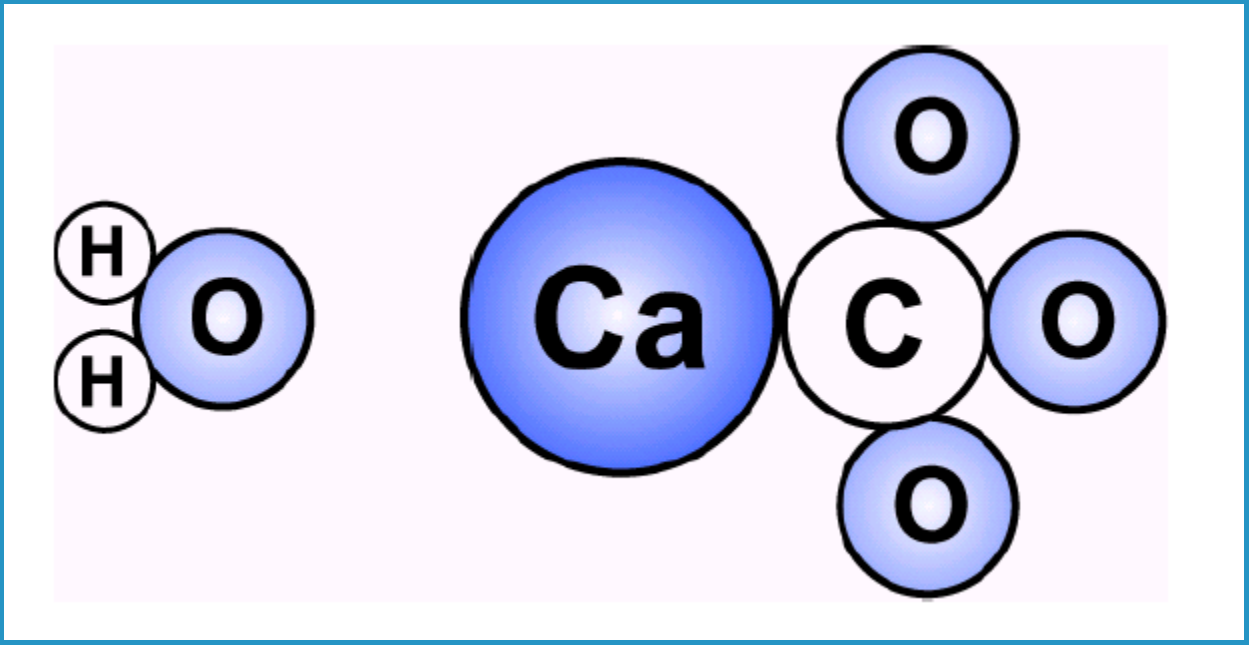
# Chapter 19: Molecules and Compounds

## Section 19.3 Comparing Molecules

# COMPARING DIFFERENT MOLECULES

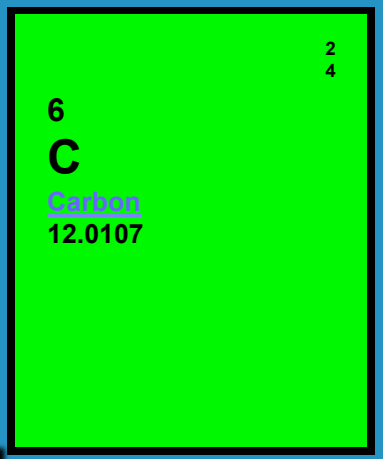
- How does the mass of different molecules compare?

# Do you think that a molecule of water has the same mass as a molecule of calcium carbonate?



# Recall atomic mass units (amu)…

- Atoms are assigned a relative mass based on carbon as the standard.
- Known as atomic mass unit



