Science 10 Unit A - Chemistry

Determining Molar Mass

Counting Atoms

Question!

"I've got 500 g of beets here. How many atoms is that?"

Good question: just how can we count atoms?

Big Numbers

Even the casual observer could tell that if we're talking about counting something so small as an atom, the numbers are going to be in the billions of billions.

Thankfully, chemists have devised an idea for counting the number of atoms in a substance.

And like all good ideas, it came from chicken farmers.

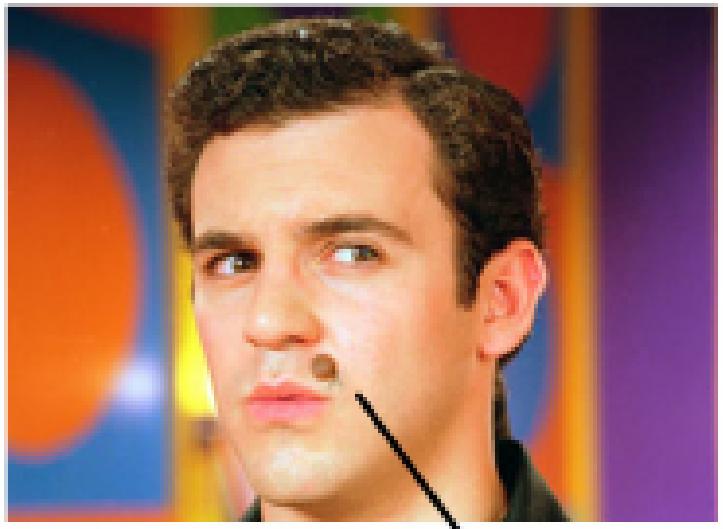
Chicken Farming Troubles

Early 15th century chicken farmers found they had difficulty counting the number of eggs their chickens were producing.

The coined the term "dozen" to make it easier.
Twelve eggs - one dozen.

Chemists use the same idea. Since atoms are way to small to be counted individually, chemists coined the term "mole".

A mole is like a dozen, a more convenient way of counting large sums. A dozen eggs represents 12 eggs, while a mole represents 6.02×10^{23} eggs.



The number 6.02×10^{23} is called Avogadro's number. This number was chosen because there is 6.02×10^{23} atoms of carbon in a 12 g sample. **One mole of any substance contains 6.02×10^{23} atoms.**

The mole is a unit of measurement which is used when writing chemical equations. Before we can use this unit, we must know how to convert from the unit used for practical purposes (grams) to moles.

But the question still remains...

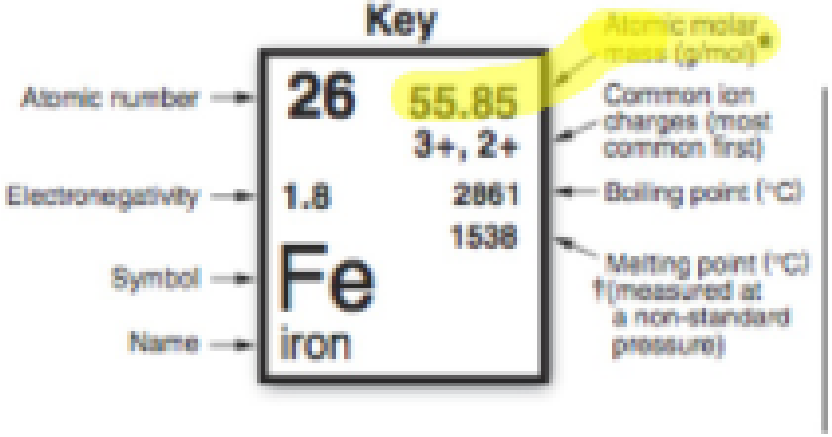
"I've got 500 g of beets here. How many atoms is that?"

How can we convert grams to atoms?

Well, we will use the idea of the mole.

Converting from mass to moles

In order to convert from grams to moles, we need to know the molar mass of the substance we're working with. The molar mass of pure substances are listed on the periodic table.



The molar mass is the number of grams of a pure substance in one mole of that substance.

To convert from grams to moles, we use this molar mass and this equation:

$$n = \frac{m}{M}$$

Where:

n = # of moles

m = mass of substance (in grams)

M = molar mass of substance (in g/mol)

ex) How many moles are present in 15.0 g of pure silver?

The molar mass of silver is 107.87 g/mol.

ex) How many moles are present in 75 g of boron?

ex) What is the mass of 3.2 mol of krypton?

ex) A silicon chip used in an integrated circuit of a microchip has a mass of 5.68 mg. How many silicon atoms are present in this chip?

Step 1: Convert to grams.

Step 2: Convert to moles.

Step 3: Use Avogadro's Number to convert to number of atoms.

ex) Cobalt is added to steel to improve its resistance to corrosion. Calculate both the number of moles in a sample of cobalt containing 5.00×10^{20} atoms and the mass of the sample.

Calculating Molar Masses

A chemical compound is made of more than one element. To determine the molar mass of a compound, we must add the molar masses of its elements.

ex) Determine the molar mass of $H_2O_{(l)}$

H - 2 x (1.01 g/mol)
O - 1 x (16.00 g/mol)

total = 18.02 g/mol

There are two atoms of hydrogen and one of oxygen. So we add the mass of two hydrogen atoms to the mass of one oxygen atom.

ex) Jugalone, a dye known for centuries, is produced from the husks of black walnuts. It is also a natural herbicide (weed killer) that kills off competitive plants around the tree. The formula for jugalone is $C_{10}H_6O_{3(aq)}$.

a) Calculate the molar mass of jugalone.

b) A sample of 1.56×10^{-2} g of pure jugalone was extracted. How many moles does this represent?