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Physics Topic P1
Conservation and dissipation of energy

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Section 1: Key terms

Dissipation	Energy becoming **spread out** to the stores of surrounding objects (usually wasted thermal energy.)
Lubrication	A method of reducing unwanted energy transfers by application of a **lubricant** (e.g. **oil**) to **reduce friction**. Occurs in machines.
Insulation	A method of reducing energy transfers by the use of **insulators**. Occurs in buildings e.g. Loft insulation.
Conservation of energy	The law that states that **energy cannot be created or destroyed**.
Closed system	An isolated system in which **no energy transfers** take place **out of or into** the **energy stores** of the system.
Work	Work is done on an object when a force makes the object move.
System	Object or group of objects.
Friction	A **contact force** resisting the relative motion between two surfaces. Friction in machines always **causes energy** to be **wasted**.
Input energy	**Energy supplied** to a device.
Useful energy	Energy transferred to where it is wanted in the way it is needed.
Wasted energy	Energy that is **not usefully** transferred.
Efficiency of a device	The proportion of the total input energy that is transferred in useful ways.

Section 3: Methods of energy transfer (also known as energy carriers)

Mechanical	Energy transferred by forces acting on objects.
Electrical	Energy transferred when an electric current flows through a device.
Radiation	Energy transferred by electromagnetic radiation (light, microwaves, sound etc.)
Heating	Energy transferred by conduction, convection or radiation.

Section 2: Different kinds of energy stores

There are a limited number of **energy stores**.

Chemical energy	(e.g. fuel + oxygen) – Can be changed by bonds being made/broken
Kinetic energy	All **moving** objects have it.
Gravitational Potential energy	Energy stored in objects raised up against the force from **gravity** (possessed by anything that can **fall**.)
Elastic Potential energy	Energy stored in an object that has been **stretched** (stretched springs, rubber bands, elastic band etc.)
Thermal (Heat) energy	Flows from **hot** objects to colder objects.
Nuclear store	Energy stored in the **nuclei** of atoms. Can be released by the fusing or splitting of nuclei.
Magnetic	Two separated magnets that are attracting, or repelling.
Vibrational	Energy from vibrations or moving to and fro (e.g. a pendulum.

Light, electrical (as in a current) or sound are **not energy stores**. These are active processes and cannot be stored in a stable state. Electricity is a **flow of charge** that **transfers energy** from **one energy store to another**.

Section 4: Energy transfers

A Coal fire	Energy is shifted from a store when a fuel like coal burns. The chemical store (fuel) is depleted and the thermal store is filled.
Bow & arrow	Elastic potential energy → kinetic and thermal energy
Placing a book on a shelf	When the book is lifted onto the shelf, energy is shifted from the chemical store of your arm to the gravitational store of the book.
Apple falling from a tree	When an apple falls and gains speed, its store of gravitational potential energy decreases and its kinetic energy store increases. When it hits the ground its kinetic energy is then transferred into thermal and sound energy.

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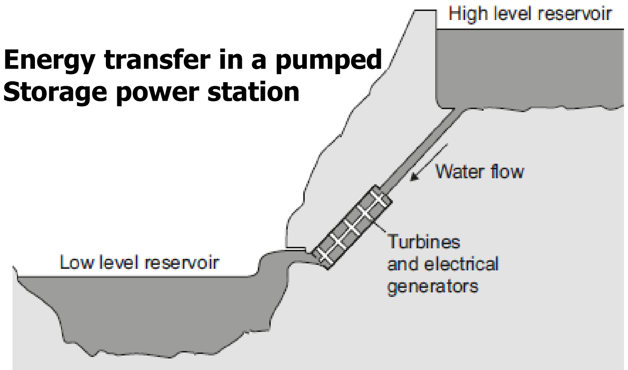
Physics Topic P1
Conservation and dissipation of energy

Energy transfer in a pumped Storage power station



When electricity is needed, water from the high level reservoir is allowed to flow into the low level reservoir. The flowing water generates electricity. The water in the high level reservoir stores **gravitational potential energy**. The flowing water has **kinetic energy**. The water turns the turbine which is connected to the generator. The generator produces some **sound**, this is **wasted energy**.

