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

PHYSICS
ATAR COURSE YEAR 12

FORMULAE AND DATA BOOKLET

2026

Static equilibrium and centre of mass

Moment of a force	$\tau = rF\sin\theta$	where θ = angle between the force F and the lever arm	
Static equilibrium	$\Sigma F = 0$	$\tau = rF\sin\theta$	$\Sigma\tau = 0$

Circular motion, gravity and relativity

Equations of circular motion	$v = \dfrac{2\pi r}{T}$	$a_c = \dfrac{v^2}{r}$	resultant $F_c = ma_c = \dfrac{mv^2}{r}$	
Law of conservation of energy	$E_p = mg\Delta h$	$W = \Delta E$	$E_k = \dfrac{1}{2}mv^2$	
Newton's law of universal gravitation	$F_g = G\dfrac{m_1 m_2}{r^2}$			
Force	$F_{net} = ma$			
Weight force	$F_{weight} = mg$			
Work done	$E_p = mg\Delta h$	$W = Fs$	$W = \Delta E$	$E_k = \dfrac{1}{2}mv^2$
Gravitational field strength	$g = \dfrac{F_g}{m} = G\dfrac{m}{r^2}$			
Kepler's third law	$\dfrac{T^2}{r^3} = \dfrac{4\pi^2}{GM}$			
Equations of motion	$v = \dfrac{s}{\Delta t}$	$a = \dfrac{\Delta v}{\Delta t} = \dfrac{v_f - v_i}{t_f - t_i}$	$v_f = v_i + a\Delta t$	
	$s = v_i\Delta t + \dfrac{1}{2}a\Delta t^2$	$v_f{}^2 = v_i^2 + 2as$	$p = mv$	
Relativistic effects	$\ell' = \ell\sqrt{\left(1 - \dfrac{v^2}{c^2}\right)}$	$\Delta t' = \dfrac{\Delta t}{\sqrt{\left(1 - \dfrac{v^2}{c^2}\right)}}$		
	$u = \dfrac{u' + v}{1 + \dfrac{u'v}{c^2}}$	$u' = \dfrac{u - v}{1 - \dfrac{uv}{c^2}}$		

See next page

Electromagnetism

Work and energy	$\Delta V = \frac{W}{q}$	
Coulomb's law	$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$	
Electric field strength	$E = \frac{F}{q}$	
Electric field between parallel plates	$E = \frac{\Delta V}{d}$	
Magnetic flux density	$B = \frac{\mu_0}{2\pi}\frac{I}{r}$	
Magnetic force on a charged particle	$F = qvB\sin\theta$	where θ = angle between the field B and the velocity v
Magnetic force on a current-carrying conductor	$F = I\ell B\sin\theta$	where θ = angle between the field B and the conductor length ℓ
Torque on a coil	$\tau = rF\sin\theta$	where θ = angle between the force F and the lever arm
Magnetic flux	$\Phi = BA_\perp$	where $A_\perp$ = area perpendicular to the field B
Electromagnetic induction	induced emf: $\varepsilon = \ell v B\sin\theta$	
	induced emf: $\varepsilon = -N\frac{\Delta\Phi}{\Delta t} = -N\frac{\Delta BA_\perp}{\Delta t}$	where $A_\perp$ = area perpendicular to the field B
	AC generator emf$_{max}$: $\varepsilon_{max} = 2N\ell vB = 2\pi NBAf$	
	$\varepsilon_{rms} = \frac{\varepsilon_{max}}{\sqrt{2}}$	
Ohm's law	$V = IR$	
Electric current	$I = \frac{q}{t}$	
Transformer theory	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$	$P = VI = I^2R = \frac{V^2}{R}$

See next page

Particle accelerators

Motion of charged particles

$$E = \frac{F}{q} = \frac{\Delta V}{d} \qquad \Delta V = \frac{W}{q} \qquad \frac{mv^2}{r} = qvB$$

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} \qquad v_f = v_i + a\Delta t$$

$$s = v_i \Delta t + \frac{1}{2} a \Delta t^2 \qquad {v_f}^2 = v_i^2 + 2as \qquad p = mv$$

