

## Percent Composition Notes

Percent composition is the percent of each element that makes up a compound based on the mass.

$$\% \text{element} = \frac{\text{mass of element}}{\text{mass of compound}} \times 100$$

**Example 1.** Determine the percent composition of carbon dioxide.

Using the periodic table, find the mass of each element then multiply by the number of atoms of each element in the compound.

Find the mass of carbon: 1 carbon  $\times$  12.01g = 12.01 g C

Find the mass of oxygen: 2 oxygen  $\times$  16.00g = 32.00g O

Find the mass of carbon dioxide: 32.00g + 12.01g = 44.01g

$$\%C = \frac{\text{mass C}}{\text{mass CO}_2} \times 100 = \frac{12.01\text{g}}{44.01\text{g}} \times 100 = 27.29\% \text{ C}$$

$$\%O = \frac{\text{mass O}}{\text{mass CO}_2} \times 100 = \frac{32.00\text{g}}{44.01\text{g}} \times 100 = 72.71\% \text{ O}$$

**Example 2.** Determine the percent of nitrogen in dinitrogen pentoxide.

Find the mass of nitrogen: 2 nitrogen  $\times$  14.01g = 28.02g N

Find the mass of oxygen: 5 oxygen  $\times$  16.00g = 80.00g O

Find the mass of  $\text{N}_2\text{O}_5$ : 28.02g + 80.00g = 108.02 g

$$\%N = \frac{\text{mass of nitrogen}}{\text{mass of N}_2\text{O}_5} \times 100 = \frac{28.02\text{g}}{108.02\text{g}} \times 100 = 25.94\% \text{ N}$$

Practice Problems:

- Determine the percent of phosphorus if a compound is made up of 10.0g of phosphorus and 25.0g of oxygen.

$$\frac{10.0\text{g P}}{35.0\text{g P+O}} \times 100 = 28.6\% \text{ P}$$

- Determine the percent composition of nitrogen in aluminum nitrate.

$$\frac{42.03\text{g N}}{213.01\text{g Al(NO}_3)_3} \times 100 = 19.73\% \text{ N}$$

- Determine the percent of potassium in potassium phosphate.

$$\frac{117.03\text{g K}}{212\text{g K}_3\text{PO}_4} \times 100 = 55.20\% \text{ K}$$

- Determine the percent of iron in iron (III) sulfate.

$$\frac{111.7\text{g Fe}}{399.91\text{g Fe}_2(\text{SO}_4)_3} \times 100 = 27.93\% \text{ Fe}$$

- What percent of tetraphosphorus decoxide is oxygen?

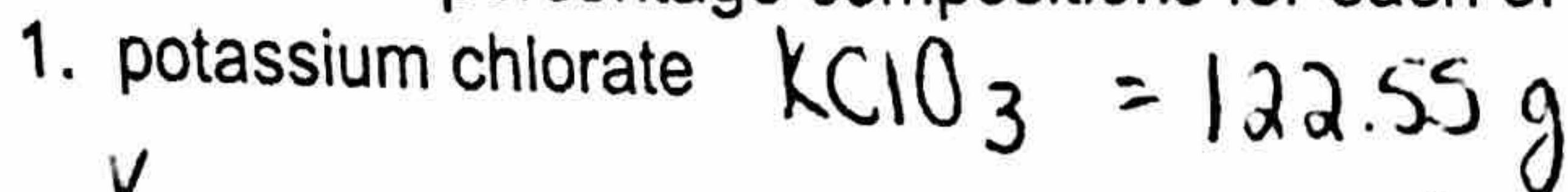
$$\frac{160\text{g O}}{283.88\text{g P}_4\text{O}_{10}} \times 100 = 56.36\% \text{ O}$$

1. 28.6%P 2. 19.73%N 3. 55.42%K 4. 27.93%Fe 5. 56.36%O

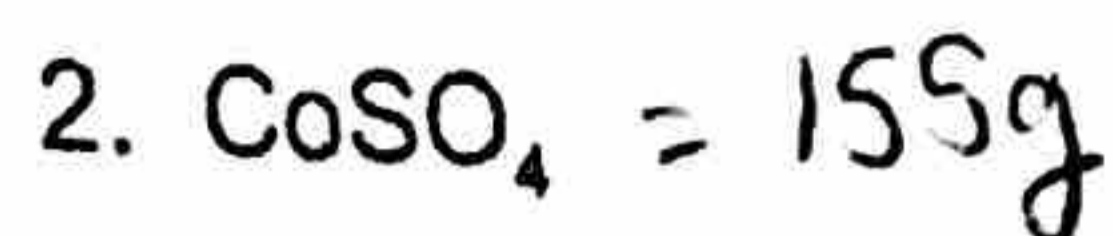
## Honors Chemistry: Moles Classwork

### CW: Percent Composition

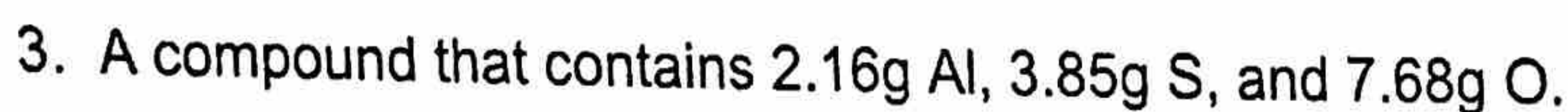
Calculate the percentage compositions for each of the following compounds.



$$\begin{array}{ccc} K & Cl & O \\ \frac{39.10}{122.55} \times 100 = 31.91\% & \frac{35.45}{122.55} \times 100 = 28.93\% & \frac{48}{122.55} \times 100 = 39.17\% \end{array}$$



$$\begin{array}{ccc} Co & S & O \\ \frac{58.93}{155} \times 100 = 38.02\% & \frac{32.07}{155} \times 100 = 20.69\% & \frac{64}{155} \times 100 = 41.29\% \end{array}$$



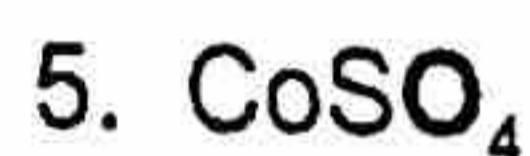
$$\begin{array}{ccc} Al & S & O \\ \frac{2.16}{13.69} \times 100 = 15.78\% & \frac{3.85}{13.69} \times 100 = 28.12\% & \frac{7.68}{13.69} \times 100 = 56.10\% \end{array}$$

$\rightarrow 13.69 \text{ g}$

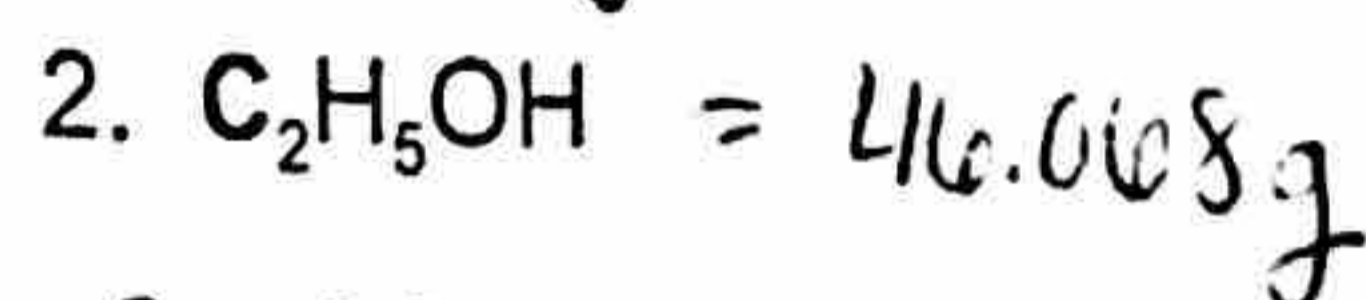
Calculate the percentage compositions for the bolded element in each of the following compounds.



