Limiting and Excess Regents

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Limiting Regents

* Limiting Reagents: 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:

  * $2Na(s) + Cl_{(g)} \rightarrow 2NaCl_{(s)}$

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

Step 1

* Step 1: List Given Values
* m_{Na}= 45.98g
* m_{Cl2} = 142.0g
* M_{Na}= 22.99 g/mol
* M_{Cl2} = 2MCl

  = 2 x 35.45 g/mol

  =70.90 g/mol

Step 2

* Step 2: Complete Reaction Chart

Balance the equation	$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$

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Balance the equation	$2Na_{(s)}$	+	$Cl_{2(g)}$	→	$2NaCl_{(s)}$
Mass before reaction occurs	45.98g		142.0g		0g

Step 2

* Step 2: Complete Reaction Chart

Balance the equation	$2Na_{(s)}$	+	$Cl_{2(g)}$	→	$2NaCl_{(s)}$
Mass before reaction occurs	45.98g		142.0g		0g
How much do I need for the reaction?	m= n x M m= 2 x 22.99 m= 45.98 g		m= n x M m= 1 x 70.90 m= 70.90 g		

* Step 2: Complete Reaction Chart

Balance the equation	$2Na_{(s)}$	+ $Cl_{2(g)}$ →	$2NaCl_{(s)}$
Mass before reaction occurs	45.98g	142.0g	0g
Mass Required How much do I need for the reaction?	m= n x M m= 2 x 22.99 m= 45.98 g	m= n x M m= 1 x 70.90 m= 70.90 g	
How much am I left with after the reaction?	mass before- mass required 45.98 - 45.98 =0g	142.0 - 70.90 =71.1g	

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

$$2Na_{(s)} + Cl_{(g)} \rightarrow 2NaCl_{(s)}$$

List given values

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

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

$$2Na_{(s)} + Cl_{(g)} \rightarrow 2NaCl_{(s)}$$

List given values

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

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

Convert from mass to moles

$$n = m/M$$

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

$$n = 2.00\ mols$$

$n = 2.00$ mols

$$2Na_{(s)} + Cl_{(g)} \rightarrow 2NaCl_{(s)}$$

List given values

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

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

Convert from mass to moles

$n = m/M$

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

$n = 2.00$ mols

Molar Ratio

$n = 2.00$ mols

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

$$2Na_{(s)} + Cl_{(g)} \rightarrow 2NaCl_{(s)}$$

List given values

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

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

Convert from mass to moles

$$n = m/M$$

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

$$n = 2.00\ mols$$

Molar Ratio

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

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

$$2Na_{(s)} + Cl_{(g)} \rightarrow 2NaCl_{(s)}$$

List given values

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

$m_{NaCl} = ?$
$M_{NaCl} = 58.44\ g/mol$

Convert from mass to moles

$$n = m/M$$

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

$$n = 2.00\ mols$$

Convert from moles to mass

$$m = n \times M$$

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

$$m = 116.88\ g$$

Molar Ratio

$n_{Na} = 2.00\ mols$ → $n_{NaCl} = 2.00\ mols$

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

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

Now you try . . .

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

* $4Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$

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