



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



PHYSICS
ATAR COURSE YEAR 12
FORMULAE AND DATA BOOKLET
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Static equilibrium and centre of mass

Moment of a force $\tau = rF \sin \theta$ where $\theta =$ 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 $v = \frac{2\pi r}{T}$ $a_c = \frac{v^2}{r}$ resultant $F_c = ma_c = \frac{mv^2}{r}$

Law of conservation of energy $E_p = mg\Delta h$ $W = \Delta E$ $E_k = \frac{1}{2}mv^2$

Newton's law of universal gravitation $F_g = G \frac{m_1 m_2}{r^2}$

Force $F_{\text{net}} = ma$

Weight force $F_{\text{weight}} = mg$

Work done $E_p = mg\Delta h$ $W = Fs$ $W = \Delta E$ $E_k = \frac{1}{2}mv^2$

Gravitational field strength $g = \frac{F_g}{m} = G \frac{m}{r^2}$

Kepler's third law $\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$

Equations of motion $v = \frac{s}{\Delta t}$ $a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$ $v_f = v_i + a\Delta t$

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

Relativistic effects $\ell' = \ell \sqrt{\left(1 - \frac{v^2}{c^2}\right)}$ $\Delta t' = \frac{\Delta t}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$

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

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Electromagnetism

Work and energy	$\Delta V = \frac{W}{q}$	
Coulomb's law	$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$	
Electric field strength	$E = \frac{F}{q}$	
Electric field between parallel plates	$E = \frac{\Delta V}{d}$	
Magnetic flux density	$B = \frac{\mu_0 I}{2\pi r}$	
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: $\varepsilon = -N \frac{\Delta \Phi}{\Delta t} = \frac{\Delta BA_{\perp}}{\Delta t}$	where A_{\perp} = area perpendicular to the field B
	AC generator emf _{max} : $\varepsilon_{\max} = 2N\ell v B = 2\pi N B A f$	
	$\varepsilon_{\text{rms}} = \frac{\varepsilon_{\max}}{\sqrt{2}}$	
Ohm's law	$V = IR$	
Electric current	$I = \frac{q}{t}$	
Transformer theory	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$	$P = VI = I^2 R = \frac{V^2}{R}$

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Particle accelerators

Motion of charged particles	$E = \frac{F}{q} = \frac{\Delta V}{d}$	$\Delta V = \frac{W}{q}$	$\frac{mv^2}{r} = qvB$
	$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$	$v_f = v_i + a\Delta t$	
	$s = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$v_f^2 = v_i^2 + 2as$	$p = mv$
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	$E_{\text{rest}} = mc^2$	$E_k = E - E_{\text{rest}}$	
Energy-momentum relation	$E^2 = p^2c^2 + m^2c^4$		

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

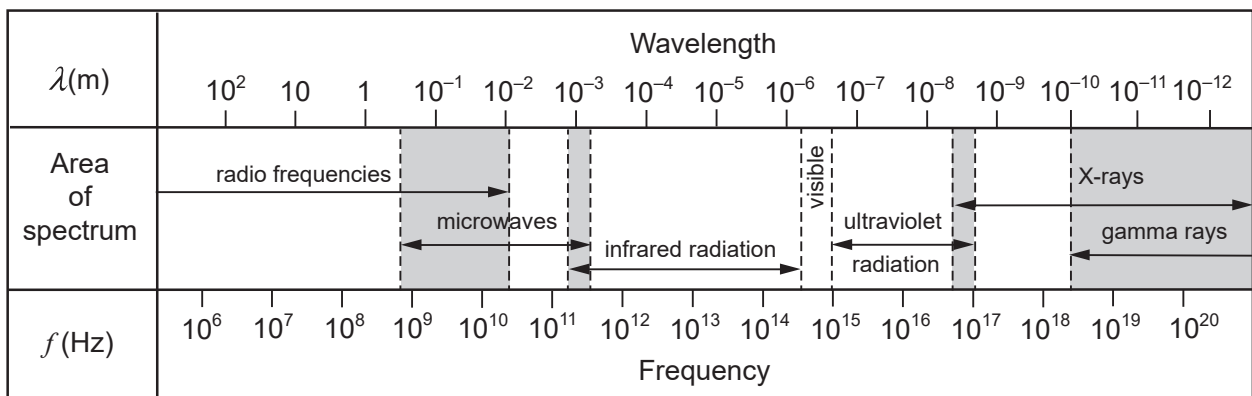
Energy transitions $\Delta E = hf$ $E_2 - E_1 = hf$

de Broglie wavelength $\lambda = \frac{h}{p}$

Cosmology

Hubble's law $v = H_0 d$

Electromagnetic spectrum



Note: shaded areas represent regions of overlap.

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 $= 1.50 \times 10^{11} \text{ m} = 1.00 \text{ astronomical unit (AU)}$

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

Physical constants

Speed of light in vacuum or air $c = 3.00 \times 10^8 \text{ m s}^{-1}$ Electron charge $e = -1.60 \times 10^{-19} \text{ C}$ Planck constant $h = 6.63 \times 10^{-34} \text{ J s}$ Newtonian constant of gravitation $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ Electric constant $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$ Magnetic constant $\mu_0 = 4\pi \times 10^{-7} \text{ N A}^{-2} = 1.26 \times 10^{-6} \text{ N A}^{-2}$ **Conversions**

Electron volt $1.00 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$ Light year $1.00 \text{ ly} = 9.46 \times 10^{12} \text{ km}$ Megaparsec $1.00 \text{ Mpc} = 3.09 \times 10^{19} \text{ km} = 3.26 \times 10^6 \text{ ly}$ **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

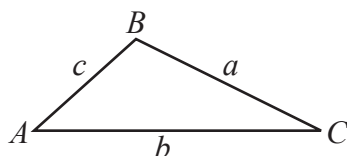
Mathematical expressions

Quadratic equations

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

Triangles

The following expressions apply to the triangle ABC as shown:



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

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

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