AQA

AS Physics data and formulae

For use in exams from the June 2016 Series onwards

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}
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	$\dfrac{e}{m_e}$	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	$\dfrac{e}{m_p}$	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 931.5 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

GEOMETRICAL EQUATIONS

arc length	$= r\theta$
circumference of circle	$= 2\pi r$
area of circle	$= \pi r^2$
curved surface area of cylinder	$= 2\pi rh$
area of sphere	$= 4\pi r^2$
volume of sphere	$= \dfrac{4}{3}\pi r^3$

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:	$e^-, \nu_e ; \mu^-, \nu_\mu$	$+1$
Antiparticles:	$e^+, \overline{\nu_e}, \mu^+, \overline{\nu_\mu}$	-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 $\lambda = \dfrac{h}{p} = \dfrac{h}{mv}$

Waves

wave speed $c = f\lambda$ period $f = \dfrac{1}{T}$

first harmonic $f = \dfrac{1}{2l}\sqrt{\dfrac{T}{\mu}}$

fringe spacing $w = \dfrac{\lambda D}{s}$ diffraction grating $d\sin\theta = n\lambda$

refractive index of a substance s, $n = \dfrac{c}{c_s}$

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 $\sin\theta_c = \dfrac{n_2}{n_1}$ for $n_1 > n_2$

Mechanics

moments $\text{moment} = Fd$

velocity and acceleration $v = \dfrac{\Delta s}{\Delta t}$ $a = \dfrac{\Delta v}{\Delta t}$

equations of motion $v = u + at$ $s = \left(\dfrac{u+v}{2}\right)t$

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

force $F = ma$

force $F = \dfrac{\Delta(mv)}{\Delta t}$

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

work, energy and power $W = F s\cos\theta$

$E_k = \dfrac{1}{2}mv^2$ $\Delta E_p = mg\Delta h$

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

$efficiency = \dfrac{useful\ output\ power}{input\ power}$

Materials

density $\rho = \dfrac{m}{V}$ Hooke's law $F = k\,\Delta L$

Young modulus $= \dfrac{tensile\ stress}{tensile\ strain}$

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

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

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

Electricity

current and pd

$$I = \frac{\Delta Q}{\Delta t} \qquad V = \frac{W}{Q} \qquad R = \frac{V}{I}$$

resistivity

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

resistors in series

$$R_\text{T} = R_1 + R_2 + R_3 + \dots$$

resistors in parallel

$$\frac{1}{R_\text{T}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$

power

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

emf

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