

1.1-6

Motion

Velocity - time have a negative.

$$1 \text{ m}^3 \rightarrow 1\,000\,000 \text{ cm}^3$$

* D-T GRAPHS

Gradient \rightarrow speed
 More steep \rightarrow More speed
 Straight line \rightarrow Constant speed
 Changing speed \rightarrow curved line

$$s \text{ (m/s)} = \frac{D \text{ (m)}}{T \text{ (s)}}$$

if speed is changing this gives the average.

Velocity is speed in a given direction

measured in m/s

* S-T GRAPHS aka Acceleration

Flat line \rightarrow Constant speed
 Steepness \rightarrow Faster acceleration
 Straight line \rightarrow Constant acceleration

Free falling objects

have acceleration of

$$10 \text{ m/s}^2$$

but eventually reach terminal velocity
 increase in drag

$$\frac{v \text{ (m/s)} - u \text{ (m/s)}}{t \text{ (s)}} = a \text{ (m/s}^2\text{)}$$

2

Forces & their effects

$$\text{mass (kg)} \times \text{gfs (N/kg)} = \text{Weight (N)}$$

$$\text{density (kg/m}^3\text{)} = \frac{\text{mass (kg)}}{\text{volume (m}^3\text{)}}$$

$$\text{Resultant Force} = ma$$

* Momentum

$$\text{Momentum (kg m/s)} = \text{mass} \times \text{velocity}$$

$$\text{change in momentum} = \text{Force} \times \text{time}$$

- The longer the impact force time the less the impact force.
- A Collision of 2 objects have equal & opposite forces
- Unchanged momentum
- Different speeds if they have unequal masses
- Total is 0

momentum is the same before & after in impact.

* ~~Great~~ Increase in Temperature causes a gas to have more kinetic energy. This causes more pressure.

* Evaporation from a liquid occurs as a result of molecules with sufficient kinetic energy leaving the liquid

* The Brownian motion is the erratic motion of microscopic particles due to random imp - acts of gas mole - cules on each particle.

- pressure increases as the volume decreases
- pressure decreases as the volume increases.

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Forces in Equilibrium

$$F \times d$$

Moment = force \times perpendicular distance to pivot
(Nm) (N) (m)

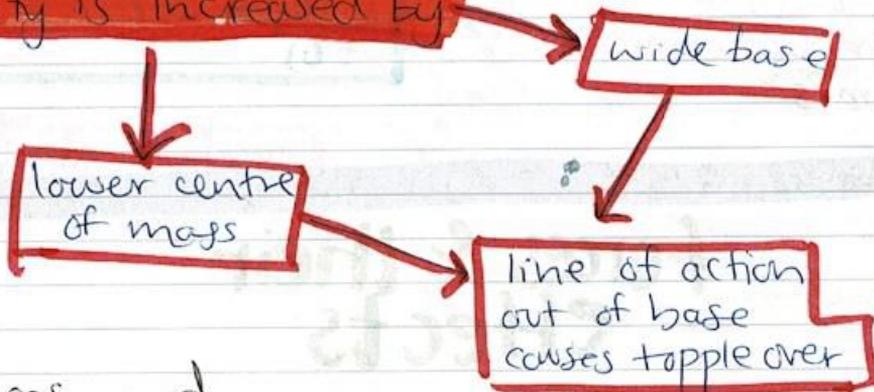
clockwise moments = anticlockwise moments

When an object is in equilibrium there is no resultant force or turning effect on it.

Centre of mass is the point where all the weight of an object acts.

$$W_1 d_1 = W_2 d_2$$

stability is increased by



Vectors and Scalar quantities

Quantities that have a magnitude & direction.
eg \rightarrow velocity

momentum

Energy

Loss in GPE = gain KE

- kinetic
- g.p
- chemical
- electrical
- elastic strain
- nuclear
- Internal
- heat
- sound
- light

energy before = energy after.

energy gets dissipated

$$\frac{\text{useful output}}{\text{the power input}} \times 100\% = \text{efficiency (J)}$$

work done = energy transferred

$$\Delta W = \text{Force} \times \text{distance}$$

(J) (N) (m)

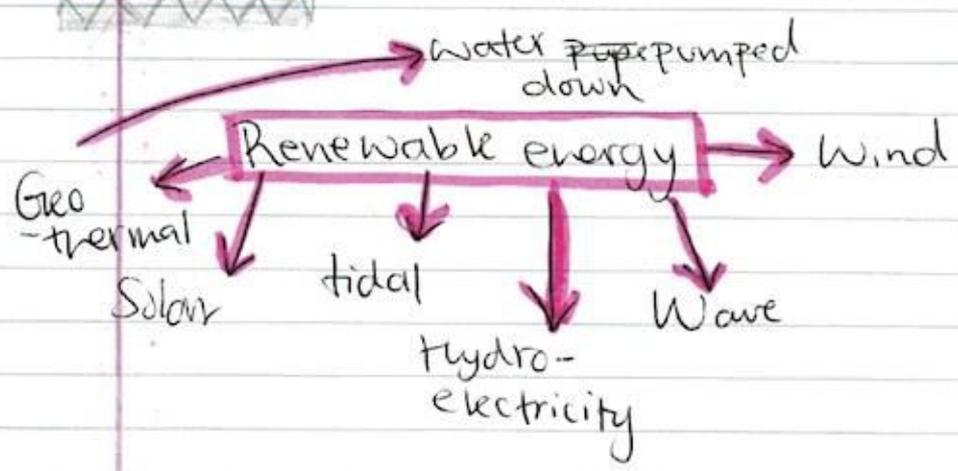
$$g.p. = mgh$$

$$k.e. = \frac{1}{2}mv^2$$

(J) (kg) (m/s)

$$P = \frac{E (J)}{t (s)}$$

(w)



