

A Mole is a Unit

Plan

- Counting Atoms
- What is a mole
- Mass of compounds

Program of Studies

3 h) define the mole as the amount of an element containing 6.02×10^{23} atoms (Avogadro's number) and apply the concept to calculate quantities of substances made of other chemical species (*e.g., determine the quantity of water that contains 6.02×10^{23} molecules of H₂O*)

3 i) interpret balanced chemical equations in terms of moles of chemical species, and relate the mole concept to the law of conservation of mass

Counting

I have 500g of aluminum metal. How many atoms is that?

We are going to learn how to count atoms, so that we can answer this for elements, and even compounds!

Counting Atoms

Atoms are really small, and there are a lot of them.

Even the amount of atoms in my small piece of aluminium is in the billions of billions.

We'll take an idea from chicken farmers to help us!

Counting Atoms

When you buy eggs, they are usually in dozens. We buy 12 eggs at a time, but they are grouped up so we don't have to count them individually!

We'll use something similar for atoms. We will group them up so they're easier to count.



The Mole

There are way more than 12 atoms in any sample of a substance, so we have to use a different unit

The unit we use is called a “mole”

While one dozen represents 12 (eggs, donuts, etc)

One mole represents 6.02×10^{23} (eggs, donuts, atoms, etc)



Aside – Scientific Notation

In science, we often deal with very large or very small numbers. We might only know the first few digits of something to any precision

In order to use the proper number of digits, and to save space, we use scientific notation.

Scientific notation tells us how big or small something is

Aside – Scientific Notation

55

550

5500

0.55

Aside – Scientific Notation

Mass of the Earth: 5 972 200 000 000 000 000 000 000 kg

Size of a virus: 0. 000 000 021 m

Aside – Scientific Notation

How can we enter this into our calculator?

The Mole

The number, 6.02×10^{23} is called **Avogadro's Number**
It is the number of atoms in a 12g sample of carbon.

One mole of any substance contains 6.02×10^{23} atoms

We will use moles when writing chemical equations,
but we need to learn how to relate them to something
measurable (mass)



Converting from mass to moles

To convert from grams to moles, we need the molar mass of the substance we are working with

The molar mass is the number of grams of a pure substance in one mole of that substance

The units of a molar mass is given in grams per mole (g/mol)

13	Al
aluminum	
26.98	
<hr/>	
Al ³⁺	
aluminium	

Converting from mass to moles

To convert from grams to moles, we need the molar mass of the substance we are working with and the following equation:

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

n = number of moles

m = mass of substance (in grams)

M = molar mass of substance (in g/mol)

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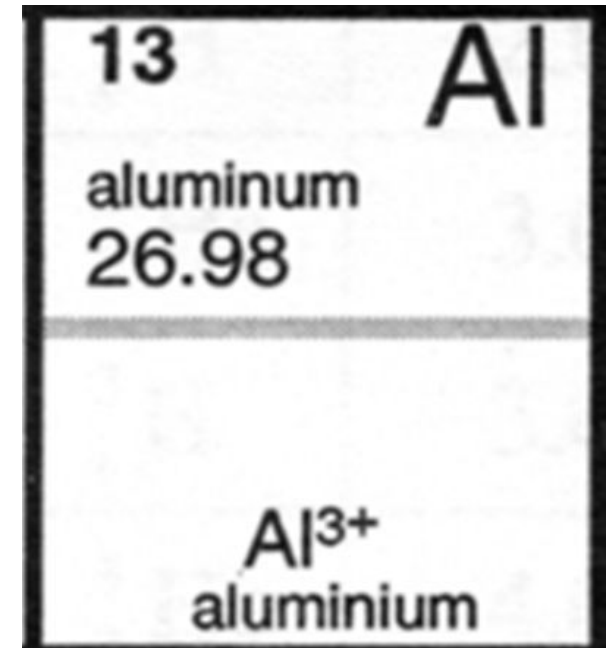
n = number of moles

m = mass of substance (in grams)

M = molar mass of substance (in g/mol)

Example

How many moles of atoms are present in my 500 g piece of aluminium?



Example

How many moles of atoms are present in 75 g of boron?

How many atoms is that?

What is the mass of 3.2 mol of krypton?

Example

A silicon chip used in an integrated circuit of a microchip has a mass of 5.68 mg. how many silicon atoms are present in this chip?

3 step problem:

Example

Cobalt is added to steel to improve its corrosion resistance. Calculate both the number of moles of atoms in a sample containing 5.00×10^{20} atoms, and the mass of the sample.

Molar Mass of a Compound

A chemical compound is made of more than one element.

To determine the molar mass of a compound, we add together the molar masses of all its components

Ex: Molar mass of H_2O

$2 \times M_{\text{H}}$ (1.01 g/mol)

$1 \times M_{\text{O}}$ (16.00 g/mol)

Total: $M_{\text{H}_2\text{O}} = 18.02$ g/mol

Molar Mass of a Compound

Example: Fructose, $C_6H_{12}O_{6(aq)}$ is a sugar that is found in plants, and often added to processed foods. High fructose corn syrup is added to soft drinks as a sweetener.

- a) Calculate the molar mass of fructose

- b) A can of pop contains 24.0g of fructose. How many moles is this?