

Summary of Key Quantities, Symbols and Units

Quantity	Symbol	Unit
length	$l, h \dots$	km, m, cm, mm
area	A	m^2, cm^2
volume	V	m^3, cm^3
weight	W	N
mass	m, M	kg, g, mg
time	t	h, min, s, ms
period	T	s
density	ρ	$g/cm^3, kg/m^3$
speed	u, v	km/h, m/s, cm/s
acceleration	a	m/s^2
acceleration of free fall	g	$m/s^2, N/kg$
force	F, f	N
moment of force	—	N m
work done	W, E	J
energy	E	J, kW h
power	P	W
pressure	p, P	Pa, N/m^2 , mm Hg
temperature	θ, T	$^{\circ}C, K$
heat capacity	C	$J/^{\circ}C, J/K$
specific heat capacity	c	$J/(g ^{\circ}C), J/(g K)$
latent heat	L	J
specific latent heat	l	$J/kg, J/g$
frequency	f	Hz
wavelength	λ	m, cm
focal length	f	m, cm
angle of incidence	i	degree ($^{\circ}$)
angles of reflection, refraction	r	degree ($^{\circ}$)
critical angle	c	degree ($^{\circ}$)
potential difference/voltage	V	V, mV
current	I	A, mA
charge	q, Q	C, A s
e.m.f.	E	V
resistance	R	Ω
proton number	Z	—
nucleon number	A	—
half-life	$t_{1/2}$	s
activity of a radioactive source	A	Bq

Glossary of Terms

Glossary of Definitions

1. Physical Quantities, Units & Measurement

- **Physical quantity:** A quantity that can be measured and consists of a numerical magnitude and a unit.
 - **Base quantity:** A quantity that cannot be defined in terms of other quantities (e.g. mass, length, time, current, temperature).
 - **Derived quantity:** A quantity derived from a combination of base quantities (e.g. speed, area, density).
 - **Scalar quantity:** A quantity that has magnitude only (e.g. distance, speed, mass, energy).
 - **Vector quantity:** A quantity that has both magnitude and direction (e.g. displacement, velocity, force, acceleration).
 - **Accuracy:** How close a measured value is to the true value.
 - **Precision:** How close repeated measurements are to one another (consistency).
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2. Kinematics

- **Distance:** The total length of the path travelled by an object.
- **Displacement:** The distance moved in a specified direction (straight-line distance from start to end point).
- **Speed:** The rate of change of distance travelled with time.
- **Velocity:** The rate of change of displacement with time.
- **Uniform velocity:** Equal displacements in equal intervals of time (constant speed in a straight line).
- **Acceleration:** The rate of change of velocity with time.
- **Uniform acceleration:** Equal changes in velocity occur in equal intervals of time.
- **Deceleration (retardation):** Negative acceleration; a decrease in velocity with time.
- **Free fall:** Motion of an object under the influence of gravity alone (no air resistance).

- **Terminal velocity:** The maximum constant velocity reached by an object falling through a fluid, when the resultant force on it is zero (weight = drag/air resistance).
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3. Dynamics (Forces & Motion)

- **Force:** A push or pull that can change the size, shape, state of rest, or state of motion of an object.
 - **Newton's First Law of Motion:** An object will remain at rest or in uniform motion in a straight line unless acted upon by a resultant (net) force.
 - **Newton's Second Law of Motion:** The acceleration of an object is directly proportional to the resultant force acting on it and inversely proportional to its mass ($F = ma$), and takes place in the direction of the force.
 - **Newton's Third Law of Motion:** When object A exerts a force on object B, object B exerts an equal and opposite force on object A.
 - **Resultant force:** The single force that has the same effect as all the original forces acting together.
 - **Friction:** A force that opposes relative motion (or attempted motion) between two surfaces in contact.
 - **Mass:** The quantity of matter in an object; a measure of an object's inertia.
 - **Inertia:** The reluctance/tendency of an object to resist a change in its state of rest or motion.
 - **Weight:** The gravitational force acting on an object.
 - **Momentum:** The product of an object's mass and velocity ($p = mv$).
 - **Principle of Conservation of Momentum:** In a system with no external resultant force, the total momentum before a collision/interaction equals the total momentum after.
 - **Elastic collision:** A collision in which both momentum and kinetic energy are conserved.
 - **Inelastic collision:** A collision in which momentum is conserved but kinetic energy is not conserved (some is converted to other forms, e.g. heat, sound).
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4. Mass, Weight & Density