$$\begin{array}{l} KClO_3 \\ = 122.55 \text{ g} \\ \frac{39.10}{122.55} \times 100 = 31.91\% \end{array}$$



$$\frac{64}{155} \times 100 = 41.29\%$$



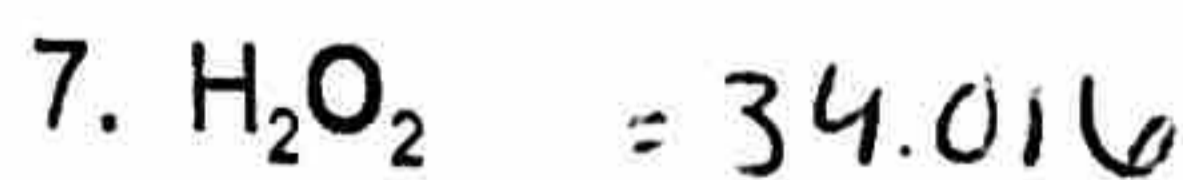
$$\frac{24.02}{46.068} \times 100 = 52.14\%$$



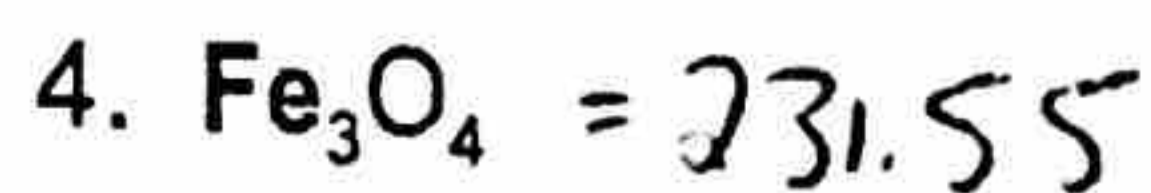
$$\begin{array}{l} Li_2C \\ = 39.774 \\ \frac{27.764}{39.774} \times 100 = 69.80\% \end{array}$$



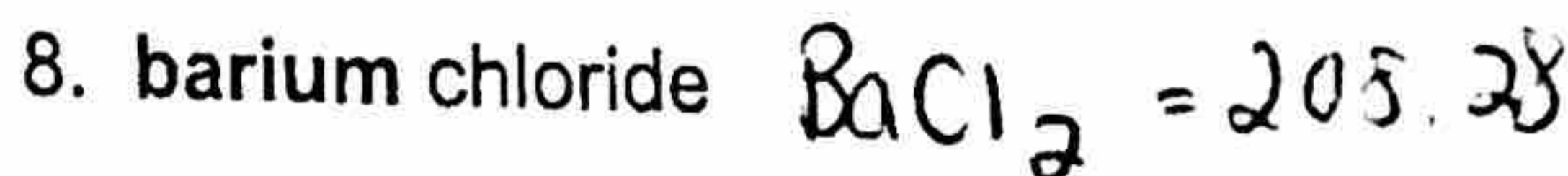
$$\begin{array}{l} P_4O_{10} = 283.88 \\ \frac{123.88}{283.88} \times 100 = 43.64\% \end{array}$$



$$\frac{32.00}{34.016} \times 100 = 94.07\%$$



$$\frac{167.55}{231.55} \times 100 = 72.36\%$$

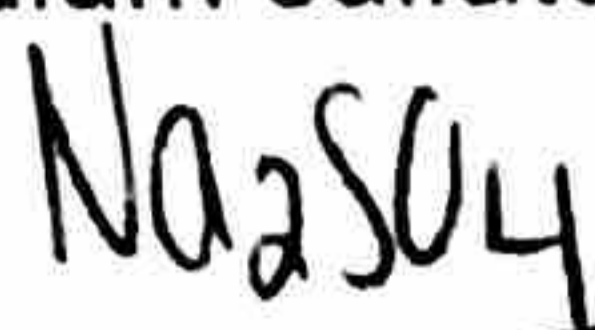


$$\frac{137.33}{208.28} \times 100 = 65.94\%$$

CW: One and Two Step Mole Problems  
 One Step Mole Problems

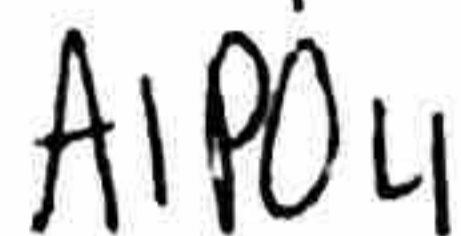
1. Calculate the molar mass for each of the following compounds.

a. sodium sulfate



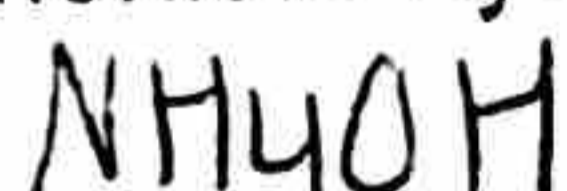
$142.05 \text{ g/mol}$

b. aluminum phosphate



$121.95 \text{ g/mol}$

c. ammonium hydroxide



$35.05 \text{ g/mol}$

2. What is the mass of 1.75 moles of zinc atoms?

$1.75 \text{ mol Zn} \left| \frac{65.39 \text{ g Zn}}{1 \text{ mol Zn}} = 114 \text{ g Zn}$

3. How many moles are there in 42.0g of aluminum?

$42.0 \text{ g Al} \left| \frac{1 \text{ mol Al}}{26.98 \text{ g Al}} = 1.56 \text{ mol Al}$

4. How many atoms are there in 1.50 moles carbon?

$1.50 \text{ mol C} \left| \frac{6.022 \times 10^{23} \text{ atoms C}}{1 \text{ mol C}} = 9.03 \times 10^{23} \text{ atoms C}$

5. How many moles are there in  $7.50 \times 10^{23}$  atoms of iron?

$7.50 \times 10^{23} \text{ atoms Fe} \left| \frac{1 \text{ mol Fe}}{6.022 \times 10^{23} \text{ atoms Fe}} = 1.25 \text{ mol Fe}$

6. How many molecules are in 0.254 moles of carbon dioxide?

$0.254 \text{ mol CO}_2 \left| \frac{6.022 \times 10^{23} \text{ molecules CO}_2}{1 \text{ mol CO}_2} = 1.53 \times 10^{23} \text{ molecules CO}_2$

7. How many moles are in 42.24 g of nickel(II) sulfite?  $\text{NiSO}_3$

$42.24 \text{ g NiSO}_3 \left| \frac{1 \text{ mol NiSO}_3}{138.76 \text{ g NiSO}_3} = 0.3044 \text{ mol NiSO}_3$

8. How many grams are in 0.049 moles of silver nitrate?  $\text{AgNO}_3$

$$\frac{0.049 \text{ mol AgNO}_3}{1 \text{ mol AgNO}_3} \times 164.88 \text{ g AgNO}_3 = 8.3 \text{ g AgNO}_3$$

9. How many liters are in 12.42 moles of chlorine gas?

$$\frac{12.42 \text{ mol Cl}_2}{1 \text{ mol Cl}_2} \times 22.4 \text{ L Cl}_2 = 278.2 \text{ L Cl}_2$$

10. How many grams are in 0.0425 moles of potassium chloride?  $\text{KCl}$

$$\frac{0.0425 \text{ mol KCl}}{1 \text{ mol KCl}} \times 74.55 \text{ g KCl} = 3.17 \text{ g KCl}$$

11. How many grams are in 6.21 mole of carbon tetrachloride?  $\text{CCl}_4$

$$\frac{6.21 \text{ mol CCl}_4}{1 \text{ mol CCl}_4} \times 153.81 \text{ g CCl}_4 = 955 \text{ g CCl}_4$$

