① Measurements

* **Physics :**
Study of natural world from Solar system to atom. Study of matter & energy ; general physics, thermal physics, light, waves, sound, electricity & magnetism.

* **Physical quantity:**
Quantity that can be measured. It consists of a numerical magnitude & a unit.

* **Base quantity:**
Quantity which is distinct in nature & cant be defined by other quantities eg length, mass, time, electric current, temperature & luminous intensity, amount of substance.

* **Derived quantity:**
Quantity that is derived from base quantity eg speed from length & time.

* **Standard form:**
1×10^{x}

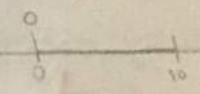
* **Prefixes :**

i) giga (G) : 10^{9}	vii) milli (m) : 10^{-3}
ii) mega (M) : 10^{6}	viii) micro (μ) : 10^{-6}
iii) kilo (k) : 10^{3}	viii) nano (n) : 10^{9}
iv) deci (d) : 10^{-1}	
v) centi (c) : 10^{-2}	

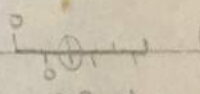
* **Precision:**
Smallest unit an instrument can measure. Eg 0.1 mm.

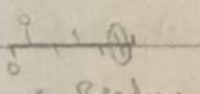
* **Parallax error :**
Error caused by viewing object from a different angle due to wrong positioning of eye.

* **Vernier calipers :**
= Upper scale + Lower Scale



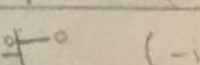
Precision : 0.1 mm

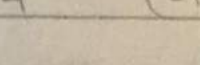




* **Micrometer screw gauge :**
= Main scale + Thimble scale (x0.01)

Precision : 0.01 mm





(Subtract both from main reading)

* **Oscillation:**
Each complete to-&-fro motion.

* **Period of simple pendulum :**
Time taken for one complete oscillation. It depends on pendulum's length.

* **Human reaction time :**
Time taken for a human to react i.e 0.3s - 0.5s.

② Kinematics

★ Scalar quantity:
Quantity that has magnitude only.
Eg Distance, speed, mass, time, energy.

★ Vector quantity:
Quantity that has magnitude & direction.
Eg Displacement, velocity, force, acceleration.

★ Distance:
Total length covered by moving object regardless of direction.

★ Displacement:
Distance measured in a straight line in a specified direction.

★ Speed:
Distance covered per unit time.
SI unit: $m\,s^{-1}$.

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}} \quad / \quad v = \frac{d}{t}$$

★ Average speed:
Total distance travelled in total time taken.

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

★ Velocity:
Rate of change of displacement.
SI unit: $m\,s^{-1}$.

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}} \quad / \quad v = \frac{d}{t}$$

★ Average velocity:
Total displacement in total time taken.

$$\text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time taken}}$$

★ Acceleration:
Rate of change of velocity.
SI unit: $m\,s^{-2}$.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}}$$

★ Deceleration:
Also known as retardation, is reduction in velocity.

★ Uniform acceleration:
Constant rate of change of velocity.

$$a = \frac{v - u}{t_v - t_u}$$

- v = final velocity in $m\,s^{-1}$
- u = Initial velocity in $m\,s^{-1}$
- t_v = Time at final velocity in s
- t_u = Time at initial velocity in s

★ Non-uniform acceleration:
Not same rate of change of velocity.

★ Displacement-time graph:
The gradient of this graph gives the velocity of object.

★ Velocity-time graph:
The gradient of this graph gives acceleration of object & area under

it gives displacement.

* Acceleration due to gravity:
Gravitational pull by Earth to objects near surface;
10 $m s^{-2}$ or 10 N/kg

* Air resistance:
A frictional force that opposes the motion of moving objects. It increases with the speed of object or size of object. It also increases with density of air.

* Terminal velocity:
When air resistance against an object = its weight. Object travel at constant speed with zero acceleration.

* Instantaneous speed:
Speed of an object at a particular moment.

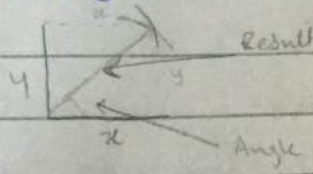
③ Forces

* Force;
A force is a push or pull. Its a vector quantity. It can produce, slow down, speed up or stop motion
SI unit: newton (N)

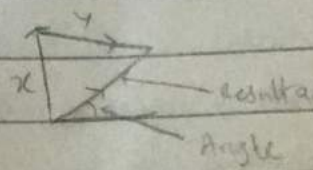
- Types of forces:
i) Contact forces:
a) Normal reaction, push exerted on surface by object.
b) Friction, opposes or tends to oppose motion between surfaces in contact.
c) Tension, pull exerted by stretched spring to object attached to it.
ii) Non-contact forces:
a) Gravitational force, pull exerted by Earth on an object.
b) Electric force, attractive or repulsive forces between electric charges.
c) Magnetic force, attractive or repulsive force between magnets.

* Resultant vector:
Combination of two or more vectors (single) in terms of magnitude & direction.

* Adding non-parallel vectors;
- Parallelogram:



- Tip-to-Tail:



* Newton's Laws of motion;

- 1st:

States that every object will continue its state of rest or uniform motion in a straight line unless a resultant force acts on it.

- 2nd:

States that when a resultant force acts on an object of a constant mass, the object will accelerate in the direction of the resultant force.

$$F = ma$$

- F = Resultant force in N.
- m = Mass in kg.
- a = Acceleration in ms^{-2}.

- 3rd:

For every action, there's an equal but opposite reaction. It acts on mutually opposite bodies.

* Friction;

A contact force that opposes or tends to oppose motion between surfaces in contact.

- Positive effects:

i) We don't slip.

ii) Vehicles slow down when needed.

- Enhancing positive effects:

i) Treads in tires.

ii) Use of chalk to increase grip.

iii) Use of parachute for greater surface area.

- Negative effects:

i) Cars efficiency decrease by 20%.

ii) Machines may suffer wear & tear.

- Reducing negative effects:

i) Using circular shaped objects.

ii) Ball bearings in machinery for reducing contact.

iii) Polishing surfaces or using lubricants.

iv) Air cushions.

(4) Mass, Weight & Density

* Mass:

Amount of matter in a body. Its a scaler quantity measured with beam balance or electronic balance.

SI unit: kilogram (kg)

* Weight:

A gravitational force. Its a vector quantity measured with spring balance.

SI unit: newton (N).

* Gravitational field:

A region where a mass experiences a force due to gravitational attraction.

* Gravitational field strength:
Gravitational force acting per unit mass.

$W = mg$

- W = weight in N
- m = mass in kg
- g = gravitational field strength in $N\ kg^{-1}$. Earth's gfs is 10 N/kg.

* Inertia:
Reluctance of an object to change its state of rest or motion due to its mass. Greater the mass, greater the inertia.

* Density:
Defined as mass per unit volume.

SI unit: kilogram per cubic metre ($kg\ m^{-3}$)

Substances that float on liquid have lower density than liquid but substances that sink have higher densities.

$\rho = \frac{m}{V}$

- ρ = density.
- m = mass
- V = volume.

⑤ Turning Effect of Forces

* Moment of force:
Also know as torque, is the product of force & perpendicular distance from pivot to where the force applied. Its a vector quantity.
SI unit: newton metre (Nm)

Moment of force = $f \times d$

- f = Force in N.
- d = Perpendicular distance from pivot in m.

* Pivot:
The central point on which a mechanism oscillates.

* Principle of moments:
When a body is in equilibrium, sum of clockwise moments about a pivot is equal to sum of anticlockwise moments about the same pivot.

- Equilibrium;

$f \times d$ (clockwise) = $f \times d$ (anti-clockwise)

* Centre of gravity:
Point through which whole weight of an object appears to act.

* Finding centre of gravity of irregular object:
Make three holes as far as possible, suspend pendulum from each hole. Mark lines. The centre of gravity is where all lines meet.

* Stability;
A measure of an object's ability to return to its original position after being displaced.
- Methods of increasing stability:
i) Centre of gravity to be as low as possible.
ii) Base area to be as wide as possible.

* Types of equilibrium;
- Stable:
When the object is slightly tilted, the centre of gravity rises a bit & returns to its original position.
- Unstable:
When the object is slightly tilted, the centre of gravity drops.
- Neutral:
When the object is slightly displaced, the centre of gravity remains at same height.

⑥ Energy, Work & Power

* Energy;
Capacity to do work.
SI unit: joule (J)
- Forms of energy:
i) Kinetic energy: Energy of a body due to its motion.
ii) Potential energy; stored energy in a system due to the state, shape or position of shape.
a) Chemical potential energy, energy stored in a substance due to the position of atoms or electrons in the substance eg in food, fossil fuel & batteries.
b) Elastic potential energy, energy stored in a body due to its elastic deformation.
c) Gravitational potential energy, energy stored in a body due to its height from ground.
iii) Electrical energy: Energy of an electric charge due to its motion & charge.
iv) Light: ~~Electro~~ magnetic wave that is visible to the eye
v) Thermal energy: Energy stored in a body due to its temperature. More heat = more thermal energy. Transferred from hotter body to colder.
vi) Nuclear energy: Energy released during a nuclear reaction. a) Fission: splitting & fusing: joining.

* Principle of conservation of energy:
Energy can't be created or destroyed but convert
another.
* Total
= useful
* Effic
Efficiency
* Kinet
Ek
• Ek
• m
• v
Faster
kin
* Gr

but converted from one form to another.

★ Total energy input:

= useful energy output + wasted energy output

★ Efficiency:

$$\text{Efficiency} = \frac{\text{Useful energy output}}{\text{Total energy input}} \times 100\%$$

★ Kinetic energy:

$$E_K = \frac{1}{2} m v^2$$

- E_K = Kinetic energy in J.
- m = Mass of body in kg.
- v = Speed of body in ms^{-1}.

Faster & heavier objects possess greater kinetic energy.

★ Gravitational potential energy:

$$E_p = mgh$$

- E_p = Potential energy in J
- m = Mass in kg.
- g = Gravitational field strength in ms^{-2}.
- h = Height in m.

★ Work:

Work done by a constant force on an object is the product of force & distance moved by the object in the direction of force.

SI unit: joule (J)

$$W = f \times s$$

W = Work done in J.

F = force (constant) in N.

s = Distance moved by object in m.

★ Power:

Rate of work done or rate of energy conversion. SI unit: watt (W)

$$P = \frac{W}{t}$$

- P = Power in W.
- W = Work done in J.

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

- E = Energy converted in J.
- t = Time taken.

⑦ Pressure

★ Pressure:

Force acting per unit area.

SI unit: Newton per square metre (Nm^{-2})

Pascal (Pa)

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

- P = Pressure in Pa.
- F = Force in N.
- A = Area in m^2.

★ Pressure in liquids:

Its the pressure exerted on a object inside liquid due to liquid weight

generated by Earth's gravitational pull.
It increase with depth of water.

$P_L = h\rho g$

- P_L = Pressure in liquid in Pa.
- h = Height of column in m.
- ρ = Density of liquid in kgm^{-3}.
- g = Gravitational field strength in $N\,kg^{-1}$

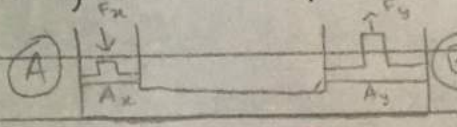
Pressure in liquids is not dependent on volume or cross-sectional area of liquid.

★ Pascal's principle:

If pressure is applied to an enclosed liquid, the pressure is transmitted equally to all other parts of liquid.
Eg in hydraulic press.

★ Hydraulic press:

A machine using hydraulic cylinder to generate a compressive force.



- $P_x = P_y$
- $\frac{F_x}{A_x} = \frac{F_y}{A_y}$
- Since $A_y > A_x$ so $F_y > F_x$

$F_x \times D_x = F_y \times D_y$

- F_x = force applied at A in N.
- A_x = Area of piston A in m^2.
- D_x = Distance moved at A in m.
- F_y = Force generated at A in N.
- A_y = Area of piston B in m^2.
- D_y = Distance moved at B in m.

★ Hydraulic disc brake system:

i) Force applied to brakes.
ii) Evenly distributed throughout liquid.
iii) Pressure applied to large pistons which in turn put pressure on brake pads.
Break pads press large disc connected to wheel thus creating friction & resulting in car to slow down.

★ Gas pressure;

- Atmospheric pressure:

The pressure exerted by layer around Earth (atmosphere) on Earth's surface & all the molecules.
The pressure inside our our body is equal to atmospheric pressure i.e 1 atmosphere so we aren't crushed.

- Applications:

i) Drinking from straw.
ii) Filling syringe.
iii) Suction cups.

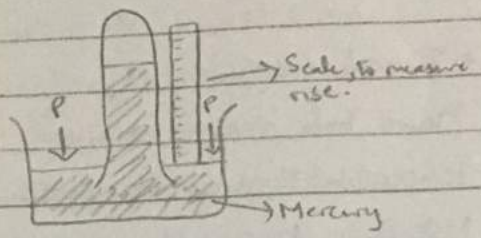
- Effects:

i) Travelling higher results in quick pressure drop causing altitude sickness.
ii) Air is pumped in airplane as it ascends to reduce pressure difference.

★ Barometre:

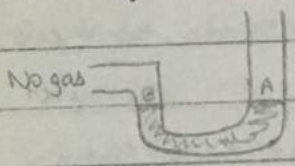
Instrument used to measure

atmospheric pressure.



* Manometre:

Instrument used to measure differences in pressure of gases or liquids.