Nuclear energy

Nuclear fission

nuclear fission
 ↓
 nucleus splits
 ↓
 generates energy

Nuclear fusion

↓
 nuclei forced together
 ↓
 heat
 ↓
 then squish

pressure

$$P = \frac{F}{A}$$

(Pa) (N) (m²)

The pressure along a horizontal liquid is constant
Pressure increases with depth.

$$P = h\rho g$$

(m) (N/kg)

in a liquid

Mercury has a density of 13600 kg/m³

mercury barometer

(kg/m³)

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(g/cm³) (g) (cm³)

Solid
liquid
Gas

factors affecting evaporation

- Surface area
- Temperature
- draught of air.

$$\text{Pressure} \times \text{Volume} = \text{constant}$$

* Pressure is force per unit area

$$1 \text{ cm}^2 \rightarrow \frac{0.001 \text{ m}^2}{10000}$$

* A hydraulic system ~~uses~~ uses fluid to exert pressure to exert a force.

Examples:-
- Robots
- Brakes in a car

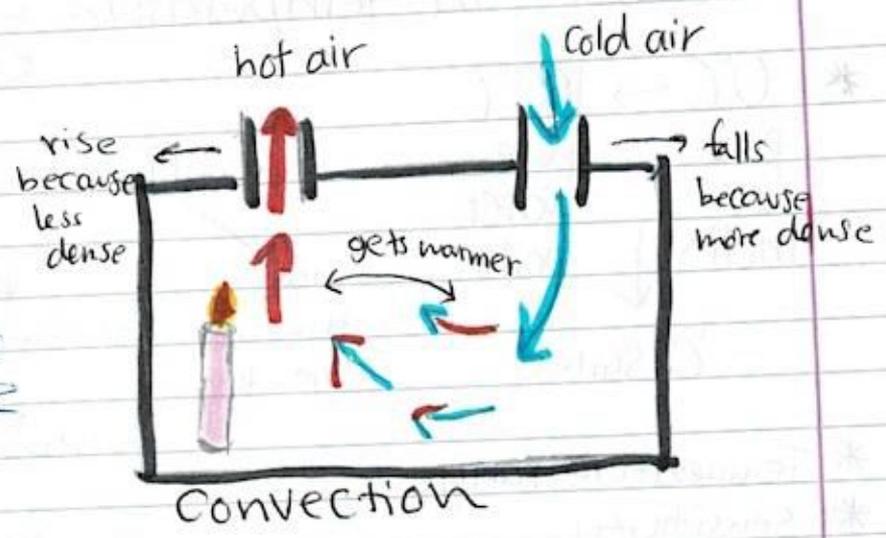
* A U-Tube meter measures gas pressure. The average atmospheric pressure is 101 Pa

Thermal Physics

Conduction

* Fibre glass & wood are good insulators because they contain ~~to~~ trapped air.

* Metals contain free electrons and positive ions. When the electrons become hot they diffuse their heat (kinetic) to the cooler parts.



* Convection is when a liquid or gas is heated. The heated (gas) liquid rises since it becomes less dense. Then it is replaced by cold liquid (gas).

Dull Black surface

- emits better
- absorbs better

White Shiny surface

- poor emitter
- poor absorber.

* Infra-red radiation is the radiation emitted by an object due to its temperature.

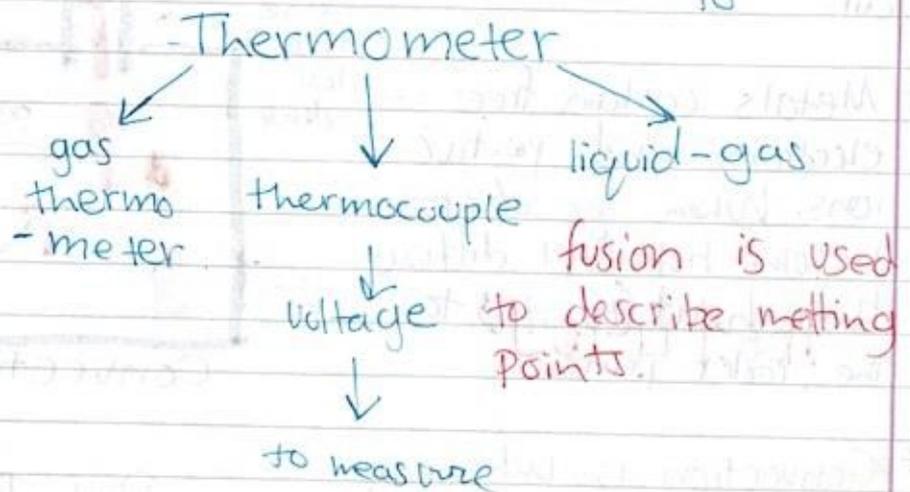
$$E = \sigma T^4$$

6

Thermal Physics

* Thermal expansion is expansion due to increase in temperature
 Expansion Gaps → prevent buckles.
 Steel tyres → easy to

