IB DP PHYSICS · EXAM SPECIAL · SL & HL · CHECKED AGAINST THE DATA BOOKLET FOR FIRST ASSESSMENT 2025 · ~8 MIN READ

IB Physics Data Booklet: Equations Not Given and How to Use It

What the IB Physics data booklet (first assessment 2025) contains, the equations and facts it leaves out that you must know or derive, and how to use the booklet quickly in Papers 1 and 2.

What the booklet contains | Constants & conversions | Equations not given (SL) | Equations not given (HL) | Quick derivations | Symbols & units | Using the booklet fast

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No tag = **SL and HL** HL ONLY HL students only DATA BOOKLET given in the exam

M1 A1 how marks are awarded highlight = comes up again and again HANDY worth memorising

Test yourself at the end

IN 30 SECONDS

- **The data booklet is available in every Physics paper.** It has the constants, unit conversions, circuit symbols and the equations for each topic, with the HL-only equations listed separately.
- **It gives magnitudes only.** There are no vector signs and no directions: you supply those (for example, which way a force or current acts).
- **Several common results aren't in it.** You either memorise them or derive them in one or two lines from equations that are.

BY THE END YOU CAN

- Know what the data booklet gives you, topic by topic.
- Learn or derive the equations it leaves out.
- Use the booklet quickly and choose the right symbols and units.

1 What the booklet contains

General pages

Section	What it gives
Mathematical equations	Areas and volumes of simple shapes; resolving a vector into components (A cos θ, A sin θ); tan θ and $\sin^2\theta + \cos^2\theta = 1$
Uncertainties	Rules for sums, products/quotients and powers
Fundamental constants	g, G, N_A, R, k_B, σ, k, ε_o, μ_o, c, h, e, masses of the electron, proton and neutron (kg, u and MeV c^{-2}), u, solar constant, Fermi radius
Multipliers	peta (10^{15}) down to femto (10^{-15})
Unit conversions	Radians ↔ degrees, °C ↔ K, light year, parsec, AU, kWh, hc in J m and eV m
Other	Circuit symbols; the electromagnetic spectrum with wavelengths

Topic equations

Theme	SL and HL	HL only
A Space, time and motion	suvat; friction; Hooke's law; drag ($6\pi\eta rv$); buoyancy; momentum and impulse; centripetal acceleration; work, KE, GPE, EPE, power, efficiency	Rigid bodies (torque, angular suvat, moment of inertia, angular momentum, rotational KE); Galilean and special relativity
B Particulate nature of matter	Density; average KE of molecules; specific heat and latent heat; conduction; Stefan–Boltzmann; intensity $b = L/4\pi d^2$; Wien; emissivity; albedo; gas laws; current, pd, resistance, resistivity, power, series/parallel, emf and internal resistance	First law, work by a gas, internal energy change, entropy ($\Delta Q/T$ and $k_B \ln \Omega$), adiabatic $pV^{5/3}$, Carnot efficiency
C Wave behaviour	SHM $a = -\omega^2 x$, periods of pendulum and mass–spring, $v = f\lambda$, Snell's law, interference conditions, double slit $s = \lambda D/d$, Doppler for light	SHM x, v and energy equations; single slit $\theta = \lambda/b$; grating $n\lambda = d \sin\theta$; Doppler for sound
D Fields	Newton's gravitation, $g = GM/r^2$, Coulomb's law, $E = F/q$, $E = V/d$, magnetic forces on charges, wires and parallel wires	Gravitational and electric potential and potential energy, field = −gradient, escape and orbital speed; induction: flux, Faraday, $\varepsilon = BvL$
E Nuclear and quantum	$E = hf$, $E = mc^2$, parallax distance	Nuclear radius, Bohr energy levels and angular momentum, photoelectric equation, de Broglie, Compton shift, exponential decay, activity, half-life

2 Equations NOT in the booklet: SL and HL

Mechanics

Result	How to get it
Conservation of momentum: total p before = total p after	Principle; learn it
Elastic collision: total KE is also conserved	Principle
Impulse = area under a force–time graph	From $J = F\Delta t$ for a varying force
Projectiles: horizontal velocity constant, vertical $a = -g$	Resolve with $A\cos\theta$, $A\sin\theta$, then suvat for each direction separately
Work done = area under a force–displacement graph	From $W = Fs$ for a varying force
Weight component down a slope = $mg\sin\theta$; normal force = $mg\cos\theta$	Resolve the weight

