## Molarity

- A method of expressing the concentration of a solution

$$
\begin{aligned}
\text { Molarity } & =\frac{\text { moles of solute }}{\text { volume }\left(L \text { or } \mathrm{dm}^{3}\right) \text { of solution }} \\
C & =\frac{n}{V} \\
C & =\text { concentration (molarity) } \\
n & =\text { number of moles } \\
V & =\text { volume }\left(L \text { or } d m^{3}\right)
\end{aligned}
$$

Example: Determine the molarity of a solution that contains 25.0 $g$ of sodium hydroxide in 300.0 mL of solution.

$$
\begin{aligned}
& \mathrm{mol}=\frac{\text { mass }}{\text { molar mass }}=\frac{25.0 \mathrm{~g} \mathrm{NaOH}}{39.99711 \mathrm{~g} / \mathrm{mol}}=0.625 \mathrm{~mol} \\
& C=\frac{n}{V}-=\frac{0.625 \mathrm{~mol}}{0.3000 \mathrm{~L}}=2.08 \mathrm{~mol} / \mathrm{L}
\end{aligned}
$$

## Dilutions

The concentration of a solution is always decreased by the addition of more solvent (water).

Moles of solute before $=$ Moles of solute after

$$
\begin{aligned}
N_{1} & =N_{2} \\
C_{1} V_{1} & =C_{2} V_{2}
\end{aligned}
$$

Example: How would you prepare 2.00 L of 0.100 M hydrochloric acid solution if the only solution you have available is 12.0 M hydrochloric acid?

## Solution:

$$
\begin{aligned}
& C_{1}=0.100 \mathrm{~mol} / \mathrm{L} \\
& \mathrm{~V}_{1}=2.00 \mathrm{~L} \\
& C_{2}=12.0 \mathrm{~mol} / \mathrm{L} \\
& V_{2}=? \\
& C_{1} V_{1}=C_{2} V_{2} \\
& V_{2}=\frac{C_{1} V_{1}}{C_{2}}=\frac{(0.100 \mathrm{~mol} / \mathrm{L})(2.00 \mathrm{~L})}{12.0 \mathrm{~mol} / \mathrm{L}}=0.0167 \mathrm{~L} \text { or } 16.7 \mathrm{~mL}
\end{aligned}
$$

You would prepare the solution by dissolving 16.7 mL of 12.0 M HCl in enough water to make 2.00 L of solution.

## Mixing Solutions

When two solutions are mixed, the concentration of the resulting solution is a value between the concentrations of the two original solutions.

$$
\begin{aligned}
& C=\frac{n}{V} \\
& C=\frac{\text { total moles }}{\text { total volume }} \\
& C_{a b}=\frac{C_{a} V_{a}+C_{b} V_{b}}{V_{a}+V_{b}}
\end{aligned}
$$

## Mixing Solutions

Example: Determine the concentration of the solution that results when 200.0 mL of $0.100 \mathrm{~mol} / \mathrm{L}$ sodium hydroxide is mixed with 700.0 mL of $3.00 \mathrm{~mol} / \mathrm{L}$ sodium hydroxide.

Solution:
Solution A

$$
\begin{aligned}
& C_{a}=0.100 \mathrm{~mol} / \mathrm{L} \\
& V_{a}=0.2000 \mathrm{~L}
\end{aligned}
$$

Moles of $A$
$=(0.100 \mathrm{~mol} / \mathrm{L})(0.2000 \mathrm{~L})$
$=0.0200 \mathrm{~mol}$

Solution B
$C_{b}=3.00 \mathrm{~mol} / \mathrm{L}$
$V_{b}=0.7000 \mathrm{~L}$

Moles of $B$
$=(3.00 \mathrm{~mol} / \mathrm{L})(0.7000 \mathrm{~L})$
$=2.10 \mathrm{~mol}$
$C=\frac{\text { total moles }}{\text { total volume }}=\frac{0.0200 \mathrm{~mol}+2.10 \mathrm{~mol}}{0.2000 L+0.7000 L}=\frac{2.12 \mathrm{~mol}}{0.9000 \mathrm{~L}}=2.36 \mathrm{~mol} / \mathrm{L}$ or

$$
\begin{aligned}
& C_{a b}=\frac{C_{a} V_{a}+C_{b} V_{b}}{V_{a}+V_{b}} \\
& C_{a b}=\frac{(0.100 \mathrm{~mol} / \mathrm{L})(0.2000 \mathrm{~L})+(3.00 \mathrm{~mol} / \mathrm{L})(0.7000 \mathrm{~L})}{0.2000 \mathrm{~L}+0.7000 \mathrm{~L}} \\
& C_{a b}=\frac{0.0200 \mathrm{~mol}+2.10 \mathrm{~mol}}{0.9000 \mathrm{~L}} \\
& C_{a b}=\frac{2.12 \mathrm{~mol}}{0.9000 \mathrm{~L}}=2.36 \mathrm{~mol} / \mathrm{L}
\end{aligned}
$$