* $0^{\circ}\text{C} \rightarrow 100^{\circ}\text{C}$
 pure ice melts ↓
 pure water boils ↓
 $^{\circ}\text{C}$ Scale



- * Temperature range
- * Sensitivity
- * linearity

- all these determine accuracy & when a thermometer is used.

$$\text{Thermal Capacity} = \frac{\text{energy supplied (J)}}{\text{increase in temperature } (^{\circ}\text{C})}$$

* Thermal Capacity is the energy given to an object to raise it by 1°C

$$C = \frac{E \text{ (J)}}{m(\Delta T) \text{ (kg } (^{\circ}\text{C}))}$$

$T = T_2 - T_1$

* Specific heat capacity of a substance is the energy needed to raise 1kg of a substance by 1°C

$$c = \frac{E \text{ (J)}}{m_2 - m_1 \text{ (kg)}}$$

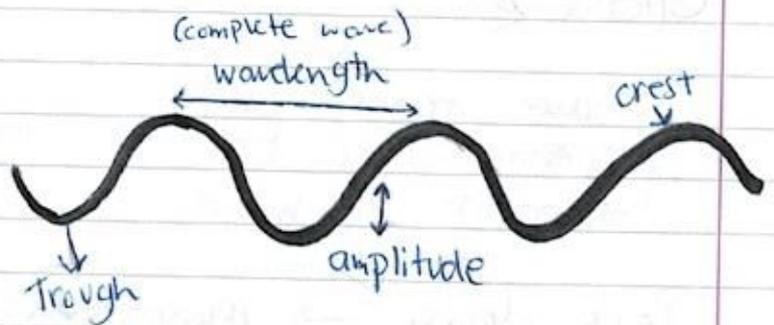
* Latent heat of fusion is the energy molecules use at the melting point to break free of bonds. potential → internal. is the energy needed to melt 1kg of a sub at its melting point. No temp change.

* Latent heat of vaporisation is the energy needed to change 1kg of the sub at its b.p. to a vapour.

* Latent heat gets either released or used to break bonds.

Waves

Waves are repeated disturbances that move along. There are different ways to make waves. On a rope, spring or using a ruler.



* Speed = frequency x wavelength
 $m/s = Hz \times m \quad v = f \lambda$

Plane waves are waves which are straight/parallel to each other & move at the same speed

- Transverse waves are waves that ~~travel~~ vibrate at right angles to the direction of travel of the waves. Light waves → can be polarised and waves on a rope

Diffraction is the spreading of waves when they pass through a gap or pass an object.

- Longitudinal waves vibrate parallel to the direction of travel of the waves. Sound waves and slinky

- narrower → more spreading
- wider → less spreading
- the gap must be similar width to the wave length

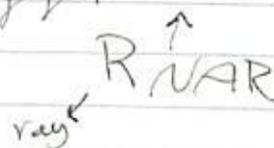
* Refraction of waves gets slower

- Deep to shallow at a non-zero angle they slow down. Shallow to deep closer to boundary

shallow → deep speeds up

- Speed up goes away from normal

faster bigger gaps



Light

Real & apparent depth

Light refracts towards the normal -
 less density $\xrightarrow{\text{speed}}$ more density

- deep to shallow / water
- air to glass
- shallow to deep
- glass to air

Refraction is the change in direction when crossing a boundary between two transparent substances.

Light refracts away from the normal

n.i. = $\frac{\text{Speed of light in air } (kms)}{\text{Speed of light in the substance } (kms)}$

more refraction = slowest in glass

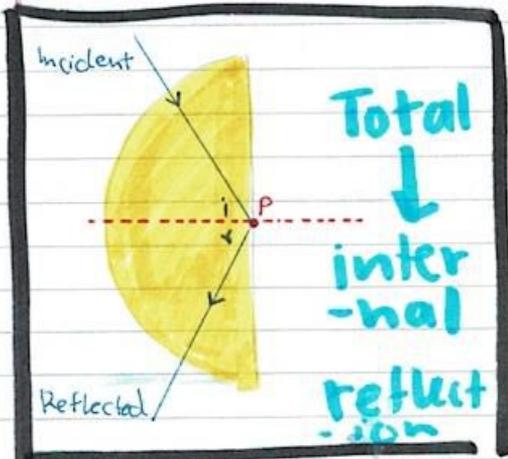
In air 300 000 km/h
 3×10^5 km/h

- Speed of light less \rightarrow more wave causes refraction

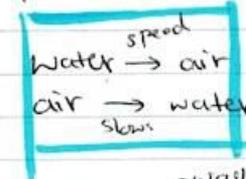
$$\frac{\sin i}{\sin r} \quad \text{more} \rightarrow \frac{r}{i}$$

In glass 200 000 km/h
 2×10^5 km/h

Speed = Frequency \times wavelength
 (m/s) (Hz) (m)



- The image seen in a plane mirror is virtual.



