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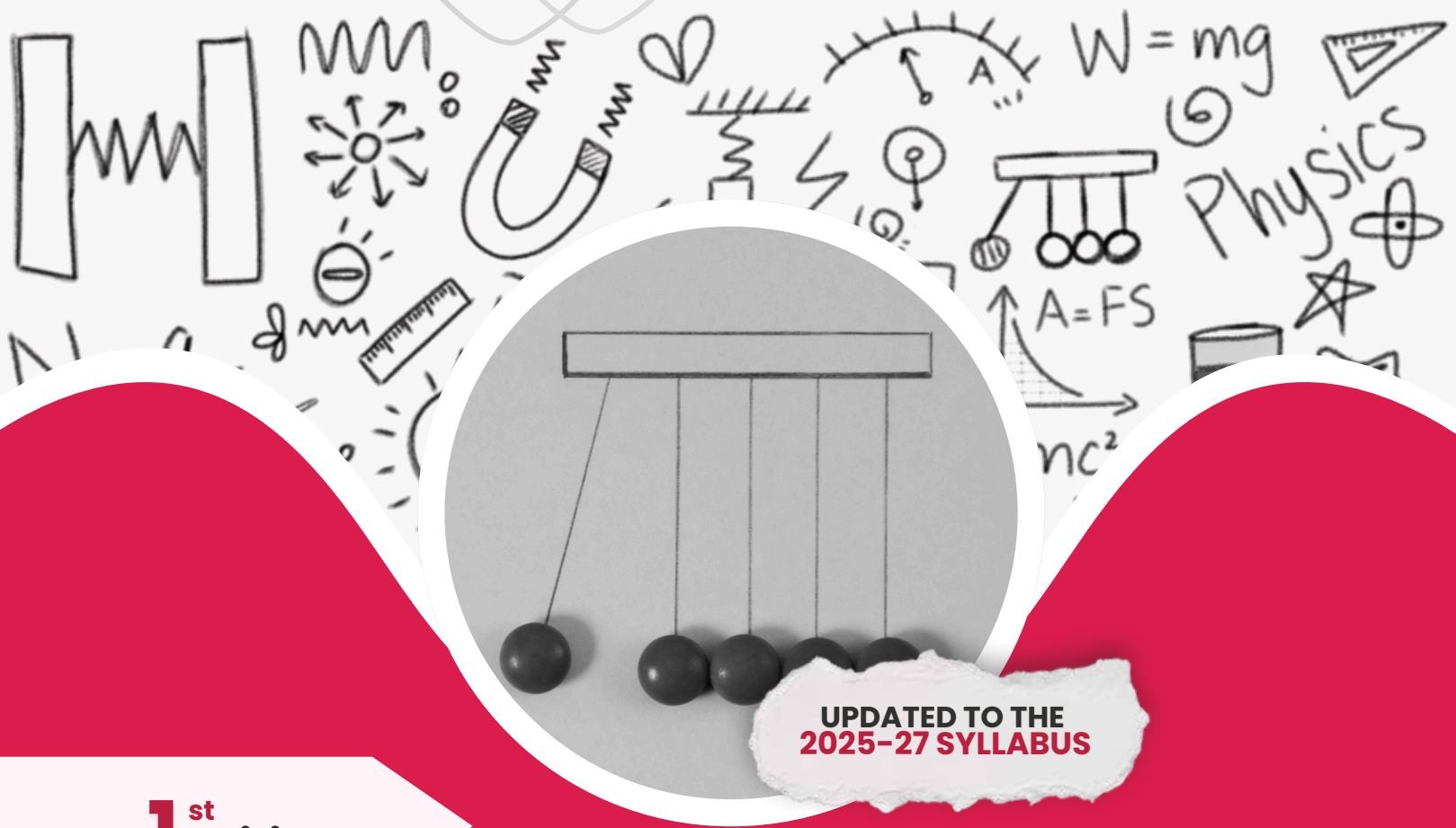
O'Levels

PHYSICS

CHAPTER SUMMARIES



UPDATED TO THE
2025-27 SYLLABUS

1st Edition

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Physics Chapter Summaries

5054

BY TEAM MOJZA

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CONTENTS

Motion, Forces & Energy

Physical quantities and measurement techniques

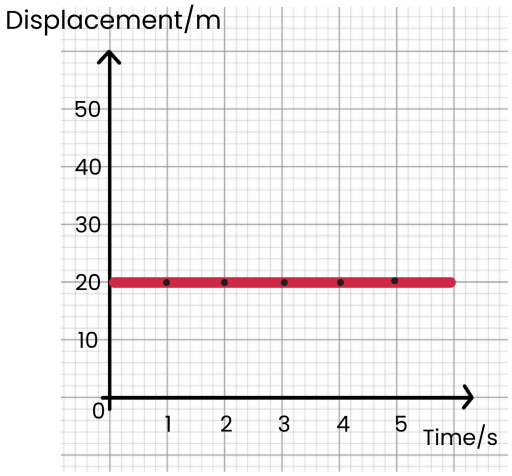
- ➔ Length has SI Unit Metre with symbol (m).
- ➔ Can be measured using the Metre rule which is suitable for straight lengths < 1 metre.
- ➔ Can be measured using Steel tape measure which is suitable for straight lengths > 1 metre.
- ➔ Can be measured using Cloth tape measure which is suitable for curved surfaces.
- ➔ Can be measured using Vernier Calipers which is useful in measuring internal and external diameters of an object with precision up to 0.01 cm.
- ➔ Can be measured using Micrometer Screw Gauge which is useful in measuring objects that are too small to be measured by vernier callipers with precision up to 0.01 mm.
- ➔ Parallax errors are common while reading a scale.
- ➔ In order to read an accurate reading, eye level must be perpendicular to the scale.
- ➔ Zero Error can be made during measurement.
- ➔ To avoid zero error, make sure zero marks of both scales coincide.
- ➔ In case of positive/negative zero error, subtract/add the error to make it accurate.
- ➔ Volume is measured using Measuring Cylinder
- ➔ For Liquid: Add liquid to Measuring Cylinder and note the volume
- ➔ For irregular Solid: add liquid to Measuring Cylinder and note initial volume, add irregular solid to Measuring Cylinder and note final volume and subtract.
- ➔ Time has SI unit Second with symbol (s).
- ➔ Can be measured using Clocks, stop watched and pendulums
- ➔ To measure short intervals of time a pendulum setup is used.
- ➔ The time for a large number of oscillations is divided by the number of oscillations for short intervals.
- ➔ Human Reaction Error may be caused by a person due to reaction time.
- ➔ It can be minimised by taking multiple readings and taking average.
- ➔ Scalar quantities have magnitude (size) only. Examples of scalar quantities are distance, speed, time, mass, energy and temperature.
- ➔ Vector quantities have both magnitude and direction. Examples of vector quantities are displacements, velocity, weight, acceleration and momentum.
- ➔ The resultant of two vectors at right angle can be calculated using the pythagoras theorem and graphically using the Head-to-Tail method.

