Units and Units conversions

In practice, we have to work with several different units to describe the same measured quantity. MatDeck can use Europe system of units SI (International System of Units) , USCS (United States Customary System) for USA or Imperial System for UK.

Quite often design calculations are first done in SI and then go to stores in USCS or vice versa and then you have to purchase the parts in a different system. In that case we have to know how to convert between the unit systems.

MatDeck supports both SI (International System of Units) and USCS (United States Customary System) system of units.

Lets show some base units

Quantity	Unit
Length	meter, m
Time	second, s
Temperature	kelvin, K
Mass	kilogram, kg
Light intensity	candela, cd
Electric current	ampere, A
Amount of substance	mole, mol

SI base units

In USCS, the base unit for length is foot (ft), the pound-mass (lb) for weight and second for time. Multiple units are multiples or fractions of the base units. Lets show some prefixes for multiple units in SI.

Multiple	Fraction
kilo (k) 10^3	centi (c) 10^{-2}
mega (M) 10^6	mili (m) 10^{-3}
giga (G) 10^9	micro (μ) 10^{-6}
tera (T) 10^{12}	nano (n) 10^{-9}
peta (P) 10^{15}	piko (p) 10^{-12}

Multiples or fractions of units

Derived units are units of measure derived from base units. They can be expressed in terms of base units by means of mathematical symbols of multiplication and division.

Unit Conversion

Unit conversion can be defined in terms of ratio, as the equivalence between two expressions of the same quantity but different units. Another name for this ratio is conversion factors and we use them to convert units from one to another. Unit conversion does not change the number of significant figures, the number remains the same after unit conversion.

Converting grams to kilograms will look like this

$$217\ \text{g} \cdot \left(\frac{1\ \text{kg}}{1000\ \text{g}}\right) = 0.217\ \text{kg}$$

When we talk about the conversion of units that are raised to a power, it will look like this (we defined centimeter first):

$$\text{cm} := \frac{\text{m}}{100}$$

$$41 \cdot \text{in}^2 \cdot \left(\frac{2.54 \cdot \text{cm}}{1\ \text{in}}\right)^2 = 0.026\ \text{m}^2$$

One of the interesting conversions is pressure conversion. Pressure is defined as force per unit area. There are two types of pressure, gauge and absolute pressure - pressure relative to a vacuum. Gauge pressure and absolute pressure are related through atmospheric pressure, with the formula:

$$P_{gauge} := P_{absoute} - P_{atmosphere}$$

Atmospheric pressure depends on the elevation and weather conditions, so it's not a constant but it has been defined as being a typical pressure at sea level.

$$1\ \text{atm} = 101325\ \text{Pa}$$

The density of liquid varies with temperature, so often the temperature of the fluid is given with the unit conversion when we talk about pressure. For example 1 atm = 33.9 ft H_2O at 4 °C.

Lets convert 3.4 inches of water at 4 °C (gauge) to Pa (gauge).

$$3.4 \cdot \text{in} \cdot \left(\frac{1\ \text{ft}}{12\ \text{in}}\right) \cdot \left(\frac{101325\ \text{Pa}}{33.9\ \text{ft}}\right) = 846.866\ \text{Pa}$$

It means that 3.4 inches of water at 4 °C is 847 Pa (gauge) approximately.

Lets now convert 520 mm Hg at 0 °C (absolute) to Pa (absolute).

$$775\ \text{mm} \cdot \text{Hg} \cdot \left(\frac{101325\ \text{Pa}}{760\ \text{mm} \cdot \text{Hg}}\right) = 103324.836\ \text{Pa}$$

Which is 103325 Pa (absolute).

Now we will show how to convert from the gauge pressure to absolute pressure. Lets convert 23 inches of water at 4 °C (gauge) to Pa (absolute).
First we will convert to the common unit, Pa in our case.

$$23 \cdot \text{in} \cdot \left(\frac{1\ \text{ft}}{12 \cdot \text{in}}\right) \cdot \left(\frac{101325\ \text{Pa}}{33.9\ \text{ft}}\right) = 5728.798\ \text{Pa}$$

Now we have 5729 Pa, so we will convert from gauge to absolute. From the formula below

$$P_{gauge} := P_{absoute} - P_{atmosphere}$$

We have

$$5729\ \text{Pa} + 101325\ \text{Pa} = 107054\ \text{Pa}$$

(gauge) (atmosphere) (absolute)