NSW Education Standards Authority

Science 7–10 (2023)

Data Book

Contents

Decimal fractions and multiples

Fraction	Prefix	Symbol
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deca	da
1	*common base unit*	
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

SI base units for base quantities

Physical quantity		SI unit	
Quantity name	**Quantity symbol**	**Unit name**	**Unit symbol**
length	*l*	metre	m
mass	*m*	kilogram	kg
time	*t*	second	s
electric current	*I*	ampere	A
temperature	*T*	kelvin	K

SI units for other common quantities

Physical quantity		SI unit	
Quantity name	**Quantity symbol**	**Unit name**	**Unit symbol**
volume	V	cubic metre	m^3
pressure	P	pascal	Pa
force	F	newton	N
resistance	R	ohm	Ω
voltage	V	volt	V
wavelength	λ	metre	m
displacement	s	metre	m
frequency	f	hertz	Hz (s^{-1})
density	ρ	kilograms per cubic metre	kg m^{-3}
velocity	v	metres per second	m s^{-1}
acceleration	a	metres per second per second	m s^{-2}

Some common formulas

Name	Formula
temperature conversion	$T\ (\mathrm{K}) = T\ (°\mathrm{C}) + 273.15$
density	$\rho = \frac{m}{V}$
weight force	$F = mg$
Newton's second law of motion	$F = ma$
Ohm's law	$V = IR$
wave equation	$\lambda = \frac{v}{f}$
average velocity	$v_{av} = \frac{\Delta s}{\Delta t}$
acceleration	$a = \frac{\Delta v}{\Delta t}$
microscopic magnification	$(power\ of\ ocular\ lens) \times (power\ of\ objective\ lens)$
experimental error	$\%\ \mathrm{error} = \left(\frac{theoretical\ value - experimental\ value}{theoretical\ value}\right) \times 100\%$

Periodic table of the elements

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

KEY

Atomic Number	79
Symbol	Au
Standard Atomic Weight	197.0
Name	Gold

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Standard atomic weights are abridged to four significant figures.
Elements with no reported values in the table have no stable nuclides.
Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).
The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of all other data. Some data may have been modified.

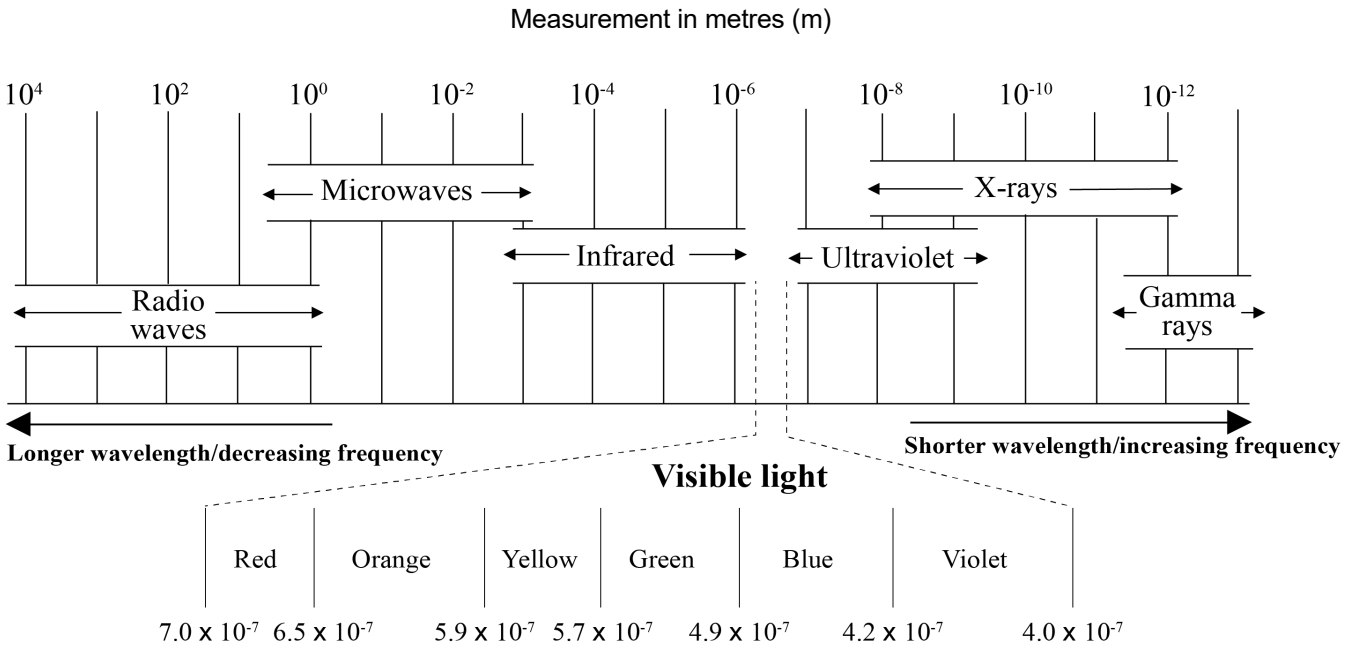
Ground state electron configurations of elements with atomic numbers 1 to 18

