APPENDIX 3

UNITS OF MEASUREMENT AND MATHEMATICAL FORMULAS

UNITS OF MEASUREMENT

Measure	Symbol	Unit of measurement	Symbol of the unit of measurement	Some equivalencies
Area	A	• Square metre (square centimetre)	m^2 (cm^2)	$1\ m^2 = 10\,000\ cm^2$
Concentration	C	• Gram of solute per litre of solution • Part per million	$\frac{g}{L}$ ppm	$\frac{1\ g}{1\ L} = \frac{1\ g}{1000\ mL}$ $1\ ppm = \frac{1\ mg}{1000\ g}$ Aqueous solution: $1\ ppm \simeq \frac{1\ mg}{1\ L}$
Current intensity	I	• Ampere	A	$1\ A = \frac{1\ C}{1\ s}$ $1\ A = \frac{1\ V}{1\ \Omega}$
Distance travelled	d	• Metre (kilometre)	m (km)	1 km = 1000 m
Electrical charge	q or Q	• Coulomb	C	$1\ C = 6.25 \times 10^{18}$ elementary charges
Electrical power	P_e	• Watt (kilowatt)	W (kW)	1 kW = 1000 W $1\ W = \frac{1\ J}{1\ s}$ $1\ W = 1\ A \times 1\ V$
Electrical resistance	R	• Ohm	Ω	$1\ \Omega = \frac{1\ V}{1\ A}$
Energy – Kinetic energy – Mechanical energy – Gravitational potential energy – Thermal energy – Electrical energy	E E_k E_m E_p E_t	• Joule (kilojoule) • Kilowatt hour	J (kJ) kWh	$1\ J = 1\ N \times 1\ m$ $1\ J = 1\ \frac{kg \times m^2}{s^2}$ 1 kJ = 1000 J 1 kWh = 3600 kJ
Force – Electrical force – Gravitational force – Buoyant force	F F_e F_g F_b	• Newton	N	$1\ N = 1\ \frac{kg \times m}{s^2}$ On Earth: $1\ N \simeq 100\ g$
Heat	Q	• Joule	J	1 kJ = 1000 J
Height	h	• Metre (kilometre)	m (km)	1 km = 1000 m

Measure	Symbol	Unit of measurement	Symbol of the unit of measurement	Some equivalencies
Intensity of the gravitational field or gravitational acceleration	*g*	• Newton per kilogram • Metre per second squared	$\frac{N}{kg}$ $\frac{m}{s^2}$	$1\ \frac{N}{kg} = 1\ \frac{m}{s^2}$
Length	*L*	• Metre (kilometre)	m (km)	1 km = 1000 m
Mass	*m*	• Gram (milligram, kilogram) • Tonne	g (mg, kg)	1 kg = 1000 g 1 tonne = 1000 kg
Molar concentration	*C*	• Mole of solute per litre of solution	$\frac{mol}{L}$	$\frac{1\ mol}{1\ L} = \frac{6.02 \times 10^{23}\ entities}{1\ L}$
Molar mass	*M*	• Gram per mole	$\frac{g}{mol}$	$\frac{1\ g}{1\ mol} = \frac{1\ g}{6.02 \times 10^{23}\ entities}$
Number of moles	*n*	• Mole	mol	1 mol = 6.02×10^{23} entities
Potential difference or voltage	*V*	• Volt	V	$1\ V = \frac{1\ J}{1\ C}$ $1\ V = 1\ A \times 1\ \Omega$
Pressure	*P*	• Pascal (kilopascal) • Millimetre of mercury	Pa (kPa) mm Hg	$1\ Pa = \frac{1\ N}{1\ m^2}$ 1 kPa = 1000 Pa 1 mm Hg = 0.13 kPa
Specific heat capacity[1]	*c*	• Joule per gram per degree Celsius	$\frac{J}{g°C}$	$1\ \frac{J}{g°C} = 1\ \frac{1\ kJ}{kg°C}$
Temperature[1]	*T*	• Degree Celsius • Kelvin	°C K	0°C = 273 K
Time	*t*	• Second • Minute • Hour	s min h	1 min = 60 s 1 h = 60 min 1 h = 3600 s
Velocity / speed	*v*	• Metre per second • Kilometre per hour	$\frac{m}{s}$ $\frac{km}{h}$	$1\ \frac{m}{s} = 3.6\ \frac{km}{h}$
Volume	*V*	• Cubic metre (cubic centimetre, cubic decimetre) • Litre (millilitre)	m^3 (cm^3, dm^3) L (mL)	1 mL = 1 cm^3 1 L = 1 dm^3 1 L = 1000 mL
Weight	*w*	• Newton	N	$1\ N = 1\ \frac{kg \times m}{s^2}$
Work	*W*	• Joule	J	1 J = 1 N × 1 m