Motion

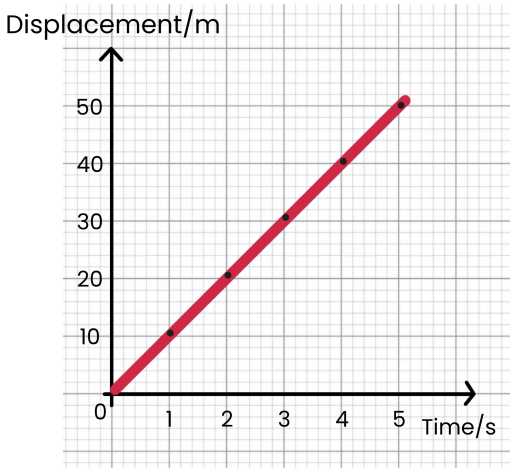
- ➔ Speed is distance travelled per unit time.
- ➔ Velocity is the change in displacement per unit time.
- ➔ speed = distance/time
- ➔ $v = s/t$
- ➔ average speed = total distance travelled/total time taken
- ➔ Acceleration is change in velocity per unit time.
- ➔ acceleration = change in velocity/time taken
- ➔ $a = \Delta v/\Delta t$
- ➔ Uniform Acceleration is when the change in velocity is constant.

- ➔ Non-Uniform Acceleration is when change in velocity is not constant.
- ➔ Deceleration is a negative acceleration.
- ➔ Displacement-Time Graphs:-

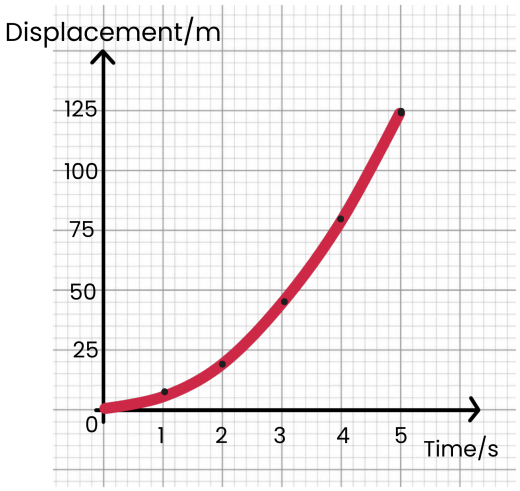
➔ Zero displacement so the car is at rest.



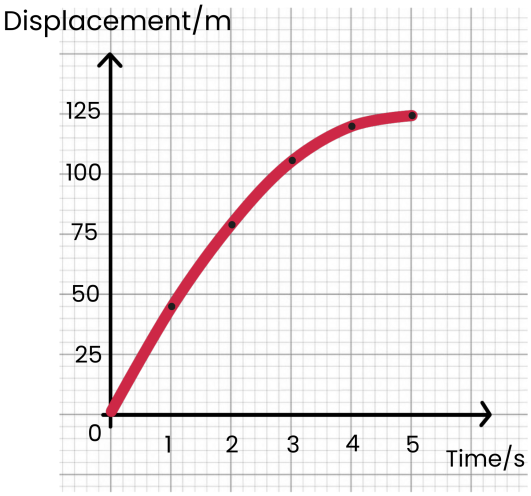
➔ Constant gradient so the car is moving at uniform velocity



➔ The gradient is increasing so, the car is is moving with increasing velocity (non-uniform velocity)

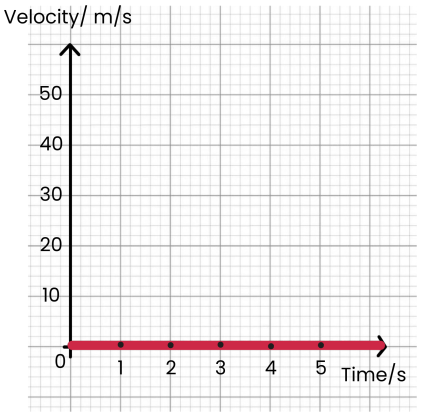


➔ The graph has decreasing gradient so the car is moving with decreasing velocity

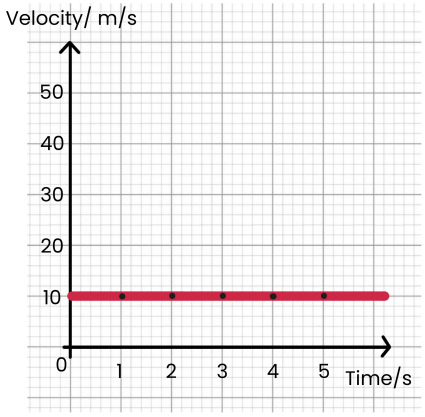


➔ Velocity-Time Graphs

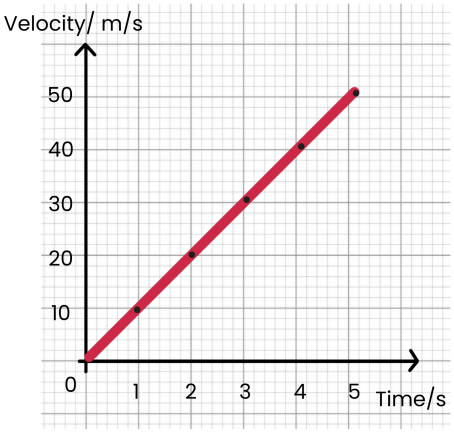
➔ Object is at rest



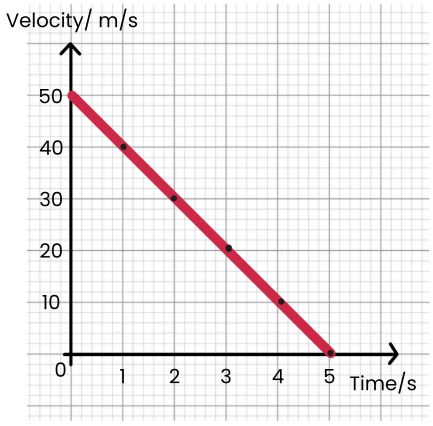
➔ Constant Velocity



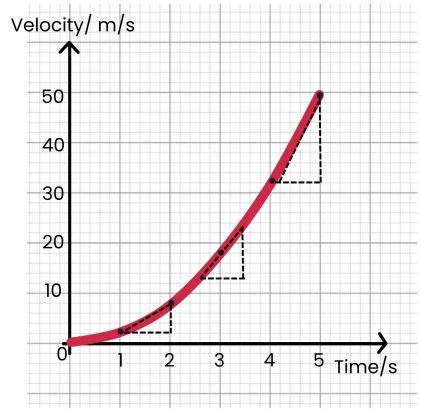
➔ Velocity is increasing uniformly



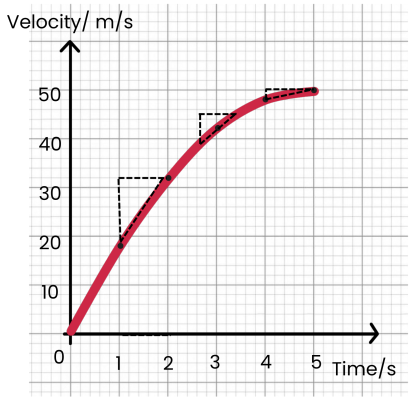
➔ Velocity is decreasing uniformly



➔ Velocity is increasing with increasing acceleration



➔ Velocity is increasing with decreasing acceleration



- ➔ Acceleration of free fall g for an object near to the surface of the Earth is approximately constant and is approximately 9.8m/s^2
- ➔ Speed = gradient of a distance–time graph.
- ➔ the area under a speed–time graph = the distance travelled for motion with constant speed or constant acceleration.
- ➔ Acceleration = gradient of a speed–time graph.

