forces & motion

average speed (m/s) = $\frac{\text{Distance}}{\text{Time}}$

acceleration (m/s^2) = $\frac{\text{change in velocity}}{\text{Time taken}}$

final speed^2 = initial speed + (2 x acceleration x distance)

$v^2 = u^2 + (2 \times a \times d)$

object moving in a circular path :-

$\text{Speed} = \frac{2\pi r}{\text{Time}}$

to find unbalanced force :-

$f = m \times a$

weight → weight = mass x gravitational field strength

stopping distance = breaking distance + thinking distance

factors affecting

braking
- road conditions
- tire conditions
- Brake conditions
- speed of car
- mass of car

thinking
- Alcohol
- Tiredness
- speed of car
- Drugs

* weight & drag are directly proportional to velocity.

* termal velocity is reached when a falling object has a balanced force.

* Hook's law ⟶ force = spring constant x extention
  - force is directly proportional to the extension.

Elastic deformation:-
when an object under effect of a force changes it's shape then turn to it's original shape after force is done.

momentum = Mass x velocity

- seat belts:- increases time taken to stop reducing the force on the body
- Crumple zone:- increases time for car's momentum to reach 0
- Air bag:- increasing the time till momentum of a body reaches zero reduces the force felt

* momentum before = momentum after

* force = $\frac{\text{change in momentum}}{\text{time taken}}$

* if object A exerts a force on object B exerts an equal and opposit force on object A

* moment ⟶ moment = force x distance from the pivot

principles of moment :-
the sum of clockwise moment is equal to the sum of anticlockwise moment (in equilibrium)

Electricity

fuse:-
Stops the current by melting the wires if the current is too high

circuit breaker:-
Breaks the circuit if the current is too high.

insulation & double insulation:-
prevents people from touching exposed wires & getting an electric shock.

Earth connection:-
provides low resistance path to the earth where fuse is then broken so circuit switches off.

* why does a current in a ressistor results in the electrical transfer of energy and an increase in temprature, and how this can be used in a variety of domestic contexts.

electricity in metals, is caused by a flow of electrons.
As electrons pass through the metal, they collide with ions: the ions resist the flow of the electrons.
as electrons flow through the metal, they collide with ions, making them vibrate more, while they collide they lose some energy to the ions causing it to vibrate more so the metal heats up.
this is used in electric heaters, ovens, ~~kettles~~ kettels & old fashioned light bulbs.

power → it is the rate of energy transfere

power = current x voltage

Energy transferred = current x voltage x time

* Alternating current (a.c):-
current that continously changes direction around the current

* Direct current (d.c):-
A current that goes in a constant direction (posetive to negative).

Series Circuits:-
- Everything connected in 1 line
- voltage shared out
- current stays the same

parallel Circuits:-
- separately connected components
- voltage stays the same
- current is shared out

in resistors → as you increase the resistance the current will decrease

to increase resistance → adding more components or ones with higher resistance

to decrease resistance → remove components or ones with lower resistance

LDR resistor:- it's a light dependent resistor.
as light intensity increases the resistance decreases

thermistor:- it's a temprature dependent resistor,
as :temprature increases :. resistance decreases

Voltage = Current x Resistance
$V = IR$

* current is the flow of charge in a circuit

charge = current x time
$Q = IT$

voltage ⟶ it is the energy Transferred per unit charge

V (J/C)

★ At a junction, current splits to take both paths & comes back together when path meets again.

★ voltage across 2 components connected in parrale! is the same.

in series circuit, measure:-

Voltage → $VT = V1 + V2$

Current → $IT = I1 = I2$

resistance → $RT = R1 + R2$

Energy transferred = Charge x voltage

$E = QV$

Conductors:-

allows charge (electrons) to flow through it

insulators:-

has no free charge & doesnt allow the flow of charge through it

* **Danger of fueling an aircraft!.**

fuel has to be pumped with high rate causing friction between the fuel & the pipe, causing fuel to gain charge so there is a risk of causing fire

Waves

Transverse
* vibrations are perpendicular to energy transfer
- EM waves

longitudinal
* vibrations are parallel to energy transfer
- sound waves

* waves transfer energy without moving matter.

