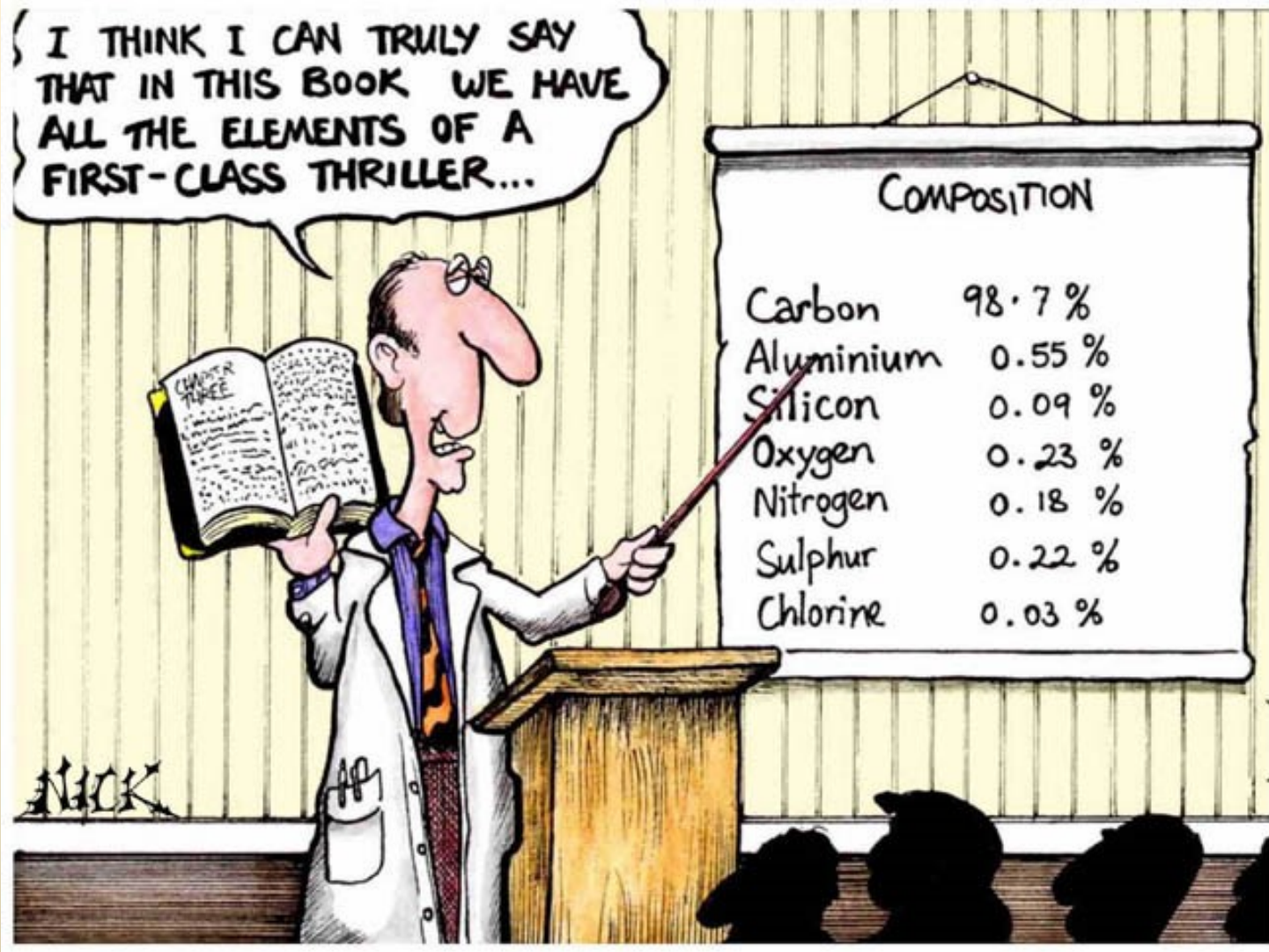


# Percent Composition, Empirical and Molecular Formulas



# Calculating Percentage Composition

Calculate the percentage composition of magnesium carbonate,  $\text{MgCO}_3$ .

