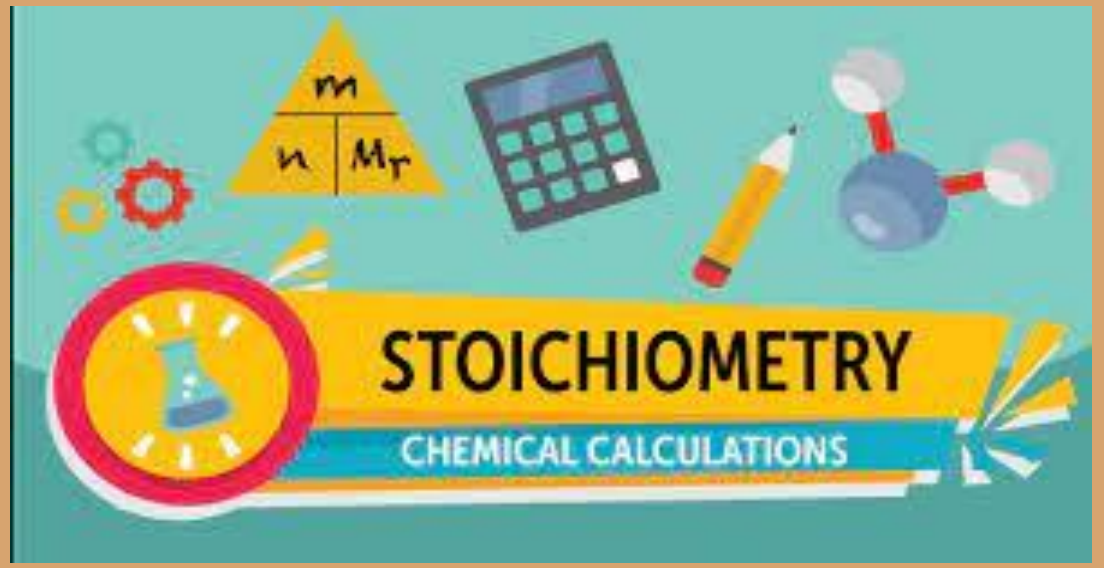
CHEMISTRY L010

QENA STUDENTS CLUB

STOICHIOMETRY

These numerical relationships are known as reaction stoichiometry, a term derived from the Ancient Greek words *stoicheion* ("element") and *metron* ("measure"). In this article, we'll look at how we can use the stoichiometric relationships contained in balanced chemical equations to determine amounts of substances consumed and produced in chemical reactions.



MOLE

In chemistry, a mole is a unit used to measure the amount of substance. One mole of a substance contains Avogadro's number of particles, which is approximately 6.022. $\times 10^{23}$ entities. These entities can be atoms, molecules, ions, or any other particles, depending on the substance being measured.

The mole allows chemists to work with amounts of substances on a macroscopic scale, facilitating calculations involving mass, volume, and number of particles. For example, the molar mass of a substance is the mass of one mole of that substance, expressed in grams per mole (g/mol).

MASS/ MOLAR MASS

Number of moles

VOLUME/22.4

NUMBER OF PARTICLES/ AVOGADRO'S NUMBER

1)**A sample of ammonia has a mass of 43.5 g. How many molecules are in this sample?**

Answer

Avogadro's number tells us there are approximately 6.02x10^23 molecules in one mole of any substance. Therefore, the number of ammonia molecules in our sample is approximately 2.56 mol x 6.02x10^23 molecules/mol =1.54x10^24 molecules.

2) **How many moles of hydrogen sulfide are contained in a 49.7-g sample of this gas?**

The Molar mass of H2S is 34.09 g/mol.
By dividing the sample weight (49.7 g) by this molecular weight, we find there are 1.46 moles of H2S in the sample.

