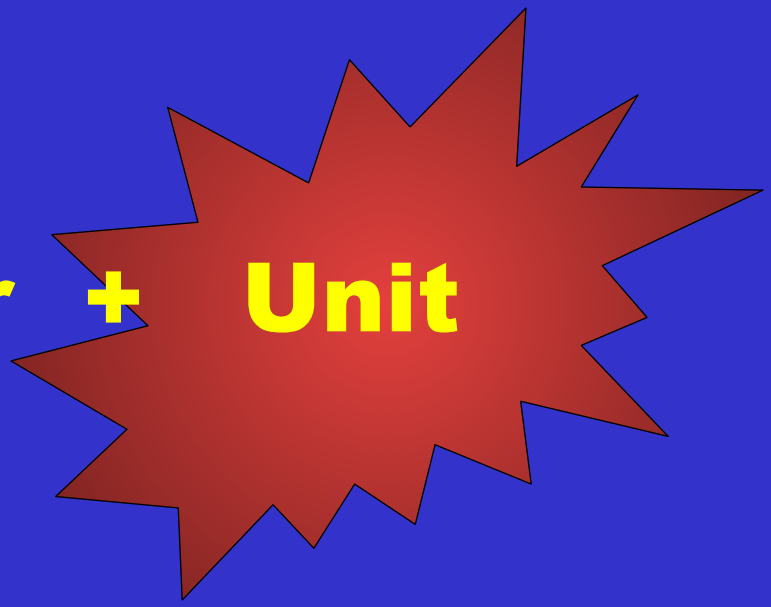
Conversion Factors and Unit Cancellation

A physical quantity must include:



Calculation Corner: Unit Conversion

1 foot = 12 inches

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$$\frac{\text{1 foot}}{\text{12 inches}} = 1$$

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Calculation Corner: Unit Conversion

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“Conversion factors”

Calculation Corner: Unit Conversion

$$\frac{1 \text{ foot}}{12 \text{ inches}} \qquad \frac{12 \text{ inches}}{1 \text{ foot}}$$

"Conversion factors"

$$\left(3 \text{ feet}\right)\left(\frac{12 \text{ inches}}{1 \text{ foot}}\right) = 36 \text{ inches}$$

How many cm are in 1.32 meters?

equality: 1 m = 100 cm (or 0.01 m = 1 cm)

applicable conversion factors:

$$\frac{1\ \text{m}}{100\ \text{cm}} \quad \text{or} \quad \frac{100\ \text{cm}}{1\ \text{m}}$$

$$X\ \text{cm} = 1.32\ \cancel{\text{m}} \left(\frac{100\ \text{cm}}{1\ \cancel{\text{m}}} \right) = 132\ \text{cm}$$

We use the idea of **unit cancellation** to decide upon which one of the two conversion factors we choose.

How many meters is 8.72 cm?

equality: 1 m = 100 cm

applicable conversion factors:

$$\frac{1\text{ m}}{100\text{ cm}} \quad \text{or} \quad \frac{100\text{ cm}}{1\text{ m}}$$

$$X\text{ m} = 8.72\text{ cm}\left(\frac{1\text{ m}}{100\text{ cm}}\right) = 0.0872\text{ m}$$

Again, the units must cancel.

How many feet is 39.37 inches?

equality: 1 ft = 12 in

applicable conversion factors:

$$\frac{1\text{ ft}}{12\text{ in}} \quad \text{or} \quad \frac{12\text{ in}}{1\text{ ft}}$$

$$X\text{ ft} = 39.37\text{ in} \left(\frac{1\text{ ft}}{12\text{ in}}\right) = \boxed{3.28\text{ ft}}$$

Again, the units must cancel.

How many kilometers is 15,000 decimeters?

$$X \text{ km} = 15{,}000 \text{ dm} \left(\frac{1 \text{ m}}{10 \text{ dm}}\right)\left(\frac{1 \text{ km}}{1{,}000 \text{ m}}\right) = \boxed{1.5 \text{ km}}$$

How many seconds is 4.38 days?

$$X\ s = 4.38\ \cancel{d}\left(\frac{24\ h}{1\ \cancel{d}}\right)\left(\frac{60\ \cancel{min}}{1\ \cancel{h}}\right)\left(\frac{60\ s}{1\ \cancel{min}}\right)$$

$$= \boxed{378{,}432\ s}$$

If we are accounting for significant figures, we would change this to…

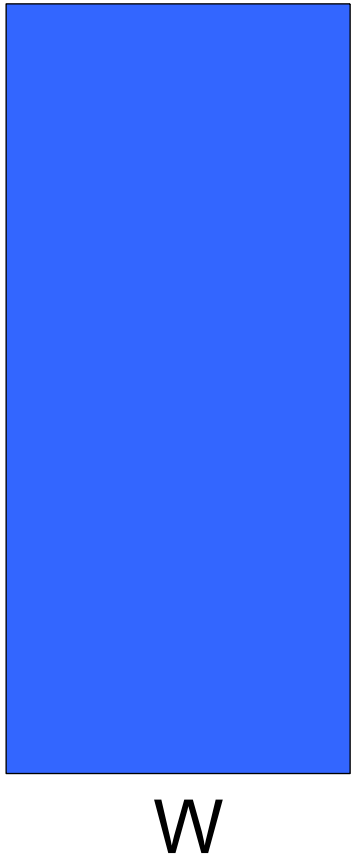
$$\boxed{3.78 \times 10^5\ s}$$

Simple Math with Conversion Factors

Example Problem

Measured dimensions of a rectangle:

length (L) = 9.70 cm
width (W) = 4.25 cm



Find area of rectangle.

