Physics Equations Sheet

GCSE Combined Science: Trilogy (8464) and GCSE Combined Science: Synergy (8465)

HT = Higher Tier only equations

kinetic energy = 0.5 × mass × (speed)^2	$E_k = \frac{1}{2} m v^2$
elastic potential energy = 0.5 × spring constant × (extension)^2	$E_e = \frac{1}{2} k e^2$
gravitational potential energy = mass × gravitational field strength × height	$E_p = m g h$
change in thermal energy = mass × specific heat capacity × temperature change	$\Delta E = m c \Delta\theta$
power = $\frac{\text{energy transferred}}{\text{time}}$	$P = \frac{E}{t}$
power = $\frac{\text{work done}}{\text{time}}$	$P = \frac{W}{t}$
efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$	
efficiency = $\frac{\text{useful power output}}{\text{total power input}}$	
charge flow = current × time	$Q = I t$
potential difference = current × resistance	$V = I R$
power = potential difference × current	$P = V I$
power = (current)^2 × resistance	$P = I^2 R$
energy transferred = power × time	$E = P t$

Turn over ►

	energy transferred = charge flow × potential difference	$E = Q\,V$
HT	**potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil**	$\boldsymbol{V_p\,I_p = V_s\,I_s}$
	density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
	thermal energy for a change of state = mass × specific latent heat	$E = m\,L$
	weight = mass × gravitational field strength	$W = m\,g$
	work done = force × distance (along the line of action of the force)	$W = F\,s$
	force = spring constant × extension	$F = k\,e$
	distance travelled = speed × time	$s = v\,t$
	acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$
	(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance	$v^2 - u^2 = 2\,a\,s$
	resultant force = mass × acceleration	$F = m\,a$
HT	**momentum = mass × velocity**	$\boldsymbol{p = m\,v}$
	period = $\frac{1}{\text{frequency}}$	$T = \frac{1}{f}$
	wave speed = frequency × wavelength	$v = f\,\lambda$
HT	**force on a conductor (at right angles to a magnetic field) carrying a current = magnetic flux density × current × length**	$\boldsymbol{F = B\,I\,l}$

Physics 1: Energy

Section 1: Energy stores and methods of transfer

Chemical store	Energy stored as chemicals waiting to **react.**
Kinetic store	Energy stored in objects that **move.**
Gravitational Potential store	Energy stored in objects raised up against the force of **gravity.**
Elastic Potential store	Energy stored in an object that have been **stretched.**
Internal store	Energy stored in the movement of particles. A combination of the **kinetic** energy of the particles and the **potential** energy of particles that are apart from each other. Can be changed by **heating** / **cooling**.
Nuclear store	Energy stored in the **nuclei** of atoms.
Magnetic store	Energy stored in **magnets** that are **attracting** or **repelling.**
Electrostatic store	Energy stored in **electric charges** that are **attracting** or **repelling**.
Mechanical transfer	Energy transferred when a **force moves through a distance**.
Electrical transfer	Energy transferred when a **charge moves**.
Wave transfer	Energy transferred by **waves** e.g. sound & light.
Heat transfer	Energy transferred when an object is **heated.**

Section 2: Important equations – you will be given the equation in the exam BUT you must learn the units and know how to use the equation

Calculation	Equation (given on equations sheet)	Symbols	Units **(must learn)**
Kinetic energy store	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 field strength** – Newtons per kilogram (N/kg) **Height** – metres (m) **Power** – Watts (W) **Time** – seconds (s) **Work done** – Joules (J) **Specific heat capacity** – Joules per kilogram degrees Centigrade (J/Kg°C)
Gravitational potential energy store	Gravitational potential energy = mass x gravitational field strength x height	$E_p = m\ g\ h$	
Power	Power =energy transferred ÷ time	$P = \frac{E}{t}$	
Power	Power = work done ÷ time	$P = \frac{W}{t}$	
Efficiency	Efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$		
Efficiency	Efficiency = $\frac{\text{useful power output}}{\text{total power input}}$		
Specific Heat Capacity	Change in thermal energy = mass x specific heat capacity x temperature change	$\Delta E = m\ c\ \Delta\theta$	

Section 3: Energy Resources

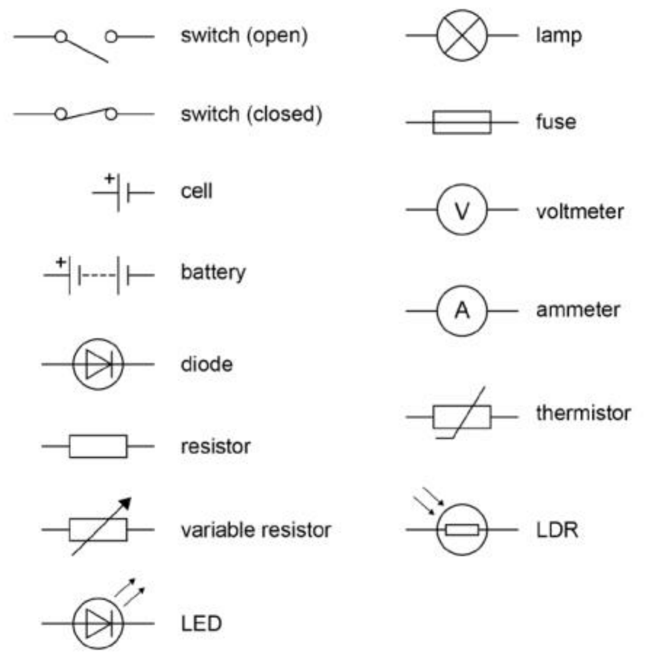
Resource	Renewable?	Uses	Advantages	Disadvantages
Fossil Fuels	Non-Renewable	Electricity, transport, heating	**Reliable** – electricity can be generated all of the time. Relatively **cheap** way of generating electricity.	Produces **carbon dioxide**, a greenhouse gas that causes **global warming.** Can 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 stays **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.	**Unreliable** – may not produce electricity during **low wind**. **Expensive** to construct.
Hydroelectricity	Renewable	Electricity	**No CO_2** produced while generating electricity.	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.	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.	**Unreliable – tides vary**. May damage **tidal ecosystem** e.g. mudflats.
Waves	Renewable	Electricity	**No CO_2** produced while generating electricity.	**Unreliable** – may not produce electricity during **calm** seas.
Solar	Renewable	Electricity, heating	**No CO_2** produced while generating electricity.	**Unreliable** – does not produce electricity at **night**. **Expensive** to construct.

Section 4: Key terms

Dissipation	Energy becoming **spread out** instead of in a concentrated store. "Wasted" 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** (non-conductive material). Occurs in buildings.
Conservation of energy	The law that states that **energy cannot be created or destroyed**.
Specific heat capacity	The energy needed to raise **1kg** of a material by **1°C.**

Physics 2: Electricity

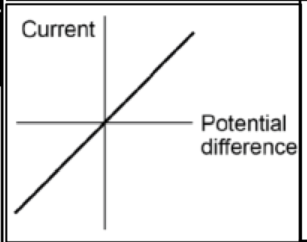
Section 1: Circuit Symbols



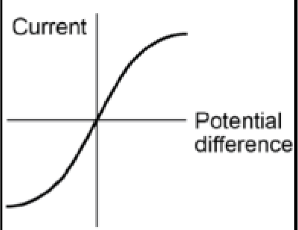
Section 4: V, I and R in Series and Parallel

Type of circuit	Current	Potential Difference	Resistance
Series	The current is the **same** at every point in the circuit and in every component.	The total potential difference is **shared** between the components.	The **more resistors, the greater the resistance.** The total resistance of a circuit is the sum of the resistance of each component. $\mathbf{R_{total} = R_1 + R_2}$
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.**	Adding **more resistors** in parallel **decreases resistance**. The **total resistance** of two resistors is **less than the resistance of the smallest individual resistor**.

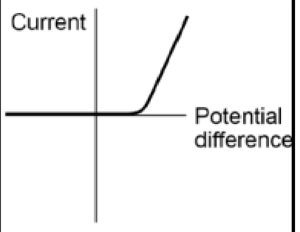
Section 5: IV Graphs



Fixed Resistor (Ohmic Conductor)
Current and potential difference are **directly proportional**. **Resistance is constant**.



Filament Lamp
Resistance of a filament lamp is **not constant**. As temperature increases, resistance increases. **Ions** within the lamp **vibrate more**, increasing **collisions** with **electrons**.



Diode/ LED
The **current** through a diode flows in **one direction only**. The diode has a **very high resistance in the reverse direction**.

Section 6: The Three Core Cable

Live	**Brown** colour. **Current flows** to the appliance. Potential difference between this and other wires should be **230V**.
Neutral	**Blue** colour. Current taken away from appliance. Potential difference should be **0V**.
Earth	**Yellow** and **green** colour. Potential difference of **0V**. Carries charge to Earth if live wire touches the metal casing of an appliance.

Section 2: Important Equations – given in exam but must learn units

Equation	Symbols	Units
Charge flow = current x time	Q = I x t	**Charge flow** - coulomb (C)
Potential difference = current x resistance	V = I x R	**Current** – amperes (A)
Power = potential difference x current	P = V x I	**Time** – seconds (s)
Power = current^2 x resistance	P = I^2 x R	**Potential difference** – volts (V)
Energy transferred = power x time	E = P x t	**Resistance** – ohms (Ω)
Energy transferred = charge flow x potential difference	E = Q x V	**Power** – watt (W)
Potential difference across primary coil x current in primary coil = potential difference across secondary coil x current in secondary coil	$V_S I_S = V_P I_P$	**Energy** = joules (J)

Section 3: Key Terms

Electric current	The **flow** of **electric charge**.
Potential difference	The potential difference between two points in an electric circuit is the **work done when a coulomb of charge passes between the points.** Potential difference **causes charge to flow.**
Resistance	Resistance is caused by anything that **opposes the flow of electric charge.**
Charge	Anything charged that is able to move within a circuit. **Electrons** or **ions**.
Series	A circuit with only **one route** for charge to take.
Parallel	A circuit with **more than one route** for charge to take.