Mass and weight

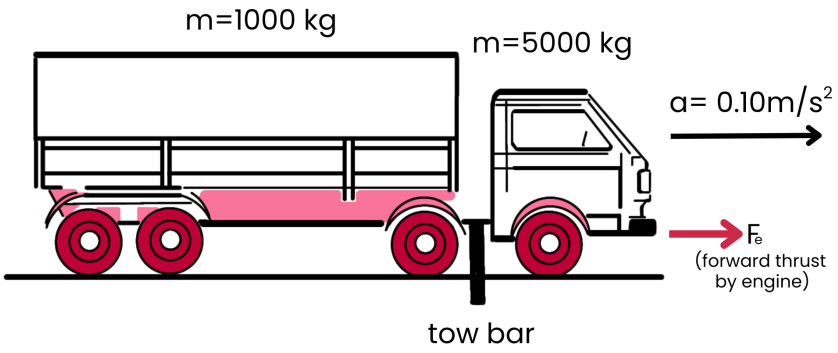
- ➔ Mass is a measure of the quantity of matter in an object at rest relative to the observer.
- ➔ Mass of an object resists change from its state of rest or motion (inertia).
- ➔ Weights, and therefore masses, may be compared using a beam balance or equal-arm balance.
- ➔ Gravitational field strength is force per unit mass.
- ➔ gravitational field strength = weight/mass
- ➔ g = W/m
- ➔ Gravitational field strength = weight/mass is equivalent to the acceleration of free fall
- ➔ Gravitational field is a region in which a mass experiences a force due to gravitational attraction

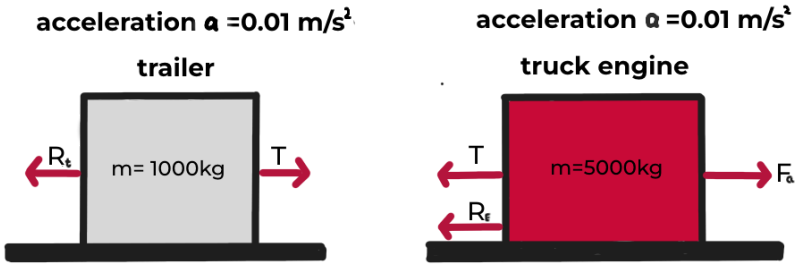
Density

- ➔ Density as mass per unit volume; recall and use the equation.
- ➔ Density = mass/volume
- ➔ ρ = m/V
- ➔ Density of Regular Shapes can be measured by making appropriate calculations for mass using balances and volume then applying formula for density
- ➔ Density of Irregular Shape is determined by measuring mass using balance, measuring volume using liquid displacement method and applying density formula.

Forces

- ➔ Weight is gravitational force acting on any object.
- ➔ Friction is a force that may impede motion and produce heating
- ➔ Drag is the air resistance acting on any moving object.
- ➔ Tension is an elastic force on any stretched object.
- ➔ Electrostatic forces are the forces acting between particles.
- ➔ Magnetic force is the attraction of repulsion between magnets or between magnets and magnetic materials.
- ➔ Thrust is a forward driving force.
- ➔ Contact force is any force generated with the contact of two objects.
- ➔ Freebody diagrams represent forces acting on an object.
- ➔ Free Body Diagrams:-
- ➔



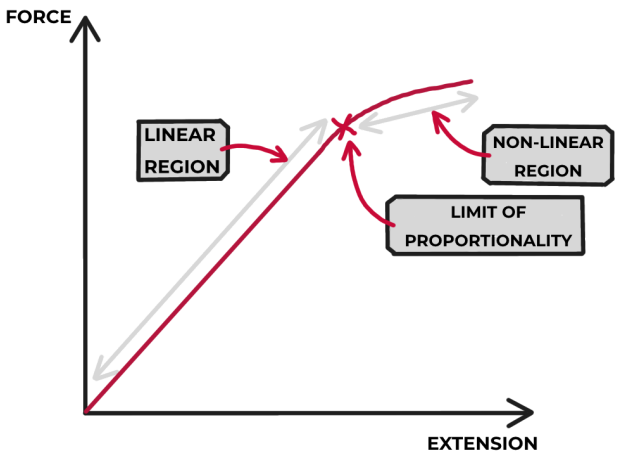


Free body-diagram of the trailer

Free-body diagram of the engine

- ➔ Newton's first law is 'an object either remains at rest or continues to move in a straight line at constant speed unless acted on by a resultant force'.
- ➔ A force may change the velocity of an object by changing its direction of motion or its speed.
- ➔ Resultant of forces in a straight line can be determined by adding or subtracting forces acting in the same or opposite direction.
- ➔ Resultant force = mass × acceleration
- ➔ F = ma
- ➔ Newton's third law is 'when object A exerts a force on object B, then object B exerts an equal and opposite force on object A'
- ➔ Newton's third law describes pairs of forces of the same type acting on different objects.
- ➔ Friction as a force that may impede motion and produce heating.
- ➔ An object can only be in free fall when only it's own weight is acting on it (no air-resistance)
- ➔ Air resistance increases with the speed,size (surface area) of an object and the density of the air.
- ➔ When the air resistance and the weight of an object falling are equal the object has reached terminal velocity.
- ➔ Thinking distance = The distance travelled in the time it takes the driver to react (reaction time) in metres.
- ➔ Braking Distance = Distance travelled under braking force.
- ➔ Stopping distance = Sum of the breaking and thinking distance.
- ➔ thinking and braking distance may be affected by speed, tiredness, alcohol, drugs, load, tyre surface and road conditions.

- Forces may produce a change in size and shape of an object.
- Spring constant is force per unit extension.
- Spring constant = force/extension
- k = F/x
- Load-Extension Graph:-



- The limit of proportionality is the point after which Hooke's Law is no longer true when stretching a material.
- Hooke's Law is the linear relationship between force and extension.
- In a circular path due to a force perpendicular to the motion speed increases if force increases, with mass and radius constant.
- In a circular path due to a force perpendicular to the motion radius decreases if force increases, with mass and speed constant.
- In a circular path due to a force perpendicular to the motion an increased mass requires an increased force to keep speed and radius constant.
- The moment of a force is a measure of its turning effect.
- Moment = force × perpendicular distance from the pivot
- The principle of moments states that when a body is in equilibrium the sum of clockwise moments is equal to the sum of anticlockwise moments.
- Condition for equilibrium is that both the moment and resultant force of a body is zero.
- The centre or gravity of an object is an imaginary point where the entire weight of the object seems to act.
- The centre of gravity of regular objects are usually their exact centres.
- The centre of gravity for an irregular object can be found by the use of a plain lamina using plumb lines.
- The points where the plumb lies intersect is the centre of gravity.
- The stability of an object is the measure of it being able to return to its original position.
- The lower the centre of gravity of an object the more stable it is.