12. How many moles are in 4.16 L of dinitrogen pentoxide?

$$\frac{4.16 \text{ L N}_2\text{O}_5}{22.4 \text{ L N}_2\text{O}_5} \times 1 \text{ mol N}_2\text{O}_5 = 0.186 \text{ mol N}_2\text{O}_5$$

**Moles 2 Step Problems** Perform the following conversions.

13. 6g of S to atoms

$$\frac{6 \text{ g S}}{32.07 \text{ g S}} \times 1 \text{ mol S} \times 6.022 \times 10^{23} \text{ atom S} = 1 \times 10^{23} \text{ atom S}$$

14.  $6.02 \times 10^{14}$  atoms of Zn to grams

$$\frac{6.02 \times 10^{14} \text{ atom Zn}}{6.022 \times 10^{23} \text{ atom Zn}} \times 1 \text{ mol Zn} \times 65.39 \text{ g Zn} = 6.54 \times 10^{-8} \text{ g Zn}$$

$\text{Cu}_2\text{SO}_4$  15.  $5.5 \times 10^{25}$  molecules copper (I) sulfate to grams

$$\frac{5.5 \times 10^{25} \text{ molecules Cu}_2\text{SO}_4}{6.022 \times 10^{23} \text{ molecules Cu}_2\text{SO}_4} \times 1 \text{ mol Cu}_2\text{SO}_4 \times 223.17 \text{ g Cu}_2\text{SO}_4 = 2.1 \times 10^4 \text{ g Cu}_2\text{SO}_4$$

$\text{CaCO}_3$  16.  $5.5 \times 10^4$  grams calcium carbonate to molecules

$$\frac{5.5 \times 10^4 \text{ g CaCO}_3}{100.9 \text{ g CaCO}_3} \times 1 \text{ mol CaCO}_3 \times 6.022 \times 10^{23} \text{ molecules CaCO}_3 = 3.3 \times 10^{26} \text{ molecules CaCO}_3$$

$\text{Ca(OH)}_2$  17. 244.2 g calcium hydroxide to liters

$$\frac{244.2 \text{ g Ca(OH)}_2}{74.096 \text{ g Ca(OH)}_2} \times 1 \text{ mol Ca(OH)}_2 \times 22.4 \text{ L Ca(OH)}_2 = 73.82 \text{ L Ca(OH)}_2$$

18. 6.89 liters of bromine gas to grams

$$\frac{6.89 \text{ L Br}_2}{22.4 \text{ L Br}_2} \times 1 \text{ mol Br}_2 \times 159.8 \text{ g Br}_2 = 49.2 \text{ g Br}_2$$

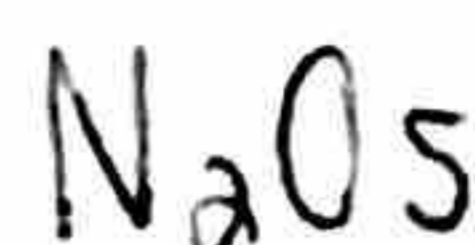
## CW: Empirical & Molecular Formulas

### Empirical formulas

1. If 4.02g of N reacts with 11.48g of O, what is the empirical formula of this compound?

$$\frac{4.02 \text{ g N}}{14.01 \text{ g N}} \times \frac{1 \text{ mol N}}{1} = 0.2869 / 0.2869 = 1 \times 2 = 2$$

$$\frac{11.48 \text{ g O}}{16.00 \text{ g O}} \times \frac{1 \text{ mol O}}{1} = 0.7175 / 0.2869 = 2.5 \times 2 = 5$$



2. Calculate the empirical formulas of the compounds with the following percentage compositions:

a) 40.2% K, 26.9% Cr, 32.9% O

$$\frac{40.2 \text{ g K}}{39.10 \text{ g K}} \times \frac{1 \text{ mol}}{1} = 1.028 / 0.5174 = 2$$



$$\frac{26.9 \text{ g Cr}}{51.99 \text{ g Cr}} \times \frac{1 \text{ mol}}{1} = 0.5174 / 0.5174 = 1$$

$$\frac{32.9 \text{ g O}}{16 \text{ g O}} \times \frac{1 \text{ mol}}{1} = 2.056 / 0.5174 = 4$$

b) 21.8% Mg, 27.9% P, 50.3% O

$$\frac{21.8 \text{ g Mg}}{24.31 \text{ g Mg}} \times \frac{1 \text{ mol}}{1} = 0.8968 / 0.8968 = 1 \times 2 = 2$$

$$\frac{27.9 \text{ g P}}{30.97 \text{ g P}} \times \frac{1 \text{ mol}}{1} = 0.9009 / 0.8968 = 1 \times 2 = 2$$



$$\frac{50.3 \text{ g O}}{16 \text{ g O}} \times \frac{1 \text{ mol}}{1} = 3.144 / 0.8968 = 3.5 \times 2 = 7$$

3. Determine the empirical formula for the following two compounds.

a) 0.89g K, 1.18g Cr, 1.27g O

$$\frac{0.89 \text{ g K}}{39.10 \text{ g K}} \times \frac{1 \text{ mol K}}{1} = 0.02276 / 0.02276 = 1 \times 2$$

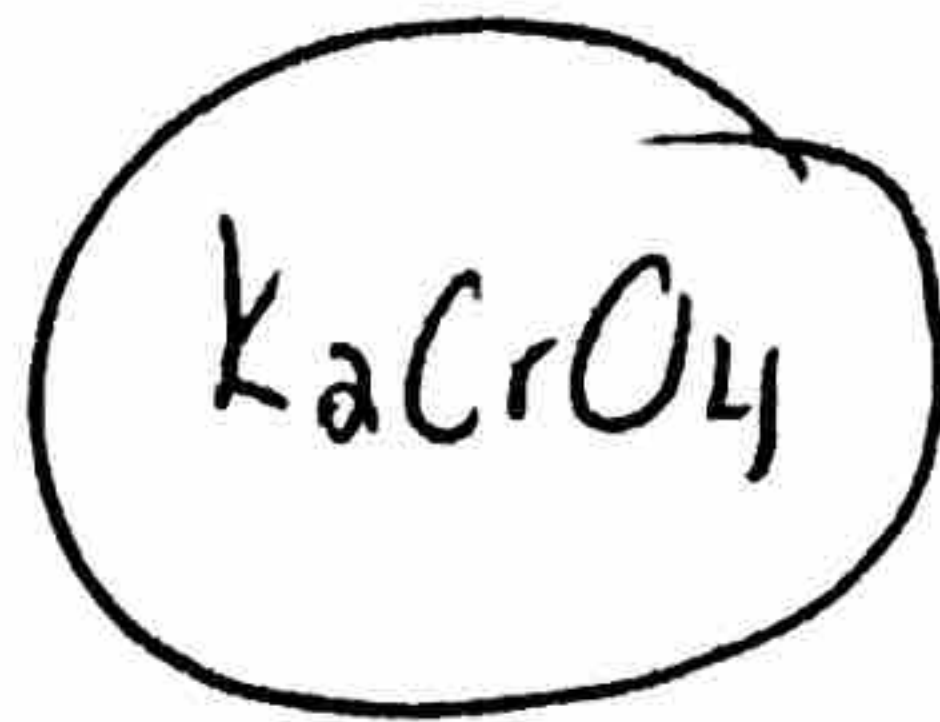
$$\frac{1.18 \text{ g Cr}}{51.99 \text{ g Cr}} \times \frac{1 \text{ mol Cr}}{1} = 0.0227 / 0.02276 = 1 \times 2$$

$$\frac{1.27 \text{ g O}}{16.00 \text{ g O}} \times \frac{1 \text{ mol O}}{1} = 0.07938 / 0.02276 = 3.5 \times 2$$



b) 1.03g K, 0.69g Cr, 0.84g O

$$\frac{1.03 \text{g K}}{39.10 \text{g}} \cdot \frac{1 \text{ mol}}{1} = 0.02634 / 0.01327 = 2$$



$$\frac{0.69 \text{g Cr}}{51.99 \text{g Cr}} \cdot \frac{1 \text{ mol}}{1} = 0.01327 / 0.01327 = 1$$

$$\frac{0.84 \text{g O}}{16 \text{g O}} \cdot \frac{1 \text{ mol}}{1} = 0.0525 / 0.01327 = 4$$

