Highsted Knowledge Organiser Physics : Electricity in the home

What I need to know

Label plug
Role of wires and pins
How to use the equations and link equations
Difference between ac and dc.
Role of transformers in the national grid

Key Vocabulary:

A battery is a **dc (direct current)** supply. A direct potential difference causes the current to **flow in one direction** only.

Mains electricity is an **ac (alternating current)** supply. An alternating potential difference causes current to **periodically reverse its direction.**

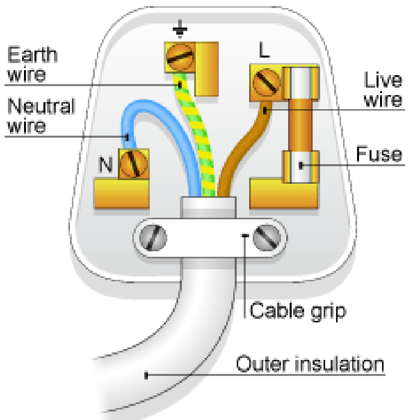
Equations

Energy transferred = Charge Flow x Potential Difference
$E = Q \times V$

Energy transferred = power x time
$E = P \times t$

Power = potential difference x current
$P = V \times I$

Student reference point



Live wire: Brown:
The live wire carries the alternating potential difference from the supply. Potential difference between the live wire and earth is 230V.

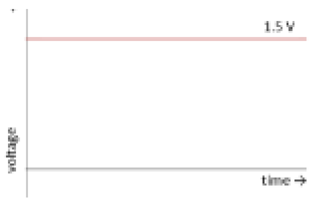
The live wire is dangerous. Touching the live wire and making a connection to earth causes a person to be electrocuted, which can be fatal.

Neutral wire: Blue
The neutral wire completes the circuit and has a potential difference of 0V

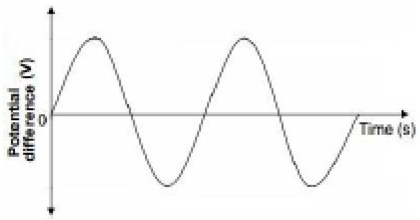
Earth wire: Green and yellow stripes
The earth wire has a potential difference of 0V. It only carries a current if there is a fault. The earth wire is a safety feature.

Alternating and direct current

A battery is a **dc (direct current)** supply. A direct potential difference causes the current to **flow in one direction** only.



Mains electricity is an **ac (alternating current)** supply. An alternating potential difference causes current to **periodically reverse its direction.**

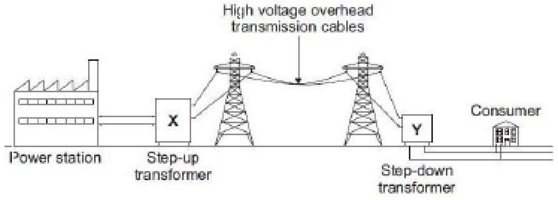


The mains supply has a frequency of **50Hz** and has a supply potential difference of **230V**.

Electrical power is transferred from power stations to consumers using the national grid. **Step up** transformers increase the potential difference in the transmission lines.

A high Potential difference means a **low current**

Low current means less **energy** is lost through heating the wire, so is a more **efficient way to transfer energy.**



Step down transformers decrease the potential difference to a safer voltage for use in homes.

$P = V \times I$ → $P = I \times R \times I$ ← $V = I \times R$

Power = Current² x Resistance
$P = I^2 \times R$

- Charge flow, Q, in Coulombs, C
- Current, I, in amperes, A
- Time, t, in seconds, s
- Potential difference, V, in volts, V
- Resistance, R, in Ohms, Ω
- Energy transferred, E, in Joules, J
- Power, in Watts, W

The amount of energy an appliance transfers is dependent on how long the appliance is switch on for and the power of the appliance.

The power of an appliance is related to:

- The potential difference across it and the current through it
- The energy transferred in a given time.