$$A = L \cdot W$$

$$= (9.70\ \text{cm})(4.25\ \text{cm})$$

$$= 41.2\ \text{cm}^2 \cdot \text{cm}$$

Convert 41.2 cm^2 to m^2.

$$X\ m^2 = 41.2\ cm^2 \left(\frac{1\ m}{100\ cm}\right) = 0.412\ m^2$$ WRONG!

$$= 0.412\ cm \cdot m$$

Recall that…$41.2\ cm^2 = 41.2\ cm \cdot cm$

$$X\ m^2 = 41.2\ \cancel{cm \cdot cm} \left(\frac{1\ m}{100\ \cancel{cm}}\right)\left(\frac{1\ m}{100\ \cancel{cm}}\right)$$

$$= \boxed{0.00412\ m^2}$$

$$X\ m^2 = 41.2\ cm^2 \left(\frac{1\ m}{100\ cm}\right)^2 = \boxed{0.00412\ m^2}$$

Convert 41.2 cm^2 to mm^2.

Recall that…41.2 cm^2 = 41.2 cm·cm

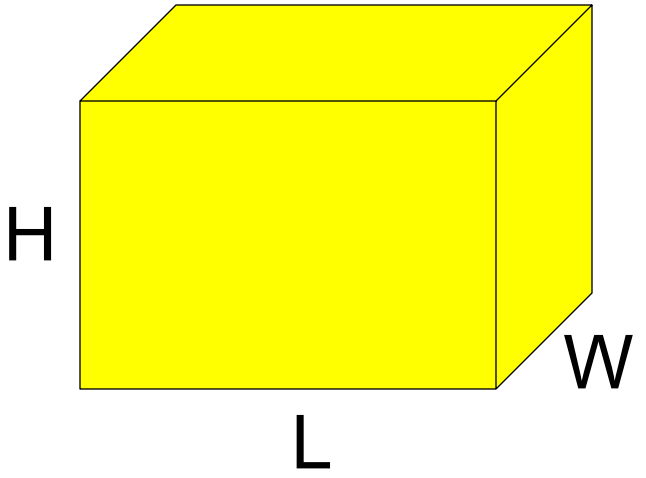
$$X\ mm^2 = 41.2\ \cancel{cm}\cdot\cancel{cm}\left(\frac{10\ mm}{1\ \cancel{cm}}\right)\left(\frac{10\ mm}{1\ \cancel{cm}}\right)$$

$$= \boxed{4{,}120\ mm^2}$$

$$X\ mm^2 = 41.2\ cm^2\left(\frac{10\ mm}{1\ cm}\right)^2 = \boxed{4{,}120\ mm^2}$$

Measured dimensions of a rectangular solid:

Length = 15.2 cm
Width = 3.7 cm
Height = 8.6 cm



Find volume of solid.

$$V = L \cdot W \cdot H$$

$$= (15.2\text{ cm})(3.7\text{ cm})(8.6\text{ cm})$$

$$= 480\ \text{cm}^3$$

Convert to m^3.

$$X\ m^3 = 480\ cm^3 \left(\frac{1\ m}{100\ cm}\right)\left(\frac{1\ m}{100\ cm}\right)\left(\frac{1\ m}{100\ cm}\right) =$$

or

$$X\ m^3 = 480\ cm^3 \left(\frac{1\ m}{100\ cm}\right)^3 = \boxed{0.000480\ m^3}$$

or

$$X\ m^3 = 480\ cm^3 \left(\frac{1\ m^3}{1000000\ cm^3}\right) = \boxed{4.80 \times 10^{-4}\ m^3}$$

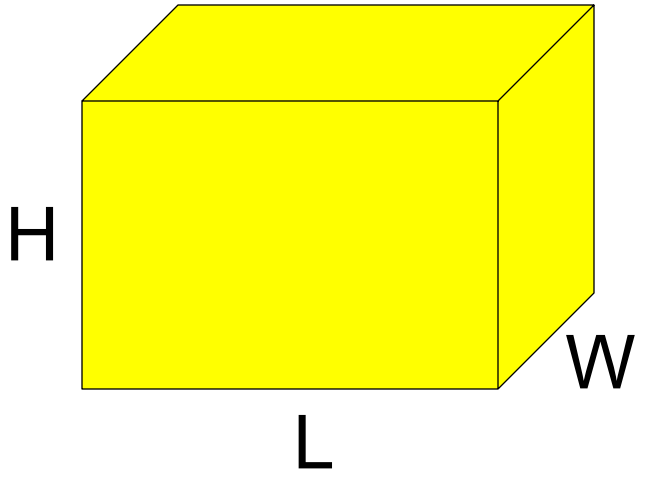
Convert to m^3...

Measured dimensions of a rectangular solid:

Length = 15.2 cm → 0.152 m

Width = 3.7 cm → 0.037 m

Height = 8.6 cm → 0.086 m



Find volume of solid.

$$V = L \cdot W \cdot H$$

$$= (0.152\ m)(0.037\ m)(0.086\ m)$$

$$= 0.000480\ m^3$$

Convert to mm^3.

By what factor do mm and cm differ?

1 cm = 10 mm 10

By what factor do mm^2 and cm^2 differ?

$(1\ cm)^2 = (10\ mm)^2$ 100

By what factor do mm^3 and cm^3 differ?

$(1\ cm)^3 = (10\ mm)^3$ 1,000