Momentum

- Momentum is mass × velocity
- p = mv
- Impulse as force × time for which force acts
- Impulse = $F\Delta t = \Delta(mv)$
- Principle of conservation of momentum states that the total momentum in a system remains constant provided no external force is applied.
- Resultant force as the change in momentum per unit time.
- Resultant force = change in momentum/time taken
- $F = \Delta p/\Delta t$

Energy, work and power

- Energy may be stored as kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic and internal (thermal) energy.
- Energy is transferred between stores during events and processes, including transfer by forces (mechanical work done), electrical currents (electrical work done), heating, and by electromagnetic, sound and other waves.
- The principle of conservation of energy states that energy can not be created or destroyed but can be transferred from one store to another, and energy in a system (isolated) remains the same.
- The equation for kinetic energy is Ek = 1/2mv^2
- The equation for the change in gravitational potential energy is ΔE p = mgΔh
- work done = force × distance moved in the direction of the force
- W = Fd
- Useful energy may be obtained, or electrical power generated, from chemical energy stored in fossil fuels.
- Useful energy may be obtained, or electrical power generated, from chemical energy stored in biofuels.
- Useful energy may be obtained, or electrical power generated, from hydroelectric resources.
- Useful energy may be obtained, or electrical power generated, from solar radiation, nuclear fuel, geothermal resources, wind, tides and from waves in the sea.
- (%) efficiency = [(useful energy output)/(total energy input)] (× 100%)
- (%) efficiency = [(useful power output)/(total power input)] (× 100%)
- Power is work done per unit time.
- Power is energy transferred per unit time.
- Power = work done/time taken
- P = W/t
- Power = energy transferred/time taken
- P = ΔE/t

Pressure

- Pressure is force per unit area.
- pressure = force/area
- p = F/A
- Pressure varies with force and area.
- The pressure at a surface produces a force in a direction at right angles to the surface.
- The height of a liquid column in a liquid barometer may be used to determine the atmospheric pressure.
- The pressure beneath the surface of a liquid changes with depth and density of the liquid.
- Change in pressure = density × gravitational field strength × change in height
- Δp = ρgΔh

Thermal Physics

Kinetic particle model of matter

- ➔ Solid, Liquids and Gases have distinguished properties.
- ➔ Solids are most closely packed with particles vibrating at mean position.
- ➔ Liquids are less densely packed than solids but more than gases and have non fixed shape but fixed volumes.
- ➔ Gases are least dense with no fixed volumes (compressible) and particles have the most energy out of the three states of matter.
- ➔ Particles gain more energy and move more erratically with higher temperatures.
- ➔ Particles move less erratically and slow down (in movement) with lower temperatures.
- ➔ There is a lowest possible temperature (−273°C), known as absolute zero, where the particles have least kinetic energy.
- ➔ Particles of gas colliding into each other and surfaces of a container release a slight pressure which creates a pressure when a gas is fit into a container.
- ➔ The pressure of a fixed mass of gas is directly proportional to the temperature provided that the volume is constant.
- ➔ The pressure of a fixed mass of gas is inversely proportional to its volume provided a constant temperature.
- ➔ The volume of a fixed mass of gas is directly proportional to its temperature provided a constant pressure.
- ➔ p1 V1 = p2V2
- ➔ The relationship between pressure and volume for a gas at constant temperature can represented by the equation: $p = k/V$ or $p \propto 1/V$

Thermal properties and temperature

- ➔ Substances including solids, liquids and gases expand when they are heated.
- ➔ When temperature is increased in any state of matter the particles gain energy and when enough energy is gained they overcome the forces binding them in place and expand.
- ➔ Convert temperatures between kelvin and degrees Celsius: T (in K) = θ (in °C) + 273
- ➔ An increase in the temperature of an object increases its internal energy.
- ➔ An increase in temperature of an object is an increase in the average kinetic energies of all of the particles in the object.
- ➔ Specific heat capacity is the energy required per unit mass per unit temperature increase.
- ➔ specific heat capacity = (change in energy)/(mass × change in temperature)
- ➔ $c = \Delta E/m\Delta\theta$
- ➔ Melting, solidification, boiling and condensation are energy transfers without a change in temperature.
- ➔ The melting point of water (ice) is 0°C at standard atmospheric pressure.
- ➔ The boiling point of water is 100°C at standard atmospheric pressure.
- ➔ Boiling occurs at specific temperature while evaporation occurs at any temperature.
- ➔ Boiling is faster than evaporation.

- ➔ Boiling takes place throughout the liquid while evaporation only takes place at liquid surface.
- ➔ Boiling forms bubbles in the liquid while evaporation does not.
- ➔ Temperature remains constant in boiling while in evaporation it can vary.
- ➔ Boiling requires an external thermal energy source while evaporation does not.
- ➔ Evaporation is the the escape of more energetic particles from the surface of a liquid.
- ➔ Rise in temperature increases the rate of evaporation.
- ➔ The rate of evaporation increases with a larger surface area.
- ➔ Moving air increases the rate of evaporation.
- ➔ Evaporation causes cooling by leaving behind particles that have lower kinetic energy than those that just evaporated.
- ➔ Latent heat is the energy required to change the state of a substance.

Transfer of thermal energy

- ➔ Thermal conduction in all solids is due to atomic or molecular lattice vibrations and also due to the movement of free (delocalised) electrons in metallic conductors.
- ➔ Convection in liquids and gases happens due to density changes.
- ➔ The process of thermal energy transfer by radiation is done by infrared radiation and it does not require a medium.
- ➔ Dull and black surfaces are better emitters and absorbers of infrared radiation than shiny and silver surfaces.
- ➔ Rate of emission of radiation depends on the surface temperature and surface area of an object.
- ➔ Everyday applications using ideas about conduction, convection and radiation include: heating objects such as kitchen pans, heating a room by convection, measuring temperature using an infrared thermometer, using thermal insulation to maintain the temperature of a liquid and to reduce thermal energy transfer in buildings.

Waves

General properties of waves

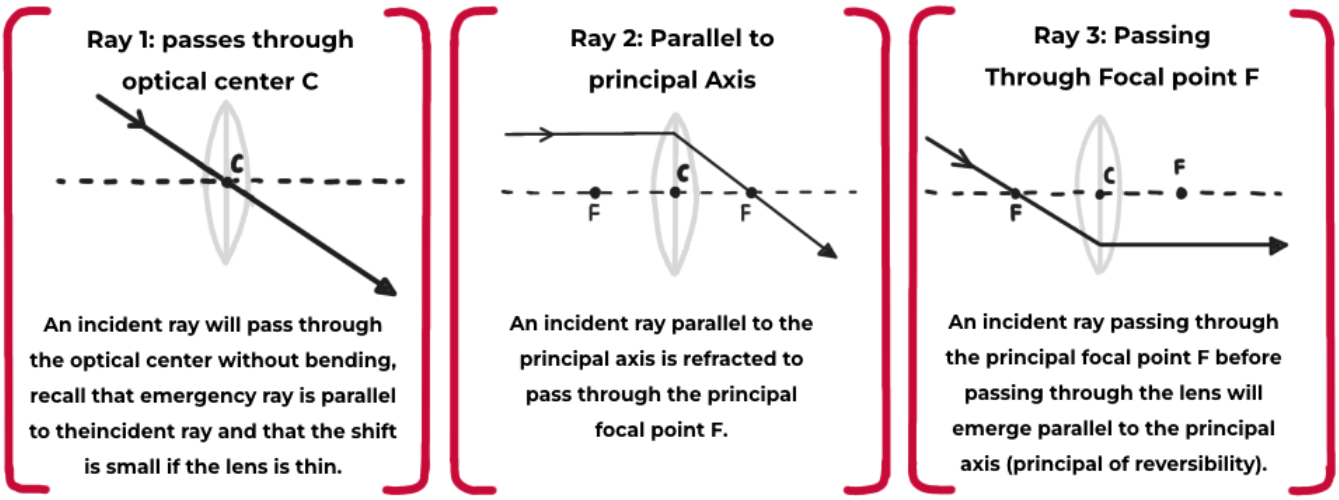
- ➔ Waves transfer energy without transferring matter.
- ➔ A wave is a periodic motion.
- ➔ Wavefront is an imaginary point on a wave that joins all adjacent points that are in a phase.
- ➔ Wavelength is the distance between two consecutive, identical points such as two consecutive crests.
- ➔ Frequency is the number of wavelengths that pass a point per unit time.
- ➔ Crest (peak) is the highest point in a transverse wave.
- ➔ Trough is the lowest point in a transverse wave.
- ➔ Amplitude is the maximum distance from the mean position.
- ➔ Wave speed is the distance travelled by a wave per second.
- ➔ wave speed = frequency × wavelength
- ➔ $v = f \lambda$
- ➔ For a transverse wave, the direction of vibration is at right angles to the direction of the energy transfer.
- ➔ For a longitudinal wave, the direction of vibration is parallel to the direction of the energy transfer.
- ➔ Waves can undergo reflection at a plane surface.
- ➔ Waves can undergo refraction due to a change of speed.
- ➔ Waves can undergo diffraction through a gap.
- ➔ Wavelength and gap size affects diffraction through a gap.
- ➔ A Ripple tank is used to show reflection at a plane surface.
- ➔ Ripple tank is used to show refraction due to a change in speed caused by a change in depth.
- ➔ A ripple tank is used to show diffraction due to a gap.
- ➔ Ripple tank is used to show diffraction due to an edge.
- ➔ Wavelength affects diffraction at an edge.