⑧ Temperature

* Temperature:

How hot or cold an object is. SI unit: kelvin(K)

* Heat:

Amount of thermal energy being transferred from a hotter region to colder region. SI unit: joule(J)

* Constructing a temperature scale & calibrating the thermometer:

i) Choose a suitable thermetric substance (whose properties change with temperature). Can be solid, liquid or gas.

ii) Calibrate the thermometer with two fixed points;

a) Ice point, as the lower fixed point. Temperature of pure melting ice at 1 atmosphere. Eg 0°C.

b) Steam point, as the upper fixed point. Temperature of steam from water boiling at 1 atmosphere. Eg 100°C.

iii) Set up the scale by dividing the gap between fixed points in eg 100 equal intervals.

* Temperature on celcius scale:

$$\theta = \frac{X_\theta - X_0}{X_{100} - X_0} \times 100\,^\circ C$$

- θ = Unknown temperature in °C.
- X_θ = Length / Resistance of unknown temperature in cm / Ω.
- X_0 = Length / Resistance of ice point in cm / Ω.
- X_{100} = Length / Resistance of steam point in cm / Ω.

* Thermocouple:

Two wires made of different metals & joined to form junctions which produce emf due to temperature difference. The temperature can be determined by comparing emf values with calibrated values for ice & steam points.

$$\frac{\Delta\theta}{\mathcal{E}} = \frac{\Delta\theta}{\mathcal{E}} \text{ (for company)}$$

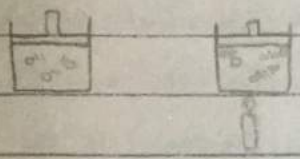
- $\Delta\theta$ = Temperature difference between junctions in K/°C
- $\mathcal{E}$ = Emf produced in V.

⑨ Kinetic Model of Matter

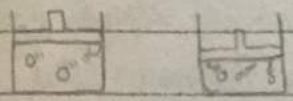
* Kinetic model of matter:
Tiny particles that make up matter are always in continuous random motion.

* Pressure in gases;
The pressure in gases is due to the collisions of gas particles with the walls of container.

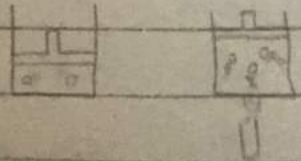
- Pressure - Temperature relationship:
The pressure of a fixed mass of gas is directly proportional to its temperature given that volume remains constant.



* Pressure - Volume relationship:
The pressure of a fixed mass of gas is inversely proportional to its volume given that temperature remains constant.



* Volume - Temperature relationship:
The volume of a fixed mass of gas is directly proportional to its temperature given that pressure remains constant.



⑩ Transfer of Thermal Energy

* Thermal energy:
Flows from a region of higher temperature to lower temperature.
Net flow of thermal energy only occurs when there is a temperature difference.

* Thermal equilibrium:
When there is no net flow of thermal energy between two objects.

* Conduction;
Transfer of thermal energy through a medium without any flow of medium.

- Working in non-metals:
i) Due to heat supply, particles at hot end vibrate vigorously.
ii) They collide with neighbouring particles resulting in vigorous vibrations.
iii) Neibouring region gets hot.
iv) Eventually all the object becomes hot.

- Working in metals:
i) Due to heat supply, free electrons gain kinetic energy due to absorbing thermal energy.
ii) These free electrons collide with atoms making them vibrate vigorously.
iii) They move to colder regions.

iv) Thermal energy is transfered via motion of free electrons.

- Working in fluids:
  Very slow process due to spacing between particles.

- Application of heat conductors:
  i) Cooking utensils made of metals.
  ii) Tips of soldering iron rods made of metals.
  iii) Heat exchangers used in large laundry facilities.

- Application of heat insulators.
  i) Handles of hot objects made of wood or plastic.
  ii) Table mats to place kitchenware made of cork.
  iii) Winter clothes made of wool.
  iv) Double-glazed windows have air in between.

* Convection;
Transfer of Thermal energy by means of convection currents in a fluid due to difference in density.

- Working in fluids:
  i) Fluid heated from bottom.
  ii) Heated molecules become less dense & rise.
  iii) Colder molecules which are denser take place of hotter molecules.
  iv) Movement of fluid occurs in form of convection currents.

- Application of convection current:
  i) Electric kettles.
  ii) Air conditioning system.
  iii) Household water heater system.

* Radiation;
Transfer of Thermal energy in the form of electromagnetic waves such as infrared radiation without the aid of medium. All objects & surfaces emit & absorb infrared radiation. Dull black surfaces absorb & emit heat better than shiny surfaces.

- Application of radiation:
  i) Greenhouse.
  ii) Thermos flask.

(11) Thermal Properties of Matter

* Internal energy:
Total energy of all the particles in the substance. Consists of (i) Internal kinetic energy; due to motion of particles, directly related to temperature (ii) Internal potential energy; due to stretching & compression of interatomic or intermolecular bonds dependent on the forces & spaces in between.

Solid —mL→ Liquid —mΔθ→ Liquid —mL→ Gas
Intramate Intermate Intramate

In this chapter, both K or °C can be used without changes in unit.

★ Heat capacity:

Amount of thermal energy required to raise the temperature of a substance by 1 K/°C. Depends upon mass and material of a substance.

SI unit: joule per degree celcius/kelvin
$J\,°C^{-1}$ / $J\,K^{-1}$.

$$C = \frac{Q}{\Delta\theta}$$

- C = Heat capacity in $J\,°C^{-1}$
- Q = Thermal energy required in J.
- Δθ = Temperature change in K/°C.

★ Specific heat capacity:

Amount of thermal energy required to raise the temperature of a unit mass of substance by 1 °C.

SI unit: joule per kilogram per degree celcius
$J\,kg^{-1}\,°C^{-1}$.

$$Q = mc(\Delta\theta) \;/\; \theta = C(\Delta\theta)$$

- Q = Thermal energy required in J.
- m = mass of substance in kg.
- c = Specific heat capacity in J/kg°C.
- Δθ = Temperature change in °C.

★ Latent heat;

Energy released or absorbed during change of state without changing its temperature.

(a) - Latent heat of fusion:

Amount of thermal energy required to change a substance between solid & liquid state without a change in temperature. More mass requires more thermal energy.

SI unit: joule (J).

- Specific latent heat of fusion:

Amount of thermal energy required to change unit mass of a substance between solid & liquid state without change in temperature.

SI unit: joule per kilogram ($J\,kg^{-1}$).

$$L_f = m \times l_f$$

- L_f: Latent heat of fusion in J.
- m: Mass of substance in kg.
- l_f: Specific latent heat of fusion in $J\,kg^{-1}$.

(b) - Latent heat of vaporisation:

Amount of thermal energy required to change a substance between liquid & gaseous state without a change in state.

SI unit: joule (J).

- Specific latent heat of vaporisation:

Amount of thermal energy required to change unit mass of a substance between liquid & gaseous state without change in temperature.

SI unit: joule per kilogram ($J\,kg^{-1}$).

$$L_v = m \times l_v$$

- L_v: Latent heat of vaporisation in J

- m = Mass of substance in kg.
- L_V = Specific latent heat of vaporisation in $J\,kg^{-1}$.

* Melting :

Thermal energy is absorbed & used to break the strong bonds between the particles of solid. Only the total internal potential energy of particles is increased. None of the thermal energy supplied is converted to internal kinetic energy so there is no change in temperature during melting. The thermal energy absorbed during melting is called latent heat of fusion.

* Solidification :

The particles of a liquid come together in freezing & strong bonds are formed. Due to this, internal potential energy decreases & thermal energy is released / lost to surroundings. Since the internal kinetic energy doesn't change, the temperature doesn't change. The thermal energy released during solidification is called latent heat of fusion.

* Boiling:

The thermal energy supplied is used to separate water molecules as well as provide them energy to push back on the surrounding atmosphere (escape into air). This energy is called latent heat of vaporisation.

* Condensation :

The particles of gas comes closer & internal potential energy decreases. A bond between particles is formed. Due to no change in internal kinetic energy, there is no change in temperature. The energy released (thermal energy) is called latent heat of vaporisation.

* Evaporation ;

Change of change from liquid to gas. The particles on the surface of liquid have enough energy to break away. It occurs at any temperature however its a slow procedure. No bubbles are formed, takes place only on surface. No external thermal energy source is required but temperature may change.

- Causes Cooling;

Liquid molecules with greater kinetic energy escape from surface leaving behind molecules with lower kinetic energy resulting in temperature decrease.

- Increases with:

i) Increasing the temperature.
ii) Increasing the movement of air.
iii) Increasing the surface area.

iv) Lowering the boiling point.

- Decreases with:

i) Increasing the pressure (atmospheric).

ii) Increasing the humidity in air.

(12) Deformation

* Extension: elastic material

When a spring is stretched, the difference between its stretched & unstretched lengths is called extension. Extension depends upon stretching force.

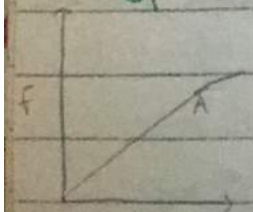
Extension = $L_e - L_o$

- L_e = Extended length.
- L_o = Original length.

* Hooke's Law:

The extension produced in the elastic material is directly proportional to the force applied provided that the limit of proportionality is not exceeded.

- $F = ke$
  - F = force in N.
  - k = Constant.
  - e = Extension.
- $\frac{F_1}{e_1} = \frac{F_2}{e_2}$

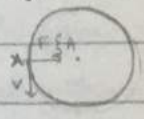


A = Limit of proportionality / elastic limit.

(13) Circular motion

* Centripetal force:

The force which keeps the body moving in a circle. It acts towards towards the centre of circle. The body moving in a circle has constant speed but velocity changes. Acceleration is towards the centre due to change in velocity (direction changing continuously).



(14) Radioactivity

* Radioactivity:

Process in which unstable atomic nuclei emit radiations to become stable. Elements that emit radiations are called radioactive materials eg U, Ra, Po etc.

- Properties of radioactivity:

i) Random process, emission of radiation from atomic nucleus at any time is not predictable.

ii) Spontaneous, doesn't depend on environmental conditions.

iii) Emission is same at all temperature & pressure.

iv) Process can't be speed up or

slow down by any scientif method.

- Types of radioactive materials:

i) Alpha particles (α): Positively charged particles with composition similar to helium nucleus.

$^{4}_{2}He$ or α

Decay: $^{100}_{50}Y^{(-4)}_{(-2)} \longrightarrow ^{96}_{48}X + ^{4}_{2}He$

ii) Beta particles (β): Negatively charged particles with composition similar to electron

$^{0}_{-1}\beta$

Decay: $^{100}_{50}Y^{(-0)}_{(+1)} \longrightarrow ^{100}_{51}X + ^{0}_{-1}\beta$

iii) Gamma rays (γ): Electromagnetic waves which are neutral.

γ or γ

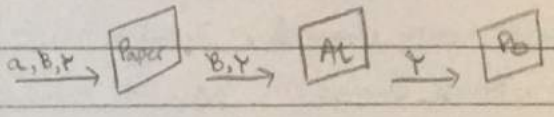
Decay: $^{100}_{50}Y \longrightarrow ^{100}_{50}X + \gamma$

* Background radiation:

Low intensity radiations present in Earth's atmosphere eg from rocks, outer space or nuclear power stations. Its important to subtract background radiation from counter readings when measuring radio-active source.

* Ionisation energy:

Amount of energy required to produce an ion from a group of atoms. Alpha has highest ionisation energy & can be stopped by a single sheet of paper. Beta particles have lower ionisation energy & can be stopped by aluminium sheet of thickness 5-10 mm. Gamma has lowest ionisation energy & can be stopped with lead sheets of thickness 15-20 cm.



* Half-Life:

The time it takes for a given amount of radioactive substance to be reduced by half due to decay.

$$N = \left(\frac{1}{2}\right)^{n} N_0$$

- N = Amount of particles left after nth half life.
- n = No. of half lives.
- N_0 = Initial quantity of substance that will undergo decay.

* Safety precaution while using radioactive substance:

i) Use radioactive symbol.
ii) Store in a long-lined container.
iii) Dont point to anyone.
iv) Handle with tongs.
v) Look at them in a mirror.

* Nuclear reactor:

A device used to initiate & control a self-sustained nuclear chain reaction

eg fission or fusion.

* Nuclear reaction:

Occurs when a nucleus is struck by another nucleus, neutron or even gamma ray so that interaction takes place.

$$E = mc^2$$

- E = Energy changed in J.
- m = Mass change in kg.
- c = Speed of light in ms^{-1}. (3.0×10^8 m/s)

* Nuclear fission:

Process in which the nucleus of an atom splits into two or more nuclei producing fission products known as fission fragments.

- Nuclear fusion:

Process in which two or more atomic nuclei are combined to form one or more different nuclei & subatomic particles such as neutrons or protons.

* Rutherford α-particle scattering experiment & atomic structure:

i) Most of space in atom is empty.

ii) +ive charge & mass of atom formed a central dense part called nucleus which is 10,000 times smaller than atom.

iii) -ive charged electrons surround nucleus.

iv) Total amount of +ive & -ive charge in a neutral atom is equal.

v) Proton is +ively charged, inside nucleus & 1/1836 mass of electron. Neutron has no charge, inside nucleus & 1/1836 mass of electron. Electron is -ively charged & outside nucleus.

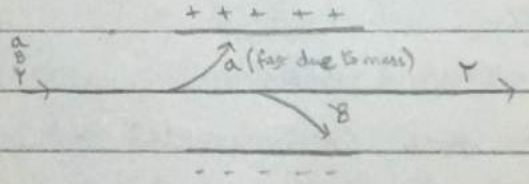
vi) Z, Atomic no. or proton no. refers to no. of protons (as well as electrons for neutral atom).

vii) N is the no. of neutrons in atom.

viii) A is the nucleon or mass no. $A = Z + N$.

ix) ${}^{A}_{Z}X$ is general symbol for representing atom.

