

## (HT) Limiting Reactants

**Answer the questions below.**

1. State which side of a chemical equation the reactants are found on.

**The left**

2. Explain why chemical equations must be balanced.

**Because atoms cannot be created or destroyed in a chemical reaction.**

3. Calculate the relative formula mass of sodium carbonate ( $\text{Na}_2\text{CO}_3$ ).

$$(23 \times 2) + 12 + (16 \times 3) = 106$$

4. Calculate the mass of 0.2 moles of sodium carbonate.

$$\text{number of moles} = \frac{\text{mass}}{M_r}$$

$$0.2 = \frac{\text{mass}}{106}$$

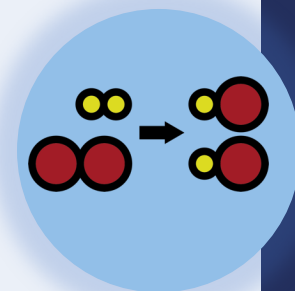
$$\text{mass} = 21.2 \text{ g}$$

5. Calculate the number of moles in 100 g of sodium carbonate.

$$\text{number of moles} = \frac{\text{mass}}{M_r}$$

$$\text{number of moles} = \frac{100}{106}$$

$$\text{number of moles} = 0.94 \text{ mol}$$



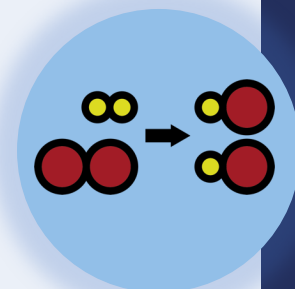
## (HT) Limiting Reactants

### Do Now:

1. State which side of a chemical equation the reactants are found on.
2. Explain why chemical equations must be balanced.
3. Calculate the relative formula mass of sodium carbonate ( $\text{Na}_2\text{CO}_3$ ).
4. Calculate the mass of 0.2 moles of sodium carbonate.
5. Calculate the number of moles in 100 g of sodium carbonate.

### Drill:

1. Calculate the  $M_r$  of lithium nitrate ( $\text{LiNO}_3$ ).  $\text{Li}=7$ ,  $\text{N}=14$ ,  $\text{O}=16$
2. Calculate the  $M_r$  of copper carbonate ( $\text{CuCO}_3$ ).  $\text{Cu}=63.5$ ,  $\text{C}=12$ ,  $\text{O}=16$
3. Calculate the  $M_r$  of calcium phosphate ( $\text{Ca}_3(\text{PO}_4)_2$ ).  $\text{Ca}=40$ ,  $\text{P}=31$ ,  $\text{O}=16$

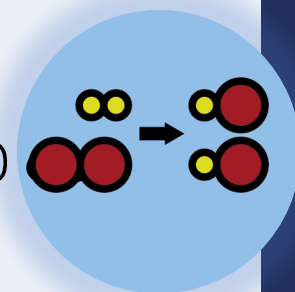


## (HT) Limiting Reactants

### Read Now:

We can use mole ratios to determine the numbers of particles involved in chemical reactions. We can use a given mass of a reactant to determine the number of moles that were reacting and therefore the number of moles of product that would be made. In reactions where there are two or more reactants, the reactant that has the fewest number of moles is the limiting reactant. This means that it will limit the amount of product that can be made. For example a car factory has made 10 car frames and 100 wheels. This would be enough wheels to make 25 cars, because each car needs 4 wheels, but there are only enough frames to make 10 cars. In this case, the car frame is the limiting reactant, because it determine the maximum amount of product (cars) that can be made.

1. Explain what is meant by a limiting reactant.
2. Identify the limiting reactant in the car factory example.
3. Explain why this is the limiting reactant.
4. Suggest which would be the limiting reactant if the car factory had made 30 frames instead.



# (HT) Limiting Reactants

C4.3.8

Science  
**Mastery**



C4.3.1 Prior Knowledge Review

C4.3.2 (HT) Introducing the Mole

C4.3.3 (HT) Mole Calculations

C4.3.4 PKR: Concentration

C4.3.5 TIF: Calculating Concentration

C4.3.6 TIF: Calculating an Unknown Concentration

C4.3.7 (HT) Amounts of Substances in Equations

➤ **C4.3.8 (HT) Limiting Reactants**

C4.3.9 PKR: Reactions of Acids

C4.3.10 Acids, Alkalis and Neutralisation

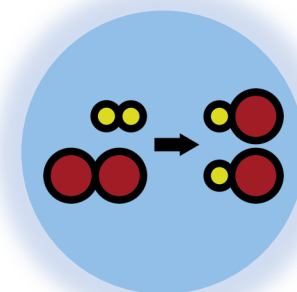
C4.3.11 TIF: Acid-Alkali Titration

C4.3.12 TIF: Acid-Alkali Titration Analysis

C4.3.13 TIF: Titration Calculations

C4.3.14 (HT) Strong and Weak Acids

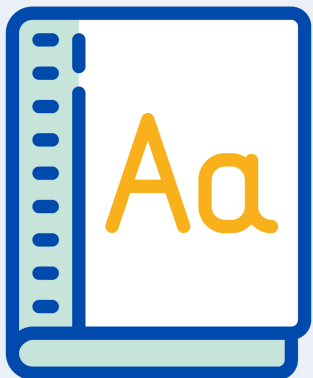
C4.3.15 TIF: Volumes of Gases



## Following this lesson, students will be able to:

- Calculate number of moles in reactions
- Use calculations to identify limiting reactants
- Calculate masses of products

## Key Words:



mass

moles

$M_r$

mole ratio

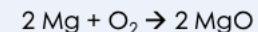
limiting reactant

# This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the **pre-unit quiz**.

- The teacher should customise this slide as needed, to facilitate
  - **reteach, explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.