$n = \frac{1}{\sin c}$ \rightarrow angle when ray is in

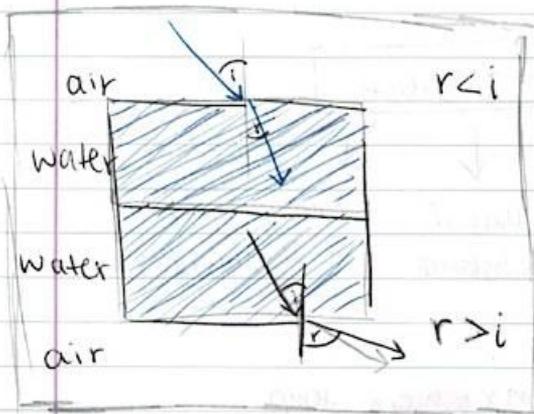
More dense \rightarrow away
 to less \leftarrow towards

- Radio waves
- Microwaves
- infra-red radiation
- light \rightarrow
- ultraviolet radiation
- X-rays
- gamma rays



7 colours Dispersion

more direction change



When the light enters from a rare to denser medium its speed decreases, whereas it is the opposite for sound waves, that the speed for sound increases when it enters from a rare to dense medium

Light $\rightarrow \frac{\sin i}{\sin r} = n$

refractive index

speed of light / speed in medium = n

2 methods to find n.

When the direction of the light is in reverse

$$\frac{\sin i}{\sin r}$$

$$\frac{\sin r}{\sin i}$$

$$f = \frac{v}{\lambda}$$

in vacuum its constant

Principal focal's point where all the light rays meet

P

violet light \rightarrow greatest refractive index and is the slowest

Red light \rightarrow

Smallest refractive index and is the fastest.

focal length is where the distance between the principal focus and the centre of the lens

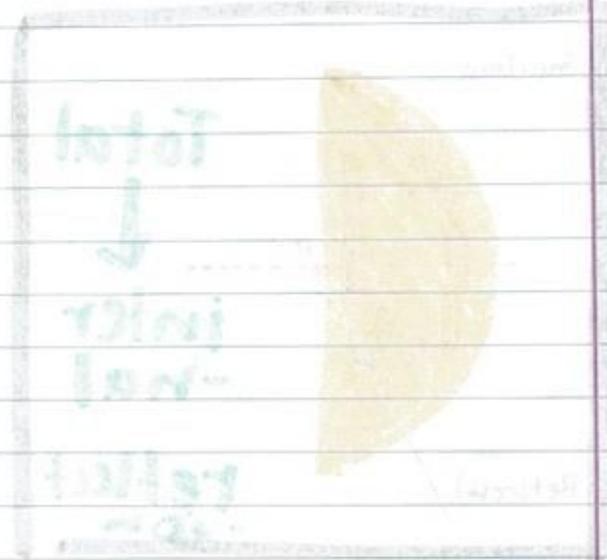
Light

* Focal point is the point where the light rays converge after passing through the converging lens. - a line passing through the centre doesn't change direction.

* If pass through the focal point it goes from:-

parallel → get refracted & goes to focal

goes through focal → gets refracted & becomes parallel.



Revision

waves

* Waves are disturbances that travel along (rope, string...)

- Amplitude
- Wavelength λ
- peak
- Trough
- Hertz

Wave fronts, water waves
Waves on a rope, or on a spring, polarized, unpolarised refracted ray, emergent ray

$$v = f \lambda$$

Speed = frequency \times wavelength
m/s = f \times m

* 1 complete wavelength is \rightarrow (P \leftrightarrow P)

* frequency is num of wavelengths passing a point in 1s. (Hz)

Transverse waves vibrate ~~per~~ perpendiculary

* Wave length distance from 1 p \rightarrow p

- light waves

* Bigger the amplitude more energy it has.

- Electromagnetic

closer together \rightarrow slower waves

Diffraction

* Polaroid filters \rightarrow TV screens, calculator, sunglasses Larger w.l. more Dif

* Aerials \rightarrow detect polarised radio waves.

* Longitudinal waves

vibrate parallel. \rightarrow use a slinky to demo

Refraction & Reflection of WAVES

* higher density slower speed e.g. air \rightarrow glass

Sound waves. compression

pressure

$$p = \frac{F}{A} \text{ or } \text{Pa} = \frac{\text{N}}{\text{m}^2}$$

* is defined as force per unit squared.

* more dense \rightarrow causes to refract towards the normal

- Sharp knives
- bed sores

* pressure can be transmitted through liquids like in a hydraulic system.

* pressure of a liquid increases with depth & is constant along a horizontal line 101 Pa \rightarrow Average atmospheric pressure

$$p = h \rho g \quad \text{pressure} = \text{height} \times \text{density} \times 10 \text{ N/kg}$$

* Temperature saturated, unsaturated

* surface area

* draught of air on surface.