* Radioactivity diagram:



* Carbon-dating:

Carbon-14 dating is a way to determine age of certain archeological artifacts of biological origin. The carbon-14 atoms that cosmic rays create combine with oxygen to form CO_2. It's taken in by plants for photosynthesis & organisms who eat plants also take in Carbon-14. The ratio of normal Carbon, Carbon-12 to Carbon-14 in the air

& in all living things is nearly same. The carbon-14 atoms are always decaying but replaced by new ones at constant rate. All the bodies have same certain % of carbon-14. As the organism dies, carbon-14 decays but not replaced. It decays with half-life of 5700 years. The amount of carbon-12 in sample remains constant. By looking at the ratio of carbon-12 & 14 in the sample & comparing it with living organism, its possible to determine the age.

* Star formation Theory:

i) Stars are formed in a huge cloud of gas mainly Hydrogen & dust, Nebula left over from big bang.
ii) Gravity pulls the dust together.
iii) As the mass falls together, it gets hot. A star is formed when it is hot enough for the Hydrogen nuclei to fuse together to form Helium.
iv) The fusion process releases energy which keeps the star hot.
v) During the stable phase in the life of a star, the force of gravity holding the star together is balanced by high pressure due to high temperature

(15) Light

* Light:
An electromagnetic wave that is visible to eye. Made up of electric & magnetic fields oscillating at a certain range of frequency within the electromagnetic spectrum.

* Light ray:
Idealized model of light drawn as a straight line.

* Beam of light:
A bundle of light rays. Light rays can be parallel, converging or diverging.

* Incident ray:
Light ray that hits the surface.

* Point of incidence:
The point at which incident ray hits the surface.

* Normal:
A line perpendicular to the surface at the point of incidence.

* Angle of incidence (i):
The angle between incident ray & normal.

* Angle of reflection / refraction (r):
The angle between reflected or refracted ray & normal.

* Reflection:
The rebounding of light at a surface.

* Laws of reflection:

- 1st:

The incident ray, reflected ray & normal at point of incidence, all lie in the same plane.

- 2nd:

The angle of incidence is equal to angle of reflection ($i = r$).

* Reflected ray:

Light ray that bounces off the reflecting surface. All surfaces reflect light but type of surface affects its reflection.

* Types of reflection:

- Regular:

Occurs at smooth surfaces. Each ray follows laws of reflection. Parallel incident rays are reflected in same direction. All rays have same i & r. The normal for each ray is parallel.

- Irregular (diffuse):

Occurs at rough surfaces. Each ray follows laws of reflection. Parallel incident rays are reflected in different direction. All rays have different i & r. The normals aren't parallel.

* Characteristics of a plane mirror image:

i) Same size as of object.

ii) Laterally inverted; whose right side is object's left side & vice versa.

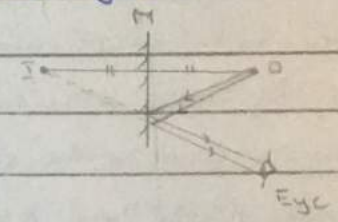
iii) Upright.

iv) Distance from mirror is equal to the distance of object from mirror.

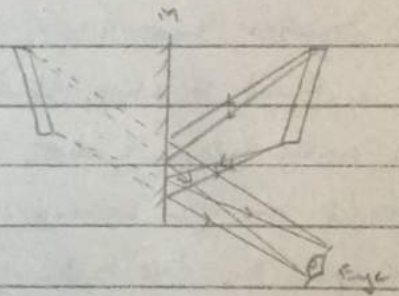
v) Virtual; can't be captured on screen. where light rays don't meet at the image position.

* Ray diagram for plane mirror;

- Point object:



- Extended object:



* Application of mirrors:

i) Vision testing.

ii) Blind corner mirror.

iii) Periscope.

iv) Instrument scale.

v) Teleprompter.

vi) optical instruments.

* Refraction:

Bending of light as it passes from one optical medium to another. It bends towards normal when travelling

Air can be used instead of vacuum.

from less dense to denser medium. Its bends away from normal when travelling from denser to less dense medium.

* Laws of refraction:

- 1st:

The incident ray, normal & refracted ray, all lie in the same plane.

- 2nd (Snells law):

For two given media, the ratio of sine i to sine r is a constant.

$$\frac{\sin i}{\sin r} = \text{constant.}$$

* Refracted ray:

A ray that undergoes a change in velocity due to interaction with different medium.

* Refractive index:

The ratio of velocity of light in a vacuum to its velocity in a specified medium.

• n = Refractive index.

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

• c = Speed of light in vacuum.

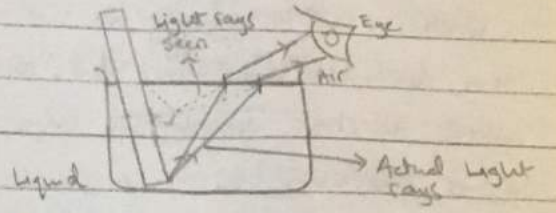
• v = Speed of light in medium.

$$- \quad n = \frac{\sin i}{\sin r}$$

• i = Angle of incidence in vacuum

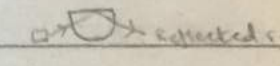
• r = Angle of refraction in medium

* Diagram of bent objects in denser medium:



* Total internal reflection:

Complete reflection of a light ray inside an optically denser medium at its boundary with an optically less dense medium. For this process to occur, the angle of incidence must increase the critical angle of denser medium. The light ray in the denser medium must strike with the boundary of less dense medium.



* Critical angle:

Defined as the angle of incidence in a denser medium for which the angle of refraction in less dense medium is 90°.

$$\sin C = \frac{1}{n}$$

• c = Critical angle.

• n = Refractive index.

* Applications of total internal reflection:

Glass prisms are used to reflect light by total internal reflection.

i) Binoculars.

ii) Periscopes.

iii) Single lens reflex cameras.

iv) Optical fibres, made of glass or plastic. Used to transmit data over long distances. Even when bent, total internal reflection occurs. They have higher flexibility, high carrying capacity, less signal degradation, lightweight & lower cost.

* Refraction by thin lenses:

Due to curved surface of lens, light refract at different angles. Most refraction in the outermost part of lens while no refraction in the middle

* Principal axis:

Horizontal line passing through the optical centre.

* Optical centre (C):

Midpoint between lens's surfaces on principal axis.

* Focal point (F):

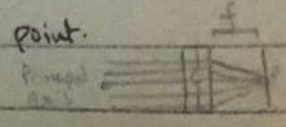
Point where all rays parallel to principal axis converge (meet) after refraction.

* Focal plane:

The plane which passes through focal point & parallel to principal axis.

* Focal length (f):

Distance between optical centre & focal point.



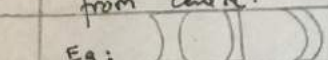
* Lenses:

Act as a set of prisms. Depending on the curvature of lens, light rays either converge or diverge.

- Diverging lens:

Causes light rays to diverge. Thinner from centre.

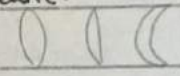
Eg:



- Converging lens:

Causes light rays to converge. Thicker from centre.

Eg:



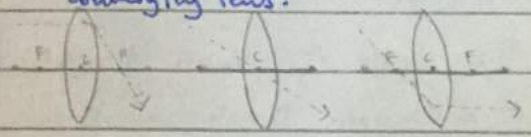
a) Applications of converging lens:

i) Magnifying glass.

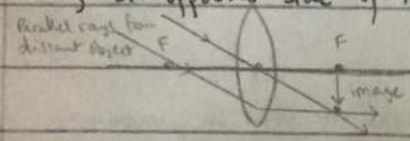
ii) LCD projector.

iii) Film camera.

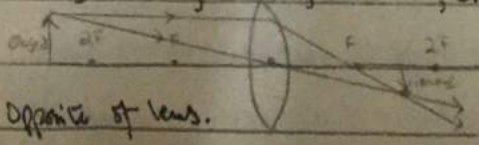
b) Types of images formed by converging lens:



i) If the object is at infinity, the image would be inverted, real, diminished & on opposite side of lens. Image at F.

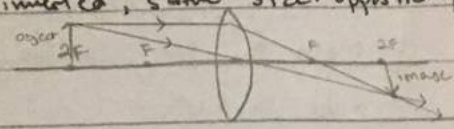


ii) If the object is beyond 2F, the image would be between F & 2F & real, inverted, diminished.

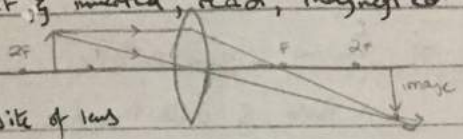


opposite of lens.

iii) If the object is placed at 2F, image would be at 2F & real, inverted, same size. Opposite of lens

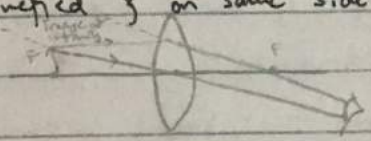


iv) If object is placed between F & 2F, image would be beyond 2F, & inverted, real, magnified.

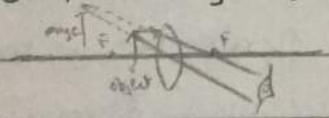


Opposite of lens

v) If object at F, image would be at infinity & virtual, upright, magnified & on same side of lens.



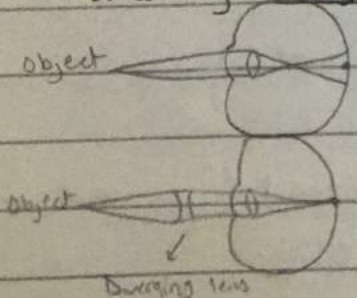
vi) If image is placed within focal length, image would be behind the object & on same side. Upright, virtual & magnified.



★ Short-Sightedness:

A disorder in which person cant focus on distant objects

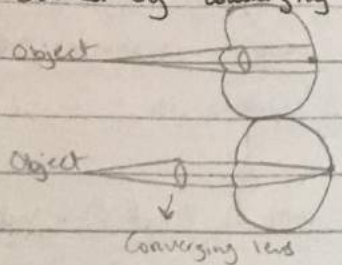
Solved by diverging lens.



★ Long-Sightedness:

A disorder in which person cant focus on near objects.

Solved by converging lens.

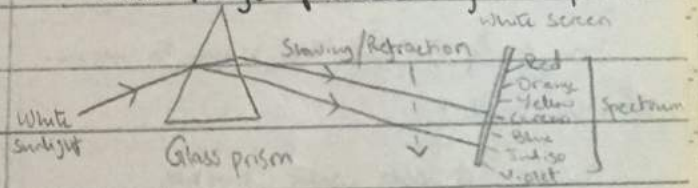


★ Dispersion:

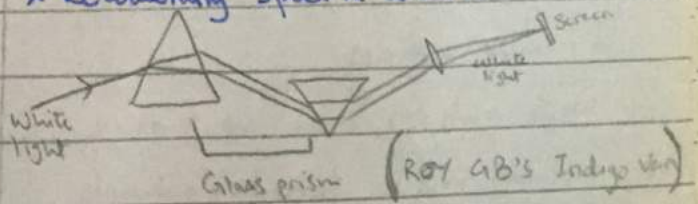
White light is made up of whole range of colours. When white light passes through glass prism, it splits into range of colours. The prism refracts these different colours by different amounts.

★ Spectrum:

Colour range produced after dispersion.



★ Recombining spectral colours:



(ROY GB's Indigo Vbg)

(16) Waves

★ Wave:

A disturbance that transfers energy

from one place to another. Doesn't transfer matter along energy. Its made up of periodic motion, motion repeated at regular intervals eg swinging of pendulum bob. Source of wave is vibration/oscillation.

* Formation of waves in;

- Rope:

i) One end of rope is fixed other held.
ii) The E$_K$ of hand is transferred to rope particles.
iii) Rope particles near free end also vibrate, move up & down as the wave passes through them.
iv) Rope wave move towards the wall.
v) The rope particles farther away also vibrate.
vi) Rope particles only vibrate about their rest positions. Rope is only the medium for the wave to move.

- Ripple tank:

i) Dipper set near water surface
ii) E$_K$ from vibrating dipper transfers to water particles.
iii) Water particles move up & down.
iv) Circular ripple spreads outwards towards tank edges.
v) E$_K$ transferred all the way to edge particles.
vi) Ripple continues to spread outwards.
vii) Water particles vibrate about their rest positions.

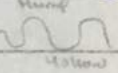
- Spring:

a) Side to side motion;
i) Move the free end from one side to another.
ii) Individual coils move perpendicular to direction of wave.

b) Push & pull motion;
i) Push & pull the free end.
ii) Individual coils move parallel to direction of wave.

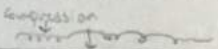
* Types of wave motion;

- Transverse:



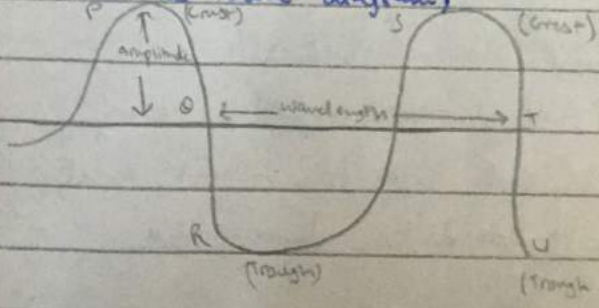
Waves that travel perpendicular to the direction of vibration eg water & light waves.