Section 5: Equations to learn

Equation	Units
Kinetic energy = 0.5 x mass x velocity^2 $E_k = 0.5\ m\ v^2$	Energy – Joules (J) Mass – kilograms (kg) Velocity – metres per second (m/s)
Gravitational potential energy = mass x gravitational field strength x height $E_p = m\ g\ h$	Energy – Joules (J) Mass – kilograms (kg) Gravitational field strength – Newtons per kilogram (N/kg) Height – metres (m)
Power =energy transferred ÷ time $P = \frac{E}{t}$	Power – Watts (W) Energy transferred – Joules (J) Time – seconds (s)
Power = work done ÷ time $P = \frac{W}{t}$	Power – Watts (W) Work done – Joules (J) Time – seconds (s)
Work done = force x distance moved	Work done – Joules (J) Force – Newtons (N) Distance – Metres (m)
Efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$	Energy – Joules (J)
Efficiency = $\frac{\text{useful power output}}{\text{total power input}}$	Power – Watts (W)

Section 6: Improving efficiency (HT)

Why devices waste energy	How to reduce the problem
Friction between moving parts **causes heating**	**Lubrication** of moving parts **reduces friction**
The resistance of a wire causes wire to get **hot** when **current passes** through.	Use **wires** with **as little resistance** as possible
Air resistance causes force on a vehicle that **opposes** it's motion.	**Streamline** the **shape** of the vehicle to reduce air resistance.
Working machinery **creates sound**	**Tighten loose parts** to reduce vibration which will reduce the noise.

Section 7: Energy dissipation & Electrical appliances

An electrical appliance is designed for a particular purpose and should dissipate (waste) as little energy as possible.

Appliance	Useful energy	Wasted energy
Light bulb	**Light** emitted from glowing element	Filament heats surroundings
Electric heater	**Heating** the surroundings	Light emitted from the glowing element
Toaster	**Heating** bread	Toaster case heats up and heats air around it.
kettle	**Heating** water	Kettle itself also heats up and the air around it.
TV	Light and sound	Heating of the TV's casing and heat transferred to surroundings.

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Physics Topic P2 Energy transfer by heating

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Section 1: Key terms

Thermal conductivity	A measure of how good something is at **conducting**.
(Thermal) Insulator	Thermal insulators **reduce energy transfers** (prevent heat loss to surroundings and hence have a **low thermal conductivity**)
Thermal Conductor	Good at **transferring heat** energy.
Specific heat capacity	The specific heat capacity of a substance is the **amount of energy** needed to change the **temperature of 1Kg** of the substance by **1°C**. Its units are J/Kg/°C
Joulemeter	Energy meter (measures energy supplied)

Section 2: Energy transfer by conduction

The higher the Thermal conductivity of a material the **higher the rate of energy transfer** by **conduction** across the material.

Metals	**Metals** are the **best conductors** of energy, Copper is a better conductor than steel.
Non-metals	**Non-metal** material (like wool and fibreglass) are the **best insulators**.

Factors affecting insulation

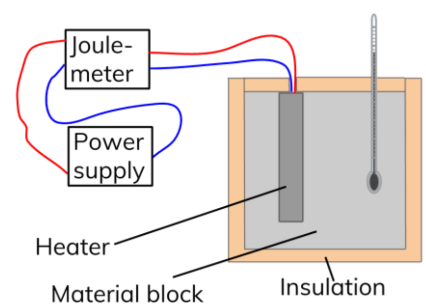
Thickness of material	The **thicker** the material the **better the insulation**.
Thermal conductivity	The **lower** the **thermal conductivity** the **better the insulator**.

Section 3: Specific heat capacity

Putting the same amount of heat into some materials gives a bigger temperature rise than in other materials. The specific heat capacity of a substance is the **energy needed** to **raise** the **temperature** of **1kg** of a material by **1°C**.
Investigations show that when a substance is heated, its temperature rise depends upon three factors:

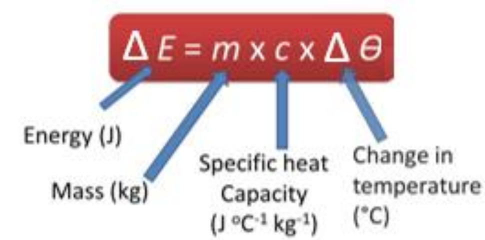
Amount of energy supplied to it	Specific heat capacity **increases** with **temperature**.
Mass of the substance	The **greater the mass** the more **slowly** its **temperature increases** when its **heated**.
What the substance is	**Metals** tend to have **lower specific heat capacities**. **Water** has a **high specific heat capacity**. Hence it takes less energy to raise the temperature of a block of aluminium metal by 1°C than it does to raise the same amount of water by 1°C.

Measuring specific heat capacity



A metal block of **known mass** is heated. A **joulemeter** is used to **measure the energy** supplied ΔE and a **thermometer** to **measure the temperature rise $\Delta\theta$**.

The measurements are then inserted into the equation and used to calculate the specific heat capacity:



Storage Heaters

Storage heaters **use electricity at night** (off peak hours) to **heat special bricks** (which have a high specific heat capacity). The bricks **store** lots of **energy** and **take time** to heat up and cool down. Hence during the day (on peak) they **release heat slowly** when **the heater element is on** and cool down slowly when it is off.

