1. Vitamin C ($C_6H_8O_6$) is an essential vitamin. It cannot be stored in the body and must be present in the diet.

   a. What is the molar mass of Vitamin C?

6 C x 12.01 = 72.06
8 H x 1.01 = 8.08
6 O x 16.00 = 96.00
176.14 g

176.14 g

   b. If a typical tablet contains 500.0 mg of vitamin C, how many moles ***and*** how many molecules of vitamin C does it contain?

$$500.0 \text{ mg } C_6H_8O_6 \times \frac{1 \text{ g } C_6H_8O_6}{1000 \text{ mg } C_6H_8O_6} \times \frac{1 \text{ mole } C_6H_8O_6}{176.14 \text{ g } C_6H_8O_6}$$

$$= 0.002839 \text{ moles } C_6H_8O_6$$

$$500.0 \text{ mg } C_6H_8O_6 \times \frac{1 \text{ g } C_6H_8O_6}{1000 \text{ mg } C_6H_8O_6} \times \frac{1 \text{ mole } C_6H_8O_6}{176.14 \text{ g } C_6H_8O_6} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mole } C_6H_8O_6}$$

$$= 1.709 \times 10^{21} \text{ molecules } C_6H_8O_6$$

2. How many atoms of nitrogen are present in 5.00 g of glycine, $C_2H_5O_2N$?

$$5.00\text{ g } C_2H_5O_2N \left| \frac{1\text{ mole } C_2H_5O_2N}{75.08\text{ g } C_2H_5O_2N} \right| \frac{1\text{ mole N}}{1\text{ mole } C_2H_5O_2N} \left| \frac{6.022 \times 10^{23}\text{ atoms N}}{1\text{ mole N}} \right.$$

$$= 4.01 \times 10^{22}\text{ atoms N}$$

3. How many grams of magnesium are present in 5.00 g of magnesium nitride?

$$5.00\text{ g } Mg_3N_2 \left| \frac{1\text{ mole } Mg_3N_2}{100.95\text{ g } Mg_3N_2} \right| \frac{3\text{ mole Mg}}{1\text{ mole } Mg_3N_2} \left| \frac{24.31\text{ g Mg}}{1\text{ mole Mg}} \right.$$

$$= 3.61\text{ g Mg}$$

4. How many nitrate ions are present in 5.00 g of calcium nitrate?

$$5.00\text{ g } Ca(NO_3)_2 \left| \frac{1\text{ mole } Ca(NO_3)_2}{164.10\text{ g } Ca(NO_3)_2} \right| \frac{2\text{ mole } NO_3^{1-}}{1\text{ mole } Ca(NO_3)_2} \left| \frac{6.022 \times 10^{23}\ NO_3^{1-}\text{ ions}}{1\text{ mole } NO_3^{1-}} \right.$$

$$= 3.67 \times 10^{22}\ NO_3^{1-}\text{ ions}$$

5. How many atoms of oxygen are present in 2.50 g of dinitrogen tetroxide?

$$2.50\ g\ N_2O_4 \left| \frac{1\ mole\ N_2O_4}{92.02\ g\ N_2O_4} \right| \frac{4\ mole\ O}{1\ mole\ N_2O_4} \left| \frac{6.022 \times 10^{23}\ O\ atoms}{1\ mole\ O} \right.$$

$$= 6.54 \times 10^{22}\ O\ atoms$$

6. Chloral hydrate ($C_2H_3Cl_3O_2$) is a drug formerly used as a sedative and hypnotic. It is the compound used to make "Mickey Finns" in detective stories.

   a. Calculate the molar mass of chloral hydrate.

$2\ C \times 12.01 = 24.02$
$3\ H \times 1.01 = 3.03$
$3\ Cl \times 35.45 = 106.35$
$2\ O \times 16.00 = 32.00$

165.40 g

   b. How many moles of $C_2H_3Cl_3O_2$ are present in 500.0 g of chloral hydrate?

$$500.0\ g\ C_2H_3Cl_3O_2 \left| \frac{1\ mole\ C_2H_3Cl_3O_2}{165.40\ g\ C_2H_3Cl_3O_2} \right.$$

$$= 3.023\ moles\ C_2H_3Cl_3O_2$$

c. What is the mass in grams of 2.0×10^{-2} mol chloral hydrate?

$$2.0 \times 10^{-2} \text{ mol } C_2H_3Cl_3O_2 \left| \frac{165.40 \text{ g } C_2H_3Cl_3O_2}{1 \text{ mole } C_2H_3Cl_3O_2} \right. = 3.3 \text{ g } C_2H_3Cl_3O_2$$

d. How many chlorine atoms are in 5.0 g of chloral hydrate?

$$5.0 \text{ g } C_2H_3Cl_3O_2 \left| \frac{1 \text{ mole } C_2H_3Cl_3O_2}{165.40 \text{ g } C_2H_3Cl_3O_2} \right| \frac{3 \text{ mole Cl}}{1 \text{ mole } C_2H_3Cl_3O_2} \left| \frac{6.022 \times 10^{23} \text{ atoms Cl}}{1 \text{ mole Cl}} \right.$$

$$= 5.5 \times 10^{22} \text{ atoms Cl}$$

e. What mass of chloral hydrate would contain 1.0 g Cl?

$$1.0 \text{ g Cl} \left| \frac{1 \text{ mole Cl}}{35.45 \text{ g Cl}} \right| \frac{1 \text{ mole } C_2H_3Cl_3O_2}{3 \text{ mole Cl}} \left| \frac{165.40 \text{ g } C_2H_3Cl_3O_2}{1 \text{ mole } C_2H_3Cl_3O_2} \right.$$

$$= 1.6 \text{ g } C_2H_3Cl_3O_2$$

f. What is the mass of exactly 500 molecules of chloral hydrate?

$$500 \text{ molecules } C_2H_3Cl_3O_2 \left| \frac{1 \text{ mole } C_2H_3Cl_3O_2}{6.022 \times 10^{23} \text{ molecules } C_2H_3Cl_3O_2} \right| \frac{165.40 \text{ g } C_2H_3Cl_3O_2}{1 \text{ mole } C_2H_3Cl_3O_2} \left.\right|$$

$$= 1.37329791 \times 10^{-19} \text{ g } C_2H_3Cl_3O_2$$