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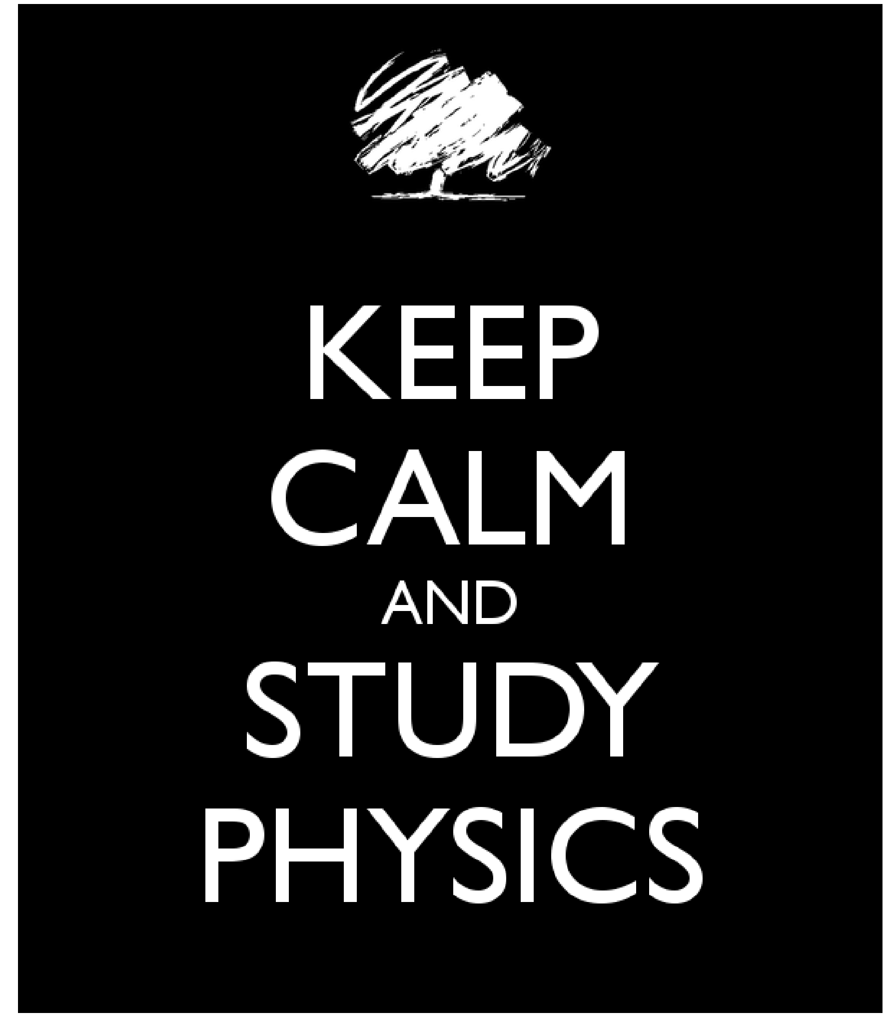


Name ______________

Physics teacher ______________

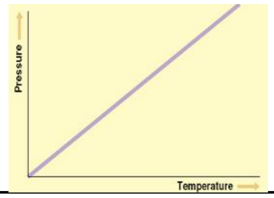
GCSE Physics

Trilogy Higher Tier

Knowledge revision booklet

You ned to MEMORISE all of this information

AQA PARTICLE MODEL OF MATTER



Particle model

State	Particle arrangement	Properties
Solid	*Packed in a regular structure. Strong forces hold in place so cannot move.*	Difficult to change shape.
Liquid	*Close together, forces keep contact but can move about.*	Can change shape but difficult to compress.
Gas	*Separated by large distances. Weak forces so constantly randomly moving.*	Can expand to fill a space, easy to compress.

Kinetic theory of gases

- Pressure of a fixed volume of gas increases as temperature increases (temperature increases, speed increases, collisions occur more frequently and with more force so pressure increases).
- Temperature of gas is linked to the average kinetic energy of the particles.
- If kinetic energy increases so does the temperature of gas.
- No kinetic energy is lost when gas particles collide with each other or the container.
- Gas particles are in a constant state of random motion.

P = m ÷ V

Density = mass ÷ volume.

Density	*Mass of a substance in a given volume*

	Units
Density	*Kilograms per metre cubed (kg/m^3)*
Mass	*Kilograms (kg)*
Volume	*Metres cubed (m^3)*
Energy needed	*Joules (J)*
Specific latent heat	*Joule per kilogram (J/kg)*
Change in thermal energy	*Joules (J)*
Specific heat capacity	*Joule per kilogram degrees Celsius (J/kg°C)*
Temperature change	*Degrees Celsius (°C)*
Pressure	*Pascals (Pa)*

Pressure

PHYSICS ONLY: when you do work the temperature increases e.g. pump air quickly into a ball, the air gets hot because as the piston in the pump moves the particles bounce off increasing kinetic energy, which causes a temperature rise.

Reducing the volume of a fixed mass of gas increases the pressure.

Halving the volume doubles the pressure.

PV = constant.

$P_1V_1 = P_2V_2$

Internal energy and energy transfers

Specific Heat Capacity	*Energy needed to raise 1kg of substance by 1°C*	Depends on: • Mass of substance • What the substance is • Energy put into the system.

Change in thermal energy = mass **X** specific heat capacity **X** temperature change.

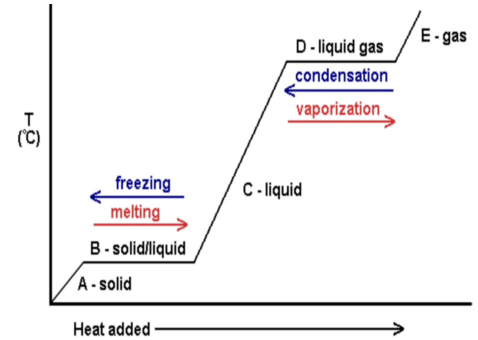
$\Delta E = m \times c \times \Delta\theta$

Internal energy		
	Energy stored inside a system by particles	Internal energy is the total kinetic and potential energy of all the particles (atoms and molecules) in a system.
	Heating changes the energy stored within a system	Heating causes a change in state. As particles separate, potential energy stored increases. Heating increases the temperature of a system. Particles move faster so kinetic energy of particles increases.

Specific Latent Heat	*Energy needed to change 1kg of a substance's state*
Specific Latent Heat of Fusion	*Energy needed to change 1kg of solid into 1 kg of liquid at the same temperature*
Specific Latent Heat of Vaporisation	*Energy needed to change 1kg of liquid into 1 kg of gas at the same temperature*

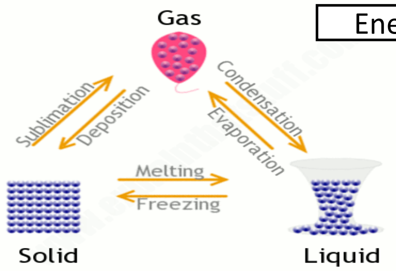
Energy needed = mass **X** specific latent heat.

$\Delta E = m \times L$



Change of state

Freezing	Liquid turns to a solid. Internal energy decreases.
Melting	Solid turns to a liquid. Internal energy increases.
Boiling / Evaporating	Liquid turns to a gas. Internal energy increases.
Condensation	Gas turns to a liquid. Internal energy decreases.
Sublimation	Solid turns directly into a gas. Internal energy increases.
Conservation of mass	When substances change state, mass is conserved.
Physical change	No new substance is made, process can be reversed.



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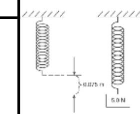
AQA ENERGY – part 1

Energy pathways

Mechanical	*Force acts upon an object*
Electrical	*Electric current flow*
Heat	*Temperature difference between objects*
Radiation	*Electromagnetic waves or sound*

Energy stores and changes

Kinetic energy	*Energy stored by a moving object*	½ X mass X (speed)^2 ½ mv^2
Elastic Potential energy	*Energy stored in a stretched spring, elastic band*	½ X spring constant X (extension)^2 ½ ke^2 (Assuming the limit of proportionality has not been exceeded)
Gravitational Potential energy	*Energy gained by an object raised above the ground*	Mass X gravitational field strength X height mgh



System	*An object or group of objects that interact together*	EG: Kettle boiling water.
Energy stores	*Kinetic, chemical, internal (thermal), gravitational potential, elastic potential, magnetic, electrostatic, nuclear*	Energy is gained or lost from the object or device.
Ways to transfer energy	*Light, sound, electricity, thermal, kinetic are ways to transfer from one store to another store of energy.*	EG: electrical energy transfers chemical energy into thermal energy to heat water up.
Unit	*Joules (J)*	

Work	*Doing work transfers energy from one store to another*	By applying a force to move an object the energy store is changed.	Work done = Force X distance moved W = Fs
Power	*The rate of energy transfer*	1 Joule of energy per second = 1 watt of power	Power = energy transfer ÷ time P = E ÷ t Power = work done ÷ time, P = W ÷ t

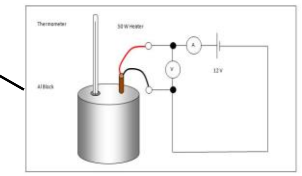
	Units
Specific Heat Capacity	*Joules per Kilogram degree Celsius (J/Kg°C)*
Temperature change	*Degrees Celsius (°C)*
Work done	*Joules (J)*
Force	*Newton (N)*
Distance moved	*Metre (m)*
Power	*Watts (W)*
Time	*Seconds (s)*

Specific heat capacity

Change in thermal energy = mass **X** specific heat capacity **X** temperature change

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

Specific Heat Capacity	*Energy needed to raise 1kg of substance by 1°C*	Depends on: mass of substance, what the substance is and energy put into the system.



Energy Conservation and Dissipation

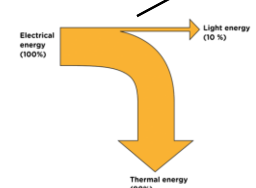
HIGHER: efficiency can be increased using machines.