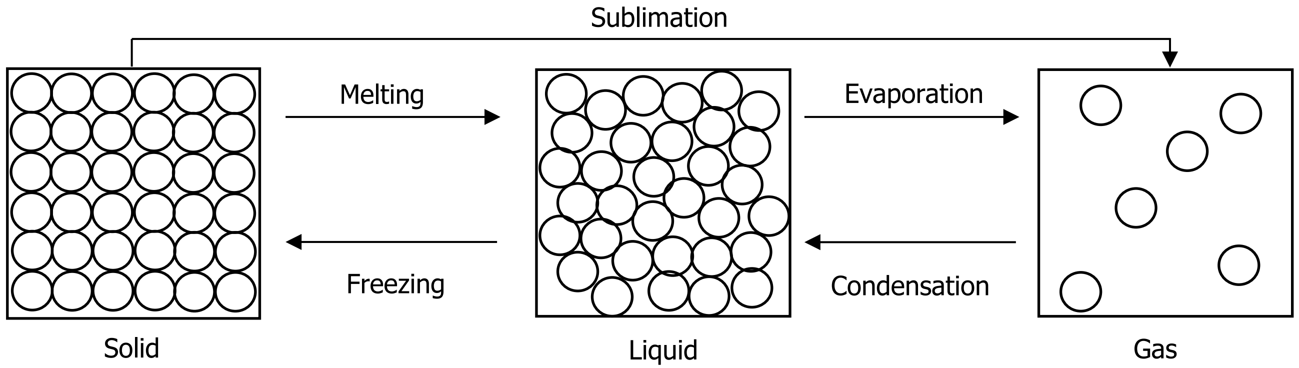
Section 7: Mains Electricity

Alternating Current	The **current** regularly **changes direction e.g. mains electricity**
Direct Current	The **current** flows in **one direction only e.g. batteries.**
Mains Electricity	UK mains is an **alternating current** of **230V** and at 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 **reduces the current** and **therefore less heat is lost** from the cables. This makes the National Grid **efficient**.
Step-down Transformer	**Reduces the potential difference** from the cables to **230V** for use by consumers.

Physics 3: Particle Model of Matter

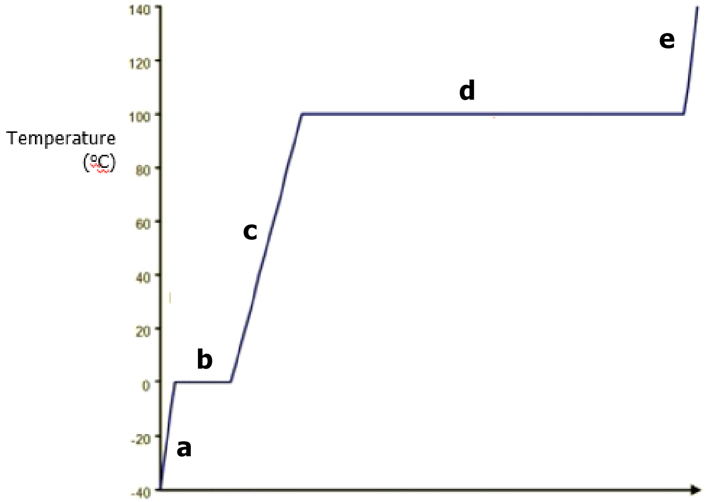
Section 1: Key Terms

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 **cannot easily 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)**.
Gas Pressure	The **force** exerted by gases on a surface as the **particles collide** with it. **As temperature increases, gas pressure increases** if the volume stays constant.



Section 2: Important equations – you will be given the equation in the exam BUT you must learn the units and know how to use the equation

Calculation	Equation (given on equations sheet)	Symbols	Units **(must learn)**
Density	Density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{v}$	Density = kilograms / metre^3 (kg/m^3) Mass = kilograms (kg) Volume = metres^3 (m^3)
Specific Latent Heat	Energy for change of state = mass x specific latent heat	E = m L	Energy – Joules (J) Mass – kilograms (Kg) Latent heat – joules per kilogram (J/kg)



Heating curve for water

Section 3: Explaining a heating curve

a. 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.
b. 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.
c. Liquid	Particles are touching but no longer arranged regularly. They are above to move. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
d. 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.
e. Gas	Particles move randomly. As more energy is absorbed the particles move more quickly and the temperature increases.

