

# Honors Chemistry

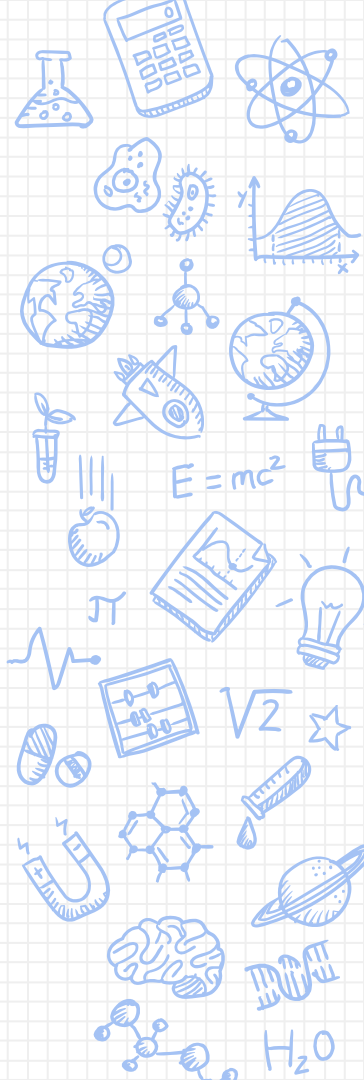
## 10.4 and 10.5





## Empirical Formula- Definition

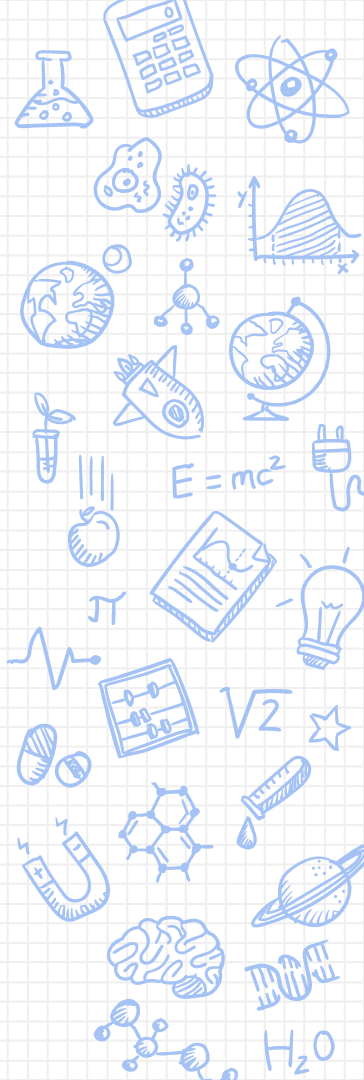
- the formula w/ the smallest whole number ratio of the elements
- this ratio provides the subscripts in the formula
- may or may not be the same as the actual formula

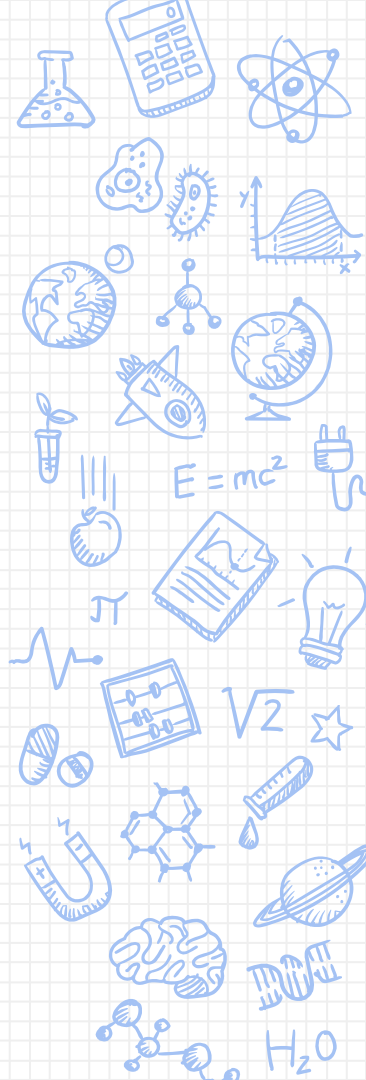


## Calculating the Empirical Formula

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- Begin with the total mass of the sample compound (if not given, assume 100 g)
- Multiply the mass by each percentage of element in the compound
- Use the molar mass to determine the moles of each element
- You have now found the molar ratios





## Calculating the Empirical Formula cont.

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- Convert the mole ratio to whole numbers to be used as subscripts
- Divide all mole values by the smallest value so that one subscript is 1
- Continue to multiply these values by the same number until whole numbers (or close to) have been reached

## Empirical Formula Example Problem

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Step 1: Evaluate known and unknown values

Known:

48.64% C

8.16% H

43.20% O

Unknown:

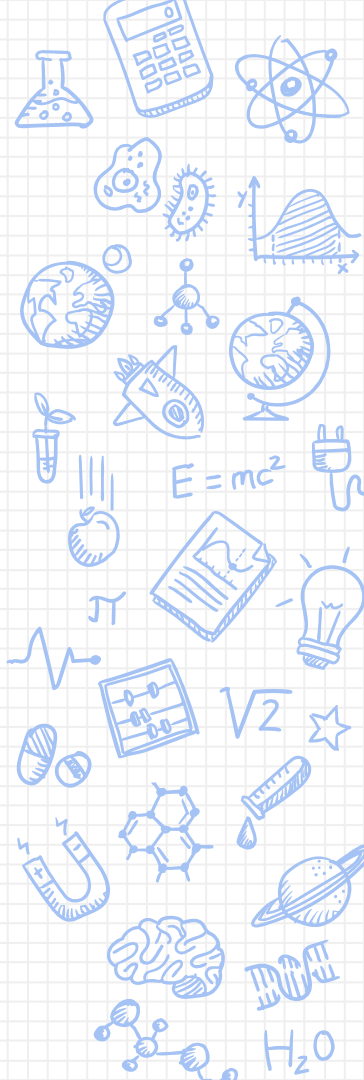
Empirical Formula

Step 2: Convert each mass to moles using the MM

48.64 g C (1 mol C/12.01 g C)  
=4.05 mol C

8.16 g H (1 mol H/1.00 g H)  
=8.10 mol H

43.20 g O (1 mol O/16.00 g O)  
=2.70 mol O



## Empirical Formula Example Problem

### Step 3: Calculate the simplest ratio of moles

$$4.05 \text{ mol C} / 2.70 = 1.5 \text{ mol C}$$

$$8.10 \text{ mol H} / 2.70 = 3 \text{ mol H}$$

$$2.70 \text{ mol O} / 2.70 = 1 \text{ mol O}$$

The simplest whole number ratio is 3 mol C, 6 mol H, and 2 mol O. The empirical formula is  $\text{C}_3\text{H}_6\text{O}_2$ . ☀



Step 4: Multiply each to get a ratio of whole numbers

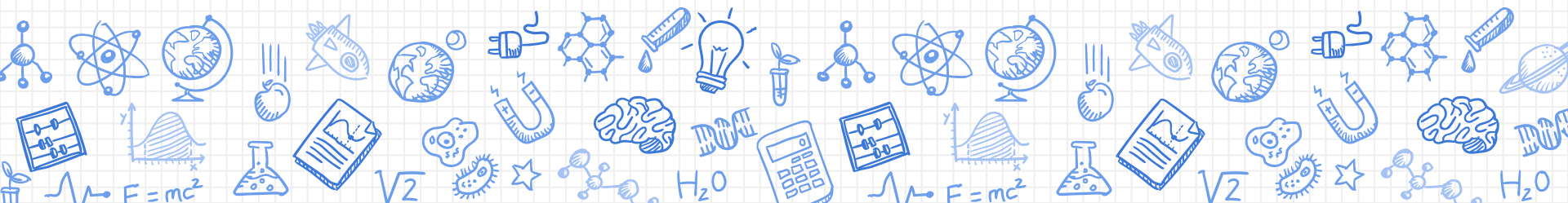
$$1.5 \text{ mol C} \times 2 = 3 \text{ mol C}$$

$$3 \text{ mol H} \times 2 = 6 \text{ mol H}$$

$$1 \text{ mol O} \times 2 = 2 \text{ mol O}$$



# Molecular Formulas



## Molecular Formula– Definition

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- the actual number of atoms of each element in one molecule of a compound
- will always be equal to or a multiple of the empirical formula





## Molecular Formula Example Problem

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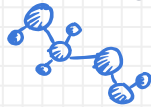
Step 1: Evaluate known and unknown values

Known:

Empirical Formula=  $\text{C}_2\text{H}_3\text{O}_2$

Unknown:

Molecular Formula



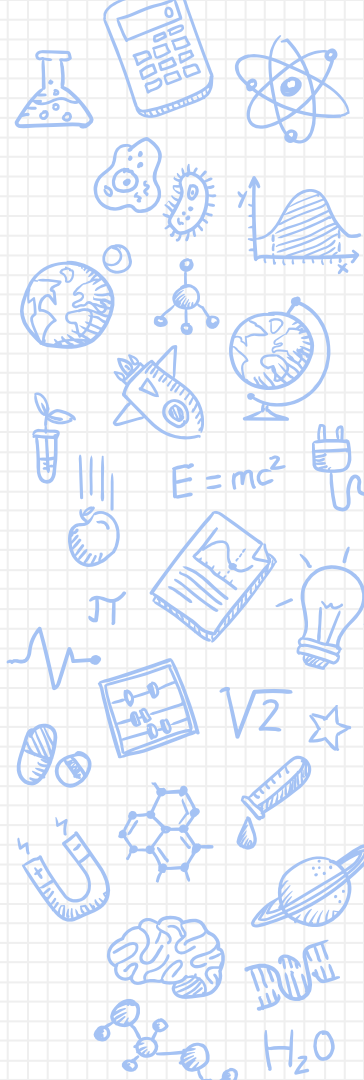
Step 2: Calculate the mass of the empirical formula

$$2 \text{ mol C}(12.01 \text{ g C})=24.02 \text{ g C}$$

$$3 \text{ mol H}(1.00 \text{ g H})=3.02 \text{ g H}$$

$$2 \text{ mol O}(16.00 \text{ g O})=32.00 \text{ g O}$$

$$(24.02+3.02+32.00)=59.04 \text{ g}$$



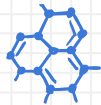
## Molecular Formula Example Problem

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Step 3: Divide the true mass  
by the empirical formula  
mass

$$118.1 \text{ g} / 59.04 \text{ g} = 2$$

Step 4: Multiply the  
subscripts by the previous  
value



The molecular formula of the compound is  $\text{C}_4\text{H}_6\text{O}_4$ .

