STUDY FORMULA BOOKLET

IB Physics data booklet: study version for first assessment 2025

The booklet prints equations for themes A to E, constants, SI prefixes and conversions; definitions and derived results, such as the critical angle, are not printed and must be learned.

IN THE BOOKLET printed in the official booklet LEARN IT not printed: students must recall it

Based on the official **IB Diploma Programme Physics data booklet, first assessment 2025, version 1.0 (published February 2023)**, with what to learn and exam tips added by CuratedPrep.

Mathematical equations

Printed at the front of the booklet and used in every theme.

Area of a triangle b base, h perpendicular height.	$A = \frac{1}{2}bh$	IN THE BOOKLET
Area of a circle r radius.	$A = \pi r^2$	IN THE BOOKLET
Circumference of a circle	$C = 2\pi r$	IN THE BOOKLET
Volume of a cuboid l length, w width, h height.	$V = lwh$	IN THE BOOKLET
Volume of a cylinder	$V = \pi r^2 h$	IN THE BOOKLET
Volume of a prism A area of cross-section.	$V = Ah$	IN THE BOOKLET
Volume of a sphere	$V = \frac{4}{3}\pi r^3$	IN THE BOOKLET
Area of the curved surface of a cylinder	$A = 2\pi rh$	IN THE BOOKLET
Vectors: horizontal component θ is the angle between the vector A and the horizontal.	$A_H = A\cos\theta$	IN THE BOOKLET
Vectors: vertical component The booklet shows this with a right-angled vector diagram.	$A_V = A\sin\theta$	IN THE BOOKLET
Trigonometric relationship: tangent	$\tan\theta = \frac{\sin\theta}{\cos\theta}$	IN THE BOOKLET
Trigonometric relationship: identity	$\sin^2\theta + \cos^2\theta = 1$	IN THE BOOKLET

Uncertainties

Three propagation rules for processed data.

Sum or difference Add the absolute uncertainties, even when you subtract the values.	$y = a \pm b \Rightarrow \Delta y = \Delta a + \Delta b$	IN THE BOOKLET
Product or quotient Add the fractional (or percentage) uncertainties.	$y = \frac{ab}{c} \Rightarrow \frac{\Delta y}{y} = \frac{\Delta a}{a} + \frac{\Delta b}{b} + \frac{\Delta c}{c}$	IN THE BOOKLET

Power Multiply the fractional uncertainty by the size of the power.	$y = a^n \Rightarrow \frac{\Delta y}{y} = \left\lvert n\frac{\Delta a}{a} \right\rvert$	IN THE BOOKLET

Fundamental constants

Approximate values as printed in the booklet; use these in calculations unless a question gives others.

Acceleration of free fall Earth's surface.	$g = 9.8\ \text{m s}^{-2}$	IN THE BOOKLET
Gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$	IN THE BOOKLET
Avogadro constant	$N_A = 6.02 \times 10^{23}\ \text{mol}^{-1}$	IN THE BOOKLET
Gas constant	$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$	IN THE BOOKLET
Boltzmann constant	$k_B = 1.38 \times 10^{-23}\ \text{J K}^{-1}$	IN THE BOOKLET
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$	IN THE BOOKLET
Coulomb constant	$k = 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$	IN THE BOOKLET
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2\ \text{N}^{-1}\ \text{m}^{-2}$	IN THE BOOKLET
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ \text{T m A}^{-1}$	IN THE BOOKLET
Speed of light in vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	IN THE BOOKLET
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	IN THE BOOKLET
Elementary charge	$e = 1.60 \times 10^{-19}\ \text{C}$	IN THE BOOKLET
Electron rest mass	$m_e = 9.110 \times 10^{-31}\ \text{kg} = 0.000549\ \text{u} = 0.511\ \text{MeV c}^{-2}$	IN THE BOOKLET
Proton rest mass	$m_p = 1.673 \times 10^{-27}\ \text{kg} = 1.007276\ \text{u} = 938\ \text{MeV c}^{-2}$	IN THE BOOKLET
Neutron rest mass	$m_n = 1.675 \times 10^{-27}\ \text{kg} = 1.008665\ \text{u} = 940\ \text{MeV c}^{-2}$	IN THE BOOKLET
(Unified) atomic mass unit	$u = 1.661 \times 10^{-27}\ \text{kg} = 931.5\ \text{MeV c}^{-2}$	IN THE BOOKLET
Solar constant	$S = 1.36 \times 10^{3}\ \text{W m}^{-2}$	IN THE BOOKLET
Fermi radius Used in the nuclear radius equation in E.1 (HL).	$R_0 = 1.20 \times 10^{-15}\ \text{m}$	IN THE BOOKLET

