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

PHYSICS

ATAR COURSE YEAR 11

FORMULAE AND DATA

2025

Motion, forces and energy

Displacement	$s = \Delta x = x_f - x_i$
Average velocity	$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$
Equations of motion	$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$ $\quad v_f = v_i + a\Delta t$ $s = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\quad {v_f}^2 = {v_i}^2 + 2as$
Momentum	$p = mv$ $\quad \Sigma mv_i = \Sigma mv_f$
Force	$\Sigma F = ma$
Change in momentum (impulse)	$\Delta p = mv_f - mv_i = F\Delta t$
Weight force	$F_{weight} = mg$
Friction	$F_f = \mu F_N$ where μ is the coefficient of static or kinetic friction

Mechanical and thermal energy

Kinetic energy	$E_k = \frac{1}{2}mv^2$
Gravitational potential energy	$E_p = mg\Delta h$
Conservation of energy	$\Sigma E_i = \Sigma E_f$
Elastic collisions	$\Sigma\frac{1}{2}mv_i^2 = \Sigma\frac{1}{2}mv_f^2$
Work done	$W = Fs$ $\quad W = \Delta E$
Power	$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t}$
Change of temperature	$Q = mc\Delta T$
Change of state	$Q = mL$

Waves

Wave velocity	$v = f\lambda$
Period	$T = \frac{1}{f}$
Strings and open pipes	$\lambda = \frac{2\ell}{n}$ where *n* = the number of the appropriate harmonic
Closed pipes	$\lambda = \frac{4\ell}{n}$ where *n* = the number of the appropriate harmonic
Beat frequency	$f_{beat} = \lvert f_2 - f_1 \rvert$

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Ionising radiation and nuclear reactions

Half-life	$N = N_0\left(\frac{1}{2}\right)^n$
Absorbed radiation dose	$\text{absorbed dose} = \frac{E}{m}$
Dose equivalent	$\text{dose equivalent} = \text{absorbed dose} \times \text{quality factor}$
Mass–energy relationship	$\Delta E = \Delta mc^2$

Electrical forces and energy

Work and energy	$\Delta V = \frac{W}{q}$
Electric current	$I = \frac{q}{\Delta t}$
Power	$P = \frac{W}{\Delta t} = VI$
Ohm's law	$R = \frac{V}{I}$
Resistance in series (I = constant)	$V_t = V_1 + V_2 + V_3 \ldots$ $R_t = R_1 + R_2 + R_3 \ldots$
Resistance in parallel (V = constant)	$I_t = I_1 + I_2 + I_3 \ldots$ $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots$

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

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

Electron volt .... 1.00 eV = 1.60×10^{-19} J

Unified atomic mass unit .... 1.00 u = 1.66×10^{-27} kg

Mass of electron .... m_e = 9.11×10^{-31} kg

Mass of proton .... m_p = 1.67×10^{-27} kg

Mass of neutron .... m_n = 1.67×10^{-27} kg

Mass of alpha particle .... m_α = 6.64×10^{-27} kg

Mass–energy equivalent .... 1.00 u = 931 MeV

Tonne .... 1.00 t = 10^{3} kg = 10^{6} g

Absolute zero .... 0 K = −273 °C

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Physical data

Mean acceleration due to gravity on Earth .... g = 9.80 m s^{-2}

Specific heat capacity of water.................................. c_w = $4.18 \times 10^3 \text{ J K}^{-1} \text{ kg}^{-1}$

Specific heat capacity of ice.. c_i = $2.10 \times 10^3 \text{ J K}^{-1} \text{ kg}^{-1}$

Specific heat capacity of steam .... c_s = $2.00 \times 10^3 \text{ J K}^{-1} \text{ kg}^{-1}$

Latent heat of fusion for H_2O .... L_f = $3.34 \times 10^5 \text{ J kg}^{-1}$

Latent heat of vaporisation for H_2O .... L_v = $2.26 \times 10^6 \text{ J kg}^{-1}$

Speed of sound in air at 25 °C .... v_s = 346 m s^{-1}

Quality factors

Approximate quality factor for alpha radiation ...... QF_α = 20

Approximate quality factor for beta radiation .... QF_β = 1

Approximate quality factor for gamma radiation ... QF_γ = 1

Approximate quality factor for slow neutrons .... QF_{sn} = 3

Approximate quality factor for fast neutrons .... QF_{fn} = 10

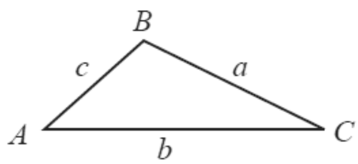
Mathematical expressions

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:



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

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

IUPAC Periodic Table of the Elements

Key:

atomic number Symbol name abridged standard atomic weight

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H hydrogen 1.0080 ± 0.0002																	2 He helium 4.0026 ± 0.0001
3 Li lithium 6.94 ± 0.06	4 Be beryllium 9.0122 ± 0.0001											5 B boron 10.81 ± 0.02	6 C carbon 12.011 ± 0.002	7 N nitrogen 14.007 ± 0.001	8 O oxygen 15.999 ± 0.001	9 F fluorine 18.998 ± 0.001	10 Ne neon 20.180 ± 0.001
11 Na sodium 22.990 ± 0.001	12 Mg magnesium 24.305 ± 0.002											13 Al aluminium 26.982 ± 0.001	14 Si silicon 28.085 ± 0.001	15 P phosphorus 30.974 ± 0.001	16 S sulfur 32.06 ± 0.02	17 Cl chlorine 35.45 ± 0.01	18 Ar argon 39.95 ± 0.16
19 K potassium 39.098 ± 0.001	20 Ca calcium 40.078 ± 0.004	21 Sc scandium 44.956 ± 0.001	22 Ti titanium 47.867 ± 0.001	23 V vanadium 50.942 ± 0.001	24 Cr chromium 51.996 ± 0.001	25 Mn manganese 54.938 ± 0.001	26 Fe iron 55.845 ± 0.002	27 Co cobalt 58.933 ± 0.001	28 Ni nickel 58.693 ± 0.001	29 Cu copper 63.546 ± 0.003	30 Zn zinc 65.38 ± 0.02	31 Ga gallium 69.723 ± 0.001	32 Ge germanium 72.630 ± 0.008	33 As arsenic 74.922 ± 0.001	34 Se selenium 78.971 ± 0.008	35 Br bromine 79.904 ± 0.003	36 Kr krypton 83.798 ± 0.002
37 Rb rubidium 85.468 ± 0.001	38 Sr strontium 87.62 ± 0.01	39 Y yttrium 88.906 ± 0.001	40 Zr zirconium 91.224 ± 0.002	41 Nb niobium 92.906 ± 0.001	42 Mo molybdenum 95.95 ± 0.01	43 Tc technetium [97]	44 Ru ruthenium 101.07 ± 0.02	45 Rh rhodium 102.91 ± 0.01	46 Pd palladium 106.42 ± 0.01	47 Ag silver 107.87 ± 0.01	48 Cd cadmium 112.41 ± 0.01	49 In indium 114.82 ± 0.01	50 Sn tin 118.71 ± 0.01	51 Sb antimony 121.76 ± 0.01	52 Te tellurium 127.60 ± 0.03	53 I iodine 126.90 ± 0.01	54 Xe xenon 131.29 ± 0.01
55 Cs caesium 132.91 ± 0.01	56 Ba barium 137.33 ± 0.01	57-71 lanthanoids	72 Hf hafnium 178.49 ± 0.01	73 Ta tantalum 180.95 ± 0.01	74 W tungsten 183.84 ± 0.01	75 Re rhenium 186.21 ± 0.01	76 Os osmium 190.23 ± 0.03	77 Ir iridium 192.22 ± 0.01	78 Pt platinum 195.08 ± 0.02	79 Au gold 196.97 ± 0.01	80 Hg mercury 200.59 ± 0.01	81 Tl thallium 204.38 ± 0.01	82 Pb lead 207.2 ± 1.1	83 Bi bismuth 208.98 ± 0.01	84 Po polonium [209]	85 At astatine [210]	86 Rn radon [222]
87 Fr francium [223]	88 Ra radium [226]	89-103 actinoids	104 Rf rutherfordium [267]	105 Db dubnium [268]	106 Sg seaborgium [269]	107 Bh bohrium [270]	108 Hs hassium [269]	109 Mt meitnerium [277]	110 Ds darmstadtium [281]	111 Rg roentgenium [282]	112 Cn copernicium [285]	113 Nh nihonium [286]	114 Fl flerovium [290]	115 Mc moscovium [290]	116 Lv livermorium [293]	117 Ts tennessine [294]	118 Og oganesson [294]

57 La lanthanum 138.91 ± 0.01	58 Ce cerium 140.12 ± 0.01	59 Pr praseodymium 140.91 ± 0.01	60 Nd neodymium 144.24 ± 0.01	61 Pm promethium [145]	62 Sm samarium 150.36 ± 0.02	63 Eu europium 151.96 ± 0.01	64 Gd gadolinium 157.25 ± 0.03	65 Tb terbium 158.93 ± 0.01	66 Dy dysprosium 162.50 ± 0.01	67 Ho holmium 164.93 ± 0.01	68 Er erbium 167.26 ± 0.01	69 Tm thulium 168.93 ± 0.01	70 Yb ytterbium 173.05 ± 0.02	71 Lu lutetium 174.97 ± 0.01
89 Ac actinium [227]	90 Th thorium 232.04 ± 0.01	91 Pa protactinium 231.04 ± 0.01	92 U uranium 238.03 ± 0.01	93 Np neptunium [237]	94 Pu plutonium [244]	95 Am americium [243]	96 Cm curium [247]	97 Bk berkelium [247]	98 Cf californium [251]	99 Es einsteinium [252]	100 Fm fermium [257]	101 Md mendelevium [258]	102 No nobelium [259]	103 Lr lawrencium [262]

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For notes and updates to this table, see www.iupac.org. This version is dated 4 May 2022.