n = shell number

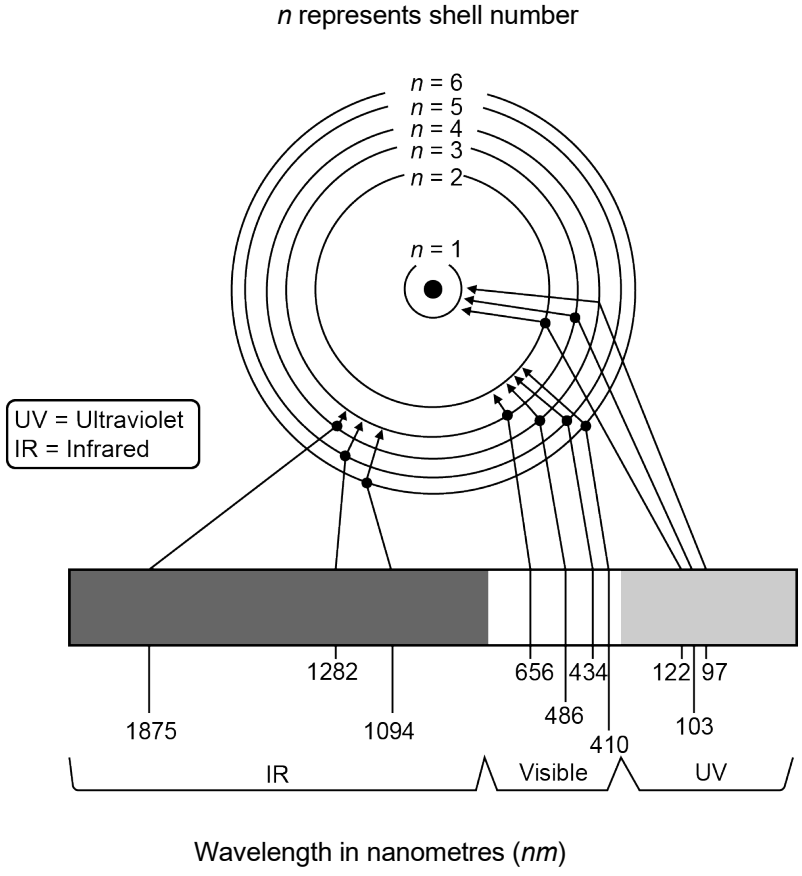
Z = *atomic number*

		n =	1	2	3
Z	**Element name**	**Element symbol**	**Electrons in shell 1**	**Electrons in shell 2**	**Electrons in shell 3**
1	Hydrogen	H	1		
2	Helium	He	2		
3	Lithium	Li	2	1	
4	Beryllium	Be	2	2	
5	Boron	B	2	3	
6	Carbon	C	2	4	
7	Nitrogen	N	2	5	
8	Oxygen	O	2	6	
9	Fluorine	F	2	7	
10	Neon	Ne	2	8	
11	Sodium	Na	2	8	1
12	Magnesium	Mg	2	8	2
13	Aluminium	Al	2	8	3
14	Silicon	Si	2	8	4
15	Phosphorus	P	2	8	5
16	Sulfur	S	2	8	6
17	Chlorine	Cl	2	8	7
18	Argon	Ar	2	8	8

