



PHYSICS ATAR COURSE YEAR 12 FORMULAE AND DATA BOOKLET 2024

PHYSICS YEAR 12

FOR

FORMULAE AND DATA BOOKLET

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

2

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
$$F_{\text{net}} = m a$$

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

Kinetic energy
$$E_k = \frac{1}{2} m v^2$$

Gravitational potential energy
$$E_p = mg\Delta h$$

Work done
$$W = Fs$$
 $W = \Delta E$

Equations of circular motion
$$v = \frac{2\pi r}{T}$$
 $a_{\rm c} = \frac{v^2}{r}$ resultant $F_{\rm c} = m a_{\rm c} = \frac{m v^2}{r}$

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
$$\Delta E = hf \qquad \quad \Delta E = E_2 - E_1$$

Photoelectric effect
$$E_k = hf - W$$

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

Electromagnetism

0 1 11 1	F	, _	1	q_1q_2
Coulomb's law	T.		$\overline{4\pi\varepsilon_0}$	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 :
$$\varepsilon = \ell v B \sin \theta$$

$$\mathrm{induced\ emf}: \varepsilon = -N\frac{(\Phi_{\scriptscriptstyle 2} - \Phi_{\scriptscriptstyle 1})}{t} = -N\frac{\Delta\Phi}{t} = -N\frac{\Delta(BA_{\scriptscriptstyle \perp})}{t}$$

where A = area perpendicular to the field B

$$\varepsilon_{\rm max} = 2N\ell vB = 2\pi NBAf$$

$$\varepsilon_{\rm rms} = \frac{\varepsilon_{\rm max}}{\sqrt{2}}$$

Ohm's law
$$V = IR$$

Electric current
$$I = \frac{q}{t}$$
 Work and energy $W = Vq$

Ideal transformer turns ratio
$$\frac{V_{\rm p}}{V_{\rm s}} = \frac{N_{\rm p}}{N_{\rm s}}$$
 Power $P = VI = I^2R = \frac{V^2}{R}$

Special relativity

Relativistic effects

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

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

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

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

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

Relativistic momentum

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

Hubble's law $v = H_0 d$

$$v = H_0 d$$

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

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

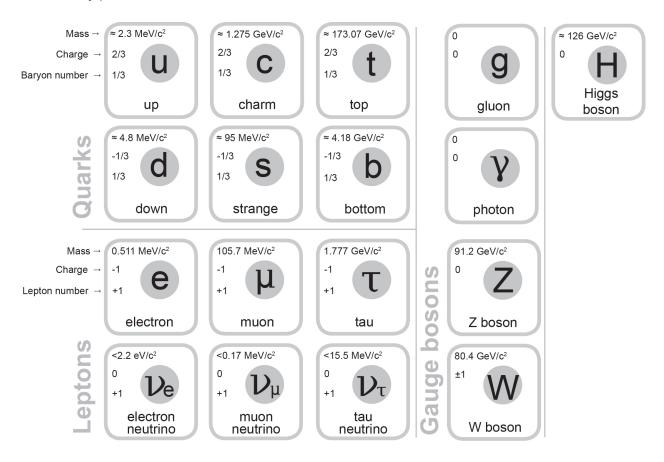
Mass-energy equivalence

$$E_{\rm t} = \frac{m\,c^2}{\sqrt{(1-\frac{v^2}{c^2})}} \qquad \qquad {\rm Total\ energy} \qquad E_{\rm rest} = m\,c^2$$

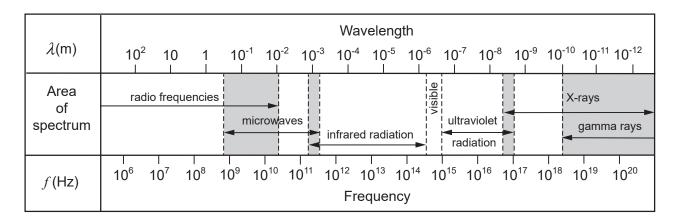
$$E_{\rm t} = E_{\rm k} + E_{\rm rest}$$

The Standard Model

Elementary particles



Electromagnetic spectrum



Note: shaded areas represent regions of overlap.

Physical data

Mean acceleration due to gravity on the Earth g	=	9.80 m s ⁻²
Mean acceleration due to gravity on the Moon $g_{\scriptscriptstyle \mathrm{M}}$	=	1.62 m s ⁻²
Mean radius of the Earth $R_{\rm E}$	=	$6.37 \times 10^6 \mathrm{m}$
Mass of the Earth $M_{\rm E}$	=	$5.97 \times 10^{24} \text{ kg}$
Mean radius of the Sun $R_{\rm S}$	=	6.96 × 10 ⁸ m
Mass of the Sun M_{S}	=	1.99 × 10 ³⁰ kg
Mean radius of the Moon R_{M}	=	$1.74 \times 10^6 \mathrm{m}$
Mass of the Moon $M_{ m M}$	=	$7.35 \times 10^{22} \text{ kg}$
Mean Earth-Moon distance	=	3.84 × 10 ⁸ m
Mean Earth-Sun distance	=	1.50 × 10 ¹¹ m
	=	1.00 astronomical unit (AU)
Mass (at rest) of electron	=	$9.11 \times 10^{-31} \text{ kg}$
Mass (at rest) of protonm _p	=	$1.67 \times 10^{-27} \text{ kg}$
Tonne	=	10 ³ kg

Physical constants

Speed of light in vacuum or air	=	$3.00 \times 10^8 \text{ m s}^{-1}$
Electron chargee	=	-1.60 × 10 ⁻¹⁹ C
Planck constanth	=	6.63 × 10 ⁻³⁴ J s
Newtonian constant of gravitation G	=	6.67 × 10 ⁻¹¹ N m ² kg ⁻²
Electric constant $arepsilon_0$	=	$8.85 \times 10^{-12} \mathrm{F m^{-1}}$
Magnetic constant μ_0	=	$4\pi \times 10^{-7} \text{ N A}^{-2} = 1.26 \times 10^{-6} \text{ N A}^{-2}$

Conversions

Electron volt	1.00 eV	=	1.60 × 10 ⁻¹⁹ J
Light year	1.00 ly	=	9.46 × 10 ¹² km
Megaparsec	1.00 Mpd	c =	$3.09 \times 10^{19} \mathrm{km} = 3.26 \times 10^{6} \mathrm{ly}$

Prefixes of the metric system

Factor	Prefix	Symbol	Factor	Prefix	Symbol
1012	tera	Т	10-3	milli	m
10 ⁹	giga	G	10 ⁻⁶	micro	μ
106	mega	M	10-9	nano	n
10 ³	kilo	k	10 ⁻¹²	pico	р

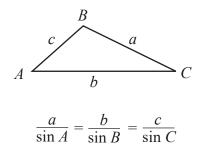
Mathematical expressions

Quadratic equations

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

Triangles

The following expressions apply to the triangle ABC as shown:



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

ACKNOWLEDGEMENTS

Elementary particles

Adapted from Standard Model image: MissMJ. (2006). *File:Standard Model of Elementary Particles.svg.* Retrieved June, 2016, from

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This document is valid for teaching and examining until 31 December 2024.

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