Challenge question: Explain the roles of the step up and step down transformers inn the National grid. (6marks)

Suggested reading: [Electricity - 2.4.3 The National Grid (GCSE Physics AQA) - Study Mind]

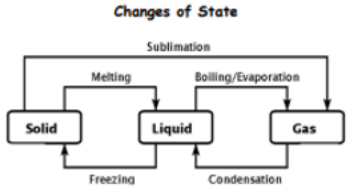
Highsted Knowledge Organiser Physics Year 10: Molecules and Matter

What I need to know

Definitions
Graphical analysis of changes of state
Required Practical—determining the density of materials.

Key Vocabulary:

Internal energy is the total kinetic energy and potential energy of all the particles that make up a system.



Equations:

$\rho = \frac{m}{V}$ $E = m \times L$

Boyle's Law:

$P \times V = \text{constant}$

Or

$P_1 \times V_1 = P_2 \times V_2$

E = energy for a change of state in Joules, J
m = mass in kilograms, kg
L = specific latent heat in Joules per kilogram, J/kg

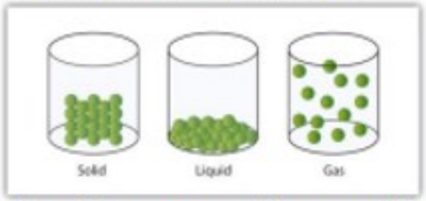
Pressure, P in Pascals, Pa
Volume, V in metres cubed, m^3

Density, ρ in kilograms per metre cubed, kg/m^3
Mass, m in kilograms, kg
Volume, V in metres cubed, m^3

Student reference point

Particle Model

Solids, liquids and gases can be represented:



In a solid, particles are arranged in rows and vibrate about a fixed position.

In a liquid, particles are closely packed but not arranged in rows.

In a gas particles are in constant random motion.

Gases have a **low density** because there are large gaps between particles.

Particle Model and Pressure

The higher the temperature of the gas, the higher the **kinetic energy** of the particles and the **faster** they move.

Increasing the temperature, at constant volume, increases the pressure as when particles move faster, they collide with the walls more often.

Changes of state are **physical changes** because the material recovers its original properties if the change is reversed (unlike chemical changes).

Mass is **conserved** in a change of state.

Pressure in Gases (Physics Only)

A gas can be **compressed** or **expanded** by pressure changes. The pressure produces a net force at right angles to the walls of the container or any surface.

Increasing the volume, at constant temperature, causes pressure to decrease as particles collide less often.

Doing **work** on a gas increases the **internal energy** of the gas and can increase the temperature.

For example, doing work on the gas in a bike pump can lead to an increase in temperature.

Internal Energy

Energy is stored inside a system by the particles (atoms and molecules) that make up the system. This is called **internal energy**.

Heating changes the energy stored within the system by increasing the energy of the particles. This either **raises the temperature** or produces a **change of state**.

Specific Latent Heat

The energy needed for a substance to change state is called **latent heat**. The energy supplied changes the internal energy but not the temperature.

The **specific latent heat** is the amount of energy needed to change the state of 1 kilogram of a substance with no change in temperature.

Density Required Practical

A **regular solid object** is one where the volume can be calculated from the dimensions. For example, a cube or cuboid.

Steps

1. Measure the mass of the object using a **balance**.
2. Measure the length of the sides of the object using a **ruler**.
3. Calculate **volume**, by multiplying the three side lengths together. E.g. A x B x C
4. Calculate density using: $\rho = \frac{m}{V}$

Density Required Practical

An **irregular solid object** is one where the volume cannot be calculated from the dimensions. For example, a pebble or chess piece.

