

A



**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	$C$	$3.00 \times 10^8$	$\text{m s}^{-1}$
permeability of free space	$\mu_0$	$4\pi \times 10^{-7}$	$\text{H m}^{-1}$
permittivity of free space	$\epsilon_0$	$8.85 \times 10^{-12}$	$\text{F m}^{-1}$
magnitude of the charge of electron	$e$	$1.60 \times 10^{-19}$	$\text{C}$
the Planck constant	$h$	$6.63 \times 10^{-34}$	$\text{J s}$
gravitational constant	$G$	$6.67 \times 10^{-11}$	$\text{N m}^2 \text{kg}^{-2}$
the Avogadro constant	$N_A$	$6.02 \times 10^{23}$	$\text{mol}^{-1}$
molar gas constant	$R$	8.31	$\text{J K}^{-1} \text{mol}^{-1}$
the Boltzmann constant	$k$	$1.38 \times 10^{-23}$	$\text{J K}^{-1}$

QUANTITY	SYMBOL	VALUE	UNITS
the Stefan constant	$\sigma$	$5.67 \times 10^{-8}$	$\text{Wm}^{-2} \text{K}^{-4}$
the Wien constant	$\alpha$	$2.90 \times 10^{-3}$	m K
electron rest mass (equivalent to $5.5 \times 10^{-4}$ u)	$m_e$	$9.11 \times 10^{-31}$	kg
Magnitude of electron charge/mass ratio	$\frac{e}{m_e}$	$1.76 \times 10^{11}$	$\text{C kg}^{-1}$
proton rest mass (equivalent to 1.00728 u)	$m_p$	$1.67 (3) \times 10^{-27}$	kg
proton charge/mass ratio	$\frac{e}{m_p}$	$9.58 \times 10^7$	$\text{C kg}^{-1}$
neutron rest mass (equivalent to 1.00867 u)	$m_n$	$1.67 (5) \times 10^{-27}$	kg

[Turn over]

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

**ALGEBRAIC EQUATION**

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

**ASTRONOMICAL DATA**

<b>BODY</b>	<b>MASS/kg</b>	<b>MEAN RADIUS/m</b>
Sun	$1.99 \times 10^{30}$	$6.96 \times 10^8$
Earth	$5.97 \times 10^{24}$	$6.37 \times 10^6$

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

[Turn over]

# PARTICLE PHYSICS

CLASS	NAME	SYMBOL	REST ENERGY/MeV
photon	photon	$\gamma$	0
lepton	neutrino	$\nu_e$	0
		$\nu_\mu$	0
	electron	$e^\pm$	0.510999
	muon	$\mu^\pm$	105.659
mesons	$\pi$ meson	$\pi^\pm$	139.576
		$\pi^0$	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

[Turn over]

**PHOTONS AND ENERGY LEVELS**

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

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

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  $n_1 > n_2$

[Turn over]

**MECHANICS****moments**

$$\text{moment} = Fd$$

**velocity and acceleration**

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

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

**equations of motion**

$$v = u + at$$

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

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

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

**force**

$$F = ma$$

**force**

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

**impulse**

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

**work, energy and power**

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

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

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

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

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

**MATERIALS**

**density**     $\rho = \frac{m}{V}$

**Hooke's law**     $F = k \Delta L$

*Young modulus* =  $\frac{\textit{tensile stress}}{\textit{tensile strain}}$

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

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

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

**[Turn over]**

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

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

**END OF DATA SHEET**

**BLANK PAGE**

**BLANK PAGE****Copyright Information**

For confidentiality purposes, from the November 2015 examination series, acknowledgements of third party copyright material will be published in a separate booklet rather than including them on the examination paper or support materials. This booklet is published after each examination series and is available for free download from [www.aqa.org.uk](http://www.aqa.org.uk) after the live examination series.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team, AQA, Stag Hill House, Guildford, GU2 7XJ.

Copyright © 2019 AQA and its licensors. All rights reserved.