Light

- ➔ Normal is the perpendicular to the reflecting surface at the point of incidence.
- ➔ Angle of incidence is the angle between the incident ray and the normal.
- ➔ Angle of reflection is the angle between the ray of reflection and the normal.
- ➔ Position and characteristics of an optical image formed by a plane mirror are the same size, same distance from the mirror as the object and virtual.
- ➔ For reflection, the angle of incidence is equal to the angle of reflection.
- ➔ Angle of refraction is the angle between the refracted ray and the normal.
- ➔ Refractive index n is $n = \sin i / \sin r$
- ➔ Critical angle is the angle of incidence for which the angle of refraction is 90°
- ➔ Total internal reflection the total reflection of a light ray inside an optically denser medium at its boundary with an optically less dense medium.
- ➔ $n = 1/\sin C$

- ➔ Light rays converge in a thin converging lens.
- ➔ Light rays diverge in a thin diverging length.
- ➔ A real image is formed by converging rays and a virtual image is formed by diverging rays.
- ➔ Focal length is the distance between the optical centre and the focal point.
- ➔ Principal axis is the horizontal line passing through the optical centre of a lens
- ➔ Principal focus is the focus point.
- ➔ Linear magnification is the ratio of image length to object length.
- ➔ linear magnification = image length/object length
- ➔ Converging and diverging lenses are used to correct long-sightedness and short-sightedness.

- ➔ Ray diagrams:-



Three key rays for drawing ray diagrams for thin converting lenses.

- ➔ The dispersion of light is illustrated by the refraction of white light by a glass prism.
- ➔ The traditional seven colours of the visible spectrum in order of frequency are red, orange, yellow, green, blue, indigo and violet (low to high).
- ➔ The traditional seven colours of the visible spectrum in order of wavelength are red, orange, yellow, green, blue, indigo and violet (high to low).

Electromagnetic spectrum

- ➔ Main regions of the electromagnetic spectrum in order of frequency are radio waves, micro-waves, infrared light, visible light, ultraviolet light, x-rays and gamma rays (low to high).
- ➔ Main regions of the electromagnetic spectrum in order of wavelength are radio waves, micro-waves, infrared light, visible light, ultraviolet light, x-rays and gamma rays (high to low).
- ➔ Speed of all electromagnetic waves in a vacuum is 3.0 × 10^8m/s
- ➔ The speed of all electromagnetic waves in air is approximately the same as in a vacuum.

- ➔ Radio waves are used in radio and television communications, astronomy.
- ➔ Microwaves are used in satellite television, mobile (cell) phone, Bluetooth, microwave ovens.
- ➔ Infrared are used in household electrical appliances, remote controllers, intruder alarms, thermal imaging, optical fibres.
- ➔ Visible light is used in photography, vision.
- ➔ Ultraviolet are used in security marking, detecting counterfeit bank notes, and sterilising water.
- ➔ X-rays are used in hospital use in medical imaging, security scanners, killing cancerous cells, engineering applications such as detecting cracks in metal.
- ➔ Gamma rays are used in medical treatment in detecting and killing cancerous cells, sterilising food and medical equipment, engineering applications such as detecting cracks in metal.
- ➔ Damage caused by electromagnetic radiation includes excessive exposure causing heating of soft tissues and burns and ionising effects caused by ultraviolet (skin cancer and cataracts), X-rays and gamma rays (cell mutation and cancer.

Sound

- ➔ Sound is produced by vibrating sources.
- ➔ Sound waves are longitudinal in nature.
- ➔ Compression is an area of high air pressure in the path of a sound wave.
- ➔ Rarefaction is an area of lower air pressure in the path of a sound wave.
- ➔ The approximate range of frequencies audible to humans is 20Hz to 20000Hz
- ➔ Sound waves cannot travel in a vacuum.
- ➔ Changes in amplitude and frequency affect the loudness and pitch of sound waves.
- ➔ Different sound sources produce sound waves with different qualities (timbres), as shown by the shape of the traces on an oscilloscope.
- ➔ An echo is the reflection of sound waves.
- ➔ The speed of sound in air is approximately 330–350m/s
- ➔ In general, sound travels faster in solids than in liquids and faster in liquids than in gases.
- ➔ Ultrasound is sound with a frequency higher than 20kHz
- ➔ Ultrasound is used in cleaning, prenatal and other medical scanning, and in sonar.

Electricity & Magnetism

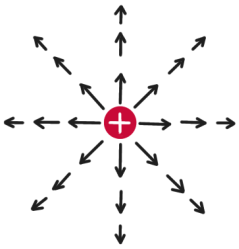
Simple magnetism and magnetic fields

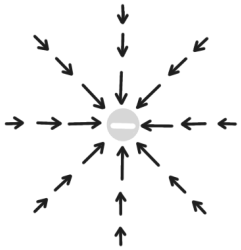
- ➔ Opposite poles (North and South) have attractive forces.
- ➔ Like or same poles (North and North or South and South) have repulsive forces.
- ➔ A magnetised material will have attraction or repulsion towards a magnet.
- ➔ A magnet will have no effect on an unmagnetized material.
- ➔ Magnetic induction is the process by which a material made of magnetic material becomes a magnet when it is near or in contact with a magnet.
- ➔ Magnetic materials experience attraction with both ends of a magnet.
- ➔ Non-magnetic material remains stationary when approached with a magnet.
- ➔ Temporary magnets are made of soft iron.
- ➔ Permanent magnets are made of steel.
- ➔ A magnetic field is a region in which a magnetic pole experiences a force.
- ➔ The plotting of magnetic field lines can be done with a compass or iron filings; a compass can be used to determine the direction of the magnetic field.
- ➔ The direction of the magnetic field at a point is the direction of the force on the N pole of a magnet at that point.
- ➔ The relative strength of a magnetic field is represented by the spacing of the magnetic field lines.
- ➔ Uses of permanent magnet include use as door catchers and in the activation of reed switches.
- ➔ Electromagnet is used in cranes that are used to separate magnetic material from non-magnetic material in scrap yards.