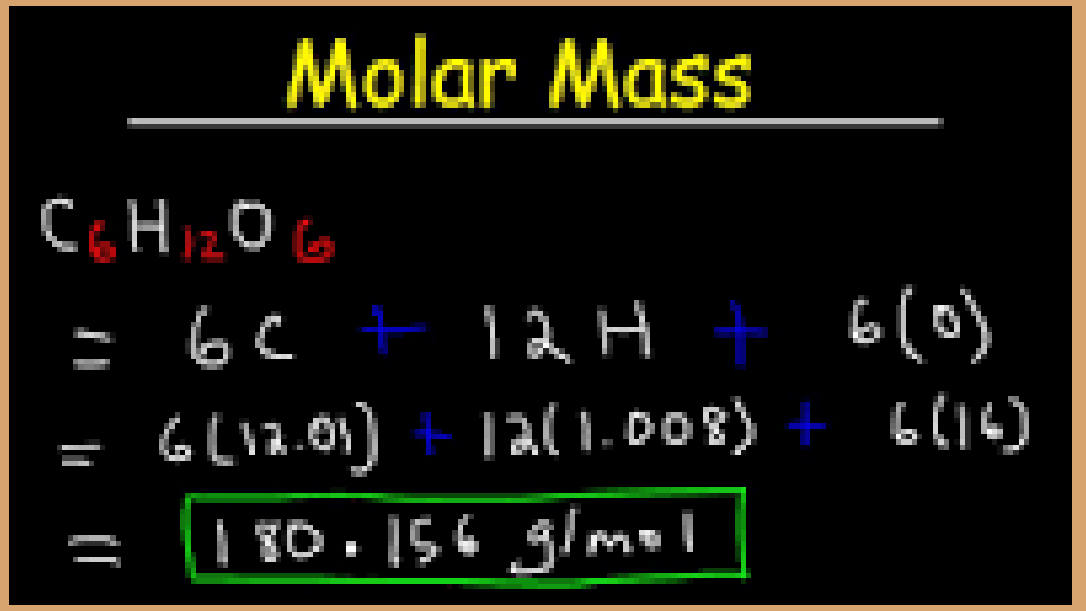
#**Try to solve it**#

What is the mass of 4 atom(s) of copper in grams?

How many oxygen atom are there in 22 gram of carbon dioxide?

MOLAR MASS

The molar mass is the weight of one sample mole. Connect the atomic masses (atomic weights) of all atoms within the molecule to calculate the molar mass. Find the atomic mass for each element using the mass shown in the Periodic Table or Atomic Weight Table.
Multiply the subscript (number of atoms) times that element's atomic mass and add the masses of all the elements in the molecule to obtain the molecular mass. Molar mass is typically expressed in either gram (g) or kilograms (kg).



Solved Example

Question:

What is the molar mass of sodium carbonate, Na_2CO_3?

Solution:

Since sodium carbonate contains two atoms of sodium, one atom of carbon and three atoms of oxygen. The molecular weight would be

Na : 2 x 23.0 = 46

C : 1 x 12.0 = 12

O : 3 x 16 = 48

When we add up the total values, 46 + 12 + 48 = 106

Therefore, the molar mass of Na_2CO_3 is 106 g/mol.

Standard temperature and pressure

STP is the abbreviation of the standard temperature and pressure.
the pressure is 1atm and the temperature is 0c
At the STP 1 mole of any gas takes up 22.4L of volume

Suppose we have 1 mole of an ideal gas at 0°C (273.2 K) and 1 atm. From the ideal gas law, the volume of the gas is given by

$$V = \frac{nRT}{P} = \frac{(1.000\ \cancel{\text{mol}})(0.08206\ \text{L} \cdot \cancel{\text{atm}}/\cancel{\text{K}} \cdot \cancel{\text{mol}})(273.2\ \cancel{\text{K}})}{1.000\ \cancel{\text{atm}}} = 22.42\ \text{L}$$

PERCENT YIELD

Percent Yield

Percent yield refers to the percent ratio of actual yield to the theoretical yield. In chemistry, yield is a measure of the quantity of moles of a product formed in relation to the reactant consumed, obtained in a chemical reaction, usually expressed as a percentage. The amount of product actually made compared with the maximum calculated yield is called the percentage yield. Let us understand the percent yield formula using solved examples.