4. Calculate the empirical formulas of the compounds with the following percentage compositions:

a) 65.7% Sr, 10.4% Si, 23.9% O

$$\frac{65.7 \text{g Sr}}{87.62 \text{g Sr}} \cdot \frac{1 \text{ mol Sr}}{1} = 0.7498 / 0.3702 = 2$$

$$\frac{10.4 \text{g Si}}{28.09 \text{g Si}} \cdot \frac{1 \text{ mol Si}}{1} = 0.3702 / 0.3702 = 1$$

$$\frac{23.9 \text{g O}}{16.00 \text{g O}} \cdot \frac{1 \text{ mol O}}{1} = 1.494 / 0.3702 = 4$$

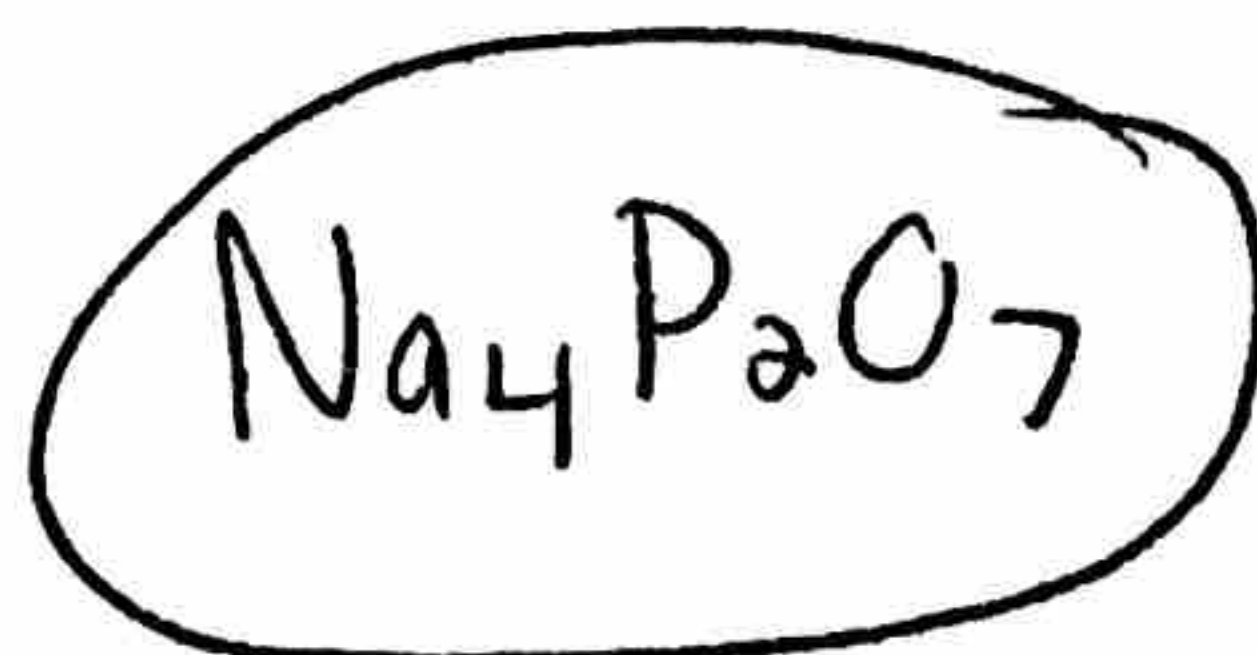


b) 34.58% Na, 23.3% P, 42.12% O

$$\frac{34.58 \text{g Na}}{22.99 \text{g Na}} \cdot \frac{1 \text{ mol}}{1} = 1.504 / 0.7523 = 2 \times 2 = 4$$

$$\frac{23.3 \text{g P}}{30.97 \text{g P}} \cdot \frac{1 \text{ mol}}{1} = 0.7523 / 0.7523 = 1 \times 2 = 2$$

$$\frac{42.12 \text{g O}}{16.00 \text{g O}} \cdot \frac{1 \text{ mol}}{1} = 2.6325 / 0.7523 = 3.5 \times 2 = 7$$



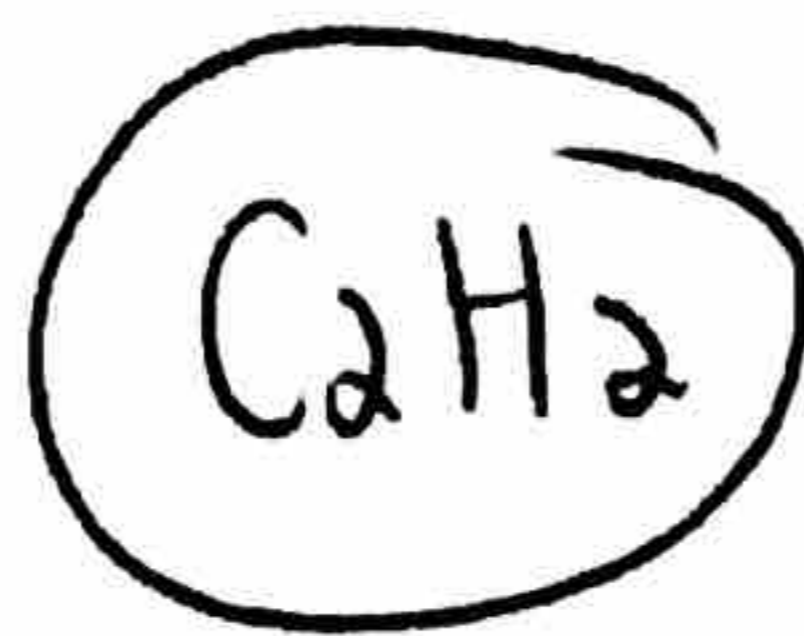
## Molecular formulas

Determine the molecular formulas for the following:

1. empirical formula is CH; molecular mass is 26g

$$13.018$$

$$26 \mid 13.018 = 2$$



2. empirical formula is  $\text{C}_2\text{H}_5$ ; molecular mass is 58g

$$\downarrow \\ 29.06$$

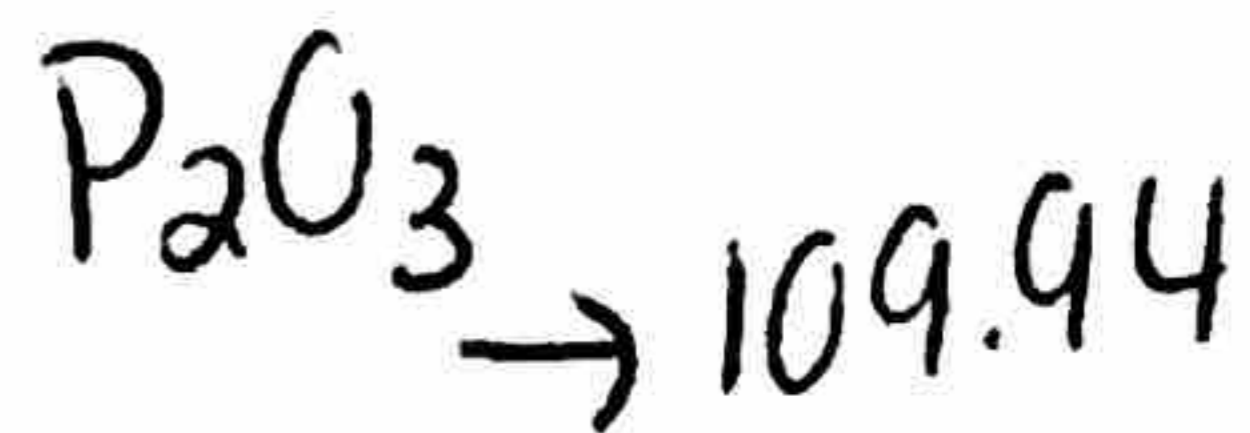
$$\frac{58}{29.06} = 2$$



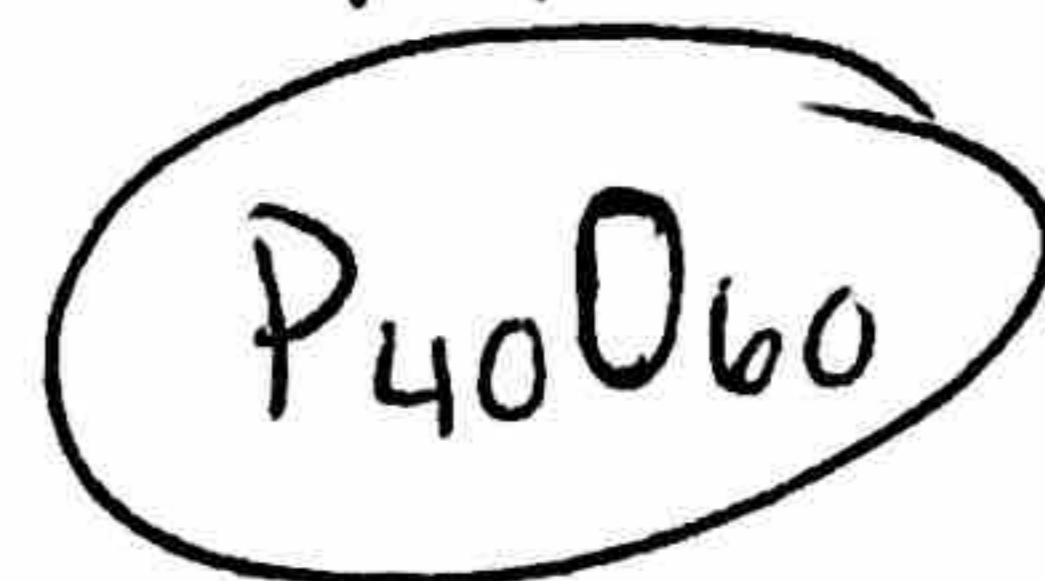
3. A compound of phosphorus and oxygen contains 56.36% phosphorus. If the molecular mass is 2204 g, what is the molecular formula?

$$\frac{56.36\text{gP}}{30.97\text{gP}} \mid \frac{1\text{mol}}{30.97\text{gP}} = 1.8198 \mid 1.8198 = 1 \times 2 = 2$$

$$\frac{43.64\text{gO}}{16.00\text{gO}} \mid \frac{1\text{mol}}{16.00\text{gO}} = 2.7275 \mid 1.8198 = 1.5 \times 2 = 3$$



$$\frac{2204}{109.94} = 20$$

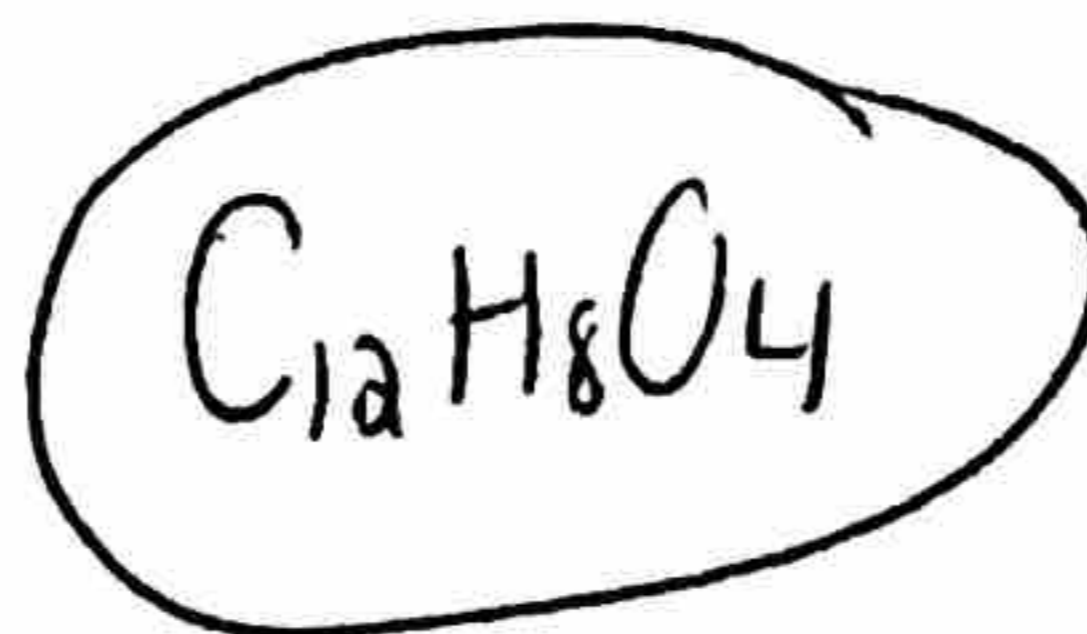


Determine the molecular formulas for the following:

4. empirical formula is  $\text{C}_3\text{H}_2\text{O}$ ; molecular mass is 216g

$$\downarrow \\ 54.046$$

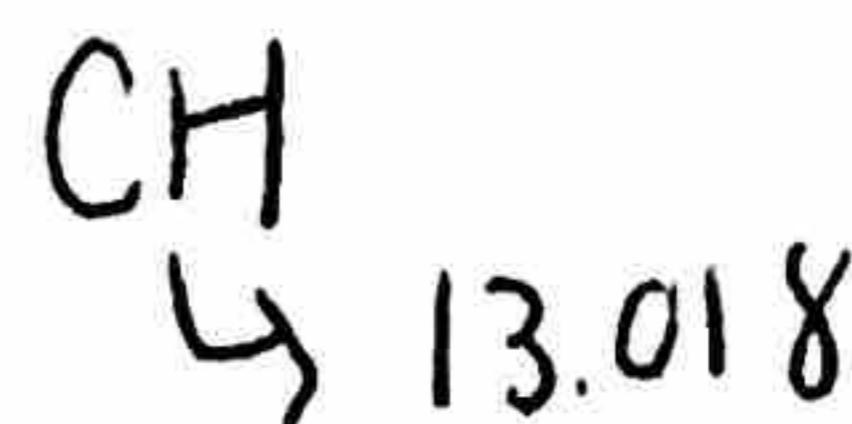
$$\frac{216\text{g}}{54.046\text{g}} = 4$$



5. compound contains 0.240 g C and 0.020 g H; molecular mass is 78g

$$\frac{0.240\text{gC}}{12.01\text{gC}} \mid \frac{1\text{molC}}{12.01\text{gC}} = 0.01998 \mid 0.0198 = 1$$

$$\frac{0.020\text{gH}}{1.008\text{gH}} \mid \frac{1\text{molH}}{1.008\text{gH}} = 0.0198 \mid 0.0198 = 1$$



$$\frac{78}{13.018} = 6$$



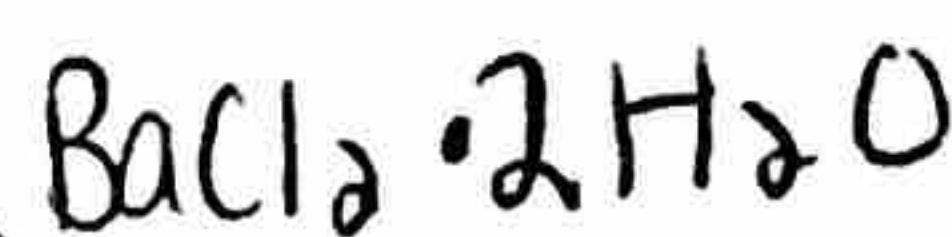
CW: Hydrates

1. What is the formula and name of a hydrate that is 85.3% barium chloride and 14.7% water?



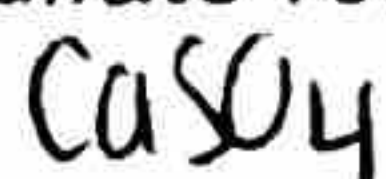
$$\frac{85.3 \text{ g}}{208.28 \text{ g BaCl}_2} \times \frac{1 \text{ mol BaCl}_2}{1} = 0.4095 \text{ mol} / 0.4095 = 1$$

$$\frac{14.7 \text{ g H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol H}_2\text{O}}{1} = 0.8159 \text{ mol} / 0.4095 = 2$$