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Physics Topic P2
Energy transfer by heating

Section 4: Heating and insulating buildings

Homes are heated by electric or gas heaters, oil or gas central heating systems or solid fuels in stoves or fireplaces. A **poorly insulated house loses** more **energy** and so **costs more** to heat. It also means that **more pollution**, particularly carbon dioxide is released into the environment. The rate of energy transfer can be reduced by:

How to prevent heat loss from a house

Loft insulation	Contains **fibreglass** which **traps air**, **reducing convection** which is a good insulator.
Cavity wall insulation	**Traps air pockets** in gaps which is a good insulator
Double glazed windows	**Traps air** in **gaps between glass** which is a good insulator.
Aluminium foil behind radiators	**Reflects radiation**.
External walls with thicker bricks	**Thicker** bricks have a **lower thermal conductivity**.

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Physics Topic P3
Energy resources

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Section 1: Key terms

Renewable resources	Resources that will **replenish themselves** (made quicker than they are used). They will **not run out**.
Non-renewable resources	Resources in **limited supply** that are used quicker than they are made, so they **will run out**.

Section 2: Energy Resources

Our **energy demands** are met mostly by burning fossil fuels (oil, coal and gas). Fossil fuels are non-renewable and causes major environmental problems, hence there is an increasing demand for renewable resources which are less damaging to the environment.

Resource	Renewable?	Uses	Advantages	Disadvantages
Fossil Fuels	Non-Renewable	Electricity, transport, heating	**Reliable** – electricity can be generated all of the time. Relatively **cheap** way of generating electricity.	Produces **carbon dioxide**, a greenhouse gas that causes **global warming.** Can produce **sulphur dioxide**, a gas that causes **acid rain**.
Nuclear Fuel	Non-Renewable	Electricity	Produces **no carbon dioxide** when generating electricity. **Reliable** – electricity can be generated all of the time.	Produces **nuclear waste** that remains **radioactive** for thousands of years. **Expensive** to build and **decommission** power stations.
Bio Fuel	Renewable	Heating, electricity	**Carbon neutral**. **Reliable** – electricity can be generated all of the time.	Production of fuel may damage ecosystems and create a **monoculture**.
Wind	Renewable	Electricity	**No CO_2** produced while generating electricity. Cheap to use.	**Unreliable** – may not produce electricity during **low wind**. **Expensive** to construct.
Hydroelectricity	Renewable	Electricity	**No CO_2** produced while generating electricity. Cheap to use.	Blocks rivers stopping **fish migration**. **Unreliable** – may not produce electricity during **droughts**.
Geothermal	Renewable	Electricity, heating	Does not damage **ecosystems**. **Reliable** source of electricity generation. Cheap to use.	Fluids drawn from ground may contain **greenhouse gases** such as **CO_2** and **methane**. These contribute to **global warming**.
Tidal	Renewable	Electricity	**No CO_2** produced while generating electricity. Cheap to use.	**Unreliable – tides vary**. May damage **tidal ecosystem** e.g. mudflats.
Waves	Renewable	Electricity	**No CO_2** produced while generating electricity. Cheap to use.	**Unreliable** – may not produce electricity during **calm** seas.
Solar	Renewable	Electricity, heating	**No CO_2** produced while generating electricity. Cheap to use.	**Unreliable** – does not produce electricity at **night**. Limited production on **cloudy** days. **Expensive** to construct.

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Physics Topic P4
Particles at Work – Electric circuits

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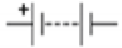
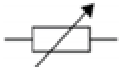
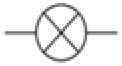
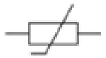
Section 1: Circuit Symbols

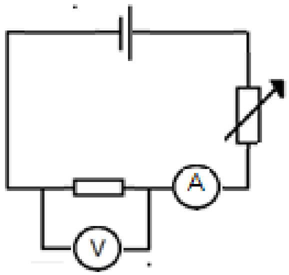
Symbol	Name	Function
	**Switch (open)**	Enables current to be switched on or off.
	**Cell**	Pushes electrons around a complete circuit.
	**Battery**	Supplies electrical energy, consists of two or more cells.
	**Diode**	Allows current in one direction only.
	**LED**	Light emitting diode emits light when a current passes through it in the correct direction.
	**Resistor**	Limits the current in a circuit.
	**Variable resistor**	Allows current to be varied.
	**Bulb**	Emits light as a signal when a current passes through it.
	**Fuse**	Breaks the circuit if current exceeds a certain amount.
	**Voltmeter**	Measures potential difference (voltage).
	**Ammeter**	Measures electric current.
	**Thermistor**	Temperature dependent resistor. Has high resistance when temperature is low.
	**LDR**	A light dependent resistor. Has high resistance when levels of light are low.