Electrical quantities

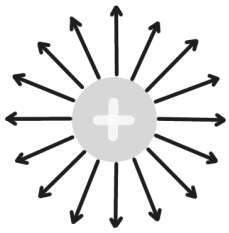
- ➔ There are positive and negative charges.
- ➔ Charge is measured in coulombs.
- ➔ Unlike charges attract and like charges repel.
- ➔ Charging of solids by friction involves only a transfer of negative charge (electrons).
- ➔ An electric field is a region in which an electric charge experiences a force.
- ➔ The direction of an electric field line at a point is the direction of the force on a positive charge at that point.
- ➔ Simple electric field patterns, including the direction of the field:-

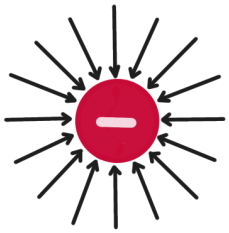
Around a Point Charge:



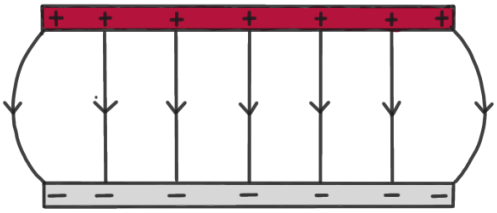


Around a charged conducting sphere:





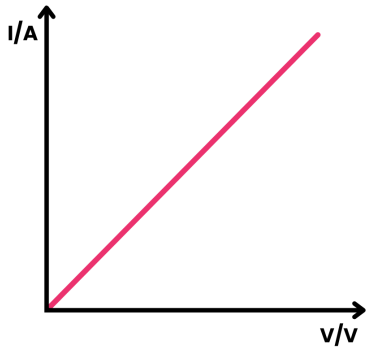
Around two oppositely charged parallel conducting plates:



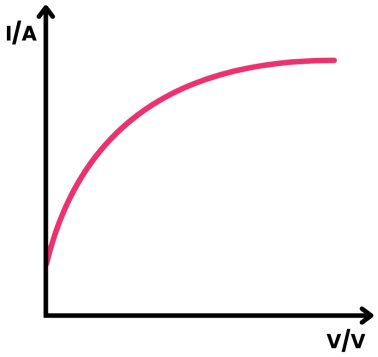
- ➔ Examples of electrical conductors include iron, steel, tungsten etc.
- ➔ Examples of electrical insulators include plastic, wood, glass etc.
- ➔ Conductors are the materials which let electric current pass through them.
- ➔ Insulators are the materials which don't let electric current pass through them.
- ➔ Electric current is the charge passing a point per unit time.
- ➔ electric current = charge/time
- ➔ I = Q/t
- ➔ Electrical conduction in metals occurs due to movement of free electrons.
- ➔ Current is measured in amps (amperes).
- ➔ Amp is given by coulomb per second (C/s).
- ➔ Alternating current has a variable magnitude and its direction changes after every half cycle.
- ➔ Direct current has a constant magnitude and direction remains the same.
- ➔ Conventional current is from positive to negative.
- ➔ The flow of free electrons is from negative to positive.
- ➔ To measure current an ammeter is connected in series to the circuit.
- ➔ E.m.f. (electromotive force) is the electrical work done by a source in moving a unit charge around a complete circuit.
- ➔ E.m.f. = work done (by a source)/charge
- ➔ E = W Q
- ➔ P.d. (potential difference) is the work done by a unit charge passing through a component.
- ➔ p.d. = work done (on a component)/charge
- ➔ V = W Q
- ➔ E.m.f. and p.d. are measured in volts.
- ➔ Volt is given by joule per coulomb (J/C).
- ➔ Voltmeter is connected in parallel to a circuit component to measure voltage.

- ➔ Total e.m.f for several sources arranged in series is calculated by adding the voltage of each source.
- ➔ The e.m.f of identical sources connected in parallel is equal to the e.m.f. of one of the sources.
- ➔ Resistance = p.d./current
- ➔ R = V/I
- ➔ For a wire resistance is directly proportional to length.
- ➔ For a wire resistance is inversely proportional to the cross-sectional area of the wire.
- ➔ Ohm's law states that current is directly proportional to voltage provided a constant temperature.
- ➔ Current–voltage graphs:-

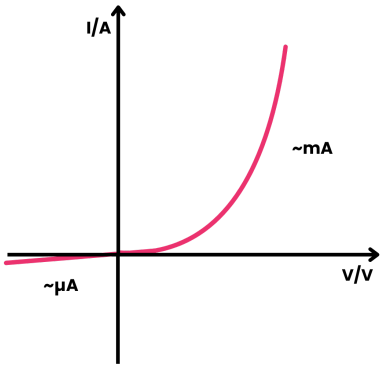
➔ The I-V characteristic graph of an ohmic conductor is a straight line passing through the origin.



➔ **Filament Lamp**

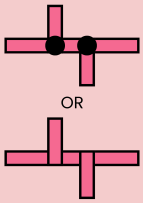
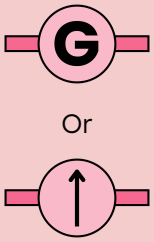
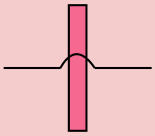
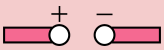
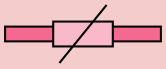
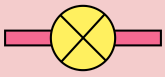
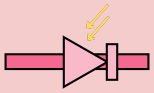
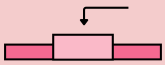
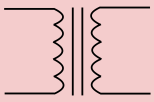
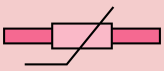
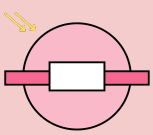
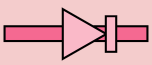
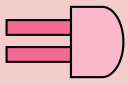


➔ **Semiconductor Diode**



Electric circuits

➔ Circuit diagrams:-

Symbol	Device	Symbol	Device	Symbol	Device
	Switch		Wired joined		Galvanometer
	Cell		Wires crossed		Ammeter
	Battery		Fixed Resistor		Voltmeter
	D.C Power Supply		Variable Resistor		Two-way switch
	A.C Power Supply		Fuse		Earth Connector
	Light Bulb		Coil of Wire		Light-emitting diode
	Potentiometer		Transformer		Thermistor
	Light-dependent resistor		Semiconductor Diode		Bell

- ➔ The current at every point in a series circuit is the same.
- ➔ The sum of the currents entering a junction in a parallel circuit is equal to the sum of the currents that leave the junction.
- ➔ The total p.d. across the components in a series circuit is equal to the sum of the individual p.d.s across each component.
- ➔ The p.d. across an arrangement of parallel resistances is the same as the p.d. across one branch in the arrangement of the parallel resistances.
- ➔ The combined resistance of two or more resistors in series is equal to the sum of the resistance of all individual components in a circuit.
- ➔ The combined resistance of two resistors in parallel is equal to 1/R where 1/R is the sum of the resistance of each component i.e. $1/R = 1/R_1 + 1/R_2 + 1/R_3$....
- ➔ Current in series circuit remains constant.
- ➔ Current in a parallel circuit is equal to the sum of current flowing through each component of the circuit.
- ➔ Voltage in a series circuit is equal to the sum of voltage of each component of the circuit.
- ➔ Voltage in each branch of a parallel circuit is the same.
- ➔ Negative temperature coefficient (NTC) thermistors and light-dependent resistors are used as input sensors.
- ➔ A thermistor is a device whose resistance is highly dependent on the temperature.
- ➔ LDR is a type of resistor whose resistance is highly dependent on light intensity.
- ➔ Potential dividers are series circuits which divide voltages according to our need .
- ➔ $R_1/R_2 = V_1/V_2$