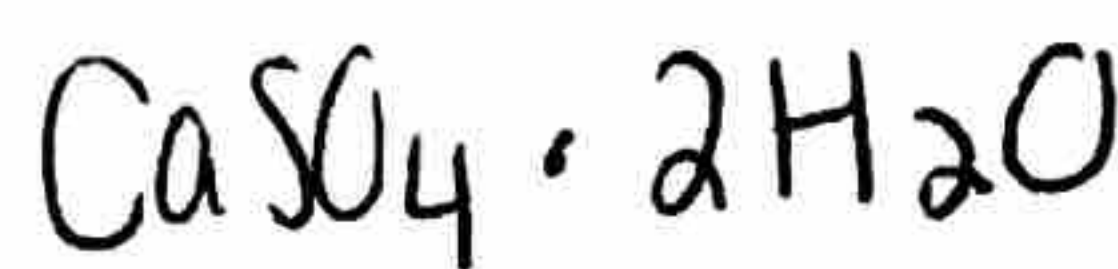


Barium chloride dihydrate

2. A 4.89 grams sample of a hydrate was heated, and after the water was driven off, 3.87 g of anhydrous calcium sulfate remained. Determine the formula of this hydrate and name the compound.



hydrate - 4.89g  
salt - 3.87g  
water - 1.02g



calcium sulfate dihydrate

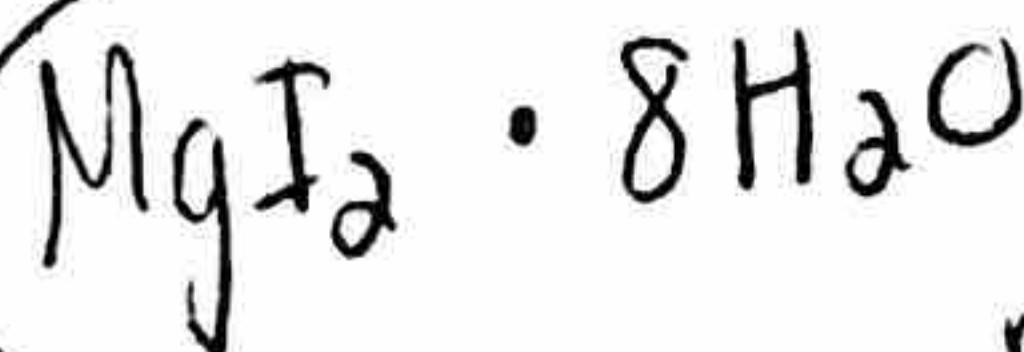
$$\frac{3.87 \text{ g CaSO}_4}{136.15 \text{ g CaSO}_4} \times \frac{1 \text{ mol CaSO}_4}{1} = 0.0284 / 0.0284 = 1$$

$$\frac{1.02 \text{ g H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol H}_2\text{O}}{1} = 0.0566 / 0.0284 = 2$$

3. A 1.628 grams sample of a hydrate of magnesium iodide is heated until its mass is reduced to 1.072 g and all water has been removed. What is the formula of the hydrate?



hydrate - 1.628g  
salt - 1.072g  
water - 0.556g



magnesium octahydrate

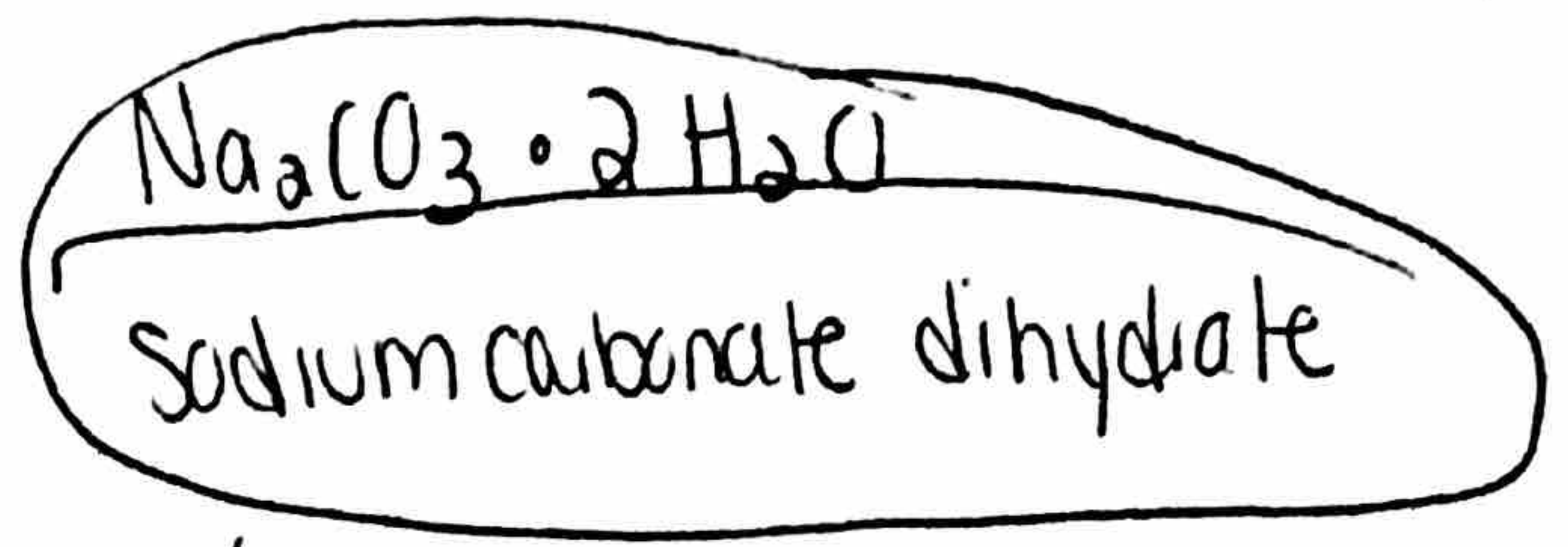
$$\frac{1.072 \text{ g MgI}_2}{278.11 \text{ g MgI}_2} \times \frac{1 \text{ mol MgI}_2}{1} = 0.00385 / 0.00385 = 1$$

$$\frac{0.556 \text{ g H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol H}_2\text{O}}{1} = 0.0309 / 0.00385 = 8$$



4. A hydrate of  $\text{Na}_2\text{CO}_3$  has a mass of 4.31 g before heating. After heating, the mass of the anhydrous compound is found to be 3.22 g. Determine the formula of the hydrate and then write out the name of the hydrate.

hydrate = 4.31g  
 salt = 3.22g  
 water = 1.09g



$$\frac{3.22\text{g Na}_2\text{CO}_3}{105.99\text{g Na}_2\text{CO}_3} \times \frac{1\text{ mol Na}_2\text{CO}_3}{1} = 0.0304 / 0.0304 = 1$$