- Longitudinal:



Waves that travel parallel to direction of vibration eg sound.

* Transverse wave diagram;



* Amplitude:

Maximum displacement of a point from its rest position.

SI unit: metre (m)

To find the amplitude, we measure the height of crest or trough from rest position.

* **Crest:**
Highest point of a transverse wave.

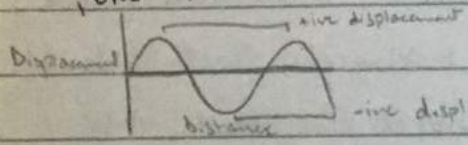
* **Trough:**
Lowest point of a transverse wave.

* **In phase:**
Points along a wave are in phase if they have the same direction of motion, same speed & same displacement from rest position.

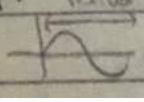
* **Wavelength (λ):**
Shortest distance between any two points in phase.
SI unit: metre (m).

To find wavelength, we can measure distance between any two nearest points in phase.

* **Displacement - distance graph:**
Describes the displacements of all particles at a particular point in time.



* **Displacement - time graph:**
Describes the displacements of one particle over a time interval.



* **Period:**
Time taken to produce one complete wave. Time equivalent to time taken for the wave to travel through a distance equal to its wavelength.
SI unit: seconds (s)

* **Frequency:**
No. of complete waves produced per second. Higher frequency means more waves produced per second but also shows that period is shorter.
SI unit: hertz (Hz)

$$f = \frac{1}{T}$$

- f = frequency in Hz.
- T = Period is s.

* **Wavespeed:**
Distance travelled by wave per second.
SI unit: metre per second (ms^{-1})

$$v = f\lambda$$

- v = wave speed in ms^{-1}.
- f = Frequency in Hz.
- λ = Wavelength in m.

* **Wave front:**
Imaginary line on a wave that joins all adjacent points that are in phase. Can be drawn by joining all the adjacent crests. Can be straight lines, concentric circles or any other shape.

(17) Electromagnetic Waves:

* **Electromagnetic waves:** Waves that are formed by simultaneous periodic variations of electric & magnetic field intensity.
* **Electromagnetic spectrum:** Entire range of wavelengths or frequencies of electromagnetic radiation.
* **Arrangement of electromagnetic waves in electromagnetic spectrum:** Wavelength decreases down the series while frequency increases. The frequency of electromagnetic wave is directly related to energy, higher frequency = higher energy. The electromagnetic spectrum is continuous.
* **Properties of electromagnetic waves:**
  i) Transverse waves. Comprise electric & magnetic fields that oscillate at 90° to each other.
  ii) Can travel through vacuum.
  iii) Transfer energy from one place to other.
  iv) Travel at same speed, $3.0 \times 10^8 ms^{-1}$ in vacuum.
  v) Follow equation, $v = f\lambda$
  vi) when travelling from one medium to other, its frequency doesn't change but speed & wavelength do change.
  vii) Carry no electric charge.
  viii) Obey laws of reflection & refraction.
* **Effects of electromagnetic waves:**
  i) Infrared heating: We feel warm because our body & clothes absorb infrared radiation.
  ii) Ionising radiation on living matter: Ionising radiation is a radiation that has enough energy to remove electrons from atoms or molecules known as ionisation. Exposure to these radiations can damage biological molecules & lead to abnormal cell divisions & cause cancer etc.
* **Electromagnetic waves & their applications:**

Ron Mcdonald Is Very Ugly e**X**cept **G**ary.

i) Radio waves: Used in radio & telecommunication.
ii) Microwaves: Transfer heat to food by making the water molecules to vibrate vigorously. Also to carry Satellite & GPS signals.
iii) Infra-red waves: In remote controls. In ear thermometres & intruder alarms by looking for heat emitted by body.
iv) Visible
v) Ultraviolet
vi) X-ray
vii) G

iv) Visible light: Allows us to see & used in optical fibre.
v) Ultraviolet radiation: Used in sunbeds for artificial tanning & for sterilising equipments.
vi) X-rays: Used in airports for security. High frequency x-rays used to kill cancer cells in radiation therapy & low frequency x-rays used to produce x-ray images for medical diagnosis.
vii) Gamma rays: Use to treat cancer & in gamma knife radio surgery, it is used to treat tumours.

(18) Sound

* **Sound:**
Form of energy that is transferred from one point to another as a longitudinal wave. It has amplitude, wavelength & frequency.

* **Production of Sound:**
Produced by vibrating sources placed in a medium. The medium is usually air but can be any gas, liquid or solid.

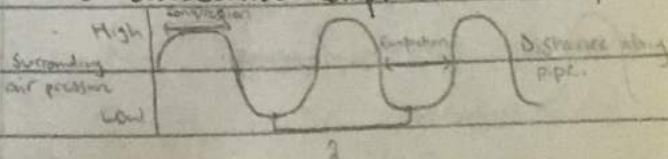
* **Sound wave propagation:**
i) An object vibrating in air causes the layers of air particles around it to be displaced.
ii) The displacement of particles caused sound waves to spread out.
iii) The direction of vibration of air molecules is parallel to the direction in which the wave travels.
iv) Sound waves spread as a series of compressions & rarefactions.

* **Compression:**
Region where air pressure is higher than surrounding air pressure.

* **Rarefaction:**
Region where air pressure is lower than surrounding air pressure.

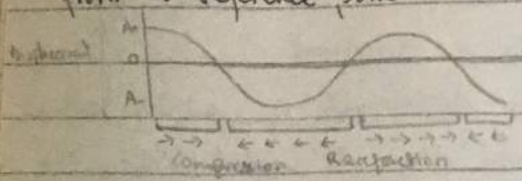
* **Sound waves graph:**

- **Pressure-distance graph:**
Shows sound wave at a certain instant. Shows sound wave produced in a hollow pipe containing air by the vibrating diaphragm of loudspeaker. The wavelength of sound wave is the distance between the centres of two consecutive compressions or rarefactions.



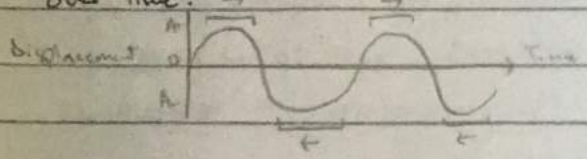
- **Displacement-distance graph:**
Shows the position of each particle

in a wave relative to its distance from a reference point.



- Displacement-time graph:

Shows the displacement of wave over time.



* Transmission of Sound:

Any medium which contains particles that can vibrate will transmit sound. However, sound can't travel through vacuum. Sound waves travel at different speeds in different media.

Speed of sound in solid > In liquid > In gas.

* Echo

Repitition of sound due to its reflection. Echoes are formed when a sound is reflected of hard & flat surfaces. Echoes are used to measure large distances & detect location of objects eg Sonar, sound navigation & ranging used by ships for navigation.

$$v = \frac{2d}{t}$$

- v = Speed of sound.
- d = Distance between source & reflecting surface.
- t = Time taken to recieve echo.

* Audibility:

means able to be heard. Human range of audibility is between 20Hz – 20,000 Hz. Sounds below 20Hz are called infrasound & sounds above 20,000 are called ultrasounds.

* Ultrasounds:

Sound with frequencies above the upper limit of the human range of audibility.

- Uses:

i) Used by bats & dolphins for echolocation.

ii) Used in most sonar technologies.

iii) Used by manufacturers of concrete to check for cracks & cavities.

iv) Used in prenatal scanning, ultrasound pulses sent into womb & by measuring the time taken for pulses to reflect, depth of womb can be derived.

v) Less hazardous than X-rays due to its lower energy.

* Pitch:

Related to the frequency of a sound wave. Higher frequency

means higher pitch. Long wavelengths produce low pitched sounds while short wavelengths produce high pitched sounds.

* Loudness:
Related to amplitude of sound wave. Larger amplitude means louder sound.

(19) Static Electricity
→ - Study of static electric charges

* Ion:
An electrically charged atom, +ive if electrons removed while -ive if electrons added.

* Charges interaction:
Like charges repel eachother while unlike charges attract eachother.

* Electric charge:
Physical property of matter that causes it to experience a force when placed in an electromagnetic field. Its either +ive or -ive.
- SI unit: coulombs (C).
- Charge of 1C = 6.25×10^{18} electrons.

Measured using a coulombmeter.

* Electrical insulators;
Ability to conduct electricity is low because charged particles arent free to move. Eg silk, wool etc.

- Method of charging: (Friction)
i) Before rubbing, two electrical insulators are neutral in charge.
ii) Different materials have different affinities, higher affinity object takes up electrons fast.
iii) During rubbing, atoms at the surface are disturbed
iv) Some electrons from a insulator are transferred to other insulator hence, one becomes +ively charged while other -ively charged.
v) The electrons transferred are unable to move freely within the material, the remain at the surface where the material has been rubbed.
vi) Electrons neither created nor destroyed during electrostatic charging but only transferred.

- Neutralising charged insulator:
i) Discharging through heating;
When brought close to a flame, the heat ionises nearby particles which in turn neutralise the excess charges on the electrical insulators.
ii) Discharging due to humidity;
Water molecules in air are electrical conductors & excess charges from

the surface of electrical insulator are transferred to water molecules.

* Electrical conductors;

Ability to conduct electricity is high because charged particles are free to move. Eg copper, iron etc, Fluids that contain mobile charged particles.

- Method of charging: (Induction)

i) Induction is the process of charging a conductor without contact between conductor & charging body as mobile electrons can easily transfer.

ii) Either place two conductors side by side, touching eachother.

iii) Bring a charged rod near them & charges in the conductors will either repel eachother or attract according to charge of rod.

iv) First seperate the conductors from eachother then seperate the rod.

v) Now both conductors have equal no. of opposite charges.

vi) Or bring an electrically charged rod near to a metal conductor.

vii) The opposite charges from rod & conductor will attract eachother.

viii) Now touch the conductor with hand which will earth it by neutralising +ive charges on the end of conductor.

ix) First remove the hand, then the rod.

x) Removing the rod will redistribute the -ive charges throughout the conductor.

xi) The conductor is now -ively charged.

-Neutralising charged conductor:

i) Discharging or adding electrons through earthing; when we earth a conductor, we provide a path for excess electrons to flow out or electrons to flow in.

ii) This makes the no. of +ive & -ive charges equal in the conductor.

* Electric force:

Attractive or repulsive forces exerted by charges on one another.

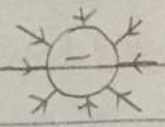
* Electric field:

A region in which electric charges experience an electric force.

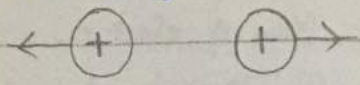
* Diagram of electric charges & their field lines;

- +ive Charge:

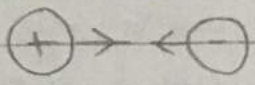
- -ive Charge:



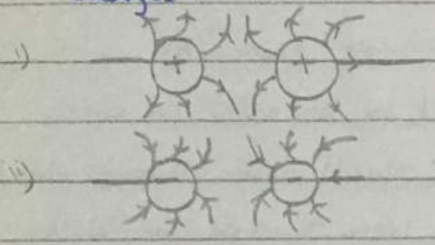
- Like charges:



- Unlike charges:



- Electric field lines of two like charges:



- Electric field lines of two unlike charges:

* Hazards of electrostatics;

- Lightning:

Electrostatic charges discharge by atmosphere. Can carry electric current of up to 30,000 amperes. Thundercloud becomes charged by friction between water molecules in cloud & air molecules. -ive charges gather at the bottom of cloud. -ively charged underside of cloud repels electrons near Earth surface which in turn tively charge the Earth surface. Due to large accumulation of charges, air particles are ionised which provide a conducting path from cloud to Earth. Lightening conductor protect tall buildings by providing path from top to underground.

- Electrostatic discharge:

Electric charges can assemble due to friction between road & tires & it can cause spark so chains are hung behind trucks (close to ground.) which provide earthing path. To protect electronic equipment, they're packed in antistatic packaging.

* Applications of electrostatics;

- Photocopiers:

i) Inside photocopier, the metal drum is coated with selenium which is photo-conductor.

ii) Drum is tively charged by rotating near wire.

iii) Image to be photocopied is placed on glass above drum.

iv) Intense beam of light is shone on image.

v) The darker areas of image reflect less light & corresponding regions on drum remain insulating hence,

+ive charges remain on surfaces.
vii) Lighter areas reflect more light & these areas of drum become conducting & are discharged.
viii) As the drum keeps rolling, +ively charged image on drum attract -ively charged tonerbridgepowder.
viii) +ively charged sheet of paper is passed & -ively charged toner powder is attracted to it.
ix) Sheet of paper is heated & pressed which fuses toner on paper.

- Spray painting:

i) Paint particles become charged by friction. when leaving nozzle.
ii) They repel eachother & spread out.
iii) They are attracted to metallic body which is earthed.
iv) Uniform paint is produced.

- Electrostatic precipitators:

i) The waste gas & fly ash, which are discharged from chimneys of factories, are passed through -ively charged wire making them -ively charged too.
ii) Then they are routed past metal which are +ively charged hence, attraction occurs.
iii) The gas leaving chimneys are free of fly ash particles.

(20) Current Electricity

* Electric current:

Rate of flow of electric charge (Q). It is formed by moving electrons. The current flows from -ive to +ive terminal however conventional current, movement of positive charges, flow from +ive to -ive terminal.

SI unit: ampere (A)

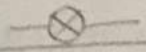
Measured by ammeter in which current should enter through +ive / red & leave through -ive/black terminal.

$$I = \frac{Q}{T}$$

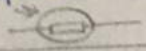
- I : Current in ampere.
- Q : Charge in C.
- t : Time taken in s.