Metric (SI) multipliers

Prefix	Abbreviation	Value
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}

Prefix	Abbreviation	Value
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Unit conversions

Radians and degrees	$1\ \text{rad} \equiv \dfrac{180^\circ}{\pi}$	IN THE BOOKLET
Kelvin and Celsius	$T(\text{K}) = T(^\circ\text{C}) + 273$	IN THE BOOKLET
Light year	$1\ \text{ly} = 9.46 \times 10^{15}\ \text{m}$	IN THE BOOKLET
Parsec	$1\ \text{pc} = 3.26\ \text{ly}$	IN THE BOOKLET
Astronomical unit	$1\ \text{AU} = 1.50 \times 10^{11}\ \text{m}$	IN THE BOOKLET
Kilowatt-hour	$1\ \text{kWh} = 3.60 \times 10^{6}\ \text{J}$	IN THE BOOKLET
Planck constant times speed of light Handy for photon energy E = hc/λ.	$hc = 1.99 \times 10^{-25}\ \text{J m} = 1.24 \times 10^{-6}\ \text{eV m}$	IN THE BOOKLET

Electrical circuit symbols

The booklet draws these 15 symbols; the drawings are not reproduced here, so learn each symbol from your class notes or the booklet.

Symbol shown	Symbol shown	Symbol shown
Cell	Battery	Switch
Voltmeter	Ammeter	Resistor
Variable resistor	Light-dependent resistor (LDR)	Thermistor
Potentiometer	Lamp	Light emitting diode (LED)
Heating element	Motor	Earth (ground)

Electromagnetic spectrum

The booklet shows a wavelength scale from 10^{-16} m to 10^{8} m with the regions in order, energy increasing towards the short-wavelength end, and an expanded view of the visible spectrum. It prints no boundary values between regions, so none are given here.

Region, shortest wavelength first	Note
Gamma rays	Highest energy
X-rays	
UV	
Visible light	VIBGYOR from 400 nm (violet) to 700 nm (red)
IR	
Microwaves	
Radio waves	Lowest energy

A.1 Kinematics

Theme A, space, time and motion. Standard level and higher level.

Displacement from average velocity u initial velocity, v final velocity, t time. Constant acceleration.	$s = \frac{u+v}{2}t$	IN THE BOOKLET
Final velocity a acceleration.	$v = u + at$	IN THE BOOKLET
Displacement	$s = ut + \frac{1}{2}at^2$	IN THE BOOKLET
Velocity without time	$v^2 = u^2 + 2as$	IN THE BOOKLET

A.2 Forces and momentum

Theme A. Standard level and higher level.

Static friction limit Coefficient of static friction times the normal force.	$F_f \leq \mu_s F_N$	IN THE BOOKLET
Dynamic friction Coefficient of dynamic friction times the normal force.	$F_f = \mu_d F_N$	IN THE BOOKLET
Hooke's law k spring constant, x extension.	$F_H = -kx$	IN THE BOOKLET
Viscous drag on a sphere η fluid viscosity, r radius, v speed.	$F_d = 6\pi\eta r v$	IN THE BOOKLET
Buoyancy ρ fluid density, V volume of fluid displaced.	$F_b = \rho V g$	IN THE BOOKLET
Weight	$F_g = mg$	IN THE BOOKLET
Linear momentum	$p = mv$	IN THE BOOKLET
Impulse	$J = F\Delta t$	IN THE BOOKLET
Newton's second law The second form allows for changing mass.	$F = ma = \frac{\Delta p}{\Delta t}$	IN THE BOOKLET
Centripetal acceleration ω angular speed, T period.	$a = \frac{v^2}{r} = \omega^2 r = \frac{4\pi^2 r}{T^2}$	IN THE BOOKLET
Speed in circular motion	$v = \frac{2\pi r}{T} = \omega r$	IN THE BOOKLET

