

MOLAR MASS

Definition: The mass of one mole of any substance. (Unit: gram, g)

For example:

a) Carbon

$A_r = 12 \rightarrow$ molar mass = 12g because 12g = 1 mole of carbon atoms.

b) Water

$M_r = 18 \rightarrow$ molar mass = 18g because 18g = 1 mole of H_2O molecules.

c) Sodium chloride

$M_r = 58.5 \rightarrow$ molar mass = 58.5g because 58.5g = 1 mole of NaCl ions.

Try this yourself:

What is the molar mass of 1 mole of; 1) Nitrogen, N_2 ?, and 2) glucose, $C_6H_{12}O_6$?

Exercise 1

Find the mass of 1 mole of the following elements.

Element	Mass of 1 mole in g
Sodium	
Magnesium	
Calcium	
Potassium	

Formula for calculating molar mass:

$$\text{Number of moles} = \frac{\text{Mass (in g)}}{\text{Molar mass (in g)}}$$

No. of moles of an element	=	$\frac{\text{Mass of the element in grams}}{\text{Ar of the element}}$
No. of moles of a compound	=	$\frac{\text{Mass of the compound in grams}}{\text{Mr of the compound}}$

Example 1:***How many moles of atoms are there in 8g of helium?***Solution – Step 1

Find the molar mass of the element in grams. (Ar of He = ____)

The molar mass of helium, He = ____ g

Step 2

Use the formula to calculate the number of moles.

$$\text{No. of moles of He atoms} = \frac{\text{Mass (in g)}}{\text{Molar mass (in g)}}$$

$$= \underline{\hspace{2cm}}$$

$$= \underline{\hspace{2cm}}.$$

Example 2:***What is the mass of 0.4 moles of iron atoms?***Solution – Step 1

Find the molar mass of the element in grams. (Ar of iron = ____)

The molar mass of iron, Fe = ____ g

Step 2

$$\begin{aligned} \text{No. of moles of iron} &= \text{Mass} / \text{Molar mass} \\ \text{Mass of iron} &= \text{No. of moles} \times \text{Molar mass} \\ &= \underline{\hspace{1cm}} \times \underline{\hspace{1cm}} = \underline{\hspace{2cm}}. \end{aligned}$$

Exercise 2

Convert the following masses into moles.

	No. of moles
20g of Calcium	
28g of Potassium	
40g of Copper (II) sulphate, CuSO_4	
53g of Sodium carbonate, Na_2CO_3	

Exercise 3

Find the relative molecular mass, Mr of the following substances.

Substance	Mr
2 moles of chlorine gas, Cl_2	
1 mole of oxygen gas, O_2	
0.2 moles of Fluorine gas, F_2	
0.025 moles of sodium hydroxide, NaOH	

EMPIRICAL FORMULA

It shows the _____ or the _____ number ratio of all the different atoms present in a compound.

Example 1: Calculating the empirical formula of a compound.

A sample of an oxide of copper contains 8g of copper combined with 1g of oxygen. Find the empirical formula of the compound.

Solution

Step 1: elements present	Copper (Cu)	Oxygen (O)
Step 2: Mass (g)		
Step 3: Molar Mass / Ar / Mr		
Step 4: No. of moles		
Step 5: Divide by the smallest number.		
Empirical formula is		

Example 2: Calculating the empirical formula from percentage composition.

An oxide of sulphur contains 40% sulphur and 60% oxygen by mass. Find the empirical formula.

Solution

Step 1: elements present	Sulphur (S)	Oxygen (O)
Step 2: % Mass		
Step 3: Molar Mass / Ar / Mr		
Step 4: No. of moles		
Step 5: Divide by the smallest number.		
Empirical formula is		

Exercise 4: Calculate the empirical formula of the following compounds.

- a) 0.62g of phosphorus combined with 0.48g of oxygen.

The empirical formula is _____

- b) 1.4g of nitrogen combined with 0.30g of hydrogen.

The empirical formula is _____

- c) 0.69g of sodium forms 0.93g of an oxide of sodium. Calculate the simplest formula of the oxide.

Mass of Oxide	
Mass of Sodium	
So, the mass of oxygen	

The empirical formula is _____

d) Sulphur 50%, Oxygen 50%

The empirical formula is _____

e) Carbon 75%, hydrogen 25%

The empirical formula is _____

f) Magnesium sulphate crystals contain 48.8% of magnesium sulphate and 51.2% water.

The empirical formula is _____

MOLECULAR FORMULA

- It is the _____ or _____ number of each atom present in a molecule of a compound.
- Sometimes the number ratio cannot be made any simpler than the actual number of atoms in the molecule. Then the empirical formula and molecular formula will be the **same**.

Exercise 5: Calculate the molecular formula of the following compounds.

1. Analysis shows the empirical formula of a compound to be CH_2O . Its relative molecular mass is 60. What is its molecular formula?
2. What is the molecular formula of a compound which has an empirical formula $\text{C}_2\text{H}_6\text{O}$ and a relative molecular mass of 46?
3. The empirical formula of butane is CH_2 . Given the relative molecular mass is 56, determine the molecular formula of butane.