**U3-LM2B-WS Molar Mass and Conversions** **Name:_____KEY_____**

1. The molar mass of chlorine is:

   2 x 35.45 g/mol Cl = 70.90 g/mol $Cl_2$

   (Remember that chlorine exists as a diatomic molecule in nature)

2. The molar mass of carbon dioxide is:

   12.01 g/mol C + (2 x 16.00 g/mol O) = 44.01 g/mol $CO_2$

3. The molar mass of aluminum carbonate, $Al_2(CO_3)_3$, is:

   (2 x 26.98 g/mol Al) + (3 x 12.01 g/mol C) + (9 x 16 g/mol O) = 234.0 g/mol $Al_2(CO_3)_3$

4. The molar mass of ascorbic acid (Vitamin C), $C_6H_8O_6$ is:

   (6 x 12.01 g/mol C) + (8 x 1.01 g/mol H) + (6 x 16 g/mol H) = 176.14 g/mol $C_6H_8O_6$

5. A 4.0g/mol represents the molar mass of the element ____helium_____.

6. A 2.0 g/mol represents the molar mass of the element ____hydrogen____.

7. A 40.0 g sample of sodium is ____1.74_____ moles of sodium and _1.05 x $10^{24}$_ atoms of sodium.

   $$40.0 \text{ g Na} \left| \frac{1 \text{ mol Na}}{22.99 \text{ g Na}} \right. = 1.74 \text{ moles Na}$$

   $$1.74 \text{ moles Na} \left| \frac{6.022 \times 10^{23} \text{ atoms Na}}{1 \text{ mol Na}} \right. = 1.05 \times 10^{24} \text{ atoms Na}$$

8. One mole of elemental diatomic chlorine is ____70.9_____ grams of chlorine and contains __1.20 x $10^{24}$_____atoms of chlorine.

   $$1 \text{ mol } Cl_2 \left| \frac{70.9 \text{ g Cl}}{1 \text{ mol } Cl_2} \right. = 70.9 \text{ g Cl}$$

   $$1 \text{ mol } Cl_2 \left| \frac{2 \text{ mol Cl}}{1 \text{ mol } Cl_2} \right| \frac{6.022 \times 10^{23} \text{ atoms Cl}}{1 \text{ mol Cl}} = 1.20 \times 10^{24} \text{ atoms Cl}$$

9. If 2 moles of magnetite, $Fe_3O_4$, are needed, one needs to weigh __463.1__ grams of the substance. This amount corresponds to ___two___ formula units and it contains __3.61 x $10^{24}$__ ions of iron and __4.82 x $10^{24}$__ ions of oxygen.

$$\frac{2 \text{ mol } Fe_3O_4}{} \left| \frac{6.022 \times 10^{23} \text{ formula units } Fe_3O_4}{1 \text{ mol } Fe_3O_4} \right. = 1.20 \times 10^{24} \text{ formula units } Fe_3O_4$$

$$\frac{1.20 \times 10^{24} \text{ formula units } Fe_3O_4}{} \left| \frac{3 \text{ ions Fe}}{1 \text{formula unit } Fe_3O_4} \right. = 3.61 \times 10^{24} \text{ ions Fe}$$

$$\frac{1.20 \times 10^{24} \text{ formula units } Fe_3O_4}{} \left| \frac{4 \text{ ions O}}{1 \text{ formula unit } Fe_3O_4} \right. = 4.82 \times 10^{24} \text{ ions O}$$

10. A sample that is 36.0 grams of water represents ___2___ moles of water. It contains ___4___ grams of hydrogen and ___32___ grams of oxygen. It also contains ___4___ moles of H atom and ___2___moles of O atoms. This sample also represents __1.20 x $10^{24}$__ molecules of water, __2.41 x $10^{24}$__ atoms of hydrogen and ___1.20 x $10^{24}$___ atoms of oxygen.

$$\frac{36.0 \text{ g } H_2O}{} \left| \frac{1 \text{ mol } H_2O}{18 \text{ g } H_2O} \right. = 2 \text{ mol } H_2O$$

$$\frac{2 \text{ mol } H_2O}{} \left| \frac{2 \text{ mol H}}{1 \text{ mol } H_2O} \right. = 4 \text{ mol H} \left| \frac{1 \text{ g H}}{1 \text{ mol H}} \right. = 4 \text{ g H}$$

$$\frac{2 \text{ mol } H_2O}{} \left| \frac{1 \text{ mol O}}{1 \text{ mol } H_2O} \right. = 2 \text{ mol O} \left| \frac{16 \text{ g H}}{1 \text{ mol H}} \right. = 32 \text{ g H}$$

$$\frac{2 \text{ mol } H_2O}{} \left| \frac{6.022 \times 10^{23} \text{ molecules } H_2O}{1 \text{ mol } H_2O} \right. = 1.20 \times 10^{24} \text{ molecules } H_2O$$

$$\frac{2 \text{ mol } H_2O}{} \left| \frac{1 \text{ mol O} \quad 6.022 \times 10^{23} \text{ atoms O}}{1 \text{ mol } H_2O} \right. = 1.20 \times 10^{24} \text{ atoms O}$$

$$\frac{2 \text{ mol } H_2O}{} \left| \frac{6.022 \times 10^{23} \text{ molecules } H_2O}{1 \text{ mol } H_2O} \right. = 1.20 \times 10^{24} \text{ molecules } H_2O$$