Steps

1. Measure the mass of the object using a **balance**.
2. Fill a displacement can with water.
3. Carefully drop the irregular object into the displacement can.
4. Measure the volume of water that leaves the can, using a **measuring cylinder**. This is equal to the volume of the irregular object.
5. Calculate density using:

$$\rho = \frac{m}{V}$$

Challenge question: State the method used to determine the density of 20ml of a liquid (6marks)

Practical video: Density - GCSE Science Required Practical - Bing video

Highsted Knowledge Organiser Physics : Radioactivity

What I need to know

The development of the model of the atom
3 types of radiation and their features
Half life calculations

Key Vocabulary:

The **atomic number** is the number of protons.
The **mass number** is the total number of protons and neutrons (number of things in the nucleus).
Isotopes are atoms of the same element that have different numbers of neutrons.

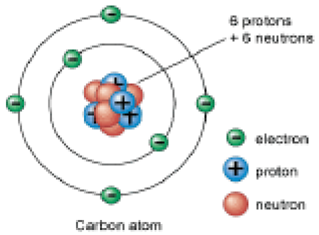
The half-life is the time it takes for the count rate, activity, or number of radioactive nuclei of an isotope to fall to half its initial value.

Equations

Student reference point

Atomic Structure: The Nuclear Model

Atoms are very small, with a radius of about 1×10^{-10}m. The structure of an atom is:



The centre of the atom is called the **nucleus**.

Most of the mass is in the nucleus.
The radius of the nucleus is 1 / 10000[th] the radius of the atom.

The electrons are arranged at different distances from the nucleus, in energy levels.

Electrons can move away from the nucleus (higher energy level) by absorption of electromagnetic radiation.
Electrons can move closer to the nucleus (lower energy level) by emission of electromagnetic radiation.

Atoms can be represented as:

Mass Number $^{12}_{6}C$
Atomic Number

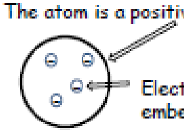
In an atom there are the same number of protons and electrons, so atoms have no overall charge.
Atoms can lose electrons to become positive **ions**.

The Development of the Model of the Atom

Before the discovery of the electron, atoms were thought to be tiny spheres that couldn't be divided.

After the discovery of the electron, scientists suggested the **plum pudding model**. The atom is a positive ball.

Can you describe differences with the nuclear model?



Electrons are embedded in it

The results from the alpha particle scattering experiment led to the discovery of the nucleus. This led to a new model, the **nuclear model**. All the mass and positive charge is thought to be in the nucleus.

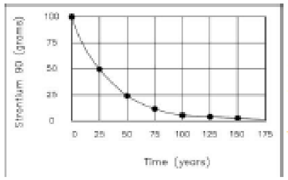
Niels Bohr adapted the nuclear model by adding electron **orbits**. Bohr's calculations agreed with experiments.

20 years after the nucleus was accepted as an idea, James Chadwick discovered **neutrons** within it.

New experimental evidence may lead to a scientific model being changed or replaced.

Half Life

Radioactive decay is **random**



The half-life for this isotope is 25 years.

The count rate or number of nuclei remaining after **n** half-lives can be calculated by dividing the initial value by 2^n. **(Higher Tier Only)**

Nuclear Radiation

Four types of radiation can be emitted from the nucleus: **Alpha, beta, gamma and neutrons.**

	What is it?	Absorbed By	Range in air	Ionising Power	Example Decay
Alpha α	2 protons, 2 neutrons (helium nucleus)	Skin Paper	About 5cm	High	$^{219}_{86}Ra \rightarrow ^{215}_{84}Po + ^{4}_{2}He$ Alpha decay causes the mass and charge of the nucleus to decrease.
Beta β	High speed electron	Thin aluminium	About 1m	Medium	$^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e$ Beta decay doesn't change the mass but the charge of the nucleus increases
Gamma γ	Electromagnetic radiation	Thick lead	Infinite	Low	Gamma ray emission does not change the mass or charge of the nucleus

Half-Life and Hazards

Radioactive isotopes have a very wide range of half life values.
For example Uranium-238 has a half-life of 4.5 billion years but Oxygen-22 has a half-life of 2 seconds (you don't need to know these examples).