A.3 Work, energy and power

Theme A. Standard level and higher level.

Work done θ is the angle between the force and the displacement.	$W = Fs\cos\theta$	IN THE BOOKLET
Kinetic energy	$E_k = \frac{1}{2}mv^2 = \frac{p^2}{2m}$	IN THE BOOKLET
Change in gravitational potential energy Near the Earth's surface only.	$\Delta E_p = mg\Delta h$	IN THE BOOKLET

Elastic potential energy	$E_H = \frac{1}{2}k\,\Delta x^2$	IN THE BOOKLET
Power	$P = \frac{\Delta W}{\Delta t} = Fv$	IN THE BOOKLET
Efficiency	$\eta = \frac{E_{\text{output}}}{E_{\text{input}}} = \frac{P_{\text{output}}}{P_{\text{input}}}$	IN THE BOOKLET

A.4 Rigid body mechanics (additional higher level)

Theme A. Higher level content only.

Torque HL only. r distance from the axis, θ angle between force and r.	$\tau = Fr\sin\theta$	IN THE BOOKLET
Angular displacement from average angular velocity HL only. Uniform angular acceleration.	$\Delta\theta = \frac{\omega_f + \omega_i}{2}\,t$	IN THE BOOKLET
Final angular velocity HL only. α angular acceleration.	$\omega_f = \omega_i + \alpha t$	IN THE BOOKLET
Angular displacement HL only.	$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$	IN THE BOOKLET
Angular velocity without time HL only.	$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$	IN THE BOOKLET
Moment of inertia of point masses HL only. Sum over every mass m at distance r from the axis.	$I = \sum mr^2$	IN THE BOOKLET
Newton's second law for rotation HL only.	$\tau = I\alpha$	IN THE BOOKLET
Angular momentum HL only.	$L = I\omega$	IN THE BOOKLET
Angular impulse HL only.	$\Delta L = \tau\Delta t$	IN THE BOOKLET
Change in angular momentum HL only.	$\Delta L = \Delta(I\omega)$	IN THE BOOKLET
Rotational kinetic energy HL only.	$E_k = \frac{1}{2}I\omega^2 = \frac{L^2}{2I}$	IN THE BOOKLET

A.5 Galilean and special relativity (additional higher level)

Theme A. Higher level content only.

Galilean position HL only. Frame S' moves at speed v along x.	$x' = x - vt$	IN THE BOOKLET
Galilean time HL only.	$t' = t$	IN THE BOOKLET
Galilean velocity addition HL only.	$u' = u - v$	IN THE BOOKLET
Lorentz position and Lorentz factor HL only.	$x' = \gamma(x - vt) \quad \text{where} \quad \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$	IN THE BOOKLET
Lorentz time HL only.	$t' = \gamma\left(t - \frac{vx}{c^2}\right)$	IN THE BOOKLET

Relativistic velocity addition HL only.	$u' = \frac{u - v}{1 - \frac{uv}{c^2}}$	IN THE BOOKLET
Spacetime interval HL only. Same in every inertial frame.	$(\Delta s)^2 = (c\Delta t)^2 - \Delta x^2$	IN THE BOOKLET
Time dilation HL only. The proper time: the interval measured in the frame where both events happen at the same place.	$\Delta t = \gamma \, \Delta t_0$	IN THE BOOKLET
Length contraction HL only. The proper length: the length measured in the rest frame of the object.	$L = \frac{L_0}{\gamma}$	IN THE BOOKLET
Spacetime diagram angle HL only.	$\tan\theta = \frac{v}{c}$	IN THE BOOKLET

B.1 Thermal energy transfers

Theme B, the particulate nature of matter. Standard level and higher level.