Percent Yield = (Actual Yield / Theoretical Yield) × 100 %

- **Actual yield - it gives the amount of product obtained from a chemical reaction**
- **Theoretical yield - it gives the amount of product obtained from the stoichiometric or balanced equation, using the limiting reactant to determine the product**
- **Units for both actual and theoretical yield need to be the same (moles or grams)**
- **Examples on Percent Yield**
- Example 1: During a chemical reaction, 0.5 g of product is made. The maximum calculated yield is 1.6 g. What is the percent yield of this reaction?

#Try to solve it#

Solution:

We know that according to Percent Yield Formula,

Percentage yield = (Actual yield/Theoretical yield)× 100%

= 0.5/1.6× 100%

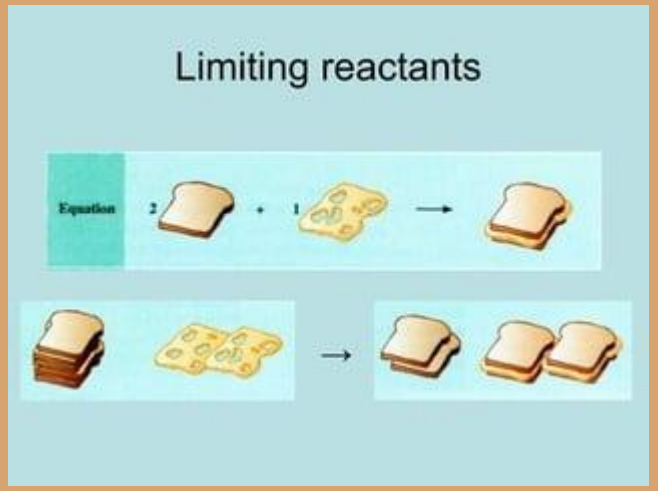
= 31.25%

Therefore, the percentage yield of this reaction is 31.25%.

LIMITING REAGENT

Definition: **The limiting reactant (or limiting reagent) is the reactant that is consumed first in a chemical reaction, limiting the amount of product that can be formed. There are numerous methods for determining the limiting reactant, but they all rely on mole ratios from the balanced chemical equation.**

The theoretical yield is the amount of product that can be formed based on the limiting reactant. In practice, the actual yield, or amount of product collected, is almost always less than the theoretical yield. The actual yield is typically expressed as a percentage yield, indicating what percentage of the theoretical yield was obtained.



1.Write and Balance the Chemical Equation: Write the balanced chemical equation for the reaction.

2.Convert Given Quantities to Moles: Convert the given quantities of each reactant (usually given in grams) to moles using the molar mass of each substance.

3.Determine the Mole Ratio: Use the coefficients from the balanced equation to set up a mole ratio between the reactants.

4.Identify the Limiting Reagent: Compare the actual mole ratio of the reactants to the mole ratio predicted by the balanced equation. The reactant that gives the smaller amount of product is the limiting reagent.

5.Calculate the Amount of Product: Use the amount of the limiting reagent to calculate the amount of product formed.

How many grams of H2O will be formed when 32.0 g H2 is mixed with 12.0 g of O2 and allowed to react to form water?

Answer

$H_2 + O_2 \longrightarrow H_2O$

#First thing balance the equation#

$2H_2 + O_2 \longrightarrow 2H_2O$

32g+12g ⟹

Number of moles =

32/2 O2 12/2*16

16 mole 0.6 mole

Then O2 is the limiting reagent

O2 ⟹ H2O

32 g ⟹ 2*18 g

12g ⟹

H2o=12*36/32=13.5 g

Iron is biologically important in the transport of oxygen by red blood cells from the lungs to the various organs of the body. In the blood of an adult human, there are approximately 2.64 1013 red blood cells with a total of 2.90 g of iron. On the average, how many iron atoms are present in each red blood cell? (molar mass Fe = 55.85 g/mol)

A) $8.44\ {}^{*}10^{-10}$

B) $1.18\ x10^{9}$

C) $3.13\ x\ 10^{22}$

D) $2.64\ x\ 10^{13}$

ANS: B

. You have a sample of zinc (Zn) and a sample of aluminum (Al). You have an equal number of atoms in each sample. Which of the following statements concerning the masses of the samples is true?

A) The mass of the zinc sample is more than twice as great as the mass of the aluminum sample.

B) The mass of the zinc sample is more than the mass of the aluminum sample, but it is not twice as great.

C) The mass of the aluminum sample is more than twice as great as the mass of the zinc sample.

D) The mass of the aluminum sample is more than the mass of the zinc sample, but it is not twice as great.

ANS: A

How many moles of hydrogen sulfide are contained in a 49.7-g sample of this gas?
A) 0.686 mol
B) 1.46 mol
C) 83.8 mol
D) 24.7 mol
E) 2.92 mol
ANS: B

. What is the molar mass of ethanol (C_2H_5OH)?
A) 45.06 g/mol
B) 34.06 g/mol
C) 46.07 g/mol
D) 30.03 g/mol
ANS: C

For which compound does 0.256 mole weigh 12.8 g?
A) C_2H_4O
B) CO_2
C) CH_3Cl
D) C_2H_6 E) none of these
ANS: C

Roundup, an herbicide manufactured by Monsanto, has the formula $C_3H_8NO_5P$. How many moles of molecules are there in a 295.1-g sample of Roundup?

A) 0.5729
B) 2.137
C) 1.745
D) 16.39

ANS: C

Calculate the molar mass of barium sulfite.

A) 233.40 g/mol
B) 201.40 g/mol
C) 354.73 g/mol
D) 514.87 g/mol
E) 217.40 g/mol

ANS: E

Phosphorus has the molecular formula P4, and sulfur has the molecular formula S8. How many grams of phosphorus contain the same number of molecules as 4.23 g of sulfur?

A) 2.04 g
B) 0.490 g
C) 4.08 g
D) 4.23 g

ANS: A

Phosphoric acid can be prepared by reaction of sulfuric acid with “phosphate rock” according to the equation: Ca3(PO4)2 + 3H2SO4 → 3CaSO4 + 2H3PO4 What is the molar mass of Ca3(PO4)2?

A) 310.18 g/mol
B) 87.05 g/mol
C) 278.18 g/mol
D) 215.21 g/mol

ANS: A

What is the mass of a 6.761-mol sample of sodium hydroxide?
A) 40.00 g
B) 270.4 g
C) 162.3 g
D) 5.916 g
E) 0.1690 g
ANS: B

The molar mass of the compound formed by potassium and selenium is
A) 157.2 g/mol
B) 197.0 g/mol
C) 118.1 g/mol
D) 276.0 g/mol
ANS: A

What is the molar mass of cryolite (Na3AlF6)?
A) 209.9 g/mol
B) 185.3 g/mol
C) 210.0 g/mol
D) 104.2 g/mol
E) 68.97 g/mol
ANS: C

One molecule of a compound weighs 2.93 *10^22 g. The molar mass of this compound is:
A) 2.06 g/mol
B) 567 g/mol
C) 168 g/mol
D) 176 g/mol
ANS: D

NaHCO3 is the active ingredient in baking soda. How many grams of oxygen are in 0.52 g of NaHCO3?

A) 0.099 g
B) B) 0.019 g
C) 6.19 *10*3 g
D) 0.033 g
E) 0.30 g

ANS: E

What would be the g Al / mole S ratio for the product of a reaction between aluminum and sulfur?