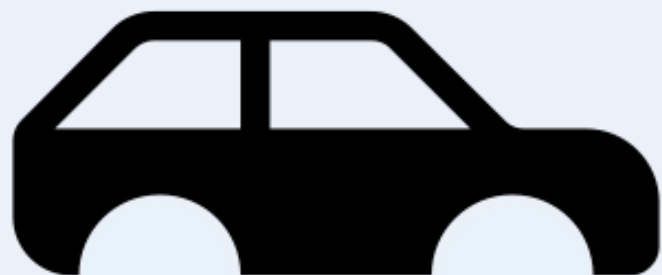
Answer the questions below.



1. 12 g of magnesium burns in oxygen. Calculate the number of moles of magnesium that reacted.
  - ☐ A. 12 mol
  - ☐ B. 2 mol
  - ☒ C. 0.5 mol
2. Calculate the number of moles of oxygen that would have reacted.
  - ☐ A. 1.0 mol
  - ☐ B. 0.5 mol
  - ☒ C. 0.25 mol
3. Calculate the mass of oxygen that would have reacted.
  - ☐ A. 4 g
  - ☒ B. 8 g
  - ☐ C. 128 g

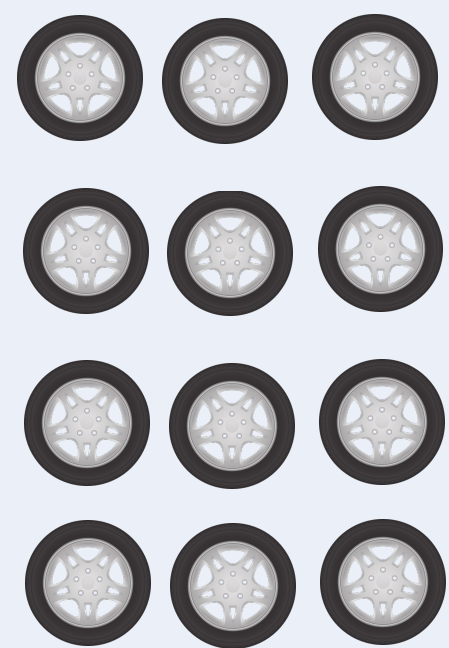
Exit ticket

# Limiting Reactants

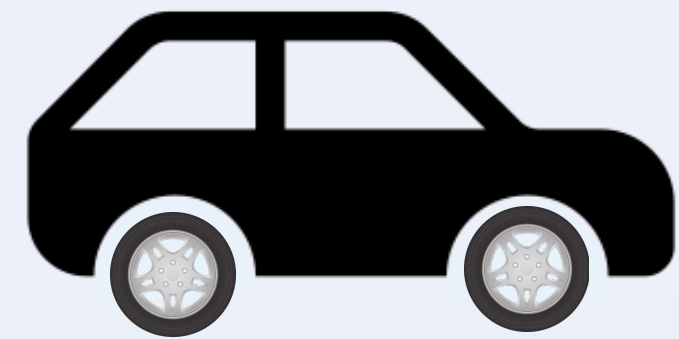
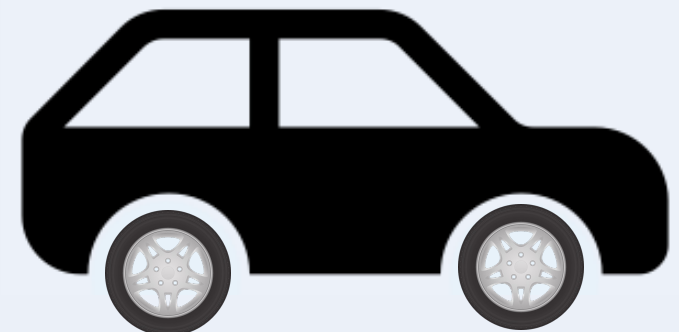


Limiting reactant

+



In excess



## Limiting Reactants



Calculate the mass of potassium oxide that can be made from 78 g of potassium and 32 g of oxygen.

mole ratio = 4 : 1

$$\text{number of moles K} = \frac{\text{mass}}{M_r} \quad \text{number of moles O}_2 = \frac{\text{mass}}{M_r}$$

$$\text{number of moles K} = \frac{78}{39} \quad \text{number of moles O}_2 = \frac{32}{32}$$

$$\text{number of moles K} = 2 \text{ mol} \quad \text{number of moles O}_2 = 1 \text{ mol}$$

$$\text{number of moles of O}_2 \text{ needed to react with 2 mol of K} \quad \checkmark$$
$$= 0.5 \text{ mol}$$

$$\text{number of moles of K needed to react with 1 mol of O}_2 \quad \times$$
$$= 4 \text{ mol}$$

