GCE A LEVEL

A420QS

PHYSICS – A level

FRIDAY, 8 JUNE 2018 – MORNING

Data Booklet

A clean copy of this booklet should be issued to candidates for their use during each A level component 2 Physics examination.

Centres are asked to issue this booklet to candidates at the start of the course to enable them to become familiar with its contents and layout.

Values and Conversions

Avogadro constant	N_A	$= 6{\cdot}02 \times 10^{23}\ \text{mol}^{-1}$
Fundamental electronic charge	e	$= 1{\cdot}60 \times 10^{-19}\ \text{C}$
Mass of an electron	m_e	$= 9{\cdot}11 \times 10^{-31}\ \text{kg}$
Molar gas constant	R	$= 8{\cdot}31\ \text{J mol}^{-1}\text{K}^{-1}$
Acceleration due to gravity at sea level	g	$= 9{\cdot}81\ \text{m s}^{-2}$
Gravitational field strength at sea level	g	$= 9{\cdot}81\ \text{N kg}^{-1}$
Universal constant of gravitation	G	$= 6{\cdot}67 \times 10^{-11}\ \text{N m}^2\text{kg}^{-2}$
Planck constant	h	$= 6{\cdot}63 \times 10^{-34}\ \text{J s}$
Boltzmann constant	k	$= 1{\cdot}38 \times 10^{-23}\ \text{J K}^{-1}$
Speed of light in vacuo	c	$= 3{\cdot}00 \times 10^{8}\ \text{m s}^{-1}$
Permittivity of free space	ε_o	$= 8{\cdot}85 \times 10^{-12}\ \text{F m}^{-1}$
Permeability of free space	μ_o	$= 4\pi \times 10^{-7}\ \text{H m}^{-1}$
Stefan constant	σ	$= 5{\cdot}67 \times 10^{-8}\ \text{W m}^{-2}\text{K}^{-4}$
Wien constant	W	$= 2{\cdot}90 \times 10^{-3}\ \text{m K}$
Hubble constant	H_0	$= 2{\cdot}20 \times 10^{-18}\ \text{s}^{-1}$

$T/\text{K} = \theta/°\text{C} + 273{\cdot}15$

$1\ \text{parsec} = 3{\cdot}09 \times 10^{16}\ \text{m}$

$1\ \text{u} = 1{\cdot}66 \times 10^{-27}\ \text{kg}$

$1\ \text{eV} = 1{\cdot}60 \times 10^{-19}\ \text{J}$

$$\frac{1}{4\pi\varepsilon_0} \approx 9{\cdot}0 \times 10^{9}\ \text{F}^{-1}\text{m}$$

$\rho = \frac{m}{V}$	$T = 2\pi\sqrt{\frac{l}{g}}$
$v = u + at$	$pV = nRT$ and $pV = NkT$
$x = \frac{1}{2}(u + v)t$	$p = \frac{1}{3}\rho\overline{c^2} = \frac{1}{3}\frac{N}{V}m\overline{c^2}$
$x = ut + \frac{1}{2}at^2$	$M \text{ / kg} = \frac{M_r}{1000}$
$v^2 = u^2 + 2ax$	$n = \frac{\text{total mass}}{\text{molar mass}}$
$\sum F = ma$	$k = \frac{R}{N_A}$
$p = mv$	$U = \frac{3}{2}nRT = \frac{3}{2}NkT$
$W = Fx\cos\theta$	$W = p\Delta V$
$\Delta E = mg\Delta h$	$\Delta U = Q - W$
$E = \frac{1}{2}kx^2$	$Q = mc\Delta\theta$
$E = \frac{1}{2}mv^2$	$I = \frac{\Delta Q}{\Delta t}$
$Fx = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$	$I = nAve$
$P = \frac{W}{t} = \frac{\Delta E}{t}$	$R = \frac{V}{I}$
$\text{efficiency} = \frac{\text{useful energy transfer}}{\text{total energy input}} \times 100\%$	$P = IV = I^2R = \frac{V^2}{R}$
$\omega = \frac{\theta}{t}$	$R = \frac{\rho l}{A}$
$v = \omega r$	$V = E - Ir$
$a = \omega^2 r$	$\frac{V}{V_{\text{total}}}\left[\text{or } \frac{V_{\text{OUT}}}{V_{\text{IN}}}\right] = \frac{R}{R_{\text{total}}}$
$a = \frac{v^2}{r}$	$C = \frac{Q}{V}$
$F = \frac{mv^2}{r}$	$C = \frac{\varepsilon_0 A}{d}$
$F = m\omega^2 r$	$E = \frac{V}{d}$
$a = -\omega^2 x$	$U = \frac{1}{2}QV$
$x = A\cos(\omega t + \varepsilon)$	$Q = Q_0\left(1 - e^{-\frac{t}{RC}}\right)$
$T = \frac{2\pi}{\omega}$	$Q = Q_0 e^{-\frac{t}{RC}}$
$v = -A\omega\sin(\omega t + \varepsilon)$	$F = kx$
$T = 2\pi\sqrt{\frac{m}{k}}$	$\sigma = \frac{F}{A}$