* Circuit Symbols;

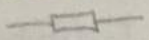
- Switch:
- Battery:
- DC power supply:
- AC power supply:
- Light bulb:



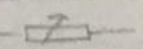
- Light-dependent resistor:



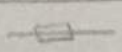
- Fixed resistor:



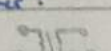
- Rheostat:



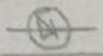
- Fuse:



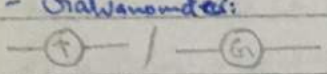
- Transformer:



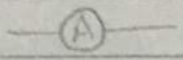
- Semiconductor diode:



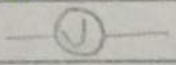
- Galvanometer:



- Ammeter:

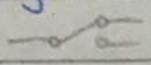


- Voltmeter:

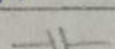


- Bell:

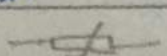
- Two-way switch:



- Capacitor:



- Thermistor:



★ Volt:

Unit of measurement for electromotive force (emf) & potential difference (pd)

Both cause the electric charge to move in a circuit.

★ Electromotive force:

$\mathcal{E}$ of an electrical energy source is the work done by the source in driving a unit charge around a complete circuit.

SI unit: joule per coulomb (JC^{-1})
volt (V).

$$\mathcal{E} = \frac{W}{Q}$$

- $\mathcal{E}$: Emf of source in V.
- W: Work done, amount of non-electrical energy converted to electrical energy in J.
- Q: Amount of charge in C.

★ Cell position affecting emf:

i) If cells are arranged in series, resultant emf is sum of emf of all cells.

iii) If cells are arranged in parallel, resultant emf is that of a single cell.

★ Potential difference:

Pd across a component in an electric circuit is the work done to drive a unit charge through the component.

SI unit: volt (V)

$$V = \frac{W}{Q}$$

• V = Potential difference in V.
• W = Work done in J.
• Q = Amount of charge in C.

To measure potential difference with voltmeter, the voltmeter must be connected in parallel with the component.

★ Resistance:

Ratio of the potential difference across it to the current flowing through it. Higher resistance means smaller distance passing through.

SI unit : ohm (Ω).

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

• R = Resistance of component in Ω.
• V = Pd across component in V.
• I = Current flowing through in A.

★ Resistors;

Conductor in a circuit used to control the size of current flowing.

- Fixed resistor:

Has a fixed resistance value eg Carbon-film resistor & wire-wound resistor.

- Variable resistor:

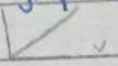
Has a resistance that can be varied eg rheostat.

★ Ohm's law:

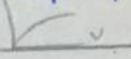
Current passing through a metallic conductor is directly proportional to the potential difference provided that physical conditions (eg temperature) remain constant.

$$\frac{V}{I} = R \text{ (constant)}$$

★ I-V graph of ohmic conductors:



★ I-V graph of non-ohmic conductors:



(Not straight)

More heat energy increases temperature which increases resistance.

★ Resistivity:

Resistance of a conductor depends on temperature, type of material it made of, length ($R \propto L$), & thickness or cross-sectional area ($R \propto \frac{1}{A}$).

SI unit : ohm meter (Ωm).

$$\rho = \frac{RA}{L}$$

ρ: Constant, resistivity of a material in Ωm.
R: Resistance of wire in Ω.
A: Thickness of wire in m^2.
L: Length of wire in m.

(21) D.C circuits

★ Series circuit;

The components are connected one

after a
Electric
to flow
- Current
The
same.
- Potentia
The su
each
differen
V
• V_s
• V_n
- Resist
The
Sum
R
★ Pa
The
ent
Ele
one
-

after another in a single loop. Electric charge has only one path to flow.

- Current:
The current at every point is same.
- Potential difference:
The sum of potential difference across each component is equal to potential difference across whole circuit.

$V_t = V_1 + V_2 + \dots + V_n$

- V_t = P.d across whole circuit.
- V_n = P.d across on component.

- Resistance:
The effective resistance is the sum of all resistances.

$R = R_1 + R_2 + \dots + R_n$

- R = Effective resistance
- R_n = Resistance of one resistor.

★ Parallel circuit;
The components are connected to emf source in two or more loops. Electric charge has more than one path to flow.

- Current:
The sum of the individual current in each of the parallel branches is equal to the main current flowing into or out the parallel branches.

$I = I_1 + I_2 + \dots + I_n$

- I = Main current.
- I_n = Current for n branches in parallel.

- Potential difference:
The potential difference across separate parallel branches is same.
- Resistance:
The reciprocal of effective resistance of resistors in parallel, $\frac{1}{R}$, is equal to sum of reciprocals of all the individual resistances.

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$

- R = Effective resistance.
- R_n = Resistance for one resistor.

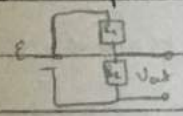
- Advantages:
i) Bulb connected in parallel glow more brightly.
ii) If one bulb blows, others still work.

- Disadvantages:
i) The source provides more power as is used up speedily.

★ Potential divider:
Line of resistors connected in series. Used to provide a fraction of voltage of source to another part of circuit. Can be used to adjust voltages.

$$V_{out} = \left(\frac{R_2}{R_1+R_2}\right) \times V_\varepsilon$$

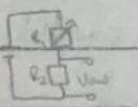
- V_{out} = Output voltage.
- R_2 = Across Resistor #2.
- R_1 = Other resistor.
- V_ε = Input voltage.



* Variable potential dividers;
Used to vary the output voltage from a source eg in guitars & mp3 players.

- Rheostat:
Variable resistor connected to two terminals. To obtain larger voltage output, R_1 should be decreased.

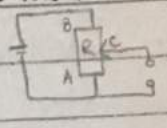
$$V_{out} = \left(\frac{R_2}{R_1+R_2}\right) \times V_\varepsilon$$



- Use of potentiometer:
Variable resistor connected to three terminals. Third point is the sliding contact. Since $R \propto l$ for a fixed cross-sectional area, third point's position determines ratio of resistance first to third & second to third.

$$V_{out} = \frac{R_{AC}}{R_{AC}+R_{BC}} \times V_\varepsilon$$

- Effective Resistance = AC + BC.



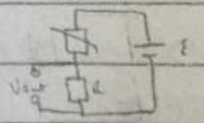
* Input transducers;
Electronic devices that convert non-electrical energy to electrical energy. Used in electronic or musical instruments eg thermistors, LDRs, microphones etc.

* Types of input transducers;

- Thermistors: T ↑ R ↓
Its resistance varies with temperature.

$$V_{out} = \frac{R}{R+R_{th}} \times V_\varepsilon$$

R: Resistance of fixed resistor in Ω.
R_{th}: Resistance of thermistor in Ω.
V_ε: Voltage supplied by electrical source in V.



- Light dependent resistor (LDR): LT R↓
Its resistance decreases with amount of light increasing & vice versa.

$$V_{out} = \frac{R}{R+R_{LDR}} \times V$$

- R_{LDR} = Resistance of LDR.

★ Electric heating:

Appliances that convert electrical energy to thermal energy. Have heating elements such as nichrome. It has high resistivity & bear high temperatures. Electric current heat these elements.

i) Electric kettle heat water by conduction & convection.

ii) Electric's iron's metal base is heated with conduction.

iii) In electric radiator, air is heated by radiation & convection.

iv) Pot of liquid placed on electric hotplate is heated by convection & conduction.

v) When current flows through filament in lamp, the tungsten coil is heated to about 2500 °C. This intense heating effect generates light. Bulb is filled with inert gases to prevent tungsten from burning.

★ Electrical Power:

Rate, per unit time at which electrical energy is transferred by an electric circuit.

SI unit: watt (W)

- $P = VI$

- P = Power in W.
- V = Potential difference in V.
- I = Current in A.

- $P = I^2R$

- R = Resistance in Ω.

- $P = \frac{V^2}{R}$

- V = Voltage in V.

★ Electrical energy:

A form of energy resulting from the flow of electric charge.

SI unit: joule (J).

- $E = VIt$ $(\because E = Pt)$

- E = Electrical energy in J.
- V = Voltage in V.
- I = Current in A.
- t = Time in s.

- $E = I^2Rt$

- R = Resistance in Ω.

- $E = \frac{V^2}{R}t$

★ Cost of electricity consumption:

$E = P \times t$

- E = Energy in kWh.
- P = Power in kW.
- t = Time in H.

★ Sources of electrical energy:

- Renewable:

i) Solar Power; Light energy → Electrical energy.

ii) Wind Power; Kinetic energy → Electrical energy.

iii) Hydroelectric power; Gravitational potential energy → Electrical power.

- Non-renewable:

i) Nuclear power; Nuclear energy → Heat energy → Electrical energy.

ii) Fossil fuel; Chemical potential energy → Heat energy → Electrical energy.

* Dangers of electricity;

- Damaged insulation:

i) The insulating materials eg rubber around wire can worn out with time & its exposure can cause electric shocks.

- Overheating of cables:

i) Overloaded power sockets.

ii) Use of inappropriate wires with inappropriate thickness.

- Damp environment:

Water can provide a conducting path for current causing electric shocks.

* Safety features for house circuitries;

- Circuit breakers:

Safety devices that can switch off the electrical supply. Once off, they can be reset by switching them on again after the fault in circuit is corrected.

- Fuses:

Safety devices added to an electrical circuits to prevent excessive current flow. It has to be replaced once blown. It consists of a short piece of wire which heats up & melts once large current flows through it thus, opens the circuit. The fuse for an electrical appliance should have a rated value slightly higher than current of the appliance. It should be connected to live wire.

- Switches:

Switches are designed to break or complete an electrical circuit. It is connected to a live wire.

- Earthing:

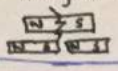
There are usually three wires in a home circuit;

i) Live wire: Brown in colour, connected to high voltage & delivers current to appliance.

ii) Neutral wire: Blue in colour, completes circuit by providing a return path for current. It is usually at 0 volt.

iii) Earth wire: Green or yellow in colour, a low resistance wire which is connected to metal casing of appliances.

Cutting a bar magnet makes a new magnet.



It provides a path for excessive current to flow into the ground known as earthing.

- Three-pin plugs:

The fused plug also known as safety plug has a cartridge fuse inside which blows due to excessive current.

- Double insulation:

Double insulation is a safety feature that can replace earth wire. In double insulation, electric cables are insulated from internal components of appliance & the internal components are insulated from external casing. Appliances with double insulation usually have two pin plug (live & neutral wire) & have non-metallic casings.

(23) Magnetism

* Magnetic materials:

Materials that are attracted to a metal.

* Non-magnetic materials:

Materials that cant be attracted to a magnet.

* Properties of magnets;

i) They have two poles where the magnetic effect is strongest.

ii) A freely suspended magnet comes to rest in a N-S direction.

iii) Magnetic like poles repel which unlike poles attract eachother.

* Magnets identification;

- Magnet:

If an end of object is taken near a suspended bar magnet & it repulses or it attracts that end but repulses other end of object.

- Unmagnetised magnetic material:

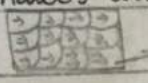
If both ends of object are attracted by magnet.

- Non-magnetic:

If object remains stationary near magnet.

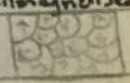
* Magnetic domains:

Consists of a group of atomic magnets pointing in the same direction as magnets are made of atoms & the orbiting motion of electrons around nucleus makes an atom, an atomic magnet.



* Magnetisation:

i) The magnetic domains in unmagnetised bar points in random direction.



iii) There is no net magnetisation because domains cancel out eachother.

iii) Magnetisation is carried out by alligning the domains.
iv) All magnetic domains point in one direction producing a net magnetisation.
v) Each arrow is arranged directly behind the arrow front of it so N poles are cancelled by adjacent S poles.
vi) The atomic magnets at both ends are free which produces a N & S effect at the ends.
vii) The atomic magnets at the ends are likely to fan out due to repulsion between like poles.

* Magnetic induction:
Process whereby an object made of a magnetic material becomes a magnet when it is near or in contact with a magnet.

* Ways of magnetising magnetic materials
- Stroking:
i) An unmagnetised - magnetic - material - made bar is stroked several times from one end to other by a permanent magnet in one direction.
ii) The stroking magnet bar should be lifted high enough from unmagnetised bar while stroking.
iii) The pole produced at the end of unmagnetised bar where the strokes finish is opposite to the stroking pole used.
- Electrically using direct current:
i) The unmagnetised bar is placed inside a solenoid through coils of wire & large direct current flows which produces a strong magnetic field.
ii) The magnetic fields allign the magnetic domains in unmagnetised bar.
iii) After some time, it will be magnetised.
iv) Determine the poles of magnet by
a) Gripping & curling finger around solenoid using right hand. The direction of thumb is N pole.
b) The current at the end flows clockwise, N pole but if anticlockwise, S pole.

* Ways of demagnetising magnetic materials;
- Heating:
i) Strongly heat a magnet & let it cool in E-W orientation.
ii) On heating, atoms will vibrate vigorously causing magnetic

domains to lose alignment.

- Hammering:

i) Hammer a metal placed in E-W direction

ii) This will cause it to lose its magnetic domains.

- Electrically using alternating current:

i) Place magnet inside solenoid using alternating current.

ii) Provide solenoid with a.c supply.

iii) Withdraw the magnet while a.c current still flowing until it's some distance away.

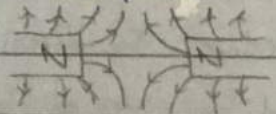
* Magnetic field:

A region surrounding a magnet in which a body of magnetic material experiences magnetic force. It is invisible but visualised by imaginary magnetic lines of force around magnet. These lines give the strenght & direction of field.

