HOMEWORK PROBLEMS:

5a. The molecular mass of benzene, an important industrial solvent, is 78.0 g/mol and its empirical formula is CH. What is the molecular formula for benzene?

Answers:

$$\boldsymbol{CH = 12.01\ g/mol + 1.008\ g/mol = 13.018\ g/mol}$$

$$n = \frac{78.0\ \frac{g}{mol}}{13.018\ \frac{g}{mol}} = 6$$

$$\boldsymbol{(CH)_n = (CH)_6 = C_6H_6}$$

5b. What is the molecular formula of dichloroacetic acid, if the empirical formula is CHOCl and the molecular mass of the acid is 129 g/mol?

Answers:

$$\boldsymbol{CHOCl = 12.01\ g/mol + 1.008\ g/mol + 16.00\ g/mol + 35.45\ g/mol = 64.468\ g/mol}$$

$$n = \frac{129\ \frac{g}{mol}}{64.468\ \frac{g}{mol}} = 2$$

$$\boldsymbol{(CHOCl)_n = (CHOCl)_2 = C_2H_2O_2Cl_2}$$

5c. What is the molecular formula of cyanuric chloride if the empirical formula is CClN and the molecular mass is 184.5 g/mol?

Answers:

$$\boldsymbol{CClN = 12.01\ g/mol + 35.45\ g/mol + 14.01\ g/mol = 61.47\ g/mol}$$

$$n = \frac{184.5\ \frac{g}{mol}}{61.47\ \frac{g}{mol}} = 3$$

$$\boldsymbol{(CClN)_n = (CClN)_3 = C_3Cl_3N_3}$$

5d. Asorbic acid, vitamin C, has a percentage composition of 40.9% carbon, 4.58% hydrogen, and 54.5% oxygen. Its molecular mass is 176.1 g/mol. What is the molecular formula?

Answers:

$$C: \frac{40.9\ g}{} \times \frac{1\ mol\ C}{12.01\ g} = 3.4055\ mol \qquad = \frac{3.4055\ mol}{3.4055\ mol} = 1 \times 3 = 3$$

$$H: \frac{4.58\ g}{} \times \frac{1\ mol\ H}{1.008\ g} = 4.5437\ mol \qquad = \frac{4.5437\ mol}{3.4055\ mol} = 1\frac{1}{3} \times 3 = 4$$

$$O: \frac{54.5\ g}{} \times \frac{1\ mol\ O}{16.00\ g} = 3.4063\ mol \qquad = \frac{3.4063\ mol}{3.4055\ mol} = 1 \times 3 = 3$$

$$\boldsymbol{C_3H_4O_3}$$

$C_3H_4O_3$ = 3(12.01 g/mol) + 4(1.008 g/mol) + 3(16.00 g/mol) = 88.062 g/mol

$$n = \frac{176.1\ \frac{g}{mol}}{88.062\ \frac{g}{mol}} = 2$$

$$\boldsymbol{(C_3H_4O_3)_n = (C_3H_4O_3)_2 = C_6H_8O_6}$$

5e. Aspirin contains 60.0% carbon, 4.48% hydrogen, and 35.5% oxygen. It has a molecular mass of 180 g/mol. What is the its empirical and molecular formulas?

Answers:

$$C: \frac{60.0\ g}{} \times \frac{1\ mol\ C}{12.01\ g} = 4.9958\ mol \qquad = \frac{4.9958\ mol}{2.21875\ mol} = 2\frac{1}{4} \times 4 = 9$$

$$H: \frac{4.48\ g}{} \times \frac{1\ mol\ H}{1.008\ g} = 4.\overline{4}\ mol \qquad = \frac{4.\overline{4}\ mol}{2.21875\ mol} = 2 \times 4 = 8$$

$$O: \frac{35.5\ g}{} \times \frac{1\ mol\ O}{16.00\ g} = 2.21875\ mol \qquad = \frac{2.21875\ mol}{2.21875\ mol} = 1 \times 4 = 4$$

$$\boldsymbol{C_9H_8O_4}$$

$C_9H_8O_4$ = 9(12.01 g/mol) + 8(1.008 g/mol) + 4(16.00 g/mol) = 180.154 g/mol

$$n = \frac{180\ \frac{g}{mol}}{180.154\ \frac{g}{mol}} = 1$$

$$\boldsymbol{(C_9H_8O_4)_n = (C_9H_8O_4)_1 = C_9H_8O_4}$$