Section 2: Key Terms

Electric current	**Flow** of electric **charge**. Units amperes, A
Potential difference	The potential difference (**voltage**) between two points in an electric circuit is the energy transferred (or the work done) when a coulomb of charge passes between the points. Units volt, V
Resistance	Resistance is caused by anything that **opposes the flow of electric charge**. Units ohm, Ω
Charge	Anything **charged** that is **able to move within a circuit**. Electrons or ions. Units are coulombs, C
Series	A circuit with only **one route for charge to take**. The different components are connected in a line, end to end.
Parallel	A circuit with **more than one route for charge to take**. Each component **separately connected** to the +ve and –ve terminals.

Section 3: The standard test circuit

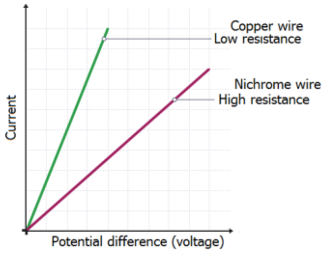
The standard test circuit is used to test components and determine the resistance of a component. By measuring the current through and potential difference across the component, the resistance can then be calculated and IV graphs obtained.

Standard test circuit		The **Ammeter** must be in **series** and placed **anywhere** in the **circuit**. The **voltmeter** must be placed in **parallel around** the **component** (so that it can compare the energy the charge has before and after passing through the component).

Section 4: Current-potential difference graphs

Increasing or decreasing the **potential difference** of the circuit will affect the current. Plotting current-potential difference results for different wires tells us about the resistance of these wires.

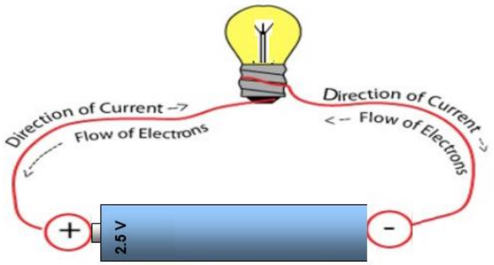
The **steeper the line**, **the lower the resistance** of the wire.



Section 5: Factors affecting resistance of a wire

Length of wire	The resistance of a wire is affected by length. Resistance of a **long wire is greater** than the resistance of a **short wire** because electrons collide with more metallic nuclei as they pass through.
Thickness of wire	The resistance of a **thin wire is greater** than the resistance of **a thick wire** because a thin wire has fewer electrons to carry the current.
Temperature	As **temperature increases** the metal nuclei begin to vibrate more. The electrons will have more chance of colliding and so **resistance increases**.

Electrical **current** is **NOT** the flow of electrons, it's the **flow of electric charge**, and as charge can be positive or negative then naturally **current** is in the **direction** of positive charge flow, and in the **opposite direction** to negative charge flow.



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Physics Topic P4
Particles at Work – Electric circuits

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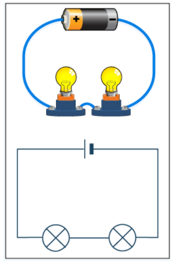
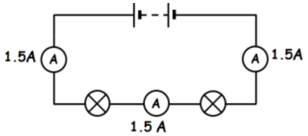
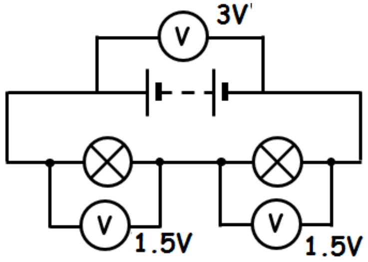
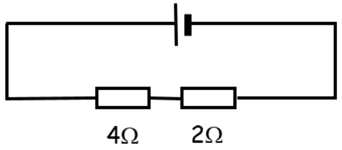
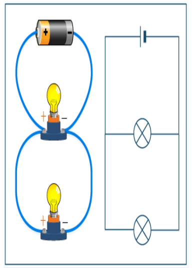
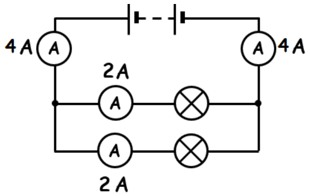
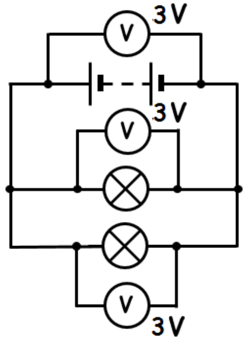
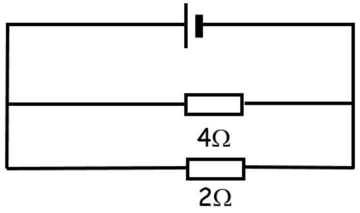
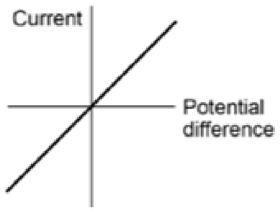
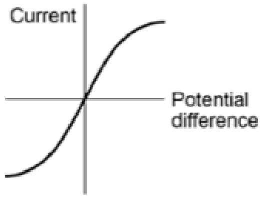
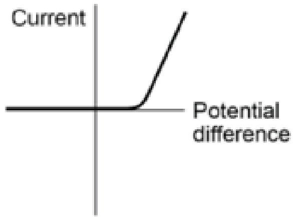
Section 6: V, I and R in Series and Parallel

