Solutions Stoichometry

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Example

* A student measures 100mL of $AgNO_{3(aq)}$ of unknown concentration and combines it with solid copper. When the reaction was complete, 1.65g of solid silver was produced. Find the molar concentration of the $AgNO_3$ solution.

Step 1: Chemical Formula and Givens

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$$Cu_{(s)} + 2AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$$

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m = 1.65 g

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V=0.100 L

m = 1.65 g

M = 107.87 g/mol

Step 2: Mass to Moles

$$Cu_{(s)} + 2AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$$

V=0.100 L

m = 1.65 g

M = 107.87 g/mol

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

$$n = \frac{1.65\ g}{107.87\ g/mol}$$

$$n = 0.015\ mol$$

0.015 mol

Step 3: Molar Ratio

$$Cu_{(s)} + 2AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$$

V=0.100 L

m = 1.65 g

M = 107.87 g/mol

$$\frac{2 \text{ mol Ag}}{2 \text{ mol } AgNO_3} = \frac{0.015 \text{ mol}}{n AgNO_3}$$

0.015 mol ← 0.015 mol

Step 4: Calculate Molar Concentration

$$Cu_{(s)} + 2AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$$

V=0.100 L

m = 1.65 g

M = 107.87 g/mol

$$\frac{2 \text{ mol Ag}}{2 \text{ mol } AgNO_3} = \frac{0.015 \text{ mol}}{n AgNO_3}$$

0.015 mol ← 0.015 mol

Step 4: Calculate Molar Concentration

Given:

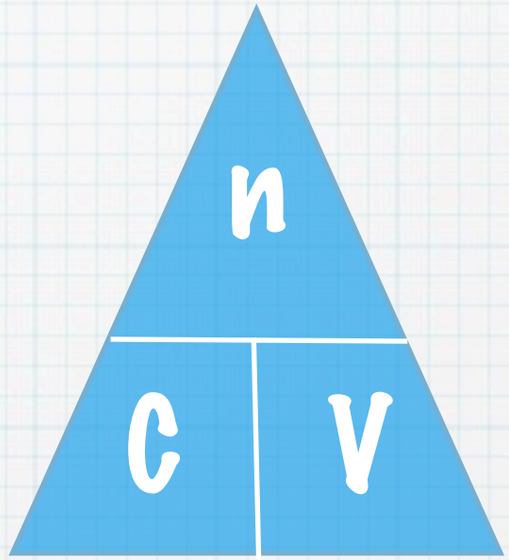
$V = 0.100\ L$

$n_{AgNO3} = 0.015\ mol$

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

$$C = \frac{0.015\ mol}{0.100\ L}$$

$$C = 0.15\ mol/L$$



Therefore the concentration of the silver nitrate solution is 0.15 mol/L

Example

* Excess $Pb(NO_3)_{2(aq)}$ was added to 125 mL of $NaI_{(aq)}$ to produce the 4.13 g of the precipitate $PbI_{2(s)}$. What is the molar concentration of iodide ions in the solution of sodium iodide?

Step 1: Chemical Formula and Givens

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$$Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow PbI_{2(s)} + 2NaNO_{3(aq)}$$

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$$Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow PbI_{2(s)} + 2NaNO_{3(aq)}$$

V=0.125 L

m = 4.13 g

M = 461.0 g/mol

Step 2: Net Ionic Equation

$$Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow PbI_{2(s)} + 2NaNO_{3(aq)}$$

$$Pb^{2+}(aq) + 2NO_3^-{}_{(aq)} + 2Na^+{}_{(aq)} + I^-{}_{(aq)} \rightarrow PbI_{2(s)} + 2Na^+{}_{(aq)} + 2NO_3{}^-{}_{(aq)}$$

Step 2: Net Ionic Equation

$$Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow PbI_{2(s)} + 2NaNO_{3(aq)}$$

$$Pb^{2+}(aq) + 2NO_3^-(aq) + 2Na^+(aq) + 2I^-(aq) \rightarrow PbI_{2(s)} + 2Na^+(aq) + 2NO_3^-(aq)$$

$$Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_{2(s)}$$

Step 2: Net Ionic Equation

$$Pb^{2+}(aq) + 2I^{-}(aq) \rightarrow PbI_{2(s)}$$

V=0.125 L

m = 4.13 g

M = 461.0 g/mol

Step 3: Mass to Moles

$$Pb^{2+}(aq) + 2I^{-}(aq) \rightarrow PbI_{2(s)}$$

V=0.125 L m = 4.13 g

M = 461.0 g/mol

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

$$n = \frac{4.13\ g}{461.0\ g/mol}$$

$$n = 0.0090\ mol$$

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Step 3: Mass to Moles

$$Pb^{2+}(aq) + 2I^{-}(aq) \rightarrow PbI_{2(s)}$$

V=0.125 L m = 4.13 g

M = 461.0 g/mol

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

$$n = \frac{4.13\ g}{461.0\ g/mol}$$

$$n = 0.0090\ mol$$

n= 0.0090 mol

Step 4: Molar Ratio

$$Pb^{2+}(aq) + 2I^{-}_{(aq)} \rightarrow PbI_{2(s)}$$

$V = 0.125\ L$ $\quad m = 4.13\ g$

$M = 461.0\ g/mol$

$$\frac{1\ mol\ PbI_2}{2\ mol\ I^-} = \frac{n = 0.0090\ mol}{nI^-}$$

$n = 0.018\ mol$

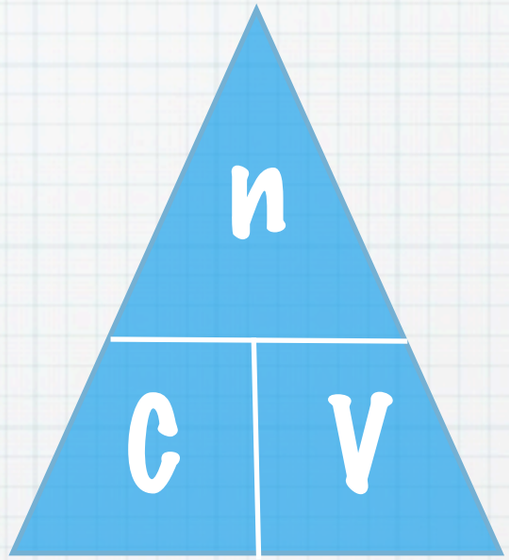
Step 5: Calculate Molar Concentration

Given:

$V = 0.125\ L$

$n_{I^-} = 0.018\ mol$

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



$$C = \frac{0.018\ mol}{0.125\ L}$$

$C = 0.14\ mol/L$

Therefore the concentration of iodide ions in solution is 0.14 mol/L

Homework

* p. 417 # 11, 12, 13