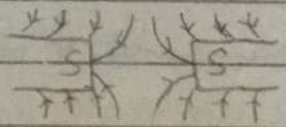
* Diagram of magnetic field lines between magnets;

- Two like poles:

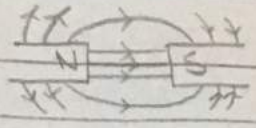
i)



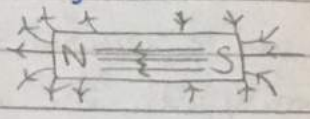
ii)



- Two unlike poles:



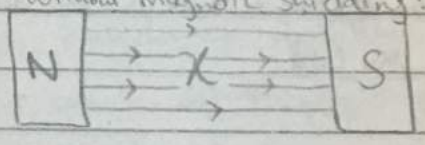
- A magnet:



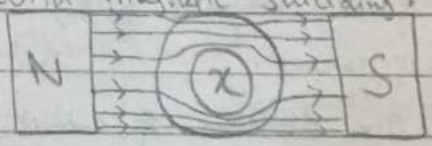
* Magnet shielding:

To prevent MRI equipment & Computer hard drives from magnetic fields, thin sheets of soft magnetic materials eg iron are used which divert magnetic field lines as they tend to pass within them.

- Without magnetic shielding:



- With magnetic shielding:



* Soft magnetic materials:

They are easily magnetised & de-magnetised eg Iron. Used to make temporary magnets; i) Used when a changing magnetic field is needed. ii) Electromagnets. iii) Core of ammeter.

* Hard magnetic materials:

They are difficult to magnetise & demagnetise eg steel. Used to make permanent magnets; i) Used when constant magnetic field is needed. ii) Magnetic door catches iii) Moving coil loudspeaker. iv) Moving coil ammeter.

•: Current coming out.
X: Current going in.

(24) Electromagnetism

* Electromagnetism:
The phenomenon of interaction between electric currents/fields with magnetic fields. A current carrying conductor produces a magnetic field around it.

* Magnetic field patterns:
Produced by current carrying conductor. Direction of magnetic field can be determined by i) Gripping the wire with thumb facing current flow.
ii) Direction of finger curl is the direction of magnetic field.

* Factors affecting magnetic field;
- Direction of current:
Reversing the direction of current also reverses the direction of magnetic field.
- Magnitude of current:
Increasing the current strengthens the magnetic field. The magnetic field is strongest, closer to wire.
* Magnetic field strength in a solenoid: increased by:
i) Increasing the current.
ii) Increasing no. of turns.
iii) Placing soft iron core within
* Circuit breakers:
i) A safety device that switches off the electrical supply due to excessive current.
ii) When switch is on, current flows through solenoid with safety bar between interrupt point & circuit closed.
iii) The safety bar is held in this position by a soft iron latch.
iv) Due to overheating, the solenoid becomes a strong electromagnet hence, attracting the iron latch.
v) This causes the safety bar to be released & displaced from its position. It pushes the on switch to off & leaves the interrupt point thus, opening the circuit.
* Motor effect.
Effect produced when a current-carrying conductor is placed in a magnetic field & it experiences a force. This force, current & magnetic field are at right angles to one another. The direction of force can be reversed by reversing the current or magnetic field.
* Determining the direction of forces during motor effect:

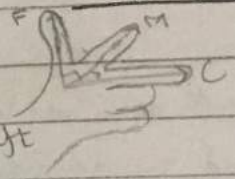
Done by
i) Thumb
ii) Forefing
iii) Second
Left
* Moto
i) Occu
curre
intera
ii) A st
at the
magn
current
poles
iii) On
direc
magn
iv) Th
field
force
condu
field
* For
Curr
- Cur

Done by Fleming's left hand rule.

i) Thumb : 90° to forefinger. Shows the direction of force.

ii) Forefinger : 90° to second finger. Shows direction of magnetic field; N-S

iii) Second finger : 90° to forefinger. Shows direction of current.



* Motor effect causes:

i) Occurs when magnetic field of current & between magnetic poles interact.

ii) A strong magnetic field is formed at the point where the direction of magnetic fields produced by current-carrying conductor & magnetic poles are same.

iii) On the opposite side, where both directions are same, weak magnetic field is formed.

iv) The difference between magnetic field strengths results in a net force acting on current-carrying conductor towards the weaker field.

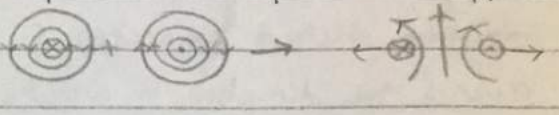
* Forces between two parallel current-carrying conductors;

- Currents in same direction:

Attraction occurs if direction same.

- Currents in opposite direction:

Repulsion occurs if direction opposite.

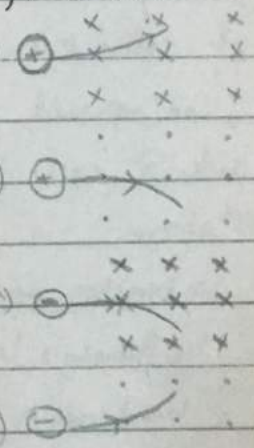


* Force on charged particles in magnetic field:

The direction of force on a beam of charged particles is reversed if

i) direction of current is reversed ii) direction of magnetic field is reversed iii) particles are oppositely charged.

It can be determined using flemming's left hand rule.

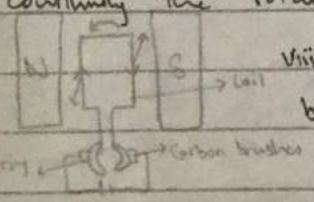


* Direct current motor:

i) Rotary electrical machine that convert direct current electrical energy into mechanical energy relying on forces produced by magnetic fields.

ii) A rectangular wire coil is mounted on

an axle which allows it to rotate.
iii) A cell is attached which provides electrical energy.
iv) The ends of coil are connected to split-ring commutator which maintains electrical connection & reverses the direction of current after each half interval when the loop is vertical.
v) Two carbon brushes press lightly against commutator to reduce its wear & maintain current supply.
vi) When the coil is in vertical position, current is cut off because commutator isn't in contact with carbon brushes however its momentum carries it.
vii) Now the direction of current is changed/reversed & an upward force acts on other side of coil & continuing the rotation.



viii) Direction measured by flemming's left hand rule.

(25) Electromagnetic Induction

★ Electromagnetic induction:
Process through which an induced emf is produced due to a changing magnetic field.

★ Magnetic flux:
A measurement of the total magnetic field which passes through a given area. Its the magnetic field linking a conductor.

★ Faraday's:
- Observation:
When a magnet was inserted into a solenoid, the galvanometers needle deflected in one direction but when it was removed, the needle deflected in other direction. However, needle wasn't deflected when magnet was stationary in solenoid.
- Law:
Magnitude of the induced emf in a circuit is directly proportional to the rate of change of magnetic flux in the circuit.
- Findings:
Magnitude of induced emf could be increased by increasing;
i) No. of turns in solenoid.
ii) Strength of magnet.
iii) Magnet's moving speed with respect to solenoid.

★ Lenz's law:

In a
direction
emf
is alwa
magnetic
motion
★ Alterna
i) Transf
eg Ex
emf.
ii) A
on a
iii) By
rotates
perma
iv) Re
brin
thus
&
v) Th
co
cu
coil
vi)
vii)

DC current: ⎓
AC current: ∿

In a closed circuit, the direction of the induced emf & hence induced current is always such that its magnetic effect opposes the motion or change producing it.

* Alternating current generator:

i) Transforms mechanical energy eg E_K into electrical energy eg emf.

ii) A rectangular coil is mounted on an axle.

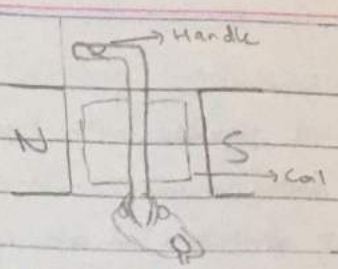
iii) By turning the handle, the coil rotates between poles of two permanent magnets.

iv) Rotation of coil in magnetic field brings change in magnetic flux thus, producing an induced emf & hence, induced current.

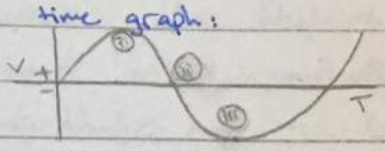
v) The slip rings are always in contact with carbon brushes to ensure that induced current in coil is transfered to external circuit.

vi) The electrical load in external circuit is powered by induced current.

vii) Direction can be determined by flemings right hand rule. (Same as left hand but with opposite directions).



* AC generator's output voltage against time graph:



i) Plane of coil is parallel to magnetic field. The arms of coil cut across the magnetic field at greatest rate. Rate of change of magnetic flux is maximum so the induced emf is maximum.

ii) Plane of coil is perpendicular to magnetic field. Rate of change of magnetic flux is 0 so does the induced emf.

iii) Plane of coil is again parallel to magnetic field but because the arms are moving in opposite direction, direction of induced emf is also opposite.

* Induced emf of AC generator:

Its magnitude can be increased by:

i) Increasing no. of turns in coil.

ii) Using stronger permanent magnets.

iii) Increasing frequency of coil rotation.

iv) Winding coil around soft iron core to strengthen the magnetic flux.

* Fixed coil generator:

i) A type of ac generator with fixed coils but rotating magnets.

ii) The magnet attached to an axle eg in bikes tire.

iii) The magnetic field rotates & changes the magnetic flux in the coil. It generates an induced emf hence induced current.

iv) The induced current is channelled directly to the external circuit through output terminals.

v) Its compact in size & slips rings or carbon brushes not required.

* Transformer;

A device used to convert high voltage into low voltage or vice versa. Used in transmission of electrical power from power stations to consumers. Also in proper regulation of voltages for appliances.

- Structure:

i) Two coils, primary & secondary are wound around a laminated soft iron core.

ii) Each coil has certain no. of turns.

iii) Iron core consists of thin sheets of soft iron isolated from one another by lacquer coating.

iv) Soft iron is used because it magnetises & demagnetises quickly & ensures better magnetic flux linkage between coils.

v) The lamination reduces heat loss.

- Working:

i) The primary coil is connected to an alternating supply.

ii) A varying magnetic field is set up in the laminated soft iron core.

iii) An emf is induced in the secondary coil along with induced current which is directed to our homes.

iv) Electrical energy is transferred from primary coil to secondary coil.

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

- V_s = Voltage in secondary coil.
- V_p = Voltage in primary coil.
- N_s = No. of turns in secondary coil.
- N_p = No. of turns in primary coil.
- I_p = Current in primary coil.
- I_s = Current in secondary coil.

* Step up transformer:

No. of turns in secondary coil is more than in primary coil hence, output voltage is greater than input voltage.

* Step down transformer:

No. of tur
less than
output vo
voltage.

* Power trans
Assuming
is 100%.
primary
to secon
- P_p
- P_s
$P_p = P_o$
$P_s = P_o$

* Energy
i) Heat
ii) Ed
iii) M

* Die
A de
- F
AC
- P
AC
*
Grid
Station

No. of turns in secondary coil is less than in primary coil hence, output voltage is lesser than input voltage.

* Power transmission in a transformer:

Assuming the efficiency of transformer is 100%. so power supplied to primary coil is fully transferred to secondary coil.

- $P_p = V_p \times I_p$
- $P_s = V_s \times I_s$

P_p = Power in primary coil.

P_s = Power in secondary coil.

* Energy loses in transformers:

i) Heat loss due to coil resistance.

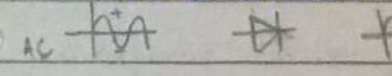
ii) Eddy current loss.

iii) Magnetic flux leakage.

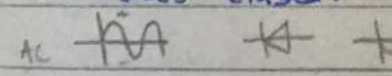
* Diode;

A device used to convert ac. to dc.

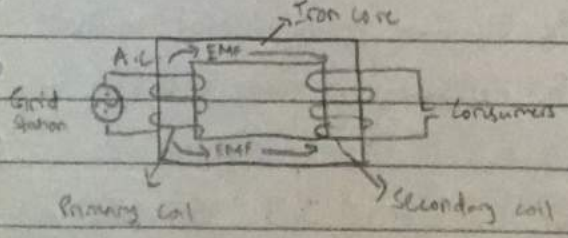
- Forward biased:



- Reverse biased:



* Diagram of transformer:



* Transmission of electricity:

Transmitted more efficiently at high voltages

* Cathode ray oscilloscope:

A device used to show how voltage varies with time. Other than that, it is used to display waveshape of voltages & soundy measure voltage, determine the frequency of input signal, determine a short time delay & display heartbeat.

* Thermionic emission:

Emissions of electrons from hot metal.

* Filament:

It converts electrical energy to heat energy.

* Cathode:

A metal plate with -ive potential, emits electrons on heating.

* Anode:

Cylindrical in shape with +ive potential. They attract the electrons from all sides thus, faccelerating & focusing them into fine beam.

* Grid:

Next to cathode, a metal mesh with varying -ive potential. It controls the no. of electrons reaching the screen hence, the brightness of spot. High -ive potential means less electrons reaching & vice versa.

* Y-Plates:

Deflects the beam of electron vertically by providing voltage to them.

★ X-Plates:

Deflect the beam of electrons horizontally by voltage given to them by time-base circuit.

