The Mole

Avagadro

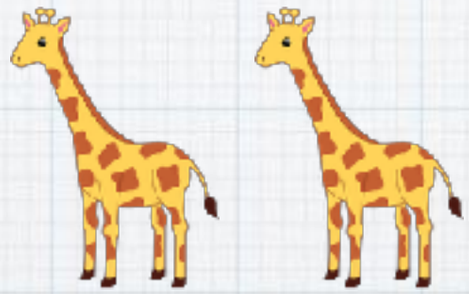
* In 1811, Amedeo Avagradro determined that any convenient quantity of matter must contain an enormous number of atoms, ion, molecules, ect.

Mole

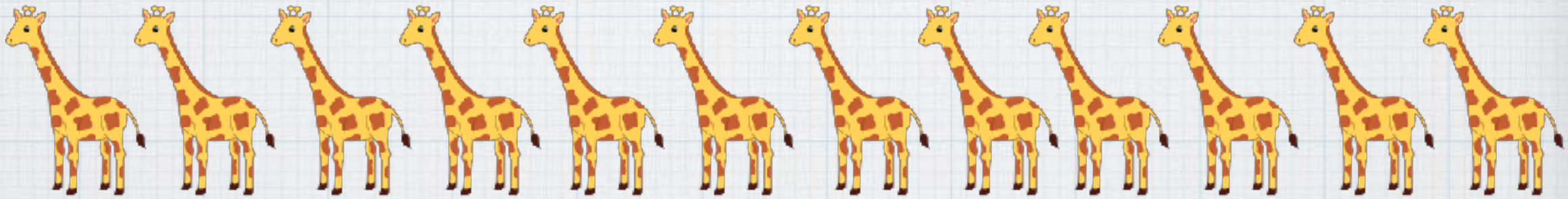
* If we look at the quantity of items equal to 6.02 x 10^{23}, we call this a mole.

* This is also know as Avagadro's Number, N_A

* A mole is just a quick way of summarizing large quantities.
* A pair giraffes:

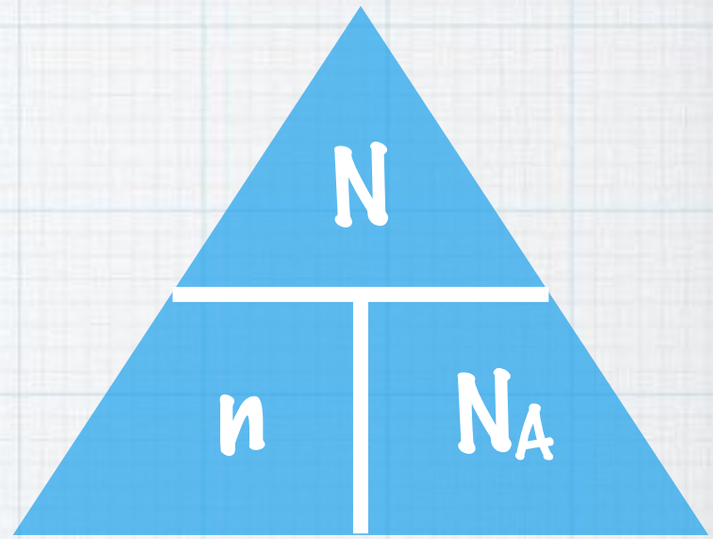


* A pair giraffes:



* A mole (6.02×10^{23}) of giraffes

Converting Mole to # of Particles



* Converting Moles to Number of Particles

* $N = n \times N_A$
    * N= Number of particles (atoms, molecules, ect)
    * n= number of moles
    * N_A = Avagadro's constants (6.023×10^{23})

