The Mole, Avogadro's Number, Molar Mass

In order to understand chemical reactions, we need to know how many atoms of a given element react with atoms of another given element.

Can we measure the number of atoms in a sample in the lab? No!

What can we measure in the lab? MASS!

Three concepts provide a basis for relating mass to number of atoms.

1. The Mole – *The amount of a substance that contains the same # of particles as the number of atoms in exactly 12 grams of Carbon -12. SI unit- amount of a substance. Abbreviated mol.*

2. Avogadro's Number – *The number of particles in 1 mole of any substance. 1 mol of anything = 6.02 X10 ^{23} anything.*

3. Molar Mass – *The mass in grams of 1 mole of atoms of a pure substance. It is numerically equivalent to the atomic mass in amu.*

MOLAR MASS = ATOMIC MASS
g/mol amu

Molar Mass can be used as a conversion factor in chemical calculations.

1 mole H atoms have a mass of 1.00795 g

Example Problems: Use dimensional Analysis!

1. How many grams of carbon contain 2.0 moles of carbon atoms?

$$\frac{2.0 \text{ moles C} \mid 12.01 \text{ g C}}{1 \text{ mol C}} = 24 \text{ g C}$$

2. What is the mass in grams of 3.50 mol of the element copper?

$$\frac{3.50 \text{ mol Cu} \mid 63.55 \text{ g Cu}}{1 \text{ mol Cu}} = 222 \text{ g Cu}$$

3. A chemist produces 11.9 grams of aluminum. How many moles of aluminum have been produced?

$$\frac{11.9 \text{ g Al} \mid 1 \text{ mol Al}}{26.98 \text{ g Al}} = 0.441 \text{ mol Al}$$

Let's review definitions:

Atomic Mass of an element = mass in **amu** of an atom of that element.

Molar Mass = mass in **grams** of 1 mole of that element.

Note: These definitions are numerically equal to eachother!

Atomic Mass of C = 12.01

Molar Mass of C = 12.01 g/mol

Calculating the number of **atoms** of an element from the number of moles:

Avogadro's Number can be used as a conversion factor from atoms to moles or moles to atoms:

Avogadro's Number = 6.022×10^{23}

There are 6.022×10^{23} atoms in 1 mole of atoms. Therefore, we can use these conversion factors:

$\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mole atoms}}$ and $\frac{1 \text{ mole of atoms}}{6.022 \times 10^{23} \text{ atoms}}$

Example Problems: Use dimensional analysis!

1. How many moles of silver are there in 3.02×10^{23} Silver atoms?

$$3.02 \times 10^{23} \text{ atoms Ag} \left| \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \right. = 0.501 \text{ moles}$$

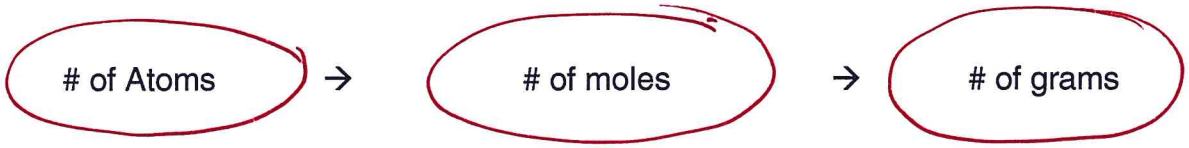
2. How many aluminum atoms are there in 2.75 mol?

$$2.75 \text{ mol Al} \left| \frac{6.022 \times 10^{23} \text{ atoms}}{\text{mol}} \right. = 1.66 \times 10^{24} \text{ atoms}$$

3. How many moles of tin are equivalent to 2500 atoms?

$$2500 \text{ atoms Sn} \left| \frac{1 \text{ mol Sn}}{6.022 \times 10^{23} \text{ atoms Sn}} \right. = 4.2 \times 10^{-21} \text{ mol}$$

To get from Atoms to Grams, or Grams to Atoms, we need both conversions:



Use Avogadro's Number Use Molar Mass

You Must Use the Grid Here!

Example Problems:

1. What is the mass in grams of 7.5 X 10 ^{15} atoms of nickel?

$$7.5\times10^{15}\text{ atoms} \left| \frac{1\text{ mol Ni}}{6.022\times10^{23}\text{ atoms}} \right| \frac{58.69\text{ g Ni}}{1\text{ mol Ni}} = 7.3\times10^{-7}\text{ g Ni}$$

2. A chemist masses out 25.0 grams of Magnesium. How many atoms are there in the sample?

$$25.0\text{ g Mg} \left| \frac{1\text{ mol Mg}}{24.30\text{ g Mg}} \right| \frac{6.022\times10^{23}\text{ atoms Mg}}{1\text{ mol Mg}} = 6.20\times10^{23}\text{ atoms}$$

Complete the following chart for the element Carbon:

	# of grams	# of moles	# of atoms
1.	0.1245		
2.		0.0375	
3.			1.7 X 10 ^{21}