THE MOLE AND MOLE CONVERSIONS

A mole is a counting unit.
Just like:

- eggs equals a dozen eggs
- pencils equals one gross of pencils
- seconds equals one minute
- 500 sheets of paper equals one ream

One mole equals 6.022×10^{23} particles

- So one *mole* of eggs would be 6.022×10^{23} eggs
- One mole of pencils would be 6.022×10^{23} pencils
- And so on…

Where did the mole come from?

- The unit, called the mole (or mol), is defined as the number of atoms in exactly 12g of the carbon-12 isotope
- The number of particles in one mole, 6.022×10^{23}, is known as Avogadro's constant or number.
- This was named after Amedeo Avogadro (1776-1856) whose ideas were crucial to the early development in Chemistry

The Mole

- 1 dozen cookies =
- 1 mole of cookies =

- 1 dozen cars =
- 1 mole of cars =

- 1 dozen Al atoms =
- 1 mole of Al atoms =

- Note that the is always the same, but the is very different!
- Mole is abbreviated mol

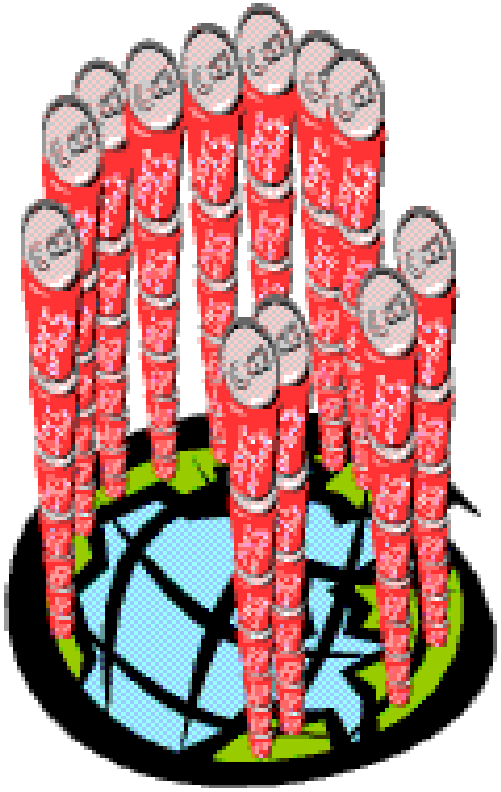
6.022×10^{23} is a very large number!

- If we did not use scientific notation to write out 6.022×10^{23}, we would write out 6022 with 20 zeros after it.
- Why don't we try it.
-

Imagine that we had a mole of gumballs.

- If all 6 billion people on Earth were to do nothing but count the gumballs in one mole at the rate of one gumball per second, it would take over 3 million years to count all the gumballs!!

Just How Big is a Mole?



- Enough soda cans to cover the surface of the earth to a depth of over 200 miles.
- If you had Avogadro's number of unpopped popcorn kernels, and spread them across the United States of America, the country would be covered in popcorn to a depth of over 9 miles.
- If we were able to count atoms at the rate of 10 million per second, it would take about 2 billion years to count the atoms in one mole.

What is all of this used for?

- Avogadro's constant can be used to convert an amount of moles into the equivalent number of atoms or grams.
- This conversion is similar to changing 8 dozen eggs into the number of individual eggs.
- Although this maybe easy to calculate quickly in your head or on your calculator, the following strategy will make it easier for you later in this Chapter.

Mole Problem Solving Strategy

Example: How many eggs are in 8 dozen?

- ☐ 1. List what you know. (What was given in the problem?)
- ☐ 2. Setup the problem. Don't forget your units and show every step.
- ☐ 3. NOW, and only now, use your calculator to verify the answer.

Looks easy right… Now you try one: **How many pencils are in 9 gross?**

- ☐ 1. List what you know. (What was given in the problem?)
- ☐ 2. Setup the problem. Don't forget your units and show every step.
- ☐ 3. NOW, and only now, use your calculator to verify the answer.

This strategy can also be used with the mole concept.

How many atoms are in 3.5 moles of copper?

- 1.***The procedure is the same.***
  List what you know.
- 2. Notice that 3.5 moles is in the numerator and then 1 mol is in the denominator. This allows you to cross out units.
- 3. Now calculate the answer. Does it make sense?

You can also convert from atoms to moles… YEAH!!

How many moles are in 3.01×10^{23} atoms of Sodium?

It's your turn again!

How many atoms are in 7.5 mol of Argon?

- Before you start throwing down random numbers. Think about the problem. Should the final answer be bigger or smaller than 6.022×10^{23}?
- Since 1 mole is 6.022×10^{23} atoms, 7.5 moles has to be a larger number of atoms.
- Thinking through the problem before you start it will allow you know if you solved the problem correctly.

Now calculate: How many atoms are in 7.5 mol of Argon?

Now in small groups try the following practice problems

1. How many atoms are present in 3.7 mol of sodium?
2. How many atoms are present in 155 mol of arsenic?
3. How many moles of xenon is 5.66×10^{26} atoms?

Molar Mass

- The Mass of 1 mole (in grams)
- Equal to the numerical value of the average atomic mass (get from periodic table)

1 mole of C atoms= 12.0 g

1 mole of Mg atoms =24.3 g

1 mole of Cu atoms =63.5 g

Other Names Related to Molar Mass

- Molecular Mass/Molecular Weight: If you have a single molecule, mass is measured in amu's instead of grams. But, the molecular mass/weight is the
  as 1 mole of molecules. Only the units are different. (This is the beauty of Avogadro's Number!)
- Formula Mass/Formula Weight: Same goes for compounds. But again, the .
  Only the units are different.
- THE POINT: You may hear all of these terms which mean the *SAME NUMBER*… just different units

Molar Mass of Molecules and Compounds

Mass in grams of 1 mole equal numerically to the sum of the atomic masses

1 mole of $CaCl_2$ = g/mol

1 mole Ca x g/mol

+ 2 moles Cl x g/mol = g/mol $CaCl_2$

1 mole of N_2O_4 =

Learning Check

Prozac, $C_{17}H_{18}F_3NO$, is a widely used antidepressant that inhibits the uptake of serotonin by the brain. Find its molar mass.

Converting Moles and Grams

Aluminum is often used for the structure of light-weight bicycle frames. How many grams of Al are in 3.00 moles of Al?

3.00 moles Al **~~? g~~ Al**

1. *Molar mass of Al*

2. *Conversion factors for Al*

3. *Setup*

Answer =