



PHYSICS

YEAR 12

FORMULAE AND DATA BOOKLET

2016

Copyright

© School Curriculum and Standards Authority, 2014

This document – apart from any third party copyright material contained in it – may be freely copied, or communicated on an intranet, for non-commercial purposes in educational institutions, provided that it is not changed and that the School Curriculum and Standards Authority is acknowledged as the copyright owner, and that the Authority's moral rights are not infringed.

Copying or communication for any other purpose can be done only within the terms of the *Copyright Act 1968* or with prior written permission of the School Curriculum and Standards Authority. Copying or communication of any third party copyright material can be done only within the terms of the *Copyright Act 1968* or with permission of the copyright owners.

Any content in this document that has been derived from the Australian Curriculum may be used under the terms of the <u>Creative</u> <u>Commons Attribution-NonCommercial 3.0 Australia licence</u>.

PHYSICS YEAR 12

Gravity and motion

| Average velocity | $v_{\rm av} = \frac{S}{t}$ |
|---------------------------------------------------------|-----------------------------------------------------------|
| Equations of motion | $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ |
| Force | $F_{net} = ma$ |
| Weight force | F = mg |
| Kinetic energy | $E_{\rm k} = \frac{1}{2} mv^2$ |
| Gravitational potential energy | $E_{\rm p} = m g \Delta h$ |
| Work done | $W = F_S = \Delta E$ |
| Centripetal acceleration | $a_{\rm c} = \frac{v^2}{r}$ $v = \frac{2\pi r}{T}$ |
| Centripetal force | $F_{\rm c} = ma_{\rm c} = \frac{mv^2}{r}$ |
| Newton's law of universal gravitation | $F = G \frac{m_1 m_2}{r^2}$ |
| Kepler's 3rd law | $T^2 = \frac{4\pi^2}{GM} r^3$ |
| Gravitational field strength | $g = G \frac{M}{r^2}$ |
| Moment of a force (force at angle $	heta$ to lever arm) | $\tau = r F \sin \theta$ |

Note: the variable *t* refers to the 'time taken', sometimes referred to as the 'change in time' or Δt .

Wave particle duality and the quantum theory

| Wave period | $T = \frac{1}{f}$ |
|-----------------------|-----------------------------|
| Wave equation | $c = f\lambda$ |
| Energy of photon | E = h f |
| Energy transitions | $\Delta E = E_2 - E_1 = hf$ |
| Photoelectric effect | $E_{\rm k} = hf - W$ |
| De Broglie wavelength | $\lambda = \frac{h}{p}$ |

See next page

Electromagnetism

| 0 | |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Coulomb's law | $F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$ |
| Electric field strength | $E = \frac{F}{q} = \frac{V}{d}$ |
| Magnetic field strength | $B = \frac{\mu_0}{2\pi} \frac{I}{r}$ |
| Magnetic force on a charged particle | $F = q \ v \ B$ where $v \perp B$ |
| Magnetic force on a current-carrying conductor | $F = I \ell B$ where $\ell \perp B$ |
| Torque on a coil | $\tau = r F$ |
| Magnetic flux | $\Phi = B A_{\perp}$ |
| Electromagnetic induction | induced emf = $\ell v B$ where $v \perp B$ |
| | induced emf = $-N \frac{(\Phi_2 - \Phi_1)}{t} = -N \frac{\Delta \Phi}{t} = -N \frac{\Delta (BA_\perp)}{t}$ |
| | AC generator $\operatorname{emf}_{\max} = -2N\ell vB = -2\pi NBA_{\perp}f$ $\operatorname{emf}_{rms} = \frac{\operatorname{emf}_{\max}}{\sqrt{2}}$ |
| Ohm's law | V = IR |
| Electric current | $I = \frac{q}{t}$ |
| Work and energy | W = Vq |
| Ideal transformer turns ratio | $\frac{V_{\rm P}}{V_{\rm s}} = \frac{N_{\rm P}}{N_{\rm s}}$ |
| Power | P = VI |
| Special relativity | |
| | |

