AS LEVEL PHYSICS 9702

Complete Equations & Formulae Reference

Cambridge International AS & A Level | Topics 1-11

Formula / Symbol	Description / Meaning	SI Unit
p (pico)	× 10^{-12}	10^{-12}
n (nano)	× 10^{-9}	10^{-9}
μ (micro)	× 10^{-6}	10^{-6}
m (milli)	× 10^{-3}	10^{-3}
c (centi)	× 10^{-2}	10^{-2}
k (kilo)	× 10^{3}	10^{3}
M (mega)	× 10^{6}	10^{6}
G (giga)	× 10^{9}	10^{9}
T (tera)	× 10^{12}	10^{12}

Formula / Symbol	Description / Meaning	SI Unit
% uncertainty = (absolute uncertainty / measured value) × 100%	Percentage uncertainty formula	%
Δ(A + B) = ΔA + ΔB	Add absolute uncertainties for sum/difference	same unit
Δ(A × B)/AB = ΔA/A + ΔB/B	Add percentage uncertainties for product/quotient	%
Δ(A^n)/A^n = n × ΔA/A	Multiply % uncertainty by power n	%

Formula / Symbol	Description / Meaning	SI Unit
v = u + at	Final velocity; u=initial, a=acceleration, t=time	$m\ s^{-1}$
s = ut + ½at^2	Displacement with initial velocity and acceleration	m
v^2 = u^2 + 2as	Velocity-displacement relation (no time)	$m\ s^{-1}$

Formula / Symbol	Description / Meaning	SI Unit
$s = \frac{1}{2}(u + v)t$	Displacement from average velocity	m
$a = \Delta v / \Delta t$	Acceleration = change in velocity / time	$m\ s^{-2}$
v = gradient of s-t graph	Velocity from displacement-time graph	$m\ s^{-1}$
a = gradient of v-t graph	Acceleration from velocity-time graph	$m\ s^{-2}$
s = area under v-t graph	Displacement = area under velocity-time graph	m
$g \approx 9.81\ m\ s^{-2}$	Acceleration of free fall (gravitational field strength)	$m\ s^{-2}$

Formula / Symbol	Description / Meaning	SI Unit
$p = mv$	Linear momentum = mass × velocity	$kg\ m\ s^{-1}$
$F = ma$	Newton's 2nd Law; F=resultant force, m=mass, a=acceleration	N
$F = \Delta p / \Delta t$	Force = rate of change of momentum	N
$Impulse = F\Delta t = \Delta p$	Impulse = change in momentum	$N\ s$
$W = mg$	Weight = mass × gravitational field strength	N

Formula / Symbol	Description / Meaning	SI Unit
$\Sigma p\ before = \Sigma p\ after$	Principle of conservation of momentum	$kg\ m\ s^{-1}$
$Elastic: \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$	KE conserved in elastic collision	J
Elastic: relative speed of approach = relative speed of separation	$u_1 - u_2 = v_2 - v_1$	$m\ s^{-1}$

Formula / Symbol	Description / Meaning	SI Unit
Moment = F × d	Moment of force; d = perpendicular distance from pivot	$N\ m$
Torque = F × d	Torque of a couple; d = perpendicular distance between forces	$N\ m$

Formula / Symbol	Description / Meaning	SI Unit
Σclockwise moments = Σanticlockwise moments	Principle of moments (equilibrium)	$N\ m$

Formula / Symbol	Description / Meaning	SI Unit
$\rho = m / V$	Density = mass / volume	$kg\ m^{-3}$
$P = F / A$	Pressure = force / area	$Pa\ (N\ m^{-2})$
$\Delta P = \rho g \Delta h$	Hydrostatic pressure increase with depth h	Pa
$F = \rho g V$	Upthrust (Archimedes' principle); V = submerged volume	N

Formula / Symbol	Description / Meaning	SI Unit
$W = Fs \cos \theta$	Work done; F=force, s=displacement, θ=angle between them	J
efficiency = useful output / total input	Efficiency ratio (no units, or as %)	—
$P = W / t$	Power = work done per unit time	W
$P = Fv$	Power = force × velocity	W

Formula / Symbol	Description / Meaning	SI Unit
$\Delta Ep = mg\Delta h$	Change in gravitational potential energy	J
$Ek = \frac{1}{2}mv^2$	Kinetic energy; m=mass, v=speed	J
$\Delta Ek = \Delta Ep$ (no air resistance)	Conservation of mechanical energy	J

Formula / Symbol	Description / Meaning	SI Unit
$F = kx$	Hooke's Law; k=spring constant, x=extension	N
$k = F / x$	Spring constant	$N\ m^{-1}$
Stress $\sigma = F / A$	Stress = force / cross-sectional area	Pa
Strain $\varepsilon = x / L$	Strain = extension / original length (dimensionless)	—
$E = \sigma / \varepsilon = (F/A) / (x/L)$	Young Modulus E	Pa

Formula / Symbol	Description / Meaning	SI Unit
$E_p = \frac{1}{2}Fx = \frac{1}{2}kx^2$	Elastic potential energy stored in a stretched spring	J
E_p = area under F-x graph	Energy from force-extension graph	J

