

# University Physics I - Basics (partial)

## §Measurements

Table 1: There are seven fundamental SI units.

symbol	name	measures
m	meter	length
kg	kilogram	mass
s	second	time
K	kelvin	temperature
mol	mole	amount of substance
A	ampere	electric current
cd	candela	luminous intensity

Table 2: Introductory mechanics and waves utilize several derived units.

combination	symbol	measures
rad		angular position
$\text{m}^2$		area
$\text{m}^3$		volume
$\text{m s}^{-1}$		velocity
$\text{rad s}^{-1}$		angular velocity
$\text{m s}^{-2}$		acceleration
$\text{rad s}^{-2}$		angular acceleration
$\text{kg m s}^{-2}$	N	force
$\text{kg m}^2 \text{s}^{-2}$	N m	torque
$\text{kg m}^2 \text{s}^{-2}$	J, N m	energy
$\text{kg m}^2 \text{s}^{-3}$	W, J s <sup>-1</sup>	power
$\text{kg m s}^{-1}$		linear momentum
$\text{kg m}^2 \text{rad s}^{-1}$		angular momentum
$\text{kg m}^{-1} \text{s}^{-2}$	Pa, N m <sup>-2</sup>	pressure
$\text{kg s}^{-2}$	N m <sup>-1</sup>	spring constant
s <sup>-1</sup>	Hz	frequency
$\text{rad s}^{-1}$		angular frequency
$\text{rad m}^{-1}$		angular wavenumber
$\text{m}^{-1}$		linear density
$\text{m}^{-2}$		areal density
$\text{m}^{-3}$		volumetric density

Table 3: Prefixes and their powers make number representations compact and consistent.

name	sym.	power	decimal
yocto	y	10 <sup>-24</sup>	0.000 000 000 000 000 000 000 001
zepto	z	10 <sup>-21</sup>	0.000 000 000 000 000 000 000 001
atto	a	10 <sup>-18</sup>	0.000 000 000 000 000 000 001
femto	f	10 <sup>-15</sup>	0.000 000 000 000 000 001
pico	p	10 <sup>-12</sup>	0.000 000 000 000 001
nano	n	10 <sup>-9</sup>	0.000 000 001
micro	μ	10 <sup>-6</sup>	0.000 001
milli	m	10 <sup>-3</sup>	0.001
centi	c	10 <sup>-2</sup>	0.01
deci	d	10 <sup>-1</sup>	0.1
		10 <sup>0</sup>	1
deca	da	10 <sup>1</sup>	10
hecto	h	10 <sup>2</sup>	100
kilo	k	10 <sup>3</sup>	1000
mega	M	10 <sup>6</sup>	1 000 000
giga	G	10 <sup>9</sup>	1 000 000 000
tera	T	10 <sup>12</sup>	1 000 000 000 000
peta	P	10 <sup>15</sup>	1 000 000 000 000 000
exa	E	10 <sup>18</sup>	1 000 000 000 000 000 000
zetta	Z	10 <sup>21</sup>	1 000 000 000 000 000 000 000
yotta	Y	10 <sup>24</sup>	1 000 000 000 000 000 000 000 000

§Math

$\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}| \cos \phi_{AB} = A_x B_x + A_y B_y + A_z B_z$

$$\begin{aligned} \vec{A} \times \vec{B} &= |\vec{A}||\vec{B}| \sin \phi_{AB} \hat{n} \\ &= (A_y B_z - A_z B_y) \hat{x} \\ &\quad - (A_x B_z - A_z B_x) \hat{y} \\ &\quad + (A_x B_y - A_y B_x) \hat{z} \end{aligned}$$

The cross product can be represented as a determinant

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

If  $ax^2 + bx + c = 0$ ,  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$$\frac{dx^m}{dx} = mx^{m-1}$$

$$\int x^m dx = \frac{x^{m+1}}{m+1} + C$$

§Concept symbols

- $A$  wave amplitude, area
- $\vec{a}$  acceleration
- $c$  speed of light
- $D$  distance, diameter
- $d$  distance, diameter, depth, differential (e.g.  $dx$ )
- $E$  energy
- $\vec{F}$  force
- $f$  (linear) frequency, factor
- $G$  gravitational constant
- $g$  acceleration due to gravity
- $H$  height
- $h$  height
- $I$  moment of inertia
- $i$  index counter
- $\hat{i}$  unit vector for  $x$
- $\vec{J}$  impulse
- $j$  index counter
- $\hat{j}$  unit vector for  $y$
- $K$  kinetic energy
- $k$  spring constant, restoring force constant, angular wavenumber, index counter
- $\hat{k}$  unit vector for  $z$
- $L$  length
- $\vec{L}$  angular momentum, length
- $l$  length
- $\ell$  length
- $M$  mass
- $m$  mass
- $\vec{N}$  normal force
- $n$  antinode number
- $\vec{n}$  unit normal
- $P$  power
- $p$  pressure
- $\vec{p}$  linear momentum
- $q$  generic variable
- $\vec{q}$  generic multi-variable
- $R$  radius
- $r$  radius, radial position
- $\vec{r}$  position
- $s$  arc length
- $\vec{s}$  displacement
- $T$  period
- $\vec{T}$  tension
- $t$  time

- $U$  potential energy
- $V$  volume
- $\vec{v}$  velocity
- $W$  work
- $w$  weight, width
- $x$  position coordinate 1
- $y$  position coordinate 2
- $z$  position coordinate 3
- $\alpha$  angular acceleration, generic angle
- $\beta$  generic angle
- $\Delta$  coarse change (e.g.  $\Delta x$ )
- $\delta$  uncertainty, small change
- $\epsilon$  strain, small value
- $\theta$  generic angle
- $\kappa$  restoring torque constant
- $\lambda$  wavelength, linear mass density
- $\mu$  coefficient of friction, linear mass density
- $\rho$  volumetric mass density
- $\sigma$  areal mass density
- $\vec{\tau}$  torque
- $\phi$  phase angle, generic angle
- $\omega$  angular frequency
- $\vec{\Omega}$  precession velocity
- $\vec{\omega}$  angular velocity