

**Paper Reference(s) 9PH0/01**

**Pearson Edexcel Level 3 GCE**

**Physics**

**Advanced**

**Paper 1: Advanced Physics I**

**DATA, FORMULAE AND RELATIONSHIPS  
BOOKLET**

**DO NOT RETURN THIS BOOKLET WITH  
THE QUESTION PAPER.**

## LIST OF DATA, FORMULAE AND RELATIONSHIPS

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$ (close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
Coulomb law constant	$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$
Electron charge	$e = -1.60 \times 10^{-19} \text{ C}$
Electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$ (close to Earth's surface)
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$
Speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Unified atomic mass unit	$u = 1.66 \times 10^{-27} \text{ kg}$

(Turn over)

## MECHANICS

### Kinematic equations of motion

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

$$v = u + at$$

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

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

### Forces

$$\Sigma F = ma$$

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

$$W = mg$$

$$\text{moment of force} = Fx$$

### Momentum

$$p = mv$$

## Work, energy and power

$$\Delta W = F\Delta s$$

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

$$\Delta E_{\text{grav}} = mg\Delta h$$

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

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

## ELECTRIC CIRCUITS

### Potential difference

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

### Resistance

$$R = \frac{V}{I}$$

**Electrical power and energy**

$$P = VI$$

$$P = I^2 R$$

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

$$W = VIt$$

**Resistivity**

$$R = \frac{\rho l}{A}$$

**Current**

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

$$I = nqvA$$

**MATERIALS****Density**

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

**Stokes' law**

$$F = 6\pi\eta r v$$

**Hooke's law**

$$\Delta F = k\Delta x$$

**Young modulus**

$$\text{Stress } \sigma = \frac{F}{A}$$

$$\text{Strain } \varepsilon = \frac{\Delta x}{x}$$

$$E = \frac{\sigma}{\varepsilon}$$

**Elastic strain energy**

$$\Delta E_{\text{el}} = \frac{1}{2} F \Delta x$$

**WAVES AND PARTICLE NATURE OF LIGHT****Wave speed**

$$v = f\lambda$$

**Speed of a transverse wave on a string**

$$v = \sqrt{\frac{T}{\mu}}$$

**Intensity of radiation**

$$I = \frac{P}{A}$$

**Power of a lens**

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

$$P = P_1 + P_2 + P_3 + \dots$$

**(Turn over)**

**Thin lens equation**

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

**Magnification for a lens**

$$m = \frac{\text{image height}}{\text{object height}} = \frac{v}{u}$$

**Diffraction grating**

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

**Refractive index**

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$n = \frac{c}{v}$$

**Critical angle**

$$\sin C = \frac{1}{n}$$

**Photon model**

$$E = hf$$

**Einstein's photoelectric equation**

$$hf = \phi + \frac{1}{2} mv_{\text{max}}^2$$

**de Broglie wavelength**

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

**(Turn over)**

## FURTHER MECHANICS

### Impulse

$$F\Delta t = \Delta p$$

### Kinetic energy of a non-relativistic particle

$$E_k = \frac{p^2}{2m}$$

### Motion in a circle

$$v = \omega r$$

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

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

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

$$a = r\omega^2$$

### Centripetal force

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

$$F = mr\omega^2$$



## FIELDS

### Coulomb's law

$$F = k \frac{Q_1 Q_2}{r^2}$$

$$\text{where } k = \frac{1}{4\pi\epsilon_0}$$

### Electric field strength

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

$$E = k \frac{Q}{r^2}$$

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

### Electric potential

$$V = k \frac{Q}{r}$$

### Capacitance

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

### Energy stored in a capacitor

$$W = \frac{1}{2} QV$$

### Capacitor discharge

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

(Turn over)

**Resistor – capacitor discharge**

$$I = I_0 e^{-t/RC}$$

$$V = V_0 e^{-t/RC}$$

**In a magnetic field**

$$F = BIl \sin \theta$$

$$F = Bqv \sin \theta$$

**Faraday's and Lenz's laws**

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

**Root-mean-square values**

$$V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$$

$$I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$$

**NUCLEAR AND PARTICLE PHYSICS****In a magnetic field**

$$r = \frac{p}{BQ}$$

## THERMODYNAMICS

### Heating

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

$$\Delta E = L\Delta m$$

### Molecular kinetic theory

$$\frac{1}{2} m \langle c^2 \rangle = \frac{3}{2} kT$$

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

### Ideal gas equation

$$pV = NkT$$

### Stefan-Boltzmann law

$$L = \sigma AT^4$$

$$L = \sigma 4\pi r^2 T^4$$

### Wien's law

$$\lambda_{\max} T = 2.898 \times 10^{-3} \text{ m K}$$

## SPACE

### Intensity

$$I = \frac{L}{4\pi d^2}$$

**Redshift of electromagnetic radiation**

$$z = \frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$$

**Cosmological expansion**

$$v = H_0 d$$

**NUCLEAR RADIATION****Mass-energy**

$$\Delta E = c^2 \Delta m$$

**Radioactive decay**

$$A = \lambda N$$

$$\frac{dN}{dt} = -\lambda N$$

$$\lambda = \frac{\ln 2}{t_{1/2}}$$

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

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

**GRAVITATIONAL FIELDS****Gravitational force**

$$F = \frac{Gm_1m_2}{r^2}$$

**Gravitational field strength**

$$g = \frac{Gm}{r^2}$$

**(Turn over)**

## Gravitational potential

$$V_{\text{grav}} = \frac{-Gm}{r}$$

## OSCILLATIONS

### Simple harmonic motion

$$F = -kx$$

$$a = -\omega^2 x$$

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

$$v = -A\omega \sin \omega t$$

$$a = -A\omega^2 \cos \omega t$$

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

$$\omega = 2\pi f$$

### Simple harmonic oscillator

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

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