BYJU'S Classes

CHEMISTRY

MOLE CONCEPT

WHY THE CONCEPT OF MOLE WAS INVENTED?

NOTES

What you will learn

- Why do we study the mole concept?
- Dozen analogy
- What is a mole?
- Mole-particle conversion

Why do we study the Mole Concept?

- The study of the mole concept helps us to connect the micro-world to the physically observable macro-world. Mole is a bridge between the atom and the macroscopic amount.
- Physical quantities like weight, volume, density, pressure are not measurable at particle level, but can be measured after the study of the mole concept.

Dozen Analogy

$$\textit{Number of dozens of item} = \frac{\textit{Number of items}}{12}$$

- 24 eggs $= \frac{24}{12} = 2$ dozen eggs
- 6 marbles $= \frac{6}{12} = \frac{1}{2}$ dozen marbles

Number of items = Number of dozens of item × 12

- 2 dozen eggs = 2 × 12 = 24 eggs
- $\frac{1}{2}$ dozen marbles $= \frac{1}{2} \times 12 = 6$ marbles

BOARDS MAIN

What is a Mole?

Mole is a unit to measure a relatively large number of entities such that 1 mole of an item contains 6.023×10^{23} entities.

1 dozen = 12 entities

Similarly, 1 mole = 6.023×10^{23} entities

Definition of mole:

1 mole of a substance is defined as the same number of entities as the number of atoms present in 12 *g* of ^{12}C isotope.

12 *g* of $^{12}C = 6.023 \times 10^{23}$ atoms of carbon = 1 mole of ^{12}C atoms

Avogadro's number

Avogadro's number is a number used to represent quantities and its value is the same as the number of entities of an item present in 1 mole of that item, i.e., 6.023×10^{23}. It is represented by N_A.

1 kilo chocolates = 10^3 chocolates | N_A chocolates = 6.023×10^{23} chocolates

1. Avogadro's number is a unitless quantity.
2. Mole is just a number and does not represent any physical quantity.
3. The value of $N_A = 6.023 \times 10^{23}$ is an approximate value.
4. Initially, when hydrogen was taken as reference, 1 mole was defined as the same number of entities as the number of atoms present in 1 *g* of ^1H isotope. Later, oxygen was taken as reference and 1 mole was defined as the same number of entities as the number of atoms present in 16 *g* of ^{16}O isotope.
5. Changing the references from hydrogen (^1H) to oxygen (^{16}O) and then carbon (^{12}C) has also changed the value of Avogadro's number.

BOARDS MAIN

Mole-Particle Conversion

Number of entities = Number of moles × N_A

Number of moles = Number of entities / N_A

Conversion: Mole to particle

Find **the number of CO_2 molecules** in **2 moles** of a pure sample **of CO_2 molecules**.

Solution:

Given,

Number of moles of CO_2 molecules = 2 *mol*

Number of CO_2 molecules = Number of moles × N_A = $2 \times 6.023 \times 10^{23} = 1.2046 \times 10^{24}$

Conversion: Mole to particle

Find the **number of He atoms** in **8/3 moles** of a **pure sample of He atoms**.

Solution:

Given,

Number of moles of He atoms = $\frac{8}{3}$ *mol*

Number of He atoms = Number of moles × N_A = $\frac{8}{3} \times 6.023 \times 10^{23} = 1.606 \times 10^{24}$

Conversion: Mole to particle

Find the **number of H_2SO_4 molecules** in **10^{-9} moles** of a **pure H_2SO_4 sample**.

Solution:

Given,
Number of moles of H_2SO_4 = 10^{-9} *mol*
Number of H_2SO_4 molecules = Number of moles × N_A = $10^{-9} \times 6.023 \times 10^{23} = 6.023 \times 10^{14}$

Conversion: Mole to particle

Find **the number of $Na_2SO_4.5H_2O$ formula units** in **5 kilomoles** of a **pure $Na_2SO_4.5H_2O$ sample**.