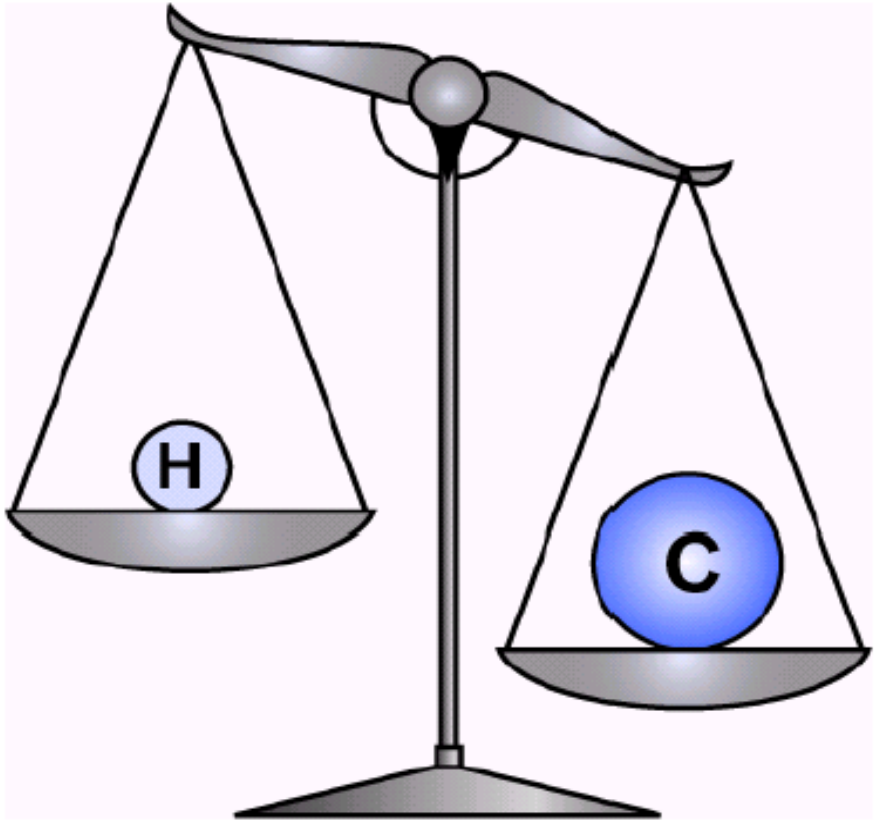



**Figure 19.28:** *One hydrogen atom is 1/12th the mass of one carbon atom.*

# Chemical formula gives 3 pieces of info:

- types / numbers of atoms.
- if polyatomic ions are present.
- allows calculation of mass of 1 molecule of a compound relative to mass of other compounds.

# Formula Mass

- Way to compare masses of molecules of different compounds.
- Calculate by adding up atomic masses of all atoms in a compound.

# Example: Figuring Formula Mass

- $H_2O$ means 2H and 1O
- 2 (1.01 amu) = 2.02
  +1 (16.00 amu) = 16.00
- Formula mass = 18.02 amu of $H_2O$

An amu is very small, so to be usable in measurements, we equate the number value of the formula mass in amu to an equal amount in grams.

# Avogadro's Number

- The formula mass in grams of any element or compound contains 6.02 x $10^{23}$ atoms or molecules.
- Known as Avogadro's # or a "mole" of the substance.

# Calculate the formula mass of calcium carbonate.

## 1. Write formula

calcium: $Ca^{2+}$ carbonate: $CO_3^{2-}$

chemical formula: $CaCO_3$

# 2. List number of atoms and atomic mass of each: $CaCO_3$

- 1 Ca = 1(40.08) = 40.08
- 1 C = 1(12.01) = 12.01
- 3 O = 3(16.00) = 48.00

# 3. Add up values to calculate formula mass

- 40.08
  12.01
  + 48.00
  100.09 amu

for $CaCO_3$

# So, how do we use this value?

- If you measure out 100.09 grams of $CaCO_3$, you have $6.02 \times 10^{23}$ molecules of $CaCO_3$.
- Likewise, 18.02 g of $H_2O$ contains $6.02 \times 10^{23}$ molecules of water.

# Hydrates ($BaCl_2 \cdot 2H_2O$)

- Some molecules contain precise numbers of $H_2O$ molecules chemically bonded to their ions.
- Called hydrates.
- Can remove $H_2O$ by heating.

# When $H_2O$ is gone, the compound is known as anhydrous ($BaCl_2$).

- To calculate formula mass, simply add the mass of the attached $H_2O$ molecules to that of the anhydrous mass.

# Example: $BaCl_2 \cdot 2H_2O$

- 1 Ba = 1(137.30) = 137.30
- 2 Cl = 2(35.45) = 70.90
- 4 H = 4(1.01) = 4.04
- 2 O = 2(16.00) = <u>32.00</u>

Formula mass = 244.24 amu