Chapter 1: Units, Physical Quantities & Vectors

Example 1.1 (Convert units via multiplication of unit multiples)

Express 763.0 mi/h into miles per second $\left(\frac{m}{s}\right)$

Given 1 mi = 1.609 km, 1 km = 1000 m, 1 h = 3600 s

$$\left(763.0 \frac{\text{mi}}{\text{h}}\right)\left(\frac{1.609\ \text{km}}{1\ \text{mi}}\right)\left(\frac{1000\ \text{m}}{1\ \text{km}}\right)\left(\frac{1\ \text{h}}{3600\ \text{s}}\right)$$

$$= \frac{(763.0)(1609\ \text{m})}{3609\ \text{s}}$$

$$= 341.0\ \text{m/s}.$$

Example 1.2 - Converting volume units

Given 1 in. = 2.540 cm, and hence $1\ \text{in}^3 = 2.54\ \text{cm}^3$,

What is the volume of 1.84 cubic inches in cm^3 and m^3?

[in cm^3]

$$1.84\ \text{in.}^3 = (1.84\ \text{in.}^3)\left(\frac{2.54\ \text{cm}}{1\ \text{in.}}\right)^3$$

$$= (1.84)(2.54)^3\ \text{cm}^3$$

$$= 30.2\ \text{cm}^3$$

[in m^3]

$$30.2\ \text{cm}^3 = (30.2\ \text{cm}^3)\left(\frac{1\ \text{m}^3}{100\ \text{cm}^3}\right) = \frac{30.2\ \text{m}^3}{100}$$

$$= 30.2 \times 10^{-2}\ \text{m}^3 = 3.02 \times 10^{-5}\ \text{m}^3$$

Example 1.3 Sig. fig in multiplication

Given $m = 9.11 \times 10^{-31}$ kg, and c = speed of light in vaccum,

find $E = mc^2$

$= 2.99792458 \times 10^8$ m/s

$E = (9.11 \times 10^{-31}\text{kg})(2.99792458 \times 10^8\ \text{m/s})^2$

$= (9.11)(2.99792458)^2(10^{-31})(10^8)^2\ \text{kg}\cdot\text{m}^2/\text{s}^2$

$= (9.11)(2.\ldots)^2(10^{-31+16})\ \text{kg}\cdot\text{m}^2/\text{s}^2$

$= (81.8765968)(10^{-15})\ \text{kg}\cdot\text{m}^2/\text{s}^2$

$= (8.18765967)(10^{-14})\ \text{kg}\cdot\text{m}^2/\text{s}^2$

$= 8.19 \times 10^{-14}\ \text{kg}\cdot\text{m}^2/\text{s}^2$

$= 8.19 \times 10^{-14}$ J

=

Test your understanding 1.5.

Mass = 1.80 kg. Volume = $6.0 \times 10^{-4} m^3$

$$\text{Density} = \frac{1.80\ kg}{6.0 \times 10^{-4} m^3}$$

$$= \left(\frac{1.80}{6.0 \times 10^{-4}}\right)\left(\frac{kg}{m^3}\right)$$

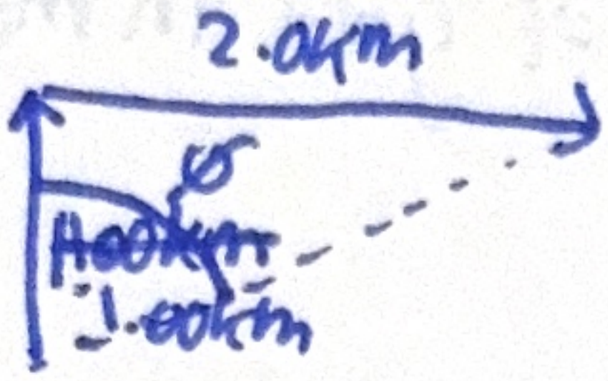
$$= (0.3)\left(\frac{1}{10^{-4}}\right)\left(\frac{kg}{m^3}\right)$$

$$= (0.3 \times 10^4)\left(\frac{kg}{m^3}\right)$$

$$= (3.0 \times 10^3)\left(\frac{kg}{m^3}\right)$$

$$= 3.0 \times 10^3\ kg/m^3$$

Example 1.5 - Adding 2 right angle vectors



Distance from starting point $= \sqrt{(1.00km)^2 + (2.00km)^2}$

$= \sqrt{5.00km^2}$

$= 2.24\,km.$

Direction

$\tan\phi = \frac{opp}{adj}$

$\tan\phi = \frac{2.00km}{1.00km}$

$\phi = \tan^{-1}\left(\frac{2}{1}\right)\left(\frac{km}{km}\right)$

$= \tan^{-1} 2.00$

$= 63.4^\circ$ (East of North)

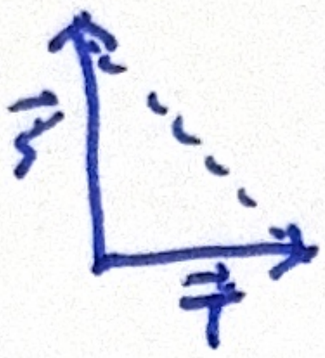
Test your understanding of Section 1.7

~~[illegible]~~ $\vec{S}$ and $\vec{T}$ has: $S = 3m$, $T = 4m$

what is the magnitude of $\vec{S} - \vec{T}$?

Depends. If $\vec{S} - \vec{T}$ ~~[illegible]~~ perpendicular

~~Hi[illegible]~~



then, $\vec{S} - \vec{T} = \sqrt{(3m^2) + (4m)^2}$

$= \sqrt{25}$

$= 5m$

$=$

If $\vec{S} - \vec{T}$ parallel, then magnitude

$= 3m + 4m$

$= 7m.$

If $\vec{S} - \vec{T}$ anti-parallel, then magnitude

$= 3m - 4m$

$= -1m$

$= 1m$ (magnitude has no negative)

$=$

Hence, 5m, 7m, or 1m.