$\varepsilon = \frac{\Delta l}{l}$	$n = \frac{c}{v}$
$E = \frac{\sigma}{\varepsilon}$	$n_1 v_1 = n_2 v_2$
$W = \frac{1}{2} Fx$	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
$F = \frac{1}{4\pi\varepsilon_0} \frac{Q_1 Q_2}{r^2}$	$n_1 \sin\theta_C = n_2$
$F = G\frac{M_1 M_2}{r^2}$	$E_{k\max} = hf - \phi$
$E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$	$p = \frac{h}{\lambda}$
$g = \frac{GM}{r^2}$	$A = \lambda N$
$V_E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r}$	$N = N_0 e^{-\lambda t}$
$PE = \frac{1}{4\pi\varepsilon_0} \frac{Q_1 Q_2}{r}$	$A = A_0 e^{-\lambda t}$
$V_g = -\frac{GM}{r}$	$N = \frac{N_0}{2^x}$
$PE = -\frac{GM_1 M_2}{r}$	$A = \frac{A_0}{2^x}$
$W = q\Delta V_E$	$\lambda = \frac{\ln 2}{T_{\frac{1}{2}}}$
$W = m\Delta V_g$	
$\lambda_{\max} = \frac{W}{T}$	
$P = A\sigma T^4$	
$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$	
$v = H_0 D$	
$\rho_c = \frac{3H_0^{\,2}}{8\pi G}$	$E = mc^2$
$r_1 = \frac{M_2}{M_1 + M_2} d$	$F = BIl\sin\theta$
$T = 2\pi\sqrt{\frac{d^3}{G(M_1 + M_2)}}$	$F = Bqv\sin\theta$
$T = \frac{1}{f}$	$B = \frac{\mu_0 I}{2\pi a}$
$c = f\lambda$	$B = \mu_0 nI$
$\lambda = \frac{a\Delta y}{D}$	$\Phi = AB\cos\theta$
$d\sin\theta = n\lambda$	flux linkage $= N\Phi$

	leptons		quarks	
particle (symbol)	electron (e^-)	electron neutrino (ν_e)	up (u)	down (d)
charge (e)	-1	0	$+\frac{2}{3}$	$-\frac{1}{3}$
lepton number	1	1	0	0

Mathematical Information

SI multipliers

Multiple	Prefix	Symbol
10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c

Multiple	Prefix	Symbol
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}	exa	E
10^{21}	zetta	Z

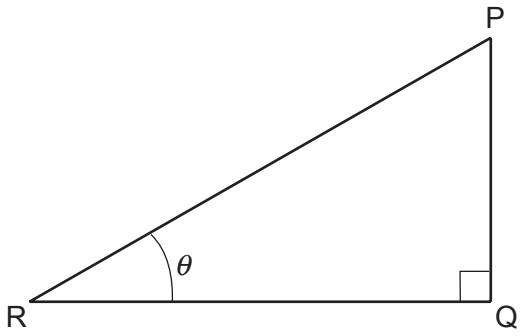
Areas and Volumes

Area of a circle = $\pi r^2 = \frac{\pi d^2}{4}$

Area of a triangle = $\frac{1}{2}$ base × height

Solid	Surface area	Volume
rectangular block	$2(lh + hb + lb)$	lbh
cylinder	$2\pi r(r + h)$	$\pi r^2 h$
sphere	$4\pi r^2$	$\frac{4}{3}\pi r^3$

Trigonometry



$$\sin\theta = \frac{PQ}{PR}, \quad \cos\theta = \frac{QR}{PR}, \quad \tan\theta = \frac{PQ}{QR}, \quad \frac{\sin\theta}{\cos\theta} = \tan\theta$$

$$PR^2 = PQ^2 + QR^2$$

Logarithms

[Unless otherwise specified 'log' can be $\log_e$ (i.e. ln) or $\log_{10}$.]

$\log(ab) = \log a + \log b$ $\qquad$ $\log\left(\frac{a}{b}\right) = \log a - \log b$

$\log x^n = n \log x$ $\qquad$ $\log_e e^{kx} = \ln e^{kx} = kx$

$\log_e 2 = \ln 2 = 0{\cdot}693$