- **Density:** The mass per unit volume of a substance ($\rho = m/V$).
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5. Turning Effects of Forces

- **Moment of a force:** The product of the force and the perpendicular distance from the pivot to the line of action of the force.
 - **Principle of Moments:** For a body in equilibrium, the sum of clockwise moments about any point equals the sum of anticlockwise moments about the same point.
 - **Centre of gravity:** The point at which the entire weight of an object may be considered to act.
 - **Equilibrium:** A state in which there is no resultant force and no resultant moment acting on an object (it remains at rest or moves with constant velocity).
 - **Stability:** The ability of an object to return to its original position after being slightly displaced/tilted.
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6. Pressure

- **Pressure:** Force acting normally (perpendicularly) per unit area ($P = F/A$).
 - **Atmospheric pressure:** The pressure exerted by the weight of the atmosphere (air) on the Earth's surface.
 - **Liquid pressure:** Pressure exerted by a liquid, given by $P = \rho gh$, where h is the depth below the surface.
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7. Energy, Work & Power

- **Energy:** The capacity to do work.
- **Principle of Conservation of Energy:** Energy cannot be created or destroyed; it can only be converted from one form to another, and the total energy in a closed system remains constant.
- **Kinetic energy:** The energy possessed by an object due to its motion ($E_k = \frac{1}{2}mv^2$).
- **Gravitational potential energy:** The energy possessed by an object due to its position in a gravitational field ($E_p = mgh$).
- **Work done:** The product of the force applied and the distance moved in the direction of the force ($W = Fd$).
- **Power:** The rate at which work is done, or the rate of energy conversion/transfer ($P = W/t$).

- **Efficiency:** The ratio of useful energy (or power) output to the total energy (or power) input, usually expressed as a percentage.
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8. Kinetic Model of Matter

- **Kinetic theory (particle model):** A model that explains the properties of solids, liquids and gases in terms of the motion and arrangement of their particles.
 - **Brownian motion:** The random, continuous movement of microscopic particles suspended in a fluid, caused by collisions with fast-moving molecules of the fluid, providing evidence for the kinetic theory.
 - **Pressure of a gas (kinetic theory):** Caused by gas molecules colliding with the walls of the container.
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9. Thermal Properties & Processes

- **Temperature:** A measure of the degree of hotness (or coldness) of a body / the average kinetic energy of the particles in a substance.
- **Thermal equilibrium:** A state in which two objects in thermal contact have no net flow of heat between them, i.e. they are at the same temperature.
- **Heat:** Thermal energy that flows from a region of higher temperature to a region of lower temperature.
- **Internal energy:** The sum of the kinetic energy and potential energy of all the particles in a system.
- **Specific heat capacity:** The amount of heat energy required to raise the temperature of a unit mass (1 kg) of a substance by 1°C (or 1 K), without a change of state.
- **Specific latent heat:** The amount of heat energy required to change the state of a unit mass (1 kg) of a substance without a change in temperature.
- **Specific latent heat of fusion:** Heat energy needed to convert 1 kg of a substance from solid to liquid at constant temperature (melting point).
- **Specific latent heat of vaporisation:** Heat energy needed to convert 1 kg of a substance from liquid to gas at constant temperature (boiling point).
- **Melting point:** The fixed temperature at which a substance changes from solid to liquid.
- **Boiling point:** The fixed temperature at which a substance changes from liquid to gas throughout the bulk of the liquid.

