AS
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	$3{\cdot}00 \times 10^{8}$	m s^{-1}
permeability of free space	μ_0	$4\pi \times 10^{-7}$	H m^{-1}
permittivity of free space	ε_0	$8{\cdot}85 \times 10^{-12}$	F m^{-1}
magnitude of the charge of electron	e	$1{\cdot}60 \times 10^{-19}$	C
the Planck constant	h	$6{\cdot}63 \times 10^{-34}$	J s
gravitational constant	G	$6{\cdot}67 \times 10^{-11}$	$\text{N m}^2\ \text{kg}^{-2}$
the Avogadro constant	N_A	$6{\cdot}02 \times 10^{23}$	mol^{-1}
molar gas constant	R	$8{\cdot}31$	$\text{J K}^{-1}\ \text{mol}^{-1}$
the Boltzmann constant	k	$1{\cdot}38 \times 10^{-23}$	J K^{-1}
the Stefan constant	σ	$5{\cdot}67 \times 10^{-8}$	$\text{W m}^{-2}\ \text{K}^{-4}$
the Wien constant	α	$2{\cdot}90 \times 10^{-3}$	m K
electron rest mass (equivalent to $5{\cdot}5 \times 10^{-4}$ u)	m_e	$9{\cdot}11 \times 10^{-31}$	kg
electron charge / mass ratio	$\frac{e}{m_e}$	$1{\cdot}76 \times 10^{11}$	C kg^{-1}
proton rest mass (equivalent to 1·00728 u)	m_p	$1{\cdot}67(3) \times 10^{-27}$	kg
proton charge/mass ratio	$\frac{e}{m_p}$	$9{\cdot}58 \times 10^{7}$	C kg^{-1}

neutron rest mass (equivalent to 1·00867 u)	m_n	$1{\cdot}67(5) \times 10^{-27}$	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 931·5 MeV)	u	$1{\cdot}661 \times 10^{-27}$	kg

ALGEBRAIC EQUATION

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

ASTRONOMICAL DATA

Body	Mass / kg	Mean radius / m
Sun	$1{\cdot}99 \times 10^{30}$	$6{\cdot}96 \times 10^{8}$
Earth	$5{\cdot}97 \times 10^{24}$	$6{\cdot}37 \times 10^{6}$

GEOMETRICAL EQUATIONS

arc length = $r\theta$

circumference of circle = $2\pi r$

area of circle = πr^2

curved surface area of cylinder = $2\pi rh$

area of sphere = $4\pi r^2$

volume of sphere = $\frac{4}{3}\pi r^3$

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
	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^-, ν_e; μ^-, ν_μ	+1
Antiparticles:	e^+, $\overline{\nu_e}$, μ^+, $\overline{\nu_\mu}$	–1

Photons and energy levels

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

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

energy levels $hf = E_1 - E_2$

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

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 $n_1 > n_2$

Mechanics

moments

moment = Fd

velocity and acceleration

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

equations of motion

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

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

force

$$F = ma$$

force

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

impulse

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

work, energy and power

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

$$E_k = \frac{1}{2}m\,v^2 \qquad \Delta E_p = mg\Delta h$$

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

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

Materials

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

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

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

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

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

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

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 $R_T = R_1 + R_2 + R_3 + ...$

resistors in parallel $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$

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

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

END OF DATA AND FORMULAE

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