Efficiency = Useful power output / Total power input

Efficiency = Useful output energy transfer / Total input energy transfer

Efficiency	*How much energy is usefully transferred*	
Dissipate	*To scatter in all directions or to use wastefully*	When energy is 'wasted', it dissipates into the surroundings as internal (thermal) energy.
Ways to reduce 'wasted' energy	*Energy transferred usefully*	Insulation, streamline design, lubrication of moving parts.
Principle of conservation of energy	*The amount of energy always stays the same.*	Energy cannot be created or destroyed, only changed from one store to another.

Closed system	*No change in total energy in system*
Open system	*Energy can dissipate*



Useful energy	*Energy transferred and used*
Wasted energy	*Dissipated energy, stored less usefully*

Prefix	Multiple	Standard form
Kilo	*1000*	10^3
Mega	*1000 000*	10^6
Giga	*100 000 000*	10^9

HIGHER: When an object is moved, energy is transferred by doing work.

Work done = Force X distance moved

Frictional forces cause energy to be transferred as thermal energy. This is wasted.

Reducing friction - using wheels, applying lubrication. Reducing air resistance – travelling slowly, streamlining.

	Units
Energy (KE, EPE, GPE, thermal)	*Joules (J)*
Velocity	*Metres per second (m/s)*
Spring constant	*Newton per metre (N/m)*
Extension	*Metres (m)*
Mass	*Kilogram (Kg)*
Gravitational field strength	*Newton per kilogram (N/Kg)*
Height	*Metres (m)*

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Global Energy Resources

AQA ENERGY – part 2

Using fuels

Transport	***Petrol, diesel, kerosene produced from oil***	Used in cars, trains and planes.
Heating	***Gas and electricity***	Used in buildings.
Electricity	***Most generated by fossil fuels***	Used to power most devices.

Using renewable energy will need to increase to meet demand.

Renewable energy makes up about 20% of energy consumption.

Fossil fuel reserves are running out.

Energy demand is increasing as population increases.

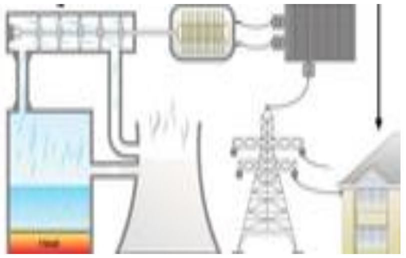
Energy resources

Non-renewable energy resource	***These will run out. It is a finite reserve. It cannot be replenished.***	e.g. Fossil fuels (coal, oil and gas) and nuclear fuels.
Renewable energy resource	***These will never run out. It is an infinite reserve. It can be replenished.***	e.g. Solar, Tides, Waves, Wind, Geothermal, Biomass, Hydroelectric

National Grid

Power station – NB: You need to understand the principle behind generating electricity. An energy resource is burnt to make steam to drive a turbine which drives the generator.

Power station	***Generates electricity***	Fuel burnt releasing thermal energy ➔	Water boils into steam ➔	Steam turns turbine ➔	Turbine turns generator ➔	Generator induces voltage
National Grid	***Transports electricity across UK***	Power station ➔	Step-up transformer ➔	Pylons ➔	Step-down transformer ➔	House, factory



Energy resource	*How it works*	Uses	Positive	Negative
Fossil Fuels (coal, oil and gas)	***Burnt to release thermal energy used to turn water into steam to turn turbines***	Generating electricity, heating and transport	Provides most of the UK energy. Large reserves. Cheap to extract. Used in transport, heating and making electricity. Easy to transport.	Non-renewable. Burning coal and oil releases sulfur dioxide. When mixed with rain makes acid rain. Acid rain damages building and kills plants. Burning fossil fuels releases carbon dioxide which contributes to global warming. Serious environmental damage if oil spilt.
Nuclear	***Nuclear fission process***	Generating electricity	No greenhouse gases produced. Lots of energy produced from small amounts of fuel.	Non-renewable. Dangers of radioactive materials being released into air or water. Nuclear sites need high levels of security. Start up costs and decommission costs very expensive. Toxic waste needs careful storing.
Biofuel	***Plant matter burnt to release thermal energy***	Transport and generating electricity	Renewable. As plants grow, they remove carbon dioxide. They are 'carbon neutral'.	Large areas of land needed to grow fuel crops. Habitats destroyed and food not grown. Emits carbon dioxide when burnt thus adding to greenhouse gases and global warming.
Tides	***Every day tides rise and fall, so generation of electricity can be predicted***	Generating electricity	Renewable. Predictable due to consistency of tides. No greenhouse gases produced.	Expensive to set up. A dam like structure is built across an estuary, altering habitats and causing problems for ships and boats.
Waves	***Up and down motion turns turbines***	Generating electricity	Renewable. No waste products.	Can be unreliable depends on wave output as large waves can stop the pistons working.
Hydroelectric	***Falling water spins a turbine***	Generating electricity	Renewable. No waste products.	Habitats destroyed when dam is built.
Wind	***Movement causes turbine to spin which turns a generator***	Generating electricity	Renewable. No waste products.	Unreliable – wind varies. Visual and noise pollution. Dangerous to migrating birds.
Solar	***Directly heats objects in solar panels or sunlight captured in photovoltaic cells***	Generating electricity and some heating	Renewable. No waste products.	Making and installing solar panels expensive. Unreliable due to light intensity.
Geothermal	***Hot rocks under the ground heats water to produce steam to turn turbine***	Generating electricity and heating	Renewable. Clean. No greenhouse gases produced.	Limited to a small number of countries. Geothermal power stations can cause earthquake tremors.