- **Evaporation:** The process by which a liquid changes into a vapour at any temperature below its boiling point, occurring only at the liquid's surface.
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10. Transfer of Thermal Energy

- **Conduction:** The transfer of thermal energy through a medium (usually a solid) from a region of higher temperature to a region of lower temperature, without bulk movement of the medium (via particle vibration/free electron collisions).
 - **Convection:** The transfer of thermal energy through a fluid (liquid or gas) by the bulk movement of the fluid itself, caused by density differences arising from temperature differences.
 - **Radiation (thermal/infrared radiation):** The transfer of thermal energy by electromagnetic waves, which does not require a medium and can travel through a vacuum.
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11. Waves — General

- **Wave:** A disturbance that transfers energy from one point to another without transferring matter.
- **Transverse wave:** A wave in which the direction of vibration of particles is perpendicular to the direction of propagation of the wave (e.g. light, water waves).
- **Longitudinal wave:** A wave in which the direction of vibration of particles is parallel to the direction of propagation of the wave (e.g. sound waves).
- **Amplitude:** The maximum displacement of a particle from its equilibrium (rest) position.
- **Wavelength (λ):** The distance between two successive points on a wave that are in phase (e.g. crest to crest).
- **Frequency (f):** The number of complete waves (oscillations) produced/passing a point per unit time.
- **Period (T):** The time taken for one complete oscillation/wave to be produced.
- **Wave speed:** The distance travelled by a wave per unit time ($v = f\lambda$).
- **Reflection (of waves):** The bouncing back of a wave when it meets a boundary/surface, obeying angle of incidence = angle of reflection.
- **Refraction (of waves):** The change in direction (and speed) of a wave as it passes from one medium into another of different density/optical density.

- **Diffraction:** The spreading of waves as they pass through a gap or around an obstacle.
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12. Light

- **Reflection of light:** Law: the angle of incidence equals the angle of reflection, and the incident ray, reflected ray and normal all lie in the same plane.
 - **Refraction of light:** The bending of light as it passes from one medium to another due to a change in speed.
 - **Refractive index:** A measure of how much a medium bends light, defined as $n = \sin(i)/\sin(r)$, or the ratio of the speed of light in vacuum to the speed of light in the medium.
 - **Critical angle:** The angle of incidence in the denser medium for which the angle of refraction is 90° .
 - **Total internal reflection:** Occurs when light travelling in a denser medium strikes a boundary with a less dense medium at an angle greater than the critical angle, and is entirely reflected back into the denser medium.
 - **Converging (convex) lens:** A lens that causes parallel rays of light to converge to a single point (the principal focus).
 - **Diverging (concave) lens:** A lens that causes parallel rays of light to spread out (diverge) as if from a single point.
 - **Focal length:** The distance between the optical centre of a lens and its principal focus.
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13. Electromagnetic Spectrum

- **Electromagnetic waves:** Transverse waves that transfer energy without requiring a medium, all travelling at the speed of light in a vacuum, arranged by wavelength/frequency into a spectrum (radio, microwave, infrared, visible light, ultraviolet, X-ray, gamma ray).
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14. Sound

- **Sound wave:** A longitudinal wave produced by a vibrating source, requiring a medium to travel through.
 - **Loudness:** A measure of sound related to the amplitude of the sound wave.
 - **Pitch:** A measure of sound related to the frequency of the sound wave.
 - **Echo:** A reflected sound wave that is heard after the original sound.
 - **Ultrasound:** Sound waves with a frequency higher than the upper limit of human hearing (above 20,000 Hz).
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15. Static Electricity