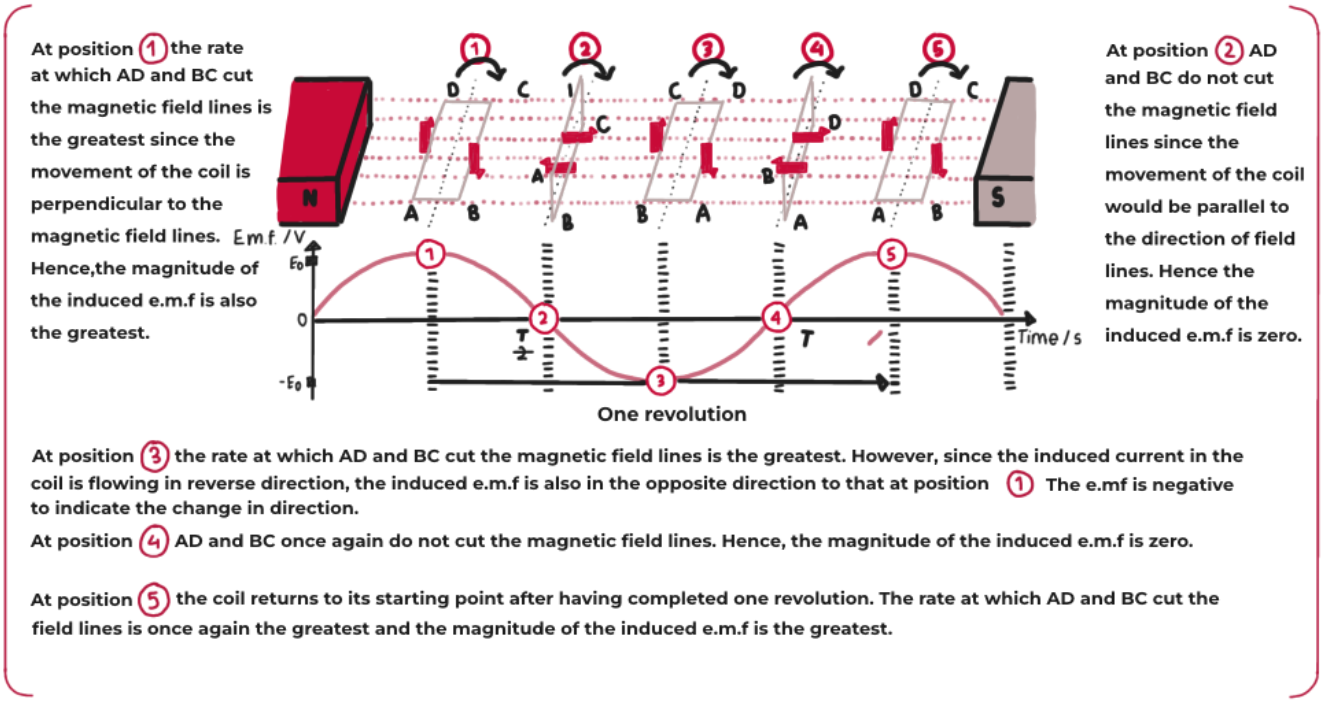
Practical electricity

- ➔ Common uses of electricity include heating, lighting, battery charging and powering motors and electronic systems.
- ➔ The advantage of connecting lamps in parallel in a lighting circuit will prevent all the lamps from turning off when one stops working.
- ➔ power = current × voltage
- ➔ P = IV
- ➔ energy = current × voltage × time
- ➔ E = IVt
- ➔ Hazard of damaged insulation: plastic protective layer of the cable can be damaged which can cause electric shock.
- ➔ Hazard of over-heating cables: can catch fire.
- ➔ Hazard of damp conditions: chances of getting electrocuted are higher.
- ➔ Hazard of excess current from overloading of plugs, extension leads, single and multiple sockets when using a mains supply: can catch fire.
- ➔ Fuses and trip switches should be used with appropriate fuse rating and trip switch settings.
- ➔ When a live wire touches a metal case that is earthed all the current flows to the earth and chances of electrocution are minimised.
- ➔ The outer casing of an electrical appliance must be either non-conducting (double-insulated) or earthed.
- ➔ A mains circuit consists of a live wire (line wire), a neutral wire and an earth wire.

- ➔ A switch must be connected into the live wire for the circuit to be switched off safely.
- ➔ Fuses and circuit breakers are connected into the live wire.

Electromagnetic effects

- ➔ The magnitude of an induced e.m.f. is affected by the rate of change of the magnetic field or the rate of cutting of magnetic field lines.
- ➔ The magnitude of an induced e.m.f. is affected by the number of turns in a coil.
- ➔ The effect of the current produced by an induced e.m.f. is to oppose the change producing it (Lenz's law).
- ➔ A.c. generator uses a rotating coil or rotating magnet and uses slip rings and brushes.
- ➔ graphs of e.m.f. against time for simple a.c. generators:-



A sinusoidal e.m.f is produced as the coil rotates through different positions.

- ➔ The use of the right-hand rule describes the pattern and direction of the magnetic field due to currents in straight wires and in solenoids.
- ➔ Changing the magnitude of current changes the strength of the magnetic field.
- ➔ Changing the direction of the current changes the direction of the magnetic field.
- ➔ The magnetic effect of a current is used in relays and loudspeakers.
- ➔ A force acts on a current-carrying conductor in a magnetic field.
- ➔ Reversing the direction of current reverses the direction of the force.
- ➔ Reversing the direction of the field will reverse the direction of the force.
- ➔ The relative directions of force, magnetic field and current can be found using Fleming's left hand rule.
- ➔ Magnetic fields like currents of parallel conductors will attract.
- ➔ Magnetic fields unlike currents of parallel conductors will repel.
- ➔ A current-carrying coil in a magnetic field may experience a turning effect.

- ➔ The turning effect is increased by increasing the number of turns on the coil.
- ➔ The turning effect is increased by increasing the current.
- ➔ The turning effect is increased by increasing the strength of the magnetic field.
- ➔ The operation of an electric motor includes the action of a split-ring commutator and brushes.
- ➔ A transformer is a device which converts Alternating voltages from low value to high value and vice versa.
- ➔ $V_p/V_s = N_p/N_s$
- ➔ P and S refer to primary and secondary.
- ➔ High voltage transformers reduce power loss.
- ➔ Power losses in cables are smaller when the voltage is greater.

Uses of an oscilloscope

- ➔ An oscilloscope is used to display waveforms.
- ➔ P.d. and short intervals of time are measured with an oscilloscope using the Y-gain and timebase.

Nuclear Physics

The nuclear model of the atom

- ➔ The structure of the atom is a positively charged nucleus and negatively charged electrons in orbit around the nucleus.
- ➔ Alpha-particle scattering experiments provide evidence for a very small nucleus surrounded by mostly empty space.
- ➔ Alpha-particle scattering experiments provide evidence for a nucleus containing most of the mass of the atom.
- ➔ Alpha-particle scattering experiments provide evidence for a nucleus that is positively charged.
- ➔ The composition of the nucleus is made of protons and neutrons.
- ➔ Atoms form positive ions by losing electrons or negative ions by gaining electrons.
- ➔ Proton number is atomic number (Z).
- ➔ Nucleon number is mass number (A).
- ➔ The number of neutrons in a nucleus are calculated by the difference between mass number and atomic number.
- ➔ A nuclide is a specific type of nucleus defined by a specific number of protons and neutrons.
- ➔ Nuclide notation ${}^{A}_{Z}X$
- ➔ Isotopes of atoms have the same number of protons but different number of neutrons.
- ➔ An element may have more than one isotope.

