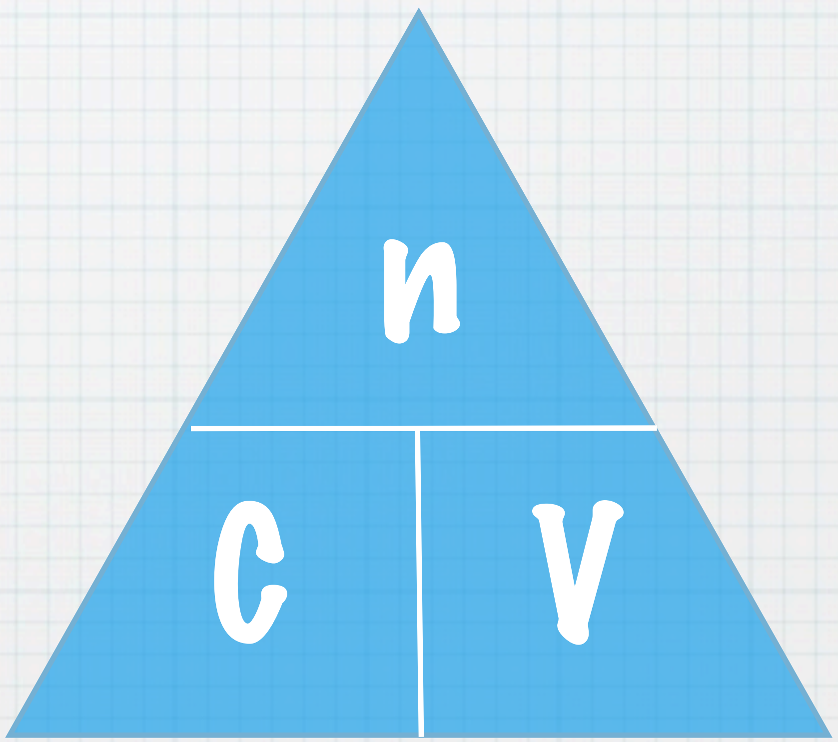
Solutions Review

J. KROPAC

Ways to Represent Concentration

* Molar Concentration or 'Molarity'
    * The number of moles of solute per liter of solution



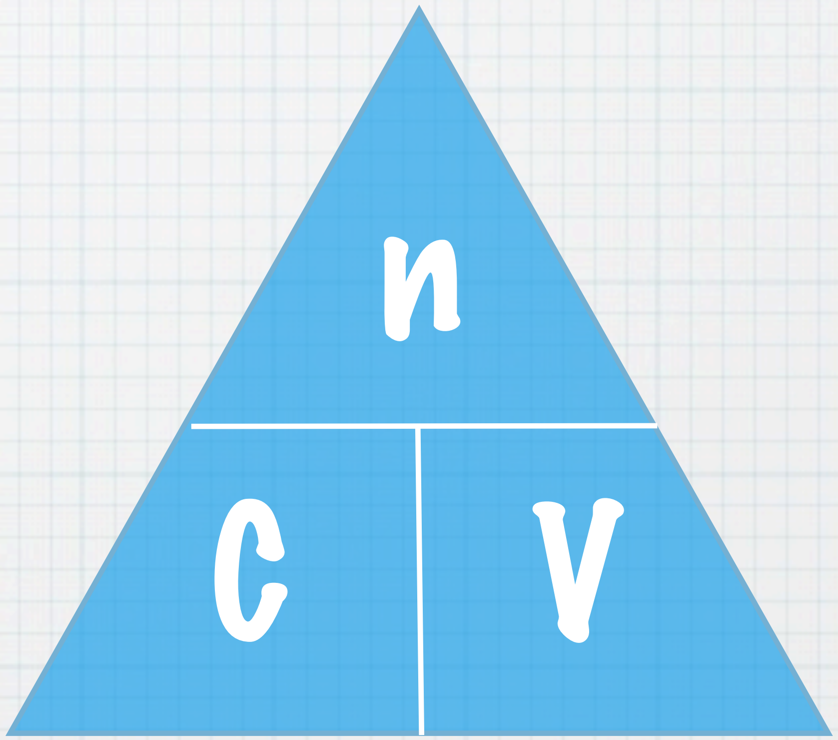
where;
n is the number of moles (mol)
V is the volume in litres (L)
C is the concentration or molarity in mol/L