Electromagnetic spectrum



Bohr model for hydrogen atom



Properties of some common elements

* = melts under pressure s = sublimes

Element name	Element symbol	Density ($g\ cm^{-3}$) at 25 °C and 100 kPa	Melting point t_m (°C)	Boiling point t_b (°C)
Aluminium	Al	2.70	660	2467
Argon	Ar	0.00161	−189	−186
Boron	B	2.34	2300	3660
Calcium	Ca	1.55	842	1484
Carbon (graphite, diamond)	C	2.26 3.51	*3974 >3550	s3930
Chlorine	Cl	0.00285	−101	−34
Copper	Cu	8.96	1085	2572
Fluorine	F	0.00153	−220	−188
Gold	Au	19.3	1064	2856
Helium	He	0.000161	*−272	−269
Hydrogen	H	0.0000813	−259	−253
Iron	Fe	7.86	1535	2750
Lead	Pb	11.3	327	1740
Magnesium	Mg	1.74	650	1110
Mercury	Hg	13.53	−39	357
Neon	Ne	0.000814	−249	−256
Nitrogen	N	0.00113	−210	−196
Oxygen (ozone)	O O_3	0.00129 0.00194	−219 −193	−183 −111
Phosphorus (white)	P	1.82	44	280
Potassium	K	0.86	63	760
Silicon	Si	2.33	1410	3267
Silver	Ag	10.5	962	2212
Sodium	Na	0.97	98	883
Sulfur (rhombic)	S	2.07	113	445
Zinc	Zn	7.14	420	907

Names and formulas of some common compounds

Name	Formula (with state at 25 °C)
ammonia	$NH_3(g)$
carbon dioxide	$CO_2(g)$
ethanol	$C_2H_5OH(l)$
glucose	$C_6H_{12}O_6(s)$
methane	$CH_4(g)$
water	$H_2O(l)$

Names and formulas of some common acids

Name	Formula
carbonic acid	H_2CO_3
ethanoic acid	CH_3COOH
hydrochloric acid	HCl
nitric acid	HNO_3
phosphoric acid	H_3PO_4
sulfuric acid	H_2SO_4

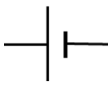
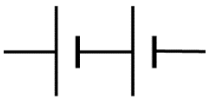
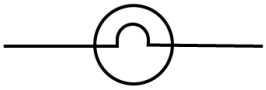
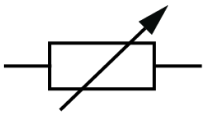
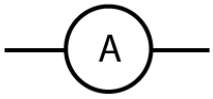
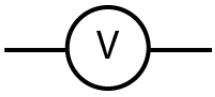
Some common polyatomic ions

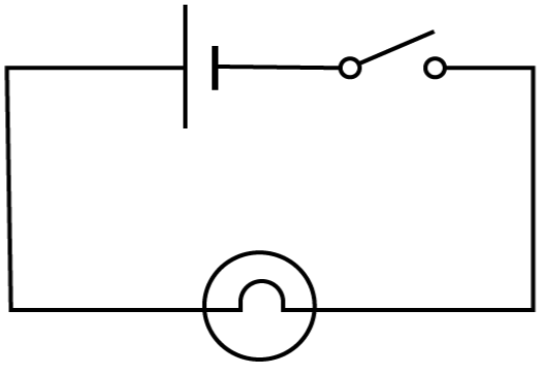
Name	Formula
ethanoate	CH_3COO^-
ammonium	NH_4^+
carbonate	CO_3^{2-}
hydroxide	OH^-
hydrogen carbonate	HCO_3^-
nitrate	NO_3^-
nitrite	NO_2^-
phosphate	PO_4^{3-}
sulfate	SO_4^{2-}

