Solutions to Problems Sets of Chapter 1

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Q17] km/h $\rightarrow$ mi/h

Note : 1km = 1000 m , 0.621 mi = 1 km , 1h = 3600 s

conversion factor from $\frac{km}{h}$ to $\frac{mi}{h}$

$$1\,\frac{km}{h} = 1\,\frac{km}{h} \times \underbrace{\left(\frac{0.621\ mi}{km}\right)}_{=1} = 0.621\,\frac{mi}{h}$$

$$\therefore\quad 1\,\frac{km}{h} = 0.621\,\frac{mi}{h} \Rightarrow 1 = \frac{0.621\ mi/h}{km/h}$$

For example what is $40 \frac{km}{h}$ in $\frac{mi}{h}$?

$$40 \frac{km}{h} = 40 \frac{km}{h} \times \frac{0.621 \frac{mi}{h}}{\frac{km}{h}} = 40 \times 0.621 \frac{mi}{h}$$

$$= 24.84 \frac{mi}{h}$$

$\frac{m}{s}$ and $\frac{ft}{s}$

$$1 \frac{m}{s} = 1 \frac{m}{s} \times \left(\frac{3.28\ ft}{m} \right) = 3.28 \frac{ft}{s}$$

$$\therefore \quad 1 = \frac{3.28 (ft/s)}{(m/s)}$$

$\frac{km}{h}$ and $\frac{m}{s}$

$$1 \frac{km}{h} = 1 \frac{km}{h} \times \left(\frac{1000\ m}{km} \right) \times \left(\frac{h}{3600 s} \right)$$

$$1 \frac{km}{h} = \frac{5}{18} \frac{m}{s} \Rightarrow 1 = \frac{5}{18} \frac{(m/s)}{(km/h)}$$

For example, what is $20 \frac{km}{h}$ in m/s

$$20 \frac{km}{h} \times \frac{5}{18} = 5 \frac{(m/s)}{(km/h)}$$

Q21] $1\,year = 1 \times 365 \times 24 \times 60 \times 60 = 3.16 \times 10^{7}\,s.$

$$1\,y = 3.16 \times 10^{7}\,s \Rightarrow 1 = \underbrace{\frac{3.16 \times 10^{7}\,s}{y}}_{\text{conversion factor}}$$

nano $\equiv 10^{-9}$

$$1\,ns = 10^{-9}\,s \Rightarrow 1 = \left(\frac{10^{-9}\,s}{ns}\right)$$

$$1y = 1y\left(\frac{3.16 \times 10^{7}\,s}{y}\right) \times \left(\frac{ns}{10^{-9}\,s}\right) = 3.16 \times 10^{16}\,ns$$

o number of the years second.

$$1s = 1s \times \left(\frac{1y}{3.16 \times 10^{7}\,s}\right) = 31.65 \times 10^{-9}\,y$$

$$\therefore\ 1 = \frac{31.65 \times 10^{-9}\,y}{s}$$

Q33] density $\rho = \frac{mass}{volume}$

dimensions of density are $\left[\frac{M}{L^{3}}\right]$.

Q34] $v = At^3 - Bt$ where t is time

The equation must be dimensionally correct

v has dimensions of L/T.

$$\left[\frac{L}{T}\right] = \left[A\,T^3\right] - \left[B\,T\right]$$

$[A\,T^3]$ must have dimensions of $\frac{L}{T}$

$[B\,T]$ Must have dimensions of $\frac{L}{T}$.

$[A\,T^3] \equiv \left[\frac{L}{T}\right] \Rightarrow$ dimensions of A must be $\frac{L}{T^3}$.

$[BT] = \left[\frac{L}{T}\right] \Rightarrow [B] = \frac{L}{T^2}$.

Q48] Angstrom $= 10^{-10}$ m

$$1\,\text{Å} = 10^{-10}\,\text{m} \Rightarrow 1 = \underbrace{\frac{10^{-10}\,\text{m}}{\text{Å}}}_{\text{conversion factor}}$$

$$1\,\text{Å} = 1\,\text{Å} \times \left(\frac{10^{-10}\,\text{m}}{\text{Å}}\right) \times \left(\frac{10^{9}\,\text{nm}}{\text{m}}\right)$$

$$1\,\text{Å} = 10^{-1}\,\text{nm} \Rightarrow 1 = \frac{10^{-1}\,\text{nm}}{\text{Å}} \Rightarrow 1 = \frac{0.1\,\text{nm}}{\text{Å}}$$