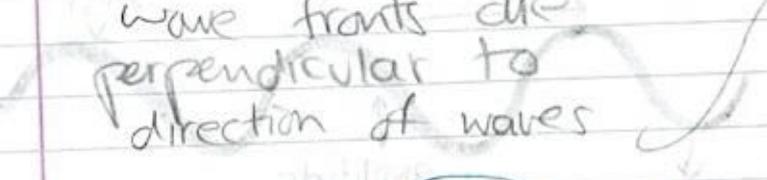
WAVES

Air \rightarrow closer
Glass \leftarrow to normal

wave fronts are perpendicular to direction of waves

refraction

less dense \rightarrow more dense
refracts towards normal



Waves are sound waves that propagate through a medium. They are perpendicular to the direction of travel. When they enter a denser medium, they refract towards the normal.

$$v = f \lambda$$

$$n = \frac{c}{v}$$

Transverse waves are waves that oscillate perpendicular to the direction of travel. They consist of crests and troughs.

Longitudinal waves are waves that oscillate parallel to the direction of travel. They consist of compressions and rarefactions.

The frequency of a wave is the number of cycles that pass a point in one second. It is measured in Hertz (Hz).

The wavelength of a wave is the distance between two consecutive crests or troughs.

The speed of a wave is the distance it travels in one second.

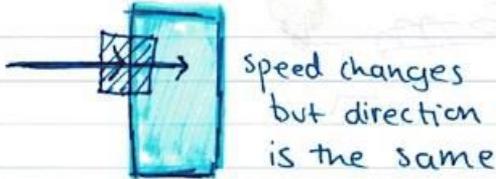
The refractive index of a medium is the ratio of the speed of light in a vacuum to the speed of light in that medium.

WAVES

Air $\xleftrightarrow[\text{increase}]{\text{decreases}}$ glass

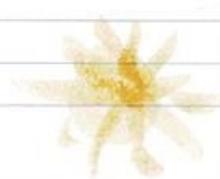
$$v = f \lambda$$

Change in speed of light \rightarrow change in direction of Light



Air $\xrightarrow{\uparrow}$ glass
bends towards normal

Glass $\xrightarrow{\uparrow}$ Air
bends away from normal



9

Sound Waves

Speed of sound in air

→ 340 m/s (always changing)

Long wavelength
→ low frequency

Short wavelength
→ high frequency

Sound waves → by vibrations

$$d = vt \frac{1}{2}$$

Speed of sound in water is around 1400 m/s

→ loudness increases height of amplitude

Speed of sound in most solids is more than 3000 m/s

→ frequency makes more waves appear (per sec)

Sound waves are produced when a vibrating surface pushes and pulls on surrounding substances

↓
Longitudinal waves

↓
rarefactions

↓
compression

magnetism

- like poles repel
- unlike poles attract
- Magnetic lines go from N to S pole.
- Ferrous materials can be magnetised (contains iron). Also cobalt and nickel
- \star Demagnetise by:
 - moving S pole along instead of N
 - alternating current
 - hammering or heating in the absence of a m.f.
- Steel \rightarrow hard
- Iron \rightarrow soft
- Lines of force.
- magnetic fields are the spaces around a magnet.
- magnetic forces are due to interactions between magnetic fields
- a plotting compass can be used to align itself with a line force. It points away from N & towards the S -pole.
- Iron is used in an electromagnet & steel is used to make a permanent magnet

Electric Charge

Coulombs \rightarrow ^{electric} charge \rightarrow 6 mil mil^{mil} \rightarrow 1 coulombs electrons

Perpex rod \rightarrow positively charged

Like repel
unlike attract

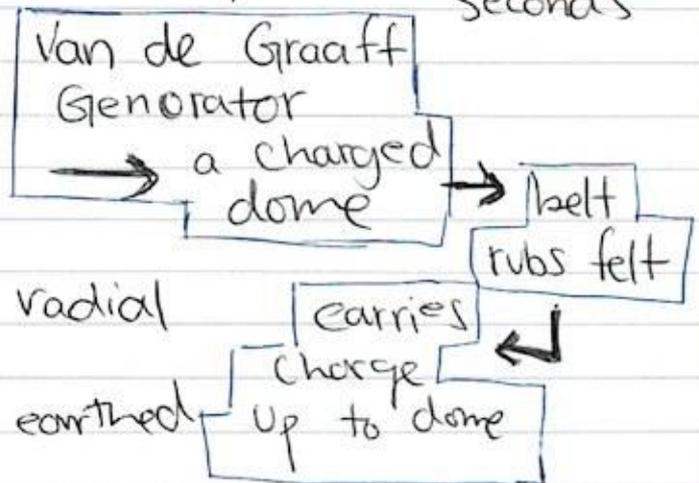
Polythene rod \rightarrow negatively charged

$$Q = It$$

Current = Total charge

Ampere = Coulombs
Seconds

* Ionisation is any process which turns uncharged atoms into ions.



Conductors \rightarrow conductor electrons

Uniform & concentrated fields.

charging by induction

* Metals conduct electricity because they contain conduction electrons. Insulators have electrons which are held in place.

* An electric current is a flow of charge. It is due to a flow of electric charge.

