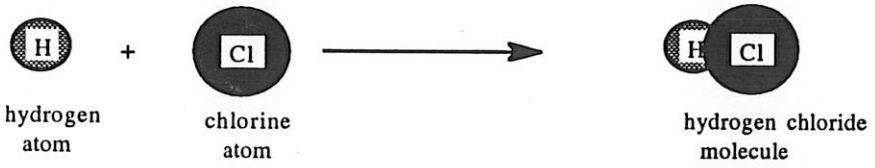
Relative Atomic Mass and Molecular Mass

Atoms are too small to weigh, however it is possible to compare the mass of one atom to another (ie. determine an atom's **relative** mass). For example, in the compound hydrogen chloride, it can be assumed that the simplest way for hydrogen atoms and chlorine atoms combine to one atom hydrogen bonded to one atom of chlorine.



Therefore, if hydrogen chloride molecules are separated into piles of hydrogen and chlorine atoms, there would be equal numbers of hydrogen and chlorine atoms. Weighing each pile would identify the heavier atom. By dividing the mass of the pile of heavier atoms by the mass of the pile of lighter atoms, we can calculate the relative mass of the heavier atom.

Separation of 100.00 grams of hydrogen chloride, for example, produces 2.76 g of hydrogen and 97.24 g of chlorine (thus chlorine is the heavier atom).

$$\text{Relative mass of chlorine} = \frac{\text{mass of Cl atoms}}{\text{mass of H atoms}} = \frac{97.24\text{g}}{2.76\text{ g}} = 35.2$$

Therefore, a chlorine (Cl) atom is 35.2 times heavier than the hydrogen (H) atom. Repeating this procedure with a variety of compounds will eventually allow us to calculate the relative mass of all atoms compared to one common atom (hydrogen in the above example).

Today, all atoms are compared to an atom of carbon isotope 12 (carbon-12) which is assigned a relative atomic mass of 12.00000̄. (Another way of expressing this idea is to say that we have assigned $^1/_{12}$ the mass of a carbon-12 atom a relative atomic mass of 1.00000̄.) Every element on the periodic table (See appendices E and F) has been assigned a relative atomic mass as compared to $^1/_{12}$ the mass of a carbon-12 atom (1.00000̄). A Cl (chlorine) atom, on this scale, is 35. 453 times heavier than $^1/_{12}$ the mass of a carbon-12 atom. An atom of Pb (lead) is 207.19 times heavier than $^1/_{12}$ the mass of a carbon-12 atom. The atomic masses listed on the periodic table are *relative atomic masses* (as compared to $^1/_{12}$ the mass of a carbon-12 atom).

The mass of a molecule (molecular mass) is also a relative mass (as compared to $^1/_{12}$ the mass of a carbon-12 atom). The molecular mass is the sum of atomic masses of all the atoms in the molecule.

eg. The molecular mass of $CuSO_4$ is:

1 atom of Cu = 1 x 63.546 = 63.546
1 atom of S = 1 x 32.064 = 32.064
4 atoms of O = 4 x 15.9994 = 63.9976
159.6076 ----> **159.608**

Assignment:

1. Compare the relative mass of a gold atom to a silver atom. Which is heavier? How many times heavier?

2. Calculate the molecular mass for:
   (a) $Ca(OH)_2$
   (b) Na(OH)
   (c) CO_2

3. Complete questions 1 to 3, page 104.

   Also problems 1 - 3, p 122.