A) 26.98 g Al / mol S
B) 80.94 g Al / mol S
C) 40.47 g Al / mol S
D) 53.96 g Al / mol S
E) 17.99 g Al / mol S

ANS: E

The limiting reactant in a reaction
A) has the lowest coefficient in a balanced equation
B) is the reactant for which you have the fewest number of moles
C) has the lowest ratio of moles available/coefficient in the balanced equation
D) has the lowest ratio of coefficient in the balanced equation/moles available
ANS: C

Suppose the reaction $Ca_3(PO_4)_2 + 3H_2SO_4 \rightarrow 3CaSO_4 + 2H_3PO_4$ is carried out starting with 153 g of $Ca_3(PO_4)_2$ and 76.8 g of H_2SO_4. How much phosphoric acid will be produced?
A) 76.7 g
B) 51.1 g
C) 229.8 g
D) 115.1 g
ANS: B

Which of the following samples contains the greatest number of moles of carbon atoms? A) 58 g of C_4H_{10}
B) 46 g of C_2H_5OH
C) 44 g of CO_2
D) 180 g of $C_6H_{12}O_6$
ANS: D

SO2 reacts with H2S as follows: 2H2S + SO2 □ 3S + 2H2O When 7.50 g of H2S reacts with 12.75 g of SO2, which statement applies?

A) 6.38 g of sulfur are formed.

B) B) 10.6 g of sulfur are formed.

C) 0.0216 moles of H2S remain.

D) 1.13 g of H2S remain..

ANS: B

How many grams of H2O will be formed when 32.0 g H2 is mixed with 12.0 g of O2 and allowed to react to form water?

A) 13.5 g

B) 286 g

C) 6.8 g

D) 3.4 g

ANS: A

Given the equation $3A + B \rightarrow C + D$, you react 2 moles of A with 1 mole of B. Which of the following is true? A) A is the limiting reactant because of its higher molar mass.
B) A is the limiting reactant because you need 3 moles of A and have 2.
C) B is the limiting reactant because you have fewer moles of B than A.
D) B is the limiting reactant because 3 A molecules react with 1 B molecule.
ANS: B

Equal masses (in grams) of hydrogen gas and oxygen gas are reacted to form water. Which substance is limiting?
A) Oxygen gas is limiting.
B) Hydrogen gas is limiting.
C) Water is limiting.
D) Nothing is limiting.
. ANS: A

If 45.0 g of O2 are mixed with 45.0 g of H2 and the mixture is ignited, what mass of water is produced? A) 45.0 g
B) 50.7 g
C) 79.9 g
D) 25.3 g
E) 90.0 g
ANS: B

What is the molar mass of tetraphosphorus decaoxide?
A) 140 g/mol
B) 410 g/mol
C) 253 g/mol
D) 204 g/mol
E) 284 g/mol
ANS: E

Which of the following samples contains the greatest number of moles of carbon atoms?

A) 58 g of C_4H_{10}

B) 46 g of C_2H_5OH

C) 44 g of CO_2

D) 180 g of $C_6H_{12}O_6$

ANS: D

Lo 10 chemistry g 10

1 STOICHIOMETRY

is a branch of chemistry that deals with the quantitative relationships between reactants and products in chemical reactions. It involves calculating the amounts of reactants required or products formed in a chemical reaction based on the balanced chemical equation.

2 MOLE

A mole is a unit of measurement used in chemistry to express the amount of a substance. One mole of any substance contains approximately 6.022×10^23 elementary entities, such as atoms, molecules, ions, or formula units. This number is known as Avogadro's number.

3 MOLAR MASS

MOLAR MASS IS THE MASS OF ONE MOLE OF A SUBSTANCE. IT IS EXPRESSED IN GRAMS PER MOLE (G/MOL). THE MOLAR MASS OF AN ELEMENT CAN BE FOUND ON THE PERIODIC TABLE BY ADDING UP THE ATOMIC MASSES OF ITS CONSTITUENT ATOMS. FOR COMPOUNDS, THE MOLAR MASS IS CALCULATED BY SUMMING THE ATOMIC MASSES OF ALL THE ATOMS IN THE CHEMICAL FORMULA.