11. a-Calculate the mass in grams of 2.5 moles of calcium.

$$\frac{2.5 \text{ mol Ca}}{} \left| \frac{40.08 \text{ g Ca}}{1 \text{ mol Ca}} \right. = 1.0 \times 10^{2} \text{ g Ca}$$

b-How many atoms are there is 20.0 grams of calcium?

$$\frac{20.0 \text{ g Ca}}{} \left| \frac{1 \text{ mol Ca}}{40.08 \text{ g Ca}} \right| \frac{6.022 \times 10^{23} \text{ atoms Ca}}{1 \text{ mol Ca}} = 3.00 \times 10^{23} \text{ atoms Ca}$$

c-What is the mass of $1.40 \times 10^{20}$ atoms of calcium?

$$\frac{1.40 \times 10^{20} \text{ atoms Ca}}{} \left| \frac{1 \text{ mol Ca}}{6.022 \times 10^{23} \text{ atoms Ca}} \right| \frac{40.08 \text{ g Ca}}{1 \text{ mol Ca}} = .00692 \text{ g Ca}$$

d-Calculate the mass in grams of one calcium atom.

$$\frac{1 \text{atom Ca}}{} \left| \frac{1 \text{ mol Ca}}{6.022 \times 10^{23} \text{ atoms Ca}} \right| \frac{40.08 \text{ g Ca}}{1 \text{ mol Ca}} = 6.7 \times 10^{-23} \text{ g Ca}$$

12. a-How many atoms are contained in 28.0 grams of nitrogen?

$$\frac{28.0 \text{ g } N_2}{} \left| \frac{1 \text{ mol } N_2}{28.0 \text{ g } N_2} \right| \frac{2 \text{ mol N}}{1 \text{ mol } N_2} \left| \frac{6.022 \times 10^{23} \text{ atoms N}}{1 \text{ mol N}} \right. = 1.20 \times 10^{24} \text{ atoms N}$$

b-How many moles of N atoms are represented in $5.0 \times 10^{30}$ atoms of nitrogen?

$$\frac{5.0 \times 10^{30} \text{ atoms N}}{} \left| \frac{1 \text{ mol N}}{6.022 \times 10^{23} \text{ atoms N}} \right. = 8.3 \times 10^{6} \text{ moles N}$$

c-Calculate the mass in grams of one molecule of nitrogen.

$$\frac{1 \text{ molecule } N_2}{} \left| \frac{1 \text{ mol } N_2}{6.022 \times 10^{23} \text{ molecules } N_2} \right| \frac{28.0 \text{ g } N_2}{1 \text{ mol } N_2} = 4.6 \times 10^{-23} \text{ g } N_2$$

d-Calculate the mass in grams of one atom of nitrogen.

$$\frac{1 \text{atom N}}{} \left| \frac{1 \text{ mol N}}{6.022 \times 10^{23} \text{ atoms N}} \right| \frac{14.0 \text{ g N}}{1 \text{ mol N}} = 2.3 \times 10^{-23} \text{ g N}$$

13. a-What masses of each element are presented in 5.60 moles of acetic acid, $CH_3COOH$?

$$\frac{5.6 \text{ mol } CH_3COOH}{} \left| \frac{2 \text{ mol C}}{1 \text{ mol } CH_3COOH} \right| \frac{12.01 \text{ g C}}{1 \text{ mol C}} = 135 \text{ g C}$$

$$\frac{5.6 \text{ mol } CH_3COOH}{} \left| \frac{2 \text{ mol O}}{1 \text{ mol } CH_3COOH} \right| \frac{16 \text{ g O}}{1 \text{ mol O}} = 179 \text{ g O}$$

$$\frac{5.6 \text{ mol } CH_3COOH}{} \left| \frac{4 \text{ mol H}}{1 \text{ mol } CH_3COOH} \right| \frac{12.01 \text{ g H}}{1 \text{ mol H}} = 22.6 \text{ g H}$$

b- How many moles of H atoms and how many atoms of H does the above sample contain?

$$5.6 \text{ mol } CH_3COOH \left| \frac{4 \text{ mol H}}{1 \text{ mol } CH_3COOH} \right. = 22.4 \text{ mol H}$$

$$22.4 \text{ mol H} \left| \frac{6.022 \times 10^{23} \text{ atom H}}{1 \text{ mol H}} \right. = 1.35 \times 10^{25} \text{ atoms H}$$

c-What is the mass of acetic acid that contains 4.0 g of hydrogen?

