Cambridge O Level Physics

Syllabus 5054 | 2026 – 2028

DEFINITIONS & FORMULAS

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Part 1

All Define Definitions

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1. Motion, Forces and Energy

Speed	Distance travelled per unit time.
Velocity	Change in displacement per unit time.
Acceleration	Change in velocity per unit time.
Deceleration	A negative acceleration.
Uniform Acceleration	Acceleration that remains constant over time.
Non-uniform Acceleration	Acceleration that changes over time.
Scalar Quantity	A quantity that has magnitude (size) only. Examples: distance, speed, time, mass, energy, temperature.
Vector Quantity	A quantity that has both magnitude and direction. Examples: displacement, force, weight, velocity, acceleration, momentum, electric field strength, gravitational field strength.
Mass	A measure of the quantity of matter in an object at rest relative to the observer.
Inertia	The property of an object to resist change from its state of rest or motion.
Weight	The gravitational force acting on an object.
Gravitational Field	A region in which a mass experiences a force due to gravitational attraction.
Gravitational Field Strength (g)	Force per unit mass; equivalent to the acceleration of free fall.
Density	Mass per unit volume.
Newton's First Law	An object either remains at rest or continues to move in a straight line at constant speed unless acted on by a resultant force.
Newton's Third Law	When object A exerts a force on object B, then object B exerts an equal and opposite force on object A.
Friction	A force that may impede motion and produce heating.
Terminal Velocity	The constant velocity reached when driving force equals drag force (resultant force = 0).
Thinking Distance	The distance a vehicle travels during the driver's reaction time.
Braking Distance	The distance a vehicle travels after the brakes are applied until it stops.
Stopping Distance	Thinking distance + braking distance.
Spring Constant (k)	Force per unit extension.
Limit of Proportionality	The point on a load–extension graph beyond which extension is no longer proportional to load.

Moment of a Force	A measure of the turning effect of a force; defined as force × perpendicular distance from the pivot.
Centre of Gravity	The point through which the entire weight of an object appears to act.
Momentum (p)	Mass × velocity.
Impulse	Force × time for which the force acts; equal to the change in momentum.
Kinetic Energy	Energy stored due to the motion of an object.
Gravitational Potential Energy	Energy stored due to the position of an object in a gravitational field.
Principle of Conservation of Energy	Energy cannot be created or destroyed; it can only be transferred from one store to another.
Work Done	Force × distance moved in the direction of the force.
Power	Work done per unit time; also energy transferred per unit time.
Efficiency	The ratio of useful energy (or power) output to total energy (or power) input, often expressed as a percentage.
Pressure	Force per unit area.

2. Thermal Physics

Absolute Zero	The lowest possible temperature (–273 °C), where particles have the least kinetic energy.
Internal Energy	The total kinetic and potential energy of all particles in a substance.
Specific Heat Capacity (c)	The energy required per unit mass per unit temperature increase.
Latent Heat	The energy required to change the state of a substance without a change in temperature.
Evaporation	The escape of more energetic particles from the surface of a liquid, causing the liquid to cool.
Boiling	Vaporisation throughout a liquid at a fixed temperature (boiling point) at a given pressure.

3. Waves

Frequency (f)	The number of wavelengths that pass a point per unit time.
Wavelength (λ)	The distance between two consecutive, identical points (e.g. two consecutive crests).
Amplitude	The maximum distance from the mean position.
Transverse Wave	A wave in which the direction of vibration is at right angles to the direction of energy transfer (e.g. EM waves, water waves, seismic S-waves).

Longitudinal Wave	A wave in which the direction of vibration is parallel to the direction of energy transfer (e.g. sound waves, seismic P-waves).
Refractive Index (n)	The ratio sin i / sin r, where i is the angle of incidence and r is the angle of refraction.
Critical Angle (c)	The angle of incidence beyond which total internal reflection occurs at a boundary.
Total Internal Reflection	Complete reflection of a ray back into the denser medium when the angle of incidence exceeds the critical angle.
Linear Magnification (M)	The ratio of image length to object length.
Ultrasound	Sound with a frequency higher than 20 kHz (above the upper limit of human hearing).

4. Electricity and Magnetism

Electric Field	A region in which an electric charge experiences a force.
Magnetic Field	A region in which a magnetic pole experiences a force.
Electric Current (I)	The charge passing a point per unit time; measured in amperes (A).
Electromotive Force / e.m.f. (E)	The electrical work done by a source in moving a unit charge around a complete circuit.
Potential Difference / p.d. (V)	The work done by a unit charge passing through a component.
Resistance (R)	The ratio of potential difference across a component to the current through it.
Ohm's Law	At constant temperature, the current through a conductor is directly proportional to the potential difference across it.
Kilowatt-hour (kWh)	A unit of energy equal to the energy transferred by a 1 kW device operating for 1 hour.
Lenz's Law	The effect of the current produced by an induced e.m.f. is to oppose the change producing it.
Direct Current (d.c.)	Current that flows in one direction only.
Alternating Current (a.c.)	Current that periodically reverses direction.

5. Nuclear Physics

Proton Number (Z)	The number of protons in the nucleus of an atom (also called atomic number).
Nucleon Number (A)	The total number of protons and neutrons in the nucleus (also called mass number).
Isotopes	Atoms of the same element with the same proton number but different nucleon numbers.
Nuclide	A specific type of nucleus characterised by its proton number and nucleon number, written as (A/Z)X.