(m/s) (Hz) (m)

wave speed = frequency X wavelength

$V = f \times \lambda$

$$\text{frequency} = \frac{1}{\text{Time}}$$

☆ The doppler effect:-
- when a source of wave is moving, the wave might be squashed or streched
- wavelength decreases ⇒ frequency & pitch increases
- wavelength increases ⇒ frequency & pitch decreases.

Electromagnetic waves:-
are transverse waves
transfer energy
travel in the same speed of light
Can be reflected & refracted.

Radio wave
micro wave
infrared
Visible light
ultra violet
X-Ray
Gamma

↓ frequency increases
wavelength decreases

frequency increases
wavelength decreases

↓ Red
orange
yellow
green
blue
indigo
violet

Radio waves → Communication & broadcasting
micro waves → cooking & satellite transmissions
infrared → heaters & night vision equipment
Visible light → optical fibers & photography
ultra violet → fluorescent lamps
X-Rays → observing internal structures of objects
gamma rays → sterelising food & medical equipment

angle of incidence = angle of reflection.

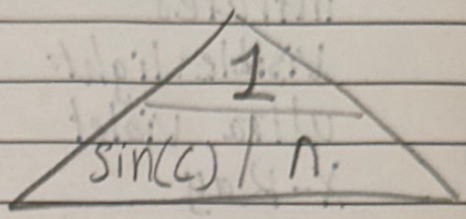
Snell's law → refractive index = $\frac{\sin(i)}{\sin(r)}$

★ Total internal reflection is used in optical fibers

★ when the angle of incidence is greater than the critical angle, total internal reflection.

$$\sin(c) = \frac{1}{n}$$

$$n = \frac{1}{\sin(c)}$$



Energy resources & transfer

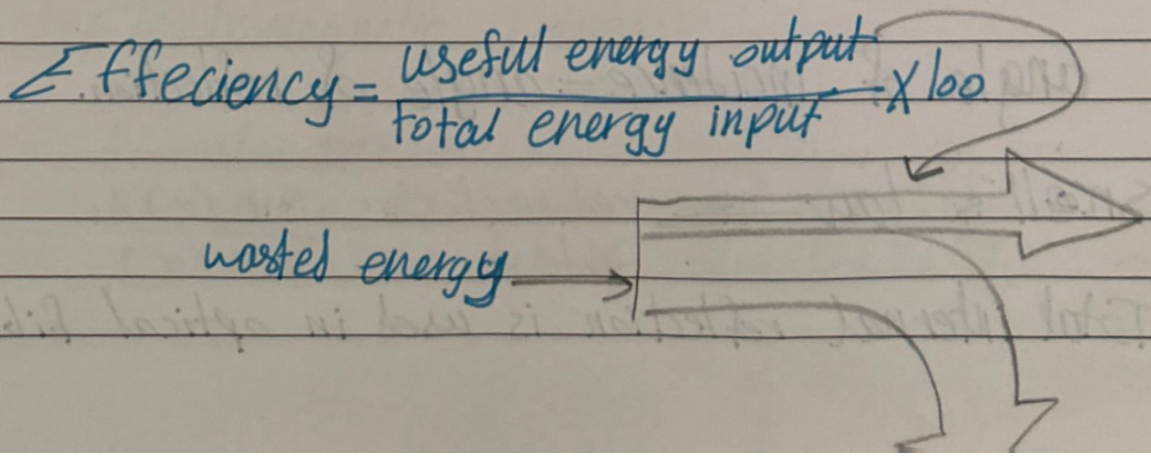
Energy transfer :-

Kinetic → energy of moving object
gravitational → ↑energy when lifted up, ↓ energy when falls
Elastic → streches spring
Electrostatic → force of attraction & repulsion
magnetic → forces of attraction & repulsion
chemical → energy contained chemical substances
Thermal → energy due temprature
Nuclear → energy within the nucleus of an atom.

Principles of Conservation of energy :-

- Energy can't be created or destroyed.
- Energy moves from 1 store to another.

$$\text{Effeciency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$



Conduction :-

Solid is heated, atoms starts to move around & vibrate & collide with each other transferring energy from atom to atom.

Convection :-

while heating, molecules push each other & expand due to less density in hot liquid / gas where it rises up & the cooler fluid sinks down where it's more dense & gets heated as well, and so on.... , this is called a convection current.