Subatomic particles and radiation

Name	Formula
alpha particle (helium nucleus)	${}_{2}^{4}\mathrm{He}$ or α
beta particle (electron)	${}_{-1}^{0}\mathrm{e}$ or β
positron	${}_{+1}^{0}\mathrm{e}$
gamma radiation	${}_{0}^{0}\gamma$
neutron	${}_{0}^{1}\mathrm{n}$
proton	${}_{1}^{1}\mathrm{p}$

Electrical circuit diagram symbols

Name	Symbol	Name	Symbol
electrochemical cell		conductor wire	
battery		light globe	
open switch		resistor	
closed switch		variable resistor	
ammeter		voltmeter	



This diagram shows a complete circuit with an electrochemical cell, an open switch and a light globe connected by a conductor wire.

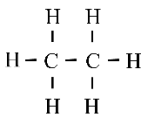
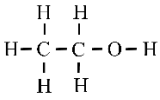
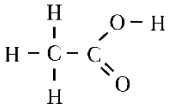
Note: Electrical drawings use symbols which align with Australian and New Zealand Standards (AS 1102.101-1989 to AS/NZS 1102.110:1997 *Graphical symbols for electrotechnology documentation*). Variation in symbols is to be expected, since not all countries use the International Standards, and standards are likely to have changed over time. (RMIT 2023)

Alkane nomenclature (with state at 25 °C)

Name	Formula	Name	Formula
*meth*ane	$CH_4(g)$	*pent*ane	$C_5H_{12}(l)$
*eth*ane	$C_2H_6(g)$	*hex*ane	$C_6H_{14}(l)$
*prop*ane	$C_3H_8(g)$	*hept*ane	$C_7H_{16}(l)$
*but*ane	$C_4H_{10}(g)$	*oct*ane	$C_8H_{18}(l)$

Note: italics indicate organic nomenclature root name

General formulas and names of some organic compounds

General formula	Homologous series	Example formula	Example name
C_nH_{2n+2}	alkane		ethane
$C_nH_{2n+1}OH$	alcohol		ethanol
$C_nH_{2n+1}COOH$	carboxylic acid		ethanoic acid

Guidelines for predicting the products of selected types of chemical reactions

Combustion of hydrocarbons

i. Complete combustion
hydrocarbon + oxygen → carbon dioxide + water

ii. Incomplete combustion (insufficient oxygen)
hydrocarbon + oxygen → carbon monoxide + water (carbon may also be formed)

Synthesis

i. Simpler reactants combine to form more complex products.

$$A + B \rightarrow AB$$

For example, direct synthesis

Decomposition

One reactant breaks down into 2 or more products.

i. Binary compound decomposition

$$AB \rightarrow A + B$$

ii. Thermal decomposition of a metal carbonate
metal carbonate → metal oxide + carbon dioxide

iii. Thermal decomposition of a metal hydroxide
metal hydroxide → metal oxide + water

iv. Thermal decomposition of a metal hydrogen carbonate
metal hydrogen carbonate → metal oxide + carbon dioxide + water

Single displacement

One element is substituted for another element in a compound.

$$A + BC \rightarrow AC + B$$

i. Very active metal with water
very active metal + water → metal hydroxide solution + hydrogen gas

ii. Active metal with acid
active metal + acid → salt solution + hydrogen gas

iii. Metal substitution
More active metal replaces a less active metal in a salt solution.

Double displacement

i. Components of 2 compounds are substituted, producing 2 new compounds.

$$AB + CD \rightarrow AD + CB$$

ii. For example, precipitation
Two soluble ionic solutions react to produce an insoluble precipitate or precipitates.