Background Radiation	Low-level radiation always present in the environment from natural sources (radon, rocks, cosmic rays, food) and artificial sources.
Radioactive Decay	A spontaneous and random change in an unstable nucleus resulting in the emission of alpha, beta or gamma radiation.
Alpha Particle (α)	A particle consisting of two protons and two neutrons (a helium nucleus), emitted from an unstable nucleus.
Beta Particle (β)	A high-speed electron emitted from the nucleus when a neutron decays into a proton.
Gamma Radiation (γ)	High-frequency electromagnetic waves emitted from an excited nucleus.
Half-life	The time taken for half the nuclei of a particular isotope in any sample to decay.
Nuclear Fission	The splitting of a heavy nucleus (e.g. U-235) into smaller daughter nuclei, releasing energy and two or more neutrons.
Nuclear Fusion	The combination of two smaller nuclei to form a larger nucleus with the release of energy; the energy source of stars.

6. Space Physics

Average Orbital Speed	The speed of an object moving in a circular orbit, defined as $v = 2\pi r / T$.
Light-year	The distance travelled in a vacuum by light in one year; used as a unit of astronomical distance.
Redshift	An increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies.
Big Bang Theory	The theory that the Universe originated from a single extremely hot, dense point and has been expanding ever since; supported by evidence from redshift of distant galaxies.

Part 2

All Formulas & Equations

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Quantity	Formula	Notes / Units
1. Motion, Forces and Energy		
Speed	$v = s / t$	v: speed (m/s) s: distance (m) t: time (s)
Average Speed	avg v = total s / total t	
Acceleration	$a = \Delta v / \Delta t$	a: acceleration (m/s²) Δv: change in velocity Δt: time (s)
Grav. Field Strength	$g = W / m$	g (N/kg) W: weight (N) m: mass (kg)
Density	$\rho = m / V$	ρ (kg/m³) m: mass (kg) V: volume (m³)
Newton's 2nd Law	$F = ma$	F: resultant force (N) m: mass (kg) a: acceleration (m/s²)
Spring Constant	$k = F / x$	k (N/m) F: force (N) x: extension (m)
Moment of a Force	$M = F \times d$	M (N m) F: force (N) d: perpendicular distance from pivot (m)
Momentum	$p = mv$	p (kg m/s) m: mass (kg) v: velocity (m/s)
Impulse	$\text{Impulse} = F\Delta t = \Delta(mv)$	F (N) Δt (s) Δ(mv): change in momentum (kg m/s)
Resultant Force	$F = \Delta p / \Delta t$	F (N) Δp: change in momentum Δt: time (s)
Kinetic Energy	$E_k = ½ mv^2$	E_k (J) m: mass (kg) v: velocity (m/s)
Change in GPE	$\Delta E_p = mg\Delta h$	ΔE_p (J) m (kg) g = 9.8 N/kg Δh: height change (m)
Work Done	$W = Fd$	W (J) F: force (N) d: distance in direction of force (m)
Power	$P = W/t$ or $P = \Delta E/t$	P (W) W (J) E (J) t (s)
Efficiency	% eff = (useful E out / total E in) × 100%	Also: (useful P out / total P in) × 100%
Pressure	$p = F / A$	p (Pa) F: force (N) A: area (m²)
Pressure in Liquid	$\Delta p = \rho g \Delta h$	Δp (Pa) ρ (kg/m³) g (N/kg) Δh: depth (m)
2. Thermal Physics		
Kelvin Conversion	$T\,(K) = \theta\,(°C) + 273$	T: Kelvin θ: Celsius
Specific Heat Capacity	$c = \Delta E / (m\Delta\theta)$	c [J/(kg°C)] ΔE (J) m (kg) Δθ: temperature change (°C)
Boyle's Law	$p_1V_1 = p_2V_2$	Constant temperature p: pressure (Pa) V: volume (m³)

3. Waves

Wave Speed	**v = fλ**	v (m/s) f: frequency (Hz) λ: wavelength (m)
Refractive Index	**n = sin i / sin r**	n: refractive index i: angle of incidence r: angle of refraction
Critical Angle	**n = 1 / sin c**	n: refractive index c: critical angle
Linear Magnification	**M = image length / object length**	M: dimensionless
Speed of EM Waves	**c = 3.0 × 10■ m/s**	In vacuum (and approximately in air)

4. Electricity and Magnetism

Electric Current	**I = Q / t**	I (A) Q: charge (C) t (s)
e.m.f.	**E = W / Q**	E (V) W: work done by source (J) Q (C)
Potential Difference	**V = W / Q**	V (V) W: work done on component (J) Q (C)
Resistance	**R = V / I**	R (Ω) V (V) I (A)
Potential Divider	**R■ / R■ = V■ / V■**	R■, R■ (Ω) V■, V■ (V)
Electrical Power	**P = IV**	P (W) I (A) V (V)
Electrical Energy	**E = IVt**	E (J) I (A) V (V) t (s)
Transformer	**Vp / Vs = Np / Ns**	Vp: primary voltage Vs: secondary voltage Np, Ns: turns

5. Nuclear Physics

Neutron Number	**N = A – Z**	N: neutrons A: nucleon number Z: proton number
Nuclide Notation	**(A over Z) X**	A: mass number (top) Z: atomic number (bottom) X: element symbol

6. Space Physics

Orbital Speed	**v = 2πr / T**	v (m/s) r: orbital radius (m) T: orbital period (s)