Radiation :-

hot objects gives off thermal energy, where the hotter they are, the more they emit.
black colour is a good emitter so as dull surfaces

insulators are used to reduce unwanted energy, where :-

Most insulators contains trapped air where air is a very bad conductor & it's trapped preventing is from making a convection current

work done = force x distance moved

work done = Energy transfer

gravitational potential Energy = mass x gravity x height

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

★ A falling object (in the absence of air resistance) ⟶ GPE is transfered into KE.
Before the object hits the ground it will equal the GPE that it loses

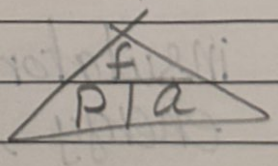
★ power is the transfer of energy per second, or the rate.

- power = $\frac{\text{work done}}{\text{Time taken}}$

solid, liquid & gases

Density = $\frac{\text{mass}}{\text{Volume}}$

pressure = $\frac{\text{force}}{\text{area}}$



★ pressure in liquid acts equally in all directions as long as the liquid is not moving.

pressure = height x density x gravity

Solids:
- Tightly packed
- Held in fixed pattern

liquids:
- Tightly packed
- can slide over each other

gases:
- very spread out.
- moves with rapid, random motion

specific heat capacity → the energy required to change the temprature of an object by 1 degree per kilograms of mass

↓

change in thermal energy = mass x specific heat capacity x change in temprature.

$\Delta Q = m \times C \times \Delta T$

IN GAS → particles have kinetic energy where they move in random direction they collide with other particles and the edges of the containers so there is force exerted on the container (pressure)

At absolute 0 c° the particles have no thermal energy, so they cannot move, and therefore cannot exert a forces

$1\,K = (K + 273)\,C^{\circ}$

* Temprature is directly proportional to kinetic energy.

$$\frac{\text{initial pressure}}{\text{initial temprature}} = \frac{\text{final pressure}}{\text{final temprature}}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

use at fixed mass and constant volume of (gas) !!!

initial pressure x initial volume = final pressure x final volume

$$P_1 V_1 = P_2 V_2$$

use at fixed mass and constant temprature of gas !!!

temprature is ~~inversly~~ directly proportional to pressure.

Magnetism & electromagnetism

like charges repel : unlike charges attract

magnetically hard substance :-
they are permanent magnets that are hard to gain or lose its magnetism.

magnetically soft substance :-
they are temporary magnets. ~~that~~ are easy to lose or gain its magnetism

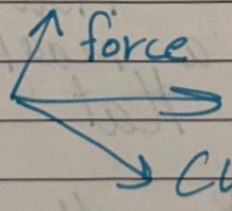
* ~~induced~~ induced magnets happens when a magnetic material is placed ~~in the~~ a magnetic field.
  - when a magnet is induced, one end of the material becomes north pole & south pole
  - iron, steel, nickle & cobalt are magnetic material

* when a current flows through a conducting wire, a magnetic field is produced around that wire
  - direction of the current can be known by right hand rule.

to increase the magnetic field in an electromagnet:-
- Coil the wire into a solenoid
- place an iron core inside the solenoid
- increase current
- increase no. of coils around the core
- Change direction of magnetic field

when a current is placed in a magnetic field, it excerts a force on a particle
- if particles is travelling perpendicular to the field lines it will experience the maximum force
- if particles is travelling parralled to the field line it wont experience a force

* The Motor effect occurs when a current-carrying wire is placed in a magnetic field and a force is exerted on the particles as the two magnetic field interact



D.C Motors:-

- in a d.c motor, a coil is placed in a uniform magnetic field.
- A force is exerted on the coil as the two magnetic field interact.
- as the current flows in opposite directions on side of the coil will experiences an upward force and one side will experience a downwards force.
- The split ring metal swaps the contacts of the coil and reverses the direction of the current, this switches the direction of the force so the coil keeps rotating.

to increase speed:-
- increase current
- increase strength of magnetic field

to chang rotation direction
- change Direction of the current
- switch poles of the magnet

to increase force:-
- increase current
- increase strength of magnetic field.
- adding more turns on the coil.

* when a conductor such as the wire is moved throug a magnetic field, it cuts through & induces a voltage.

induced voltage & current are affected by:-
- strength of magnetic field
- speed of the wire's movement
- no. of turns in the coil

Transformers

* A transformer is made from 2 separate coils around an iron core.

