

# Limiting and Excess Reagents

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# Limiting Regents

- \* Limiting Reagents: the reactant that is used up first



**\* 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 and Balance Equation

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

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

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

\*  $M_{\text{Cl}_2} = 2 \times 35.45 \text{ g/mol}$   
 $= 70.90 \text{ g/mol}$

# Step 2

- \* Step 2: Convert each substance from mass to moles

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\* Sodium:

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

$$n = \frac{45.98 \text{ g}}{22.98 \text{ g/mol}}$$

$$n = 2.0 \text{ mol}$$

# Step 2

\* Step 2: Convert each substance from mass to moles

\* Chlorine:

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

$$n = \frac{142.00 \text{ g}}{70.90 \text{ g/mol}}$$

$$n = 2.0 \text{ mol}$$

# Step 3

Complete molar ratio for both

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

\* Sodium

\* Chlorine



# Step 3

Complete molar ratio for both

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

\* Sodium

$$\frac{2}{2} = \frac{2.0 \text{ mol}}{n_{\text{required}}}$$

$$2n = 4$$
$$n = 2$$

\* Chlorine

# Step 3

Complete molar ratio for both

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

\* Sodium

$$\frac{2}{2} = \frac{2.0 \text{ mol}}{n_{\text{required}}}$$

$$2n = 4$$
$$n = 2$$

\* Chlorine

$$\frac{1}{2} = \frac{2.0 \text{ mol}}{n_{\text{required}}}$$

$$1n = 4$$
$$n = 4$$

**Whichever is the smaller number is the limiting reagent**

**You will now use this to find this value to find the mass of the substance**

# Step 4

\* Convert from moles of limiting reagent to mass of substance

$$* m = n \times M$$

$$n = 2.0 \text{ mol}$$

$$M = \text{Na} + \text{Cl}$$

$$= 22.99 \text{ g/mol} + 35.45 \text{ g/mol}$$

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

# Step 4

\* Convert from moles of limiting reagent to mass of substance

\*  $m = n \times M$

$$n = 2.0 \text{ mol}$$

$$M = \text{Na} + \text{Cl}$$

$$= 22.99 \text{ g/mol} + 35.45 \text{ g/mol}$$

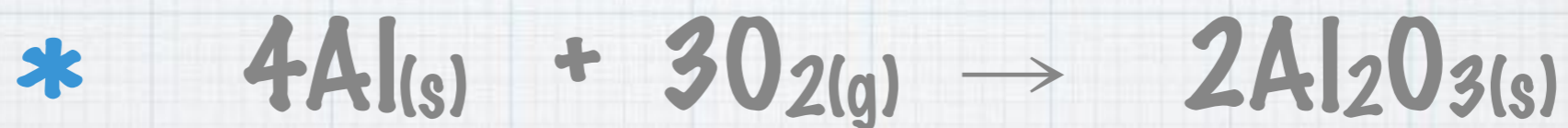
$$= 58.44 \text{ g/mol}$$

$$m = 2.0 \text{ mol} \times 58.44 \text{ g/mol}$$

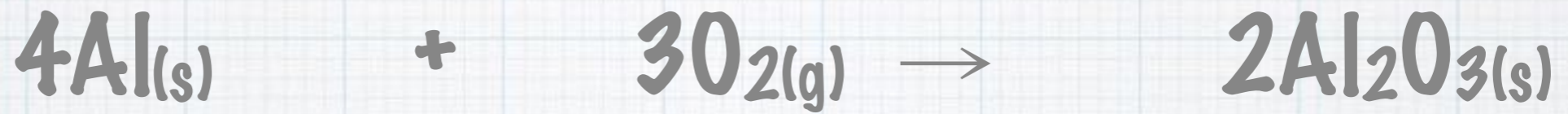
$$m = 116.88 \text{ g}$$

Therefore 116.88 g of NaCl will be created.

# Now you try . . .



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

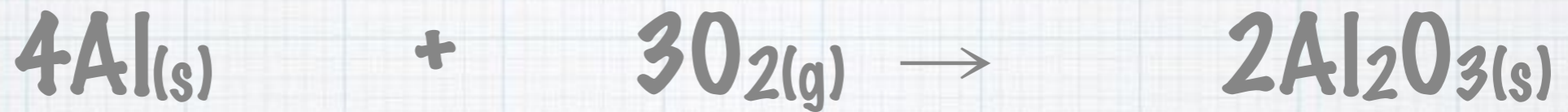


List given values

$$m_{\text{Al}} = 134.9 \text{ g}$$
$$M_{\text{Al}} = 26.98 \text{ g/mol}$$

$$m_{\text{O}_2} = 96.0 \text{ g}$$
$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$
$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$



List given values

$$m_{\text{Al}} = 134.9 \text{ g}$$
$$M_{\text{Al}} = 26.98 \text{ g/mol}$$

$$m_{\text{O}_2} = 96.0 \text{ g}$$
$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