Neutralisation

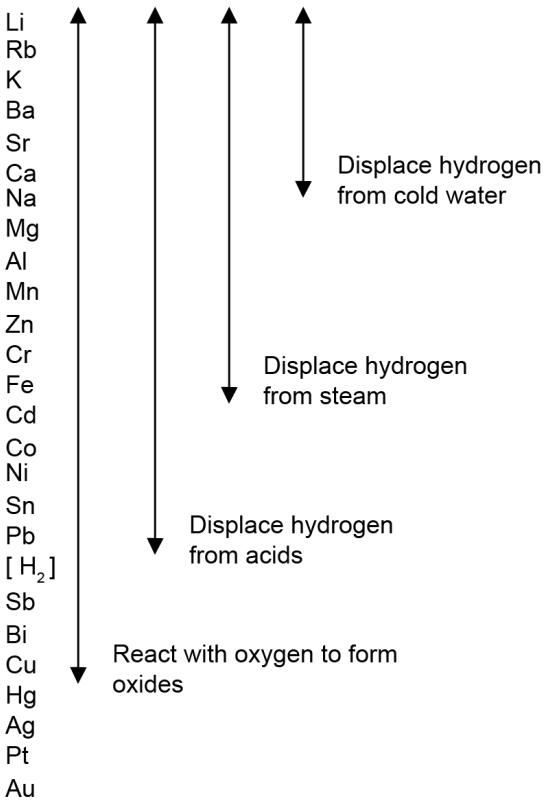
i. Acid + metal hydroxide → salt + water

Solubility table

Key: s = soluble i = insoluble * = slightly soluble - = solubility data unavailable

	F^-	Cl^-	Br^-	I^-	NO_3^-	CH_3COO^-	OH^-	SO_4^{2-}	CO_3^{2-}
NH_4^+	s	s	s	s	s	s	s	s	s
Na^+	s	s	s	s	s	s	s	s	s
K^+	s	s	s	s	s	s	s	s	s
Mg^{2+}	i	s	s	s	s	s	i	s	i
Ca^{2+}	i	s	s	s	s	s	*	*	i
Ba^{2+}	*	s	s	s	s	s	s	i	i
Fe^{2+}	*	s	s	s	s	s	i	*	i
Fe^{3+}	*	s	s	-	s	i	i	*	-
Cu^{2+}	s	s	s	-	s	s	i	s	i
Ag^+	s	i	i	i	s	s	i	*	i
Zn^{2+}	s	s	s	s	s	s	i	s	i
Al^{3+}	*	s	s	s	s	-	i	s	-
Pb^{2+}	i	*	*	i	s	s	i	i	i

