STEP - 1 Revise mole concept

STEP-2 Watch this video

https://www.youtube.com/watch?v=TEl4jeETVmg

STEP-3 Read this topic from N.C.E.R.T

Links which explain how calculation is done

https://youtu.be/wI56mHUDJgQ

https://youtu.be/BO9M1hbs88s

https://youtu.be/BO9M1hbs88s

https://youtu.be/04AOsVQI9Bo(indian)

https://youtu.be/yIwFqIt3NQo

# Mole Concept

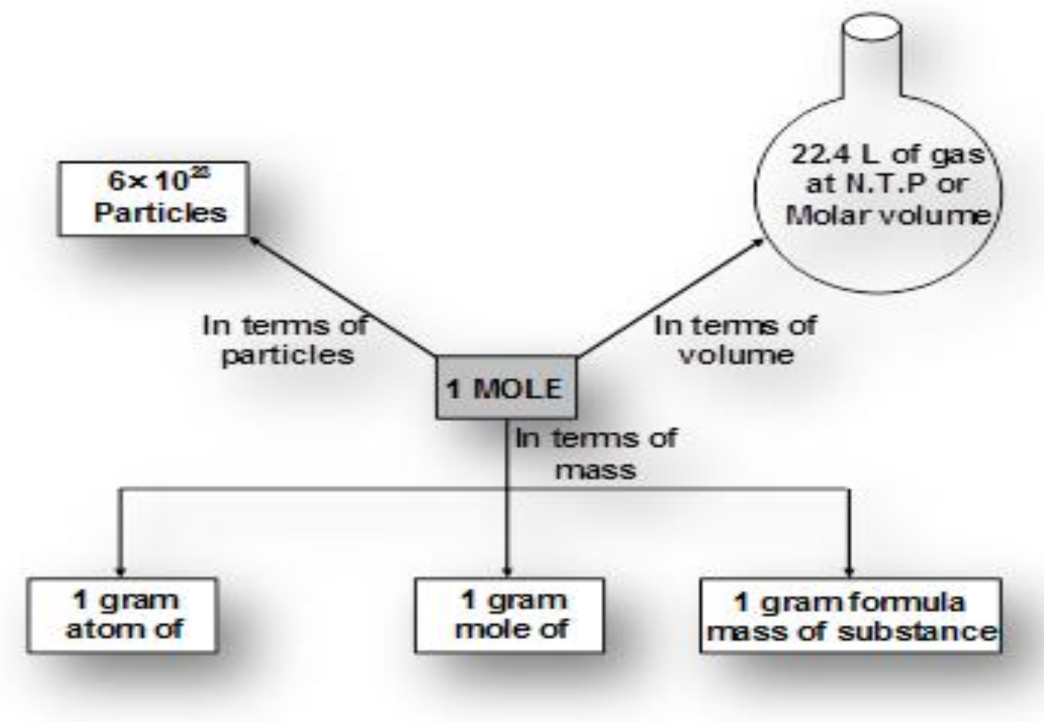
## What is a Mole?

- Atoms and molecules are too small to count.

- To solve this problem their numbers are expressed in terms of Avogadro's number ($N_A$ = 6.023 $10^{23}$).
- Mole is the number equal to Avogadro's number just like a dozen is equal to 12, a century means 100