Formula mass of magnesium carbonate:

$$24.31 \text{ g} + 12.01 \text{ g} + 3(16.00 \text{ g}) = 84.32 \text{ g}$$

$$\text{Mg} = \left( \frac{24.31}{84.32} \right) \cdot 100 = 28.83\%$$

$$\text{C} = \left( \frac{12.01}{84.32} \right) \cdot 100 = 14.24\%$$

$$\text{O} = \left( \frac{48.00}{84.32} \right) \cdot 100 = \underline{56.93\%}$$

**100.00**

# Formulas

Empirical formula: the lowest whole number ratio of atoms in a compound.

Molecular formula: the true number of atoms of each element in the formula of a compound.

- ❑ molecular formula = (empirical formula)<sub>n</sub>
- ❑ molecular formula = C<sub>6</sub>H<sub>6</sub> = (CH)<sub>6</sub>
- ❑ empirical formula = CH

## Formulas (continued)

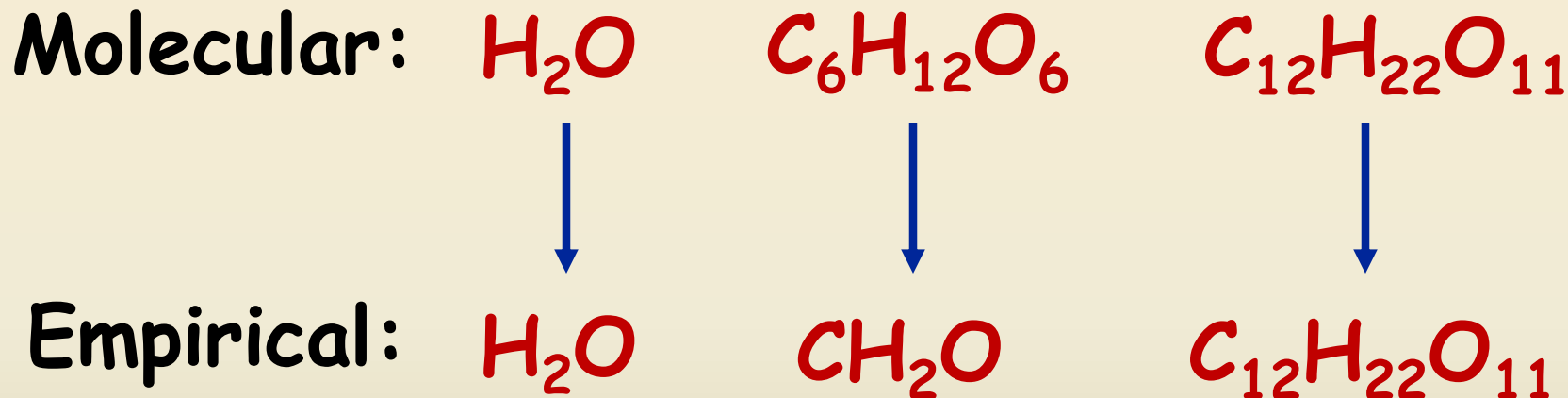
Formulas for ionic compounds are ALWAYS empirical (lowest whole number ratio).

Examples:



## Formulas (continued)

Formulas for molecular compounds MIGHT be empirical (lowest whole number ratio).



# Empirical Formula Determination

1. Base calculation on 100 grams of compound. Determine moles of each element in 100 grams of compound.
2. Divide each value of moles by the smallest of the values.
3. Multiply each number by an integer to obtain all whole numbers.

# Empirical Formula Determination

Adipic acid contains 49.32% C, 43.84% O, and 6.85% H by mass. What is the empirical formula of adipic acid?