Waves

Result	How to get it
Refractive index $n = c/v$	Snell's law with medium 1 as vacuum
Critical angle: $\sin c = n_2/n_1$	Snell's law with $\theta_2 = 90°$
String or pipe open at both ends: $L = n\lambda/2$	Draw the standing wave: nodes (or antinodes) at both ends
Pipe closed at one end: $L = (2n - 1)\lambda/4$ (odd harmonics only)	A node at the closed end, an antinode at the open end
Intensity $\propto$ amplitude^2	Learn it
$f = 1/T$ and $\omega = 2\pi f$	$\omega = 2\pi/T$ is given; rearrange

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Fields and circuits

Result	How to get it
Potential divider: $V_{out} = V_{in} \times R_2/(R_1 + R_2)$	Same current through both resistors
Terminal pd: $V = \varepsilon - Ir$	Rearrange $\varepsilon = I(R + r)$
Field of a long straight wire: $B = \mu_0 I/(2\pi r)$	From the given force between parallel wires, $F/L = \mu_0 I_1 I_2/(2\pi r)$, and $F = BIL$: the field of wire 1 at wire 2 is $B = \mu_0 I_1/(2\pi r)$
Radius of a charge's circle in a B-field: $r = mv/(qB)$	$qvB = mv^2/r$
Kepler's third law: $T^2 = 4\pi^2 r^3/(GM)$	$GMm/r^2 = m(4\pi^2 r/T^2)$
Orbital speed $v = \sqrt{(GM/r)}$ (given at HL; derive at SL if needed)	$GMm/r^2 = mv^2/r$

Thermal, nuclear and quantum

Result	How to get it
Half-lives (SL): after n half-lives $N = N_0(½)^n$	Halve n times
Binding energy = mass defect × c^2 (931.5 MeV per u)	$E = mc^2$ with the u conversion given
Photon energy in eV: $E = 1.24 \times 10^{-6} / \lambda$ (λ in m)	hc in eV m is given
Energy level transition: $\Delta E = hf$	$E = hf$
Conservation of A and Z (charge) in nuclear equations	Principle
Decay products: $\alpha = {}^4_2\text{He}$, β^- emits an electron + antineutrino, β^+ a positron + neutrino	Learn them

3 Quick derivations worth practising

WORKED EXAMPLE

Derive Kepler's third law for a circular orbit.

1. Gravity provides the centripetal force: $GMm/r^2 = mv^2/r$
2. $v = 2\pi r/T$, so $GM/r^2 = 4\pi^2 r/T^2$
3. **$T^2 = (4\pi^2/GM)\, r^3$, so $T^2 \propto r^3$**

WORKED EXAMPLE

Find the critical angle for glass (n = 1.50) in air.

1. $\sin c = n_2/n_1 = 1.00/1.50 = 0.667$
2. **$c = 41.8°$**

WORKED EXAMPLE

A pipe closed at one end is 0.85 m long. Find the fundamental frequency if the speed of sound is 340 m s^{-1}.

1. $L = \lambda/4 \Rightarrow \lambda = 3.4$ m
2. **$f = v/\lambda = 340/3.4 = 100$ Hz**

4 Constants and symbols

- **g = 9.8 m s^{-2} in the booklet.** Examiners accept 9.81 too; use the value the question gives if there is one.
- **Use the booklet's symbols:** E_k, E_p, F_H for Hooke's law, ε for emf. Defining your own is fine, but say what they are.
- **Know the units of each constant** to check your answers: G in N m^2 kg^{-2}, σ in W m^{-2} K^{-4}, k_B in J K^{-1}.
- **Temperatures in kelvin** for gas laws, Stefan–Boltzmann and Wien. The booklet gives K = °C + 273.
- **Electronvolts:** 1 eV = 1.60×10^{-19} J (the elementary charge e is given).

5 Using the booklet fast

- **Learn the order:** general pages first, then themes A to E, each with SL equations followed by "Additional higher level".
- **Write the equation you are using** before substituting. Copying it from the booklet isn't enough on its own; the substitution earns the method mark.
- **Check which symbol means what.** L is length in some equations, luminosity in $b = L/4\pi d^2$, and angular momentum in A.4.

COMMON MISTAKE

Searching for an equation that isn't there. Learn the "not given" tables above so you know at once whether to derive.

LINKING QUESTION

For the physics behind these results see C.4 Standing waves and resonance, D.1 Gravitational fields and D.3 Motion in electromagnetic fields. For exam technique see Paper 2 answers.

Test yourself — cover the answers first

QUICK CHECK

1. Is the critical angle formula in the data booklet?
2. What length is a closed pipe for its fundamental?
3. Is Kepler's third law in the data booklet?
4. What value of g does the data booklet give?
5. Is the B-field of a long straight wire given?

Show answers

1. no; use $\sin c = n_2/n_1$ from Snell's law
2. $\lambda/4$
3. no; derive it from gravity = centripetal force
4. 9.8 m s^{-2}
5. no; $B = \mu_0 I/(2\pi r)$

Stuck on a question?

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