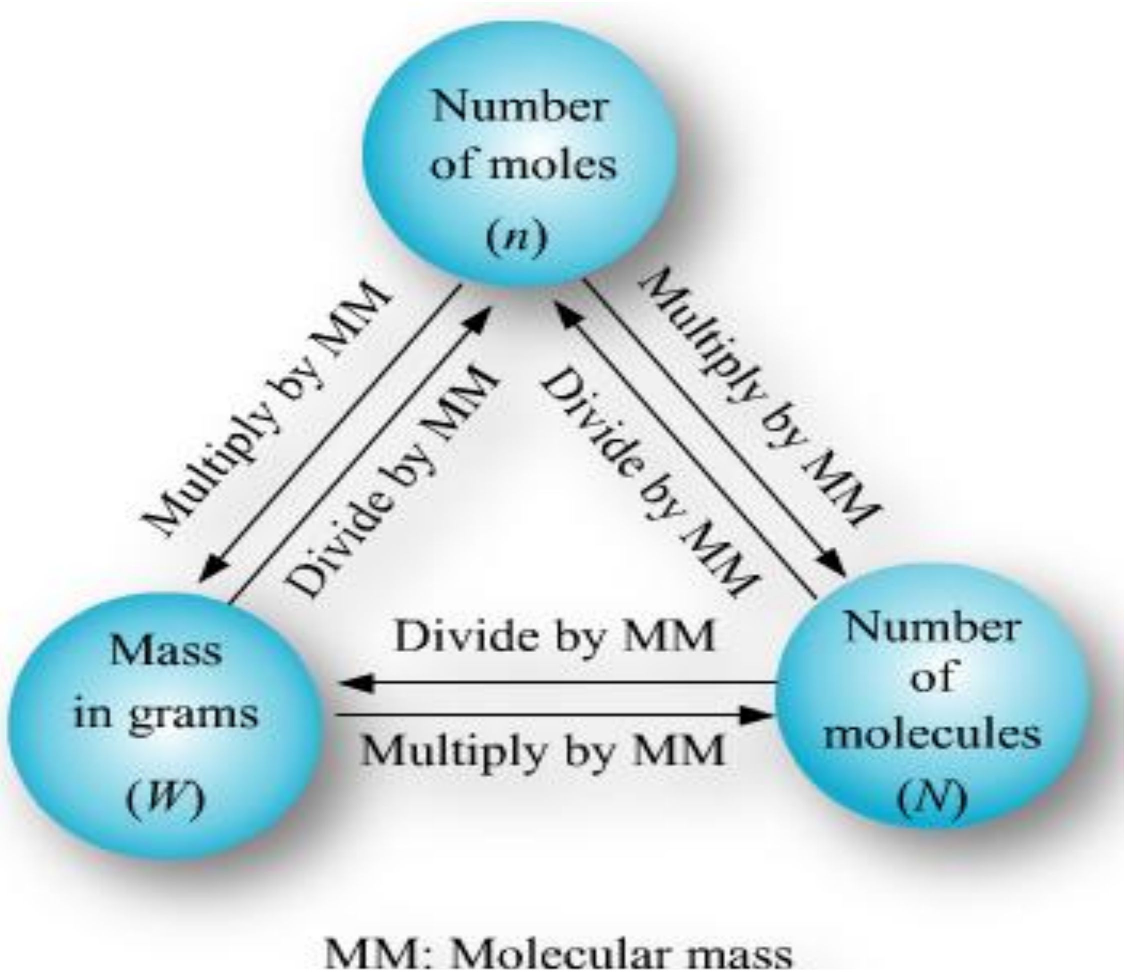
A mole (symbol mol) is defined as the amount of substance that contains as many atoms, molecules, ions, electrons or any other elementary entities as there are carbon atoms in exactly 12 gm of Carbon.. The number of atoms in 12 gm of Carbon is called Avogadro's number .

1) One mole of any element = G.A.M(atomic mass in gm)
2) G.A.M of any element has Avagadro no of atoms = 6.022 X $10^{23}$
3) One mole of any molecule ==G.M.M(gram molecular mass)
4) G.M.M of any molecule has $N_A$ no of molecules= 6.022 X $10^{23}$




The number of moles of a substance can be calculated by various means depending on data available, as follows.