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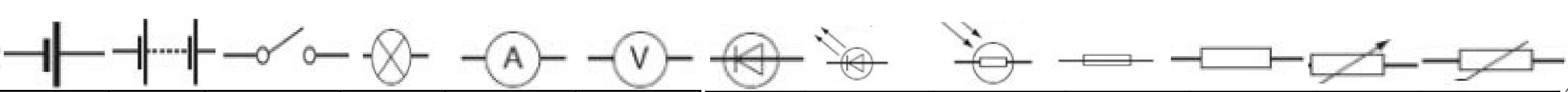
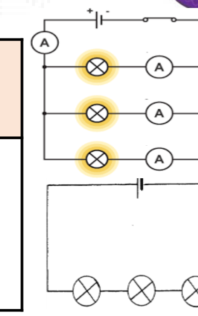


Cell	Battery	Switch	Lamp	Ammeter	Volt meter	Diode	LED	LDR	Fuse	Resistor	Variable resistor	Thermistor
Store of chemical energy	*Two or more cells in series*	*Breaks circuit, turning current off*	*Lights when current flows*	*Measures current*	*Measures potential difference*	*Current flows one way*	*Emits light when current flows*	*Resistance low in bright light*	*Melts when current is too high*	*Affects the size of current flowing*	*Allows current to be varied*	*Resistance low at high temp*



Electrons carry current. Electrons are free to move in metal.

Circuit symbols

Current, potential difference and resistance

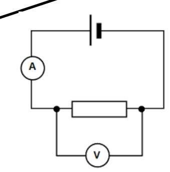
Current and Charge

Current	*Flow of electrical charge*	Ampere (A)
Potential difference (p.d.)	*How much electrical work is done by a cell*	Volts (V)
Charge	*Amount of electricity travelling in a circuit*	Coulombs (C)

Charge = Current X time — Q = I X t

Controlling current

Changing current	*Change the p.d. of the cells*
	Add more components



Ammeter	*Set up in series with components*
Voltmeter	*Set up parallel to components*

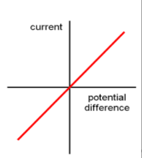
R = V ÷ I

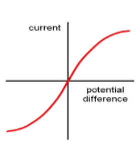
Resistance = Potential difference ÷ Current

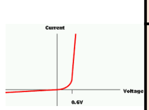
Resistance (Ω)	*A measurement of how much current flow is reduced*
The higher the resistance, the more difficult it is for current to flow.	
Increasing resistance, reduces current.	
Increasing voltage, increases current.	

Thermistor	LDR
Resistance varies with temperature	*Resistance varies with light intensity*
Resistance decreases as temperature increases.	Resistance decreases as light increases.

Current – Potential difference graphs







Ohmic conductor	*At a constant temperature, current is directly proportional to the p.d. across the resistor.*
Filament lamp	*As current increases, the resistance increases. The temperature increases as current flows.*
Diode	*Current flows when p.d. flows forward. Very high resistance in reverse.*

AQA Electricity

Series and parallel circuits

Series circuit	Current is the same in all components.	Total p.d. from battery is shared between all the components.	Total resistance is the sum of each component's resistance.
Parallel circuit	Total current is the sum of each component's current.	p.d. across all components is the same.	Total resistance is less than the resistance value of the smallest individual resistor.

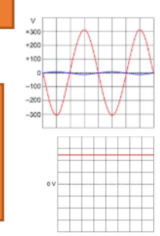
Series	Parallel
A circuit with one loop	*A circuit with two or more loops*

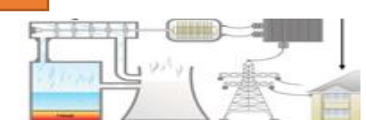
Total p.d: *If cells are joined in series, add up individual cell values*

Energy transfers

Work is done when charge flowing.

- Power (W) = potential difference X current — R = V X I
- Power = $(current)^2$ X resistance — $P = I^2 X R$
- Energy transferred = Power X time — E = P X t





National Grid: *Distributes electricity generated in power stations around UK*

Step-up transformers	Step-down transformers
Increase voltage, decrease current	*Decrease voltage, increase current*
Increases efficiency, reduces heat loss.	Makes safer for houses.

Domestic uses and safety

Alternating current	Direct current
p.d. switches direction many times a second, current switches direction	*p.d. remains in one direction, current flows the same direction*
Generator.	Cell or battery.

'Earthing' a safety device; Earth wire joins the metal case.

Mains supply
Frequency 50Hz, 230V

3 pin plug

Live - Brown	Carries p.d from mains supply.	p.d between live and earth = 230V
Neutral - Blue	Completes the circuit.	p.d. = OV
Earth – Green and Yellow stripes	Only carries current if there is a fault.	p.d. = 0V

AQA FORCES – part 1

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Forces and their interactions

Each Kg has a gravitational pull of 9.8N.