Solution:

Step 1:

Converting kilomoles into moles.

1 *kilomole* = 10^3 *mol*

∴ Number of moles of $Na_2SO_4.5H_2O$

= 5 × 1000 = 5 × 10^3 *mol*

Step 2:

Finding the number of formula units from the given amount of moles.

Number of formula units = Number of moles × N_A

= $5 \times 10^3 \times 6.023 \times 10^{23} = 3.011 \times 10^{27}$

Conversion: Particle to mole

Find **the number of moles of CO_2 molecules** in a sample containing **3.0115×10^{23} CO_2 molecules**.

Solution:

Given,

Number of molecules of CO_2 = 3.0115×10^{23}

Number of moles of CO_2 = $\frac{\textit{Number of particles}}{N_A} = \frac{3.0115 \times 10^{23}}{6.023 \times 10^{23}} = 0.5\ mol$

Conversion: Particle to mole

Find **the number of moles of He atoms** in a sample containing **3.0115 × 10^{40} He atoms**.

Solution:

Given,

Number of He atoms = 3.0115 × 10^{40}

Number of moles of He = $\frac{\textit{Number of particles}}{N_A} = \frac{3.0115 \times 10^{40}}{6.023 \times 10^{23}} = 5 \times 10^{16}$ *mol*

Conversion: Particle to mole

Find the number of **moles of H_2SO_4 molecules** in a sample containing **10^{10} H_2SO_4 molecules.**

Solution:

Given,

Number of molecules of H_2SO_4 = 10^{10}

Number of moles of H_2SO_4 = $\frac{\textit{Number of particles}}{N_A} = \frac{10^{10}}{6.023 \times 10^{23}} = 1.66 \times 10^{-14}$ *mol*

Conversion: Particle to mole

Find the number of **moles of H_2SO_4 molecules** in a sample containing **10 H_2SO_4 molecules.**

Solution:

Given,

Number of molecules of H_2SO_4 = 10

Number of moles of H_2SO_4 = $\frac{\textit{Number of particles}}{N_A} = \frac{10}{6.023 \times 10^{23}} = 1.66 \times 10^{-23}$ *mol*

Finding weight of an entity using mole-particle conversion

Find the **mass of one mole of chalk**, if the mass of **1 chalk is 20 *g***. Compare it with the mass of the **Moon**. (**Mass of Moon = 7.34 × 10^{22} *kg***)

Solution:

Given,

Mass of one chalk = 20 g

Step 1:

Finding the mass of 1 mole of chalk.

Mass of one mole of chalk = Mass of one chalk × N_A

$20 \times 6.023 \times 10^{23} = 1.2046 \times 10^{25}\ g$

Unit conversion grams to kilograms,
$1\ g = 10^{-3}\ kg$

$1.2046 \times 10^{25}\ g = 1.2046 \times 10^{22}\ kg$

Step 2:

Comparing the total mass of chalk to the mass of the Moon.

$$\frac{7.34 \times 10^{22}\ kg}{1.2046 \times 10^{22}\ kg} = 6.093$$

Mass of the Moon is approximately 6 times greater than the mass of one mole of chalk.

Finding the required time using mole-particle conversion

How many **years** would it take to **count 1 mole of rupees**, if a machine can count **1 billion rupees/second**?

Solution:

Given,

The amount counted by the machine per second is 1 billion rupees.

Step 1:

Calculating the time required in seconds to count 1 mole of rupees.

1 billion = 10^9

1 mole of rupees = 6.023×10^{23} *rupees*

Time taken to count 1 mole of rupees = $\frac{6.023 \times 10^{23}\ rupees}{10^9\ rupees\ s^{-1}} = 6.023 \times 10^{14}\ s$

Step 2:

Converting the time required in years.

$$= \frac{6.023 \times 10^{14}}{60 \times 60 \times 24 \times 365} = 1.91 \times 10^7\ years$$