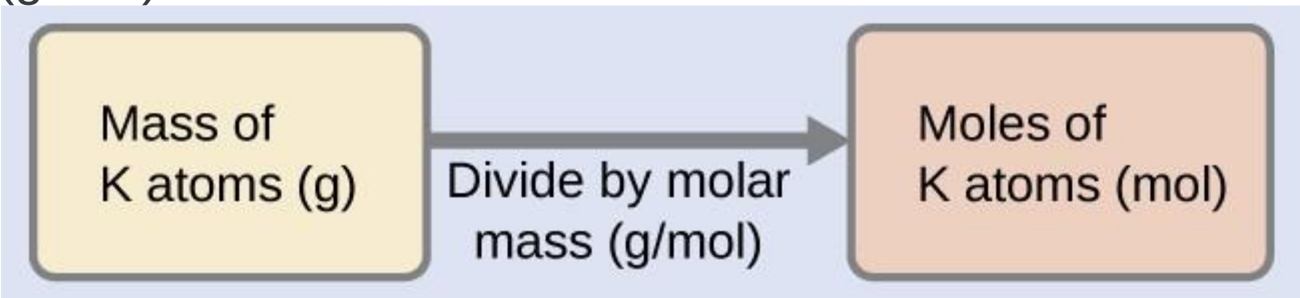
- Number of moles of molecules
- Number of moles of atoms
- Number of moles of gases (Standard molar volume at STP = 22.4 lit)
- Number of moles of particles e.g. atoms, molecules ions etc




## EXAMPLE 1: DERIVING MOLES FROM GRAMS FOR AN ELEMENT

Q1 According to nutritional guidelines from the US Department of Agriculture, the estimated average requirement for dietary potassium is 4.7 g. What is the estimated average requirement of potassium in moles?

Ans  the atomic mass of K is 39.10 amu, and so its molar mass is 39.10 g/mol. The given mass of K = 4.7 g The molar amount of a substance may be calculated by dividing its mass (g) by its molar mass (g/mol):




4.7gK(mol K39.10g)=0.12mol K4.7gK(mol K39.10g)=0.12mol

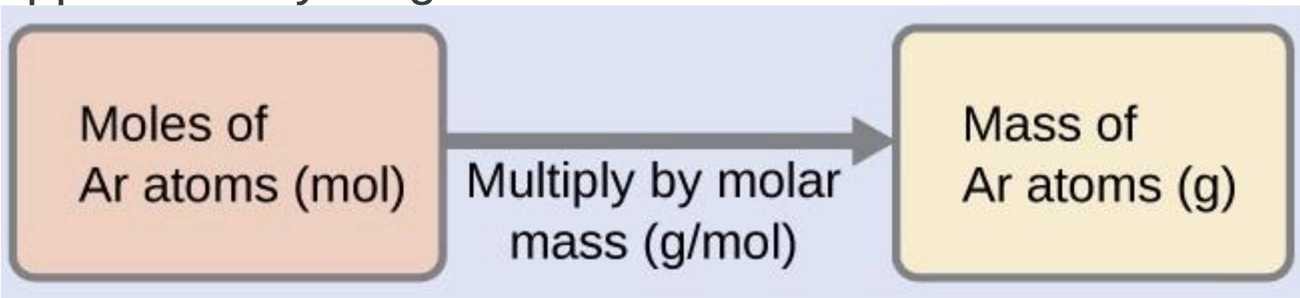
***Q2*** **Beryllium is a light metal used to fabricate transparent X-ray windows for medical imaging instruments. How many moles of Be are in a thin-foil window weighing 3.24 g?**

**Ans 0.36 mol**

## EXAMPLE 2: DERIVING GRAMS FROM MOLES FOR AN ELEMENT

Q3 A litre of air contains $9.2\times10-4$ mol of argon. What is the mass of Ar in a litre of air?

The molar amount of Ar is provided and must be used to derive the corresponding mass in grams. Since the amount of Ar is less than 1 mole, the mass will be less than the mass of 1 mole of Ar, approximately 40 g.




multiplying the provided amount (mol) by the molar mass (g/mol):

$$9.2\times10^{-4}\,\text{mol Ar}\left(\frac{39.95\,\text{g}}{\text{mol Ar}}\right)=0.037\,\text{g}$$