Unit	Newton (N)	1N
Kilo	Kilonewton (KN) = 1000	$1X\ 10^3$
Mega	Meganewton (MN) = 1000,000	$1\ X\ 10^6$

Gravitational field strength	*Gravity exerted around an object.*	Earth's gfs = 9.8N/kg

Centre of mass	*The weight of an object acts through a single point*

Weight = mass X gravitational field strength — W = m X g

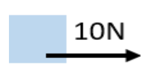
Gravity

Weight	*Force acting upon an object due to gravity*	Newton (N)
Mass	*How much matter*	Kilograms (Kg)

Scalar and vector quantities

Scalar	*A quantity that only has magnitude (size)*	e.g. mass, time, speed, temperature, energy,
Vector	*A quantity that only has magnitude and direction*	e.g. force, velocity, momentum

An arrow can be used to show vectors	*Length of arrow = magnitude of vector*
	Direction of arrow = direction of vector



Velocity	*Speed + direction*	The speed of a car is 30m/s. A car moves forward with a velocity of 30m/s
Distance	*How far*	The table is 1m long
Displacement	*Distance + direction*	The beach is 1km due east of the town

Area	*Metres squares (m^2)*
Weight	*Newton (N)*
Mass	*Kilograms (kg)*
Gravitational field strength	*Newton per kilogram (N/Kg)*
Force	*Newton (N)*
Work done	*Joules (J)*
Distance	*Metres (m)*
Moment	*Newton-metres (Nm)*

Contact and Resultant forces

Force	*Push or pull*	Stretch, squash, turn.
Contact force	*Exerted between two objects when they touch*	Friction, air resistance, tension.
Non-contact force	*Exerted between two objects without touching*	Gravity, electrostatic forces, magnetic forces.

Resultant force	*The overall effect of all the forces acting upon an object*	Two forces acting in the same direction are added.
		Two forces acting in the opposite direction are taken away.

HIGHER ONLY

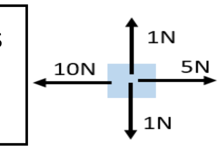
Resolving forces	*An object pulled with a force at an angle*	A single force can be split into two components acting at right angles to each other.

The component forces combined have the same effect.

Work done against frictional forces, temperature of object rises.

Free body diagram	*Show magnitude and direction of all forces upon an object*

Object moves left with a force of 5N



If force is at right angles to direction of movement, NO work is done.

Work done and energy transfer

Work done	*When work is done, energy is transferred*	Work done = force X distance moved W = F X s
		1J of work is done when 1N of force moves an object through a distance of 1m, in the direction of the force.

PHYSICS ONLY

Moments, levers and gears

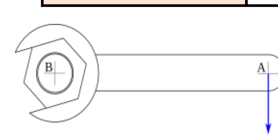
M = F X d

Moment = force X distance

Moment	*Turning effect of a force about a pivot*
Lever	*A small force exerted with a long lever applies a large force*
Gears	*Increase or decrease the rotational effect of a force*

Principle of moments

In a balanced system, the sum of the clockwise moments = the sum of the anti-clockwise moments



Pressure

HIGHER ONLY

Pressure = Force ÷ Area

P = F ÷ A

Fluid	*A liquid or gas*
	Flows and changes shape to fill a container.

Pressure and depth
Pressure on divers depends on weight of water above

Pressure = height X density X gfs

Upthrust
Resultant force exerted by a fluid

Hydraulic machine	*Use liquids to transmit pressure*

Atmospheric pressure
Caused by billions of air particles colliding with a surface.

Forces and elasticity

One force	*The object changes speed or direction*
More than one force	*The object changes shape*

Two balanced forces can stretch a object.

Two balanced forces can compress an object.

Three balanced forces can bend an object.

Elastic deformation	*The object has been stretched but returns to its original length*
Inelastic deformation	*The object has been stretched but does not return to its original length*
Extension	*The difference between stretched and unstretched lengths*

Limit of proportionality
Beyond this point the spring is permanently deformed

Stretching a spring	Force = spring constant X extension, F = k X e
	EPE = ½ X spring constant X $(\text{extension})^2$, EPE = ½ ke^2

Elastic Potential energy (EPE)	*Energy stored in a stretched spring*

Force	*Newton (N)*
Spring constant	*Newton per metre (N/m)*
Extension	*Metres (m)*
EPE	*Joules (J)*

AQA FORCES – part 2

Observing and recording motion

Describing motion

Speed	*How fast an object moves*	Scalar
Displacement	*Includes the distance and direction an object moves*	vector
Distance	*How far an object moves*	scalar

Speed = distance ÷ time

v = s ÷ t

Speed is rarely constant.

Car on motorway	*30m/s*
Train	*60m/s*
Jet plane	*200m/s*

Walking	*1.5m/s*
Running	*3m/s*
Cycling	*6m/s*

Speed of sound 330m/s.

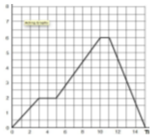
Velocity	*The speed of an object with direction*	Vector

HIGHER ONLY

Changing velocity	*Objects in a circular motion, change direction but keep a constant speed*

Aeroplane banks to change direction	Velocity changes.
Car travelling around a bend	Constant speed, direction changes.
Satellite orbiting the Earth	Constant speed, direction changes.

