**Empirical Formulas**

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| **Student Objectives:** | | |
| * Know how formula mass relates to moles. * Use factor-label to determine empirical formulas. * Use an empirical formula to determine a molecular formula. |  |  |

**Empirical Formula:**

**the simplest formula that represents the  
whole number ratio between the elements in a compound.**

http://www.howe.k12.ok.us/~jimaskew/chem/asterix.gif**Molecular formulas and empirical formulas are sometimes the same:**

http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifThe molecular formula for water is H2O, a 2 to 1 ratio.   
http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifSince the subscripts will not reduce H2O is also water's empirical formula.

http://www.howe.k12.ok.us/~jimaskew/chem/asterix.gif**Molecular formulas and empirical formulas are not always the same:**

http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifThe molecular formula for glucose is C6H12O6, not a 1 to 1 ratio.

http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifReduce the subscripts to the lowest form.   
http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifThe empirical formula for glucose is CH2O, a 1 to 1 ratio.

http://www.howe.k12.ok.us/~jimaskew/chem/asterix.gif**Calculating Empirical Formulas:**

http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifSubscripts in a chemical formula are usually thought of as a ratio of atoms.   
http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifSubscripts can also be thought of as a ratio of **moles**.   
http://www.howe.k12.ok.us/~jimaskew/chem/tridot.gifTo determine an empirical formula, **one must determine the mole ratio**.

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| http://www.howe.k12.ok.us/~jimaskew/chem/tip.gif | **A mole is the number of atoms needed to equal the atomic mass of an element, therefore the atomic mass of an element in grams is equal to one mole of its atoms.** |
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| |  | | --- | | **Sample Empirical Formula Problem:**  Determine the empirical formula of a compound that is composed of 36.5% sodium, 25.4% sulfur, and 38.1% oxygen.   1. **Find the number of moles of each element present.** Since the amount of each element is given in percentage, you must convert the percentage to a mass. If 100 grams of the sample are assumed, the percentages given are the same as grams.   http://www.howe.k12.ok.us/~jimaskew/chem/empform.gif   1. **Determine the whole number mole ratio.** Divide each mole number by the smallest mole number.   http://www.howe.k12.ok.us/~jimaskew/chem/empform2.gif   1. **Use the mole ratio for the subscripts of each element in the formula.**   The empirical formula is **Na2SO3** | |

**Molecular formulas from empirical formulas:**

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| [http://www.howe.k12.ok.us/~jimaskew/chem/demo.gif](teacher/demo/demochm.htm#8) | The formula mass of the empirical formula above is 126u.  If the molecular mass is known to be 378u, what is the molecular formula?   * + Divide the molecular mass by the empirical formula mass to get a whole number.   **378/126  = 3**   * + Multiply each subscript in the empirical formula by this whole number.   + You now have the molecular formula - **Na6S3O9** |  |

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| |  | | --- | | **Concept Understanding:** http://www.howe.k12.ok.us/~jimaskew/chem/question.gif   1. Use factor-label to do the following conversions:    1. 0.775 mole of sodium chloride to grams.    2. 35.5 grams of aluminum hydroxide to moles.    3. 126.4 grams of calcium nitrate to moles.    4. 3.5 moles of water to grams. 2. What is the empirical formula of a compound that contains 53.73% iron and 46.27% sulfur? 3. The molecular mass of benzene, a proven carcinogen, is 78.0u and its empirical formula is CH. What is the molecular formula for benzene? | |

**Research Links:**

[**Empirical Formulas**](http://dbhs.wvusd.k12.ca.us/Stoichiometry/EmpiricalFormula.html) **- Diamond Bar High School**