



Physics A

PHYA1

Unit 1 Particles, Quantum Phenomena and Electricity

Data and Formulae Booklet

DATA

FUNDAMENTAL CONSTANTS AND VALUES

<i>Quantity</i>	<i>Symbol</i>	<i>Value</i>	<i>Units</i>
speed of light in vacuo	c	3.00×10^8	m s^{-1}
permeability of free space	μ_0	$4\pi \times 10^{-7}$	H m^{-1}
permittivity of free space	ϵ_0	8.85×10^{-12}	F m^{-1}
magnitude of the charge of electron	e	1.60×10^{-19}	C
the Planck constant	h	6.63×10^{-34}	J s
gravitational constant	G	6.67×10^{-11}	$\text{N m}^2 \text{kg}^{-2}$
the Avogadro constant	N_A	6.02×10^{23}	mol^{-1}
molar gas constant	R	8.31	$\text{J K}^{-1} \text{mol}^{-1}$
the Boltzmann constant	k	1.38×10^{-23}	J K^{-1}
the Stefan constant	σ	5.67×10^{-8}	$\text{W m}^{-2} \text{K}^{-4}$
the Wien constant	α	2.90×10^{-3}	m K
electron rest mass (equivalent to 5.5×10^{-4} u)	m_e	9.11×10^{-31}	kg
electron charge/mass ratio	e/m_e	1.76×10^{11}	C kg^{-1}
proton rest mass (equivalent to 1.00728 u)	m_p	$1.67(3) \times 10^{-27}$	kg
proton charge/mass ratio	e/m_p	9.58×10^7	C kg^{-1}
neutron rest mass (equivalent to 1.00867 u)	m_n	$1.67(5) \times 10^{-27}$	kg
gravitational field strength	g	9.81	N kg^{-1}
acceleration due to gravity	g	9.81	m s^{-2}
atomic mass unit (1u is equivalent to 931.3 MeV)	u	1.661×10^{-27}	kg

GEOMETRICAL EQUATIONS

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

ASTRONOMICAL DATA

<i>Body</i>	<i>Mass/kg</i>	<i>Mean radius/m</i>
Sun	1.99×10^{30}	6.96×10^8
Earth	5.98×10^{24}	6.37×10^6

AS FORMULAE

PARTICLE PHYSICS

Rest energy values

class	name	symbol	rest energy /MeV
photon	photon	γ	0
lepton	neutrino	ν_e	0
		ν_μ	0
	electron	$e^\pm$	0.510999
	muon	$\mu^\pm$	105.659
mesons	π meson	$\pi^\pm$	139.576
		π^0	134.972
	K meson	$K^\pm$	493.821
		K^0	497.762
baryons	proton	p	938.257
	neutron	n	939.551

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
particles: $e^-, \nu_e; \mu^-, \nu_\mu$	+1
antiparticles: $e^+, \bar{\nu}_e; \mu^+, \bar{\nu}_\mu$	-1

Photons and Energy Levels

photon energy $E = hf = hc/\lambda$ photoelectricity $hf = \phi + E_{K(\max)}$ energy levels $hf = E_1 - E_2$ de Broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{mv}$

ELECTRICITY

current and pd $I = \frac{\Delta Q}{\Delta t}$ $V = \frac{W}{Q}$ $R = \frac{V}{I}$ emf $\varepsilon = \frac{E}{Q}$ $\varepsilon = I(R + r)$ resistors in series $R = R_1 + R_2 + R_3 + \dots$ resistors in parallel $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$ resistivity $\rho = \frac{RA}{L}$ power $P = VI = I^2 R = \frac{V^2}{R}$ alternating current $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$

MECHANICS

moments moment = Fd velocity and acceleration $v = \frac{\Delta s}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$ equations of motion $v = u + at$ $s = \frac{(u+v)}{2}t$

$$v^2 = u^2 + 2as \quad s = ut + \frac{1}{2}at^2$$

force $F = ma$ work, energy and power $W = F s \cos \theta$ $E_K = \frac{1}{2} m v^2$ $\Delta E_p = mg\Delta h$

$$P = \frac{\Delta W}{\Delta t}, P = Fv$$

efficiency = $\frac{\text{useful output power}}{\text{input power}}$

MATERIALS

density $\rho = \frac{m}{V}$ Hooke's law $F = k \Delta L$ Young modulus = $\frac{\text{tensile stress}}{\text{tensile strain}}$ tensile stress = $\frac{F}{A}$

$$\text{tensile strain} = \frac{\Delta L}{L}$$

energy stored $E = \frac{1}{2} F \Delta L$

WAVES

wave speed $c = f\lambda$ period $T = \frac{1}{f}$ fringe spacing $w = \frac{\lambda D}{s}$ diffraction grating $d \sin \theta = n\lambda$ refractive index of a substance s, $n = \frac{c}{c_s}$ for two different substances of refractive indices n_1 and n_2 ,law of refraction $n_1 \sin \theta_1 = n_2 \sin \theta_2$ critical angle $\sin \theta_c = \frac{n_2}{n_1}$ for $n_1 > n_2$