Density	$\rho = \frac{m}{V}$	IN THE BOOKLET
Mean kinetic energy per particle T in kelvin.	$\overline{E_k} = \frac{3}{2}k_B T$	IN THE BOOKLET
Thermal energy for a temperature change c specific heat capacity.	$Q = mc\,\Delta T$	IN THE BOOKLET
Thermal energy for a phase change L specific latent heat.	$Q = mL$	IN THE BOOKLET
Rate of conduction k thermal conductivity, A cross-sectional area.	$\frac{\Delta Q}{\Delta t} = kA\frac{\Delta T}{\Delta x}$	IN THE BOOKLET
Stefan-Boltzmann law L power radiated (luminosity), A surface area.	$L = \sigma A T^4$	IN THE BOOKLET
Apparent brightness d distance to the source.	$b = \frac{L}{4\pi d^2}$	IN THE BOOKLET
Wien's displacement law	$\lambda_{\max} T = 2.9 \times 10^{-3}\ \text{m K}$	IN THE BOOKLET

B.2 Greenhouse effect

Theme B. Standard level and higher level.

Emissivity	$\text{emissivity} = \frac{\text{power radiated per unit area}}{\sigma T^4}$	IN THE BOOKLET
Albedo	$\text{albedo} = \frac{\text{total scattered power}}{\text{total incident power}}$	IN THE BOOKLET

B.3 Gas laws

Theme B. Standard level and higher level.

Pressure	$P = \frac{F}{A}$	IN THE BOOKLET
Amount of substance N number of molecules.	$n = \frac{N}{N_A}$	IN THE BOOKLET

Combined gas law T in kelvin.	$\frac{PV}{T} = \text{constant}$	IN THE BOOKLET
Ideal gas law The second form uses the number of molecules N.	$PV = nRT = Nk_BT$	IN THE BOOKLET
Pressure from kinetic theory The booklet prints ρ v squared; v^2 is the mean square speed of the molecules.	$P = \frac{1}{3}\rho\langle v^2\rangle$	IN THE BOOKLET
Internal energy of an ideal gas Monatomic gas.	$U = \frac{3}{2}nRT = \frac{3}{2}Nk_BT$	IN THE BOOKLET

B.5 Current and circuits

Theme B. Standard level and higher level.

Electric current	$I = \frac{\Delta q}{\Delta t}$	IN THE BOOKLET
Potential difference	$V = \frac{W}{q}$	IN THE BOOKLET
Resistance	$R = \frac{V}{I}$	IN THE BOOKLET
Resistivity A cross-sectional area, L length.	$\rho = \frac{RA}{L}$	IN THE BOOKLET
Electrical power	$P = IV = I^2R = \frac{V^2}{R}$	IN THE BOOKLET
Series circuit: current The current is the same everywhere.	$I = I_1 = I_2 = \dots$	IN THE BOOKLET
Series circuit: potential difference	$V = V_1 + V_2 + \dots$	IN THE BOOKLET
Series circuit: resistance	$R_s = R_1 + R_2 + \dots$	IN THE BOOKLET
Parallel circuit: current	$I = I_1 + I_2 + \dots$	IN THE BOOKLET
Parallel circuit: potential difference The potential difference is the same across each branch.	$V = V_1 = V_2 = \dots$	IN THE BOOKLET
Parallel circuit: resistance	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	IN THE BOOKLET
EMF and internal resistance R external resistance, r internal resistance.	$\varepsilon = I(R + r)$	IN THE BOOKLET

B.4 Thermodynamics (additional higher level)

Theme B. Higher level content only.

