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

PHYSICS
ATAR COURSE YEAR 12

FORMULAE AND DATA BOOKLET

2025

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

Gravity and motion

Average velocity	$v_{av} = \frac{s}{t}$			
Equations of motion	$v = u + at$	$s = ut + \frac{1}{2}at^2$	$v^2 = u^2 + 2as$	$p = mv$
Force	$F_{net} = ma$			
Weight force	$F_{weight} = mg$			
Kinetic energy	$E_k = \frac{1}{2}mv^2$			
Gravitational potential energy	$E_p = mg\Delta h$			
Work done	$W = Fs$	$W = \Delta E$		
Equations of circular motion	$v = \frac{2\pi r}{T}$	$a_c = \frac{v^2}{r}$	resultant $F_c = ma_c = \frac{mv^2}{r}$	
Newton's law of universal gravitation	$F_g = G\frac{m_1 m_2}{r^2}$			
Kepler's 3rd law	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$			
Gravitational field strength	$g = \frac{F_g}{m} = G\frac{M}{r^2}$			
Moment of a force	$\tau = rF\sin\theta$	where θ = angle between the force F and the lever arm		

Wave particle duality and the quantum theory

Wave period	$T = \frac{1}{f}$	
Wave equation	$c = f\lambda$	
Energy of photon	$E = hf$	$E = \frac{hc}{\lambda}$
Energy transitions	$\Delta E = hf$	$\Delta E = E_2 - E_1$
Photoelectric effect	$E_k = hf - W$	
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 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

Particle motion in a magnetic field $r = \frac{mv}{qB}$

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 = area perpendicular to the field B

Electromagnetic induction

induced emf : $\varepsilon = \ell v B\sin\theta$

induced emf : $\varepsilon = -N\frac{(\Phi_2 - \Phi_1)}{t} = -N\frac{\Delta\Phi}{t} = -N\frac{\Delta(BA_{\perp})}{t}$

where A = area perpendicular to the field B

$\varepsilon_{max} = 2N\ell vB = 2\pi NBAf$ $\varepsilon_{rms} = \frac{\varepsilon_{max}}{\sqrt{2}}$

Ohm's law $V = IR$

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

Work and energy $W = Vq$

Ideal transformer turns ratio $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

