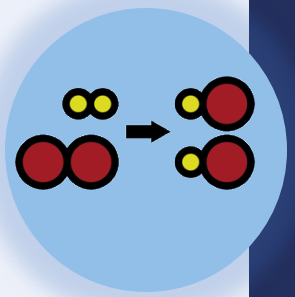
Prior Knowledge Review: Relative Formula Mass and Percentage by Mass

Answer the questions below.

1. State the chemical symbol for nitrogen.
   N
2. State how many atoms of each different element are present in $CaCO_3$.
   1 calcium atom, 1 carbon atom and 3 oxygen atoms
3. State where metals are found on the periodic table.
   On the left hand side.
4. Explain the difference between an element and a compound.
   An element is made of one type of atom but a compound is made from two or more types of atom (elements) chemically bonded together.
5. State the mass number of oxygen.
   16

Do Now



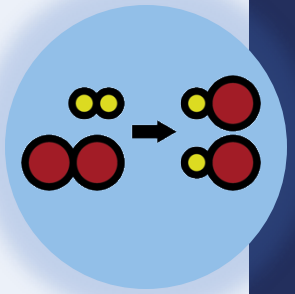
Prior Knowledge Review: Relative Formula Mass and Percentage by Mass

Do Now:

1. State the chemical symbol for nitrogen.
2. State how many atoms of each different element are present in $CaCO_3$.
3. State where metals are found on the periodic table.
4. Explain the difference between an element and a compound.
5. State the mass number of oxygen.

Drill:

1. Calculate 65% of 120.
2. A sample is made up of 40 g of water and 12 g of sugar. Calculate the percentage of the sample that is sugar.
3. Write the chemical symbol for potassium.



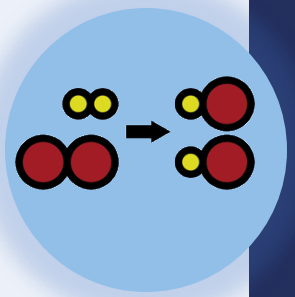
Do Now

Prior Knowledge Review: Relative Formula Mass and Percentage by Mass

Read Now:

The relative atomic mass of an element is the average mass of the atoms in the element compared to the mass of carbon-12. This means that relative atomic mass takes into account the mass of different isotopes of an element and how much of each isotope exists. The relative formula mass is the sum of the relative atomic masses of the elements in a compound. This is calculated using the relative atomic mass of each element present and how many of each atom are present in an element or compound. The relative atomic mass is taken from the mass number on the periodic table. The relative atomic mass of hydrogen is 1 and the relative atomic mass of oxygen is 16. Water has the formula H_2O, so its relative formula mass is 18 because it has two hydrogen atoms and one oxygen atom.

1. Define relative atomic mass.
2. Explain what is meant by isotopes.
3. Define relative formula mass.
4. State the relative formula mass of water.
5. Explain where this number comes from.

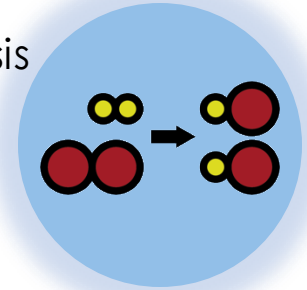


Do Now

Prior Knowledge Review
Relative Formula Mass and Percentage by Mass

C4.3.1

Science Mastery

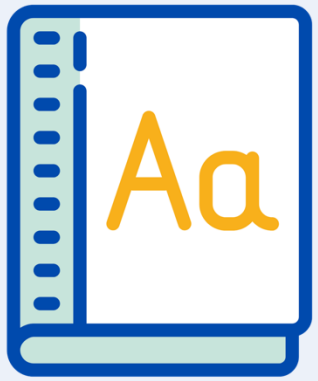


Lesson Objectives

Following this lesson, students will be able to:

- Define relative atomic mass and relative formula mass
- Calculate relative formula mass
- Calculate percentage by mass

Key Words:



relative atomic mass

relative formula mass

percentage by mass

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**.

