



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



PHYSICS
ATAR COURSE YEAR 12
FORMULAE AND DATA BOOKLET
2021

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

$$v = u + at \quad s = ut + \frac{1}{2} at^2 \quad v^2 = u^2 + 2as$$

$$p = mv$$

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

$$v = \frac{2\pi r}{T} \quad a_c = \frac{v^2}{r} \quad F_c = ma_c = \frac{mv^2}{r}$$

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

$$\tau = r F \sin\theta$$

(force at angle θ to lever arm)

Wave particle duality and the quantum theory

Wave period

$$T = \frac{1}{f}$$

Wave equation

$$c = f\lambda$$

Energy of photon

$$E = hf$$

Energy transitions

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

Photoelectric effect

$$E_k = hf - W$$

De Broglie wavelength

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

See next page

Electromagnetism

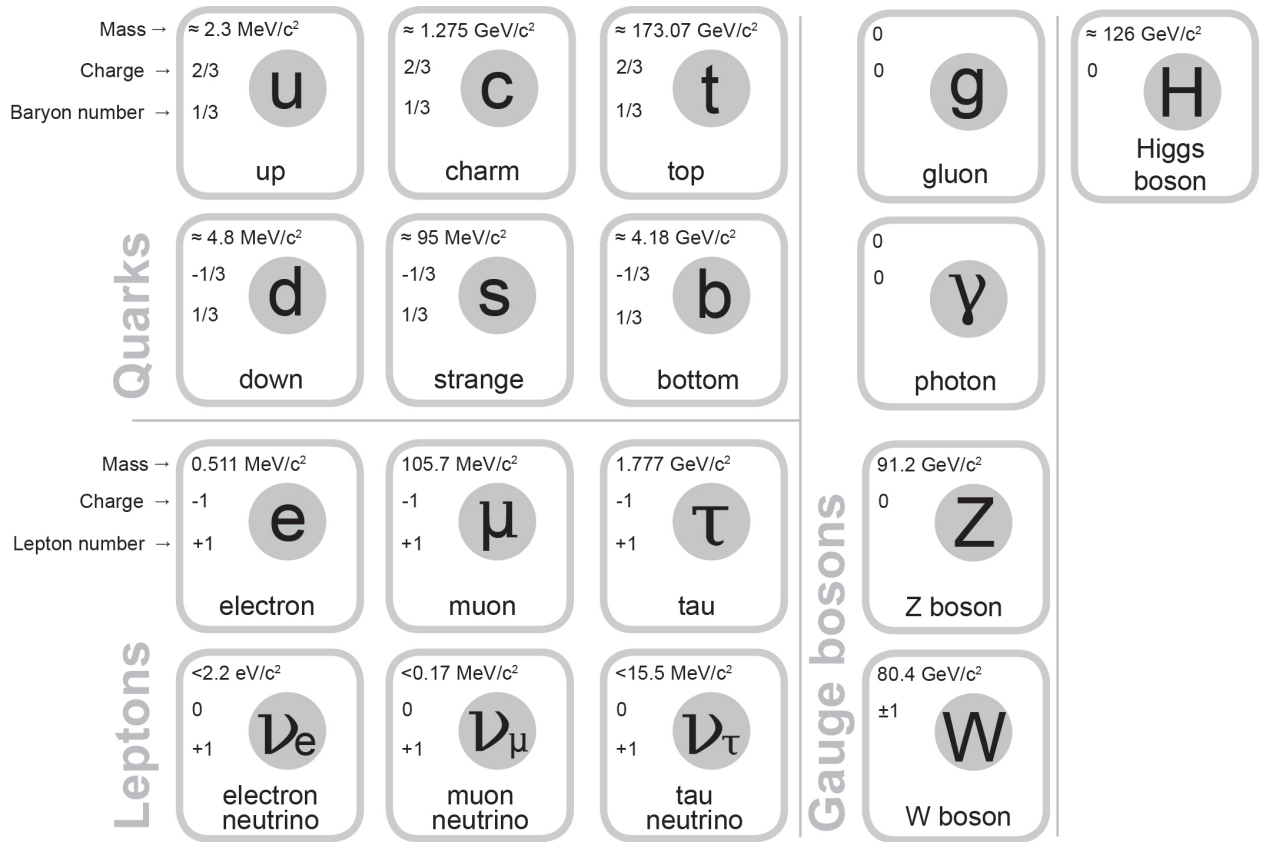
| | | | |
|--|--|-----------------|--|
| Coulomb's law | $F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$ | | |
| Electric field strength | $E = \frac{F}{q} = \frac{V}{d}$ | | |
| Magnetic field strength | $B = \frac{\mu_0}{2\pi} \frac{I}{r}$ | | |
| Magnetic force on a charged particle | $F = q v B$ 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} : $\mathcal{E}_{\text{max}} = 2N\ell v B = 2\pi N B A_{\perp} f$ | | $\mathcal{E}_{\text{rms}} = \frac{\mathcal{E}_{\text{max}}}{\sqrt{2}}$ |
| 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