* In Series is when the same amount of charge flows through each circuit component each second.

\Rightarrow Electric measured with charge is an ammeter measured (ampere (A)) in coulombs

from the + terminal to the - terminal

* charge flowing = current \times time
(coulombs) (amps) (s)

$$Q = I \times t$$

Electrical Energy

* a battery consists of electric cells. They take chemical energy and convert it into electrical energy

1 volt = 1 J/C
 = 1 volt = 1 J/C
 = 1 volt = 1 J/C

* Solar cells take light energy and convert it to electrical energy.

$$\text{emf of battery in Volts} = \frac{\text{electrical energy (J)}}{\text{charge in coulombs}}$$

* emf is the push or charge of a battery

$$\text{power (w)} = \frac{\text{energy transformed (J)}}{\text{time taken (s)}}$$

* a series is the components connected back to back

$$I = \frac{V}{R}$$

* a parallel circuit is components connected side by side (in the middle)

* A voltmeter is connected in parallel with a component to measure the Pd across the component

* or how much 'push' can be provided to force change around the circuit. The greater the emf, the more energy the cell can deliver for every electron that passes through it.

$$\text{pd (v)} = \frac{\text{electrical supply (J)}}{\text{charge (coulombs)}}$$

$$\text{emf of the battery} = \text{pd across the lamp} + \text{pd across variable resistor}$$

$$\text{resistance (ohms } \Omega) = \frac{\text{pd (volts)}}{\text{current (amps)}}$$

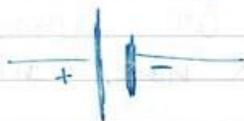
$\frac{P}{I}$

$\frac{P}{I}$

Electrical Circuits

* An Electrical Circuit is a closed loop of wire

having electrical components by a battery



* Series circuits. The current flows through all the components, & is the same through.

* You can find the total resistance by adding the separate ones together.

$$\text{Power} = \text{current} \times \text{pd}$$

* For components in series:

- current is the same in each
- resistances add up to give the total resistance
- pd across each component add to give total pd

* Parallel circuit:

- current from power supply is the sum of the currents in the branches of a parallel circuit.

* Input transducer
→ Sensor circuit

* A fuse protects an appliance & is connected in series. It has a thin wire which melts when too much current passing through it.

* A diode allows current through on direction. (the direction it points)

* The total emf of cells in series acting in the same direction is the sum of the individual emfs of the cells.

* Sensor circuits respond to change in an external change such as temperature.

* A potential divider consists of 2 or more resistors in series & is a resistor that's sensitive to changes.

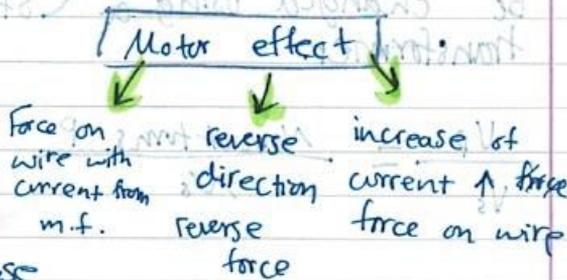
* A potentiometer is a variable potential divider consisting of a resistive metal. Increases ↑ decreases ↓.

* Thermistor is a temp depended resistor. Its resistance ↓ as it get hot

Electromagnetism

* The direction of the field is reversed if the current is reversed.

* Direction of the field is reversed if the current is reversed, & strength increase with current.



1) Uniform magnetic fields inside a solenoid is used for MR brain scanner.

2) Magnetic field outside a solenoid is used for electromagnets.

power = current x voltage

current x voltage = power

- direction is reversed -
if mag field & current are reversed direction of force is unchanged

- Force can be increased by ↑ current using a stronger magnet

- Force is perpendicular → bigger force
Wire is parallel → 0 force

- Direction of force is at a right angle to the wire & field lines.

* Electrons in a beam are pushed sideways when a mag.f. is applied at right angles to it.

* In a simple electric motor a force acts on each side in the opposite direction causing it to turn.

* A practical electric motor has more than 1 coil around an iron core.

* The magnitude of the induced emf is greatest when the plane of the coil is parallel to the direction of the magnetic field. It is 0 when perpendicular.

Faster rotation → greater frequency of a.c.
↓ larger peak value.

* Dangers of Electricity

- Damaged insulation
- Overheating of cables
- Damp conditions

* Electromagnetic Induction

* Fuse → weak point which breaks the circuit when too much current passes through it

* Circuit Breaker → magnetised iron core pulling rocker stopping the flow. Reset with a switch.

* Lenz's Law

the direction of an induced current opposes the change producing it.

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magnets → like repel

↓ unlike attract

attracts
ferromagnetic
materials

domains line up in a
ferromagnetic material ~~to~~
when a magnet is
placed next to it.

Iron → soft
electromagnetics & transformers

Steel → hard
permanent magnets

methods starting is N

- Stroking method →
- Electrical method ↘
direct current
- hammering
- heating
- alternating current



field lines go
from N-pole to
S-pole

P.m. → E.m. ↘

- Compass - scrapyards
- loudspeaker - relay switches
- iron oxide in video tapes

has { leaf moves away so +
+ charge { leaf moves closer so -

* Electric field is
a region in which
an electric charge → coulombs (C)
experiences a force.

