Unit Conversions

Physical Quantity		Base unit	Symbol
length	l	meter	m
mass	m	kilogram	kg
time	t	second	s
electric current	I	ampere	A
thermodynamic temperature	T	kelvin	K
amount of substance	n	mole	mol
luminous intensity	I_v	candela	cd

7 - SI base units.

d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}
z	zepto	10^{-21}
y	yocto	10^{-24}

da	deca	10
h	hecto	10^{2}
k	kilo	10^{3}
M	mega	10^{6}
G	giga	10^{9}
T	tera	10^{12}
P	peta	10^{15}
E	exa	10^{18}
Z	Zeta	10^{21}
Y	Yotta	10^{24}

$1 A^{\circ} = 10^{-10}$ m

1 tonne = 1 t = 10^3 kg

1 bar = 10^5 Pa

1 atm = 101.325 kPa

1 eV = $1.60217653 \times 10^{-19}$ J

= 96.485 kJ mol^{-1}.

minute	min	1 min	= 60 s
hour	h	1 h	= 3600 s
day	d	1 d	= 86400 s
year	a	1 a	= 31556952 s

Force — $kg\ m\ s^{-2}$ ⇒ N - newton

Pressure — $kg \cdot m^{-1}\ s^{-2}$, $N\ m^{-2}$ ⇒ Pa - pascal

Energy — $kg \cdot m^2\ s^{-2}$, $N\ m$, $Pa\ m^3$ ⇒ J - joule

Power — $kg \cdot m^2\ s^{-3}$, $J\ s^{-1}$ ⇒ W - watt.

$s = \frac{d}{t}$	average speed = $\frac{\text{total distance travelled}}{\text{total time taken}}$
$a = \frac{v-u}{t}$	acceleration = $\frac{\text{final velocity - initial}}{\text{time taken}}$
$F = m \times a$.	force = mass x acceleration
$P = \frac{W}{t}$	power = $\frac{\text{work done}}{\text{time taken}}$
$W = mg$.	weight = mass x acceleration due to gravity
$P = \frac{F}{A}$	pressure = $\frac{\text{force}}{\text{area}}$
$E = \frac{1}{2} mv^2$	K.E. = $\frac{1}{2}$ x mass x velocity^2
$V = IR$	voltage = electric current x resistance
$f = \frac{v}{\lambda}$	frequency = $\frac{\text{velocity}}{\text{wavelength}}$

Conversion in spectroscopy / atomic structure-

① Energy - (E)

$$E = h\nu = \frac{hc}{\lambda}$$

$$\boxed{\text{Joule} = h \cdot sec^{-1} = hc \cdot cm^{-1}}$$

② Moment of Inertia - (I)

$$I = \mu r^2 \Rightarrow \boxed{kg \cdot m^2}$$

for microscopic quantities like molecules / atoms masses are expressed in terms of gram mol^{-1}.

ex. H_2 - $m_H = 1\ g \cdot mol^{-1}$!

$$\therefore \mu = x \cdot gm \cdot mol^{-1}$$

$$= \frac{x \times 10^{-3}}{6.023 \times 10^{23}}\ kg.$$

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$$\boxed{\mu = x \times 1.67 \times 10^{-27}\ kg.}$$

$$kg \cdot m^2 = \frac{kg\, m^2 \cdot sec^2}{sec^2} = J\ sec^2$$

$$\boxed{kg\ m^2 = J\ sec^2}$$

③ Force constant - (k)

Hooke's law $\Rightarrow$ $f \propto x$

$f = -kx$

$$k = \frac{\text{force}}{\text{distance}} \Rightarrow \frac{N}{m} \Rightarrow \boxed{Nm^{-1}}$$

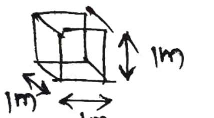
$$\text{force} = \text{mass} \times \text{acceleration} = m.\frac{dv}{dt} = m.\frac{d^2x}{dt^2}$$
$$= kg\ m.s^{-2}$$

$$\therefore \text{force constant} = \frac{\text{force}}{\text{distance}} = \frac{kg.m\,s^{-2}}{m} \Rightarrow kg\,s^{-2}$$

$$\boxed{N\,m^{-1} = kg\,s^{-2}}$$

Conversion in thermodynamics / kinetic theory of gases.