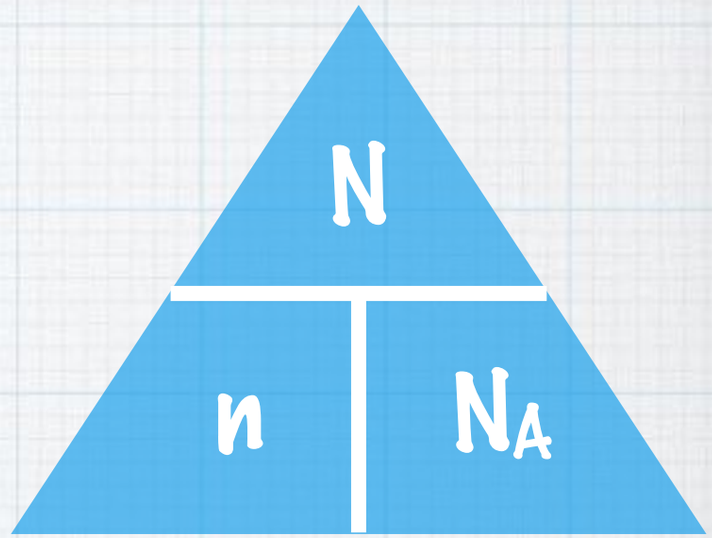
Example

* A sample contains 1.25 mole of nitrogen dioxide, NO_2, how many molecules are in the sample?