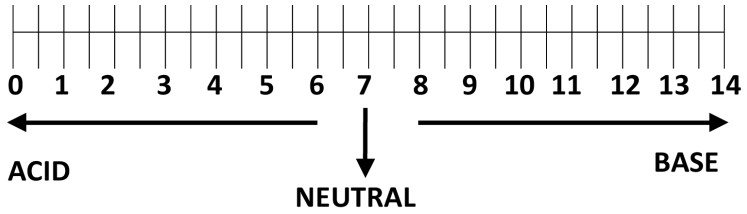
Activity series of metals



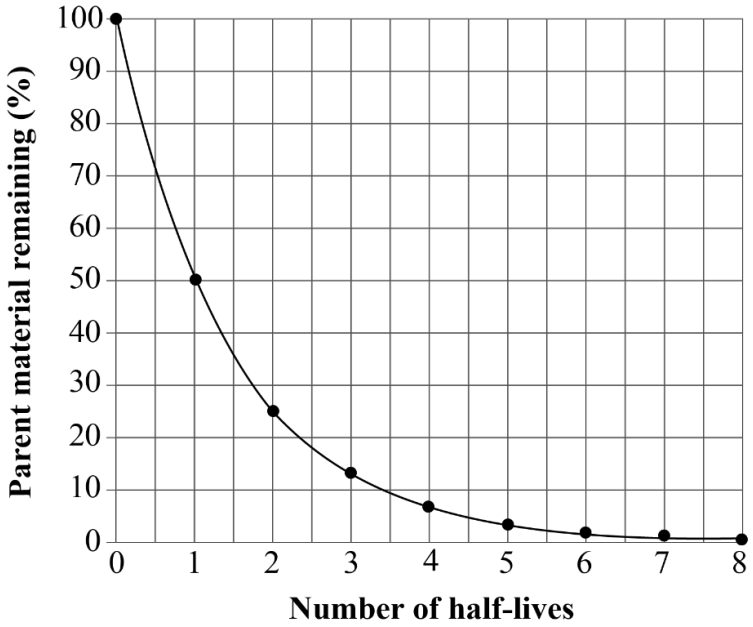
Acid to base indicators

Name of indicator	Colour at lower pH	pH range for colour change	Colour at higher pH
thymol blue	red	1.2–2.8	yellow
methyl orange	red	3.2–4.4	yellow
bromocresol green	yellow	3.8–5.4	blue
methyl red	red	4.2–6.3	yellow
bromothymol blue	yellow	6.0–7.6	blue
phenolphthalein	colourless	8.2–10.0	pink/violet

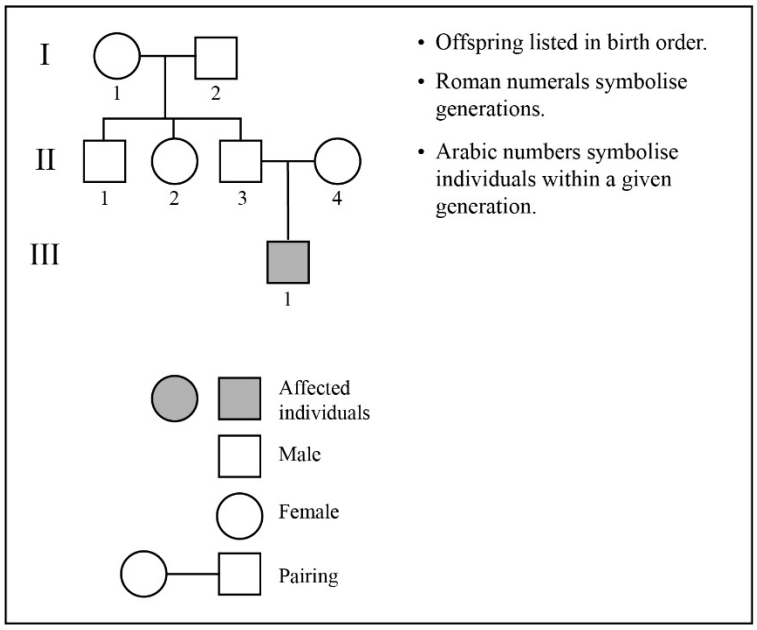
pH scale



Nuclear decay curve



Pedigree chart



DNA nitrogen bases

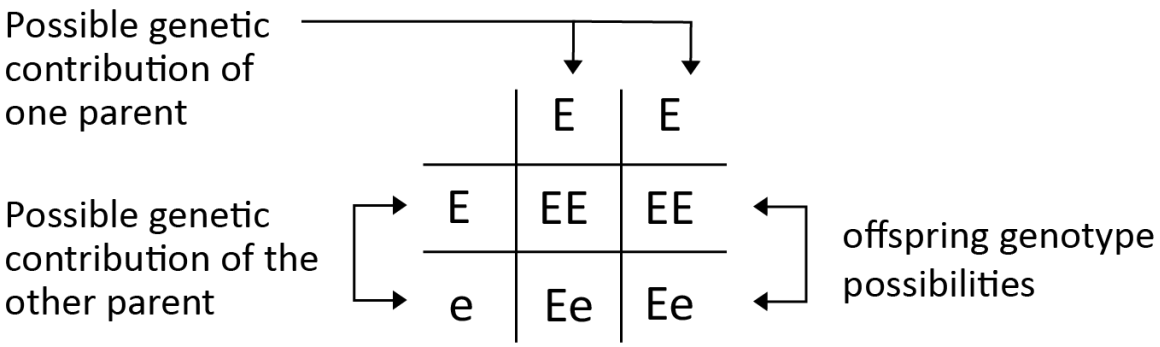
Nitrogen base	Abbreviation
adenine	A
cytosine	C
guanine	G
thymine	T