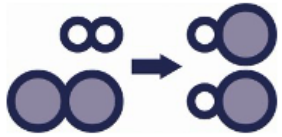
- The teacher should customise this slide as needed, to facilitate
  - **reteach**, **explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving**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

Fix-it

The Big Idea: Reactions rearrange matter

Science Mastery

Quantitative Chemistry



What does it mean to have an amount of a substance? How can I use information about different elements and compounds to predict the outcomes of reactions? How could we use this information in industrial processes to calculate how much of a reactant we need to make a certain amount of product?

Quantitative chemistry allows us to do calculations to find out about quantities of substances. This is a very important application of chemistry that is used in industry and research. Using the relative formula mass and number of moles of a substance we can look closely at the amount of reactants and productions in chemical reactions.

This is the **fourth** unit we are studying as part of the big idea: **Reactions Rearrange Matter**

In this unit, we will begin by recapping the ideas of relative atomic mass and relative formula mass, as well as how we can use relative formula mass to determine the percentage by mass of an element in a compound. We will then look at the concept of moles in chemistry and how we can use them in chemical equations to calculate reacting masses and limiting reactants.

We will also review the idea of concentration and learn how to calculate the concentration of different solutions. We will also look at acids, alkalis and neutralisation and the difference between strong and weak acids. Separate science students will also look at titrations of acids and alkalis and the volume of gases.

In this unit, we will revisit some key skills including balancing equations, calculating percentages and substituting into and solving equations.

TASKS:
What subject will this unit focus on? BIOLOGY CHEMISTRY PHYSICS
(circle the correct subject)

There are lots of keywords underlined above. List these into the two columns:

Words I know	Words I haven't seen before

Science Mastery

To answer before the unit:

1. What are you most excited to learn about in this topic?
2. What do you already know about this topic?
3. Why do you think it's important to learn how reactions rearrange matter?
4. What knowledge from previous science lessons might help us?
5. What questions do you have about this topic?

To answer at the end of the unit:

1. Tick off any words in the 'words I haven't seen before' column that you are now confident with. Circle any you still need more practice to use.
2. What have you most enjoyed about this unit?
3. What more would you like to learn about reactions as part of the big idea: 'Reactions Rearrange Matter'?

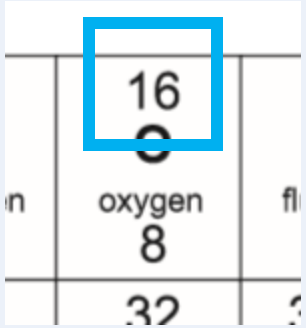
Introduction

Relative Atomic Mass

Relative means compared to something else

Atoms are very small and have very little mass. So instead of using their actual mass in kg, their **relative** masses are used. This is the **relative atomic mass** or $\mathbf{A_r}$.

The relative atomic mass of an **element** can be found in the **periodic table**.



Use a periodic table to find the A_r of carbon. 12

The **relative atomic mass** ($\mathbf{A_r}$) is the average mass of the atoms of an element compared to the mass of carbon-12.

State the relative atomic mass (A_r) for the following elements.

1. Potassium **39**
2. Iron **56**
3. Neon **20**
4. Hydrogen **1**
5. Gold **197**
6. Sulfur **32**
7. Helium **4**
8. Magnesium **24**
9. Carbon **12**

You'll need your Periodic Table for this!

Check for understanding

Relative Formula Mass

For compounds (different elements combined together chemically) we can calculate the **relative formula mass** or **M_r**.

This is calculated by adding up the relative atomic masses of the all the atoms in the **formula.**

CO_2 contains 1 carbon atom and 2 oxygen atoms.
A_r: C = 12
O = 16

To calculate the M_r:
M_r of CO_2 = 12 + (2 x 16) = 44

The **relative formula mass** (**M_r**) is the sum of the relative atomic masses of the elements in a compound.