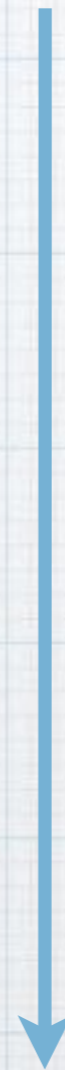
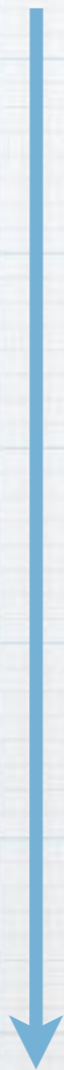
$$m_{\text{Al}_2\text{O}_3} = ?$$
$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

Convert  
from mass  
to moles

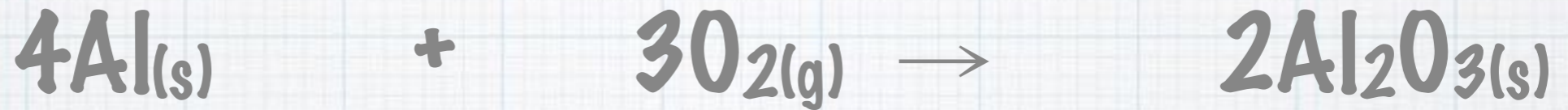
$$n = m/M$$

$$n = \frac{134.9 \text{ g}}{26.98 \text{ g/mol}}$$

$$n = 5.00 \text{ mols}$$







$$m_{\text{Al}} = 134.9 \text{ g}$$
$$M_{\text{Al}} = 26.98 \text{ g/mol}$$

$$m_{\text{O}_2} = 96.0 \text{ g}$$
$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$
$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

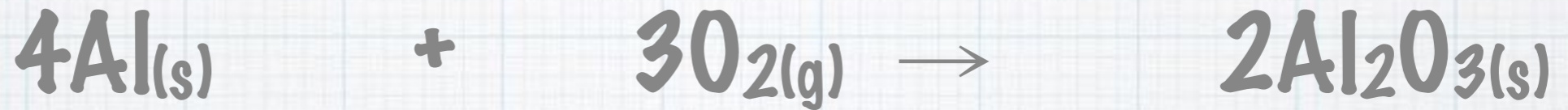
Convert  
from mass  
to moles

$$n = m/M$$
$$n = \frac{134.9 \text{ g}}{26.98 \text{ g/mol}}$$
$$n = 5.00 \text{ mols}$$

$$n = m/M$$
$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$
$$n = 3.00 \text{ mols}$$