* the primary coil is connected to an A.C (because there needs to be a changing magnetic field to induce a potential difference).

* As the current flows through the primary coil it creates a changing magnetic field.

- the magnetic field is transmitted across the iron core & passes through the secondary coil, inducing a potential difference.
- the iron core increases the strength of the magnetic field.

* if the primary & the secondary coil have the same no. of turns, the potential difference will be the same in both coils (If it's 100% efficient)

step up transformer:-
- increase voltage
- reduce current
- decrease energy
- less volume needed.

* if the secondary coil has more turns than the primary coil, the potential difference at the secondary coil will be greater than the primary coil
  - this is a step up transformer where the potential difference increases.

* if the primary coil has more turns than the secondary coil, the potential difference will be greater at the primary coil.
  - treats a step down transformer where the potential difference decreases.

THE USE OF STEP UP & STEP DOWN TRANSFORMERS

- when electricity is transmitted over long distances, the current causes the wire to heat up & lose heat, so energy is lost

- step-up transformers are placed after the power station so there is a low current & high voltage so less energy is lost as heat

- step-down transformers are placed before buildings because voltage needs to be low for domestic use

$$\frac{\text{Primary Voltage}}{\text{secondary Voltage.}} = \frac{\text{No. of primary Coils}}{\text{No. of secondary Coils.}}$$

Input & ~~Voltage~~ output Voltages $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

Primary voltage X
primary current

= secondary voltage X
secondary current

input power ← output power

$V_p I_p = V_S I_S$

Radioactivity

* Isotopes are unstable due to the size or number of protons & neutrons are unbalanced
- these isotopes will decay - emitting little radiation in order to reduce size or stabillize.

alpha particles → helium nuclei

Beta particles → fast moving electrons

gamma rays → waves of electromagnetic radiation releases by the nucleus

- these radiation particles can knock out electrons of other atoms, ionising them.
- ionisation causes atoms to become ions & can cause chemical changes in materials and can damage or kill living cells..

* any form of radiation that has the ability to remove electrons from atoms & molecules.

☆ Radiation → the energy radiated or transmitted through space in the form of rays, waves, or particles.

alpha:	Beta:-	gamma:-
- high ionising power	- medium ionising power	- weak ionising power
- Stopped by a paper	- stopped by aluminium sheet	- stopped by few mm of lead.

to investigate the penetrating power of radiations:-

- Detect using a geiger muller Tube connected to a counter
- Try different materials absorbers in order (paper, aluminium, lead).
- Repeat 3 times & take an average where count rate will significally decrease if radiation is stopped.

SAFETY:-

- keep source in lead lined container when not used.
- keep a distance when used.
- keep source away from you when handling.

(a) Alpha:- X^{-4}_{-2}

(β-) Beta:- X^{0}_{+1}

(γ) Gamma:- X^{0}_{0}

Geiger-Muller tube:-

electrons in gas particles is knocked out, is attracted to tube, forms ion pairs and creates current.

Background radiation:- it's the radiation that's always present around us such as

Radon gas
Rocks & building material
medical (X-rays)
food
Cosmic rays

↓ most to least.

* Activity of radioactive sources decreases over time.
* Activity of that isotope will also decrease over time.

Half life:- is the time taken for the isotope to drop to half of it's initial value

uses of radioactivity in industry:-

Alpha → *smoke detectors
- when smoke enters the detector, the alpha particles are absorbed and the current no longer flows - triggering the alarm

Beta → * measuring the thickness & material
- if the material gets thicker more particles will be absorbed, meaning that less will get through

gamma → * sterilising equipments
- kills bacteria on the equipments.

IRRADIATION:-
- Exposing a material to alpha, beta & gamma radiation, will not make that material radioactive.

CONTAMINATION:-
- Small amount of radioactive isotope leaked onto the material, contaminated parts of Isotope will give off radiation.

Health dangers:-
- Causes mutation
- Causes cell to become cancerous
- kills cells

Nuclear wastes:-
- very radioactive → needs thick shielding.
- long half-life → needs to be stored for long time

to reduce the risk.....
- use containers that must not corrode or degrade over time which could allow leaks
- store away from the danger of earth quackes
- Keep away from water to prevent contamination.

