SHOW ***ALL WORK***, ALL EQUATIONS, and ALL UNITS Name: ______________________________

Moles, Molar Mass, Molarity, Empirical Formula, Molecular Formula, and Hydrates:

1. Calculate the **molar mass** for: $CoCl_2 \bullet 6\ H_2O$
(Hint: the "dot" means that you have a hydrate)

Answers:

$$\left(58.93\frac{g}{mol}\right) + 2\left(35.45\frac{g}{mol}\right) + 6\left[2\left(1.008\frac{g}{mol}\right) + \left(16.00\frac{g}{mol}\right)\right] = 237.926\frac{g}{mol}$$

2. Calculate **molar mass** for iron(III) carbonate.

Answers:

$$Fe_2\left(CO_3\right)_3 \ : \ 2\left(55.85\frac{g}{mol}\right) + 3\left(12.01\frac{g}{mol}\right) + 9\left(16.00\frac{g}{mol}\right) = 291.73\frac{g}{mol}$$

3. Calculate the number of **moles** for 466 milligrams of $LiOH$.

Answers:

Recall the steps:

$$mg \leftrightarrow g \leftrightarrow moles \leftrightarrow molecules \leftrightarrow atoms$$

$$\frac{466\ \ mg\ \ LiOH}{} \times \frac{1\ \ g}{1000\ \ mg} \times \frac{1\ \ mol\ \ LiOH}{23.948\ \ g} = 0.0195\ \ mol\ \ LiOH$$

4. Calculate the number of **moles** for 723 grams of magnesium phosphate.

Answers:

Recall the steps:

$$kg \leftrightarrow g \leftrightarrow moles \leftrightarrow molecules \leftrightarrow atoms$$

$$\frac{723\ \ g\ \ Mg_3\left(PO_4\right)_2}{} \times \frac{1\ \ mol\ \ Mg_3\left(PO_4\right)_2}{262.84\ \ g} = 2.75\ \ mol\ \ Mg_3\left(PO_4\right)_2$$

5. Calculate the number of **molecules** for 1.50 kilograms of $C_6H_{12}O_6$.

Answers:

Recall the steps:

$$kg \leftrightarrow g \leftrightarrow moles \leftrightarrow molecules \leftrightarrow atoms$$

$$\frac{1.50\ \ kg}{} \times \frac{1000\ \ g}{1\ \ kg} \times \frac{1\ \ mol\ \ C_6H_{12}O_6}{180.156\ \ g} \times \frac{6.02\times10^{23}\ \ molecules}{1\ \ mol\ \ C_6H_{12}O_6} = 5.01\times10^{24}\ \ molecules\ C_6H_{12}O_6$$

6. Calculate the number of **molecules** for 3.55 moles of chromium(VI) sulfate .

Answers:

A question like this is perfect for LEARNING HOW to read a question – Notice, you DO NOT need to write the formula for the chromium(VI) sulfate to answer the question since it asked only for MOLECULES and you know the number of MOLES !!!

Recall the steps:

$$kg \leftrightarrow g \leftrightarrow moles \leftrightarrow molecules \leftrightarrow atoms$$

$$\frac{3.55\ mol\ Cr\left(SO_4\right)_3}{} \times \frac{6.02\times10^{23}\ molecules}{1\ mol\ Cr\left(SO_4\right)_3} = 2.14\times10^{24}\ molecules\ Cr\left(SO_4\right)_3$$

7. Calculate the number of **atoms** for 4.23×10^{-5} kilograms of tin(IV) nitrate.

Answers:

This will be the LONGEST problem (the one with the most steps)

$$\frac{4.23\times10^{-5}\ kg}{} \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol\ Sn\left(NO_3\right)_4}{366.75\ g} \times \frac{6.02\times10^{23}\ molecules}{1\ mol\ Sn\left(NO_3\right)_4} \times \frac{17\ atoms}{1\ molecule\ Sn\left(NO_3\right)_4} = 1.18\times10^{21}\ atoms$$

8. Calculate the number of **moles** of titanium(III) chlorate that are dissolved in 4.22 L of a 12.5 *M* solution?

Answers:

If you KNOW both the volume and molarity of a substance, ALWAYS start with the VOLUME !!!

$$\frac{4.22\ L}{} \times \frac{12.5\ mol}{1\ L} = 52.8\ mol$$

A question like this is perfect for LEARNING HOW to read a question – Notice, you DO NOT need to write the formula for titanium(III) chlorate to answer the question since it asked only for MOLES !!!

9. Calculate the number of **grams** of sodium hydroxide are needed to make three liters of a 6.99 *M* NaOH solution?

Answers:

If you KNOW both the volume and molarity of a substance, ALWAYS start with the VOLUME !!!

$$\frac{3\ L}{} \times \frac{6.99\ mol\ NaOH}{1\ L} \times \frac{39.998\ g}{1\ mol\ NaOH} = 839\ g$$

10. Calculate the **molarity** of a sodium acetate solution where one kilogram of $NaC_2H_3O_2$ is dissolved in enough water so that the final volume is two liters?

Answers:

$$M = \frac{moles}{liters}$$

$$NaC_2H_3O_2: \ \frac{1\ kg}{} \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol\ NaC_2H_3O_2}{82.034\ g} = 12.19\ mol$$

$$M = \frac{12.19\ mol}{2\ liters} = 6.10\ M$$

OR

$$M = \frac{1\ kg}{2\ L} \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol\ NaC_2H_3O_2}{82.034\ g} = 6.10\ \frac{mol}{L}$$

11. A certain compound contains the elements carbon, hydrogen, and oxygen (**in that order**). When a 10.72657 gram sample was analyzed, 5.14714 grams of carbon, and 1.008 grams of hydrogen were detected. What is the **molecular formula for this compound** if the molecular mass is 225.258 grams / mole?

Answers:

$$mass\ of\ O: \ 10.72657\ g\ C_xH_yO_z - \left[(5.14714\ g\ C) + (1.008\ g\ H)\right] = 4.57143\ g$$

$$C: \ \frac{5.14714\ g}{} \times \frac{1\ mol\ C}{12.01\ g} = 0.42857\ mol \quad ; \quad \frac{0.42857\ mol}{0.28571\ mol} = 1.50 \quad ; \quad 1.50 = 1\frac{1}{2}\ x\ 2 = 3$$

$$H: \ \frac{1.008\ g}{} \times \frac{1\ mol\ H}{1.008\ g} = 1.00\ mol \quad ; \quad \frac{1.00\ mol}{0.28571\ mol} = 3.50 \quad ; \quad 3.50 = 3\frac{1}{2}\ x\ 2 = 7$$

$$O: \ \frac{4.57143\ g}{} \times \frac{1\ mol\ O}{16.00\ g} = 0.28571\ mol \quad ; \quad \frac{0.28571\ mol}{0.28571\ mol} = 1 \quad ; \quad 1.00 = 1\ x\ 2 = 2$$

Empirical Formula = $C_3H_7O_2$

$$Empirical\ formula\ mass\ of\ C_3H_7O_2 = 3(12.01\ g) + 7(1.008\ g) + 2(16.0\ g) = 75.086\ g$$

$(C_3H_7O_2)_n$

$$n = \frac{molecular\ formula\ mass}{empirical\ formula\ mass} = \frac{225.258\ g}{75.086\ g} = 3$$

$(C_3H_7O_2)_3 = C_9H_{21}O_6$

12. What is the **formula for the hydrate** that is 89.62% $CuWO_4$ and 10.38% H_2O?

Answers:

$$CuWO_4: \frac{89.62\ g}{} \times \frac{1\ mol\ CuWO_4}{311.2\ g} = 0.287982\ mol \quad ; \quad \frac{0.287982\ mol}{0.287982\ mol} = 1.00$$

$$H_2O: \frac{10.38\ g}{} \times \frac{1\ mol\ H_2O}{18.016\ g} = 0.57615\ mol \quad ; \quad \frac{0.57615\ mol}{0.287982\ mol} = 2.00$$

$$\boldsymbol{CuWO_4 \cdot\ 2\ H_2O}$$