Components connected in…	Current	Potential Difference	Resistance
Series 	The **current** is the **same everywhere** in the circuit and in every component. 	The total **potential difference** of the power supply is **shared** between the components. 	The **total resistance** is the **sum** of the **individual resistances**. $R_{total} = R_1 + R_2$ Adding **more resistors increases resistance.**  Total resistance = 6 Ω
Parallel 	The **total current** through the whole circuit is the **sum** of the **currents** through **the separate components.** 	The **potential difference** across each component is the **same.** 	The **total resistance** of **two resistors** is **less** than the **resistance** of the **smallest** individual **resistor.**  The **total resistance** for this circuit is **less than 2Ω** (the resistance of the smallest resistor). Resistance **decreases** as **more resistors** are added.

Section 7: IV Graphs

Graph	Example	Explanation
	**Ohmic conductor** (Fixed resistor or wire)	**Fixed Resistor or wires are Ohmic Conductors.** Current and potential difference are **directly proportional. Resistance is constant.**
	Filament Lamp (bulb) **non** Ohmic conductors	Resistance of a filament lamp is **not constant.** As temperature increases, resistance increases. **Ions** within the lamp **vibrate more**, increasing **collisions** with **electrons.**
	**Diode** or LED	**Diode/LED** The **current** through a diode/LED flows in **one direction only.** The diode has a **very high resistance in the reverse direction.**

Section 8: Equations to learn

Charge = current x time $Q = I \times t$	Charge flow - coulomb (C) Current – amperes (A) Time – seconds (s)
Potential difference = current x resistance $V = I \times R$	Potential difference – volts (V) Current – amperes (A) Resistance – ohms (Ω)
Energy transferred = charge x potential difference $E = Q \times V$	Energy = joules (J) Charge flow - coulomb (C) Potential difference – volts (V)

KNOWLEDGE

Physics Topic P5
Particles at Work – Electricity in the home

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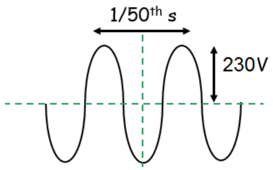
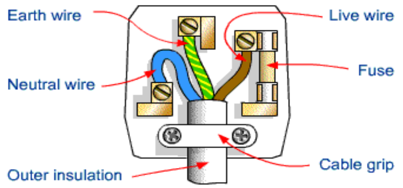
Section 1: Key Terms

Electric current	**Flow** of electric **charge**. Units amperes, A
Alternating Current **AC**	The **current alternates** (changes direction) **e.g. mains electricity**
Direct Current **DC**	The **current** flows in **one direction only e.g. cells or batteries.**
Mains Electricity	Electricity provided by the national grid (is an **alternating current** of **230V** and a frequency of **50Hz.**)
National Grid	A series of **cables** and **transformers** linking power stations to consumers.
Step-up Transformer	**Increases the potential difference** for **transmission** across power cables. This makes the National Grid **efficient.**
Step-down Transformer	**Reduces the potential difference** from the cables to 230V for use by consumers.

Section 2: Alternating current

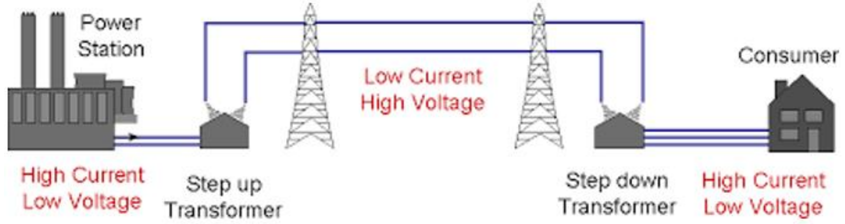
Alternating Current **AC**	 The **current alternates** (changes direction.)
Direct current **DC**	 Direct current flows **in one direction**

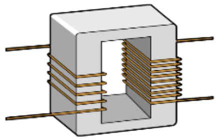
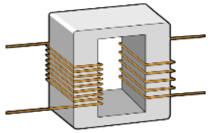
Section 3: plugs, sockets & cables

Three pin electrical plug	
Live wire	Carries the current (**brown** wire). Connects to fuse. About 230V.
Neutral wire	Completes the circuit (**blue** wire). Around 0V
Earth	Prevents electric shock (**green & yellow** wire). Is connected to the longest pin in a plug and carries current safely to earth if there is a fault.
Fuse	Contains a thin wire that melts and cuts off the current if too much current passes through it.
Sockets and plug cases	made of **plastic** because it's a good electrical **insulator.**
Mains cable	made up of two or three insulated copper wires surrounded by an outer layer of plastic.

