

Modified Enlarged 36pt

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

AS Level Physics B (H157)

A Level Physics B (H557)

Data, Formulae and Relationships Booklet

READ INSTRUCTIONS OVERLEAF

CST990

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INSTRUCTIONS

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Data, Formulae and Relationships

DATA

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

PHYSICAL CONSTANTS

speed of light

$$c \quad 3.00 \times 10^8 \text{ m s}^{-1}$$

permittivity of free space

$$\epsilon_0 \quad 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2} \\ (\text{or } \text{F m}^{-1})$$

electric force constant

$$k = \frac{1}{4\pi\epsilon_0} \quad 8.98 \times 10^9 \text{ N m}^2 \text{ C}^{-2} \\ (\approx 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2})$$

permeability of free space

$$\mu_0 \quad 4\pi \times 10^{-7} \text{ N A}^{-2} \text{ (or } \text{H m}^{-1}\text{)}$$

charge on electron

$$-e \quad -1.60 \times 10^{-19} \text{ C}$$

mass of electron

$$m_e \quad 9.11 \times 10^{-31} \text{ kg} = 0.00055 \text{ u}$$

mass of proton

$$m_p \quad 1.673 \times 10^{-27} \text{ kg} = 1.0073 \text{ u}$$

mass of neutron

$$m_n \quad 1.675 \times 10^{-27} \text{ kg} = 1.0087 \text{ u}$$

mass of alpha particle

$$m_\alpha \quad 6.646 \times 10^{-27} \text{ kg} = 4.0015 \text{ u}$$

Avogadro constant

$$L, N_A \quad 6.02 \times 10^{23} \text{ mol}^{-1}$$

Planck constant

$$h \quad 6.63 \times 10^{-34} \text{ J s}$$

Boltzmann constant

$$k \quad 1.38 \times 10^{-23} \text{ J K}^{-1}$$

molar gas constant

$$R \quad 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$$

gravitational force constant

$$G \quad 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$$

OTHER DATA

standard temperature and pressure (stp)
 $273\text{ K } (0^\circ\text{C}), 1.01 \times 10^5\text{ Pa}$
(1 atmosphere)

molar volume of a gas at stp
 V_m $2.24 \times 10^{-2}\text{ m}^3$

gravitational field strength at the Earth's surface in the UK
 g 9.81 N kg^{-1}

CONVERSION FACTORS

unified atomic mass unit
 $1\text{ u} = 1.661 \times 10^{-27}\text{ kg}$

$1\text{ day} = 8.64 \times 10^4\text{ s}$

$1\text{ year} \approx 3.16 \times 10^7\text{ s}$

$1\text{ light year} \approx 10^{16}\text{ m}$

MATHEMATICAL CONSTANTS AND EQUATIONS

$$e = 2.72 \quad \pi = 3.14$$
$$1 \text{ radian} = 57.3^\circ$$

$$\text{arc} = r\theta$$

$$\sin \theta \approx \tan \theta \approx \theta$$
$$\text{and } \cos \theta \approx 1 \text{ for small } \theta$$

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

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

$$\text{circumference of circle} = 2\pi r$$

$$\text{area of circle} = \pi r^2$$

$$\text{surface area of cylinder} = 2\pi rh$$

$$\text{volume of cylinder} = \pi r^2 h$$

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

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

PREFIXES

10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^3	10^6	10^9
p	n	μ	m	k	M	G

FORMULAE AND RELATIONSHIPS

IMAGING AND SIGNALLING

focal length

$$\frac{1}{v} = \frac{1}{u} + \frac{1}{f}$$

linear magnification

$$m = \frac{v}{u}$$

refractive index

$$n = \frac{\sin i}{\sin r} = \frac{C_{1\text{st medium}}}{C_{2\text{nd medium}}}$$

