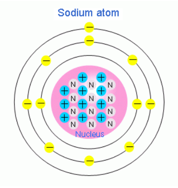
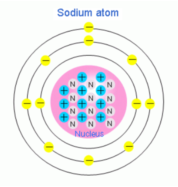
Atomic Diversity: The Elements

- Each element has distinct physical and chemical properties caused by differences among atoms. All atoms are composed of electrons, protons and neutrons so elements differ from one another because their atoms contain different numbers of these subatomic particles.

Mass number	A	Protons and neutrons in nucleus
Elemental symbol	X	
Atomic number	Z	Protons in nucleus





Mass number	23	Protons and neutrons in nucleus
Elemental symbol	Na	
Atomic number	11	Protons in nucleus

Isotopes

- The identity of an atom is determined by its nuclear charge but its mass is the sum of the contributions from all of its atomic building blocks. Thus, the mass of an atom depends on the number of protons and neutrons in its nucleus. Two atoms with the same number of protons but different numbers of neutrons are called **isotopes**.

Isotopes

- Uranium-238 or ^{238}U

Isotopes

- Uranium-238 or ^{238}U
- Mass is 238
- 238 protons and neutrons
- Atomic number is 92 which signifies 92 protons and 92 electrons.
- 238 - 92 = 146 neutrons

- How about ^{235}U?

Atomic Mass

- An isotope is usually specified by giving its mass number. Some elements (F and P) occur naturally with just one isotope.

Mass #	Protons	Neutrons	Abundance%
46	22	24	8.2
47	22	25	7.4
48	22	26	73.8
49	22	27	5.4
50	22	28	5.2

The Mole

- It is difficult to count atoms and molecules but we can weigh substances routinely. From the mass of a sample we can calculate the number of molecules it contains if we know the mass of an individual molecule. As chemists we can do this using modern instrumentation. Unfortunately, there is a big problem with this in that there is an enormous difference between the mass of one molecule and the masses that we measure in the laboratory.

The Mole

- To avoid having to work with HUGE numbers, we use a unit called the **mole** (mol) which is the number of atoms in a reference sample having a convenient mass.
- **One mole is the number of atoms in exactly 12 g of the pure isotope carbon-12.**

The Mole

- Given the mass of one 12C is 1.992648 X 10^{-23} g/atom, then
- 12 g ^{12}C/mol / 1.992648 X 10^{-23} ^{12}C/atom =

6.022 X 10^{-23} atoms / mol

The mass of 1 mol of any naturally occurring element is the sum of the contributions from each of its isotopes.

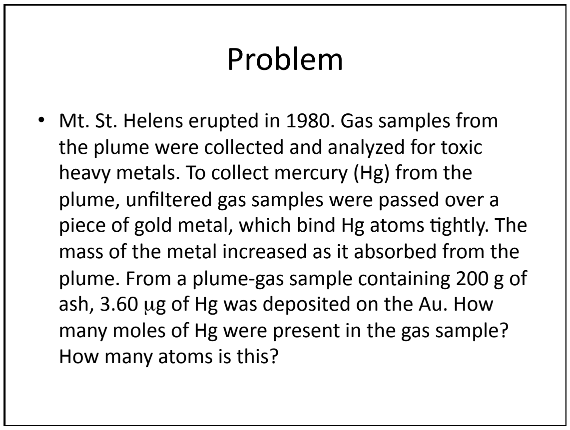
The Mole

Elemental
molar mass = (fractional abundance) (isotopic molar mass)

Isotope	Isotopic Molar Mass (g/mol)	Abundance%
^{54}Fe	53.940	5.82
^{56}Fe	55.935	91.66
^{57}Fe	56.935	2.19
^{58}Fe	57.933	0.33

Mass-Mole-Atom Conversions

- Elemental molar masses can be thought of as conversion factors between masses in grams and # of moles. To determine the amount of an elemental sample, we can meausre its mass and convert to moles by dividing by the molar mass of that element. Similarly, if we wish to know the mass of a particular # of moles of an element, we can multiply that # of moles by the elemental molar mass.



Problem

- Mt. St. Helens erupted in 1980. Gas samples from the plume were collected and analyzed for toxic heavy metals. To collect mercury (Hg) from the plume, unfiltered gas samples were passed over a piece of gold metal, which bind Hg atoms tightly. The mass of the metal increased as it absorbed from the plume. From a plume-gas sample containing 200 g of ash, 3.60 μg of Hg was deposited on the Au. How many moles of Hg were present in the gas sample? How many atoms is this?