## Chapter 6: Empirical and Molecular Formulas

1. In each case below, the molecular formula for a compound is given. Determine the empirical formula for each compound.

   a) $C_6H_6$. This is the molecular formula for benzene, a liquid commonly used in industry as a starting material for many important products.   CH

   b) $C_{12}H_4Cl_4O_2$. This is the molecular formula for a substance commonly called dioxin, a powerful poison that sometimes occurs as a by-product in the production of other chemicals.   $C_6H_2Cl_2O$

   c) $C_6H_{16}N_2$. This is the molecular formula for one of the reactants used to produce nylon.   $C_3H_8N$

2. When a 0.3546 g sample of vanadium metal is heated in air, it reacts with oxygen to achieve a final mass of 0.6330 g. Calculate the empirical formula of this vanadium oxide.

   0.6330g − 0.3546g = mass O

   V : 0.3546g / 50.94 g/mol = 0.00696 mol /0.00696 = 1    × 2 → 2

   O : 0.2784g / 16 g/mol = 0.0174 mol /0.00696 = 2.5  × 2 → 5    $V_2O_5$

3. A sample of lead arsenate, an insecticide used against the potato beetle, contains 1.3813 g of lead, 0.00672 g of hydrogen, 0.4995 g of arsenic, and 0.4267 g of oxygen. Calculate the empirical formula for the lead arsenate.

   Pb : 1.3813g / 207.19 g/mol = 0.00667 / 0.00665 = 1

   H : 0.00672g / 1.01 g/mol = 0.00665 / 0.00665 = 1

   As : 0.4995g / 74.92 g/mol = 0.00667 / 0.00665 = 1

   O : 0.4267g / 16 g/mol = 0.0267 / 0.00665 = 4

   $PbHAsO_4$

4. Cisplatin, the common name for a platinum compound that is used to treat cancerous tumors, has the composition (mass percent) 65.02% platinum, 9.34% nitrogen, 2.02% hydrogen, and 23.63% chlorine. Calculate the empirical formula for cisplatin.

   Pt : 65.02g / 195.08g/mol = 0.333 / 0.333 = 1

   N : 9.34g / 14.01g = 0.667 / 0.333 = 2

   H : 2.02 g / 1.01 g = 2 / 0.333 = 6

   Cl : 23.63g / 35.45g = 0.667 / 0.333 = 2

   $PtN_2H_6Cl_2$

5. The most common form of nylon (Nylon-6) is 63.68% carbon, 12.38% nitrogen, 9.80% hydrogen, and 14.14% oxygen. Calculate the empirical formula for Nylon-6.

   C : 63.68g / 12.01g/mol = 5.30 / 0.883 = 6

   N : 12.38g / 14.01g/mol = 0.884 / 0.883 = 1

   H : 9.80g / 1.01g/mol = 9.70 / 0.883 = 11

   O : 14.14g / 16 g/mol = 0.883 / 0.883 = 1

   $C_6NH_{11}O$

6. A white powder is analyzed and found to have an empirical formula of $P_2O_5$. The compound has a molar mass of 283.88 g. What is the compound's molecular formula?

   emp. form mass → 141.94     $\dfrac{283.88g}{141.94g} = 2$    $2(P_2O_5) \Rightarrow \boxed{P_4O_{10}}$

7. A compound used as an additive for gasoline to help prevent engine knocks shows the following percentages:

   71.65% Cl          24.27% C          4.07% H

   The molar mass is known to be 98.96 g. Determine the empirical formula and the molecular formula for this compound.

   Cl : 71.65g / 35.45 g/mol = 2.02 mol / 2.02 = 1

   C : 24.27g / 12.01g/mol = 2.02 mol / 2.02 = 1

   H : 4.07g / 1.01g/mol = 4.0 mol / 2.02 = 2

   $ClCH_2 \rightarrow$ 49.48g    $\dfrac{98.96}{49.48} = 2$    $2(ClCH_2) \Rightarrow \boxed{Cl_2C_2H_4}$

8. A compound consists of 40.00% C, 6.713% H, and 53.28% O on a mass basis and has a molar mass of approximately 180 g. Determine the molecular formula of the compound.

   C : 40.0/12.01 = 3.33 / 3.33 = 1

   H : 6.713/1.01 = 6.64 / 3.33 = 2

   O : 53.28/16 = 3.33 / 3.33 = 1

   $CH_2O \rightarrow$ 30.03g    $\dfrac{180g}{30.03g} = 6$    $6(CH_2O) \Rightarrow \boxed{C_6H_{12}O_6}$

35.45
× 0.03