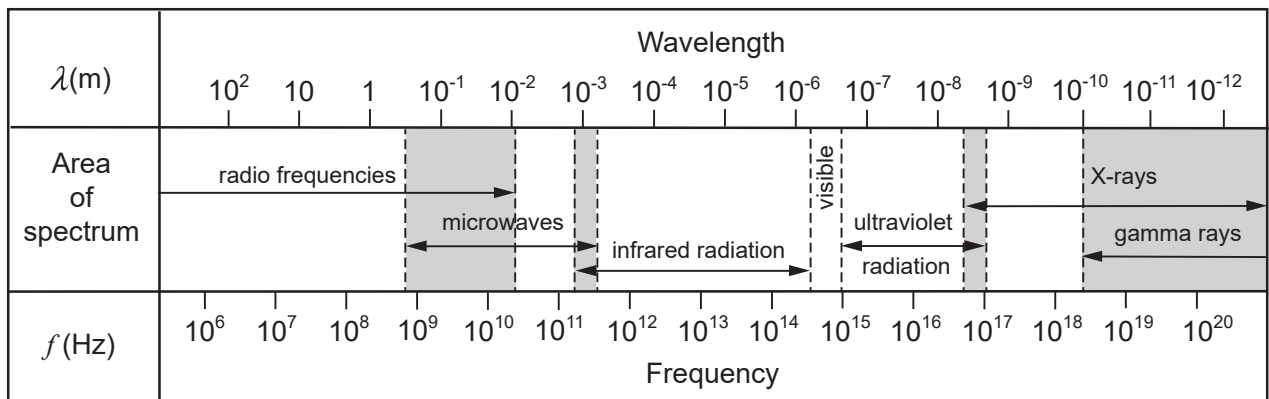
| | | | |
|-------------------------|---|---|-------------|
| Relativistic effects | $\ell = \ell_0 \sqrt{\left(1 - \frac{v^2}{c^2}\right)}$ | $t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$ | |
| | $u = \frac{v + u'}{1 + \frac{v u'}{c^2}}$ | $u' = \frac{u - v}{1 - \frac{v u}{c^2}}$ | |
| Relativistic 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 | $E = m c^2$ |

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 | = | $6.37 \times 10^6 \text{ m}$ |
| 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..... | = | $1.50 \times 10^{11} \text{ m}$ |
| Mass (at rest) of electron..... m_e | = | $9.11 \times 10^{-31} \text{ kg}$ |
| Mass (at rest) of proton..... m_p | = | $1.67 \times 10^{-27} \text{ kg}$ |
| Tonne..... 1 t | = | 10^3 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..... ϵ_0 | = | $8.85 \times 10^{-12} \text{ F m}^{-1}$ |
| 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 eV | = | $1.60 \times 10^{-19} \text{ J}$ |
| Light year..... ly | = | $9.46 \times 10^{12} \text{ km}$ |
| Megaparsec..... Mpc | = | $3.09 \times 10^{19} \text{ km} = 3.26 \times 10^6 \text{ ly}$ |

Prefixes of the metric system

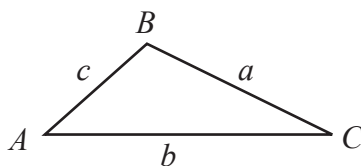
| Factor | Prefix | Symbol | Factor | Prefix | Symbol |
|-----------|--------|--------|------------|--------|--------|
| 10^{12} | tera | T | 10^{-3} | milli | m |
| 10^9 | giga | G | 10^{-6} | micro | μ |
| 10^6 | mega | M | 10^{-9} | nano | n |
| 10^3 | kilo | k | 10^{-12} | pico | p |

Mathematical expressions**Quadratic equations**

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:



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

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

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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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