Government of **Western Australia**
School Curriculum and Standards Authority

PHYSICS
ATAR COURSE YEAR 12

FORMULAE AND DATA BOOKLET

2016

This document is valid for teaching and examining until 31 December 2016.

Gravity and motion

Average velocity	$v_{av} = \frac{s}{t}$
Equations of motion	$v = u + at \quad s = ut + \frac{1}{2} at^2 \quad v^2 = u^2 + 2as$
Force	$F_{net} = ma$
Weight force	$F = mg$
Kinetic energy	$E_k = \frac{1}{2} mv^2$
Gravitational potential energy	$E_p = m\, g\, \Delta h$
Work done	$W = Fs = \Delta E$
Centripetal acceleration	$a_c = \frac{v^2}{r} \qquad v = \frac{2\pi\, r}{T}$
Centripetal force	$F_c = ma_c = \frac{mv^2}{r}$
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 θ 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	$\Delta E = E_2 - E_1 = h\, f$
Photoelectric effect	$E_k = h\, f - \mathrm{W}$
De Broglie wavelength	$\lambda = \frac{h}{p}$

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Electromagnetism

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

$$\text{induced emf} = \ell\ v\ B \quad \text{where } v \perp B$$

$$\text{induced emf} = -N\frac{(\Phi_2 - \Phi_1)}{t} = -N\frac{\Delta\Phi}{t} = -N\frac{\Delta(B A_\perp)}{t}$$

$$\text{AC generator emf}_{max} = -2N\ell vB = -2\pi NBA_\perp f \qquad emf_{rms} = \frac{emf_{max}}{\sqrt{2}}$$

Ohm's law $V = IR$

Electric current $I = \frac{q}{t}$

Work and energy $W = Vq$

Ideal transformer turns ratio $\frac{V_P}{V_s} = \frac{N_P}{N_s}$

Power $P = VI$

Special relativity

Relativistic effects

$$\ell = \ell_0\sqrt{\left(1 - \frac{v^2}{c^2}\right)} \qquad t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$u = \frac{v + u'}{1 + \frac{v\,u'}{c^2}} \qquad u' = \frac{u - v}{1 - \frac{v\,u}{c^2}}$$

Relativistic momentum $p_v = \frac{m\ v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$

Mass-energy equivalence $E = \frac{m\,c^2}{\sqrt{1 - \frac{v^2}{c^2}}}$

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The Standard Model

Particle motion in a magnetic field $r = \frac{m\ v}{q\ B}$

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_M	=	1.62 m s^{-2}
Mean radius of the Earth	R_E	=	6.37×10^6 m
Mass of the Earth	M_E	=	5.97×10^{24} kg
Mean radius of the Sun	R_S	=	6.96×10^8 m
Mass of the Sun	M_S	=	1.99×10^{30} kg
Mean radius of the Moon	R_M	=	1.74×10^6 m
Mass of the Moon	M_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_e	=	9.11×10^{-31} kg
Mass of proton	m_p	=	1.67×10^{-27} kg
Tonne	1 t	=	10^3 kg

Physical constants

Speed of light in vacuum or air	c	=	3.00 × 10^8 m s^{-1}
Electron charge	e	=	-1.60×10^{-19} C
Planck constant	h	=	6.63×10^{-34} J s
Newtonian constant of gravitation	G	=	6.67×10^{-11} N m^2 kg^{-2}
Electron volt	1 eV	=	1.60×10^{-19} J
Electronic constant	ε_0	=	8.85×10^{-12} F m^{-1}
Magnetic constant	μ_0	=	$4\pi \times 10^{-7}$ N A^{-2} = 1.26×10^{-6} N A^{-2}

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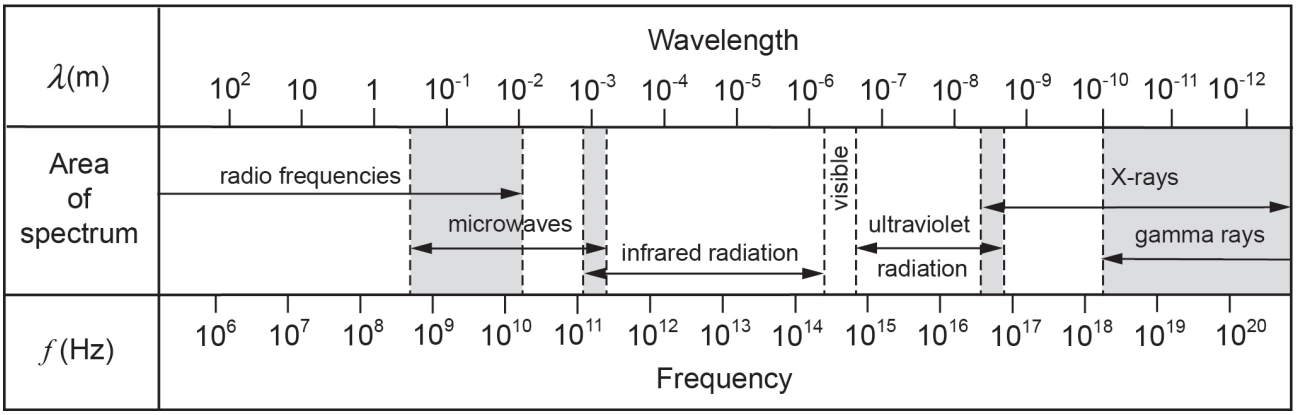
Electromagnetic spectrum



Note: shaded areas represent regions of overlap.

Prefixes of the metric system

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{12}	tera	T	10^{-3}	milli	m
10^{9}	giga	G	10^{-6}	micro	μ
10^{6}	mega	M	10^{-9}	nano	n
10^{3}	kilo	k	10^{-12}	pico	p

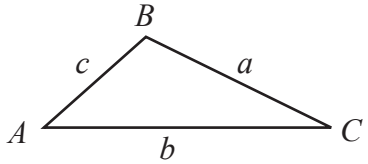
Mathematical expressions

Quadratic equations

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

Triangles

The following expressions apply to the triangle ABC as shown:



$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a = \sqrt{b^2 + c^2 - 2bc \cos A}$$

End of booklet

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