Example

* Given
  * n=1.25 mol
  * NA = 6.023×10^{23}
* Required
  * N

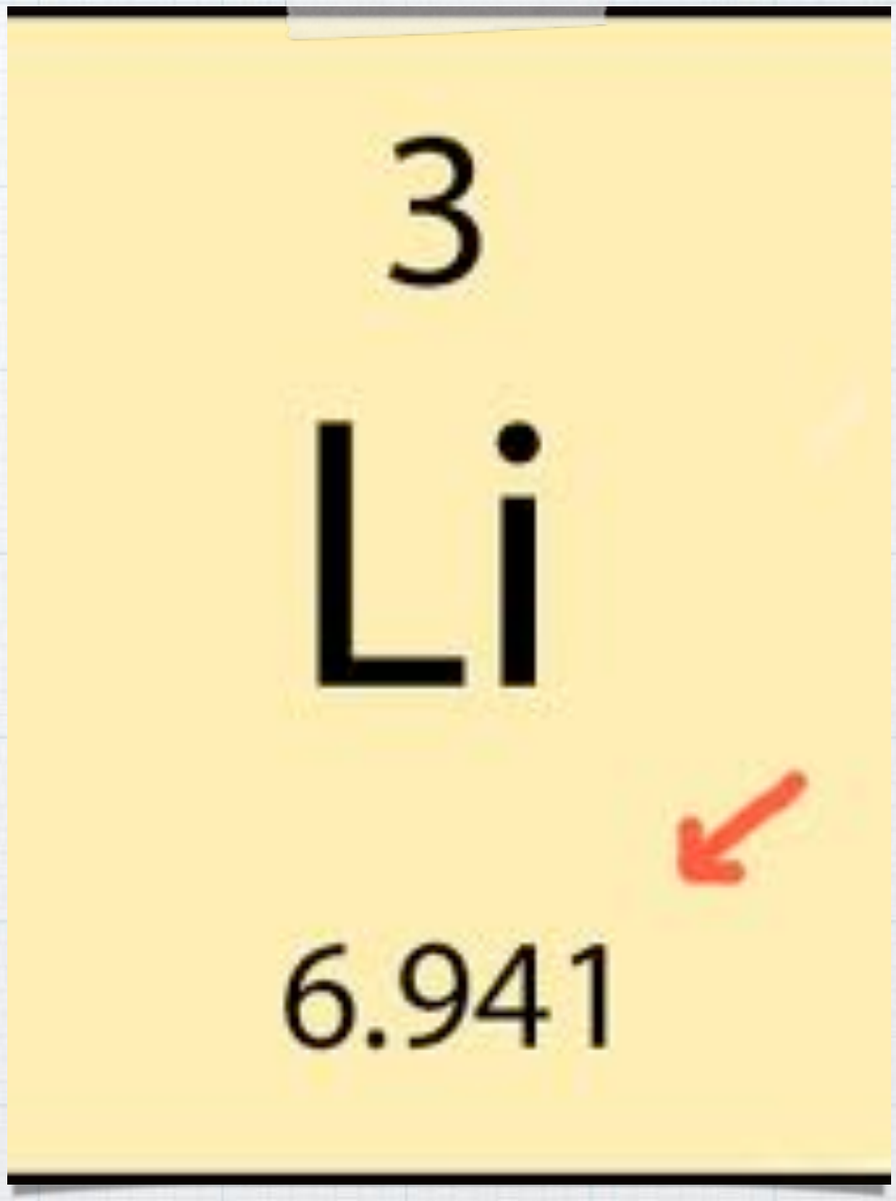
Example



* Given
  * n=1.25 mol
  * NA = 6.023×10^{23}
* Required
  * $N = n \times N_A$
  * $N = 1.25 \times (6.023 \times 10^{23})$
  * $N = 7.52 \times 10^{23}$

Atomic Mass

* Atomic Mass: The mass of one atom of an element



Molar Mass

* Molar Mass: sum of the total mass of all atoms that make up one mole of substance

Molar Mass

* On the periodic table, atomic weight is equal to the mass of one mole of substance.
    * Example: What is the molar mass of one mole of sodium?

Molar Mass

* Example: Eg: Determine the mass of one molecule of carbon dioxide, CO_2

Practice

* What is the molar mass of each of the following?
  * Al H_2S
  * $BiSO_3$
  * $ClPO_3$

Practice

* Example: Molar mass of alanine, $C_3H_7NO_2$
  * C= 3 x 12.01 g = 36.03 g
  * H= 7 x 1.01 = 7.07 g
  * N= 1 x 14.01 g
  * O = 2 x 16.00 g = 32 g
* TOTAL: 89.01 g/mol

Example

* Example molar mass of an ionic compound
* Molar mass of $Al(NO_3)_3$
    * Al = 1 x 26.98 g = 26.98
    * N= 3 x 14.01 g = 42.03 g
    * O = 9 x 16.00 g = 144 g
* TOTAL= 213.01 g/mol

Try It!

* Calculate the molar mass of each of the following
* C_6H_6
* $Ba(NO_3)_2$
* K_3PO_4
* NH_3

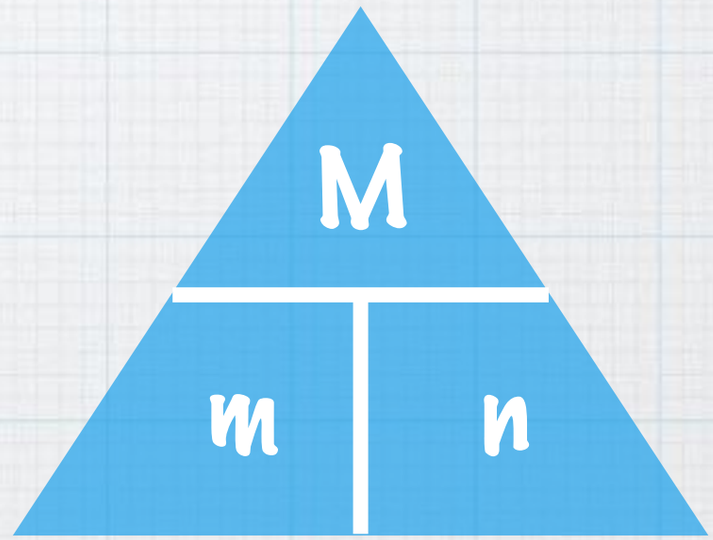
Answers

* Answers:
* C_6H_6, M=78.0 g/mol
* $Ba(NO_3)_2$, M=261.35 g/mol
* K_3PO_4, M= 212.27 g/mol
* NH_3, M=17.04 g/mol

Converting From Mass to Moles

* We know that molar mass represents the mass in grams per mole of substance (g/mol)

* Therefore, M= m/n
  * Where M= molar mass
  * Where m = mass
  * Where n= number of moles

