Concentration Units

Quantitative measures:

3 common units —

(1) Percent by mass, %(w/w)

(2) Molarity, $\frac{mol}{L}$ or M

(3) Molality, $\frac{mol}{kg}$ or m

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i) % by mass = $\frac{\text{mass of solute}}{\text{mass of soln}} \times 100$

ex: $\underbrace{8.5\,g\ CaCl_2(s) + 78.2\,g\ H_2O(l)}_{\text{mix}}$

↓

soln

% by mass = $\frac{8.5\,g}{8.5\,g + 78.2\,g} \times 100 = 9.8\%\,(w/w)$

soln = solute + solvent

Q. How many mol of H_2SO_4 in 85.0 g of a 37.1% (w/w) aqueous soln?

37.1% (w/w) → $\frac{37.1\,g\ H_2SO_4}{100\,g\ solution.}$

$85.0\,g\ soln \times \frac{37.1\,g\ H_2SO_4}{100\,g\ soln} \times \frac{1\,mol\ H_2SO_4}{98.09\,g\ H_2SO_4}$

3 s.f. | 3 s.f. | ∞ s.f. | ∞ s.f. | 4 s.f.

$= 0.321\ mol\ H_2SO_4$

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2. Molarity. (Molar conc)

$= \frac{\#\text{mol solute}}{\#\text{L of soln}}$

ex: 0.31 mol HCl in 0.72 L soln

molar conc of HCl = $[HCl] = \frac{0.31\,mol\ HCl}{0.72\,L}$

$\Rightarrow$ [HCl] = 0.43 $\frac{mol}{L}$ HCl

= 0.43 M HCl

$\rightarrow$ conv. factor!! $\frac{0.43\ mol\ HCl}{1\ L}$ ← $\frac{0.120\ mol}{1\ L}$

ex: 3.20 mL of a 0.120 M soln contains 0.054 g of an unknown substance.

Q. What's the molar mass of this substance?

$$\mathcal{M} = \frac{\#g}{\#mol}$$

$$3.20\ \cancel{mL} \left| \frac{1\ \cancel{L}}{1000\ \cancel{mL}} \right| \frac{0.120\ mol}{1\ \cancel{L}} \Big| = 3.84 \times 10^{-4}\ mol$$

$$\mathcal{M} = \frac{0.054\ g}{3.84 \times 10^{-4}\ mol} = 141\ g/mol$$

3. Molality, or molal conc.

$$= \frac{\#mol\ solute}{Kg\ of\ solvent}$$ units: $\frac{mol}{kg}$ or m

%(w/w)	M	m
$\frac{g\ solute}{g\ soln} \times 100$	$\frac{\#mol\ solute}{\#L\ soln}$ Σ changes w/ T	$\frac{\#mol\ solute}{\#Kg\ solvent}$
T-independent	is T-dependent — 1 M soln, say, will change conc as T changes!	T-independent. ***

ex: 950 g H_2O + 25 g solute NaCl.

Q. What's %(w/w) + molal conc?

$$\%(w/w) = \frac{25\ g}{950\ g + 25\ g} \times 100 = 2.6\%\ (w/w)$$

$$\text{Molal conc} = \frac{\#\text{mol NaCl}}{\#\text{kg } H_2O}$$

← ? 25g

0.95kg

$$\frac{25\text{g NaCl} \mid 1\text{ mol NaCl}}{58.44\text{g NaCl}} = 0.427789\ldots \text{ mol NaCl}$$

$$= 0.428 \text{ mol NaCl}$$

↑ Guard digit.

$$\text{molal conc} = \frac{0.428\text{ mol}}{0.95\text{kg}} = 0.45\text{m}$$

Converting conc. units.

%(w/w) ⟷ molarity ($d = m/V$)

molal conc

masses.

volume.

ex: convert 5.42M $NaHCO_3$(aq) w/ a $d = 1.19\text{g/mL}$ to molal conc!

MON↑

WED↓