Alleles

Upper case – dominant (B)

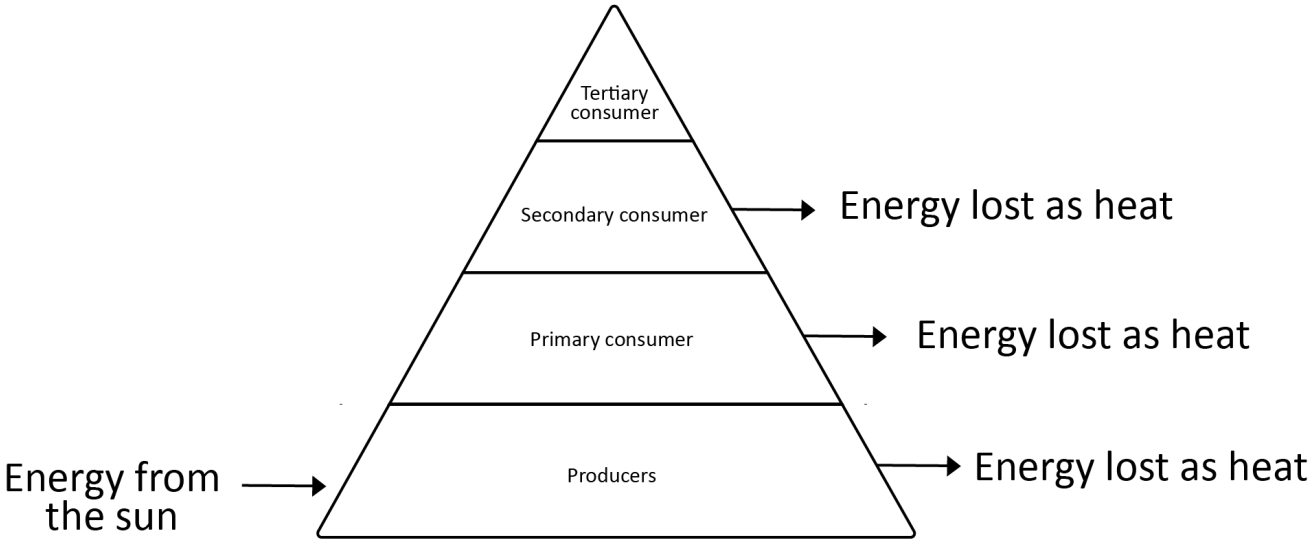
Lower case – recessive (b)

Punnett square



This Punnett square shows the possible genotype combinations for a dominant/recessive pattern of inheritance, this would mean all offspring would display the dominant phenotype.

