(HT) Amounts of Substances in Equations

Answer the questions below.

1. Define relative formula mass.
   The sum of the relative atomic mases in a compound (formula).
2. Calculate the relative formula mass of magnesium chloride ($MgCl_2$).
   Mg = 24, Cl = 35.5
   24 +(2x35.5) = 95
3. Calculate the percentage by mass of chlorine in magnesium chloride.

$$\%\ \text{by mass} = \frac{\text{mass of element}}{\text{mass of compound}} \times 100$$

$$\%\ \text{by mass} = \frac{71}{95} \times 100$$

$$\%\ \text{by mass} = 74.74\%$$

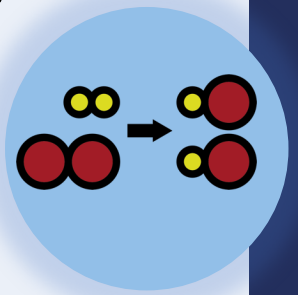
4. Calculate the number of moles in 47.5 g of magnesium chloride.

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

$$\text{number of moles} = \frac{47.5}{95}$$

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

Do Now



(HT) Amounts of Substances in Equations

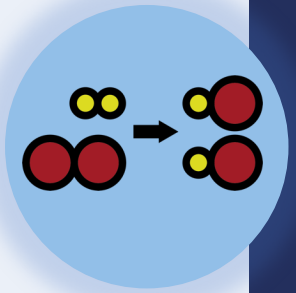
Do Now:

1. Define relative formula mass.
2. Calculate the relative formula mass of magnesium chloride ($MgCl_2$). Mg = 24, Cl = 35.5
3. Calculate the percentage by mass of chlorine in magnesium chloride.
4. Calculate the number of moles in 47.5 g of magnesium chloride

Drill:

1. Calculate the M_r of potassium sulfate (K_2SO_4). K=39, S=32, O=16
2. Calculate the M_r of aluminium hydroxide ($Al(OH)_3$). Al=27, O=16, H=1
3. Calculate the M_r of calcium nitrate ($Ca(NO_3)_2$). Ca=40, N=14, O=16

Do Now

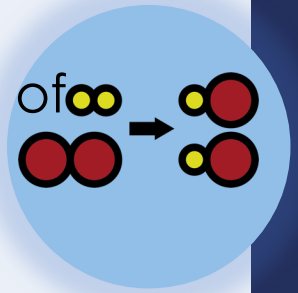


(HT) Amounts of Substances in Equations

Read Now:

Chemical equations must be balanced because atoms cannot be created or destroyed in a chemical reaction, only rearranged. A balanced chemical equation shows us the ratio in which reactants react or products or made. For example, in the reaction $2H_2 + O_2 \rightarrow 2H_2O$, we can see that two molecules of hydrogen react with every oxygen molecule to produce two molecules of water. In real chemical equations, it would be extremely unlikely to just have a couple of molecules reacting, so instead we can use the balanced chemical equation to show us the ratio of moles that are involved. This means that 2 moles of hydrogen react with1 mole of oxygen to produce 2 moles of oxygen. Remember that 1 mole of any substance contains 6.02×10^{23} particles.

1. Explain why chemical equations must be balanced.
2. Describe the reaction between hydrogen and oxygen to form water in terms of molecules.
3. Describe the reaction between hydrogen and oxygen to form water in terms of moles.
4. State the number of particles that are present in 1 mole of a substance.

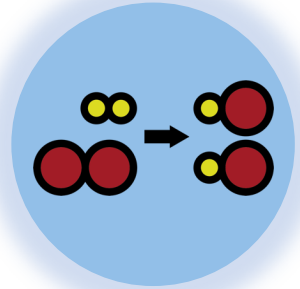


Do Now

(HT) Amounts of Substances in Equations

C4.3.7

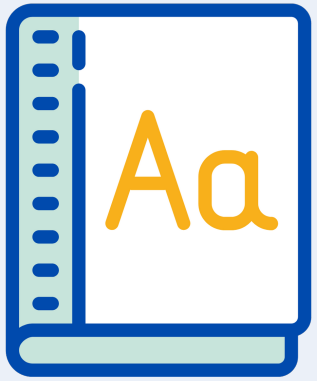
Science Mastery



Following this lesson, students will be able to:

- Describe chemical reactions in terms of number of moles
- Calculate number of moles in reactions
- Calculate masses of reactants or products from balanced symbol equations

Key Words:



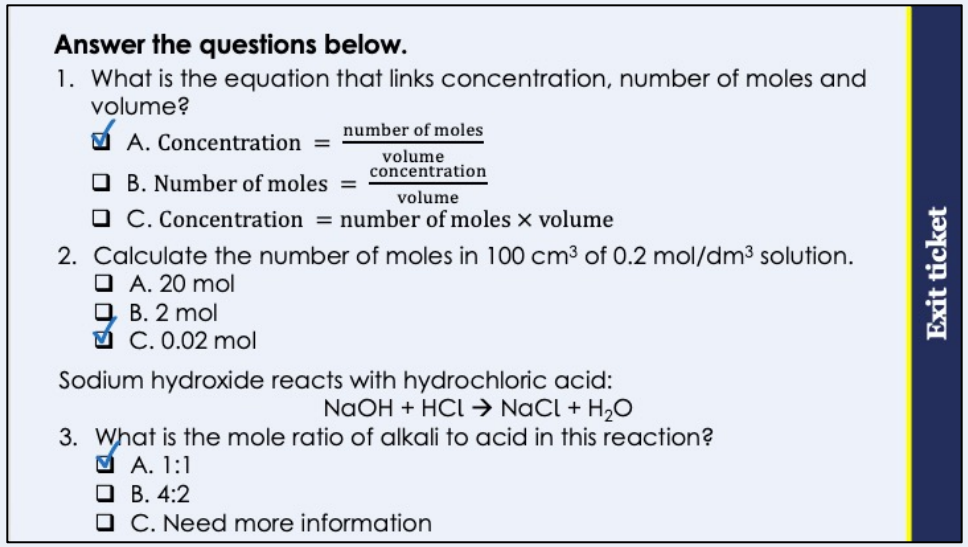
mass | **moles** | **M_r** | **mole ratio**