Distance-time graph	*Shows how far an object moves along a straight line*
Speed of object	*Use the gradient of graph*



Gradient = vertical ÷ horizontal

Accelerating objects	*It takes time for objects to reach top speed*	Draw a tangent to the curve, work out gradient.

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Distance travelled	*Area under the graph shape*

HIGHER ONLY

Velocity-time graph	*Shows speed of an object*
Accelerating	*Object getting faster*
Decelerating	*Object slowing down*

Acceleration = change in velocity ÷ time taken

Acceleration	*Change in velocity*	Vector

Constant acceleration
(final velocity) ^{2} – (initial velocity) ^{2} = 2 X acceleration X distance $V^2 - u^2 = 2 \times a \times s$

Falling objects

Falling objects accelerate due to gravity.	In no air resistance, objects accelerate at 9.8m/s²	Air resistance slows falling objects down.

Terminal velocity	*Weight of an object is balanced by resistive forces*	Object moves at a constant velocity. Resultant force = 0.

PHYSICS ONLY

Parachuting	*Size of air resistance depends on area of object and speed*

Larger the area, the larger the air resistance.

Larger the speed, the larger the air resistance.

Forces, acceleration and Newton's Laws of motion

Inertia	*When objects continue in the same state of motion*

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Speed or direction only changes if a resultant force acts on the object

Newton's first Law	*Balanced forces*	When the resultant force on an still object = 0, the object is stationary. When the resultant force on a moving object = 0, the object is at a constant speed.
Newton's second Law	*Unbalanced forces*	When the resultant force is greater than 0, the object accelerates. It could speed up, slow down or change direction.
Newton's third Law	*Equal and opposite forces*	When two objects interact the forces exerted are equal and in an opposite direction.

Acceleration is proportional to resultant force.

Acceleration is inversely proportional to mass.

Force = mass X acceleration

HIGHER ONLY

F = m X a

Inertial mass	*How difficult it is to change the velocity of an object*

Inertial mass = force ÷ acceleration

If the mass is large, to change velocity a big force is needed.

Momentum

HIGHER ONLY

Is a vector

p = m X v

Momentum = mass X velocity

HIGHER ONLY

Conservation of momentum
When two objects collide, the momentum they have before the collision = the momentum they have after the collision
Closed system = no external forces acting on it.

Forces and braking

Frictional forces decelerate a moving object and bring it to rest.

Speed affects both thinking and braking distances.

Typical reaction time = 0.7s

Thinking distance	*Distance travelled whilst the driver reacts*
Braking distance	*Distance travelled whilst the car is stopped by the brakes*
Stopping distance	*Total thinking and braking distances*

Factors affecting stopping distances		
	Drivers reaction times	Drinking alcohol, taking drugs, tired.
	Braking distances	Weather conditions, worn brakes or tyres, road surface, size of braking force.

Braking and kinetic energy	*Work done by braking force, reduces kinetic energy*	Kinetic energy decreases, temperature of brakes increases due to frictional forces.

Speed / velocity	*Metres per second (m/s)*
Distance	*Metres (m)*
Time	*Seconds (s)*
Acceleration	*Metres per second squared (m/s²)*
Force	*Newton (N)*
Mass	*Kilogram (Kg)*
Momentum	*Kilograms metres per second (Kgm/s)*

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Radius of an atom
1 X 10^{-10}m

Electrons gained	Electrons lost
Negative ion	Positive ion

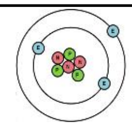
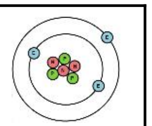
AQA ATOMIC STRUCTURE

Atom structure

Atom	*Same number of protons and electrons*
Ion	*Unequal number of electrons to protons*
Mass number	*Number of protons and neutrons*
Atomic number	*Number of protons*

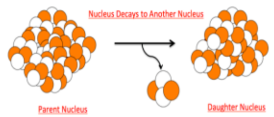
Particle	Charge	Size	Found
Neutron	*None*	*1*	*In the nucleus*
Proton	*+*	*1*	*In the nucleus*
Electron	*-*	*Tiny*	*Orbits the nucleus*

Atoms and Isotopes

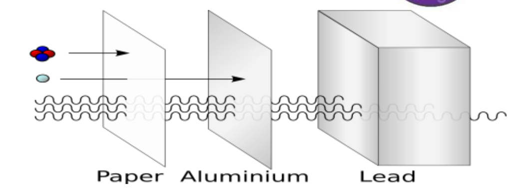
Isotope	$^{6}_{3}$Li		$^{7}_{3}$Li	

Different forms of an element with the same number of protons but different number of neutrons

Atoms and Nuclear Radiation



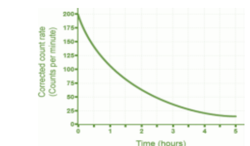
Decay	Range in air	Ionising power	Penetration power
Alpha	Few cm	Very strong	Stopped by paper
Beta	Few m	Medium	Stopped by Aluminium
Gamma	Great distances	Weak	Stopped by thick lead



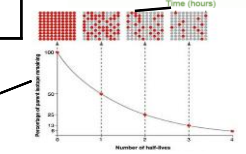
Radioactive decay	*Unstable atoms randomly emit radiation to become stable*
Detecting	*Use Geiger Muller tube*
Unit	*Becquerel*
Ionisation	*All radiation ionises*