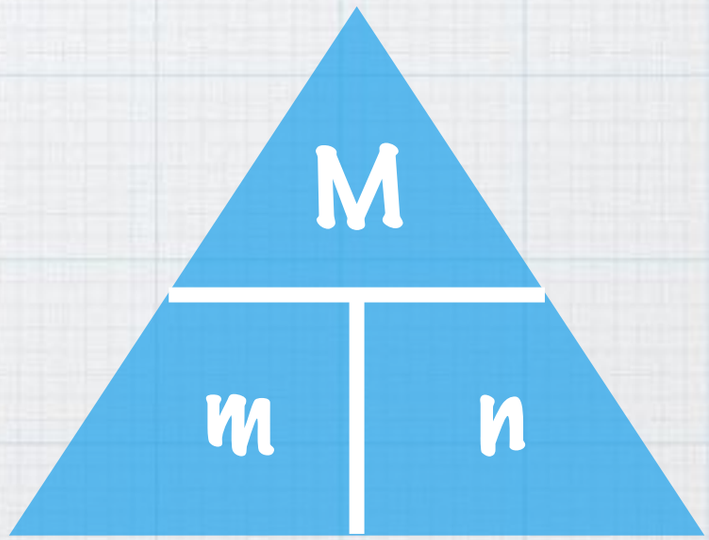


Converting to Mass

* To convert to mass from number of moles

* Mass= Number of Moles x Molar Mass

* m = n x M



Example

* What is the mass of 2.0 moles of Na?

Example

* What is the mass of 2.0 moles of Na?
* $m = n \times M$
* $m = 2.0 \text{ mols} \times 23 \text{ g/mol}$

Therefore the mass of 2.0 mols of Na is 46 g.

Example

* How many moles are in 57.5 g of Na?

Example

* How many moles are in 57.5 g of Na?

* n = m / M

* Given: m=57.5g M=23.00 g/mol (from periodic)

Example

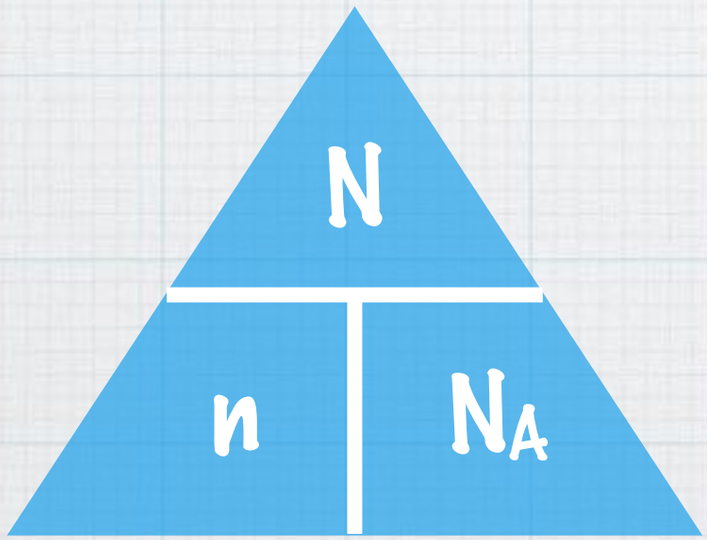
* n = $\frac{57.5\ g}{23.00\ g/mol}$

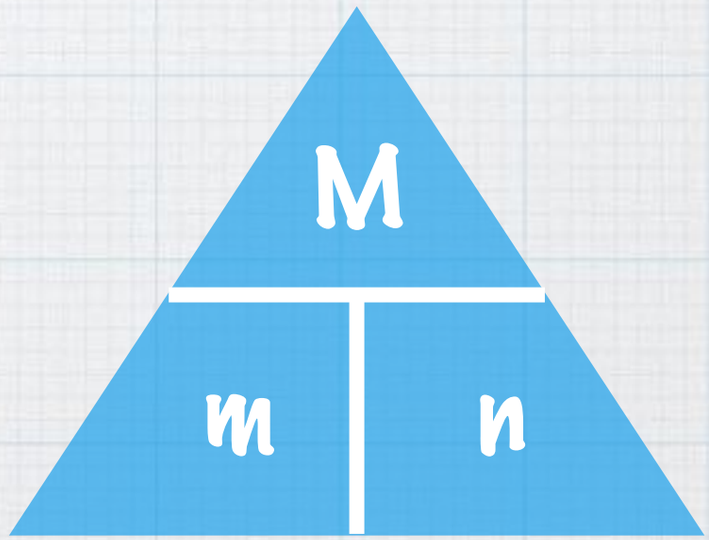
* n=2.5 mol

Therefore there are 2.5 moles in 57.5 g of Na.