① Volume - (V)



$$1m.\,1m.\,1m = 1000\,L$$
$$1m^3 = 1000\,L$$
$$\boxed{1m^3 = 10^3\,L}$$

$1m = 100\ cm.$

$$1m \times 1m \times 1m = 1000\,L$$
$$100\,cm \times 100\,cm \times 100\,cm = 1000\,L$$
$$10^6\,cm^3 = 1000\,L$$
$$\boxed{1L = 10^3\,cm^3}$$

$1m = 10\ dm$

$$1m \times 1m \times 1m = 1000\,L$$
$$10\,dm \times 10\,dm \times 10\,dm = 1000\,L$$
$$10^3\,dm^3 = 10^3\,L$$
$$\boxed{1\,dm^3 = 1L}$$

$$m^3 > L = dm^3 > cm^3$$

② Pressure - (P)

$P = \frac{F}{A} = \frac{N}{m^2} \Rightarrow \boxed{N m^{-2}} \rightarrow$ (Pa) (pascal)

$\boxed{1 \text{ atm} = 101325 \text{ Pa}} \rightarrow \boxed{1 \text{ atm} = 101.325 \times 10^3 \text{ Pa}}$

↓

$\boxed{1 \text{ atm} = 101.325 \text{ kPa}}$

$\boxed{1 \text{ atm} = 0.101325 \times 10^6 \text{ Pa}} \rightarrow \boxed{1 \text{ atm} = 0.101325 \text{ MPa}}$

$\boxed{1 \text{ atm} = 1.01325 \times 10^5 \text{ Pa}} \rightarrow \boxed{1 \text{ atm} = 1.01325 \text{ bar}}$

$\boxed{10^5 \text{ Pa} = 1 \text{ bar}}$ ***

$\boxed{1 \text{ atm} = 760 \text{ torr}}$

$\boxed{1 \text{ bar} = 750 \text{ torr}}$

$\boxed{1 \text{ torr} \equiv 1 \text{ mm of Hg}}$

$\boxed{1 \text{ torr} = 133.32 \text{ Pa}}$

③ Energy - (E)

gas constant.

↳ $\boxed{R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}}$

$\boxed{R = 0.0821 \text{ L atm K}^{-1} \text{mol}^{-1}}$

$1 \text{ atm} = 1.01325 \text{ bar}$

$R = 0.0821 \times 1.01325 \text{ L bar K}^{-1} \text{mol}^{-1}$

$\boxed{R = 0.08314 \text{ L bar K}^{-1} \text{ mol}^{-1}}$

$1 \text{ bar} = 10^5 \text{ Pa}$

$\boxed{R = 2 \text{ cal K}^{-1} \text{mol}^{-1}}$

$R = 0.08314 \times 10^5 \text{ Pa . L K}^{-1} \text{ mol}^{-1}$

$R = 8.314 \times 10^3 \text{ Pa L . K}^{-1} \text{ mol}^{-1}$

$\boxed{R = 8.314 \text{ kPa L K}^{-1} \text{ mol}^{-1}}$

8.314 J	= 0.0821 L atm	= 0.08314 L bar
= 8.314 kPa L	= 2 cal	

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Conversions in mole concept -

conc.

- temp. depedent
  - ↳ volume dependent
    1) % v/v
    2) % w/v
    3) M.
    4) N
- temp independent
  - ↳ mass dependent
    1) % w/w
    2) x
    3) m
    4) ppm

$$\% \, v/v \Rightarrow \frac{V_{solute}}{V_{solution}} \times 100$$

⇒ volume of solute in 100 ml solution

Conversion

- Within a group conversion
  - % v/v ⟶ M
  - x ⟶ m
  - No extra quantity or info required.
- Intergroup conversion
  - % v/v → % w/w
  - M → ppm
  - Extra info. required
    ↳ i.e density of solⁿ

Que. Within a group conversion.

% w/v ⟶ M

20 % w/v NaOH (aq)

⇓

20 gram NaOH present in 100 ml of solution

$\frac{20}{40} = 0.5$ moles

100 ml ≡ 0.5 moles

1000 ml ≡ 5 moles

20 % w/v aq. NaOH ≡ 5 M aq. NaOH.

Que. Intergroup conversion.

M ⟶ m

2 M aq. NaOH solution ($d_{NaOH\ solution} = 1.2$ g/ml)

⇓

2 moles (2×40 = 80 g.) NaOH present in 1000 ml solution

	Solute	Solvent (water)	Solution
mass	80 g.	1120 g.	1200 = 1000×1.2
volume		1120 ml.	1000 ml.
density		1	1.2 g/ml

$$\therefore m = \frac{2 \text{ moles}}{1120 \text{ g.}} \times 1000 = 1.7857 \text{ m.}$$

2 M aq. NaOH ≡ 1.78 m NaOH.