Physics 4: 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.
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**.
Radioactive 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	The **unwanted presence of materials containing radioactive atoms** e.g. within liquids, with the body/ 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: Properties of Sub-Atomic Particles

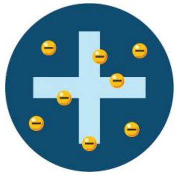
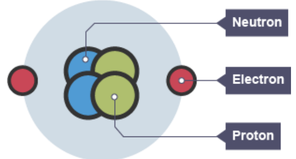
Sub-atomic particle	Mass	Charge	Position in Atom
Proton	1	+1	Nucleus
Neutron	1	0	Nucleus
Electron	Very small	-1	Orbiting in shells

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

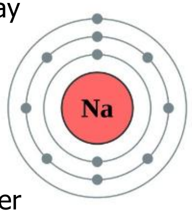
$$^{23}_{11}\mathrm{Na}$$

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

Section 3: Development of Atomic Model

Plum Pudding 	The 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 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).



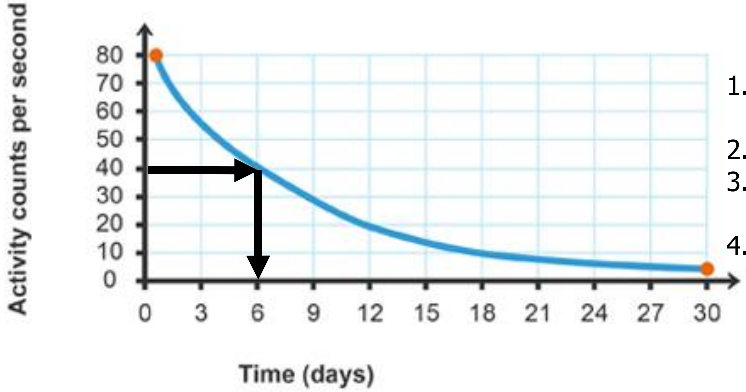
Section 4: Nuclear Radiation

Radiation	Range in air	Absorbed by	Ionizing Power	Product emitted when nuclei decay
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	**Many kilometres**	**Several centimetres** of **lead.**	**Low**	**Electromagnetic wave**

Section 5: 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. - An 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. - An atomic number increases by 1.
Gamma decay	There are no changes to the nucleus when gamma rays are emitted.

Section 6: Finding Half Life



1. Find the initial count rate.
2. Half that value.
3. Draw a line across and then down.
4. This is the half life of the isotope.

Physics 5: Forces

Section 1: Key terms

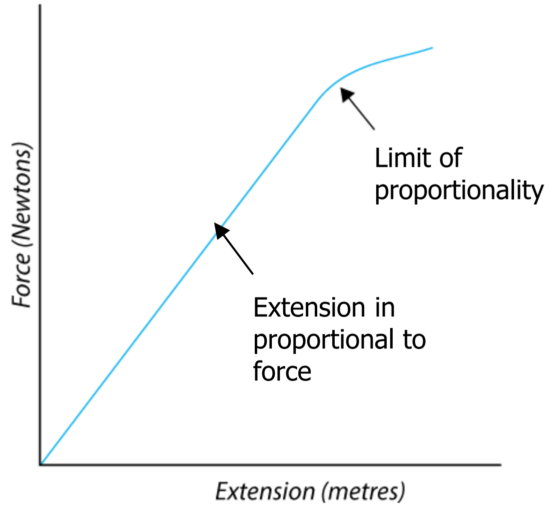
Scalar	A value with **magnitude (size) only,** e.g. **speed, distance.**
Vector	A value with **magnitude (size)** and **direction,** e.g. **all forces, displacement, velocity.**
Contact force	Force between objects that are **touching** e.g. friction, air resistance.
Non-contact force	Force between **separate objects** e.g. gravitational force, magnetic force.
Weight	The **force of gravity** acting **on an object's mass**. Measured using a **newtonmeter**.
Centre of mass	The **single point** at which the **object's weight appears to act**.
Resultant force	A resultant force is a **single force** that has the **same effect as all the forces** acting on an object.
Work done	Work is done when an **object is moved through a distance**. When work is done **against friction** there is a **temperature rise**.
Momentum (HT)	Moving objects with mass have momentum. Momentum is "**mass in motion**".
Conservation of momentum (HT)	In a closed system, the **total momentum before an event is equal to the total momentum after the event**.