Decay	Emitted from nucleus	Changes in mass number and atomic number		Equation
Alpha (α)	*Helium nuclei ($^{4}_{2}He$)*	*-4*	*-2*	$^{238}_{92}U \rightarrow \, ^{234}_{90}Th + \, ^{4}_{2}He$
Beta (β)	*Electron ($^{0}_{-1}e$)*	*0*	*+1*	$^{14}_{6}C \rightarrow \, ^{14}_{7}N + \, ^{0}_{-1}e$
Gamma (γ)	*Electromagnetic wave*	*0*	*0*	$^{99}_{43}Tc \rightarrow \, ^{99}_{43}Tc + \gamma$
Neutron	*Neutron*	*-1*	*0*	

Contamination	*Unwanted presence of radioactive atoms*
Irradiation	*Person is in exposed to radioactive source*



Half life	*The time taken to lose half of its initial radioactivity*



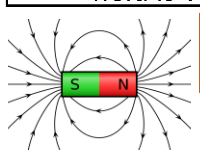
Discovery of the nucleus

Democritus	Suggested idea of atoms as small spheres that cannot be cut.
J J Thomson (1897)	Discovered electrons– emitted from surface of hot metal. Showed electrons are negatively charged and that they are much less massive than atoms.
Thomson (1904)	Proposed *'plum pudding'* model – atoms are a ball of positive charge with negative electrons embedded in it.
Geiger and Marsden (1909)	Directed beam of alpha particles (He^{2+})at a thin sheet of gold foil. Found some travelled through, some were deflected, some bounced back.
Rutherford (1911)	Used above evidence to suggest alpha particles deflected due to electrostatic interaction between the very small charged nucleus, nucleus was massive. Proposed mass and positive charge contained in nucleus while electrons found outside the nucleus which cancel the positive charge exactly.
Bohr (1913)	Suggested modern model of atom – electrons in circular orbits around nucleus, electrons can change orbits by emitting or absorbing electromagnetic radiation. His research led to the idea of some particles within the nucleus having positive charge; these were named protons.
Chadwick (1932)	Discovered neutrons in nucleus – enabling other scientists to account for mass of atom.

Nuclear fission and fusion

AQA MAGNETISM AND ELECTROMAGNETISM

Permanent and Induced Magnetism



Magnets

Magnetic	*Materials attracted by magnets*	Uses non-contact force to attract magnetic materials.
North seeking pole	*End of magnet pointing north*	Compass needle is a bar magnet and points north.
South seeking pole	*End of magnet pointing south*	Like poles (N – N) repel, unlike poles (N – S) attract.
Magnetic field	*Region of force around magnet*	Strong field, force big. Weak field, force small. Field is strongest at the poles.
Permanent	*A magnet that produces its own magnetic field*	Will repel or attract other magnets and magnetic materials.
Induced	*A temporary magnet*	Becomes magnet when placed in a magnetic field.

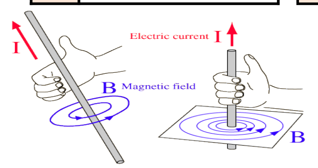
Magnetic field around a wire

Electric current flowing in a wire produces a magnetic field around it.

- If current is small, magnetic field is very weak.
- Current large enough, iron filings show circular magnetic field.
- Further away from the wire, magnetic field is weaker.
- Reverse current, magnetic field direction reverses.

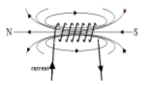
Right hand rule

Thumb	Direction of current.
Fingers	Direction of magnetic field.



Solenoid

Solenoid	*A long coil of wire*	Magnetic field from each loop adds to the next.



Electromagnet

Electromagnet	*Lots of turns of wire increase the magnetising effect when current flows*
	Turn current off, magnetism lost.

Increase strength of magnetic field

- *Use larger current*
- *Use more turns of wire*
- *Put turns of wire closer together*
- *Use iron core in middle*

Relay

Relay	*A device using a small current to control a larger current in another circuit*	Solenoid is wound around an iron core. Small current magnetises the solenoid. This attracts to electrical contacts, making a complete circuit. Current flows from battery to starter motor.

Motor effect

HIGHER only

Magnetic fields from the permanent magnet and current in the foil interact. This is called the motor effect.

- Reverse the current , foil moves upwards.
- Aluminium foil placed between two poles of a strong magnet, will move downwards when current flows through the foil.
- Size of force acting on foil depends on magnetic flux density between poles, size of current, length of foil between poles.

F = B X I X l

Force = magnetic flux density X current X length

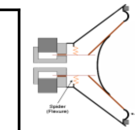
If current and magnetic field are parallel to each other , no force on wire.

Magnetic flux	*Lines drawn to show magnetic field*	Lots of lines = stronger magnets.
Magnetic flux density	*Number of lines of magnetic flux in a given area*	Measures the strength of magnetic force.

Electric motor

Electric motor	*Coil of wire rotates about an axle*	Current flows through the wire causing a downward movement on one side and an upward movement on the other side.