4 STANDARD TEMPERATURE AND PRESSURE (STP)

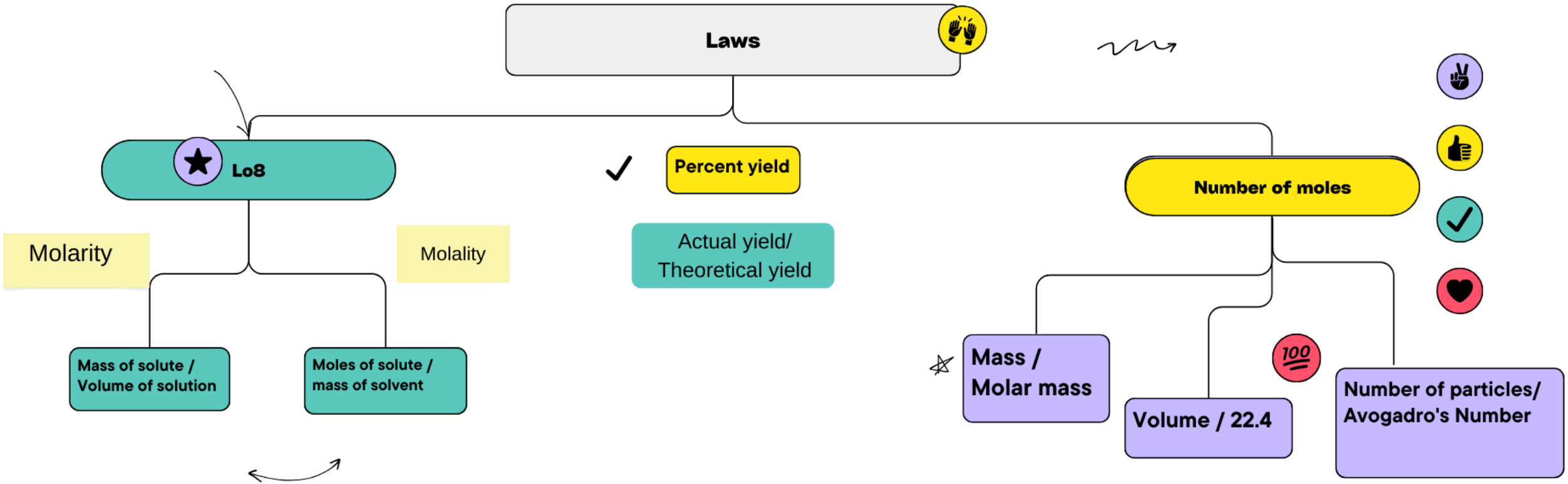
STP IS A SET OF STANDARD CONDITIONS USED FOR MEASURING AND COMPARING PROPERTIES OF GASES. THE STANDARD TEMPERATURE IS 0∘0∘ CELSIUS (273.15 KELVIN), AND THE STANDARD PRESSURE IS 1 ATMOSPHERE (ATM) OR 101.3 KILOPASCALS (KPA). .

5 Percentage yield:

Percentage yield is a measure of the efficiency of a chemical reaction. It represents the ratio of the actual yield (the amount of product obtained in a reaction) to the theoretical yield (the maximum amount of product that could be obtained under ideal conditions), expressed as a percentage. It is calculated using the formula:

6 Limiting reagent

The limiting reagent, also known as the limiting reactant, is a fundamental concept in chemistry, particularly in stoichiometry. It refers to the reactant that is completely consumed first in a chemical reaction.


Laws
Lo8
Molarity
Molality
Mass of solute / Volume of solution
Moles of solute / mass of solvent
Percent yield
Actual yield/ Theoretical yield
Number of moles
Mass / Molar mass
Volume / 22.4
Number of particles/ Avogadro's Number

THANKS

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