Calculating relative formula mass

Magnesium nitrate, $Mg(NO_3)_2$

Mg is Magnesium, 24
N is Nitrogen, 14
O is Oxygen, 16

Magnesium: 1
Nitrogen: 2
Oxygen: 6

Magnesium: 24 x 1 = 24
Nitrogen: 14 x 2 = 28
Oxygen: 16 x 6 = 96

24 + 28 + 96 = 148

Steps:

1. Write out the **elements** and their **relative atomic masses**
2. Use the formula to write the **number of atoms** of each element
3. Calculate the **mass of the atoms** of each element (Relative atomic mass x number of atoms)
4. **Add up the total mass** of the elements (this is your M_r)

Calculating relative formula mass

Calcium carbonate, $CaCO_3$

Ca is Calcium, 40
C is Carbon, 12
O is Oxygen, 16

Calcium: 1
Carbon: 1
Oxygen: 3

Calcium: 40 x 1 = 40
Carbon: 12 x 1 = 12
Oxygen: 16 x 3 = 48

40 + 12 + 48 = 100

Steps:

1. Write out the **elements** and their **relative atomic masses**
2. Use the formula to write the **number of atoms** of each element
3. Calculate the **mass of the atoms** of each element (Relative atomic mass x number of atoms)
4. **Add up the total mass** of the elements (this is your M_r)

Calculating the relative formula mass (M_r)

1. Calculate the M_r for the following compounds.
   (A_r: H = 1; C = 12; N = 14; O = 16; K = 39)
   a. NH_3 **14 + (1 x 3) = 17**
   b. O_2 **16 x 2 = 32**
   c. H_2O **(1 x 2) + 16 = 18**
   d. KOH **39 + 16 + 1 = 56**

2. Use your understanding of the conservation of mass to find the M_r of CaO. (M_r: $CaCO_3$ = 100; CO_2 = 44)

$CaCO_3$ → CaO + CO_2

100 ? 44

100 – 44 = 56

100 = 56 + 44

Check for understanding

Percentage by mass

Percentage by mass is used to calculate the percentage by mass of an **element** within a **compound**

$$\%\ by\ mass = \frac{A_r \times number\ of\ atoms\ in\ a\ compound}{M_r\ of\ the\ compound} \text{ x } 100$$

What is the Percentage by mass of oxygen in water (H_2O)?

1. A_r of oxygen = 16
   Number of oxygen atoms = 1
2. M_r of H_2O = 18
3. $\frac{16}{18}$ = 0.888
4. 0.888 x 100 = 88.8%

Steps:

1. Find the A_r and count the **number of each type of atom**.
2. Find the M_r
3. **Divide** the **sum of the relative atomic masses** of all atoms you are investigating **by the relative formula mass**
4. **Multiply by 100**

Percentage by mass

The chemical octyl acetate smells like oranges.

It has the formula $C_{10}H_{20}O_2$.

Calculate the percentage by mass of oxygen in octyl acetate.

1. A_r of oxygen = 16
   Number of oxygen atoms = 2
2. M_r of $C_{10}H_{20}O_2$ = 172
3. $\frac{32}{172}$ = 0.186
4. 0.186 x 100 = <u>18.6%</u>

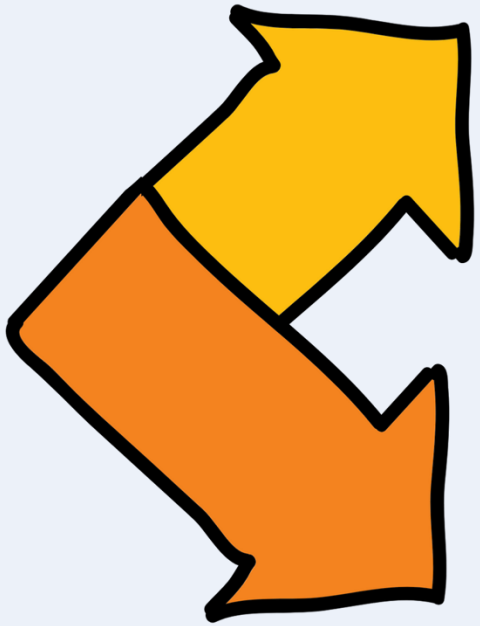
What is the percentage by mass of carbon in CO_2?