Section 4: The National Grid

The National Grid supplies electricity from power stations via a series of cables and transformers to customers at **high voltages** to **reduce energy loss**.



Step-up transformer	Step-down transformer
	
More turns on secondary coil than on primary, therefore **increases voltage.** Increasing voltage **decreases the current** in the wires which means **less resistance.** Less resistance means **less energy lost as heat**, therefore it is **more efficient** to transmit electricity at high voltage.	Fewer turns on secondary coil than on primary, therefore **decreases voltage.** Reducing the voltage makes it **safer** to use in the **home.**

Section 5: Equations to learn

Equation	Units
Charge flow = current x time Q = I x t	Charge flow - coulomb (C) Current – amperes (A) Time – seconds (s)
Power = potential difference x current P = V x I	Power – watt (W) Potential difference – volts (V) Current – amperes (A)
Power = current^2 x resistance P = I^2 x R	Power – watt (W) Current – amperes (A) Resistance – ohms (Ω)
Energy transferred = power x time E = P x t	Energy = joules (J) Power – watt (W) Time – seconds (s)

Section 6: Choosing appliances

Clockwork radio	Battery radio
Store **elastic potential energy** in a **spring** when someone winds them up. They are **free** to use. **Better for the environment.**	Stores **chemical energy** and turns it into **electrical energy. Expensive to buy** and have to be replaced when used up. A **lot of energy and harmful chemicals** go into making batteries.

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Physics Topic P6
Particles at Work – Molecules and matter

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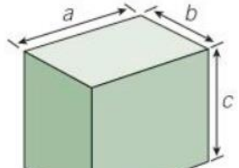
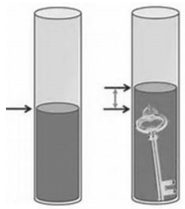
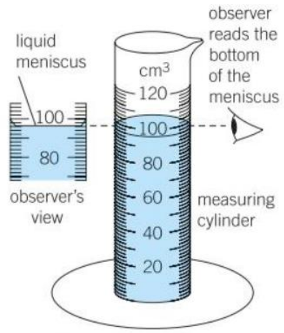
Section 1: Key Terms

Density	How much **mass** a substance contains **compared to its volume**. Solids are usually dense because the particles are closely packed.
State of matter	The way in which the **particles are arranged** – solid, liquid or gas.
Change of state	When a substance **changes from one state of matter** to another (e.g. melting is the change from a solid to a liquid). Energy changes the state, not the temperature.
Physical change	A change that can be **reversed** to recover the original material. **E.g. a change of state.**
Chemical change	A change that **creates new products**. It **should not be reversed**. E.g. a chemical reaction.
Internal energy	The **energy stored** inside a system **by the particles** (atoms and molecules) that make up the system. Internal energy is the **total kinetic energy and potential energy of all the particles.**
Kinetic energy	**Energy stored** within **moving objects** (e.g. particles).
Potential energy	**Energy stored** in **particles** because of their **position.** The **further apart** particles are, **the greater the potential energy.**
Specific heat capacity	The specific heat capacity of a substance is the **amount of energy** required to **raise the temperature of one kilogram** of the substance **by one degree Celsius**.
Temperature	The **average kinetic energy** of the **particles**.
Specific latent heat	The **amount of energy** required to **change the state of one kilogram** of the substance with **no change in temperature**.
Latent heat of fusion	**Energy required** to change state from **solid to liquid**.
Latent heat of vaporisation	**Energy required** to change state from **liquid to vapour**.
Gas Pressure	The **force** exerted by gases on surface as the **particles collide** with it. **As temperature increases, gas pressure increases** if the volume stays constant.

Section 2: Density

The **density of water** is **1000kg/m^3** . Objects that have a lower density than water will float in water. **Density** can be **calculated** by measuring its **mass** and **volume**.

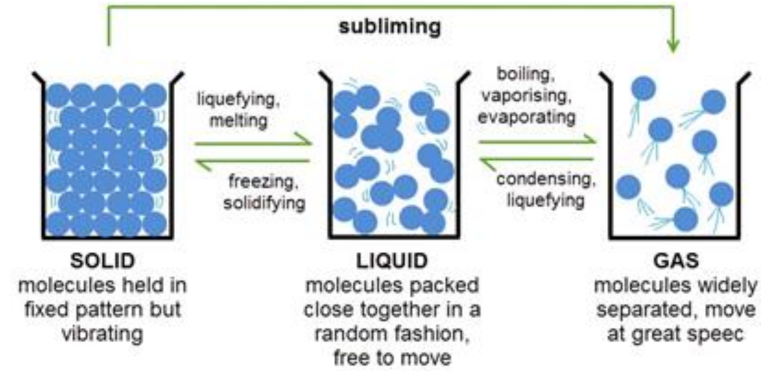
Measure **volume** of a **cuboid** = a x b x c	
Volume of **an irregular object** can be found by **dropping in a liquid** and **measuring Displacement**.	
When reading a meniscus the observer must read the **bottom** of the **meniscus**.	

Calculation	Equation	Symbol equation	Units
Density	Density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{v}$	Density = kg/m^3 Mass = kg Volume = m^3

Section 3: States of matter

Everything around you is made up of matter and exists in one of **three states**. **Solids**, **liquids** and **gases** are made of particles, the physical arrangement of particles determines the state of a particular substance.

Kinetic theory of matter



Changes of state

Condensation	Process in which a gas turns into a liquid
Evaporation	Process in which a liquid turns into a gas
Freezing	Process in which a liquid turns into a solid
Melting	Process in which a solid turns into a liquid
Sublimation	Process in which a solid turns into a gas

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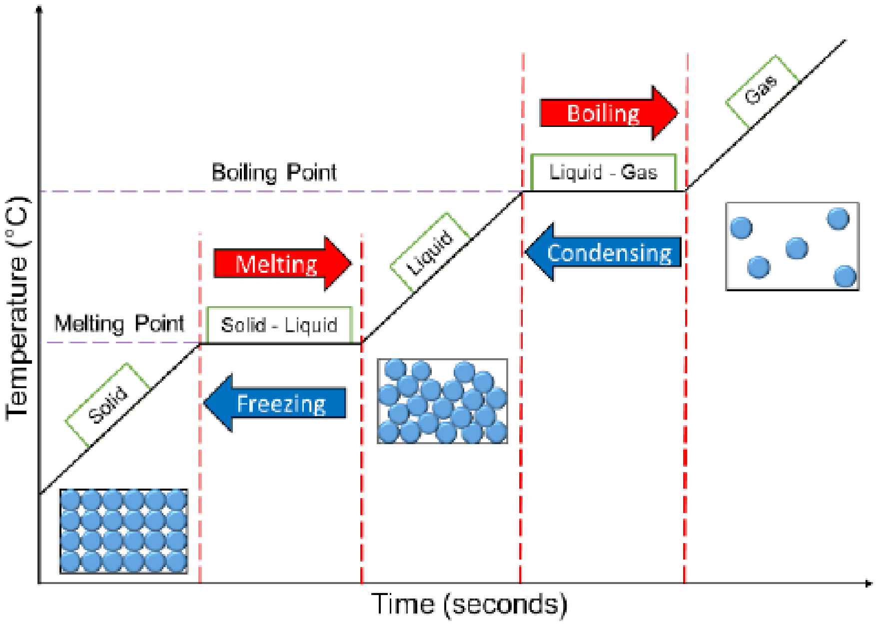
Section 4: The Heating Curve



Solid	Particles are closely packed, fixed and arranged in regular layers. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
Melting	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed the potential energy and therefore the internal energy of the material increases.
Liquid	Particles are touching but no longer arranged regularly. They are able to move. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
Evaporation	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed the potential energy and therefore the internal energy of the material increases.
Boiling point	The temperature at which a liquid boils and turns into a gas
Melting point	The temperature at which a solid melts and turns into a liquid.
Gas	Particles move randomly. As more energy is absorbed the particles move more quickly and the temperature increases.

State	**Particle arrangement**	**Distance between molecules**	**Strength of forces**	**Movement of particles**	**Internal energy**
Solid	Fixed	Close together	Strong	vibrates	Lowest internal energy
Liquid	Not fixed	Touching but not arranged regularly	Weak	Move about	Higher than solids but lower than gases
Gas	Not fixed	Far apart	Very weak (insignificant)	Move about freely	Highest internal energy.

Section 5: Internal energy

The energy stored by the **particles** of a substance is called its **internal** energy. This is caused by their individual motions and positions. The internal energy is the sum of a particles

- **kinetic energy** (due their individual motions relative to each other.)
- **potential energy** (due to their individual positions relative to each other.)

Increasing the temperature increases the **internal energy** of a substance because:

- Increasing temperature increases kinetic energy
- If it melts or boils, the potential energy increases.