 $\ell = \ell_0 \sqrt{\left(1 - \frac{\nu^2}{c^2}\right)}$ $t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$ **Relativistic effects** $u' = \frac{u - v}{1 - \frac{v u}{c^2}}$ $u = \frac{v + u'}{1 + \frac{v \, u'}{c^2}}$ $p_v = \frac{m v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$ Relativistic momentum E

Mass-energy equivalence

$$C = \frac{m c^2}{\sqrt{1 - \frac{v^2}{c^2}}}$$

The Standard Model

| Particle motion in a | r = | m | |
|----------------------|-----|---|---|
| magnetic field | ' | q | T |

Physical data

| Mean acceleration due to gravity on the Earth g | = | 9.80 m s ⁻² |
|----------------------------------------------------------|---|-----------------------------|
| Mean acceleration due to gravity on the Moon $g_{\rm M}$ | = | 1.62 m s ⁻² |
| Mean radius of the Earth $R_{\rm E}$ | = | 6.38 × 10 ⁶ m |
| Mass of the Earth $M_{\rm E}$ | = | 5.97 × 10 ²⁴ kg |
| Mean radius of the Sun $R_{\rm s}$ | = | 6.96 × 10 ⁸ m |
| Mass of the Sun $M_{\rm s}$ | = | 1.99 × 10 ³⁰ kg |
| Mean radius of the Moon $R_{\rm M}$ | = | 1.74 × 10 ⁶ m |
| Mass of the Moon $M_{\rm M}$ | = | 7.35 × 10 ²² kg |
| Mean Earth-Moon distance | = | 3.84 × 10 ⁸ m |
| Mean Earth-Sun distance | = | 1.50 × 10 ¹¹ m |
| Mass of electron $m_{\rm e}$ | = | 9.11 × 10 ⁻³¹ kg |
| Mass of protonm _p | = | 1.67 × 10 ⁻²⁷ kg |
| Tonne1 t | = | 10³ kg |

4

Physical constants

| Speed of light in vacuum or air c | = | 3.00 × 10 ⁸ m s ⁻¹ |
|----------------------------------------------|-----|----------------------------------------------------------------------------------|
| Electron chargee | = - | -1.60 × 10 ⁻¹⁹ C |
| Planck constanth | = | 6.63 × 10 ⁻³⁴ J s |
| Newtonian constant of gravitation $\ldots G$ | = | 6.67 × 10 ⁻¹¹ N m ² kg ⁻² |
| Electron volt1 eV | = | 1.60 × 10 ⁻¹⁹ J |
| Electronic constant \mathcal{E}_0 | = | 8.85 × 10 ⁻¹² F m ⁻¹ |
| Magnetic constant $\mu_{_0}$ | = | $4\pi \times 10^{-7} \text{ NA}^{-2}$ = 1.26 × 10 ⁻⁶ NA ⁻² |

| | Wavelength | | | |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|
| λ (m) | 10^{2} 10 1 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12} | | | |
| Area of | radio frequencies 것-rays | | | |
| spectrum | microwaves infrared radiation radiation | | | |
| <i>f</i> (Hz) | 10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19} 10^{20} | | | |
| | Frequency | | | |

Electromagnetic spectrum

Note: shaded areas represent regions of overlap.

Prefixes of the metric system

| Factor | Prefix | Symbol | Factor | Prefix | Symbol |
|------------------|--------|--------|-------------------|--------|--------|
| 10 ¹² | tera | Т | 10 ⁻³ | milli | m |
| 10 ⁹ | giga | G | 10-6 | micro | μ |
| 10 ⁶ | mega | Μ | 10 ⁻⁹ | nano | n |
| 10 ³ | kilo | k | 10 ⁻¹² | pico | р |

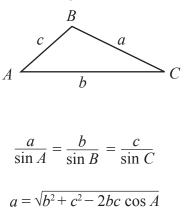
Mathematical expressions

Quadratic equations

Given
$$ax^2 + bx + c = 0$$
, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Triangles

The following expressions apply to the triangle ABC as shown:



See next page

6

7