Q4 ***What is the mass of 2.561 mol of gold?***

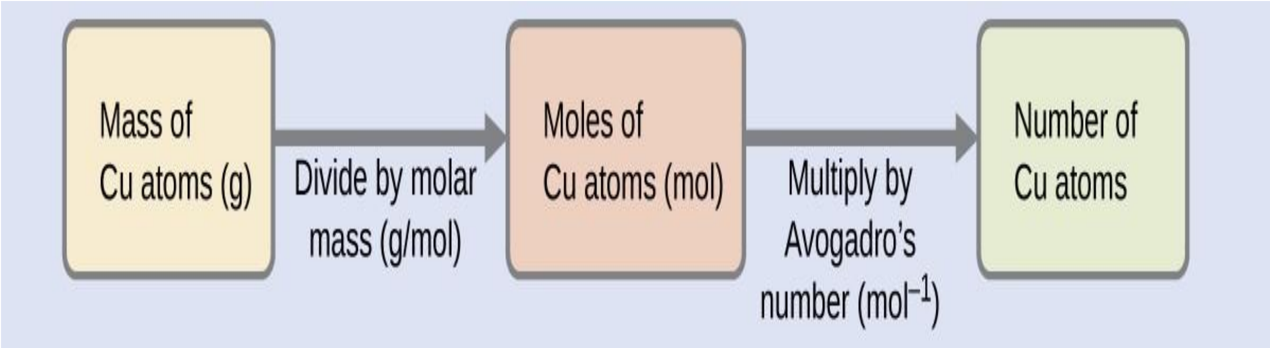
## EXAMPLE 3: DERIVING NUMBER OF ATOMS FROM MASS FOR AN ELEMENT

Q5 Copper is commonly used to fabricate electrical wire. How many copper atoms are in 5.00 g of copper wire?

The number of Cu atoms in the wire may be conveniently derived from its mass by a two-step computation:

- first calculating the molar amount of Cu,
- and then using Avogadro's number ($N_A$) to convert this molar amount to number of Cu

atoms:




First step =copper5.00gCu X molar massCu63.55g) = 0.078gm

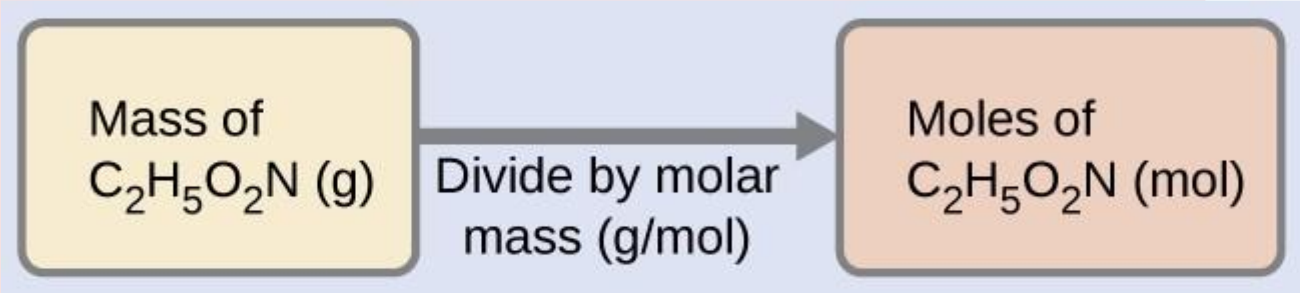
Second step(0.078 X $N_A$=$4.74\times10^{22}$atoms of copper

Q6 A prospector panning for gold in a river collects 15.00 g of pure gold. How many Au atoms are in this quantity of gold?

## EXAMPLE 4: DERIVING MOLES FROM GRAMS FOR A COMPOUND

Q7 Our bodies synthesize protein from amino acids. One of these amino acids is glycine, which has the molecular formula $C_2H_5O_2N$. How many moles of glycine molecules are contained in 28.35 g of glycine?