The hazards associated with radioactive materials differ according to their half-life values.

Short Half-Life
Isotopes with a short half-life have a high activity as they emit more radiation per second. This makes them dangerous as they can provide a high dose.

Long Half-Life
Isotopes with a long half-life emit less radiation per second but will stay radioactive for a long time. Some of the radioactive waste products from nuclear power stations need to be stored for hundreds of years before they become safe.

Hazards
Alpha, Beta and Gamma are **ionizing**, which means they can remove electrons from atoms. In our cells this increases the risk of cancer.
Irradiation is the process of exposing an object to nuclear radiation. **Radioactive contamination** is the unwanted presence of radioactive substances on other materials.

Challenge question: Is alpha or beta radiation more dangerous. (6marks)

Suggested reading: [Chernobyl: what happened, and the long-term impact | National Geographic]

Highsted Knowledge Organiser Physics : Radioactivity

What I need to know

Define fission
Define Fusion
Medical Uses of Radiation

Key Vocabulary:

Nuclear fission is the splitting of a **large** and **unstable** **nucleus.**

Nuclear fusion is the joining of two **light** **nuclei** to form a heavier one.

Equations

Student reference point

Background Radiation

Background Radiation is around us all the time. It comes from:

- Natural sources such as rocks and cosmic rays from space
- Man-made sources such as the fallout from nuclear weapons tests and nuclear accidents

The level of background radiation and radiation dose may be affected by occupation (e.g. a miner might have a higher dose) and location.

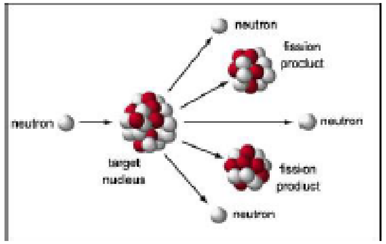
Radiation dose is measured in Sieverts (Sv). You do not need to remember this unit, but you may be asked to answer questions about dose.

Dose is often given in millisieverts (mSv).
1000 millisievert (mSv) = 1 sievert (Sv)

Fission

Spontaneous fission is rare. Usually the unstable nucleus must **absorb** a **neutron**.

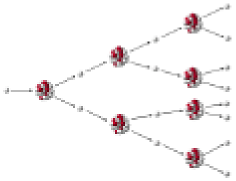
$^{1}_{0}n + ^{235}_{92}U \longrightarrow ^{236}_{92}U \longrightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3^{1}_{0}n$ + energy



The nucleus undergoing fission splits into **two smaller nuclei**, roughly equal in size, and emits two or three **neutrons** plus gamma rays. **Energy** is released by the fission reaction.

Chain Reactions

All the fission products have **kinetic energy**.
The neutrons may go on to start a **chain reaction**.



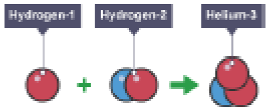
A chain reaction is where each fission goes on to cause at least one more fission.

The explosion of a nuclear weapon is an example of an **uncontrolled** chain reaction.

The chain reaction in a nuclear reactor is **controlled** to control the energy release.

Fusion

$$^{1}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + energy$$



In this process some of the **mass** is converted into **energy** in the form of radiation.

Medical Uses of Nuclear Radiation

Exploration of Internal Organs

Radioactive isotopes are taken into the body, and the radiation they emit can be detected outside the body.
Benefit: doctors can investigate internal organs without surgery (which is higher risk)
Risk: increased danger of developing cancers

Control or Destruction of Unwanted Tissue

A beam of high energy radiation (usually gamma) is fired at a tumour.
Benefit: cancerous tumours can be destroyed or diminished
Risk: increased danger of developing new cancers

In medical treatments the benefit of using nuclear radiation outweighs the risk.

Challenge question: Is alpha or beta radiation more dangerous (6marks)

Suggested reading: [Chernobyl: what happened, and the long-term impact | National Geographic]