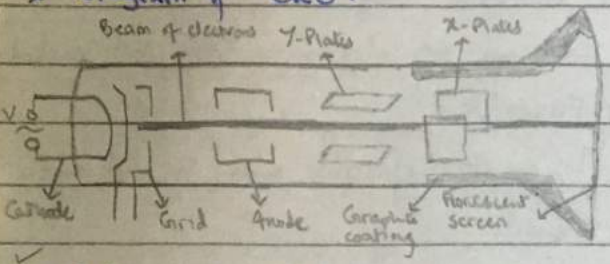
★ Y-Gain control:

Calibrates the vertical axis.

★ X-Gain control:

Calibrates the horizontal axis.

★ Diagram of CRO:



★ Working of CRO:

i) The CR tube is a vacuum glass containing electron gun, deflecting system & fluorescent screen (coated with zinc sulfide).

ii) The cathode ray emits beam of electrons

iii) The anode turns it into a fine beam.

iv) Varying the voltage across Y-plates changes the vertical deflection of beam.

v) Varying the voltage across X-plates changes the speed at which beam sweeps horizontally across the screen.

vi) A bright spot is created as beam strikes the screen due to coating of ZnS on the screen because this chemical glows when electrons strike it.

★ Cases of CRO:

- 1st:

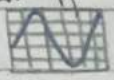
D.C is given to y-plates & time-base setting is off. A spot of light is seen either above or below central position.

- 2nd

D.C is given to y-plates & time-base circuit is on. A horizontal line is seen either above or below central position.

- 3rd

A.C is given to y-plates & time-base circuit is off. A spot of light is seen oscillating up & down about central position if frequency is low (Less than 20Hz) but a vertical line is seen if frequency high.



- 4th

A.C is given to y-plates & time-base circuit is on. A wave is seen on screen.

★ Displaying voltage waveforms:

No. of complete cycles displayed.

$$\frac{f_y}{f_x}$$

- F_y = Frequency of a.c input in Hz.
- F_x = Frequency of time base in Hz.

(26) Formulas Sheet Chap 1 – 22 + Additional Chapters

① Measurement

* Vernier calipers:
= Upper scale + Lower scale

* Micrometer screw gauge:
= Main scale + Thimble scale (x0.01)

② Kinematics

* Speed:
$v = \frac{d}{t}$

* Average speed:
Avg $v = \frac{\text{Total } d}{\text{Total } t}$

* Velocity:
$v = \frac{d}{t}$

* Average velocity:
Avg $v = \frac{\text{Total } d}{\text{Total } t}$

* Acceleration:
$a = \frac{\text{Velocity change}}{t}$

* Uniform acceleration:
$a = \frac{v-u}{t_v - t_u}$

③ Forces

* Newton's 2nd law:
$F = m \times a$

④ Mass, weight & density

* Gravitational field strength:
$W = m \times g$

* Density:
$\rho = \frac{m}{V}$

⑤ Turning effect of forces

* Moment of force:
Moment of force = $F \times d$

* Principle of moments (equilibrium):
$F \times d$ (clockwise) = $F \times d$ (anti-clockwise)

⑥ Energy, work & power

* Total energy input:
= Useful energy output + wasted energy output

* Efficiency:
$\text{Eff.} = \frac{\text{Useful energy output}}{\text{Total energy input}} \times 100\%$

* Kinetic energy:
$E_K = \frac{1}{2} mv^2$

* Gravitational potential energy:
$E_p = m \times g \times h$

* Work:
$W = F \times s$

* Power:
- $P = \frac{W}{t}$
- $P = \frac{E}{t}$

⑦ Pressure

* Pressure:
$p = \frac{F}{A}$

* Pressure in liquids:
$p = \rho \times g \times h$

* Hydraulic press:
$f_x \times D_x = F_y \times D_y$

⑧ Temperature

* Temperature on celcius scale:
$\theta = \frac{X_\theta - X_0}{X_{100} - X_0} \times 100\,^\circ C$

* Thermocouple:
$\frac{\Delta\theta}{\mathcal{E}} = \frac{\Delta\theta}{\mathcal{E}}$ (for comparing)

⑨ Thermal properties of matter

* Heat capacity:
$C = \frac{Q}{\Delta\theta}$

* Specific heat capacity:
- $Q = mc(\Delta\theta)$
- $Q = C(\Delta\theta)$

* Specific latent heat of fusion:
$L_f = m \times l_f$

* Specific latent heat

* Vaporisation:

$L_v = m \times L_v$

⑩ Deformation

* Extension:

$Ext = L_e - L_o$

* Hooke's law:

- $F = ke$

- $\frac{F_1}{e_1} = \frac{F_2}{e_2}$

⑪ Radioactivity

* Half life:

$N = \left(\frac{1}{2}\right)^n N_0$

* Nuclear reaction:

$E = m \times c^2$

⑫ Light

* Refractive index:

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

- $n = \frac{\sin i}{\sin r}$

* Critical angle:

$\sin C = \frac{1}{n}$

⑬ Frequency

* Frequency:

$f = \frac{1}{T}$

* Wavespeed:

$v = f \times \lambda$

⑭ Sound

* Echo:

$v = \frac{2d}{t}$

⑮ Current electricity

* Electric current:

$I = \frac{Q}{t}$

* Electromotive force:

$\mathcal{E} = \frac{W}{Q}$

* Potential difference:

$V = \frac{W}{Q}$

* Resistance:

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

* Resistivity:

$\rho = \frac{R \times A}{L}$

⑯ D.C circuits

* Potential difference in series circuit:

$V_s = V_1 + V_2 \dots + V_n$

* Resistance in series circuit:

$R_s = R_1 + R_2 \dots + R_n$

* Current in parallel circuit:

$I = I_1 + I_2 \dots + I_n$

* Resistance in parallel circuit:

$\frac{1}{R_s} = \frac{1}{R_1} + \frac{1}{R_2} \dots + \frac{1}{R_n}$

* Potential divider:

$V_{out} = \left(\frac{R_2}{R_1 + R_2}\right) \times V_s$

* Rheostat:

$V_{out} = \left(\frac{R_2}{R_1 + R_2}\right) \times V_s$

* Potentiometer:

$V = \frac{L_1}{L} \times V$

* Thermistor:

$V_{out} = \frac{R}{R + R_{th}} \times V_s$

* Light dependent resistor:

$V_{out} = \frac{R}{R + R_{LDR}} \times V$

⑰ Practical electricity

* Electrical power:

- $P = V \times I$

- $P = I^2 \times R$

- $P = \frac{V^2}{R}$

* Electrical energy:

- $E = V \times I \times T$

- $E = \frac{V^2 t}{R}$

- $E = I$

* Cost of

Consump

$E =$

⑱ Elec

indu

* Transf

$\frac{V_s}{V_p} =$

* Power

transfo

- $P_p =$

- $P_s =$

* Displa

wavef

⑳ E

* Res

colo

Tenth val

* G

i)

coil

dire

G

ii)

- $E = I^2 \times R \times t$

* Cost of electricity consumption:

$E = P \times t$

(18) Electromagnetic induction

* Transformer:

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

* Power transmission in transformer:

- $P_p = V_p \times I_p$
- $P_s = V_s \times I_s$

* Displaying voltage waveforms:

$$\frac{F_y}{f_x}$$

(27) Extras

* Resistance of coloured wire:

* Galvanometer:

i) Inserting magnet in coil in direction: ←, direction of needle in (G): →.

ii) Vice versa for other direction.

* Boyle's law:

For a fixed amount of an ideal gas kept at a fixed temperature, volume & pressure are inversely proportional.

- $P_1 V_1 = k$
- $P_2 V_2 = k$
- $P_1 V_1 = P_2 V_2$

* Speed when two sounds involved (can be echo):

$$V = \frac{\Delta d}{\Delta t}$$

- V = Speed.
- Δd = Distance travelled by both sounds.
- Δt = Time interval between both sounds.

① Mass, Weight, Density & Volume

* Density of an object is directly proportional to its mass & indirectly proportional to its volume.
* In order to double the mass, either double the mass or half the volume.

② Kinematics

* When moving in a circular path, friction between tires & road provides the resultant force acting towards the centre of circular path.
* As the speed of vehicle increases, air resistance also increases which decreases the resultant force. To maintain a constant acceleration, the driving force must be increased so that resultant force remains constant.
* The Kinetic energy of any object remains constant if speed is constant.
* The chemical energy of fuel in a vehicle is converted to heat energy due to its burning which in turn changes into kinetic energy & finally changes into heat & internal energy due to friction & air resistance.

③ Force, Vector & Scalar Quantities

* Acceleration is inversely proportional to mass.
* The electrostatic force of attraction between +ively charged nucleus & -ively charged electron provides the centripetal force towards nucleus for the motion of electron around nucleus.
* When speed is constant, value of forward force is equal to value of backward force.
* Factors affecting the distance travelled by car during time that the brakes are applied are force applied, speed of vehicle & friction between tires & road.
* When a mass with string is streetched, the tension increases, greater than mass which makes the object accelerate.
* A vehicle carrying heavy load decelerates slower.
* In vaccuum, both heavy & light objects reach bottom at same time. Their heights at all time is same.

Since their acceleration is 10 m/s, their motion is identical.

④ Work, Energy & Power

* In a coal-fired power station, the chemical energy stored in coal is released as heat energy on burning coal. Coals are burnt to heat water to produce steam. The kinetic energy of steam is used to turn the blades of turbine, it turns the generator & electrical energy is produced.
* The boiler converts chemical energy to internal energy. The turbine converts internal energy into kinetic energy. The generator converts kinetic energy into electrical energy.
* The advantages of hydroelectric power station are that it doesn't produce harmful gases, no fuel costs & uses renewable energy source while still it can destroy habitats, forests & even cause flooding if dam fails.
* Wasted % = $\frac{\text{Energy wasted}}{\text{Energy Supplied}} \times 100\%$
* Water resistance is also known as fluid friction or drag force of water.

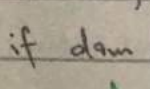
⑤ Principles of Moments

To verify the principle of moments set up the apparatus. Place metre rule on pivot at 50 cm mark. Add weights & balance the metre rule by adjusting distances d_1 & d_2. Calculate clockwise & anti clockwise moments ($f \times d$). If ① = ②, then it verifies Principle of moments. Use weights of different values & repeat experiment.

⑥ Pressure

* Pressure at two pistons:

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

* The gas pressure in (open) manometre is the atmospheric pressure + h (extended length).
* The height does not depend on cross-sectional area of manometre.
* 

The increasing slope (gradient) shows the increasing speed/acceleration later constant gradient shows constant speed.
* The airbag increases the time interval during which the ball comes to a rest after the impact

so the val
reduced. As
human is
because
contact
human
acting
decreases
also dec
of impa
so force

⑦ Hea

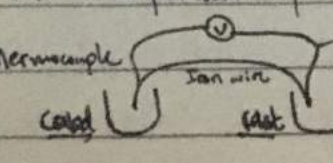
* When
a tun
in the
expan
surfac
is
* At
h
al
th
is
re
en
i
* Th

so the value of acceleration is reduced. As a result, the force on human is also reduced during impact because $f \propto a$. Else, the area in contact between the air bag & human increases so the force acting per unit area on human decreases hence pressure exerted also decreases. Some of the force of impact is absorbed by airbag so force exerted on human decreases.

⑦ Heat Capacity & Expansion

* When hot water is poured into a tumblr glass, cracks are developed in the glass due to uneven expansion of inner & outer surfaces of glass. Thats why, glass is made of thin glass.
* At higher temperatures, rate of heat loss & rate of evaporation also becomes higher. So more of the heat supplied to the water is lost to the surroundings & remaining less amount of heat energy causes a smaller increase in temperature of water.

* Thermocouple



* The release of latent energy doesn't affect the kinetic energy of molecules. It only decreases their potential energy hence temperature remains constant during change of state from liquid to solid.

⑧ Transfer of Heat

⑨ Temperature

* If the distance between each division along the scale is same, the scale of thermometer is same.
* Thermometer range $\propto \frac{1}{\text{Liquid expansion}}$
* Thermometer sensitivity $\propto \frac{1}{\text{Thermometer bore}}$
* A very narrow bore allows thermometer its sensitivity to small temperature changes.
* Thermocouple has low heat capacity which makes it suitable for measuring rapidly changing temperatures.

⑩ Gas Laws & Particles of Matter

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

Since val

S. $P_1 \times L_1 = P_2 \times L_2$

* When putting ice in water, the temperature of air in bottle decreases, (4) the speed of air molecules decrease. The air molecules in the bottle now exert a smaller force than before & hence the pressure in the bottle decreases. The air molecules outside the bottle dont experience any temperature change & continues to exert same force as before. This produces a pressure difference crushing the bottle.

(11) Change of State

* Heat capacity & specific heat capacity involves heat required for temperature change. Latent heat is the total heat required for change in state.
* Fans increase the rate of evaporation from skin causing coolness.
* To measure the electrical input of kettle, place the kettle on mass balance & wait until the water is boiling. Start a stopwatch & record the reading on the mass balance as m_1. After an interval of time, stop the stopwatch & record the reading on the mass balance again as m_2. Note this time as t. Power is equal to $m_1 - m_2$ multiplied by specific latent heat of vaporisation of water divided by time.

(12) Longitudinal Waves

* The loudness of sound heard depends on amplitude of sound wave while the pitch depends on its frequency.
* The sounds which have same fundamental frequencies but different shape of sound waves have basically different quality/timbre.
* Speed of sound in air is lesser than in metals
* 1 ms = 0.001 s.
* When producing sound by a mobile phone, its electrical energy (from the mains) is converted to kinetic energy in speaker.
* The pressure increases & decreases alternately along the path of the ultrasound in the body which causes the gas bubbles in the body to expand & contract.

