Paper Reference(s) 9PH0/02

Pearson Edexcel Level 3 GCE

Physics

Advanced

PAPER 2: Advanced Physics II

Monday 9 June 2025 – Morning

Time: 1 hour 45 minutes

Data, Formulae and Relationships Booklet

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Pearson

Acceleration of free fall

$g = 9{\cdot}81\ \mathrm{m\ s^{-2}}$ (close to Earth's surface)

Boltzmann constant

$k = 1{\cdot}38 \times 10^{-23}\ \mathrm{J\ K^{-1}}$

Coulomb law constant

$$k = \frac{1}{4\pi\varepsilon_0} = 8{\cdot}99 \times 10^{9}\ \mathrm{N\ m^2\ C^{-2}}$$

Electron charge

$e = -1{\cdot}60 \times 10^{-19}\ \mathrm{C}$

Electron mass

$m_e = 9{\cdot}11 \times 10^{-31}\ \mathrm{kg}$

Electronvolt

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

Gravitational constant

$G = 6{\cdot}67 \times 10^{-11}\ \mathrm{N\ m^2\ kg^{-2}}$

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Gravitational field strength

$g = 9{\cdot}81\ \mathrm{N\ kg^{-1}}$ (close to Earth's surface)

Permittivity of free space

$\varepsilon_0 = 8{\cdot}85 \times 10^{-12}\ \mathrm{F\ m^{-1}}$

Planck constant

$h = 6{\cdot}63 \times 10^{-34}\ \mathrm{J\ s}$

Proton mass

$m_p = 1{\cdot}67 \times 10^{-27}\ \mathrm{kg}$

Speed of light in a vacuum

$c = 3{\cdot}00 \times 10^{8}\ \mathrm{m\ s^{-1}}$

Stefan-Boltzmann constant

$\sigma = 5{\cdot}67 \times 10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}}$

Unified atomic mass unit

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

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

$$\sum F = ma$$

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

$$W = mg$$

moment of force = Fx

Momentum

$$p = mv$$

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Mechanics continued.

Work, energy and power

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

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

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

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

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

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

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

Turn over

Electric circuits

Potential difference

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

Resistance

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

Electrical power and energy

$$P = VI$$

$$P = I^2R$$

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

$$W = VIt$$

Resistivity

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

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Electric circuits continued.

Current

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

$$I = nqvA$$

Turn over

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

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

Turn over

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

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

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

Thin lens equation

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

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Waves and Particle Nature of Light continued.

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

$$E = hf$$

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Turn over

Waves and Particle Nature of Light continued.

Einstein's photoelectric equation

$$hf = \phi + \frac{1}{2}mv^2_{max}$$

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

$$v = \omega r$$

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

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

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

$$a = r\omega^2$$

$$F = mr\omega^2$$

Turn over

Fields

Coulomb's law

$$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$$

Electric field strength

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

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

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

Electric potential

$$V = \frac{Q}{4\pi\varepsilon_0 r}$$

Capacitance

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

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Fields continued.

Energy stored in a capacitor

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

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

$$W = \frac{1}{2} \frac{Q^2}{C}$$

Capacitor discharge

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

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

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

$$\ln Q = \ln Q_0 - \frac{t}{RC}$$

$$\ln I = \ln I_0 - \frac{t}{RC}$$

$$\ln V = \ln V_0 - \frac{t}{RC}$$

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Fields continued.

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

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

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

Nuclear and particle physics

In a magnetic field

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

Turn over

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

$$L = \sigma AT^4$$

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

Wien's law

$$\lambda_{max}T = 2{\cdot}898 \times 10^{-3}\ \text{m K}$$

Turn over

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

$$v = H_0 d$$

Turn over

Nuclear radiation

Mass-energy

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

Radioactive decay

$$A = \lambda N$$

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

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

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

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

Turn over

Gravitational fields

Gravitational force

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

Gravitational field strength

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

Gravitational potential

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

Turn over

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

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

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