Data and Formulae Booklet

The following equations may be useful in answering some of the questions in the examination.

**Uniformly accelerated motion:**

Useful formulae:

\[ v = u + at \]
\[ s = ut + \frac{1}{2}at^2 \]
\[ v^2 = u^2 + 2as \]
\[ s = \left( \frac{u + v}{2} \right) t \]

**Circular motion:**

Centripetal acceleration:

\[ a = \frac{v^2}{r} \]

Period:

\[ T = \frac{2\pi r}{v} \]

**Materials:**

Hooke's law:

\[ F = k\Delta x \]

Stress:

\[ \sigma = \frac{F}{A} \]

Strain:

\[ \varepsilon = \frac{\Delta l}{l} \]

Young's modulus:

\[ Y = \frac{\sigma}{\varepsilon} \]

Energy stored in a stretched wire:

\[ E = \frac{1}{2}k(\Delta l)^2 \]

**Mechanics:**

Momentum:

\[ p = m v \]

Newton’s second law:

\[ F = ma \]

Kinetic energy:

\[ KE = \frac{1}{2}mv^2 \]

Gravitational potential energy:

\[ PE = \Delta (mgh) \]

Mechanical work done:

\[ W = F\Delta d \]

**Fields due to point sources:**

Force between point charges:

\[ F = \frac{Q_1Q_2}{4\pi\varepsilon_0r^2} \]

Force between point masses:

\[ F = G\frac{M_1M_2}{r^2} \]

**Vibrations and waves:**

Acceleration in s.h.m.:

\[ a = -kx \]

Period:

\[ T = \frac{2\pi}{\sqrt{k}} \]

Velocity of a wave:

\[ v = f\lambda \]

**Current electricity:**

Current:

\[ I = nAve \]

Ohm’s law:

\[ V = IR \]

Resistors in series:

\[ R_{TOTAL} = R_1 + R_2 + \ldots \]

Resistors in parallel:

\[ \frac{1}{R_{TOTAL}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \]

Power:

\[ P = IV = I^2R = \frac{V^2}{R} \]

**Electromagnetism:**

Electric field strength:

\[ E = \frac{F}{q} \]

Electric potential (uniform field):

\[ V = Ed \]

Energy of a particle accelerated by an electric field:

\[ QV = \Delta \left( \frac{1}{2}mv^2 \right) \]

Force on a moving charge:

\[ F = BQv \]

Magnetic flux:

\[ \Phi = BA \]

Force on current:

\[ F = BIl \]

Emf induced in a moving conductor:

\[ E = Blv \]
Induced emf: \[ E = -N \frac{d\Phi}{dt} \]

**Alternating current:**

Root mean square for sinusoidal alternating current and voltage:

\[ I_{rms} = \frac{I_0}{\sqrt{2}} ; \quad V_{rms} = \frac{V_0}{\sqrt{2}} \]

**Physics of nuclei and atoms:**

Radioactivity: \[ A = \lambda N \]

Mass-energy relation: \[ E = mc^2 \]

Line spectra: \[ \Delta E = hf = \frac{hc}{\lambda} \]

**Capacitance:**

Charge on capacitor: \[ Q = CV \]

Parallel-plate capacitor: \[ C = \varepsilon_0 \varepsilon_r \frac{A}{d} \]

**Ray optics:**

Thin lenses:

\[ \frac{1}{f} = \frac{1}{u} + \frac{1}{v} \] (real is positive)

\[ \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \] (Cartesian)

Magnification:

\[ m = \frac{v}{u} = \frac{h_1}{h_0} \] (real is positive)

\[ m = -\frac{v}{u} = -\frac{h_1}{h_0} \] (Cartesian)

**Mathematical Formulae:**

Surface area of a sphere: \[ S = 4\pi r^2 \]

Volume of a sphere: \[ V = \frac{4}{3}\pi r^3 \]

Surface area of a cylinder: \[ S = 2\pi rh + 2\pi r^2 \]

Volume of a cylinder: \[ V = \pi r^2 h \]

The following constants may be useful in answering some of the questions in the examination.

- Acceleration of free fall on and near the Earth’s surface \( g = 9.81 \text{ m s}^{-2} \)
- Gravitational field strength on and near the Earth’s surface \( g = 9.81 \text{ N kg}^{-1} \)
- Coulomb’s law constant \( k = \frac{1}{4\pi \varepsilon_0} = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2} \)
- Charge of an electron \( e = -1.60 \times 10^{-19} \text{ C} \)
- Mass of an electron \( m_e = 9.11 \times 10^{-31} \text{ kg} \)
- Electronvolt 1 eV = \( 1.60 \times 10^{-19} \text{ J} \)
- Gravitational constant \( G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \)
- Permittivity of free space \( \varepsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1} \)
- Planck constant \( h = 6.63 \times 10^{-34} \text{ J s} \)
- Speed of light in a vacuum \( c = 3.00 \times 10^8 \text{ m s}^{-1} \)
- Unified atomic mass unit \( u = 1.66 \times 10^{-27} \text{ kg} \)