**$n = 5.0 \text{ mol}$**

**$n = 3.0 \text{ mol}$**



$$m_{\text{Al}} = 134.9 \text{ g}$$

$$M_{\text{Al}} = 26.98 \text{ g/mol}$$

$$m_{\text{O}_2} = 96.0 \text{ g}$$

$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$

$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

$$n = m/M$$

$$n = \frac{134.9 \text{ g}}{26.98 \text{ g/mol}}$$

$$n = 5.00 \text{ mols}$$

$$n = m/M$$

$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$

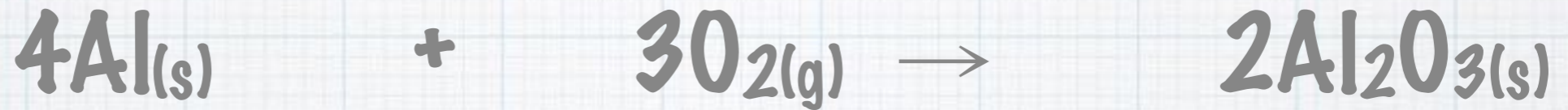
$$n = 3.00 \text{ mols}$$

**n = 5.0 mol**

**n = 3.0 mol**

Molar Ratio

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



$$m_{\text{Al}} = 134.9 \text{ g}$$

$$M_{\text{Al}} = 26.98 \text{ g/mol}$$

$$m_{\text{O}_2} = 96.0 \text{ g}$$

$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$

$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

$$n = m/M$$

$$n = \frac{134.9 \text{ g}}{26.98 \text{ g/mol}}$$

$$n = 5.00 \text{ mols}$$

$$n = m/M$$

$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$

$$n = 3.00 \text{ mols}$$

$$n = 5.0 \text{ mol}$$

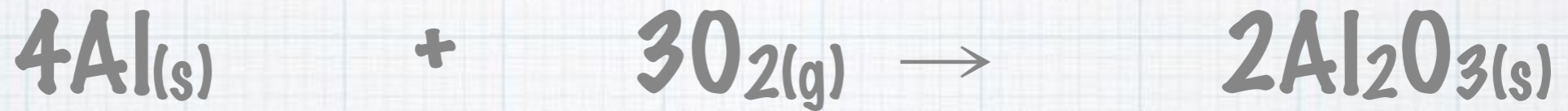
$$n = 3.0 \text{ mol}$$

Molar Ratio

$$\frac{4}{2} = \frac{5}{n_{\text{required}}}$$

$$4n = 10$$

$$n = 2.5$$



$$m_{\text{Al}} = 134.9 \text{ g}$$

$$M_{\text{Al}} = 26.98 \text{ g/mol}$$

$$m_{\text{O}_2} = 96.0 \text{ g}$$

$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$

$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

$$n = m/M$$

$$n = \frac{134.9 \text{ g}}{26.98 \text{ g/mol}}$$

$$n = 5.00 \text{ mols}$$

$$n = m/M$$

$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$

$$n = 3.00 \text{ mols}$$

$$n = 5.0 \text{ mol}$$

$$n = 3.0 \text{ mol}$$

Molar Ratio

$$\frac{4}{2} = \frac{5}{n_{\text{required}}}$$

$$\frac{3}{2} = \frac{3}{n_{\text{required}}}$$

$$4n = 10$$

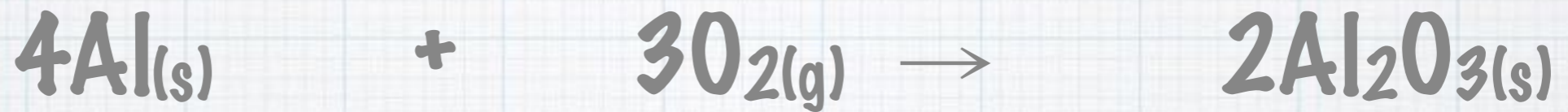
$$n = 2.5$$

$$3n = 6$$

$$n = 2.0$$

Since oxygen is the smaller number, it is the limiting reagent.

Use it to calculate the mass of product.



$$m_{\text{O}_2} = 96.0 \text{ g}$$
$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

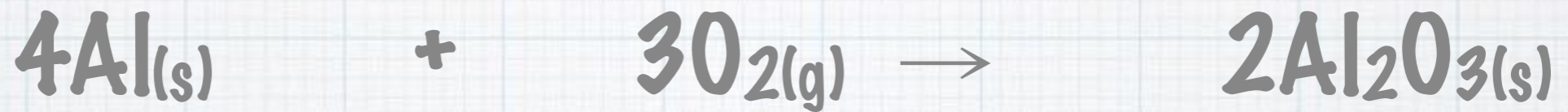
$$m_{\text{Al}_2\text{O}_3} = ?$$
$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

$$n = m/M$$
$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$
$$n = 3.00 \text{ mols}$$

$$n = 3.0 \text{ mol} \rightarrow n = 2.0 \text{ mol}$$

$$\frac{3}{2} = \frac{3}{n_{\text{required}}}$$

$$3n = 6$$
$$n = 2.0$$



$$m_{\text{O}_2} = 96.0 \text{ g}$$
$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$
$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

$$n = m/M$$
$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$
$$n = 3.00 \text{ mols}$$

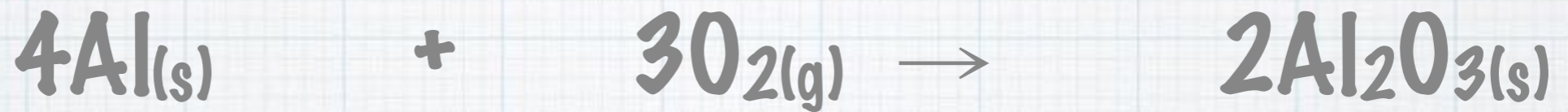
Convert from  
moles to mass

$$n = 3.0 \text{ mol}$$

$$n = 2.0 \text{ mol}$$

$$\frac{3}{2} = 3$$

$n_{\text{required}}$



$$m_{\text{O}_2} = 96.0 \text{ g}$$

$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$

$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

$$n = m/M$$

$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$

$$n = 3.00 \text{ mols}$$

Convert from moles to mass

$$m = n \times M$$

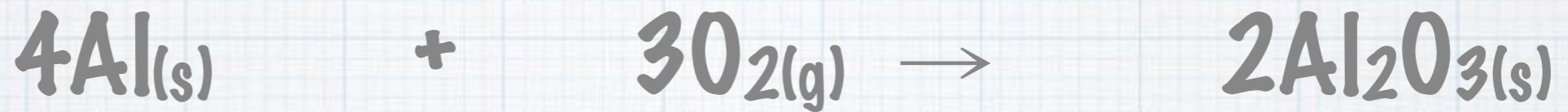
$$n = 3.0 \text{ mol}$$

$$n = 2.0 \text{ mol}$$

$$\frac{3}{2} = 3$$

$n_{\text{required}}$





$$m_{\text{O}_2} = 96.0 \text{ g}$$

$$M_{\text{O}_2} = 32.00 \text{ g/mol}$$

$$m_{\text{Al}_2\text{O}_3} = ?$$

$$M_{\text{Al}_2\text{O}_3} = 101.96 \text{ g/mol}$$

$$n = m/M$$

$$n = \frac{96 \text{ g}}{32.00 \text{ g/mol}}$$

$$n = 3.00 \text{ mols}$$

Convert from  
moles to mass

$$m = n \times M$$

$$m = 2.0 \times 101.96$$

$$m = 203.92 \text{ g}$$

$$n = 3.0 \text{ mol}$$

$$n = 2.0 \text{ mol}$$

$$\frac{3}{2} = 3$$

$n_{\text{required}}$