Relativistic momentum

$$p = \frac{mv}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

Mass-energy equivalence

$$E = \frac{mc^2}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

Total energy

$$E_{\text{rest}} = mc^2 \qquad E_k = E - E_{\text{rest}}$$

Energy-momentum relation

$$E^2 = p^2c^2 + m^2c^4$$

See next page

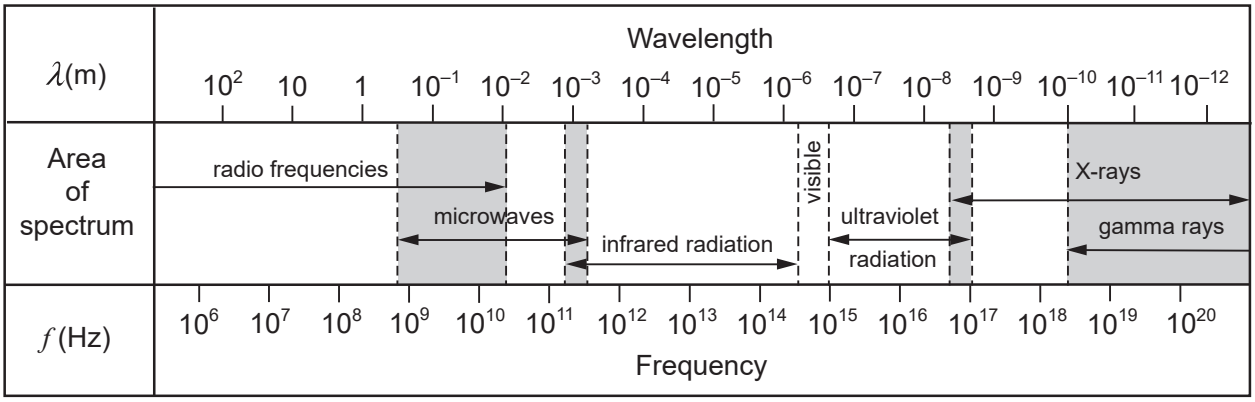
Wave particle duality and the quantum theory

Wave period	$T = \frac{1}{f}$	
Wave equation	$c = f\lambda$	
Energy of photon	$E = hf = \frac{hc}{\lambda}$	$E = pc$
Photoelectric effect	$E_k = hf - \phi$	where ϕ = the work function of the surface
Energy transitions	$\Delta E = hf$	$E_2 - E_1 = hf$
de Broglie wavelength	$\lambda = \frac{h}{p}$	

Cosmology

Hubble's law	$v = H_0 d$

Electromagnetic spectrum



Note: shaded areas represent regions of overlap.

See next page

Physical data

Mean acceleration due to gravity on Earth ..... $g = 9.80 \text{ m s}^{-2}$

Mean acceleration due to gravity on Moon .... $g_M = 1.62 \text{ m s}^{-2}$

Mean radius of the Earth ..... $R_E = 6.37 \times 10^6 \text{ m}$

Mass of the Earth ..... $M_E = 5.97 \times 10^{24} \text{ kg}$

Mean radius of the Sun ..... $R_S = 6.96 \times 10^8 \text{ m}$

Mass of the Sun ..... $M_S = 1.99 \times 10^{30} \text{ kg}$

Mean radius of the Moon ..... $R_M = 1.74 \times 10^6 \text{ m}$

Mass of the Moon ..... $M_M = 7.35 \times 10^{22} \text{ kg}$

Mean Earth-Moon distance ..... $= 3.84 \times 10^8 \text{ m}$

Mean Earth-Sun distance ..... $= 1.50 \times 10^{11} \text{ m} = 1.00$ astronomical unit (AU)

Mass of electron ..... $m_e = 9.11 \times 10^{-31} \text{ kg}$

Mass of proton ..... $m_p = 1.67 \times 10^{-27} \text{ kg}$

Tonne ..... $1.00 \text{ t} = 10^3 \text{ kg}$

See next page

Physical constants

Speed of light in vacuum or air ..... $c = 3.00 \times 10^{8}$ m s^{-1}

Electron charge ..... $e = -1.60 \times 10^{-19}$ C

Planck constant ..... $h = 6.63 \times 10^{-34}$ J s

Newtonian constant of gravitation ..... $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

Electric constant ..... $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}

Magnetic constant ..... $\mu_0 = 4\pi \times 10^{-7}$ N A^{-2} $= 1.26 \times 10^{-6}$ N A^{-2}

Conversions

Electron volt ..... 1.00 eV $= 1.60 \times 10^{-19}$ J

Light year ..... 1.00 ly $= 9.46 \times 10^{12}$ km

Megaparsec ..... 1.00 Mpc $= 3.09 \times 10^{19}$ km $= 3.26 \times 10^{6}$ ly

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

See next page

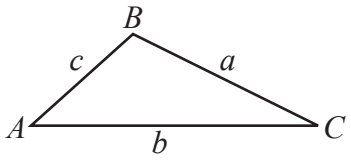
Mathematical expressions

Quadratic equations

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

Triangles

The following expressions apply to the triangle ABC as shown:



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

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

Published by the School Curriculum and Standards Authority of Western Australia
303 Sevenoaks Street
CANNINGTON WA 6107