First law of thermodynamics HL only. Q heat added, W work done by the gas.	$Q = \Delta U + W$	IN THE BOOKLET
Work done by a gas HL only. Constant pressure.	$W = P\,\Delta V$	IN THE BOOKLET
Change in internal energy HL only. Monatomic ideal gas.	$\Delta U = \frac{3}{2}nR\,\Delta T = \frac{3}{2}Nk_B\,\Delta T$	IN THE BOOKLET

Entropy change HL only.	$\Delta S = \frac{\Delta Q}{T}$	IN THE BOOKLET
Entropy and microstates HL only. Omega is the number of microstates.	$S = k_B \ln \Omega$	IN THE BOOKLET
Adiabatic change HL only. Monatomic ideal gas.	$PV^{5/3} = \text{constant}$	IN THE BOOKLET
Efficiency of a heat engine HL only.	$\eta = \frac{\text{useful work}}{\text{input energy}}$	IN THE BOOKLET
Carnot efficiency HL only. Temperatures in kelvin.	$\eta_{\text{Carnot}} = 1 - \frac{T_c}{T_h}$	IN THE BOOKLET

C.1 to C.5 Wave behaviour

Theme C, wave behaviour. Standard level and higher level.

C.1 Defining equation of simple harmonic motion	$a = -\omega^2 x$	IN THE BOOKLET
C.1 Period, frequency and angular frequency	$T = \frac{1}{f} = \frac{2\pi}{\omega}$	IN THE BOOKLET
C.1 Mass on a spring	$T = 2\pi\sqrt{\frac{m}{k}}$	IN THE BOOKLET
C.1 Simple pendulum Small angles.	$T = 2\pi\sqrt{\frac{l}{g}}$	IN THE BOOKLET
C.2 Wave speed	$v = f\lambda = \frac{\lambda}{T}$	IN THE BOOKLET
C.3 Snell's law n refractive index, θ measured from the normal.	$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1}$	IN THE BOOKLET
C.3 Constructive interference n = 0, 1, 2, ...	$\text{path difference} = n\lambda$	IN THE BOOKLET
C.3 Destructive interference	$\text{path difference} = \left(n + \frac{1}{2}\right)\lambda$	IN THE BOOKLET
C.3 Double-slit fringe spacing D slit to screen, d slit separation.	$s = \frac{\lambda D}{d}$	IN THE BOOKLET
C.5 Doppler effect for light or sound at low speed	$\frac{\Delta f}{f} = \frac{\Delta\lambda}{\lambda} \approx \frac{v}{c}$	IN THE BOOKLET

C.1, C.3 and C.5 (additional higher level)

Theme C. Higher level content only.

C.1 Displacement in SHM HL only. x0 amplitude, φ phase constant.	$x = x_0 \sin(\omega t + \phi)$	IN THE BOOKLET
C.1 Velocity in SHM HL only.	$v = \omega x_0 \cos(\omega t + \phi)$	IN THE BOOKLET
C.1 Velocity from displacement HL only.	$v = \pm\omega\sqrt{x_0^2 - x^2}$	IN THE BOOKLET
C.1 Total energy in SHM HL only.	$E_T = \frac{1}{2}m\omega^2 x_0^2$	IN THE BOOKLET

C.1 Potential energy in SHM HL only.	$E_p = \frac{1}{2}m\omega^2x^2$	IN THE BOOKLET
C.3 Single-slit diffraction HL only. b slit width, small angles.	$\theta = \frac{\lambda}{b}$	IN THE BOOKLET
C.3 Diffraction grating HL only. d grating spacing, n order.	$n\lambda = d\sin\theta$	IN THE BOOKLET
C.5 Doppler effect: moving source HL only. v wave speed, us speed of the source.	$f' = f\left(\frac{v}{v \pm u_s}\right)$	IN THE BOOKLET
C.5 Doppler effect: moving observer HL only. uo speed of the observer.	$f' = f\left(\frac{v \pm u_o}{v}\right)$	IN THE BOOKLET

D.1 to D.3 Fields

Theme D, fields. Standard level and higher level.