Example from homework

* A sodium hydroxide solution contains 0.186 g of NaOH in 250mL of solution. Calculate the molar concentration of sodium hydroxide solution.

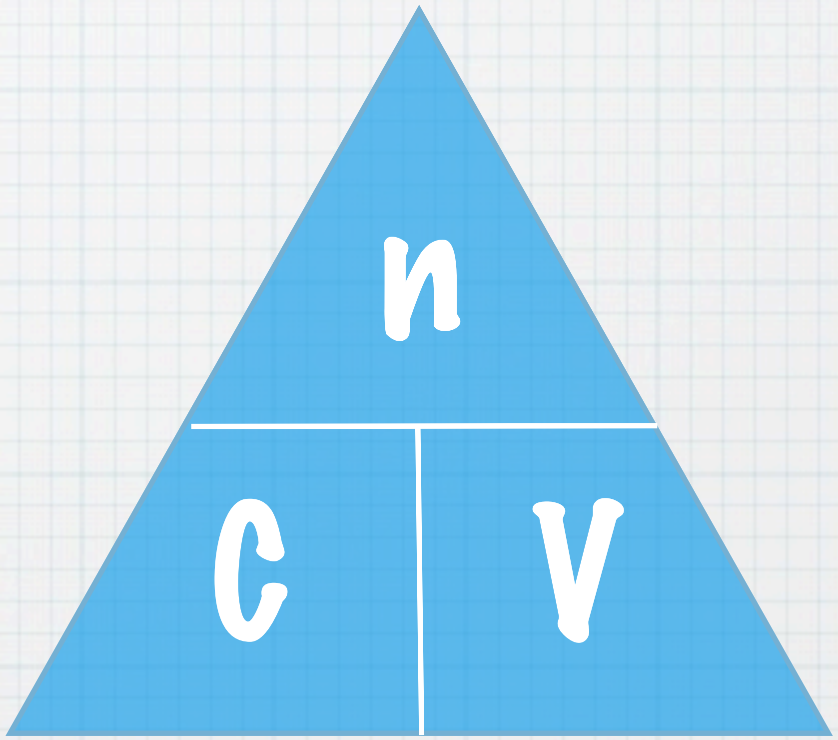
Example from homework

* Given
  * m= 0.186 g of NaOH
  * V= 250 mL
  * C= ?



Example from homework

* Given
  * m= 0.186 g of NaOH
  * V= 250 mL = 0.250 L
  * C= ?



Step 1: Calculate Number of Moles of NaOH

Given:

m_{NaOH}= 0.186 g
M_{NaOH}= 40.00 g/mol

Step 1: Calculate Number of Moles of NaOH

Given:

m_{NaOH} = 0.186 g
M_{NaOH} = 40.00 g/mol

Formula:

$$n = \frac{m}{M}$$

Step 1: Calculate Number of Moles of NaOH

Given:

$m_{NaOH} = 0.186\ g$
$M_{NaOH} = 40.00\ g/mol$

Formula:

$$n = \frac{m}{M}$$

Solution:

$$n_{NaOH} = \frac{0.186\ g}{40.00\ g/mol}$$

$n_{NaOH} = 0.0047\ mol$

Step 1: Calculate Number of Moles of NaOH

Given:

$m_{NaOH} = 0.186\ g$
$M_{NaOH} = 40.00\ g/mol$

Formula:

$n = \frac{m}{M}$

Solution:

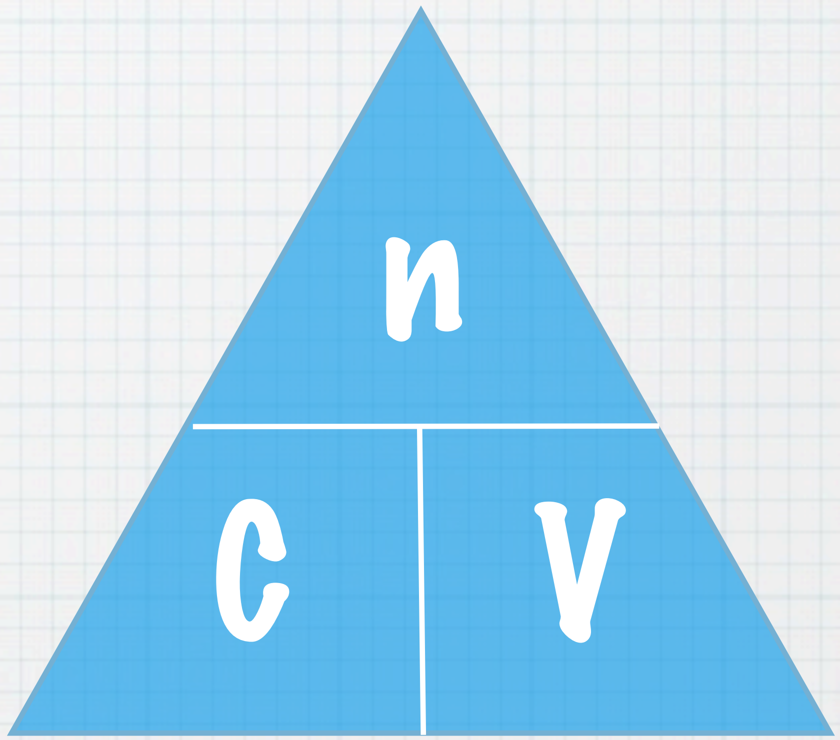
$n_{NaOH} = \frac{0.186\ g}{40.00\ g/mol}$

$n_{NaOH} = 0.0047\ mol$

Therefore there are 0.0047 mol of NaOH.

Step 2: Solve for C

* Given
  * n = 0.0047 mol
  * V= 0.250 L
  * C= ?



Step 2: Solve for C

$$C = \frac{n}{V}$$

$$C = \frac{0.0046\ mol}{0.250\ L}$$

$$C = 0.0184\ M$$

Therefore the concentration of NaOH is 0.0184 M.

Solutions Stoichiometry

Example

* If 8.5 g of pure ammonium phosphate, $(NH_4)_3PO_{4(s)}$, is dissolved in distilled water to make 400 mL of solution, what are the concentrations(in moles per litre) of the ions in solution?

Step 1: Chemical Formula

$$(NH_4)_3PO_{4(s)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + PO_4^{3-}{}_{(aq)} + H_2O_{(l)}$$

Step 1: Chemical Formula

$$(NH_4)_3PO_{4(s)} + H_2O_{(l)} \rightarrow 3NH_4{}^{+}{}_{(aq)} + PO_4{}^{3-}{}_{(aq)} + H_2O_{(l)}$$

Step 2: Net Ionic Equation

$$(NH_4)_3PO_{4(s)} + \cancel{H_2O}_{(l)} \longrightarrow 3NH_4{}^+{}_{(aq)} + PO_4{}^{3-}{}_{(aq)} + \cancel{H_2O}_{(l)}$$

$$(NH_4)_3PO_{4(s)} \longrightarrow 3NH_4{}^+{}_{(aq)} + PO_4{}^{3-}{}_{(aq)}$$

Step 3: Stoichiometry

$(NH_4)_3PO_{4(s)} \longrightarrow 3NH_4^{+}{}_{(aq)} + PO_4^{3-}{}_{(aq)}$

m=8.5g

M = 149.12 g/mol

Step 3: Stoichiometry

$(NH_4)_3PO_{4(s)} \rightarrow 3NH_4^{+}{}_{(aq)} + PO_4^{3-}{}_{(aq)}$

m=8.5g

M = 149.12 g/mol

Convert mass to moles

$$n = \frac{m}{M}$$

$$n = \frac{8.5\ g}{149.12\ g/mol}$$

n= 0.057 mol

Therefore there are 0.057 moles of ammonium phosphate.