Relay uses an electromagnet to turn on dangerous larger currents. ~~Plays 50 Hz AC~~



Diodes only lets current flow in one direction. The direction it points in. Only positive current can pass through it.



A.C is what you get in the lights ~~or~~ laptop

D.C is after a diode removes the negative current



A diode takes an a.c then turns it into d.c. When it goes into an appliance

a transistor. is an electrically powered switch.

Signal is

Digital \rightarrow ~~one~~ on or off

Analogue \rightarrow varies

A logic gate is a circuit containing transistors and other components.

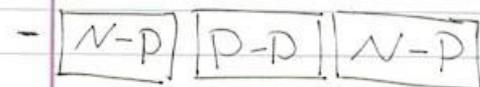


use blocks

OR	AND	NAND	NOR	NOT
if there is a 1 it gives 1	same \rightarrow 1	if they are different they give 1	both 0 gives 1	0 1 1 0

Radioactivity

* Nuclear Force



- acts only inside the nucleus.
- has short range
- Protons don't repel when a Nuclear force is present.

- alpha radiation
- beta radiation
- gamma radiation

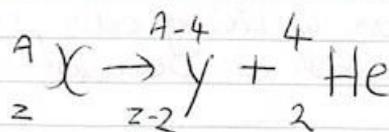
- most of atom mass is in the nucleus

* Proton number is the number of protons in an atom.

* Marie Curie discovered radioactivity. She was awarded 2 Nobel prizes.

* Mass number is ~~the~~ protons & neutrons

* Nucleus is positively charged & is repelled by alpha particles.



* Nuclear reaction release more energy than chemical reactions

* The time it takes to convert half a radioactive element into a different element is called half life.

* Count rate = ~~the~~ s.r. - b.r.

- kept at a safe distance
- separated using a thick lead screen
- in use for shortest time possible
- moved using long tools and put back.

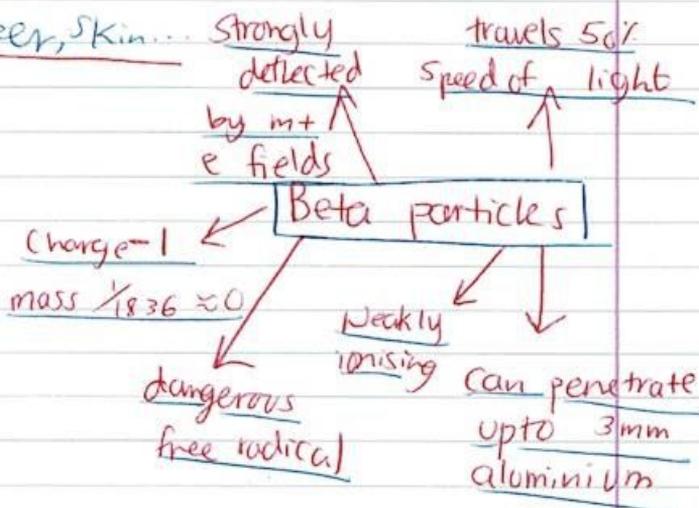
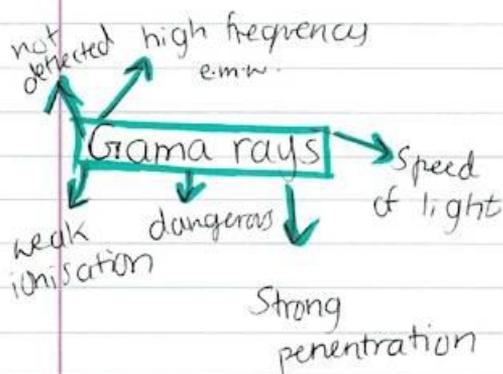
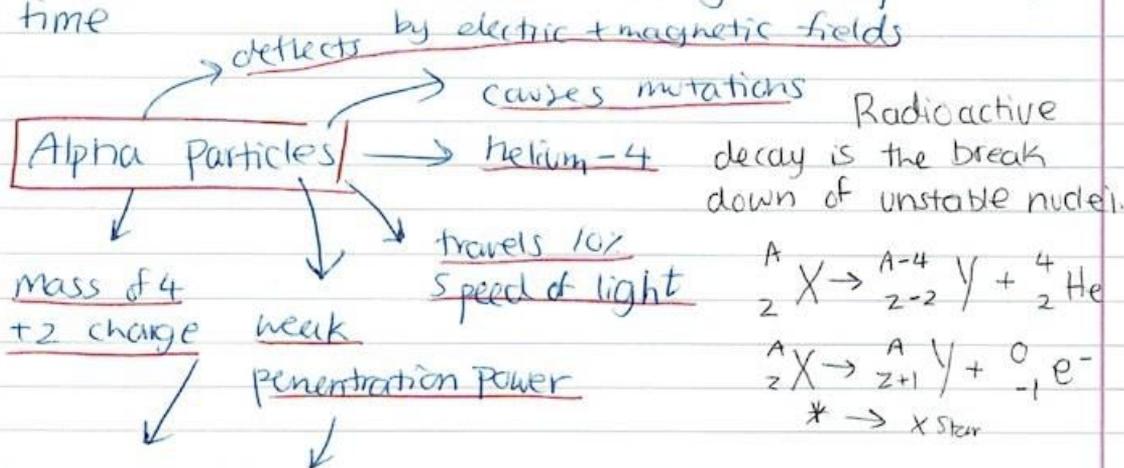
* Activity of a radioactive substance is the number of nuclei that decay per second.