## Limiting Reactants



Calculate the mass of potassium oxide that can be made from 78 g of potassium and 32 g of oxygen.

mole ratio = 4 : 2

$$\text{number of moles K} = \frac{\text{mass}}{M_r}$$

$$\text{number of moles K} = \frac{78}{39}$$

$$\text{number of moles K} = 2 \text{ mol}$$

$$\text{number of moles K}_2\text{O} = 1 \text{ mol}$$

$$\text{number of moles K}_2\text{O} = \frac{\text{mass}}{M_r}$$

$$1 = \frac{\text{mass}}{94}$$

$$\text{mass} = 94 \text{ g}$$

Is this correct?



39 g of potassium reacts with 32 g of oxygen.

Oxygen is the limiting reactant because the mole ratio is 4:1.

Describe how you would solve this question.




Calculate the mass of magnesium that could be made from 12 g of magnesium and 64 g of oxygen.

mole ratio = 2 : 1

$$\text{number of moles Mg} = \frac{\text{mass}}{M_r}$$

$$\text{number of moles Mg} = \frac{12}{24}$$

$$\text{number of moles Mg} = 0.5 \text{ mol}$$

number of moles of O<sub>2</sub> needed to react with 0.5 mol of Mg 

= 0.25 mol

number of moles of Mg needed to react with 2 mol of O<sub>2</sub> 

= 4 mol

mole ratio = 2 : 2

$$\text{number of moles O}_2 = \frac{\text{mass}}{M_r}$$

$$\text{number of moles MgO} = \frac{\text{mass}}{M_r}$$

$$\text{number of moles O}_2 = \frac{64}{32}$$

$$2 \text{ mol}$$

mass = 20 g

Identify the mistake(s) in this working.



Identify the limiting reactant when 8 g of hydrogen reacts with 16 g of oxygen.

mole ratio = 2 : 1

$$\text{number of moles H}_2 = \frac{\text{mass}}{M_r}$$

$$\text{number of moles O}_2 = \frac{\text{mass}}{M_r}$$

$$\text{number of moles H}_2 = \frac{8}{2}$$

$$\text{number of moles O}_2 = \frac{16}{32}$$

$$\text{number of moles H}_2 = 2 \text{ mol}$$

$$\text{number of moles O}_2 = 0.5 \text{ mol}$$

$$\text{number of moles of O}_2 \text{ needed to react with 2 mol of H}_2 = 2 \text{ mol} \quad \times$$

$$\text{number of moles of H}_2 \text{ needed to react with 0.5 mol of O}_2 = 0.5 \text{ mol} \quad \checkmark$$

Identify the mistake(s) in this working.



Identify the limiting reactant when 7.75 g of phosphorus reacts with 48 g of oxygen.

mole ratio = 4 : 5

$$\text{number of moles P} = \frac{\text{mass}}{M_r}$$

$$\text{number of moles P} = \frac{7.75}{31}$$

$$\text{number of moles P} = 0.25 \text{ mol}$$

$$\text{number of moles O}_2 = \frac{\text{mass}}{M_r}$$

$$\text{number of moles O}_2 = \frac{48}{16}$$

$$\text{number of moles O}_2 = 3 \text{ mol}$$

number of moles of O<sub>2</sub> needed to react with 0.25 mol of P  
= 0.3125 mol



number of moles of P needed to react with 3 mol of O<sub>2</sub>  
= 2.4 mol



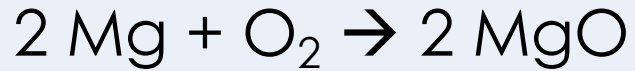
# Drill

1. State the equation that links number of moles, mass and  $M_r$ .
2. Explain what is meant by a limiting reactant.
3. Explain what it means for a reactant to be in excess.
4. Describe where reactants and products are found in a chemical equation.
5. State the units for number of moles.

# Drill answers

1. number of moles =  $\frac{\text{mass}}{M_r}$
2. The reactant that will run out first/will be all used up.
3. The reactant that will not run out.
4. Reactants are found on the left and products are found on the right.
5. Mol

## Answer the questions below.



48 g of magnesium burns in 100 g of oxygen.

1. Calculate the number of moles of magnesium present.
  - ☐ A. 0.5 mol
  - ☐ B. 1 mol
  - ☒ C. 2 mol
2. Calculate the number of moles of oxygen present.
  - ☐ A. 6.25 mol
  - ☒ B. 3.125 mol
  - ☐ C. 0.32 mol
3. Which is the limiting reactant?
  - ☒ A. Mg
  - ☐ B. O<sub>2</sub>
  - ☐ C. MgO

## Lesson C4.3.8

What was good about this lesson?

What can we do to improve this lesson?

[Send us your feedback by clicking this link](#)  
or by emailing [sciencemastery@arkonline.org](mailto:sciencemastery@arkonline.org)  
Thank you!