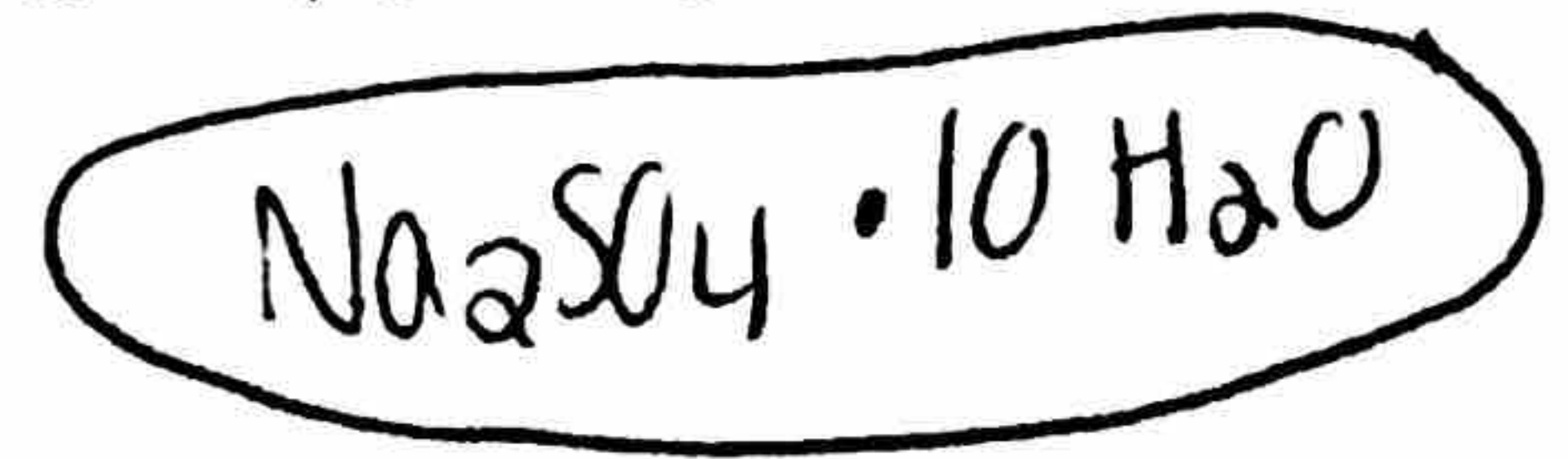
$$\frac{1.09\text{g H}_2\text{O}}{18.016\text{g H}_2\text{O}} \times \frac{1\text{ mol H}_2\text{O}}{1} = 0.0605 / 0.0304 = 2$$

5. Given that the molar mass of  $\text{Na}_2\text{SO}_4 \cdot n\text{H}_2\text{O}$  is 322.1 g/mol, calculate the value of n.

① find percent of anhydrous salt and water

$$\frac{142.05\text{g}}{322.1\text{g}} \times 100 = 44.1\% \text{ Na}_2\text{SO}_4$$

$$100 - 44.1 = 55.9\% \text{ H}_2\text{O}$$

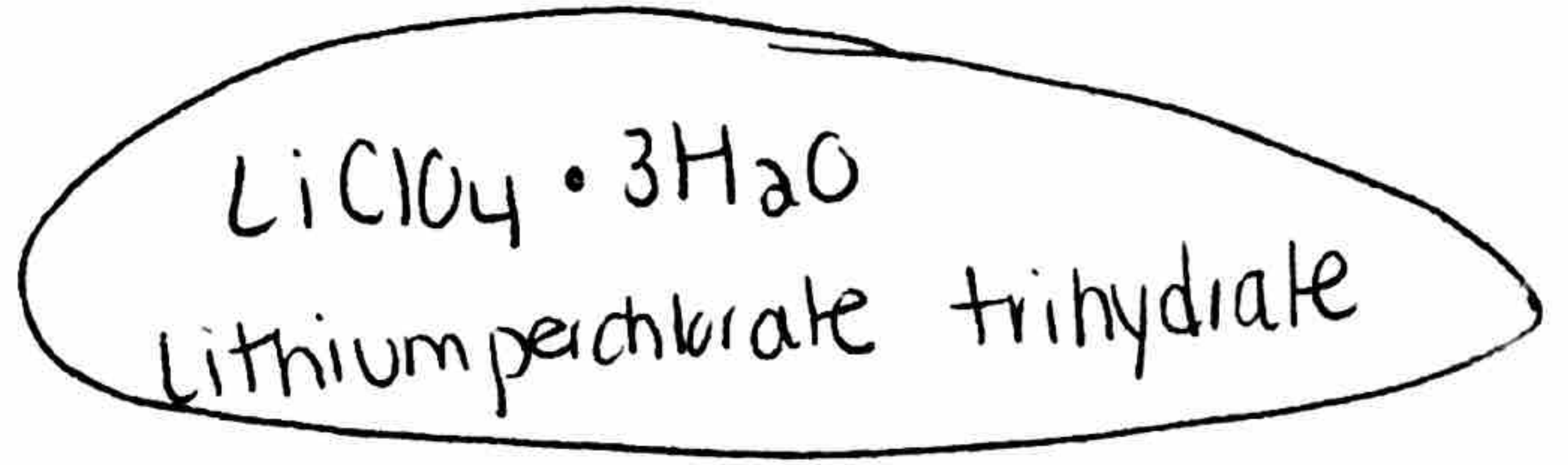


$$\frac{44.1\text{g Na}_2\text{SO}_4}{142.05\text{g Na}_2\text{SO}_4} \times \frac{1\text{ mol Na}_2\text{SO}_4}{1} = 0.3105 / 0.3105 = 1$$

$$\frac{55.9\text{g H}_2\text{O}}{18.016\text{g H}_2\text{O}} \times \frac{1\text{ mol H}_2\text{O}}{1} = 3.1028 / 0.3105 = 10$$

6. Anhydrous lithium perchlorate (4.78 g) was dissolved in water and re-crystallized. Care was taken to isolate all the lithium perchlorate as its hydrate. The mass of the hydrated salt obtained was 7.21 g. What hydrate is it?

hydrate = 7.21g  
 salt = 4.78g  
 H<sub>2</sub>O = 2.43g



$$\frac{4.78\text{g LiClO}_4}{106.39\text{g LiClO}_4} \times \frac{1\text{ mol LiClO}_4}{1} = 0.0449 / 0.0449 = 1$$

$$\frac{2.43\text{g H}_2\text{O}}{18.016\text{g H}_2\text{O}} \times \frac{1\text{ mol H}_2\text{O}}{1} = 0.1349 / 0.0449 = 3$$

7. A substance was found to have the following percentages by mass: 23% zinc; 11% sulfur; 22% oxygen; 44% water. What is the empirical formula?

$$\frac{2.3 \text{ g Zn}}{65.34 \text{ g Zn}} \times \frac{1 \text{ mol Zn}}{1} = 0.3517 / 0.343 = 1$$

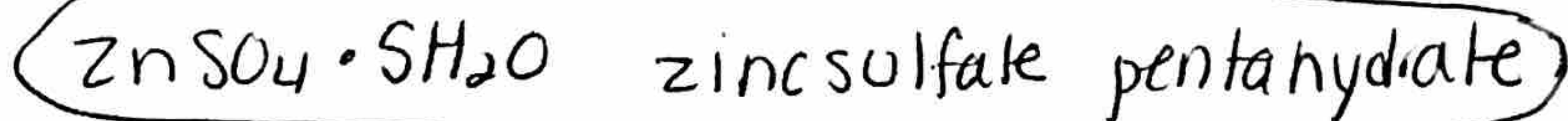
$$\frac{1.1 \text{ g S}}{32.07 \text{ g S}} \times \frac{1 \text{ mol S}}{1} = 0.343 / 0.343 = 1$$

$$\frac{2.2 \text{ g O}}{16.00 \text{ g O}} \times \frac{1 \text{ mol O}}{1} = 1.375 / 0.343 = 4$$