Step 3: Stoichiometry

$$(NH_4)_3PO_{4(s)} \longrightarrow 3NH_4^+{}_{(aq)} + PO_4^{3-}{}_{(aq)}$$

m=8.5g

M = 149.12 g/mol

Molar Ratio

For NH_4^+

For PO_4^{3-}

Step 3: Stoichiometry

$$(NH_4)_3PO_{4(s)} \longrightarrow 3NH_4^+{}_{(aq)} + PO_4^{3-}{}_{(aq)}$$

m=8.5g

M = 149.12 g/mol

Molar Ratio

For NH_4^+

$$\frac{1}{3} = \frac{0.057\text{ mol}}{n_{NH4}}$$

n_{NH4} = 0.171 mol

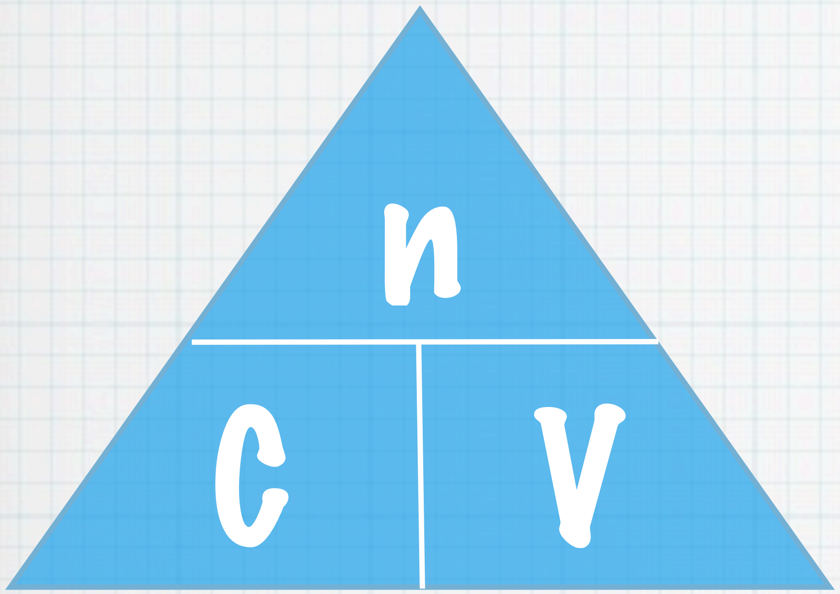
For PO_4^{3-}

$$\frac{1}{1} = \frac{0.057\text{ mol}}{n_{PO4}}$$

n_{PO4} = 0.057 mol

Step 3: Stoichiometry

Therefore there are 0.171 moles of NH_4^+ ions and 0.057 moles of PO_4^{3-} ions.



Step 4: Calculate Concentrations

For NH_4^+

Given: $n_{NH4} = 0.171$ mol

$V = 0.400$ L

$$C = \frac{n}{V}$$

$$C = \frac{0.171 \text{ mol}}{0.400 \text{ L}}$$

$C = 0.428$ M

For PO_4^{3-}

Given: $n_{PO4} = 0.057$ mol

$V = 0.400$ L

$$C = \frac{n}{V}$$

$$C = \frac{0.057 \text{ mol}}{0.400 \text{ L}}$$

$C = 0.143$ M

Solution

* Therefore, in the 400 mL solution, there is a 0.4 M concentration of NH_4^+ ions and a 0.1 M concentration of PO_4^{3-} ions.