Radioactivity

- ➔ The detection of alpha particles (α-particles) is done using a cloud chamber or spark counter.
- ➔ The detection of beta particles (β-particles) (β-particles will be taken to refer to β^-) and gamma radiation (γ-radiation) is done by using a Geiger-Müller tube and counter.
- ➔ Count rate is measured in counts/s or counts/minute
- ➔ Background radiation is the measure of ionising radiation existing in any location.
- ➔ The sources that make a significant contribution to background radiation include radon gas (in the air), rocks and buildings, food and drink, cosmic rays.
- ➔ Measurements of background radiation can be used to determine a corrected count rate.
- ➔ Emission of radiation from a nucleus is spontaneous and random in direction.
- ➔ α-particles are two protons and two neutrons (helium nuclei).
- ➔ β-particles are high-speed electrons from the nucleus.
- ➔ γ-radiation is high-frequency electromagnetic waves.
- ➔ α-particles have most relative ionising effects while γ-radiation has least relative ionising effects.
- ➔ Γ-radiation has most relative penetrating powers while α-particles have least relative penetrating powers.
- ➔ α-particles in an electric field are deflected negatively towards negatively charged plates, in a magnetic field it is deflected positively.
- ➔ β-particles in an electric field are deflected positively toward positively charged plates, in a magnetic field it is deflected negatively.

- ➔ γ-radiation is not deflected, neither in electric field nor magnetic field.
- ➔ Radioactive decay is a change in an unstable nucleus that can result in the emission of α-particles or β-particles and/or γ-radiation.
- ➔ These changes are spontaneous and random.
- ➔ Decay equations use nuclide notation, to show the emission of α-particles, β-particles and γ-radiation.
- ➔ The process of fusion is the formation of a larger nucleus by combining two smaller nuclei with the release of energy.
- ➔ Fusion is the energy source for stars.
- ➔ The process of fission is when a nucleus, such as uranium-235 (U-235), absorbs a neutron and produces daughter nuclei and two or more neutrons with the release of energy.
- ➔ The neutrons produced in fission create a chain reaction and this is controlled in a nuclear reactor, including the actions of coolant, moderators and control rods.
- ➔ The half-life of a particular isotope is the time taken for half the nuclei of that isotope in any sample to decay.
- ➔ The dating of objects is done by the use of ^{14}C
- ➔ The type of radiation emitted and the half-life of the isotope determine which isotope is used for applications.
- ➔ Applications include: household fire (smoke) alarms, irradiating food to kill bacteria, sterilisation of equipment using gamma rays, measuring and controlling thicknesses of materials with the choice of radiations used linked to penetration and absorption , diagnosis and treatment of cancer using gamma rays.
- ➔ The effects of ionising nuclear radiations on living things include cell death, mutations and cancer.
- ➔ Radioactive materials are moved to be used and stored in a safe way to reduce exposure time, to increase distance between source and living tissue, by the use of shielding to absorb radiation.

Space Physics

Earth and the Solar System

- The Earth is a planet that orbits the Sun once in approximately 365 days.
- The orbit of the Earth around the Sun is an ellipse which is approximately circular.
- The Earth rotates on its axis, which is tilted, once in approximately 24 hours.
- It takes approximately one month for the Moon to orbit the Earth.
- It takes approximately 500s for light from the Sun to reach the Earth.
- average orbital speed = $v = 2\pi r/T$
- r is the average radius of the orbit and T is the orbital period
- The Solar System contains one star, the Sun.
- The Solar System contains the eight named planets in order (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus. Neptune).
- The Solar System contains minor planets that orbit the Sun, including dwarf planets such as Pluto and asteroids in the asteroid belt.
- The Solar System contains moons that orbit the planets.
- The Solar System contains smaller Solar System bodies, including comets and natural satellites.
- The strength of the gravitational field at the surface of a planet depends on the mass of the planet.
- The strength of the gravitational field around a planet decreases as the distance from the planet increases.
- The Sun contains most of the mass of the Solar System.
- The gravitational field at the surface of the Sun is greater than the strength of the gravitational field at the surface of the planets.
- The force that keeps an object in orbit around the Sun is the gravitational attraction of the Sun.
- The strength of the Sun's gravitational field decreases.
- The orbital speeds of the planets decrease as the distance from the Sun increases.

Stars and the Universe

- The Sun is a star of medium size, consisting mostly of hydrogen and helium.
- It radiates most of its energy in the infrared, visible and ultraviolet regions of the electromagnetic spectrum.
- Stars are powered by nuclear reactions that release energy.
- In stable stars the nuclear reactions involve the fusion of hydrogen into helium.
- Galaxies are each made up of many billions of stars.
- The Sun is a star in the galaxy known as the Milky Way
- Other stars that make up the Milky Way are much further away from the Earth than the Sun is from the Earth
- Astronomical distances can be measured in light-years, where one light-year is the distance travelled in a vacuum by light in one year.
- A star is formed from interstellar clouds of gas and dust that contain hydrogen.

- ➔ A protostar is an interstellar cloud collapsing and increasing in temperature as a result of its internal gravitational attraction.
- ➔ A protostar becomes a stable star when the inward force of gravitational attraction is balanced by an outward force due to the high temperature in the centre of the star.
- ➔ All stars eventually run out of hydrogen as fuel for the nuclear reaction.
- ➔ Most stars expand to form red giants and more massive stars expand to form red supergiants when most of the hydrogen in the centre of the star has been converted to helium.
- ➔ A red giant from a less massive star forms a planetary nebula with a white dwarf at its centre.
- ➔ A red supergiant explodes as a supernova, forming a nebula containing hydrogen and new heavier elements, leaving behind a neutron star or a black hole at its centre.
- ➔ The nebula from a supernova may form new stars with orbiting planets.
- ➔ The Milky Way is one of many billions of galaxies making up the Universe.
- ➔ The diameter of the Milky Way is approximately 100000 light-years.
- ➔ Redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies.
- ➔ The light from distant galaxies shows redshift and that the further away the galaxy, the greater the observed redshift and the faster the galaxy's speed away from the Earth.
- ➔ Redshift provides evidence for the Big Bang theory.

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A Note from Mojza

This resource for Physics (5054) has been prepared by Team Mojza, covering the content for O Level 2025-27 syllabus. The content of this resource has been prepared with utmost care. We apologise for any issues overlooked; factual, grammatical or otherwise. We hope that you benefit from these and find them useful towards achieving your goals for your Cambridge examinations.

If you find any issues within these notes or have any feedback, please contact us at support@mojza.org.

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5054

O'Levels

PHYSICS

CHAPTER SUMMARIES

These notes are made to encompass the complete syllabus for 5054 from 2025 to 2027, with great attention and care for every topic. All information is curated in a simple, clear, and concise manner. The aim is to aid students and make learning easier in preparation for their exams. Team Mojza makes every effort to error-check all the content; if you find any discrepancies, please reach out to us at *support@mojza.org*.