- **Electric charge:** A fundamental property of matter that can be positive or negative, causing it to experience a force in an electric field.
 - **Electric field:** A region of space in which a charged object experiences an electric force.
 - **Law of electrostatics:** Like charges repel; unlike charges attract.
 - **Electrostatic induction:** The process of charging a conductor without direct contact, by bringing a charged object near it.
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16. Current Electricity (DC Circuits)

- **Electric current:** The rate of flow of electric charge ($I = Q/t$).
- **Electromotive force (e.m.f.):** The electrical work done by a source (e.g. a battery) in driving a unit charge around a complete circuit.
- **Potential difference (voltage):** The work done (energy converted) in driving a unit charge from one point to another in a circuit.
- **Resistance:** The opposition to the flow of electric current, defined as the ratio of potential difference across a component to the current through it ($R = V/I$).
- **Ohm's Law:** The current through a metallic conductor is directly proportional to the potential difference across it, provided physical conditions (e.g. temperature) remain constant.
- **Ohmic conductor:** A conductor that obeys Ohm's Law, i.e. one whose resistance remains constant regardless of current/voltage (at constant temperature).
- **Series circuit:** A circuit in which components are connected end-to-end, so the same current flows through each component.

- **Parallel circuit:** A circuit in which components are connected across common points, so the potential difference across each branch is the same.
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17. Practical Electricity

- **Fuse:** A safety device containing a thin wire that melts and breaks the circuit if the current exceeds a certain (rated) value, protecting the circuit/appliance from overheating/fire.
 - **Short circuit:** A low-resistance connection that allows current to bypass part of a circuit, resulting in a very large current.
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18. Magnetism

- **Magnetic field:** A region of space in which a magnetic material or moving charge experiences a magnetic force.
 - **Magnetic field line:** A line that shows the direction of the magnetic field, running from the north pole to the south pole outside a magnet.
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19. Electromagnetism

- **Electromagnet:** A magnet whose magnetic field is produced by an electric current, typically a coil of wire wound around a soft iron core.
 - **Right-hand grip rule:** If the thumb of the right hand points in the direction of conventional current flow, the curled fingers show the direction of the magnetic field around the wire.
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20. Electromagnetic Induction

- **Electromagnetic induction:** The production of an e.m.f. (and hence current, in a closed circuit) when there is relative motion between a magnet and a conductor, or when the magnetic flux linking a circuit changes.
 - **Faraday's Law:** The magnitude of the induced e.m.f. is directly proportional to the rate of change of magnetic flux (linkage).
 - **Lenz's Law:** The direction of the induced current is such that it opposes the change (in magnetic flux) that produces it.
 - **Transformer:** A device that uses electromagnetic induction to change (step up or step down) the voltage of an alternating current.
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21. Radioactivity & Nuclear Physics

- **Atom:** The basic building block of matter, consisting of a nucleus (protons and neutrons) surrounded by orbiting electrons.
- **Proton number (atomic number), Z :** The number of protons in the nucleus of an atom.
- **Nucleon number (mass number), A :** The total number of protons and neutrons in the nucleus of an atom.
- **Isotopes:** Atoms of the same element (same proton number) with different numbers of neutrons (different nucleon numbers).
- **Radioactive decay:** The spontaneous and random disintegration of an unstable nucleus, accompanied by the emission of radiation (alpha, beta, or gamma).
- **Alpha particle (α):** A helium nucleus (2 protons + 2 neutrons), emitted from an unstable nucleus; weakly penetrating, strongly ionising.
- **Beta particle (β):** A fast-moving electron emitted from an unstable nucleus (when a neutron converts to a proton); moderately penetrating and ionising.
- **Gamma ray (γ):** High-frequency electromagnetic radiation emitted from an unstable nucleus; highly penetrating, weakly ionising.
- **Half-life:** The time taken for half the number of undecayed nuclei in a radioactive sample (or its activity) to decay.
- **Background radiation:** Radiation that is present in the environment from natural (e.g. cosmic rays, rocks) and artificial (e.g. medical, nuclear) sources.