1. In this textbook, we use the degree Celsius (°C) rather than the kelvin, which is the SI base unit.

MATHEMATICAL FORMULAS

THE MATERIAL WORLD

AVERAGE SPEED

$v = \frac{d}{\Delta t}$ where v is the average speed (in m/s)
d is the distance travelled (in m)
Δt is the time variation—in other words, the travelling time (in s)

CONCENTRATION

$C = \frac{m}{V}$ where C is the concentration (in g/L)
m is the mass of the solute (in g)
V is the volume of solution (in L)

$C = \frac{n}{V}$ where C is the concentration (in mol/L)
n is the amount of solute (in mol)
V is the volume of solution (in L)

COULOMB'S LAW

$F_e = \frac{kq_1q_2}{r^2}$ where F_e is the electrical force (in N)
k is Coulomb's constant, which is 9×10^9 Nm^2/C^2
q_1 is the charge of the first particle (in C)
q_2 is the charge of the second particle (in C)
r is the distance between the two particles (in m)

CURRENT INTENSITY

$I = \frac{q}{\Delta t}$ where I is the current intensity (in A)
q is the charge (in C)
Δt is the time interval (in s)

EFFECTIVE FORCE (USEFUL TRIGONOMETRIC FUNCTIONS)

$$\text{Sin } A = \frac{\text{side opposite to angle } A}{\text{hypotenuse}}$$

$$\text{Cos } A = \frac{\text{side adjacent to angle } A}{\text{hypotenuse}}$$

$$\text{Tan } A = \frac{\text{side opposite to angle } A}{\text{side adjacent to angle } A}$$

Note: Most scientific calculators immediately give the sine (sin), cosine (cos) and tangent (tan or tg) values of any angle. However, make sure the calculator measures angles in degrees (and not in radians or grads).

ELECTRICAL ENERGY USED

$E = P_e\Delta t$ where E is the electrical energy used (in J or kWh)
P_e is the electrical power (in W or kW)
Δt is the time interval (in s or h)

ELECTRICAL POWER

$P_e = \frac{W}{\Delta t}$ where P_e is the electrical power (in W)
W is the work (in J)
Δt is the time required (in s)

$P_e = VI$ where P_e is the electrical power (in W)
V is the potential difference (in V)
I is the current intensity (in A)

GRAVITATIONAL POTENTIAL ENERGY

$E_p = mgh$ where E_p is the gravitational potential energy (in J)
m is the mass of the object (in kg)
g is the gravitational field intensity (in N/kg)
h is the height of the object above the reference surface (in m)

HEAT AND THERMAL ENERGY

$Q = \Delta E_t$ where Q is the heat (in J)
ΔE_t is the variation in thermal energy (in J)

$Q = mc\Delta T$ where Q is the heat (in J)
m is the mass (in g)
c is the specific heat capacity (in J/g°C)
ΔT is the temperature variation (in °C)

$\Delta T = T_f - T_i$ where T_f is the final temperature (in °C)
T_i is the initial temperature (in °C)

KINETIC ENERGY

$E_k = \frac{1}{2} mv^2$ where E_k is the kinetic energy of the object (in J)
m is the mass of the object (in kg)
v is the velocity of the object (in m/s)

MECHANICAL ENERGY

$E_m = E_k + E_p$ where E_m is the mechanical energy (in J)
E_k is the kinetic energy (in J)
E_p is the potential energy (in J)

MOLAR MASS

$M = \frac{m}{n}$ where M is the molar mass (in g/mol)
m is the mass (in g)
n is the number of moles (in mol)

OHM'S LAW

$V = RI$ where V is the potential difference (in V)
R is the resistance (in Ω)
I is the current intensity (in A)

POTENTIAL DIFFERENCE

$V = \frac{E}{q}$ where V is the potential difference (in V)
E is the energy transferred (in J)
q is the charge (in C)

PRESSURE

$P = \frac{F}{A}$ where P is the pressure (in Pa)
F is the force perpendicular to the surface (in N)
A is the surface area subjected to the force (in m^2)

WEIGHT AND GRAVITATIONAL FORCE

$w = F_g = mg$ where w is the weight (in N)
F_g is the gravitational force (in N)
m is the mass (in kg)
g is the gravitational field intensity (in N/kg)

WORK

$W = \Delta E$ where W is the work (in J)
ΔE is the variation in energy in an object or a system (in J)

$W = F_{//}d$ where W is the work (in J)
$F_{//}$ is the force or the force component parallel to the direction of travel (in N)
d is the distance travelled by the object (in m)

THE LIVING WORLD

POPULATION DENSITY

$$\text{Population density} = \frac{\text{Number of individuals}}{\text{Space (area or volume) occupied}}$$

POPULATION SIZE, ESTIMATED USING SAMPLE AREAS

$$\text{Population size} = \frac{\text{Average number of individuals per section} \times \text{Total study area}}{\text{Area of a section}}$$

POPULATION SIZE, ESTIMATED USING THE MARK-RECAPTURE METHOD

$$\text{Population size} = \frac{\text{Number of marked animals} \times \text{Total number of animals captured the second time}}{\text{Number of marked animals recaptured}}$$