key

Empirical and Molecular Formula Worksheet

1. An oxide of chromium is found to have the following % composition: 68.4 % Cr and 31.6 % O. Determine this compound's empirical formula.

Cr $\frac{68.4\text{ g}}{52\text{ g/mol}} = \frac{1.315}{1.315} = 1$

O $\frac{31.6\text{ g}}{16\text{ g/mol}} = \frac{1.975}{1.315} = 1.5$

$Cr_1O_{1.5}$

Cr_2O_3

2. The percent composition of a compound was found to be 63.5 % silver, 8.2 % nitrogen, and 28.3 % oxygen. Determine the compound's empirical formula.

Ag $\frac{63.5\text{ g}}{107.87\text{ g/mol}} = \frac{0.589}{0.589} = 1$

N $\frac{8.2\text{ g}}{14.01\text{ g/mol}} = \frac{0.585}{0.585} = 1$

O $\frac{28.3\text{ g}}{16\text{ g/mol}} = \frac{1.769}{0.585} = 3$

$AgNO_3$

3. A 170.00 g sample of an unidentified compound contains 29.84 g sodium, 67.49 g chromium, and 72.67 g oxygen. What is the compound's empirical formula?

Na: $\frac{29.84}{170.00} = 17.55 \text{ g} \times \frac{1\text{ mol}}{22.99\text{ g}} = \frac{0.76}{0.76} = 1$

Cr $\frac{67.49}{170.00} = 39.7 \text{ g} \times \frac{1\text{ mol}}{52\text{ g}} = \frac{0.76}{0.76} = 1$

O $\frac{72.67}{170.00} = 42.7 \text{ g} \times \frac{1\text{ mol}}{16\text{ g}} = \frac{2.7}{0.76} = 3.5$

$NaCrO_{3.5}$

$Na_2Cr_2O_7$

4. A 60.00 g sample of tetraethyl lead, a gasoline additive, is found to contain 38.43 g lead, 17.83 g carbon, and 3.74 g hydrogen. Find its empirical formula.

Pb $\frac{38.43}{60.00}$ $64.05 \text{ g} \times \frac{1\text{ mol}}{207.2\text{ g}} = \frac{0.3}{0.3} = 1$

C $\frac{17.83}{60.00}$ $29.72 \text{ g} \times \frac{1\text{ mol}}{12.01\text{ g}} = \frac{2.47}{0.3} = 8.2$

H $\frac{3.74\text{ g}}{60.00\text{ g}}$ $6.23 \text{ g} \times \frac{1\text{ mol}}{1.01\text{ g}} = \frac{6.17}{0.3} = 21$

PbC_8H_{21}

5. A compound containing 5.9265 % H and 94.0735 % O has a molar mass of 34.01468 g/mol. Determine the empirical and molecular formula of this compound.

H $5.9265\text{ g} \times \frac{1\text{ mol}}{1.01\text{ g}} = \frac{5.87}{5.87}$

O $94.075\text{ g} \times \frac{1\text{ mol}}{16.00\text{ g}} = \frac{5.88}{5.87}$

E: HO

M: H_2O_2

EFM = 17.01

$\frac{34}{17.01} = 2$

6. The empirical formula for trichloroisocyanuric acid, the active ingredient in many household bleaches, is OCNCl. The molar mass of this compound is 232.41 g/mol. What is the molecular formula of trichloroisocyanuric acid?

16
12
14
+35.4
77.4 g/mol

$\frac{MM\ of\ M.F.}{MM\ of\ E.F.} = \frac{232.41\ g/mol}{77.4\ g/mo} = 3.00$

$\times 3$

$O_3C_3N_3Cl_3$

7. Determine the molecular formula of a compound with an empirical formula of NH_2 and a formula mass of 32.06 amu.

14
1
1
16g

$\frac{MM\ of\ M.F.}{MM\ of\ E.F.} = \frac{32.06}{16} = 2$

$\times 2$

N_2H_4

8. The empirical formula of a hydrocarbon (compound that contains only C and H) is found to be CH. Laboratory procedures have found that the molar mass of the compound is 78 g/mol. What is the molecular formula of this compound?

$\frac{MM\ of\ M.F.}{MM\ of\ E.F.} = \frac{78}{13} = 6$

$\times 6$

C_6H_6

9. The molar mass of nicotine is 162.1 g/mol. It contains 74.0 % carbon, 8.7 % hydrogen, and 17.3 % nitrogen. Determine nicotine's empirical formula and molecular formula.

$C = \frac{74}{12} = 6.17/1.2 = 5.1$

$H = \frac{8.7}{1} = 8.7/1.2 = 7.25$

$N = \frac{17.3}{14} = 1.2/1.2 = 1.2$

E.F. $= C_5H_7N_1$

$\frac{MM\ of\ M.F.}{MM\ of\ E.F.} = \frac{162.1}{81} = 2$

$\times 2$

M.F. $= C_{10}H_{14}N_2$

12(5)
1(7)
14
81 g/mol

10. Phenyl magnesium bromide is used as a Grignard reagent in organic synthesis. Determine its empirical and molecular formula if its molar mass is 181.313 g/mol and it contains 39.7458 % C, 2.77956 % H, 13.4050 % Mg, and 44.0697 % Br.

$C = \frac{39.75}{12} = 3.31/.55 = 6$

$H = \frac{2.78}{1} = 2.78/.55 = 5$

$Mg = \frac{13.40}{24.3} = 0.55/.55 = 1$

$Br = \frac{44.07}{80} = 0.55/.55 = 1$

E.F. $= C_6H_5MgBr =$ M.F.

$\frac{MM\ of\ M.F.}{MM\ of\ E.F.} = \frac{181.313}{181.3} = \times 1$

12(6)
1(5)
24.3
80
181.31 g/mo