Section 2: Important equations – you will be given the equation in the exam **BUT** you must **learn** the **units** and know how to use the equation

Equation (given on equations sheet)	Symbols	Units **(must learn)**
Weight = mass x gravitational field strength	$W = m\,g$	**Weight** – newtons (N) **Mass** – kilograms (kg) **GFS** – newtons per kilogram (N/kg)
Work done = force x distance	$W = F\,s$	**Work done** – joules (J) **Force** – newtons (N) **Distance** – metres (m)
Force = spring constant x extension	$F = k\,e$	**Spring constant** – newtons per metre (N/m) **Extension** – metres (m)
Distance = speed x time	$s = v\,t$	**Distance** – metres (m) **Speed** – metres per second (m/s) **Time** – seconds (s)
Acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$	**Acceleration** = metres per second squared (m/s^2)
Resultant force = mass x acceleration	$F = m\,a$	**Velocity** = metres per second (m/s)
Elastic Potential Energy = 0.5 x spring constant x Extension²	$E_e = 0.5\,k\,e^2$	**Energy** – Joules (J)

Section 3: Elasticity

Elastic deformation	Occurs when a **spring is stretched** and can then **return to its original length.**
Inelastic deformation	Occurs when a **spring is stretched** and its **length is permanently altered.**
Limit of proportionality	The **length** a spring can be **stretched before it no longer is able to return to its original length**. Beyond the limit of proportionality, a force-extension graph is curved.



Force-extension graph

Section 4: Forces and Braking

Reaction time	The **time it takes for a driver to react**, typically **0.2-0.9s**. Affected by **tiredness**, **drugs**, **alcohol** and **distractions**.
Thinking distance	The **distance a vehicle travels** while a driver is **reacting**.
Braking distance	The **distance a vehicle travels under braking**. Affected by **weather conditions** (e.g. rain or ice) and the **conditions of the brakes** and **tyres** of a vehicle.
Stopping distance	The stopping distance of a vehicle is the **sum** of the **distance the vehicle travels** during the driver's reaction time (**thinking distance**) and the distance it travels under the braking force (**braking distance**).
Braking force	When the brakes are pressed, **work done** by the **friction** force between the brakes and the wheel **reduces the kinetic energy** of the vehicle and the **temperature of the brakes increases**. The **greater the speed** of a vehicle, the **greater the force** needed to stop the vehicle. **Large decelerations** may lead to **loss of control** or **overheating** of the brakes.

Section 5a: Motion

Displacement	The **distance** an object moves and the **direction** in which it occurs. A **vector** quantity.
Velocity	The **speed** of an object in a **particular direction**.
Acceleration	The change of an object's speed in a certain amount of time. If an object is **falling near the surface** of the Earth its **acceleration will be 9.8m/s^2**.
Terminal velocity	The **maximum speed** of a moving object. Occurs when the **force moving** an object (e.g. gravity) is **balanced by frictional forces** (e.g. air resistance).
Circular motion (HT)	An object **moving in a circle** has **constant speed but changing velocity**. This is because the direction in which the object is moving is constantly changing, and velocity is a vector quantity that measures direction and speed.

Distance-time graph	Velocity-time graph
Constant speed - straight line	Constant speed - horizontal line
Accelerating - curved line upwards	Accelerating - straight line with velocity increasing
Decelerating - curved line going towards horizontal	Decelerating - straight line with velocity decreasing
Stationary - horizontal line	Stationary - horizontal line on x-axis (velocity = 0)
	Moving backwards - below x-axis
Gradient of line can be calculated to give speed	Gradient of line can be calculated to give acceleration or deceleration

Section 5b: Typical Values of Speed

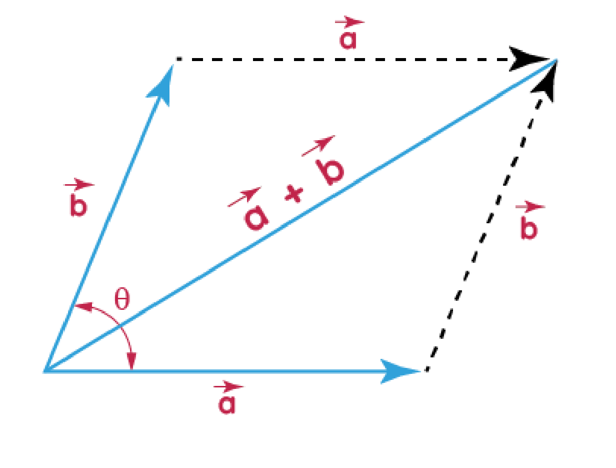
Walking	1.5 m/s
Running	3 m/s
Cycling	6 m/s
Sound in air	330 m/s