Split-ring commutator	*Split ring touching two carbon brush contacts*

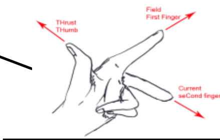


Loud speakers	*Converts variations in electrical current into sound waves .*	Varying current flows through a coil that is in a magnetic field. A force on the wire moves backwards and forwards as current varies. Coil connected to a diaphragm. Diaphragm movements produce sound waves.
Generators	*Coil of wire rotating inside a magnetic field. The end of the coil is connected to slip rings.*	Produces altering current.
Microphones	*Converts pressure variations in sound waves into variations in current in electrical circuits.*	

Fleming's left-hand rule

To predict the direction a straight conductor moves in a magnetic field.

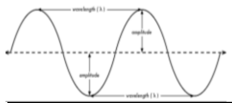
Thumb	Direction of movement.
First finger	Direction of magnetic field.
Second finger	Direction of current.



Induced potential, transformers and National Grid

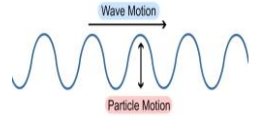
National Grid	*Distributes electricity generated in power stations around UK*

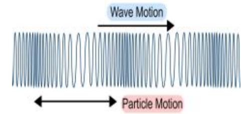
Partners in excellence



Wave speed	Wave speed = frequency X wavelength	V = f X λ
Wave period	Wave period = 1 ÷ frequency	T = 1 ÷ f
Speed	Speed = distance ÷ time	v = d ÷ t

Wavelength	***Distance from one point on a wave to the same point of the next wave***
Amplitude	***The maximum disturbance from its rest position***
Frequency	***Number of waves per second***
Period	***Time taken to produce 1 complete wave***





Transverse wave	***Vibration causing the wave is at right angles to the direction of energy transfer***	Energy is carried outwards by the wave.	Water and light waves, S waves.
Longitudinal wave	***Vibration causing the wave is parallel to the direction of energy transfer***	Energy is carried along the wave.	Sound waves, P waves.

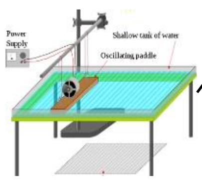
Transverse and Longitudinal waves

Waves in air, fluids and solids

AQA Waves

Properties

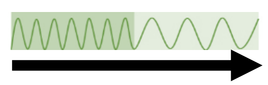
Measuring speed

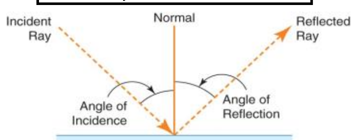


In water, use a ripple tank.

In air, use echoes.

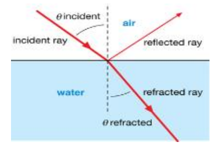
Air Water





Angle of incidence = angle of reflection (i) = (r)

Reflection	Wave bounces off the surface.
Refraction	Waves changes direction at boundary.
Transmitted	Passes through the object.
Absorbed	Passes into but not out of, transfers energy and heats up the object.



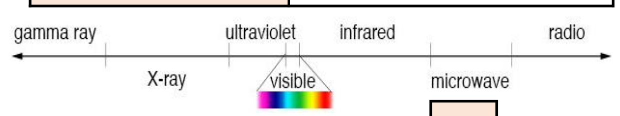
Light refracts as it slows down in a denser substance

Electromagnetic waves

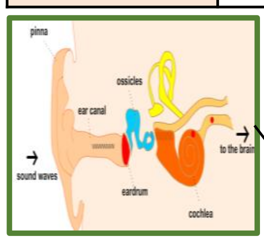
e.g. Gamma

Short wavelengths have high frequency and high energy.

Electromagnetic wave	***Continuous spectrum of transverse waves***



	Units
Distance	***Metres (m)***
Wave speed	***Metres per second (m/s)***
Wavelength	***Metres (m)***
Frequency	***Hertz (Hz)***
Period	***Seconds (s)***

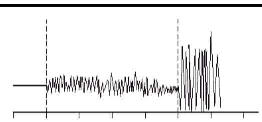


PHYSICS HIGHER ONLY

Hearing	***Frequencies between 20 – 20,000 Hz***	Longitudinal waves cause ear drum to vibrate, amplified by three ossicles which creates pressure in the cochlea.

Absorbed light changes into thermal energy store.

HIGHER: Properties



Black surfaces	***Good emitters, good absorbers***
White surfaces	***Poor emitters, poor absorbers***
Shiny surfaces	***Good reflectors***

EM waves refract

Ultra sound	***Partially reflected off boundary***	Used for medical and foetal scans.
Sonar	***Reflected off objects***	Used to determine depth of objects under the sea.

EM wave	Danger	Use
Radio	Safe.	Communications, TV, radio.
Microwave	Burning if concentrated.	Mobile phones, cooking, satellites.
Infrared		Heating, remote controls, cooking.
Visible	Damage to eyes.	Illumination, photography, fibre optics.
Ultra violet	Sunburn, cancer.	Security marking, disinfecting water.
X-ray	Cell destruction, mutation, cancer.	Broken bones, airport security.
Gamma		Sterilising, detecting and killing cancer.

Low frequency, long wavelength.

White	Wave lengths reflected
Black	Wave lengths absorbed

High frequency, short wavelength