Formula / Symbol	Description / Meaning	SI Unit
$v = f\lambda$	Wave equation; v=speed, f=frequency, λ=wavelength	$m\ s^{-1}$
$T = 1 / f$	Period = 1 / frequency	s
$I = P / A$	Intensity = power / area	$W\ m^{-2}$
$I \propto A^2$	Intensity proportional to (amplitude)²	—

Formula / Symbol	Description / Meaning	SI Unit
$f_o = f_s \times v / (v \pm v_s)$	Observed frequency; fs=source freq, v=wave speed, vs=source speed	Hz
Use (v − vs) if source approaches observer	Source moving towards observer → higher frequency	Hz
Use (v + vs) if source recedes from observer	Source moving away → lower frequency	Hz

Formula / Symbol	Description / Meaning	SI Unit
$c = 3.00 \times 10^8$ m s^{-1}	Speed of all EM waves in free space	$m\ s^{-1}$
Visible light: 400–700 nm	Visible wavelength range	nm

Formula / Symbol	Description / Meaning	SI Unit
$I = I_0 \cos^2\theta$	Malus's Law; I_0=incident intensity, θ=angle between polariser and wave	$W\ m^{-2}$

Formula / Symbol	Description / Meaning	SI Unit
$\lambda = ax / D$	Double-slit interference; a=slit separation, x=fringe spacing, D=screen distance	m

Formula / Symbol	Description / Meaning	SI Unit
$d \sin \theta = n\lambda$	Diffraction grating; d=slit spacing, n=order, λ=wavelength, θ=angle	m
$d = 1 / N$	Slit spacing from number of slits per metre N	m

Formula / Symbol	Description / Meaning	SI Unit
$Q = It$	Charge = current × time	C
$I = nAvq$	Current; n=charge carrier density, A=area, v=drift speed, q=charge	A
$e = 1.6 \times 10^{-19}\ C$	Elementary charge (charge on one electron)	C

Formula / Symbol	Description / Meaning	SI Unit
$V = W / Q$	Potential difference = energy per unit charge	V
$P = VI$	Electrical power	W
$P = I^2R$	Power in terms of current and resistance	W
$P = V^2 / R$	Power in terms of voltage and resistance	W

Formula / Symbol	Description / Meaning	SI Unit
$R = V / I$	Resistance (Ohm's Law definition)	Ω
$R = \rho L / A$	Resistivity; ρ=resistivity, L=length, A=cross-section area	Ω
$\rho = RA / L$	Resistivity formula rearranged	$\Omega\ m$

Formula / Symbol	Description / Meaning	SI Unit
$\varepsilon = E / Q$	EMF = energy transferred per unit charge	V
$\varepsilon = V + Ir$	EMF = terminal p.d. + voltage drop across internal resistance r	V

Formula / Symbol	Description / Meaning	SI Unit
$V = \varepsilon - Ir$	Terminal potential difference	V

Formula / Symbol	Description / Meaning	SI Unit
$\Sigma I_{in} = \Sigma I_{out}$ (at junction)	Kirchhoff's 1st Law — conservation of charge	A
$\Sigma V = \Sigma IR$ (around loop)	Kirchhoff's 2nd Law — conservation of energy	V
$R_{total} = R_1 + R_2 + R_3 + \ldots$	Resistors in series	Ω
$1/R = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$	Resistors in parallel	Ω
$R_{parallel} = R_1R_2 / (R_1 + R_2)$	Two resistors in parallel (simplified)	Ω

Formula / Symbol	Description / Meaning	SI Unit
$V_{out} = V_{in} \times R_2 / (R_1 + R_2)$	Potential divider output voltage across R_2	V
$V_1/V_2 = R_1/R_2$	Voltage ratio equals resistance ratio	–

Formula / Symbol	Description / Meaning	SI Unit
$A = Z + N$	Nucleon number = proton number + neutron number	–
${}^{A}_{Z}X$ notation	A = nucleon (mass) number, Z = proton number, X = element symbol	–
Alpha: ${}^{4}_{2}\alpha$ (He nucleus)	Composition: 2 protons + 2 neutrons; charge +2e	–
Beta$^-$: ${}^{0}_{-1}\beta$ (electron)	Produced with antineutrino $\bar{\nu}e$; charge −e	–
Beta$^+$: ${}^{0}_{+1}\beta$ (positron)	Produced with neutrino ve; charge +e	–
Gamma: ${}^{0}_{0}\gamma$ (photon)	Electromagnetic radiation; no charge, no mass	–
$1\ u = 1.66 \times 10^{-27}$ kg	Unified atomic mass unit	kg

Formula / Symbol	Description / Meaning	SI Unit
up (u): charge +2/3 e	Up quark charge	e
down (d): charge −1/3 e	Down quark charge	e
Proton = uud	Quark composition of proton; charge = +2/3+2/3−1/3 = +1	–
Neutron = udd	Quark composition of neutron; charge = +2/3−1/3−1/3 = 0	–
β^- decay: d → u + e^- + $\bar{\nu}e$	Down quark changes to up quark	–
β^+ decay: u → d + e^+ + νe	Up quark changes to down quark	–
Baryon: 3 quarks | Meson: quark + antiquark	Hadron classification	–
Leptons: electrons & neutrinos (fundamental)	Lepton classification	–