How to calculate number of atoms from mass

* Remember





How to calculate number of atoms from mass

* How to calculate number of atoms from mass

* 1) Step 1: Calculate the number of moles using $n = m / M$

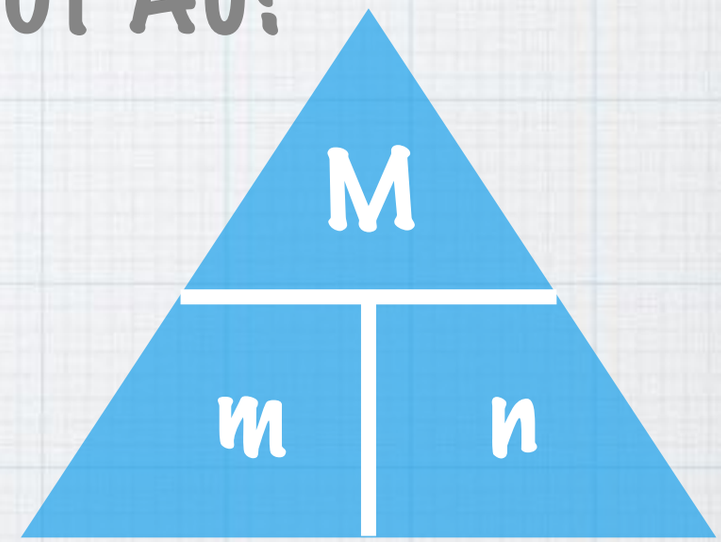
* 2) Step 2: Calculate the number of atoms using $N = n \times N_A$

Example

* Calculate the number of atoms of gold in a 275.8g nugget of pure gold.

Example

* How many moles are in 275.8 g of Au?
* Given:
  * m=275.8g
  * M=196.97 g/mol(from periodic table)



Example

* $n = m / M$

* $n = \frac{275.8\ g.}{196.97\ g/mol}$

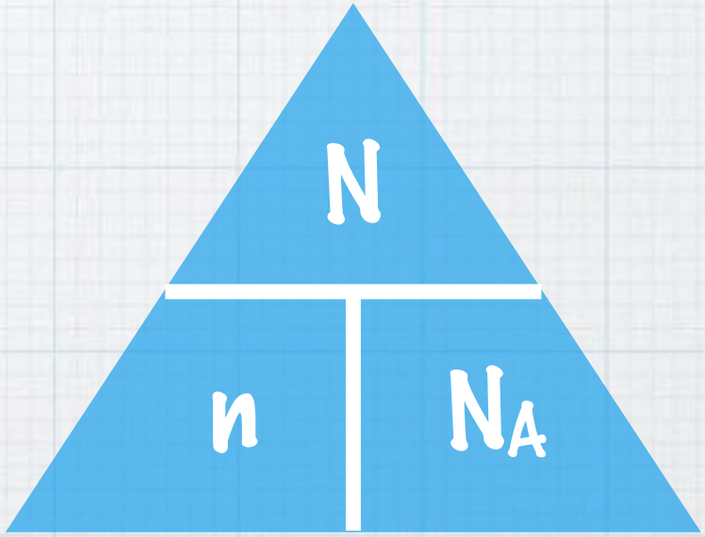
* $n = 1.40\ mol$

Therefore there are 2.5 moles in 1.40g of Au.

Example

* How many particles are in 1.40 mol of Au?

* Given:
  * n= 1.40 mol
  * N_A=6.02 x 10^{23}



Example

* $N = n \times NA$
* $N = 1.40 \times 6.02 \times 10^{23}$
* $N = 8.43 \times 10^{23}$ atoms
* Therefore there are 8.43×10^{23} atoms in one nugget of gold.

Try It!

* How many atoms of sulphur are in a 230.0g sample of pure sulphur?