

Physics (B): Physics in Context
Unit 1 Harmony and Structure in the Universe

PHYB1

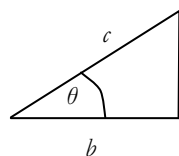
Data and Formulae Booklet

**FUNDAMENTAL CONSTANTS AND
OTHER NUMERICAL DATA**

Quantity	Symbol	Value	Units
speed of light in vacuo	c	3.00×10^8	m s^{-1}
Planck constant	h	6.63×10^{-34}	J s
gravitational constant	G	6.67×10^{-11}	$\text{N m}^2 \text{kg}^{-2}$
gravitational field strength	g	9.81	N kg^{-1}
acceleration due to gravity	g	9.81	m s^{-2}
electron rest mass	m_e	9.11×10^{-31}	kg
	m_e	$5.5 \times 10^{-4} \text{ u}$	
electron charge	e	-1.60×10^{-19}	C
proton rest mass	m_p	$1.67(3) \times 10^{-27}$	kg
	m_p	1.00728 u	
neutron rest mass	m_n	$1.67(5) \times 10^{-27}$	kg
	m_n	1.00867 u	
permittivity of free space	ϵ_0	8.85×10^{-12}	F m^{-1}
molar gas constant	R	8.31	$\text{J K}^{-1} \text{mol}^{-1}$
Boltzmann constant	k	1.38×10^{-23}	J K^{-1}
Avogadro constant	N_A	6.02×10^{23}	mol^{-1}
Wien constant	α	2.90×10^{-3}	m K

**GEOMETRICAL
EQUATIONS**

arc length	$r\theta$
circumference of circle	$2\pi r$
area of circle	πr^2
surface area of sphere	$4\pi r^2$
volume of sphere	$\frac{4}{3}\pi r^3$
surface area of cylinder	$2\pi rh$
volume of cylinder	$\pi r^2 h$



$$\sin \theta = \frac{a}{c}$$

$$\cos \theta = \frac{b}{c}$$

$$\tan \theta = \frac{a}{b}$$

$$c^2 = a^2 + b^2$$

Unit Conversions

1 atomic mass unit (u)	$1.661 \times 10^{-27} \text{ kg}$
1 year (y)	$3.15 \times 10^7 \text{ s}$
1 parsec (pc)	$3.08 \times 10^{16} \text{ m}$
1 parsec	3.26 ly
1 light year (ly)	$9.46 \times 10^{15} \text{ m}$

Particle Properties

Properties of quarks *antiquarks have opposite signs*

type	charge	Baryon number	strangeness
u	$+\frac{2}{3}e$	$+\frac{1}{3}$	0
d	$-\frac{1}{3}e$	$+\frac{1}{3}$	0
s	$-\frac{1}{3}e$	$+\frac{1}{3}$	-1

Properties of Leptons

	Lepton Number
<i>particles:</i> $e^-, \nu_e; \mu^-, \nu_\mu; \tau^-, \nu_\tau$	+1
<i>antiparticles:</i> $e^+, \bar{\nu}_e; \mu^+, \bar{\nu}_\mu; \tau^+, \bar{\nu}_\tau$	-1

AS FORMULAE

	Waves		Quantum Physics and Astrophysics
wave speed	$c = f\lambda$	photon energy	$E = hf$
period	$T = \frac{1}{f}$	Einstein equation	$hf = \phi + E_{k(\max)}$
intensity	$I = \frac{P}{A}$	line spectrum equation	$hf = E_1 - E_2$
stretched string frequency	$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$	de Broglie wavelength	$\lambda = \frac{h}{p} = \frac{h}{mv}$
beat frequency	$f = f_1 - f_2$	Doppler shift for $v \ll c$	$\frac{\Delta f}{f} = -\frac{\Delta \lambda}{\lambda} = \frac{v}{c}$
fringe spacing	$w = \frac{\lambda D}{s}$	Wien's law	$\lambda_{\max} T = 0.0029 \text{ m K}$
diffraction grating	$n\lambda = d \sin \theta$	Hubble law	$v = Hd$
half beam width	$\sin \theta = \frac{\lambda}{a}$	intensity for a point source	$I = \frac{P}{4\pi r^2}$
refractive index of a substance (s)	$n = \frac{c}{c_s}$		
for two different substances of refractive indices n_1 and n_2	$n_1 \sin i_1 = n_2 \sin i_2$		
critical angle	$\sin \theta_c = \frac{n_2}{n_1}$ for $n_1 > n_2$		
	Mechanics		Electricity
speed or velocity	$v = \frac{\Delta s}{\Delta t}$	current	$I = \frac{\Delta Q}{\Delta t}$
acceleration	$a = \frac{\Delta v}{\Delta t}$	electromotive force (emf)	$\varepsilon = \frac{E}{Q}$
equations of motion	$v = u + at$ $s = \frac{(u+v)t}{2}$ $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2}at^2$	resistance	$R = \frac{V}{I}$
force	$F = ma$	resistors in series	$R = R_1 + R_2 + R_3 + \dots$
change in potential energy	$\Delta E_p = mg\Delta h$	resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$
kinetic energy	$E_k = \frac{1}{2}mv^2$	resistivity	$\rho = \frac{RA}{L}$
momentum	$p = mv$	power	$P = VI = I^2R = \frac{V^2}{R}$
impulse	$F\Delta t = \Delta(mv)$	potential divider formula	$V_o = \left(\frac{R_1}{R_1 + R_2} \right) \times V_i$
spring stiffness	$k = \frac{F}{\Delta L}$	energy	$E = VI t$
energy stored for $F \propto L$	$E = \frac{1}{2}F\Delta L$	efficiency	$\frac{\text{useful output power}}{\text{input power}}$
work done	$W = Fs \cos \theta$		
power	$P = \frac{\Delta W}{\Delta t} = Fv$		
density	$\rho = \frac{m}{V}$		
			Energy production and transmission
		rate of heat transfer by conduction	$= UA \Delta \theta$
		maximum power for a wind turbine	$= \frac{1}{2} \pi r^2 \rho v^3$