D.1 Newton's law of gravitation	$F = G\frac{m_1m_2}{r^2}$	IN THE BOOKLET
D.1 Gravitational field strength	$g = \frac{F}{m} = G\frac{M}{r^2}$	IN THE BOOKLET
D.2 Coulomb's law	$F = k\frac{q_1q_2}{r^2} \quad \text{where} \quad k = \frac{1}{4\pi\varepsilon_0}$	IN THE BOOKLET
D.2 Electric field strength	$E = \frac{F}{q}$	IN THE BOOKLET
D.2 Uniform field between plates	$E = \frac{V}{d}$	IN THE BOOKLET
D.3 Force on a moving charge θ is the angle between v and B.	$F = qvB\sin\theta$	IN THE BOOKLET
D.3 Force on a current-carrying wire	$F = BIL\sin\theta$	IN THE BOOKLET
D.3 Force per unit length between parallel wires r separation of the wires.	$\frac{F}{L} = \mu_0\frac{I_1I_2}{2\pi r}$	IN THE BOOKLET

D.1, D.2 and D.4 (additional higher level)

Theme D. Higher level content only. D.4 has no standard level content.

D.1 Gravitational potential energy HL only.	$E_p = -G\frac{m_1m_2}{r}$	IN THE BOOKLET
D.1 Gravitational potential HL only.	$V_g = -G\frac{M}{r}$	IN THE BOOKLET
D.1 Field strength from potential gradient HL only.	$g = -\frac{\Delta V_g}{\Delta r}$	IN THE BOOKLET
D.1 Work in a gravitational field HL only.	$W = m\,\Delta V_g$	IN THE BOOKLET
D.1 Escape speed HL only.	$v_{\text{esc}} = \sqrt{\frac{2GM}{r}}$	IN THE BOOKLET
D.1 Orbital speed HL only. Circular orbit.	$v_{\text{orbital}} = \sqrt{\frac{GM}{r}}$	IN THE BOOKLET

D.2 Electric potential energy HL only.	$E_p = k\frac{q_1 q_2}{r}$	IN THE BOOKLET
D.2 Electric potential HL only.	$V_e = \frac{kQ}{r}$	IN THE BOOKLET
D.2 Field strength from potential gradient HL only.	$E = -\frac{\Delta V_e}{\Delta r}$	IN THE BOOKLET
D.2 Work in an electric field HL only.	$W = q\,\Delta V_e$	IN THE BOOKLET
D.4 Magnetic flux HL only. θ is the angle between B and the normal to the area.	$\Phi = BA\cos\theta$	IN THE BOOKLET
D.4 Faraday's law HL only. N number of turns.	$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$	IN THE BOOKLET
D.4 EMF in a moving conductor HL only. Conductor moves perpendicular to B.	$\varepsilon = BvL$	IN THE BOOKLET

E.1, E.3 and E.5 Nuclear and quantum physics

Theme E, nuclear and quantum physics. Standard level and higher level.

E.1 Photon energy	$E = hf$	IN THE BOOKLET
E.3 Mass-energy equivalence	$E = mc^2$	IN THE BOOKLET
E.5 Stellar parallax p is the parallax angle in arc-seconds.	$d(\text{parsec}) = \frac{1}{p(\text{arc-second})}$	IN THE BOOKLET

E.1 to E.3 (additional higher level)

Theme E. Higher level content only.

E.1 Nuclear radius HL only. A nucleon number; R0 is the Fermi radius, which is given.	$R = R_0 A^{1/3}$	IN THE BOOKLET
E.1 Hydrogen energy levels HL only.	$E = -\frac{13.6}{n^2}\ \text{eV}$	IN THE BOOKLET
E.1 Quantised angular momentum (Bohr) HL only.	$mvr = \frac{nh}{2\pi}$	IN THE BOOKLET
E.2 Photoelectric effect HL only. Φ work function.	$E_{\max} = hf - \Phi$	IN THE BOOKLET
E.2 De Broglie wavelength HL only.	$\lambda = \frac{h}{p}$	IN THE BOOKLET
E.2 Compton shift HL only. Photon scattered by an electron.	$\lambda_f - \lambda_i = \Delta\lambda = \frac{h}{m_e c}(1 - \cos\theta)$	IN THE BOOKLET
E.3 Radioactive decay law HL only. λ decay constant.	$N = N_0 e^{-\lambda t}$	IN THE BOOKLET
E.3 Activity HL only.	$A = \lambda N = \lambda N_0 e^{-\lambda t}$	IN THE BOOKLET
E.3 Half-life HL only.	$T_{1/2} = \frac{\ln 2}{\lambda}$	IN THE BOOKLET