(13) Transverse Waves

* The spe
wave o
in medi
* The wa
the de
as they
Its spe
frequency
Refracti
& wa
deep
* Wave
oscillat
from
without
mediu

(14) D

* Wh
to
ligh
* Th
bet
Red
ori
den

(15)

* The speed & wavelength of a wave only change during a change in medium.
* The water waves refract due to the decrease in their speed as they enter a shallow region. Its speed also decreases but frequency remains constant. Refraction is towards the normal & wavelength also decreases from deep water to shallow water.
* Wave motion is a vibration or oscillation which carries energy from one point to another without any net movement of medium.

(14) Dispersion of Light

* Wavelength decreases from red to violet in dispersion of white light through glass prism.
* The dispersed light rays always bent towards base of prism. Red is deviated least from its orignal path while violet deviates most. Frequency decreases downwards

(15) Lenses

* If incident & emergent ray in refraction are perpendicular to glass surface then refracted ray in the lens must also be perpendicular to the glass surface.
* Converging lens's real images are inverted but virtual images are upright.
* Human eye has converging lens system that produces real, inverted & diminished image.
* To use the converging lens as a magnifying glass, the object must be placed at a distance less than focal length away from lens.
* Linear magnification:

$$\frac{\text{Image length/distance}}{\text{Object length/distance}}$$

* Wherever the object is positioned, the image formed by diverging lens is always small, upright, virtual & formed between object & lens on same side of lens.
* When taking photograph of an object at a far distance, it is necessary to focus a clear & sharp image of the object on the film by moving the lens towards the film otherwise blurred image is formed in front of film.

(16) Refraction

* When light passes from glass to air its wavelength increases because its speed increases.

④ * If refraction diagram is then $n = \frac{\sin \hat{r}}{\sin \hat{i}}$

* An experiment to measure critical angle is that place a semi circular block on paper & draw its outline. Draw a normal from the middle "O". Direct a ray of light towards "O" using ray box. Move the ray box left to normal, round the circular side of block. Angle of incidence & refraction increases. Continue moving the ray box until refracted ray is seen lying flat on the boundary making $\hat{r} = 90°$ hence showing critical angle presence. Mark the position of ray box. Remove glass block & draw incident & refracted rays. The angle of incidence equals to critical angle.

⑰ Reflection

⑱ Electromagnetic waves

* All E.M waves have same speed in vacuum so the frequency of E.M wave is inversely proportional to its wavelength.
* All E.M waves are unaffected by electric or magnetic fields.
* The long wavelength X-rays are less penetrating & are used in Radiology, the science of applying X-rays to medicine to produce pictures of internal organs of body. They can pass through flesh but are stopped by the bones so the bones will show up on X-ray photograph.
* Microwaves are used in the transmission of television signals by satellite as the transmitted signals from earth pass through the atmosphere & travel through space. The boosted signals are then transmitted by the satellite & are recieved by a dish on earth.

⑲ Static Electricity

* Earthing is the connection of metal conductor with earth.

⑳ Current Electricity

* Unit of potential difference can be written as J/C.
* When a lamp is connected in series & an identical lamp

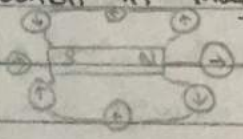
is connected in parallel to the lamp, the overall resistance of circuit decreases to half & current becomes double.

* Live wire = Brown
  Neutral wire = Blue
  Earth wire = Green & Yellow
* Power rating of 1W means that it converts 1J of electrical energy to other forms of energy in 1s.
* Resistance is a property of a material that hinders the movement of free electrons in the material.
* When the current through the filament of the lamp increases with increase in potential difference across it, heating effect in filament increases thus its temperature rises. As a result, resistance of filament increases.
* $EMF = \frac{Energy}{Charge}$
  - $V = \frac{E}{Q}$
  - $E = VQ$
* To measure the electrical power supplied to lamp, a power supply of EMF, lamp, switch & ammeter are connected in series & a voltmeter is connected across the lamp. Switch is closed & voltmeter & ammeter readings are noted. Power supplied can be calculated by $P = V \times I$
* Earth wire & fuse work together as earth wire directs the current into the ground & flow of excessive current causes fuse to melt disconnecting flow of current.
* Metal Conductor
* If voltmeter is calibrated & temperature values are marked on its scale using known values of temperature then a circuit with metal conductor can be used as a thermometer to measure temperature of a hot body by using metal conductor as probe. On touching the probe, voltmeter will show temperature of body directly.
* To measure the resistance variation with temperature, dip resistive wire in water connected with ammeter & voltmeter. Turn on switch & measure R by V/I. Rise the temperature of water with 10°C & measure R again. Do this for few sets & plot a graph. The graph shows that resistance of wire increases

linearly with temperature.
* When the potential difference of wire is directly proportional to current in it. $R \propto I$

(21) Magnetism

* Magnetic attraction between a magnet & magnetic material is due to induced magnetism.
* Only repulsion can be used to determine if a metal bar is magnet.
* Compass direction in magnetic field



* To demagnetise a magnet, place it under a.c current. As the a.c current in the coil reverses 50 times a second, the direction of the magnetic in the coil also reverses 50 times a second. This alters the alignment of domains in the magnet & magnetic field becomes weaker & weaker until it is not strong enough to align domains again.

(22) Magnetic Effect

Direction of current in the coil has no effect on the size of the turning effect on the coil of an electric motor.
* In a loudspeaker, a.c is passed through the coil placed in a magnetic field to vibrate it alongwith the cone attached to it forward & backward resulting in cone producing compression & rarefactions in the surrounding air that gives rise to sound.
* The soft iron coil helps to concentrate the magnetic flux from the field magnets on the sides of coil.
* In d.c motor, split ring commutator is made up of copper as its a good conductor of electricity.
* A simple circuit breaker works as magnetic field produced by soft iron core increased & pulls the iron lever towards it by magnetic attraction. The spring pulls the springy metal away from contact & contacts get broken
* In a d.c motor, no current is delivered to the coil if the carbon

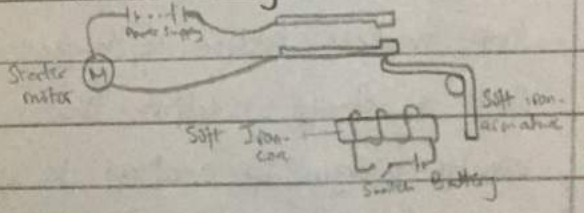
brushes a
commutat
between
* The th
resistan
heating
decrease
* A rel
small
switch
current
a curr
& soft
in the
arma
As
move
its
close
the
it

(23)

brushes are not in contact with commutators due to the air gap between the two split ring commutators.

* The thick wires have low resistance which reduces the heating effect in the wires hence decrease power loss.

* A relay is a circuit with a small current which is used to switch on a circuit with large current. When switch is closed, a current flows in the solenoid & soft iron core is magnetised. This in turn attracts the soft-iron armature by magnetic induction. As the vertical part of armature moves towards the soft-iron core, its horizontal part moves up & closes the contacts. This completes the circuit of starter motor & it starts working.



(23) Electromagnetic Induction

* If the speed is doubled, the amplitude of a.c voltage is doubled & the period of voltage is halved & vice versa in a voltage/time graph.

* A step up transformer is used at power station to increase voltage but decrease current in transmission cables to reduce power losses.

* The resistance of the conductor affects the value of induced current but not induced emf.

* The magnitude of the emf induced in the coil depends on i) Speed of magnet. ii) Strength of magnet. iii) No. of turns in coil.

* In a simple ac generator, as the coil rotates, it cuts the magnetic field lines between the N-S magnetic poles of the field magnets. A change in the magnetic flux takes place & as a result, emf is induced in the coil according to law of electromagnetic induction.

(24) Electronics, CRO

* The resistance of a thermistor decreases with increase in its temperature. If its attached in series, its resistance is directly proportional to potential difference

across it thus, P.D & R both decrease but not to 0.

* If alternating P.D is applied to the deflecting plates of CRO, it causes the charge on the plates to alternate. The beam of electrons is attracted to the plate which is positive hence an oscillatory movement is seen on the screen.
* A vacuum in glass vessel of CRO is neccessary to avoid electrons colliding with air molecules causing a decrease in their kinetic energy.
* If the value of time-based is reduced, frequency lowers & trace expands horizontally. If the value of Y-gain is reduced, trace expands vertically.
* Total Charge: $Q = It$
* Total number of particles:

$$N_p = \frac{\text{Total Charge}}{\text{Charge on one particle}}$$

(25) Radioactivity

* Radioactive decay is a process in which the nucleus of an unstable atom emits atleast one kind of radiation spontaneously & transforms into a new atom who nucleus is more stable than its parent.
* Connect the geiger-muller tube to a ratemeter to measure the count-rate from the source. The random fluctuation of the count rate shows that the emission is random.
* To determine the penetrating powers, count the background radiation first then emit radiation from a source. Place a G.M tube infront & measure reading after putting paper to aluminium one by one. Deduce the penetrating power & show that gamma rays are high penetrating.
* In a nuclear power station, the splitting of an atom produces neutrons with lots of kinetic energy. The neutrons continue the nuclear fission & hence start a chain reaction. The kinetic energy of neutrons is converted into heat energy in the reactor core. Heat is absorbed by the coolant which transfers heat to water. Water turns into steam which drives turbine.

* Distance-time graph:
Flat part on the graph shows 0 speed, stationary.

* Air resistance:
Air resistance occurs due to collisions of air particles. With increasing speed, collisions increase hence air resistance increase.

* Terminal velocity:
When a parachutist jumps, the initial force acting on him is his weight so he falls faster but then air resistance occurs & when both forces match, terminal velocity is reached. When he opens parachute, air resistance increases & he slows down. Due to slow speed; less air particles collisions; air resistance decreases & again terminal velocity is reached.

* Drag:
Force opposing motion. Acts upwards.

* Experimental questions:
Identify to take average for precise measurements.

* Momentum:
Mass x Velocity

* Resistance on metal wire:
The resistance on metallic object increases with temperature because positive ions vibrate more & stop the flow of subsik electrons.

* Gas bubble in water:
The volume of gas bubble increases from bottom to top because the pressure decreases near surface & bubble expand or it get warmer near surface & particles vibrate more.

* Alpha particles:
Alpha particles have heavier mass & charge. They cause more ionisation. Energy lost from ionisation means alpha particles cant penetrate as far. They are more likely to collide with atoms as they are bigger.

* Diode:
An electrical component that allows electricity to flow in one direction only.

* Relay:
An electromagnetic switch, operated by a relatively small electric current that can turn off or on a much larger electric current.

* Image:
If image is at f or near middle it is virtual & upright but if its far from f, it is magnified & inverted.

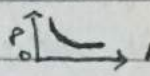
PHYSICS

Oct/Nov 18

* Speed of light in air = 10^6 / Speed of sound in air
* Power station transmits electrical energy to distant locations using a.c current at high voltage.
* Range of thermometer refers to difference between max & min marked temperatures.
* Its sensitivity refers to the change in property (length, volume etc) per unit degree.
* Magnets attract iron due to the influence of their magnetic field upon iron. Exposed to magnetic field, iron atoms begin to align their electrons with the flow of magnetic field which magnetises it. This creates attraction between both magnetised objects.
* Light is transverse in nature.
* In a nuclear reactor, scientists shoot a whole bunch of neutrons at uranium-235 atoms. When it absorbs neutron, it becomes U-236 & wants to split apart.
* Insulator doesn't has free to move electrons unlike conductor.
* Ac current has varying size or is sinusoidal.
* Object is dipped into cleaning solution & the ultrasonic waves are sent into the solution. Due to the high frequency sound, the dust & grease gets detached from object.

May/Jun 18

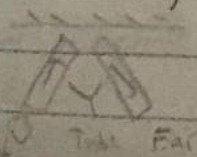
* Pressure – Base Area relation.



PHYSICS

Oct/Nov 17

* Electromagnetic waves:
  R ⟶ G ;
  ① Wavelength decreasing.
  ② Frequency increasing
  ③ Energy increasing
* Thermocouple can measure rapidly varying temperatures.
* The no. of atoms in a radioisotope reduces after half-life. May/Jun 17
* To determine time between two pulses on oscilloscope, find distance between them & multiply with time-base / no. of ms/div.
* Alpha particle is positive so it gains electrons from air.
* (Idea) Electrons can travel back to sphere from earth.
* Particles moving far ; V↑, Dens↓
* Large bulb, narrow tube = most sensitive thermometer.
* Healthy ear frequency:
  Low: 15-25 Hz
  High: 15000 - 30000 Hz
* Experiment to show sound waves follow law of reflection.



Virtual image is not formed on screen, nothing at image position.

Oct / Nov 16

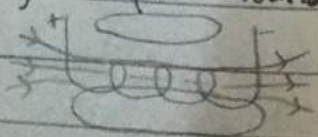
* Transformer coil is made up of copper.
* Balanced forces:

May / Jun 16

* Microwaves penetrate atmosphere without significant loss of energy.
* Bubbles in liquid contains its gaseous state.
* High temperature required for fusion because like charges repel.
* Electric field accelerates electron in CRO.

Oct / Nov 15

* Magnetic field around solenoid:



* Energy changes during terminal velocity: $E_G \rightarrow E_T$ or (E_K of air).

May / Jun 15

* Image formed by lens ; magnifying virtual & erect

May / Jun 14

* Atmospheric pressure with height
* Alpha particles is few cm

Oct / Nov

* Presence of water prevents it from after taken out

May / Jun 15

* Image formed by thin converging lens ; magnifying glass is virtual & erect.

May / Jun 14

* Atmospheric pressure decreases with height.
* Alpha particles range in air is few centimetres.

Oct / Nov 13

* Presence of kink in mercury prevents it from falling back after taken out // constriction.