Radioactivity

Revision

* Back ground radiation

* Radioactive emmition occurs randomly over space and time



REVISION TOPICS

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{momentum} = \text{mass} \times \text{velocity}$$

(kg m/s) (kg) (m/s)

$$\text{change in momentum (Ns)} \\ = \text{force} \times \text{time}$$

(N) (s)

$$\text{Work done} = \text{energy}$$

$$\text{Work done} = \text{Force} \times \text{distance}$$

(J) (N) (m)

$$\text{gravitational potential} =$$

$$\text{mass} \times g \cdot \frac{1}{2} \cdot \text{height}$$

(kg) ~~height~~ (m)

$$\text{Kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{velocity}^2$$

Terminal velocity is when an object

falling ~~10 m/s~~

reaches a steady state where drag & weight are equal.

Conservation of

* 2 colliding objects exert have equal & opposite forces acting on each other.

* Increase in impact time causes decrease in impact force.

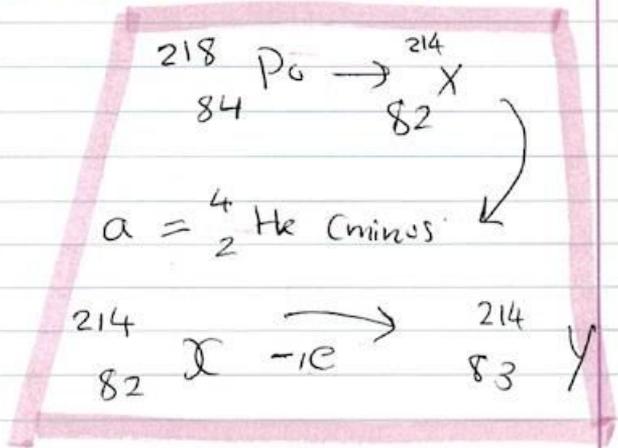
Momentum

$$p = \frac{E}{t}$$

Test Questions revision

* Convection can happen in the surrounding air
aluminium

* Iron & steel can retain their magnetism while iron cannot.



Physics formulas

$$s = \frac{d}{t} \quad a = \frac{v-u}{t} \quad d = \frac{m}{V} \quad \frac{g}{\text{cm}^3} = 9/\text{cm}^3$$

$$W = m \times g \quad F = kx \quad \rho = \frac{m \times v}{\text{kg} \times \text{m/s}}$$

$$N = \text{kg} \times \text{N/kg} \quad F = ma$$

$$\frac{mv - mV}{t} = \leftarrow N = \text{kg} \times \text{m/s}^2 \quad \text{101kPa}$$

$$\text{moment} = f \times \text{distance} \quad W = f \times d \quad G_{\text{ipe}} = mgh$$

$$\text{Nm} = \text{N} \times \text{m} \quad J = \text{N} \times \text{m} \quad \text{kg} \times 10 \times \text{m}$$

$$K_e = \frac{1}{2}mv^2 \quad p = \frac{E}{t} \rightarrow W = \frac{J}{s} \quad p = \frac{F}{A}$$

$$t_c = \frac{E}{t} \quad J/K = \frac{J}{^\circ\text{C}} \quad \rho_a = \frac{N}{\text{m}^2}$$

$$t_e = \frac{E}{m(\Delta T)} \quad v = f \lambda \quad p = \text{hg} \rho$$

density

Precautions

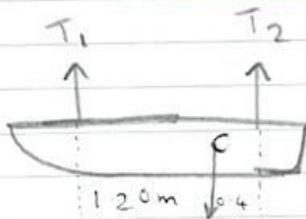
Stir before reading
Keep Thermometer at the same level
Set eye to same level
wait till reading stops rising.
position clock so thermometer can easily be seen

Use insulation.
all water in tube below level in beaker.
Same starting temperatures

Readings are always perpendicular to the scale.

$$P_1 \times V_1 = P_2 \times V_2$$

Light/Visible radiation



← heat gain

gas liquid solid

→ heat release

Saturated, unsaturated

boiling & evaporation

energy

- draught of air
- surface area
- temperature

* $P \times \text{Volume} = \text{constant}$

* Density & Gas

thermal expansion

EXPANSION GAP

Transformer → soft iron core

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

only for alternating current

alternating input emf

$$\text{Power} = V_p I_p = V_s I_s$$

Provides protection changes to a circuit

100% efficient transformer

- * Step-down transformer has more coils on the primary coil
- * Step-up transformer has more coils on the secondary coil
- * Low current and high voltage reduces energy lost as heat.

magnetic field → distance reduces strength around a current

reversing current

reverses magnetic field

more current gives more strength