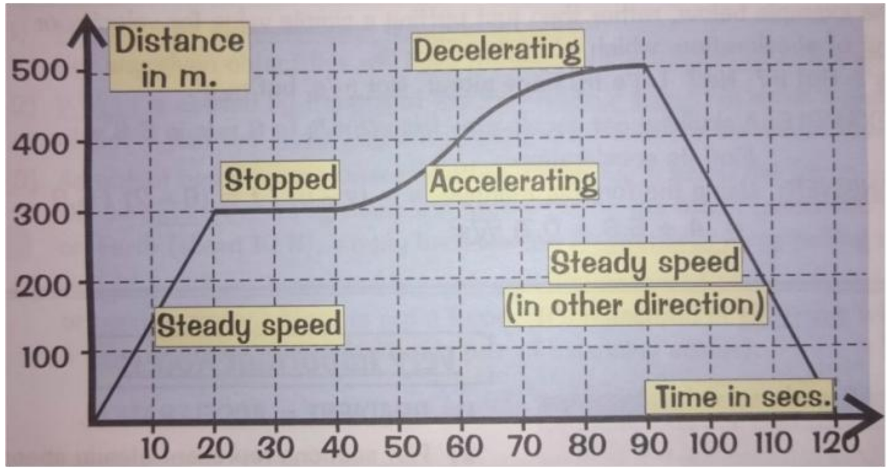
Section 6: Newton's Laws

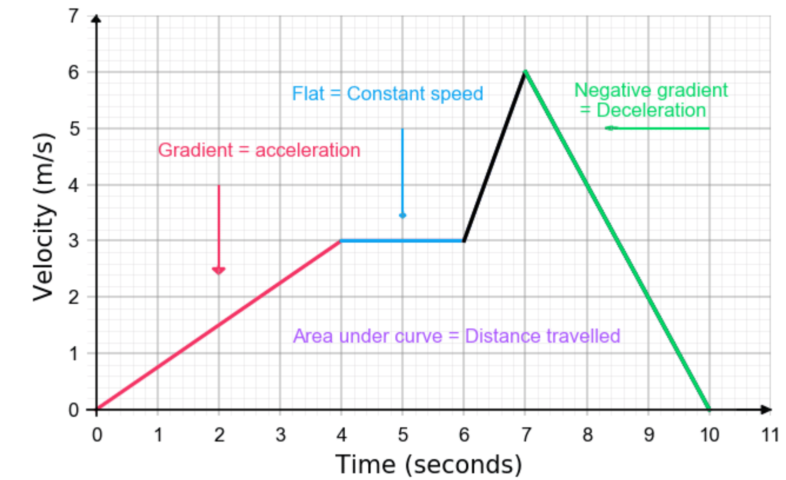
Newton's First Law	The **velocity** of an object will **only change** if a **resultant force is acting** on the object. If there is **no resultant force** the object will: - **Remain stationary** if it was not moving. - **Continue at a constant speed** if it was already moving.
Newton's Second Law	The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object. i.e. Force = mass x acceleration.
Newton's Third Law	Whenever **two objects interact**, the **forces** they exert on each other are **equal and opposite**.
Inertia (HT)	The **tendency** of objects to **continue in their state of rest** or of **uniform motion**.

Section 7: Vector Diagrams (HT)

Determine the resultant of two vectors using the parallelogram method. When drawn to scale, the angle (direction) of the vectors can be measured with a protractor







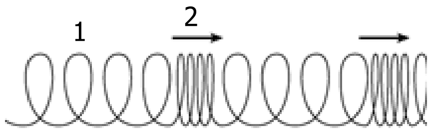
Section 8: **HT** equations – you will be given the equation in the exam BUT you must learn the units and know how to use the equation

Calculation	Equation (given on equations sheet)	Symbols	Units **(must learn)**
Momentum	Momentum = mass x velocity	ρ = m v	**Momentum** – kilograms metres per second (kg m/s) **Mass** – kilograms (kg)
Uniform acceleration	Final velocity^2 – initial velocity^2 = 2 x acceleration x distance	$v^2 - u^2 = 2as$	**Velocity** = metres per second (m/s) **Acceleration** – metres per second squared (m/s^2)

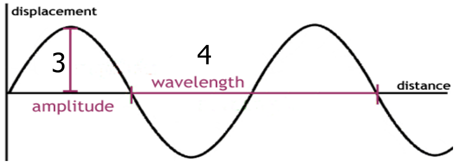
Physics 6: Waves

Section 1: Describing Waves

Amplitude (3)	The **maximum displacement** of a point on a wave away from its **undisturbed position**.
Wavelength (4)	The **distance** from a point on one wave to the **equivalent point** on the **next wave**.
Frequency	The **number of waves** passing a **point each second**.
Longitudinal	**Oscillations** are along **the same direction as the direction of travel** e.g. **sound** waves.
Transverse	**Oscillations are at right angles** to the **direction of travel** e.g. **water** waves, all **electromagnetic** waves.
Period	The **time needed** for **one wave** to **pass a given point**.
Compression (2)	Area in a **longitudinal** wave where particles are **closest** together.
Rarefaction (1)	Area in a **longitudinal** wave where particles are **furthest** apart.
Absorb	When the **energy** of an **EM wave** is **taken up by an object**.
Transmit	When a wave is able to **pass through** a material.
Reflect	The wave **bounces off a surface**; the **angle of incidence** is **equal** to the **angle of reflection**.
Refract	The wave **changes direction** when it enters a **medium of different density** where it has a **different speed**.



