended purpose.

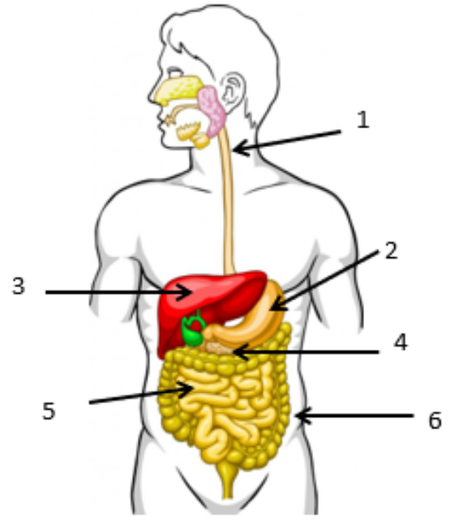
Challenge Questions

1	Why can't measles be treated using antibiotics?
2	Why is it important that a drug development trial is carried out by an independent company?
3	Suggest how the development of antibiotic resistant bacteria can be reduced.
4	Evaluate the use of unlicensed vaccines or drugs to treat COVID-19.

Science: GCSE Organisation

1. Digestive system

	Organ	Function
1	Oesophagus	Muscle contractions push food into the stomach
2	Stomach	Hydrochloric acid and pepsin chemically digest food, stomach muscles churn the food.
3	Liver	Produced bile that is added into the first part of the small intestines called the ileum
4	Pancreas	Produces enzymes that are released into the small intestines to complete digestion.
5	Small Intestines	Chemical digestion continues and small soluble molecules are absorbed into the blood
6	Large intestines	Water is removed from the waste faeces and absorbed back into the blood



2. Key words

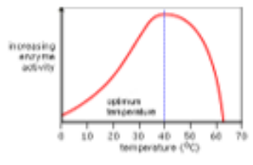
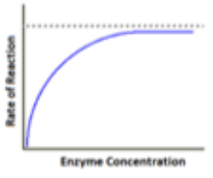
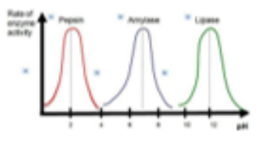
Optimum	The best conditions for the reaction to take place fastest
Active site	The specific point in the structure of the enzyme where the reaction occurs
Denature	When the active site changes shape permanently so the enzyme no longer binds to the substrate
Emulsify	When fat droplets are broken down in to small ones to help mix them with the enzyme and increase the surface area for digestion
Bile	Alkali released from the liver in the duodenum to neutralise neutralise stomach acid and emulsify fats

3. Enzymes

Enzymes are **biological catalysts** that speed up the digestion of large insoluble molecules to small soluble ones that can be absorbed into the blood.

Enzyme	Released from	Function
Amylase	Salivary Glands, pancreas and small Intestines	Breaks down starch into glucose
Protease (Pepsin)	Stomach (pepsin), pancreas and small intestines	Breaks down proteins into amino acids
Lipase	Pancreas and small intestines	Breaks down fats into fatty acids and glycerol

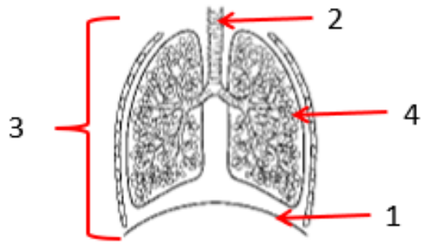
4. Factors affecting the rate of an enzyme reaction

Temperature	pH	Concentration
		

Science: GCSE Organisation

5. Key Words

1	Diaphragm	Flat muscle underneath the lungs that contracts and relaxes to cause breathing
2	Trachea	Tube containing rings of cartilage that allows air to move in and out of the lungs
3	Thorax	Air tight chest cavity containing the respiratory system and the heart.
4	Alveoli	Small blind ending sacs where gases are exchanged between the air and the blood



Inhaling	Exhaling
Diaphragm contracts	Diaphragm relaxes
Volume in the thorax increases	Volume in the thorax decreases
Pressure in the thorax decreases	Pressure in the thorax increases
Air is pulled into the lungs	Air is pushed out of the lungs

Challenge Questions	
1	Why does boiled amylase not work when cooled down to room temperature?
2	How and why does asthma affect breathing?
3	How are the lungs adapted for gas exchange?
4	Why is both diffusion and active transport needed to absorb digested nutrients into the blood?

6. Circulatory system

	Key Word	
1	Vena cava	Vein that brings deoxygenated blood back to the heart from the body
2	Right atrium	Pumps blood in to the ventricle and where the pacemaker cells are located
3	Right ventricle	Pimps blood out of the heat to the lungs
4	Pulmonary artery	Takes deoxygenated blood to the lungs
5	Pulmonary vein	Brings oxygenated blood back to the heart from the lungs
6	Left atrium	Pumps blood to the left atrium
7	Left ventricle	Pumps blood out of the heart to the body. Has a large muscle wall to pump blood at a high pressure
8	Aorta	Artery that carries blood away from the heart to the body
9	Valves	These prevent the backflow of blood through the circulatory system

The blood flows through the heart in the order of 1 to 8