2020/57941

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

PHYSICS
ATAR COURSE YEAR 12

FORMULAE AND DATA BOOKLET

2020

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	$v = u + at \qquad s = ut + \frac{1}{2} at^2 \qquad v^2 = u^2 + 2as$
	$p = mv$
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	$W = Fs = \Delta E$
Equations of circular motion	$v = \frac{2\pi r}{T} \qquad a_c = \frac{v^2}{r} \qquad F_c = ma_c = \frac{mv^2}{r}$
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)	$\tau = r\, F \sin\theta$

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	$\lambda = \frac{h}{p}$

See next page

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 $\ell \perp B$

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

Torque on a coil $\tau = r\,F$

Magnetic flux $\Phi = B\,A_\perp$

Electromagnetic induction

induced emf: $\mathcal{E} = \ \ell\ \ v\ \ B$ where $v \perp B$

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

AC generator emf$_{max}$: $\mathcal{E}_{max} = 2N\ell vB = 2\pi NBA_\perp f$ $\mathcal{E}_{rms} = \frac{\mathcal{E}_{max}}{\sqrt{2}}$

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

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

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

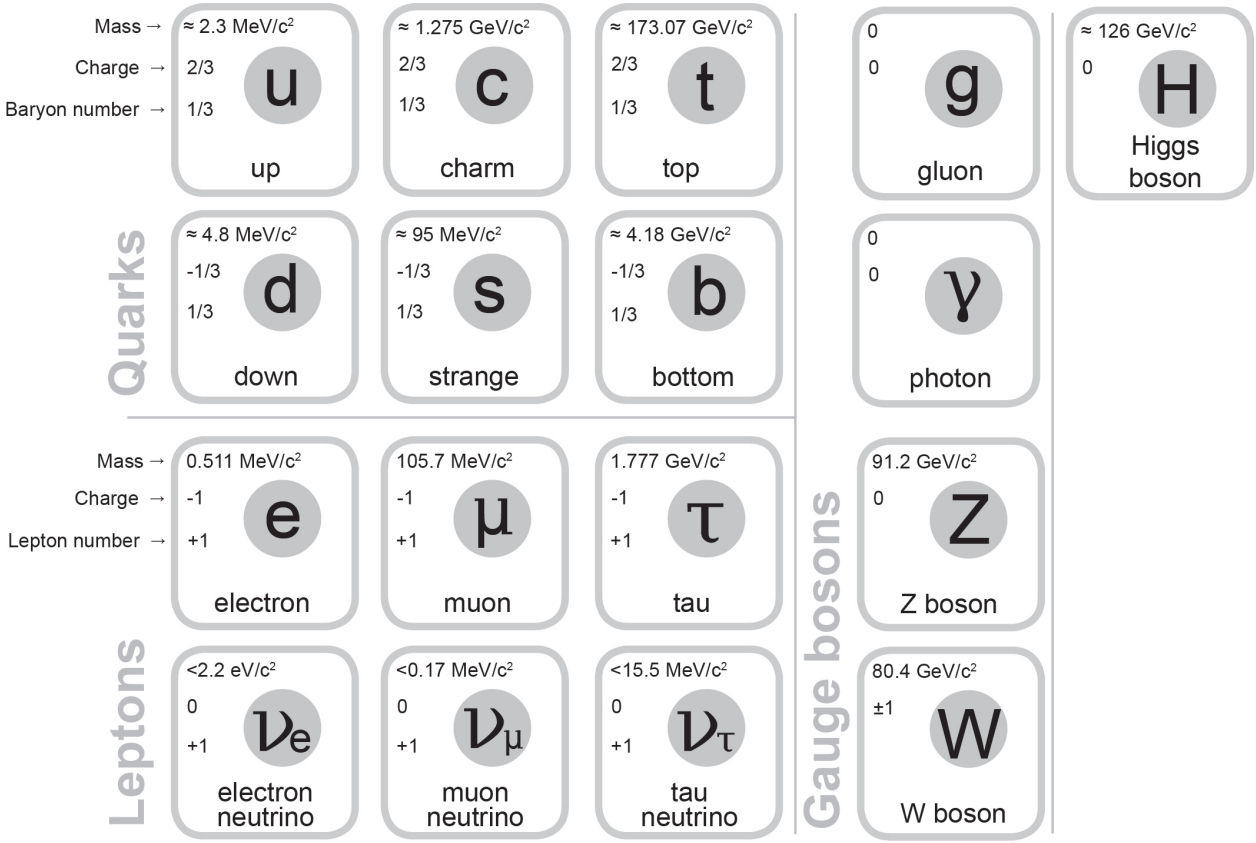
Mass-energy equivalence $E = \frac{m\,c^2}{\sqrt{1 - \frac{v^2}{c^2}}}$

Rest energy $E = m\,c^2$

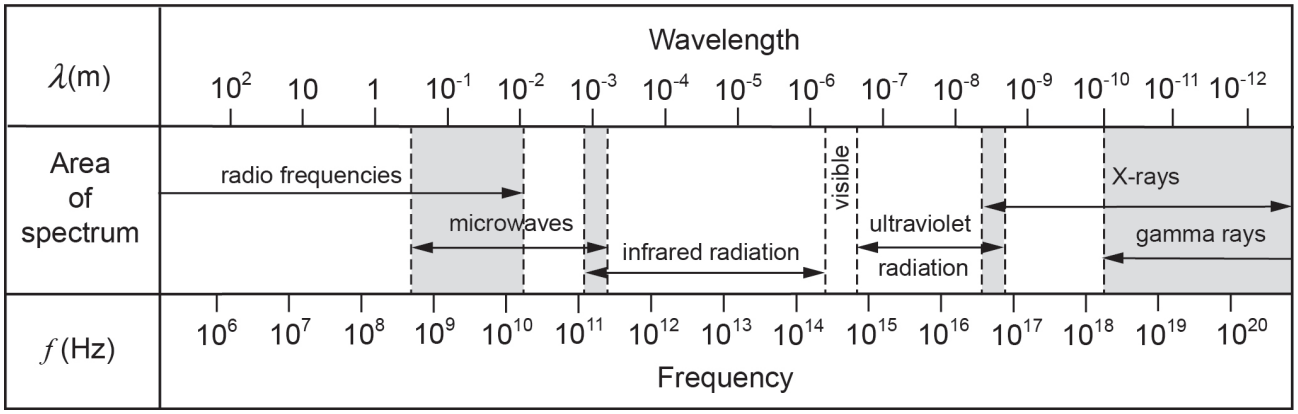
See next page

The Standard Model

Elementary particles



Electromagnetic spectrum



Note: shaded areas represent regions of overlap.

See next page

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 (at rest) of electron	m_e	=	9.11×10^{-31} kg
Mass (at rest) 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}
Electric 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}

Conversions

Electron volt	1 eV	=	1.60×10^{-19} J
Light year	ly	=	9.46×10^{12} km
Megaparsec	Mpc	=	3.09×10^{19} km = 3.26×10^6 ly

See next page

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

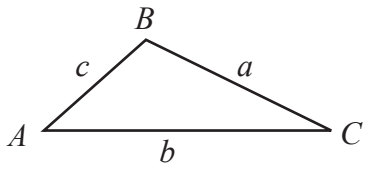
Mathematical expressions

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

This page has been left blank intentionally

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
Used under Creative Commons Attribution 3.0 Unported licence.

This document is valid for teaching and examining until 31 December 2020.

2018/54476

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