Longitudinal Wave



Transverse Wave

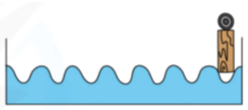
Section 2: Measuring the Speed of Sound

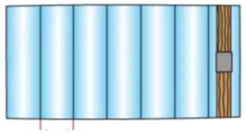
1	**Measure** the **distance** to a building.
2	**Fire a starting pistol** and **start a timer.**
3	**Stop the timer** when the **echo** is heard.
4	**Half** your value for **time** and Work out the **speed** using **distance divided by time.**

Section 3: Important Equations – given in exam but must learn units

Calculation	Equation	Symbols	Units
Wave speed	Wave speed = frequency x wavelength	$v = f\lambda$	**Wave speed** - metres per second (m/s) **Frequency** - hertz (Hz) **Wavelength** - metres (m) **Time** – seconds (s)
Frequency	Period = 1 / frequency	$T = 1/f$	

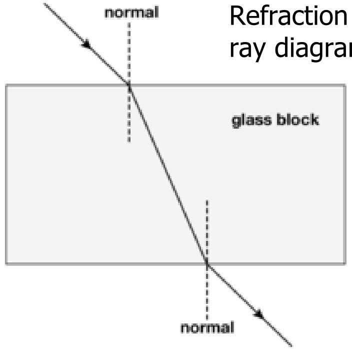
Section 4a: Using a Ripple Tank to Study Waves



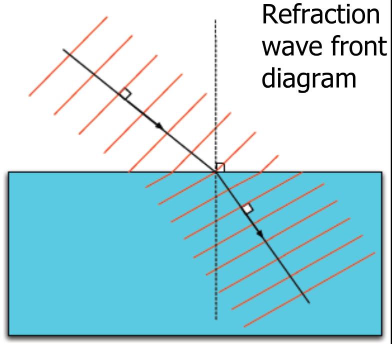


1) Count the number of waves passing a point in 10 seconds
2) Divide this number by 10 to get the **frequency**
3) Take a photo of the waves
4) Measure the length of 10 waves
5) Divide this number by 10 to get the **wavelength**
6) Calculate the **wave speed** using your answers to parts 2 & 5. Wave speed = frequency x wavelength

Section 4b: Refraction Diagrams (HT)



Refraction ray diagram



Refraction wave front diagram

Section 5: Properties of EM Waves and Sound Waves

Property	EM Wave	Sound Wave
Speed	300,000,000 m/s	around 330 m/s
Medium it can travel through	Anything, even a vacuum (space).	Solids, liquids, gases
Type of wave	Transverse	Longitudinal
Wavelength	Very short	Longer

Section 5a: The Electromagnetic Spectrum

The collective name for **all types of EM radiation**. They are all **transverse waves** that travel at **300,000,000 m/s**.

Long wavelength → Short wavelength

Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays

Low frequency → High frequency

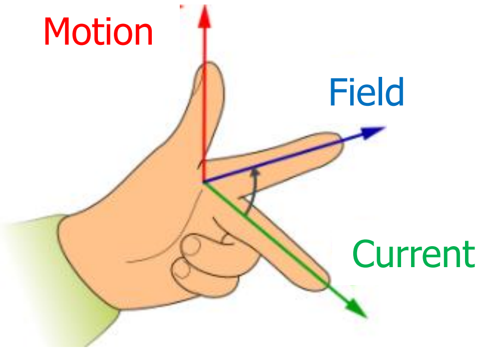
Section 5b: Uses and Risks of EM Radiation

EM Wave	Use	Why it's suitable (HT)	Risks
Radio Waves	**Television** and **radio**	**Reflected** by **ionosphere** so can broadcast over **long distances.**	
Microwaves	**Satellite communications, cooking food**	Able to **pass through the atmosphere** to **satellites.** Has a **heating** effect.	
Infrared	**Electrical heaters, cooking food, infrared cameras**	Has a **heating** effect. **Emitted by objects** so can be **detected.**	
Visible Light	**Fibre optic communications**	Able to **pass along a cable** by **total internal reflection.**	
Ultraviolet	**Energy efficient lamps, sun tanning**	**Increases** amount of **melanin** (brown pigment) in **skin.**	**Premature skin ageing,** increase **risk of skin cancer** (some can **ionize**)
X-Rays	**Medical imaging and treatments**	**Absorbed by bone** but **transmitted through soft tissue.**	**Ionizing** – can cause **mutation of genes** and **cancer**
Gamma Rays	**Medical imaging and treatments**	Able to **pass out of body** and be **detected by gamma cameras.** Can **kill cancerous cells.**	**Ionizing** – can cause **mutation of genes** and **cancer**

