

Limiting and Excess Regents

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Limiting Regents

- * Limiting Regents: the reactant that is used up first and limits the amounts of product that is obtained. The reaction stops and the other reactant(s) are in excess.

* Table salt, NaCl(s), can be formed by the reaction of sodium metal and chlorine gas:



* A reaction mixture contains 45.98g of sodium and 142.0 g of chlorine. Calculate the mass of sodium chloride that is produced.

Step 1

* Step 1: List Given Values

* $m_{\text{Na}} = 45.98\text{g}$

* $m_{\text{Cl}_2} = 142.0\text{g}$

* $M_{\text{Na}} = 22.99\text{ g/mol}$

* $M_{\text{Cl}_2} = 2M_{\text{Cl}}$

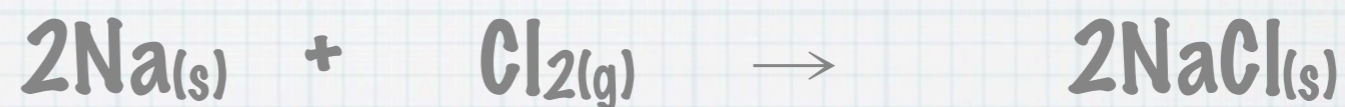
$= 2 \times 35.45\text{ g/mol}$

$= 70.90\text{ g/mol}$

Step 2

* Step 2: Complete Reaction Chart

Balance the
equation



* Step 2: Complete Reaction Chart

Balance the equation	$2\text{Na}_{(s)}$	+	$\text{Cl}_{2(g)}$	\rightarrow	$2\text{NaCl}_{(s)}$
Mass before reaction occurs	45.98g		142.0g		0g

Step 2

* Step 2: Complete Reaction Chart

Balance the equation	$2\text{Na}_{(s)} + \text{Cl}_{2(g)} \rightarrow 2\text{NaCl}_{(s)}$
Mass before reaction occurs	45.98g 142.0g 0g
How much do I need for the reaction?	$m = n \times M$ $m = n \times M$ $m = 2 \times 22.99$ $m = 1 \times 70.90$ <u>$m = 45.98 \text{ g}$</u> <u>$m = 70.90 \text{ g}$</u>

* Step 2: Complete Reaction Chart

Balance the equation	$2\text{Na}_{(s)} + \text{Cl}_{2(g)} \rightarrow 2\text{NaCl}_{(s)}$		
Mass before reaction occurs	45.98g	142.0g	0g
<u>Mass Required</u> How much do I need for the reaction?	$m = n \times M$ $m = 2 \times 22.99$ $m = 45.98 \text{ g}$	$m = n \times M$ $m = 1 \times 70.90$ $m = 70.90 \text{ g}$	
How much am I left with after the reaction?	mass before - mass required $45.98 - 45.98$ $= 0\text{g}$	$142.0 - 70.90$ $= 71.1\text{g}$	

Step 3

- * **Step 3: Identify Limiting and Excess Reagents**
- * **Sodium used up in reaction and therefore is limiting reagent. Some chlorine left over after reaction, therefore excess reagent.**
- * **Mass of available sodium determine the mass of NaCl formed**

Now that we know the limiting reagent,
we can use this mass to solve for the
amount of product produced