We can derive the number of moles of a compound from its mass following the same procedure we used for an element i




The molar mass of glycine is required for this calculation, and it is computed in the same fashion as its molecular mass. One mole of glycine, $C_2H_5O_2N$, contains 2 moles of carbon, 5 moles of hydrogen, 2 moles of oxygen, and 1 mole of nitrogen:

Dividing the compound’s mass by its molar mass yields:

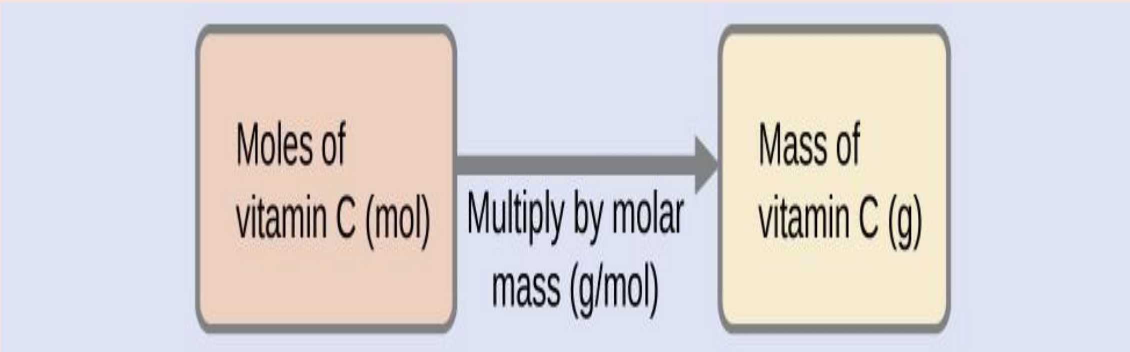
28.35gglycine(mol glycine75.07g)=0.378 mol glycine

Q7 How many moles of sucrose, $C_{12}H_{22}O_{11}$, are in a 25-g sample of sucrose?

## EXAMPLE 5: DERIVING GRAMS FROM MOLES FOR A COMPOUND

Q8 Vitamin C is a covalent compound with the molecular formula $C_6H_8O_6$. The recommended daily dietary allowance of vitamin C for children aged 4–8 years is 1.42×10−4mol. What is the mass of this allowance in grams?

As for elements, the mass of a compound can be derived from its molar amount as shown:




The molar mass for this compound is computed to be 176.124 g/mol. Performing the calculation, we get:

1.42×10−4molvitamin C(176.124gmolvitamin C)=0.0250g vitamin C

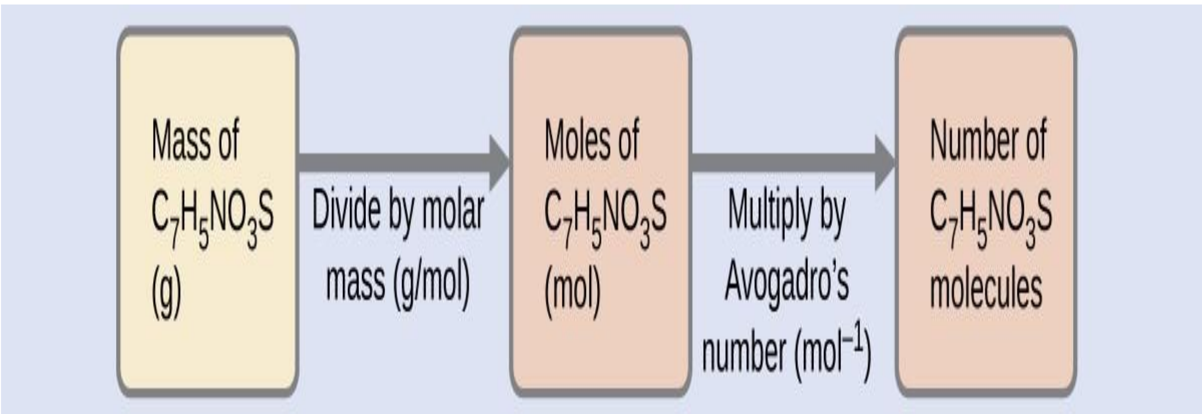
**Q9 What is the mass of 0.443 mol of hydrazine, $N_2H_4$?**

# EXAMPLE 6: DERIVING THE NUMBER OF ATOMS AND MOLECULES FROM THE MASS OF A COMPOUND

Q9 A packet of an artificial sweetener contains 40.0 mg of saccharin ($C_7H_5NO_3S$), which

Given that saccharin has a molar mass of 183.18 g/mol, how many saccharin molecules are in a 40.0-mg (0.0400-g) sample of saccharin? How many carbon atoms are in the same sample?

