empirical formula: _relative_ numbers of atoms present; shows atoms present in smallest possible whole number ratios

molecular formula: _exact_ numbers of atoms present

- empirical formula is determined from the molecular formula by dividing the subscripts in the chemical formula by the greatest common denominator
  
  _example_: the molecular formula for benzene is C₆H₆ (greatest common denominator of the subscripts is 6), the empirical formula for benzene is CH

- an empirical formula is the empirical formula for many substances
  
  _example_: CH₂ is the empirical formula for C₂H₆, C₃H₁₂, C₄H₁₆ etc.

- an empirical and molecular formula may be the same
  
  _example_: the molecular and empirical formulas for propane are the same: C₃H₈ (greatest common denominator is 1)

- empirical and molecular formulas can be determined from mass percent composition data and combustion analysis data

_to determine an empirical formula:_
1. determine the quantity (in moles) of each element present
2. determine the mole ratio of the elements present in the smallest possible whole numbers

_to determine the molecular formula:_
3. divide the actual molar mass of the compound by the molar mass of the empirical formula; this will equal a small whole number, n
4. use n as a multiplier for the subscripts in the empirical formula; write the molecular formula

_example_: Vitamin C (molar mass = 176.1 g/mol) is composed of 40.9% C, 4.57% H and 54.5% O by mass. Determine the empirical and molecular formulas of vitamin C.

1. determine mol of C, H, O in vitamin C
   
   If no sample mass is given, assume a 100 g sample. A 100 g sample is composed of 40.9 g C, 4.57 g H, and 54.5 g O.

2. determine the mole ratio of C:H:O (smallest possible whole number ratio) and write the empirical formula for vitamin C

3. for molecular formula: divide the actual molar mass of vitamin C (176.1 g/mol) by the molar mass of its empirical formula

4. multiply the subscripts of the empirical formula by the factor determined in step 3

_example_: Ethanol, a molecular compound composed of C, H, and O only (molar mass = 46.08 g/mol) is analyzed by combustion. A 1.621 mg sample of ethanol produced 1.902 mg H₂O and 3.095 mg CO₂. Determine the empirical and molecular formulas of ethanol.

1. determine mol C, H, and O in this sample of ethanol
   
   Remember that in combustion analysis, all of the C and H from the sample ends up in the CO₂ and H₂O collected, meaning that mol C in CO₂ = mol C in sample and mol H in H₂O = mol H in sample.

   You cannot determine mol O in sample directly based on quantities of CO₂ and H₂O collected because there is more than one source of oxygen in the analysis system. So - to determine mole of oxygen you will need to start with the following relationship: mass sample = mass C + mass H + mass O.

Steps 2, 3, and 4 are the same as outlined above.