## molarity

$$M = \frac{n_{substance}}{V_{solution}} \quad \text{or} \quad M = \frac{m_{substance}}{m_{Msubstance} V_{solution}}$$

## normality

$$N = Eq_{substance} / V_{solution}$$

## molality

$$m = \frac{n_{substance}}{m_{solvent}} \quad \text{or} \quad m = \frac{m_{substance}}{m_{Msubstance} m_{solvent}}$$

## % w/w

$$c_{\% w/w} = \frac{m_{substance}}{m_{solution}} \cdot 100\% \quad \text{or}$$

$$c_{\% w/w} = \frac{m_{substance}}{m_{substance} + m_{solvent}} \cdot 100\%$$

## ppm, ppb, ppt

$$ppm = \frac{m_{substance}}{m_{solution}} \cdot 10^6 \quad ppb - 10^9, \, ppt - 10^3$$

## molar fraction

$$x = \frac{n_{substance}}{\sum n_i} \quad \text{sum all substances present}$$

## dilution and mixing

$$M_1 V_1 + M_2 V_2 + \ldots = M_F V_F \quad \text{F for final}$$

## other equations

$$n_{substance} = m_{substance} / m_{Msubstance}$$

$$m_{solution} = m_{solvent} + m_{substance}$$

$$d = m_{solution} / (1000 \, V) \quad \text{V in L}$$

## symbols used:

M – molarity [mol/L]
N – normality [Eq/L]
m – molality [mol/kg]
Eq – number of equivalents
n – number of moles
$m_{Mx}$ – molar mass of x [g]
V – volume [L]
$m_x$ – mass of x [g]
d – density – [g/mL]

## Concentration and Solution Calculator

**CASC** – program for fast and easy concentration calculations and solution recipes preparation.

| **conversion – to molarity** | **density tables [g/mL]** | | | | |
|---|---|---|---|---|---|

**conversion – to molarity**

% w/w to molarity

$$M = \frac{10\ c_{\%w/w}\ d}{m_{Msubstance}}$$

molality to molarity

$$M = \frac{1000\ m\ d}{1000 + m\ m_{Msubstance}}$$

molar fraction to molarity

$$M = \frac{1000\ d}{m_{Msubstance} + \frac{(1-x)}{x}\ m_{Msolvent}}$$

**conversion – from molarity**

molarity to % w/w

$$c_{\%w/w} = \frac{M\ m_{Msubstance}}{10\ d}$$

molarity to molality

$$m = \frac{1000\ M}{1000\ d - M\ m_{Msubstance}}$$

molarity to molar fraction

$$x = \frac{M\ m_{Msolvent}}{1000\ d + M\ (m_{Msolvent} - m_{Msubstance})}$$

**density tables [g/mL]**

| % w/w | NaOH | H$_2$SO$_4$ | acetic | HCl | NH$_3$ |
|---|---|---|---|---|---|
| 0.0 | 0.9991 | 0.9991 | 0.9982 | 0.9982 | 0.9991 |
| 1.0 | 1.0106 | 1.0054 | 0.9997 | 1.0032 | 0.9956 |
| 2.0 | 1.0219 | 1.0129 | 1.0012 | 1.0082 | 0.9913 |
| 3.0 | 1.0331 | 1.0198 | 1.0026 | 1.0132 | 0.9832 |
| 4.0 | 1.0443 | 1.0266 | 1.0041 | 1.0181 | 0.9792 |
| 5.0 | 1.0554 | 1.0334 | 1.0055 | 1.0230 | 0.9597 |
| 10.0 | 1.1111 | 1.0687 | 1.0126 | 1.0474 | 0.9421 |
| 15.0 | 1.1655 | 1.1048 | 1.0195 | 1.0725 | 0.9256 |
| 20.0 | 1.2219 | 1.1430 | 1.0261 | 1.0980 | 0.8951 |
| 30.0 | 1.3311 | 1.2212 | 1.0383 | 1.1493 | |
| 40.0 | 1.4339 | 1.3070 | 1.0488 | 1.1980 | |
| 50.0 | 1.5290 | 1.3989 | 1.0575 | | |
| 60.0 | | 1.5031 | 1.0642 | | |
| 70.0 | | 1.6150 | 1.0686 | | |
| 80.0 | | 1.7323 | 1.0699 | | |
| 90.0 | | 1.8197 | 1.0660 | | |
| 100.0 | | 1.8305 | 1.0497 | | |