OCR
RECOGNISING ACHIEVEMENT

Data, Formulae and Relationships Booklet
(Revised Version 2.1)

GCE Advanced Level and Advanced Subsidiary

Physics A

Physics units G481, G482, G484, G485

Instructions to Exams Officer/Invigilator

• **Do not send this Data Sheet for marking; it should be retained in the centre or destroyed.**

These data, formulae and relationships are for the use of candidates following the Physics A specification.

Clean copies of this booklet must be available in the examination room, and must be given up to the invigilator at the end of the examination.

Copies of this booklet may be used for teaching.

Data

Values are given to three significant figures, except where more are useful.

speed of light in a vacuum	c	3.00×10^8 m s^{-1}
permittivity of free space	ε_0	8.85×10^{-12} C^2 N^{-1} m^{-2} (F m^{-1})
elementary charge	e	1.60×10^{-19} C
Planck constant	h	6.63×10^{-34} J s
gravitational constant	G	6.67×10^{-11} N m^2 kg^{-2}
Avogadro constant	N_A	6.02×10^{23} mol^{-1}
molar gas constant	R	8.31 J mol^{-1} K^{-1}
Boltzmann constant	k	1.38×10^{-23} J K^{-1}
electron rest mass	m_e	9.11×10^{-31} kg
proton rest mass	m_p	1.673×10^{-27} kg
neutron rest mass	m_n	1.675×10^{-27} kg
alpha particle rest mass	m_α	6.646×10^{-27} kg
acceleration of free fall	g	9.81 m s^{-2}

Conversion factors

unified atomic mass unit	$1\ u = 1.661 \times 10^{-27}\ kg$
electron-volt	$1\ eV = 1.60 \times 10^{-19}\ J$
	$1\ day = 8.64 \times 10^4\ s$
	$1\ year \approx 3.16 \times 10^7\ s$
	$1\ light\ year \approx 9.5 \times 10^{15}\ m$

Mathematical equations

arc length $= r\theta$

circumference of circle $= 2\pi r$

area of circle $= \pi r^2$

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

volume of cylinder $= \pi r^2 h$

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

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

Pythagoras' theorem: $a^2 = b^2 + c^2$

For small angle $\theta \Rightarrow \sin\theta \approx \tan\theta \approx \theta$ and $\cos\theta \approx 1$

$\lg(AB) = \lg(A) + \lg(B)$

$\lg(\dfrac{A}{B}) = \lg(A) - \lg(B)$

$\ln(x^n) = n\ \ln(x)$

$\ln(e^{kx}) = kx$

Formulae and relationships

Unit 1 – Mechanics

$F_x = F \cos\theta$

$F_y = F \sin\theta$

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

$v = u + at$

$s = \dfrac{1}{2}(u + v)t$

$s = ut + \dfrac{1}{2}at^2$

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

$F = ma$

$W = mg$

moment $= Fx$

torque $= Fd$

$\rho = \dfrac{m}{V}$

$p = \dfrac{F}{A}$

$W = Fx \cos\theta$

$E_k = \dfrac{1}{2}mv^2$

$E_p = mgh$

efficiency $= \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100\%$

$F = kx$

$E = \dfrac{1}{2}Fx \qquad E = \dfrac{1}{2}kx^2$

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

strain $= \dfrac{x}{L}$

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

Unit 2 – Electrons, Waves and Photons

$\Delta Q = I\Delta t$

$I = Anev$

$W = VQ$

$V = IR$

$R = \dfrac{\rho L}{A}$

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

$W = VIt$

e.m.f. $= V + Ir$

$V_{\text{out}} = \dfrac{R_2}{R_1 + R_2} \times V_{\text{in}}$

$v = f\lambda$

$\lambda = \dfrac{ax}{D}$

$d \sin\theta = n\lambda$

$E = hf \qquad E = \dfrac{hc}{\lambda}$

$hf = \phi + \text{KE}_{\text{max}}$

$\lambda = \dfrac{h}{mv}$

$R = R_1 + R_2 + \ldots$

$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \ldots$

Unit 4 – Newtonian World

$$F = \frac{\Delta p}{\Delta t}$$

$$v = \frac{2\pi r}{T}$$

$$a = \frac{v^2}{r}$$

$$F = \frac{mv^2}{r}$$

$$F = \frac{-G Mm}{r^2}$$

$$g = \frac{F}{m}$$

$$g = \frac{-G M}{r^2}$$

$$T^2 = \left(\frac{4\pi^2}{GM}\right) r^3$$

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

$$\omega = \frac{2\pi}{T} = 2\pi f$$

$$a = -(2\pi f)^2 x$$

$$x = A \cos(2\pi f t)$$

$$v_{max} = (2\pi f)\, A$$

$$E = mc\Delta\theta$$

$$pV = NkT$$

$$pV = nRT$$

$$E = \frac{3}{2} kT$$

Unit 5 – Fields, Particles and Frontiers of Physics

$$E = \frac{F}{Q}$$

$$F = \frac{Qq}{4\pi\varepsilon_0 r^2}$$

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

$$E = \frac{V}{d}$$

$$F = BIL \sin\theta$$

$$F = BQv$$

$$\phi = BA \cos\theta$$

induced e.m.f. = − rate of change of magnetic flux linkage

$$\frac{V_s}{V_p} = \frac{n_s}{n_p}$$

$$Q = VC$$

$$W = \frac{1}{2} QV \qquad W = \frac{1}{2} CV^2$$

time constant = CR

$$x = x_0 e^{-\frac{t}{CR}}$$

$$C = C_1 + C_2 + \ldots$$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$$

$$A = \lambda N$$

$$A = A_0\, e^{-\lambda t}$$

$$N = N_0\, e^{-\lambda t}$$

$$\lambda t_{\frac{1}{2}} = 0.693$$

$$\Delta E = \Delta mc^2$$

$$I = I_0\, e^{-\mu x}$$

$$Z = \rho c$$

$$\frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$$

$$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

$$\text{age of Universe} = \frac{1}{H_0}$$

$$\rho_0 = \frac{3H_0{}^2}{8\pi G}$$

$$\frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$$

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