**Review**

Molecule: more than one atom, e.g., $O_2$, $H_2$, CO, $H_2O$.

Compound: more than one kind of atom in a fixed ratio, e.g., $H_2O$, CO, etc.

Not all molecules are compounds, e.g., $O_2$.

Not all compounds are molecules because solid compounds have a distinct type of bonding, e.g., NaCl.

Chemical transformations involve forming new combinations of atoms in whole-number ratios, e.g., $H_2O$ = 2 H : 1 O.

Atoms are conserved in chemical and physical transformations.

$$2\,H_2 \quad + \quad O_2 \rightarrow 2\,H_2O$$

# Atomic structure and isotopes in Chapter 2

An atom is composed of a tiny, dense, positive nucleus surrounded by a gigantic cloud of electrons (a pea surrounded by a sports stadium).

Although the nucleus fills a tiny space at the center of an atom, the nucleus has nearly all the mass of the atom.

The nucleus can contain protons and neutrons, so the *mass number* of an atom has been defined as the number of protons and neutrons.

The mass number is given the symbol A:

A = mass number
= # of protons + # of neutrons.

The number of protons is unique to an element and is shown on the periodic table.

<u>Examples</u>:
Hydrogen atom (H)
Carbon atom (C)

The number of protons is called the *atomic number* and is given the symbol Z.

Z = atomic number = # of protons.

Example: element X with mass number A and atomic number Z is given the symbol …

$$^{A}X$$

Example: $^{12}C$ (pronounced "carbon 12") and $^{14}C$ (pronounced "carbon 14")

Isotope: an atom of a given element that has a different number of neutrons from another atom of that element.

Example: $^{12}C$ and $^{14}C$ are isotopes of the element carbon.

## Practice: Nitrogen-15 and Bromine-81

1. For each, give $^{A}X$ symbol, and give the number of protons and neutrons.
   (and electrons if you can)

2. For each, draw a nanoscale picture of one atom

3. For each, give $^{A}X$ symbol for a possible isotope, and draw a nanoscale picture of that isotope.

# Ions in Section 2.1 and Section 3.5

Neutral: a condition in which positive charges are balanced by the same number of negative charges, no net charge is leftover. In a neutral atom, the number of protons equals the number of electrons.

Example: $^{12}C$

(6 protons balanced by 6 electrons)

Ion: an atom or molecule that has a net electrical charge.

Examples: $Na^{+}$(sodium ion), $Cl^{-}$ (chloride), $NH_4^{+}$ (ammonium).

# Periodic trends and ions

(Sections 2.9 and 3.5, and Figures 3.1 and 3.2)

Group = column = elements with similar properties.

| Group | Usual charge* |
|---|---|
| alkali metals | +1 ions |
| alkaline earth metals | +2 ions |
| halogens | -1 ions |
| oxygen group | -2 ions |

*sometimes they have other charges

Periods = rows = elements with similar sizes.

## Mass percent (mass %)

$$\text{mass \%} = \frac{\text{mass of component}}{\text{mass of total}} \times 100\%$$

mass in units of grams (g), pounds (lb), kg, ton, oz, mg, etc.

Example: A fertilizer contains 16% nitrogen source. If you have a 40-lb bag of this fertilizer, how many grams of nitrogen source are in it?

Practice: A cancer treatment contains 65.0% platinum.  If you have 1.53 g of this drug, how many grams of platinum are in it?

# The Mole Unit (Chapter 2.7)

1 dozen = 12 “things” or items
(1 dozen eggs = 12 eggs, 1 dozen pencils = 12 pencils, etc.)

1 mole = 6.02214199 x $10^{23}$ “things” or items
(1 mole eggs = 6.02214199 x $10^{23}$ eggs)

Large: $10^9$ = 1 billion
$10^{18}$= 1 billion x 1 billion.

1 mole = 1 mol = Avogadro’s number = Avogadro’s constant = $N_A$.

$N_A$ = 6.022 x $10^{23}$ items/mol

Why use the mole? Need a human scale.
6 atoms, even 600 atoms, are too small to see and work with easily.

**The mole unit connects the nanoscale to the macroscale.**

1 mole of copper atoms found in ≈24 pennies.