Physics 7: Magnetism and Electromagnetism

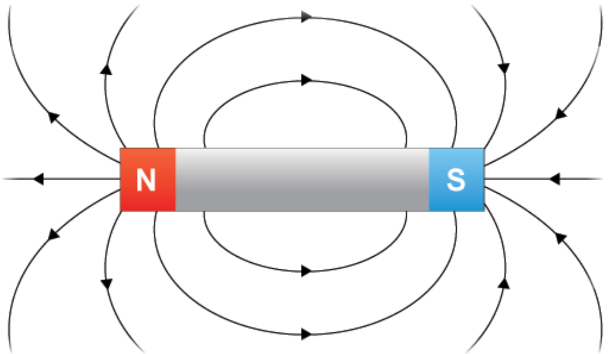
Section 1: Magnetism Key Terms	
Pole	The **places** on a magnet where the **magnetic forces** are **strongest**.
Magnetic Field	The **area** around a magnet where a **force acts** on another magnet or magnetic material.
Repel	Occurs when two **like poles** are brought close together. The magnets **push apart**.
Attract	Occurs when two **opposite poles** are brought close together. The magnets **move together**.
Permanent magnet	A magnet that produces its **own magnetic field**.
Induced magnet	A magnetic material that **becomes a magnet** when it is placed in a **magnetic field**. When **removed** from the **field** it **quickly loses its magnetism**.
Magnetic material	There are four magnetic materials: **iron**, **steel**, **cobalt** and **nickel**.
Compass	Compasses contain small bar magnets which **points** to the **north pole** of the **Earth's magnetic field**.

Section 2: Electromagnetism Key Terms	
Solenoid	A **coil of wire** that will create a **magnetic field** when **current** is passed through it. The magnetic field **inside** the solenoid is **strong** and **uniform**. It acts in the same way as a bar magnet.
Electromagnet	A **solenoid containing an iron core** which increases its strength.
Motor effect (HT)	When a **conductor carrying a current is placed in a magnetic field, the magnet producing the field and the conductor exert a force on each other**. This can be used to create a motor.
Fleming's Left Hand Rule (HT)	A rule that shows the **relative direction** of the **current**, **force** and **magnetic field** in the motor effect.



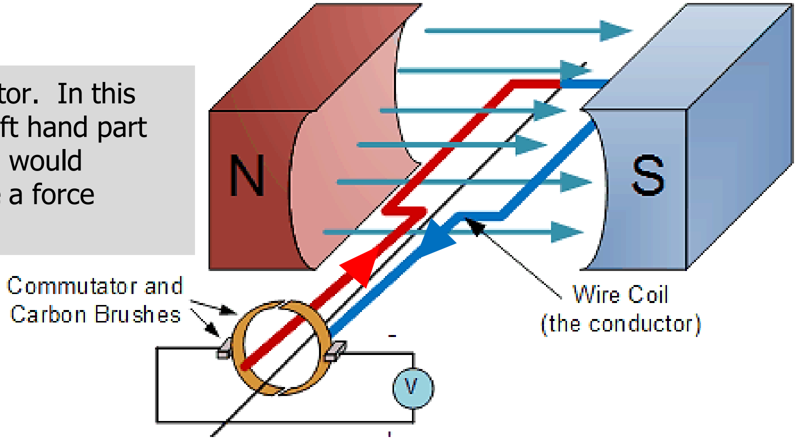
(HT) Fleming's Left Hand Rule. Align fingers to the field and the direction of the current to work out the way the wire moves.

The magnetic field around a bar magnet. The **field lines** always go **from North to South**

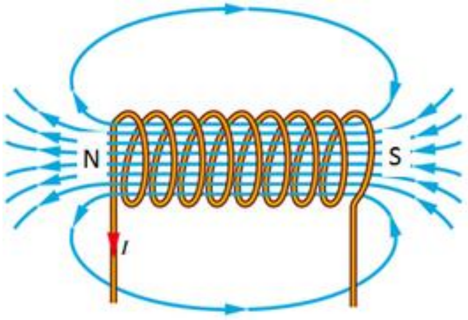


Section 3: Increasing the force of…	
A Solenoid	**A Motor (HT)**
Add an **iron core**	Increase the **number of coils** of wire
Increase the **number of coils** of wire	Increase the **strength of the magnetic field**
Increase the **current**	Increase the **current**
Move the magnetic material/ magnet **closer** to the solenoid	

(HT) A motor. In this case the left hand part of the wire would experience a force upwards.



The magnetic field in a **solenoid** is concentrated **inside the coil in a uniform direction**, otherwise it acts in the same way as a bar magnet.



Section 4: Equations HT – you will be given the equation in the exam BUT you must learn the units and know how to use the equation

Calculation	Equation (given on equations sheet)	Symbols	Units **(must learn)**
Force on a current-carrying wire	Force = magnetic flux density x current x length	F = B I l	**Force** – Newtons (N) **Magnetic flux density** – Tesla (T) **Current** – Amps (A) **Length** – metres (m)