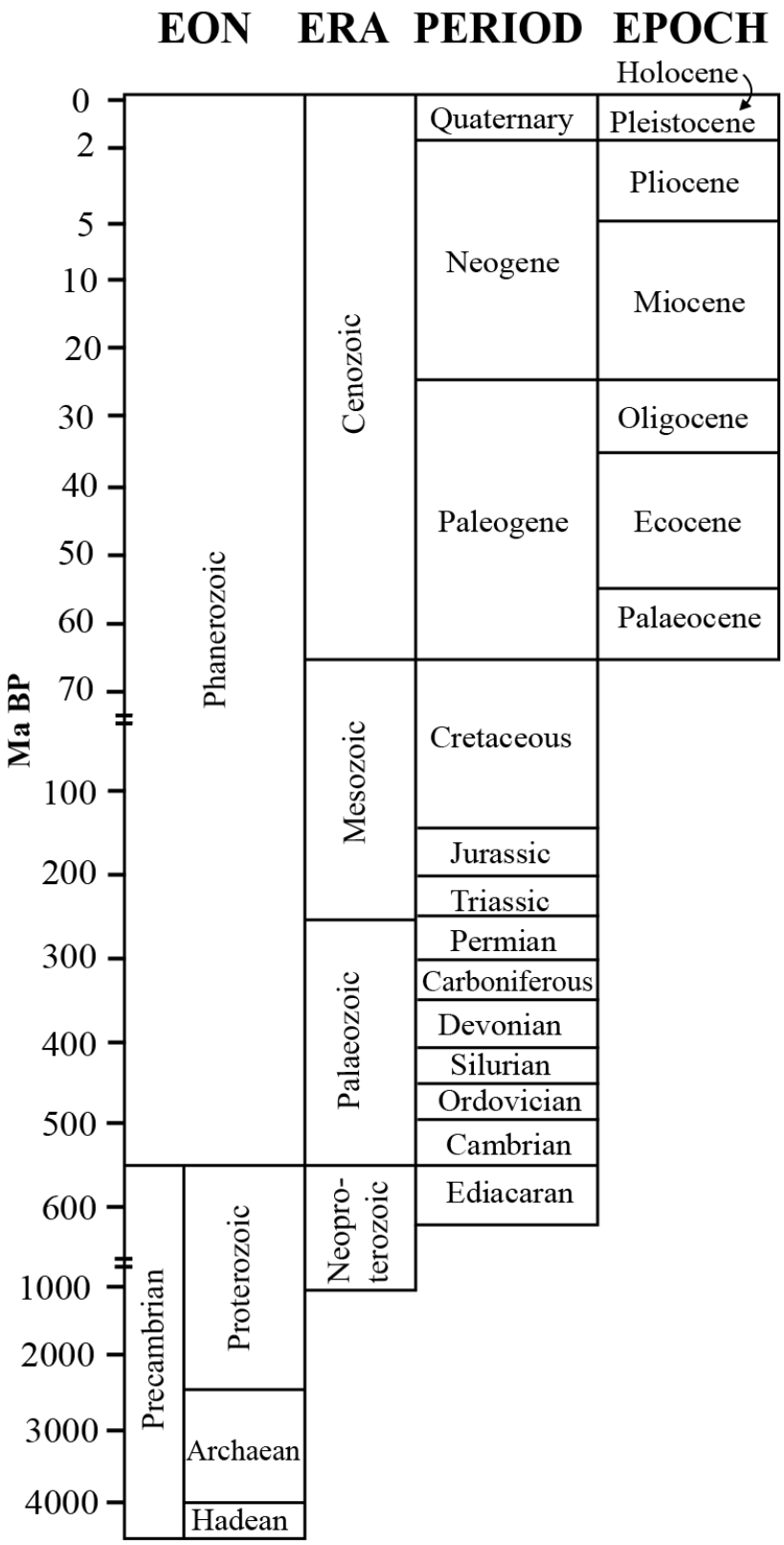
Energy pyramid



Energy pyramids illustrate how energy flows through ecosystems, with producers at the bottom harnessing sunlight to convert into biomass, and each successive trophic level receiving only about 10% of the energy from the level below, resulting in a pyramid shape that represents the decreasing energy transfer as it ascends to the top with tertiary consumers.

Geological timescale

Ma BP = million years before present



References

Blackman AG and Gahan LR (2014) *Aylward and Findlay's SI chemical data*, 7th edn, John Wiley & Sons Australia, Milton.

Coghill AM and Garson LR (2006) *The ACS style guide: effective communication of scientific information*, 3rd edn, American Chemical Society, Washington.

Perelman LC, Paradis J and Barrett (n.d.) E *Line graphs*, The Mayfield Handbook of Technical & Scientific Writing, accessed 22 June 2023. https://web.mit.edu/course/21/21.guide/grf-line.htm#:~:text=Line%20graphs%20visualize%20trends%20among,axis%20showing%20the%20independent%20variable

Rumble JR (2019) *CRC handbook of chemistry and physics*, 100th edn, CRC Press, Boca Raton.

RMIT (Royal Melbourne Institute of Technology) (2023) Electrical drawings, RMIT, accessed 3 October 2023. https://learninglab.rmit.edu.au/dlsweb/Toolbox/electrotech/toolbox1204/resources/04diagrams/03electrical/06symbols.htm