noise limitation on maximum bits per sample

$$b = \log_2 \left(\frac{V_{\text{total}}}{V_{\text{noise}}} \right)$$

alternatives, N , provided by b bits

$$N = 2^b, b = \log_2 N$$

ELECTRICITY

current

$$\mathbf{I = \frac{\Delta Q}{\Delta t}}$$

potential difference

$$\mathbf{V = \frac{W}{Q}}$$

power and energy

$$\mathbf{P = IV = I^2R, W = VIt}$$

e.m.f and potential difference

$$\mathbf{V_{load} = \varepsilon - Ir}$$

conductors in series and parallel

$$\mathbf{\frac{1}{G} = \frac{1}{G_1} + \frac{1}{G_2} + ...}$$

$$\mathbf{G = G_1 + G_2 + ...}$$

resistors in series and parallel

$$\mathbf{R = R_1 + R_2 + ...}$$

$$\mathbf{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + ...}$$

potential divider

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

conductivity and resistivity

$$G = \frac{\sigma A}{L} \quad R = \frac{\rho L}{A}$$

capacitance

$$C = \frac{Q}{V}$$

energy stored in a capacitor

$$E = \frac{1}{2} QV = \frac{1}{2} CV^2$$

discharge of capacitor

$$\frac{dQ}{dt} = -\frac{Q}{RC}$$

$$Q = Q_0 e^{-t/RC} \quad \tau = RC$$

MATERIALS

Hooke's law

$$F = kx$$

elastic strain energy

$$\frac{1}{2} kx^2$$

Young modulus

$$E = \frac{\text{stress}}{\text{strain}}$$

$$\text{stress} = \frac{\text{tension}}{\text{cross-sectional area}}$$

$$\text{strain} = \frac{\text{extension}}{\text{original length}}$$

GASES

kinetic theory of gases

$$pV = \frac{1}{3} Nm\overline{c^2}$$

ideal gas equation

$$pV = nRT = NkT$$

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MOTION AND FORCES

momentum

$$p = mv$$

impulse

$$F\Delta t$$

force

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

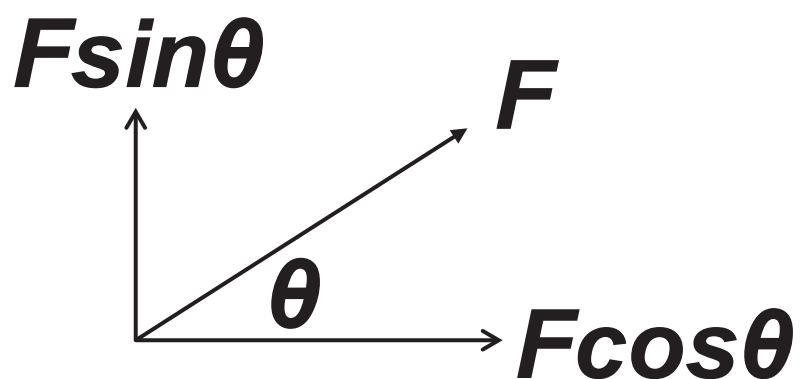
work done

$$W = Fx \quad \Delta E = F\Delta s$$

power

$$P = Fv, \quad P = \frac{\Delta E}{t}$$

components of a vector in two perpendicular directions



equations for uniformly accelerated motion

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

$$v = u + at$$

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

for circular motion

$$a = \frac{v^2}{r}, F = \frac{mv^2}{r} = mr\omega^2$$

ENERGY AND THERMAL EFFECTS

energy

$$\Delta E = mc\Delta\theta$$

average energy approximation

$$\text{average energy} \sim kT$$

Boltzmann factor

$$e^{-\frac{E}{kT}}$$

WAVES

wave formula

$$v = f\lambda$$

frequency and period

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

diffraction grating

$$n\lambda = d \sin \theta$$

OSCILLATIONS

simple harmonic motion

$$\frac{d^2 x}{dt^2} = a = -\left(\frac{k}{m}\right)x = -\omega^2 x$$

$$x = A \cos (\omega t)$$

$$x = A \sin (\omega t)$$

$$\omega = 2\pi f$$

Periodic time

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$\text{total energy } E = \frac{1}{2} kA^2 = \frac{1}{2} mv^2 + \frac{1}{2} kx^2$$

ATOMIC AND NUCLEAR PHYSICS

radioactive decay

$$\frac{\Delta N}{\Delta t} = -\lambda N$$

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

half life $T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$

radioactive dose and risk

absorbed dose = energy deposited per unit mass

effective dose = absorbed dose × quality factor

risk = probability × consequence

mass–energy relationship

$$E_{\text{rest}} = mc^2$$

relativistic factor

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

relativistic energy

$$E_{\text{total}} = \gamma E_{\text{rest}}$$

energy–frequency relationship for photons

$$**$E = hf$**$$

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

FIELD AND POTENTIAL

for all fields

$$**\text{field strength} = - \frac{dV}{dr} \approx - \frac{\Delta V}{\Delta r}**$$

gravitational fields

$$**$g = \frac{F}{m}, E_{\text{grav}} = - \frac{GmM}{r}$**$$

$$**$V_{\text{grav}} = - \frac{GM}{r}, F = - \frac{GmM}{r^2}$**$$

electric fields

$$**$E = \frac{F}{q} = \frac{V}{d},$**$$

$$**\text{electrical potential energy} = \frac{kQq}{r}**$$

$$**$V_{\text{elec}} = \frac{kQ}{r}, F = \frac{kQq}{r^2}$**$$

ELECTROMAGNETISM

magnetic flux

$$\phi = BA$$

force on a current carrying conductor

$$F = ILB$$

force on a moving charge

$$F = qvB$$

Induced e.m.f

$$\varepsilon = - \frac{d(N\phi)}{dt}$$

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