Power $P = VI = I^2R = \frac{V^2}{R}$

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Special relativity

Relativistic effects

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

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

Relativistic momentum

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

Hubble's law $v = H_0 d$

Rest energy $E_{rest} = mc^2$

Mass-energy equivalence

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

Total energy $E_t = E_k + E_{rest}$

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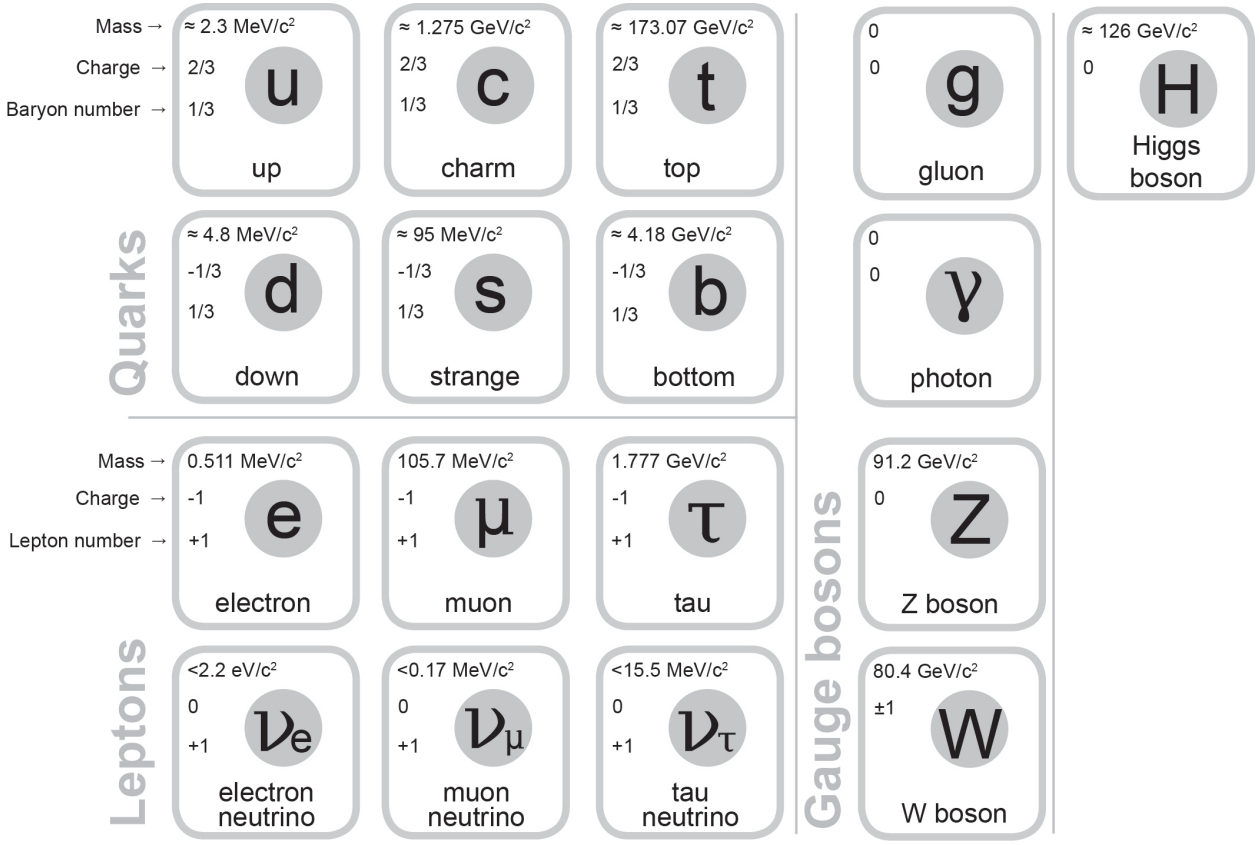
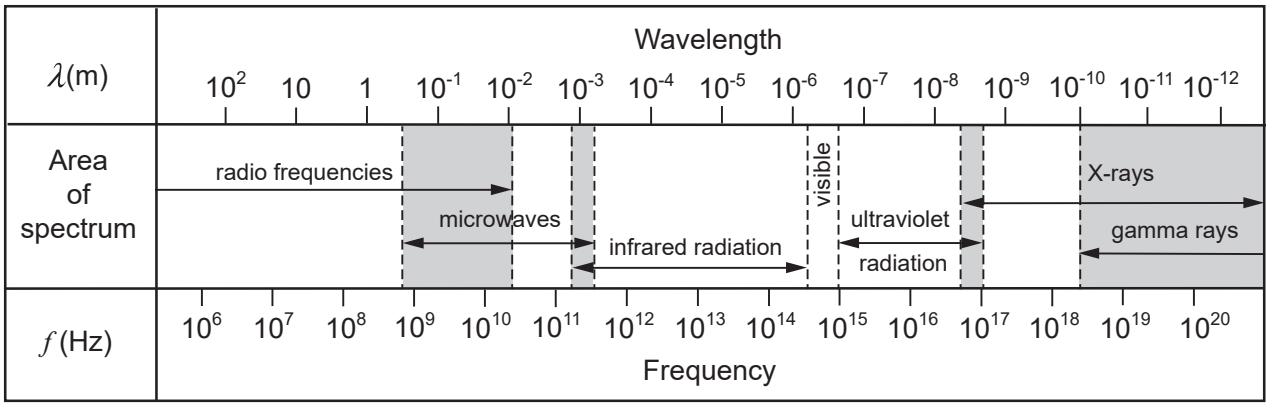
The Standard Model

Elementary particles



Electromagnetic spectrum



Note: shaded areas represent regions of overlap.

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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
		=	1.00 astronomical unit (AU)
Mass of electron	m_e	=	9.11 × 10^{-31} kg
Mass of proton	m_p	=	1.67 × 10^{-27} kg
Tonne	1.00 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}
Electric constant	ε_0	=	8.85 × 10^{-12} F m^{-1}
Magnetic constant	μ_0	=	4π × 10^{-7} N A^{-2} = 1.26 × 10^{-6} N A^{-2}

Conversions

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

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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

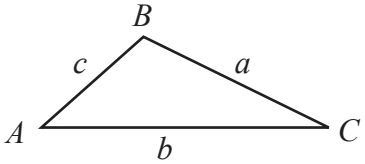
Mathematical expressions

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

ACKNOWLEDGEMENTS

Elementary particles Adapted from Standard Model image: MissMJ. (2006). *File:Standard Model of Elementary Particles.svg.* Retrieved June, 2016, from https://commons.wikimedia.org/wiki/File:Standard_Model_of_Elementary_Particles.svg
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