



AS PHYSICS

Physics data and formulae

**For use in exams from the June 2016
Series onwards**

[Turn over]

DATA — FUNDAMENTAL CONSTANTS AND VALUES

QUANTITY	SYMBOL	VALUE	UNITS
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} ²
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

QUANTITY	SYMBOL	VALUE	UNITS
the Planck constant	h	6.63×10^{-34}	J s
gravitational constant	G	6.67×10^{-11}	N m ² kg ⁻²
the Avogadro constant	N_A	6.02×10^{23}	mol ⁻¹
molar gas constant	R	8.31	J K ⁻¹ mol ⁻¹
the Boltzmann constant	k	1.38×10^{-23}	J K ⁻¹

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QUANTITY	SYMBOL	VALUE	UNITS
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 $5.5 \times 10^{-4} \text{ u}$)	m_e	9.11×10^{-31}	kg
magnitude of electron charge/mass ratio	$\frac{e}{m_e}$	1.76×10^{11}	C kg^{-1}

QUANTITY	SYMBOL	VALUE	UNITS
proton rest mass (equivalent to 1.00728 u)	m_p	$1.67\ (3) \times 10^{-27}$	kg
proton charge/mass ratio	$\frac{e}{m_p}$	9.58×10^7	C kg ⁻¹
neutron rest mass (equivalent to 1.00867 u)	m_n	$1.67\ (5) \times 10^{-27}$	kg

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QUANTITY	SYMBOL	VALUE	UNITS
gravitational field strength	g	9.81	N kg^{-1}
acceleration due to gravity	g	9.81	m s^{-2}
atomic mass unit (1 u is equivalent to 931.5 MeV)	u	1.661×10^{-27}	kg

ALGEBRAIC EQUATION

quadratic equation $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

ASTRONOMICAL DATA

BODY	MASS/kg	MEAN RADIUS/m
Sun	1.99×10^{30}	6.96×10^8
Earth	5.97×10^{24}	6.37×10^6

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GEOMETRICAL EQUATIONS

arc length

$$= r\theta$$

circumference of circle

$$= 2\pi r$$

area of circle

$$= \pi r^2$$

curved surface area of cylinder

$$= 2\pi rh$$

surface area of sphere

$$= 4\pi r^2$$

volume of sphere

$$= \frac{4}{3} \pi r^3$$

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PARTICLE PHYSICS

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

CLASS	NAME	SYMBOL	REST ENERGY/MeV
	K meson	$K^{\pm}$	493.821
		K^0	497.762
baryons	proton	p	938.257
	neutron	n	939.551

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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:	$e^{+}, \overline{\nu_e}, \mu^{+}, \overline{\nu_{\mu}}$	− 1

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PHOTONS AND ENERGY LEVELS

photon energy $E = hf = \frac{hc}{\lambda}$

photoelectricity $hf = \phi + E_{\text{k}} (\text{max})$

energy levels $hf = E_1 - E_2$

de Broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{mv}$

[Turn over]

WAVES

wave speed

$$c = f\lambda$$

period

$$f = \frac{1}{T}$$

first harmonic

$$f = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$$

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 $n_1 > n_2$

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MECHANICS

moments

$$\text{moment} = Fd$$

velocity and
acceleration

$$v = \frac{\Delta s}{\Delta t}$$

$$a = \frac{\Delta v}{\Delta t}$$

equations of
motion

$$v = u + at$$

$$s = \left(\frac{u + v}{2} \right) t$$

$$s = ut + \frac{at^2}{2}$$

$$v^2 = u^2 + 2as$$

force

$$F = ma$$

force

$$F = \frac{\Delta(mv)}{\Delta t}$$

impulse

$$F \Delta t = \Delta(mv)$$

**work, energy
and power**

$$W = F s \cos \theta$$

$$E_k = \frac{1}{2} m v^2$$

$$\Delta E_p = mg \Delta h$$

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

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

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MATERIALS

density $\rho = \frac{m}{V}$

Hooke's law $F = k \Delta L$

Young modulus = $\frac{\text{tensile stress}}{\text{tensile strain}}$

tensile stress = $\frac{F}{A}$

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

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

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ELECTRICITY

current and pd

$$I = \frac{\Delta Q}{\Delta t}$$

$$V = \frac{W}{Q}$$

$$R = \frac{V}{I}$$

resistivity

$$\rho = \frac{RA}{L}$$

resistors in series

$$R_T = R_1 + R_2 + R_3 + \dots$$

resistors in
parallel

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

power $P = VI = I^2R = \frac{V^2}{R}$

emf $\mathcal{E} = \frac{E}{Q} \qquad \mathcal{E} = I(R + r)$

END OF DATA SHEET

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