1. Treat % as mass, and convert grams to moles

$$\frac{49.32 \text{ g carbon}}{12.01 \text{ g carbon}} \left| \frac{1 \text{ mol carbon}}{12.01 \text{ g carbon}} \right. = 4.107 \text{ mol carbon}$$

$$\frac{6.85 \text{ g hydrogen}}{1.01 \text{ g hydrogen}} \left| \frac{1 \text{ mol hydrogen}}{1.01 \text{ g hydrogen}} \right. = 6.78 \text{ mol hydrogen}$$

$$\frac{43.84 \text{ g oxygen}}{16.00 \text{ g oxygen}} \left| \frac{1 \text{ mol oxygen}}{16.00 \text{ g oxygen}} \right. = 2.74 \text{ mol oxygen}$$

# Empirical Formula Determination

2. Divide each value of moles by the smallest of the values.

**Carbon:** 
$$\frac{4.107 \text{ mol carbon}}{2.74 \text{ mol}} = 1.50$$

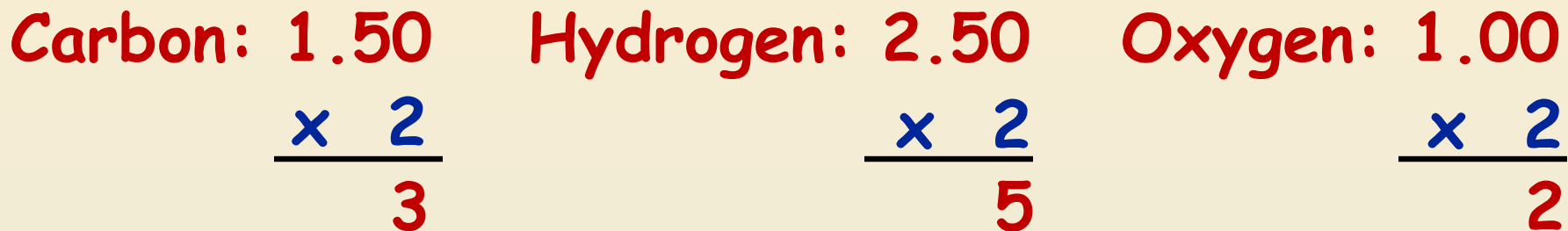
**Hydrogen:** 
$$\frac{6.78 \text{ mol hydrogen}}{2.74 \text{ mol}} = 2.47$$

**Oxygen:** 
$$\frac{2.74 \text{ mol oxygen}}{2.74 \text{ mol}} = 1.50$$



# Empirical Formula Determination

3. Multiply each number by an integer to obtain all whole numbers.



Empirical formula:  $C_3H_5O_2$

## Finding the Molecular Formula

The empirical formula for adipic acid is  $C_3H_5O_2$ . The molecular mass of adipic acid is 146 g/mol. What is the molecular formula of adipic acid?

1. Find the formula mass of  $C_3H_5O_2$

$$3(12.01 \text{ g}) + 5(1.01) + 2(16.00) = 73.08 \text{ g}$$

# Finding the Molecular Formula

The empirical formula for adipic acid is  $C_3H_5O_2$ . The molecular mass of adipic acid is 146 g/mol. What is the molecular formula of adipic acid?

$$3(12.01 \text{ g}) + 5(1.01) + 2(16.00) = 73.08 \text{ g}$$

2. Divide the molecular mass by the mass given by the empirical formula.

$$\frac{146}{73} = 2$$

## Finding the Molecular Formula

The empirical formula for adipic acid is  $C_3H_5O_2$ . The molecular mass of adipic acid is 146 g/mol. What is the molecular formula of adipic acid?

$$\frac{146}{73} = 2 \quad (C_3H_5O_2) \times 2 = C_6H_{10}O_4$$

3. Multiply the empirical formula by this number to get the molecular formula.