

## The Mole and Quantities in Compounds Review

- In a relative atomic mass experiment, 0.50 g of hydrogen gas is completely combusted in an atmosphere of oxygen, producing 4.50 g of water.
  - What mass of oxygen reacted? Determine the ratio of  $m_{\text{oxygen}} : m_{\text{hydrogen}}$ .
  - If hydrogen was assigned a mass of 1.00 u, what would be the relative atomic mass of oxygen? [Consider the actual formula of water and show this in the calculation.]
  - Given this relative atomic mass of oxygen, what mass of calcium would completely react with 2.00 g of oxygen gas to produce calcium oxide,  $\text{CaO}_{(s)}$ ?

- Determine the formula for sucrose (**Fig. 1**), common table sugar.
  - What is the mass of one molecule of sucrose?
  - If  $1 \text{ u} = 1.6605 \times 10^{-27} \text{ kg}$ , what is the mass of one molecule of sucrose (in grams, g)?
  - If there are  $6.0225 \times 10^{23}$  molecules in a mole, what is the mass of one mole of sucrose (in grams per mole, g/mol)?
  - Explain the similarities and the differences between the mass of one molecule of a compound and the molar mass of the compound.

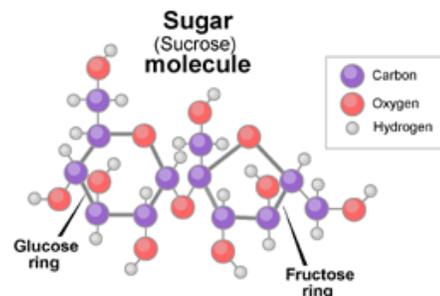


Figure 1. A molecule of sucrose

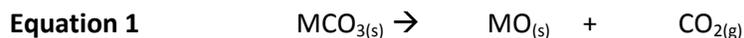
- Aspirin<sup>®</sup> is medication used for its analgesic, antipyretic, and anti-inflammatory properties. The active molecule is acetylsalicylic acid,  $\text{C}_9\text{H}_8\text{O}_4$ , a member of the salicylate family of drugs that are derived from the bark of the willow tree and have been used for centuries for relieving pain and discomfort.
  - Calculate the molar mass of acetylsalicylic acid (ASA).
  - How many moles of ASA are in a 500 mg tablet of Aspirin<sup>®</sup>? [Assume the tablet is pure ASA.]
  - How many molecules of ASA are in a 500 mg tablet of Aspirin<sup>®</sup>? [Assume the tablet is pure ASA.]
- Solid calcium metal placed in excess fluorine gas reacts quickly and explosively under SATP (standard atmospheric temperature and pressure) conditions producing calcium fluoride.
  - Write the balanced chemical equation for this reaction.
  - Determine the percentage composition of each element in calcium fluoride
  - What mass of calcium fluoride would be produced if 2.50 g of solid calcium metal was used?
  - If there was only 2.00 g of fluorine available, and not excess, what mass of calcium fluoride would be produced? How much calcium would remain unreacted?

- Capsaicin is the compound that is responsible for the “hotness” of chili peppers (for evidence see **Figure 1**). Chemical analysis reveals capsaicin to contain 71.0 % by mass carbon, 8.60 % by mass hydrogen, 15.8 % by mass oxygen, and the rest of the mass is nitrogen.
  - Determine the empirical formula of capsaicin.
  - The molar mass of the compound is 304 g/mol. What is the molecular formula of capsaicin?



Figure 1. Evidence for “hotness” of chili peppers

6. In the process of calcination, metal carbonates are heated to remove carbon dioxide and yield metal oxide for further treatment (**Eq. 1**). However, the process can be used to identify the metal present in the compound.



In a simple experiment, a light green powder that exhibits carbonate properties in solution (reacts with acidic solutions releasing bubbles) is assayed. To assist in identifying the metal ion, the powder undergoes calcination in which heating is continued until the mass remains constant. The observations are provided in **Table 1**.

**Table 1. Calcination of unknown metal carbonate**

Observations on reaction	Mass of carbonate (g)	Mass of product (g)
green powder with sticky texture that tends to clump; powder becomes lighter green and much finer and soft in appearance – “fluffier”	2.00	1.26

- Using the empirical evidence, what mass of carbon dioxide was released?
- What percentage of the metal carbonate was carbon dioxide?
- How many moles of carbon dioxide were produced in the reaction?
- How many moles of metal oxide,  $\text{MO}_{(s)}$ , were produced?
- Assuming the reaction went to completion, determine the molar mass of the metal oxide.
- Based on this analysis (and any other research), what is the identity of the metal ion in this experiment?