$$4.0 \text{ g H} \left| \frac{1 \text{ mol H}}{1 \text{ g H}} \right| \frac{1 \text{ mol } CH_3COOH}{4 \text{ mol H}} \left| \frac{60.06 \text{ g } CH_3COOH}{1 \text{ mol } CH_3COOH} \right. = 60.06 \text{ g } CH_3COOH$$

d-What is mass of acetic acid that contains 32.0 g of oxygen?

$$32.0 \text{ g O} \left| \frac{1 \text{ mol O}}{16 \text{ g O}} \right| \frac{1 \text{ mol } CH_3COOH}{2 \text{ mol O}} \left| \frac{60.06 \text{ g } CH_3COOH}{1 \text{ mol } CH_3COOH} \right. = 60.06 \text{ g } CH_3COOH$$

e-What mass of acetic acid contains 48.0 grams of carbon?

$$48.0 \text{ g C} \left| \frac{1 \text{ mol C}}{12 \text{ g C}} \right| \frac{1 \text{ mol } CH_3COOH}{2 \text{ mol C}} \left| \frac{60.06 \text{ g } CH_3COOH}{1 \text{ mol } CH_3COOH} \right. = 120.12 \text{ g } CH_3COOH$$

14. There are 737 g of sodium chloride in a can of salt.
a-How many moles of sodium chloride does the can of salt contain?

$$737 \text{ g NaCl} \left| \frac{1 \text{ mol NaCl}}{58.44 \text{ g NaCl}} \right. = 12.6 \text{ mol NaCl}$$

b-How many formula units of salt does the can of salt contain?

$$12.6 \text{ mol NaCl} \left| \frac{6.022 \times 10^{23} \text{ formula unit NaCl}}{1 \text{ mol NaCl}} \right. = 7.59 \times 10^{24} \text{ formula unit NaCl}$$

c-Calculate the mass in grams of one formula unit of sodium chloride.

$$1 \text{ formula unit NaCl} \left| \frac{1 \text{ mol NaCl}}{6.022 \times 10^{23} \text{ formula unit NaCl}} \right| \frac{58.44 \text{ g NaCl}}{1 \text{ mol NaCl}} = 9.7 \times 10^{-23} \text{ g NaCl}$$

d-How many ions of sodium does the can of salt contain?

$$12.6 \text{ mol NaCl} \left| \frac{1 \text{ mol } Na^+}{1 \text{ mol NaCl}} \right| \frac{6.022 \times 10^{23} \text{ ions } Na^+}{1 \text{ mol } Na^+} = 7.59 \times 10^{24} \text{ ions } Na^+$$

e-How many moles of chloride ions does the can contain?

$$12.6 \text{ mol NaCl} \left| \frac{1 \text{ mol } Cl^-}{1 \text{ mol NaCl}} \right. = 12.6 \text{ mol } Cl^-$$

f-How many grams of sodium does the can of salt contain?

$$12.6 \text{ mol NaCl} \left| \frac{1 \text{ mol } Na^+}{1 \text{ mol NaCl}} \right| \frac{22.99 \text{ g } Na^+}{1 \text{ mol } Na^+} = 289.67 \text{ g } Na^+$$

15. a-How many moles of ammonium sulfate are in 32.0 g of ammonium sulfate?

$$32.0 \text{ g } (NH_4)_2SO_4 \left| \frac{1 \text{ mol } (NH_4)_2SO_4}{132.17 \text{ g } (NH_4)_2SO_4} \right. = .242 \text{ mol } (NH_4)_2SO_4$$

b-How many formula units of ammonium sulfate are there in 32.0 g of ammonium sulfate?

$$32.0 \text{ g } (NH_4)_2SO_4 \left| \frac{1 \text{ mol } (NH_4)_2SO_4}{132.17 \text{ g } (NH_4)_2SO_4} \right| \frac{6.022 \times 10^{23} \text{ formula units } (NH_4)_2SO_4}{1 \text{ mol } (NH_4)_2SO_4} = 1.46 \text{ f.u.s } (NH_4)_2SO_4$$

* f.u = formula unit

c-How many atoms of H are found in 32.0 g of ammonium sulfate?

$$32.0 \text{ g } (NH_4)_2SO_4 \left| \frac{1 \text{ mol } (NH_4)_2SO_4}{132.17 \text{ g } (NH_4)_2SO_4} \right| \frac{8 \text{ mols H}}{1 \text{ mol } (NH_4)_2SO_4} \left| \frac{6.022 \times 10^{23} \text{ atoms H}}{1 \text{ mol H}} \right. = 1.17 \text{ X } 10^{24} \text{atoms H}$$

d-How many grams of hydrogen are found in 32.0 g of ammonium sulfate?

$$32.0 \text{ g } (NH_4)_2SO_4 \left| \frac{1 \text{ mol } (NH_4)_2SO_4}{132.17 \text{ g } (NH_4)_2SO_4} \right| \frac{8 \text{ mols H}}{1 \text{ mol } (NH_4)_2SO_4} \left| \frac{1.01 \text{ g H}}{1 \text{ mol H}} \right. = 1.94 \text{ g H}$$