General Certificate of Education
Advanced Subsidiary Examination
January 2010

Physics (B) Physics in Context — PHYB2
Unit 2 Physics Keeps us Going

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}	N m^{2} 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	5.5×10^{-4} 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_o	8.85×10^{-12}	F m^{-1}
molar gas constant	R	8.31	J K^{-1} 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

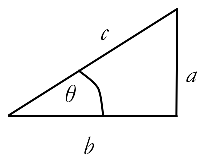
Particle Properties

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

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)	1.661×10^{-27} kg
1 year (y)	3.15×10^{7} s
1 parsec (pc)	3.08×10^{16} m
1 parsec	3.26 ly
1 light year (ly)	9.46×10^{15} m

Properties of Leptons

	Lepton Number
particles: $e^-, \nu_e; \mu^-, \nu_\mu; \tau^-, \nu_\tau$	**+1**
antiparticles: $e^+, \overline{\nu_e}; \mu^+, \overline{\nu_\mu}; \tau^+, \overline{\nu_\tau}$	**−1**

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AS FORMULAE

Waves

wave speed	$c = f\lambda$
period	$T = \frac{1}{f}$
intensity	$I = \frac{P}{A}$
stretched string frequency	$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$
beat frequency	$f = f_1 - f_2$
fringe spacing	$w = \frac{\lambda D}{s}$
diffraction grating	$n\lambda = d \sin \theta$
half beam width	$\sin\theta = \frac{\lambda}{a}$
refractive index of a substance s	$n = \frac{c}{c_s}$
for two different substances of refractive index n_1 and n_2	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
critical angle	$\sin\theta_c = \frac{n_2}{n_1}$ for $n_1 > n_2$

Mechanics

speed or velocity	$v = \frac{\Delta s}{\Delta t}$
acceleration	$a = \frac{\Delta v}{\Delta t}$
equations of motion	$v = u + at$
	$s = \frac{(u+v)}{2}t$
	$v^2 = u^2 + 2as$
	$s = ut + \frac{1}{2}at^2$
force	$F = ma$
change in potential energy	$\Delta E_p = mg\Delta h$
kinetic energy	$E_k = \frac{1}{2}mv^2$
momentum	$p = mv$
impulse	$F\Delta t = \Delta(mv)$
spring stiffness	$k = \frac{F}{\Delta L}$
energy stored for $F \propto L$	$E = \frac{1}{2}F\Delta L$
work done	$W = Fs$
power	$P = \frac{\Delta W}{\Delta t} = Fv$
density	$\rho = \frac{m}{V}$

Quantum Physics and Astrophysics

photon energy	$E = hf$
Einstein equation	$hf = \phi + E_{k(max)}$
line spectrum equation	$hf = E_1 - E_2$
de Broglie wavelength	$\lambda = \frac{h}{p} = \frac{h}{mv}$
Doppler shift for $v << c$	$\frac{\Delta f}{f} = -\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$
Wien's law	$\lambda_{max}T = 0.0029\ \text{m K}$
Hubble law	$v = H d$
intensity for a point source	$I = \frac{P}{4\pi r^2}$

Electricity

current	$I = \frac{\Delta Q}{\Delta t}$
electromotive force (emf)	$\varepsilon = \frac{E}{Q}$
	$\varepsilon = I(R + r)$
resistance	$R = \frac{V}{I}$
resistors in series	$R = R_1 + R_2 + R_3 + \ldots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$
resistivity	$\rho = \frac{RA}{L}$
power	$P = VI = I^2R = \frac{V^2}{R}$
potential divider formula	$V_o = \left(\frac{R_1}{R_1 + R_2}\right) \times V_i$
energy	$E = VIt$
efficiency	$\frac{\text{useful output power}}{\text{input power}}$

Energy production and transmission

rate of heat transfer by conduction	$= UA\,\Delta\theta$
maximum power for a wind turbine	$= \frac{1}{2}\pi r^2 \rho v^3$