- ❑ A. $\frac{12}{16}$ X 100 = 75%
- ❑ B. $\frac{24}{32}$ X100 = 75%
- ❑ C. $\frac{12}{32}$ X100 = 37.5 %
- ☑ D. $\frac{12}{44}$ X 100 = 27.3%

1. A_r of carbon = 12
   Number of carbon atoms = 1
2. M_r of CO_2 =44
3. $\frac{12}{44}$ = 0.2727
4. 0.2727 x 100 = 27.3%

Check for understanding

What is the difference between these two terms?

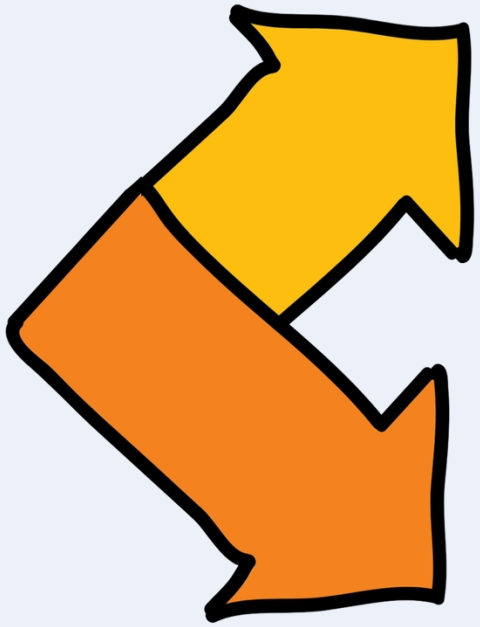


A_r

M_r

Talk Task

Which of these compounds contain a greater percentage of oxygen?



$CaCO_3$

H_2O

Talk Task

Drill

1. Define relative atomic mass.
2. State the relative atomic mass of carbon.
3. State the relative atomic mass of oxygen.
4. Define relative formula mass.
5. Calculate the relative formula mass of CO_2.
6. Calculate the relative formula mass of KOH.
7. State the equation to calculate percentage by mass.
8. Calculate the percentage by mass of potassium in potassium hydroxide (KOH).
9. Calculate the percentage by mass of chlorine in calcium chloride ($CaCl_2$).

Check for understanding

Drill answers

1. The average mass of the atoms of an element compared to the mass of carbon-12.
2. 12
3. 16
4. The sum of the relative atomic masses of the elements in a compound.
5. 12 + (16x2) = 44
6. 39 + 16 + 1 = 56
7. $\%\ \mathbf{by\ mass} = \frac{\mathbf{mass\ of\ element}}{\mathbf{mass\ of\ compound}} \times 100$
8. $\%\ \mathbf{by\ mass} = \frac{39}{56} \times 100 = 69.64\%$
9. $\%\ \mathbf{by\ mass} = \frac{40}{40+(35.5 \times 2)} \times 100 = 36.36\%$

Check for understanding

Answer the questions below.

1. Choose the correct definition of relative formula mass.

- ☐ A. The average mass of atoms of an element compared to the mass of Carbon-12
- ☑ B. The sum of relative atomic masses in a compound
- ☐ C. The percentage of a compound is made of a particular element

2. Calculate the relative formula mass of carbon dioxide (CO_2).

C = 12, O = 16

- ☐ A. 28
- ☑ B. 44
- ☐ C. 56

3. Calculate the percentage by mass of oxygen in carbon dioxide.

- ☐ A. 27.27%
- ☐ B. 36.36%
- ☑ C. 72.72 %

Exit ticket

Feedback

Lesson C4.3.1	
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!