Lesson Objectives

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. What is the equation that links concentration, number of moles and volume?
   - ☑ A. $\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$
   - ☐ B. $\text{Number of moles} = \frac{\text{concentration}}{\text{volume}}$
   - ☐ C. $\text{Concentration} = \text{number of moles} \times \text{volume}$
2. Calculate the number of moles in 100 cm^3 of 0.2 mol/dm^3 solution.
   - ☐ A. 20 mol
   - ☐ B. 2 mol
   - ☑ C. 0.02 mol

Sodium hydroxide reacts with hydrochloric acid:

$NaOH + HCl \rightarrow NaCl + H_2O$

3. What is the mole ratio of alkali to acid in this reaction?
   - ☑ A. 1:1
   - ☐ B. 4:2
   - ☐ C. Need more information

Exit ticket

Fix-it

Mole Ratios

What does this mean in terms of moles?

$4\ K$	+	O_2	→	$2\ K_2O$
1 mol		0.25 mol		0.5 mol
12 mol		3 mol		6 mol
0.2 mol		0.05 mol		0.1 mol

4 moles of potassium reacts with 1 mole of oxygen to produce 2 moles of potassium oxide.

Complete the tables to show the mole ratios

N_2	+	$3\ H_2$	→	$2\ NH_3$
1 mol		3 mol		2 mol
0.2 mol		0.6 mol		0.4 mol
0.05 mol		0.15 mol		0.1 mol

$3\ C$	+	$2\ Fe_2O_3$	→	$4\ Fe$	+	$3\ CO_2$
3 mol		2 mol		4 mol		3 mol
0.75 mol		0.5 mol		1.0 mol		0.75 mol
0.075 mol		0.05 mol		0.1 mol		0.075 mol

Check for understanding

Moles, Mass and M_r

If we have a mass, we can calculate number of moles.

$$4\,K + O_2 \rightarrow 2\,K_2O$$

*Calculate the **mass** of **potassium oxide** that can be made from 78 g of **potassium**.*

mole ratio = 4 : 2

mole ratio = 2 : 1

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

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

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

$$\text{number of moles K2O} = 1\ \text{mol}$$

$$\text{number of moles K2O} = \frac{\text{mass}}{M_r}$$

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

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

Is this statement correct?

$$4\,K + O_2 \rightarrow 2\,K_2O$$

4 g of potassium reacts with 1 g of oxygen to produce 2 g of potassium oxide

Talk Task

Describe how you would solve this question.

$$2\,Mg + O_2 \rightarrow 2\,MgO$$

Calculate the mass of magnesium oxide that could be made from reacting 12 g of magnesium with oxygen.

mole ratio = 2 : 2

mole ratio = 1: 1

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

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

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

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

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

$$0.5\ \text{mol} = \frac{\text{mass}}{40}$$

$$\text{mass} = 20\ \text{g}$$

Talk Task

Identify the mistake(s) in this working.

$2\ H_2 \quad + \quad O_2 \quad \rightarrow \quad 2\ H_2O$

Calculate the mass of water that could be made from reacting 8 g of hydrogen with oxygen.

mole ratio = 2 : 2

mole ratio = 1: 1

$$\text{number of moles H2} = \frac{\text{mass}}{M_r}$$

$$\text{number of moles H2} = \frac{8}{4}$$

$$\text{number of moles H2} = 2\ \text{mol}$$

$$\text{number of moles H2O} = 2\ \text{mol}$$

$$\text{number of moles H2O} = \frac{\text{mass}}{M_r}$$

$$2\ \text{mol} = \frac{\text{mass}}{36}$$

$$\text{mass} = 72\ \text{g}$$

Check for understanding

Identify the mistake(s) in this working.

$$4\,P + 5\,O_2 \rightarrow 2\,P_2O_5$$

Calculate the mass of diphosphorus pentachloride that could be made from reacting 7.75 g of phosphorus with oxygen.

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

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

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

$$\text{number of moles P2O5} = 0.25\ \text{mol}$$

$$\text{number of moles } P_2O_5 = \frac{\text{mass}}{M_r}$$

$$0.25\ \text{mol} = \frac{\text{mass}}{142}$$

$$\text{mass} = 35.5\ \text{g}$$

Check for understanding

Drill

1. State the equation that links number of moles, mass and M_r.
2. Define relative formula mass.
3. State the units for mass.
4. State the units for number of moles.
5. Calculate the relative formula mass of ammonia (NH_3).
6. Calculate the relative formula mass of sodium oxide (Na_2O).
7. Calculate the number of moles in 34 g of ammonia.
8. Calculate the number of moles in 15.5 g of sodium oxide.
9. Calculate the mass of 0.1 moles of ammonia.
10. Calculate the mass of 0.05 moles of sodium oxide.

Check for understanding

Drill answers

1. $\text{number of moles} = \frac{\text{mass}}{M_r}$
2. The sum of the relative atomic masses in a compound (or formula).
3. g
4. mol
5. 14+(3x1) = 17
6. (23x2)+16 = 62
7. 2 mol
8. 0.25 mol
9. 1.7 g
10. 3.1 g

Check for understanding

Answer the questions below.

$$2\ Mg + O_2 \rightarrow 2\ MgO$$

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

Feedback

Lesson C4.3.7	
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
Thank you!