Section 6: Specific latent heat

The **latent heat** is the **energy needed** for a substance to **change its state without changing** its **temperature**.

Specific latent heat of fusion $L_f = \frac{\text{energy, } E}{\text{mass, } m}$

Specific latent heat of vaporisation $L_v = \frac{\text{energy, } E}{\text{mass, } m}$

Section 7: Gas Pressure

Gas Pressure	Caused by the force exerted when particles collide with their container
Increasing temperature increases the gas pressure	Gas molecules move faster and hit the surfaces with more force. The number of impacts between the gas molecules and the surface of the container increases, so the total force of impact increases
Motion of gases	The unpredictable motion of smoke particles is evidence of the random motion of gas molecules – this is called Brownian motion

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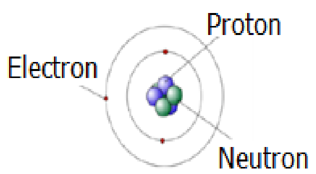
Physics Topic P7
Particles at work – Atomic structure

Section 1: Key Terms

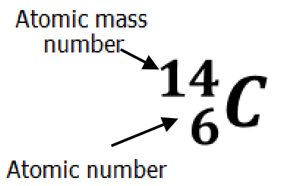
Atom	The **smallest part of an element** that can exist. All substances are made of atoms. **No** overall **electrical charge**. **Very small**, radius of 0.1nm.
Element	An element **contains only one type of atom**. Found on the Periodic Table. There are about 100 elements.
Isotope	An atom of the **same element** with **different numbers of neutrons**.
Radioactive decay	When an **unstable nucleus changes** to **become more stable** and **gives out radiation. Random.**
Activity	The **rate at which decay occurs**. Measured in **becquerels (Bq).**
Count rate	**Number of decays** recorded **each second** by a Geiger-Muller tube.
Half life	The **time it takes** for the **number of nuclei of the isotope in a sample to halve** Or, The **time it takes for the count rate** (or activity) from a sample containing the isotope **to fall to half its initial level**.
Contamination	Is when **radioactive particles get into objects** e.g. within liquids, with the body or on the skin.
Irradiation	When an object is **exposed to radiation.** The object does not become radioactive itself.
Ionisation	Radiation can ionize by **removing electrons from atoms to form ions**. If this happens in **DNA** it could lead to a **mutation that causes cancer**.
Peer review	The **checking of scientific results** by other **scientific experts.**

Section 2: Development of Atomic Model

Plum Pudding 	Thompson's plum pudding model shows that the atom is a **ball of positive charge** with **negative electrons embedded** in it. Was **incorrect.**
Nuclear Model 	**Rutherford's** alpha particle scattering experiment found a **central area of positive charge.** The nuclear model has a **positive nucleus** and **electrons in shells.** Later, neutrons were discovered and included in the nucleus.

Energy levels:
Absorption of radiation may lead to electrons moving further from the nucleus (higher energy level).
Emission of radiation may lead to electrons moving closer to the nucleus (lower energy level).

Section 3: Atomic mass number and atomic number



Atomic number – the **number of protons** (the number of electrons is the same in an atom)

Mass number – the total number of **protons** and **neutrons**

Section 4: Properties of Sub-Atomic Particles

Sub-atomic particle	Mass	Charge	Position in Atom
Proton	1	+1	Nucleus
Neutron	1	0	Nucleus
Electron	$\frac{1}{2000}$	-1	Orbiting in shells

Section 5: Nuclear Radiation

Radiation	Range in air	Absorbed by	Ionizing Power	Product emitted when nuclei decays
Alpha	Short **– up to 5cm**	**Paper** and **skin**	**Very High**	**2 protons** and **2 neutrons**
Beta	Medium – **about 1m**	About 5mm of **aluminium.**	**Medium**	**Electron**
Gamma	**Unlimited –** spreads out	**Several centimetres** of **lead.**	**Low**	**Electromagnetic wave**

Section 6: Nuclear Decay Equations

Alpha decay	$^{219}_{86}Rn \rightarrow {}^{215}_{84}Po + {}^{4}_{2}He$ In alpha decay a **helium nucleus** (2 protons and 2 neutrons) is **emitted**. The new element formed has a **mass number** that has **decreased by 4** and **atomic number** that has **decreased** by **2.**
Beta decay	$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$ In beta decay a **neutron turns into a proton**. An **electron** is **emitted**. The new element formed has a **mass number** that **stays** the **same** and an **atomic number** which **increased by 1**.
Gamma ray	There are **no changes to** the **nucleus** when gamma rays are emitted.

Section 7: Activity & half-life

Halve the initial activity (80 ÷ 2 = 40)
Draw a line across on the graph until you reach the curve
Draw a line down (half-life = 6 days)
Half life **never** drops to zero.