* the nucleus requires energy given by hitting the nucleus with a neutron, where it releases 2 daughter nuclei & 2 or 3 neutrons

✱ Chain reactions:-

when fission requires a neutron to start it but releases 2 or 3 neutrons. These neutrons can go on to create further fissions known as chain reactions

- Control rods (silver or boron):
- it absorbs neutrons to reduce number of fissions and prevents chain reactions.

- moderator:-
- Absorbs fast neutrons
- slows down neutrons to prevent them from being absorbed by uradium 238 to allow them to create further fission.

- shield:-
- prevents the radiation that's released during fission from leaving the reactor because it is hazardous

✱ fusion is the energy source for stars.
✱ fusion requires high temprature & high pressure ~~because~~ due to electrostatic repulsion of protons
— protons normally reped because they have same charge where ↑ temprature is needed to increase collisions between protons to overcome repulsion so as pressure so fusion happens.

Astrophysics

- universe is a large collection of billion of galaxies.
- galaxy is a large collection of billion of stars.
- Solar system is in the milky way.

* the larger the mass the stronger the gravitational field lenght.

* planets with large radius has weak gravitational strength : as it's surface is far away from the centre of the planet.

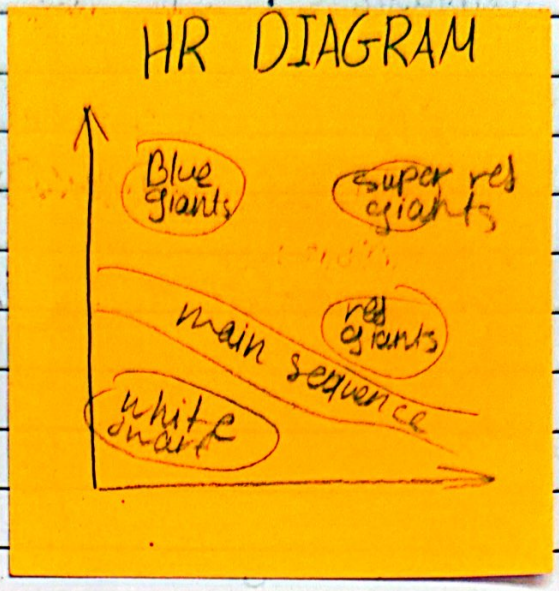
- ~~orbits~~ comets → * Are extremly elliptical
  - as it approches the sun it's speed increases but as it moves away it's speed decreases.
- moon → orbits planet in a circular path
- planets → * slightly elliptical
  - they have different orbital radius & orbital speed & orbits at different times.

* the further the planet from the sun the slower it goes.

* orbital speed = $\frac{2\pi \times \text{orbital radius}}{\text{Time period}}$

hottest to lowest

Blue
Blue-white
white
yellow white
yellow
orange
red



The Big Bang theory :-
the universe began as hot, dense & infinitely small points called singularity. this singularity began to rapidly expand & cool down forming the universe.

$\frac{\text{Change in wavelength}}{\text{reference wavelength}} = \frac{\text{velocity of a galaxy}}{\text{speed of light}}$

* As evidence of the big bang theory is the red shift where it ~~using mice~~ looks as if the galaxy is expanting ~~& where~~ it seems as it's moving away in all directions.

stages of a star

1 * Nebula :- large cloud of dust & particles of gas

2 * protostar :- gravity pulls dust and gas together to form protostar.

3 * main sequence (sun) :- outward pressure caused by nuclear fusion expands the star pushing everything inward

4 * Red giant :- when hydrogen runs out, the main sequence swells and forms to a red giant.

5 * white dwarf :- red giant becomes unstable & ejects it's outer layer of dust & gas leaving behind hot, dense solid core (white dwarf)

6 * black dwarf :- white dwarf cools down because it emits less energy & turns to black dwarf.

7 * super red giant :- undergoes more fusion & turns to super red giant.

8 * Super nova :- super red giant explodes forming super nova.

9 * neutron star :- super nova explodes leaving very dense core.

10 * Black hole :- if the star is massive enough it turns to black hole

How does the transformer works?
the primary coil is connected to the alternative current source. the alternative current has an alternating magnetic field.
The alternating magnetic field interacts with the secondary coil causing voltage and current to be induced in secondary coil.

$$\frac{V_P}{V_S} = \frac{N_P}{N_S}$$