The number of molecules in a given mass of compound is computed by first deriving the number of moles, and then multiplying by Avogadro's number:



1. 0.0400 / 183,18 = 0.000218moles
2. 0.000218 X 6.022 X $10^{23}$ = 1.31 X $10^{20}$

The compound's formula shows that each molecule contains seven carbon atoms, and so the number of C atoms in the provided sample is:

$$1.31\times10^{20} C_7H_5NO_3S \text{ molecules}$$
$$=9.20\times1021 \text{ C atoms}$$

Q 10 How many $C_4H_{10}$ molecules are contained in 9.213 g of this compound? How many hydrogen atoms?

## Solved Examples

**Question 1:** Calculate the mass of (i) an atom of silver (ii) a molecule of carbon dioxide.

**Solution:**

- 1 mole of Ag atoms = 108 g

= 6.022 x $10^{23}$ atoms

6.022 x $10^{23}$ atoms of silver have mass = 108g

Mass of one atom of silver

- 1 mole of $CO_2$ = 44 g

= 6.022 x $10^{23}$ molecules

Thus, 6.022 x $10^{23}$ molecules of $CO_2$ has mass = 44 g

1 molecule of $CO_2$ has mass

= 7.307 ´ $10^{-23}$ g

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**Question 2:** Calculate the number of molecules present

- in 34.20 grams of cane sugar ($C_{12}H_{22}O_{11}$)
- in one litre of water assuming that the density of water is 1 $g/cm^3$
- in one drop of water having mass 0.05 g.

**Solution:**

- 1 mole of $C_{12}H_{22}O_{11}$ = 342 g

= 12 x 12 + 22 x 1 + 11 x 16 = 342 amu

= 6.022 x 1023 molecules

Now 342 g of cane sugar contain 6.022

x 1023 molecules.

34.2 g of cane sugar will contain

= 6.022 x $10^{22}$ molecules

- 1 mole of water = 18 g = 6.022 x $10^{23}$ molecules.

Mass of 1 litre of water = Volume x density = 1000 x 1 = 1000 g

Now 18 g of water contains = 6.022 x $10^{23}$ molecules.

1000 g of water will contain =

= 3.346 x 1025 molecules

- 1 mole of $H_2O$ = 18 g = 6.022 x $10^{23}$ molecules.

Mass of 1 drop of water = 0.05 g

Now 18 g of H2O contain = 6.022 x 1023 molecules.

0.05 g of H2O will contain =

**Question 3**: Calculate the number of moles in each of the following:

- 392 grams of sulphuric acid
- 44.8 litres of carbon dioxide at STP
- 6.022 x $10^{23}$ molecules of oxygen (iv) 9.0 grams of aluminium (v) 106gm of Fe ) **Solution:**
- 1 mole of $H_2SO_4$ = 98 g

Thus 98 g of $H_2SO_4$ = 1 mole of $H_2SO_4$

392 g of $H_2SO_4$ = = 4 moles of $H_2SO_4$

- 1 mole of $CO_2$ = 22.4 litres at STP

i.e. 22.4 litres of $CO_2$ at STP = 1 mole

44.8 litres of $CO_2$ at STP =

= 2 moles $CO_2$

- 1 mole of $O_2$ molecules = 6.022 x 1023 molecules.

6.022 x 1023 molecules = 1 mole of oxygen molecules.

- 1 mole of Al = 27 g of Al

i.e. 27 g of aluminium = 1 mole of Al

9 g of aluminium = = 0.33 mole of Al

1 mole of Fe = 56 g of Fe

106 g of Fe =