Learn these: not in the booklet

Velocity and acceleration as rates of change

$$v = \frac{\Delta s}{\Delta t}, \quad a = \frac{\Delta v}{\Delta t}$$

Conservation of linear momentum

$$\sum p_{\text{before}} = \sum p_{\text{after}}$$

Work-energy principle

$$W = \Delta E_k$$

Centripetal force

$$F = \frac{mv^2}{r} = m\omega^2 r$$

Equilibrium

$$\sum F = 0, \quad \sum \tau = 0$$

Translational, then rotational equilibrium (HL).

Kepler's third law

$$\frac{T^2}{r^3} = \text{constant}, \quad T^2 = \frac{4\pi^2 r^3}{GM}$$

The second form is for a circular orbit.

Critical angle (from Snell's law with a 90 degree refracted ray)

$$\sin\theta_c = \frac{n_2}{n_1}$$

Refractive index in terms of wave speed

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

Intensity of a wave

$$I = \frac{P}{A}, \quad I \propto \frac{1}{r^2}$$

The inverse square law is for a point source.

Standing waves, string fixed at both ends

$$\lambda = \frac{2L}{n}, \quad f_n = \frac{nv}{2L}$$

Terminal potential difference

$$V = \varepsilon - Ir$$

Charge and energy in a circuit

$$q = It, \quad E = Pt = IVt$$

Electric field of a point charge

$$E = \frac{kQ}{r^2}$$

Radius of a charged particle's circular path in a magnetic field

$$r = \frac{mv}{qB}$$

Energy gained by a charge through a potential difference

$$\Delta E_k = qV$$

Photon energy from wavelength

$$E = \frac{hc}{\lambda}$$

Energy level transition

$$hf = E_i - E_f$$

Photoelectric threshold frequency

$$hf_0 = \Phi$$

Mass defect and binding energy

$$\Delta m = Zm_p + (A - Z)m_n - m_{\text{nucleus}}, \quad E_b = \Delta m\, c^2$$

Half-life (whole numbers of half-lives, SL)

$$N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$$

Stellar radius from luminosity and temperature

$$L = 4\pi R^2 \sigma T^4 \Rightarrow R = \sqrt{\frac{L}{4\pi\sigma T^4}}$$

SHM maximum values (HL)

$$v_{\max} = \omega x_0, \quad a_{\max} = \omega^2 x_0$$

Stopping potential (HL)

$$eV_s = E_{\max}$$

The potential difference that just stops the fastest photoelectrons.

Nuclear composition

$$A = Z + N$$

Nucleon number = proton number + neutron number.

Using the booklet in the exam

- Learn the layout by theme, so in the exam you can find an equation in seconds instead of scanning every page.
- Check what each angle means before substituting: in F = qvB sin θ it is the angle between the velocity and the field.
- Equations in the booklet give magnitudes only, so decide directions and signs yourself from the physics.
- Convert units before using constants: radians for angular quantities, kelvin for temperature, kilograms for mass, metres for lengths.
- Use the printed constants to the given precision, then quote your answer to the same number of significant figures as the data in the question.

Based on: International Baccalaureate Diploma Programme Physics (first assessment 2025), Physics data booklet, first assessment 2025, version 1.0. Statistical tables are calculated by CuratedPrep to the same layout. Updated 31 October 2026. Always practise with the version of the official booklet your exam uses. More free sheets and topic worksheets at curatedprep.com.