List given values

$$m_{\text{Na}} = 45.98 \text{ g}$$
$$M_{\text{Na}} = 22.99 \text{ g/mol}$$

$$m_{\text{NaCl}} = ?$$
$$M_{\text{NaCl}} = 116.88 \text{ g/mol}$$



List given values

$$m_{\text{Na}} = 45.98 \text{ g}$$
$$M_{\text{Na}} = 22.99 \text{ g/mol}$$

$$m_{\text{NaCl}} = ?$$
$$M_{\text{NaCl}} = 116.88 \text{ g/mol}$$

Convert from mass to moles

$$n = m/M$$

$$n = \frac{45.98 \text{ g}}{22.99 \text{ g/mol}}$$

$$n = 2.00 \text{ mols}$$

$$n = 2.00 \text{ mols}$$



List given values

$$m_{\text{Na}} = 45.98 \text{ g}$$
$$M_{\text{Na}} = 22.99 \text{ g/mol}$$

$$m_{\text{NaCl}} = ?$$
$$M_{\text{NaCl}} = 116.88 \text{ g/mol}$$

Convert from mass to moles

$$n = m/M$$

$$n = \frac{45.98 \text{ g}}{22.99 \text{ g/mol}}$$

$$n = 2.00 \text{ mols}$$

Molar Ratio

$$n = 2.00 \text{ mols}$$

$$\frac{\text{Ratio given}}{\text{Ratio required}} = \frac{n_{\text{given}}}{n_{\text{required}}}$$



List given values

$$m_{\text{Na}} = 45.98 \text{ g}$$

$$M_{\text{Na}} = 22.99 \text{ g/mol}$$

$$m_{\text{NaCl}} = ?$$

$$M_{\text{NaCl}} = 116.88 \text{ g/mol}$$

Convert from mass to moles

$$n = m/M$$

$$n = \frac{45.98 \text{ g}}{22.99 \text{ g/mol}}$$

$$n = 2.00 \text{ mols}$$

Molar Ratio

$$n_{\text{Na}} = 2.00 \text{ mols} \longrightarrow n_{\text{NaCl}} = 2.00 \text{ mols}$$

$$\frac{\text{Ratio Na}}{\text{Ratio NaCl}} = \frac{n_{\text{Na}}}{n_{\text{NaCl}}} \longrightarrow \frac{2}{2} = \frac{2 \text{ mol}}{n_{\text{NaCl}}} \longrightarrow n_{\text{NaCl}} = 2.00 \text{ mols}$$



List given values

$$m_{\text{Na}} = 45.98 \text{ g}$$

$$M_{\text{Na}} = 22.99 \text{ g/mol}$$

$$m_{\text{NaCl}} = ?$$

$$M_{\text{NaCl}} = 58.44 \text{ g/mol}$$

Convert from mass to moles

$$n = m/M$$

$$n = \frac{45.98 \text{ g}}{22.99 \text{ g/mol}}$$

$$n = 2.00 \text{ mols}$$

Convert from moles to mass

$$m = n \times M$$

$$m = 2.00 \text{ g} \times \frac{58.44 \text{ g}}{\text{mol}}$$

$$m = 116.88 \text{ g}$$

Molar Ratio

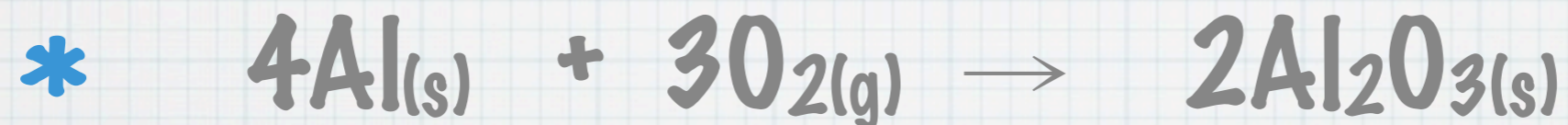
$$n_{\text{Na}} = 2.00 \text{ mols} \rightarrow n_{\text{NaCl}} = 2.00 \text{ mols}$$

$$\frac{\text{Ratio Na}}{\text{Ratio NaCl}} = \frac{n_{\text{Na}}}{n_{\text{NaCl}}} \rightarrow \frac{2}{2} = \frac{2 \text{ mol}}{n_{\text{NaCl}}} \rightarrow n_{\text{NaCl}} = 2.00 \text{ mols}$$

* Therefore, 116.90 g of NaCl will be produced when there is 45.98 g of sodium and 142.0 g of chlorine.

Now you try . . .

* Aluminum and oxygen react to form aluminum oxide, as shown in the following balanced chemical equation:



* A reaction mixture contains 134.9 g of aluminum and 96.0 g of oxygen. Calculate the mass of aluminum oxide that is present.