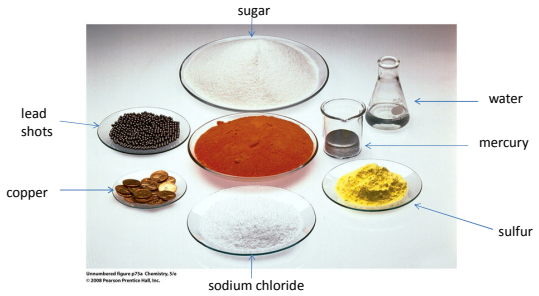
The Mole Concept

Chapter 9

Avogadro's Number

602, 000, 000, 000, 000, 000, 000, 000 = 6.02 x 10^{23}



Each example shows 6.02 x 10^{23} atoms, formula units or molecules of that element.

Copper has an atomic mass of 63.55 amu.
When there are 6.02 x 10^{23} atoms of copper on a balance the mass is 63.55 g.

How?

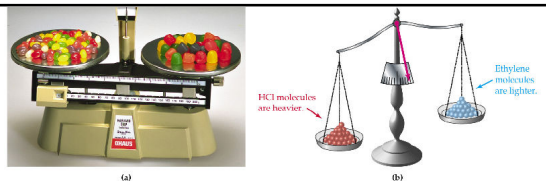
Avogadro's Number and The Mole

How many eggs are in one dozen?

The **mole** is a number just like a dozen is a number.

When you have one mole of a substance you have 6.02 x 10^{23} of that substance!

Definition: One mole is the amount of any substance that contains the same number of atoms in exactly 12 grams of carbon-12.



The two candies may weigh the same, but there are not the same number of each.
The same holds true with atoms.

***The Mole:* Allows us to make comparisons between substances that have different masses.**

So when one mole of copper atoms has a mass of 63.55 g.
If we counted out all the atoms on the balance making up one mole, there would be 6.02 x 10^{23} Cu atoms!

How many atoms are in 107.87 grams of silver?

What is the mass of 6.02 x 10^{23} atoms of calcium?

So Avogadro's number can be written as 6.02 x 10^{23} atoms in one mole:

$$= \frac{6.02 \times 10^{23} \text{ atoms, molecules, formula units}}{\text{mol}}$$

1. Calculate the number of calcium atoms in 0.250 moles of calcium:

2. Calculate the moles of 3.75 x 10^{23} molecules of oxygen gas:

Every mass on the periodic table can be written as g/mol:

Silver has an atomic mass of 107.87 g/mol

Iron has an atomic mass of 55.85 g/mol

Molar Mass:

$Ba(OH)_2$ — 1 atom barium, 2 atoms oxygen, 2 atoms hydrogen

Each oxygen atom has an atomic mass of 16.00 g/mol.

2 atoms of oxygen has an atomic mass of 2(16.00 g/mol) = 32.00 g/mol.

1 atom barium has an atomic mass of 137.33 g/mol

2 atoms of hydrogen has an atomic mass of 2(1.01 g/mol) = 2.02 g/mol

The total atomic mass for the compound $Ba(OH)_2$ is ???????

Calculate the molar mass of the following compounds:

H_2O

$CaSO_4$

$C_6H_{12}O_6$

Calculate the number of moles of $NaNO_3$ in 3.25 x 10^{23} molecules $NaNO_3$.

Calculate the number of moles of one oxygen atom in 3.25 x 10^{23} molecules $NaNO_3$.

Calculate the number of hydrogen atoms in 3.54 moles PH_3.

We can now perform calculations that relate mass to the number of particles.

If we had 4.62 x 10^{23} atoms of gold (Au) we can determine the mass of this:

What is the mass in grams of 2.11 x 10^{23} atoms of phosphorus?

What is the mass in grams of 3.54 x 10^{23} atoms of silver?

Calculate the mass of .256 moles of water.

Calculate the moles of 2.78 grams of nitrogen dioxide.

Calculate the number of molecules of beryllium hydroxide in 1.75 grams.

How many nitrogen atoms are in 6.99 grams of magnesium nitrite?

Molar Volume

Use Molar Volume for GASES ONLY at STP !

Table 9.1 Mole Relationships for Selected Gases

Gas	No. of Moles	No. of Molecules	Molar Mass	Molar Volume at STP
hydrogen, H_2	1.00	6.02×10^{23}	2.02 g/mol	22.4 L/mol
oxygen, O_2	1.00	6.02×10^{23}	32.00 g/mol	22.4 L/mol
carbon dioxide, CO_2	1.00	6.02×10^{23}	44.01 g/mol	22.4 L/mol
ammonia, NH_3	1.00	6.02×10^{23}	17.04 g/mol	22.4 L/mol
argon, Ar*	1.00	6.02×10^{23}	39.95 g/mol	22.4 L/mol

*Argon gas is composed of atoms rather than molecules.

STP is Standard Temperature and Pressure

0°C and 1 atm

Examples

Calculate the density of ammonia gas, NH_3, at STP.

A fire extinguisher releases 1.96 g of an unknown gas that occupies 1.00 L at STP. What is the molar mass (g/mol) of the unknown gas?

What is the mass of 4.50 L of chlorine gas at STP?

Percent Composition

Percent is the amount of one part of a mixture per 100 parts in that mixture.

CaI_2

% composition of Ca in CaI_2:

% composition of I in CaI_2:

$MgCl_2$

% composition of Mg in $MgCl_2$:

% composition of Cl in $MgCl_2$:

K_2CO_3

% composition of K in $KHCO_3$:

% composition of C in $KHCO_3$:

% composition of O in $KHCO_3$: