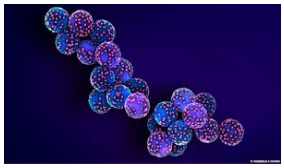
9.1 Measuring Matter

Counting Particles

Chemistry is all about particles: atoms, electrons, molecules, ions, formula units, or whatever you want to count (like students!).

To calculate particles, chemists use a unit called a "mole" (mol).

1 mole = 6.02 E 23 particles.
It equals the number of atoms in 12.0 grams of C-12.



Weird particles to count

Avogadro's Number

6.02 E 23 is also called Avogadro's Number, after Amedeo Avogadro, an Italian Physicist in the early 1800's.
Here's what he looked like:

They were experimenting with fish-eye lens technology back then.

Brief History Lesson

It's worth noting how Avogadro's Number was determined to be 6.02 E 23 particles.

In the mid to late 1800s, as atomic theory was widely accepted, scientists realized the need to define a number of particles with respect to a standard mass.

It was realized that hydrogen was the lightest element, so arbitrarily, Avogadro's Number was assigned to be the number of hydrogen atoms needed to have a mass exactly 1.00 grams.

Later, with the discovery of isotopes, the definition was refined to be the number of particles in 12.000 grams of carbon - 12.

1. Conversions

A. How many eggs are in a dozen? 12
B. How many in three dozen? 36
C. Half a dozen? 6
D. A mole? 6.02 E 23
E. Two moles? 1.204 E 24 (or 12.04 E 23)

FYI: Two moles of eggs would have a volume roughly 1/9 that of the Earth!

Egg-Planet!

Conversions Process

1. Determine what your given information is.
2. Determine what you are seeking (solving for).
3. A. If going from moles to particles, use the following template:

$$x.xx\,moles \bullet \frac{6.02\,E\,23\,particles}{1.0\,mol} = particles$$

3. B. If going from particles to moles, use:

$$x.xx\,particles \bullet \frac{1\,mol}{6.02\,E\,23\,particles} = moles$$

Calculator Review: Exponent Key = EE

2. Moles to Particles Example

How many atoms are there in 3.5 moles of zinc?

Known: 3.5 moles Zn.

Seeking: atoms of zinc. Which Equation do you use?

$$x.xx\,moles \bullet \frac{6.02\,E\,23\,particles}{1.0\,mol} = particles$$

$$3.5\ \cancel{mol\ Zn} \bullet \frac{6.02E23\,atoms}{1\,\cancel{mol\ Zn}} = 2.1E\ 24\,atoms\ Zn$$

3. Particles to Moles Example

It works the other way also.
How many moles of phosphorus are there in 1.5 E 23 atoms of phosphorus?

Known: 1.5 E 23 atoms phosphorus.

Seeking: moles phosphorus. Which Equation?

$$x.xx\ particles \bullet \frac{1\,mol}{6.02\,E\,23\,particles} = moles$$

$$1.5\,E23\,atoms\ P \bullet \frac{1.0\,mol}{6.02\,E\,23\,atoms} = 0.25\,mol\ P$$

4. Conversions Example

How many molecules are there in 5.4 moles of H_2?

$$5.4\,\cancel{mol\ H_2} \bullet \frac{6.02\,E\,23\,molecules}{1\,\cancel{mol\ H_2}} = 3.3\ E\,24\,molecules\ H_2$$

5. Last Example

Now this one: How many moles of sodium are there in 4.8 E 22 atoms of sodium?

$$4.8\ E\ \ 22\,\cancel{atoms\ Na} \bullet \frac{1.0\,mole\ Na}{6.02\,E\,23\,\cancel{atoms\ Na}} = 0.080\,moles\ \ Na$$

Sodium in Water

http://www.youtube.com/watch?v=RAFcZo8dTcU

Homework

9.1 Booklet Problems
Due: Next class.