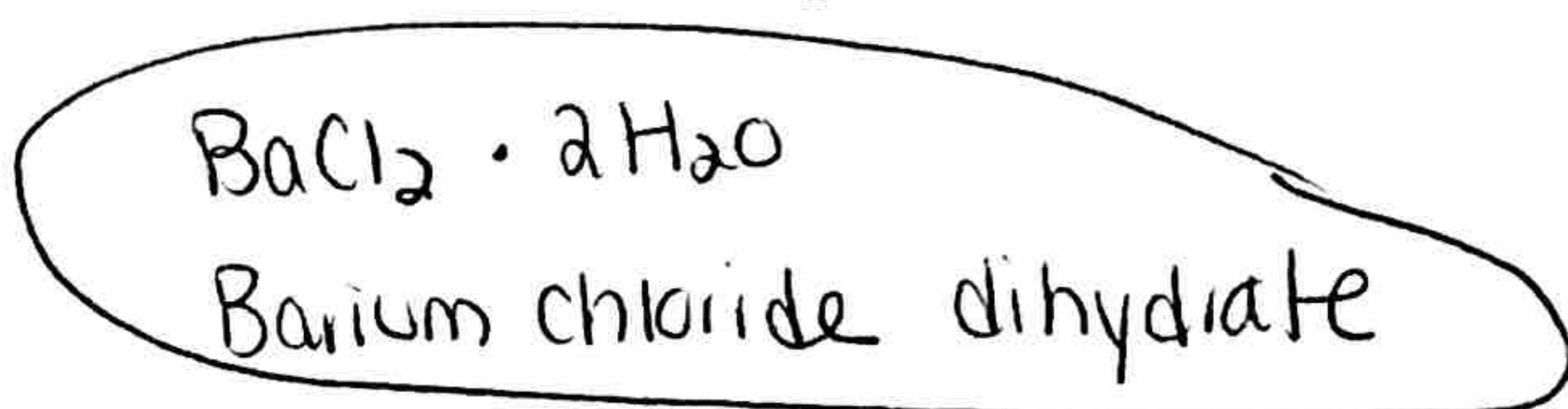
$$\frac{56 \text{ g ZnSO}_4}{113.46 \text{ g ZnSO}_4} \times \frac{1 \text{ mol ZnSO}_4}{1} = 0.4936 / 0.343 = 1$$

$$\frac{44 \text{ g H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol H}_2\text{O}}{1} = 2.44 / 0.4936 = 5$$



8. A 5.00 g sample of hydrated barium chloride,  $\text{BaCl}_2 \cdot n\text{H}_2\text{O}$ , is heated to drive off the water. After heating, 4.26 g of anhydrous barium chloride,  $\text{BaCl}_2$ , remains. What is the value of  $n$  in the hydrate's formula?

hydrate = 5.00g  
salt = 4.26g  
water = 0.74g

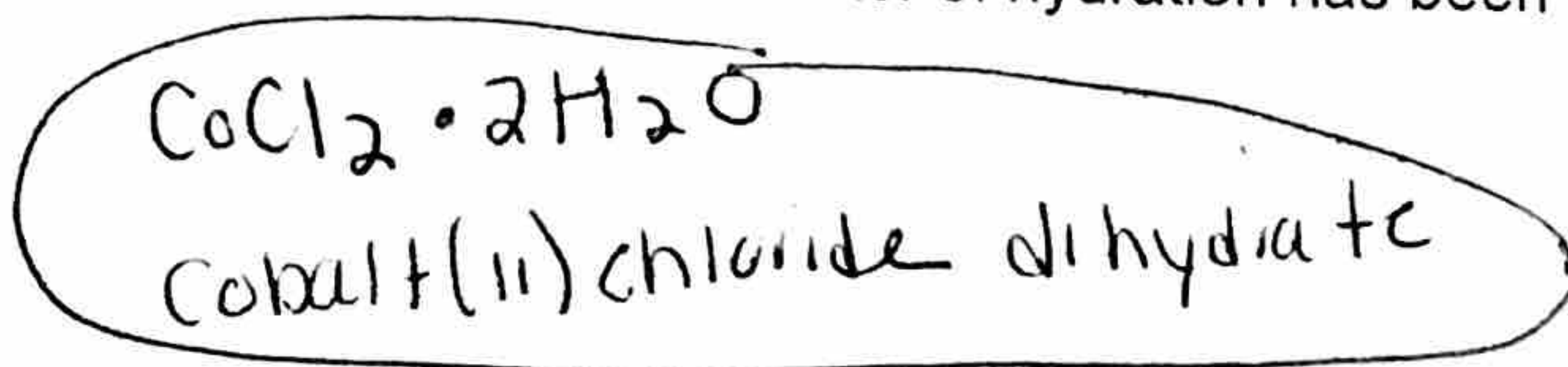


$$\frac{4.26 \text{ g BaCl}_2}{208.23 \text{ g BaCl}_2} \times \frac{1 \text{ mol BaCl}_2}{1} = 0.0205 / 0.0205 = 1$$

$$\frac{0.74 \text{ g H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol H}_2\text{O}}{1} = 0.0411 / 0.0205 = 2$$

9. A 1.98 g sample of a cobalt(II) chloride hydrate is heated over a burner. When cooled, the mass of the remaining dehydrated compound is found to be 1.55 g. What is the formula for the original hydrate? How can you make sure that all of the water of hydration has been removed?

hydrate = 1.98g  
salt = 1.55g  
water = 0.43g



$$\frac{1.55 \text{ g CoCl}_2}{129.83 \text{ g CoCl}_2} \times \frac{1 \text{ mol CoCl}_2}{1} = 0.0119 / 0.0119 = 1$$

$$\frac{0.43 \text{ g H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol H}_2\text{O}}{1} = 0.0239 / 0.0119 = 2$$

||

Stoichiometry Class Work

**Part 1: Moles → Moles & Grams → Moles**

1. According to the equation:  $N_2 + 3H_2 \rightarrow 2NH_3$ , how many moles of ammonia will be produced if 14.0 mol of hydrogen react with excess nitrogen?

$$\frac{14.0 \text{ mol } H_2}{3 \text{ mol } H_2} \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} = 9.33 \text{ mol } NH_3$$

2. How many moles of sodium will react with water to produce 8.0 mol of hydrogen in the following reaction?  $2Na + 2H_2O \rightarrow 2NaOH + H_2$

$$\frac{8.0 \text{ mol } H_2}{1 \text{ mol } H_2} \times \frac{2 \text{ mol } Na}{1 \text{ mol } H_2} = 16 \text{ mol } Na$$

3. How many mole of lithium chloride will be formed by the reaction of chlorine with 3.60 mol of lithium bromide in the following reaction?  
 $2LiBr + Cl_2 \rightarrow 2LiCl + Br_2$

$$\frac{3.60 \text{ mol } LiBr}{2 \text{ mol } LiBr} \times \frac{2 \text{ mol } LiCl}{1 \text{ mol } Cl_2} = 3.60 \text{ mol } LiCl$$

4. How many moles of  $CO_2$  and  $H_2O$  are formed from 7.26 mol of propane?  $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

$$\frac{7.26 \text{ mol } C_3H_8}{1 \text{ mol } C_3H_8} \times \frac{3 \text{ mol } CO_2}{1 \text{ mol } C_3H_8} = 21.8 \text{ mol } CO_2$$

$$\frac{7.26 \text{ mol } C_3H_8}{1 \text{ mol } C_3H_8} \times \frac{4 \text{ mol } H_2O}{1 \text{ mol } C_3H_8} = 29.0 \text{ mol } H_2O$$

5. What mass of potassium chlorate is needed to produce 8.50 mol of oxygen?  $2KClO_3 \rightarrow 2KCl + 3O_2$

$$\frac{8.50 \text{ mol } O_2}{3 \text{ mol } O_2} \times \frac{2 \text{ mol } KClO_3}{1 \text{ mol } KClO_3} \times 122.55 \text{ g } KClO_3 = 694 \text{ g } KClO_3$$

6. According to the equation:  $N_2 + 3H_2 \rightarrow 2NH_3$ , how many grams of ammonia will be produced if 14.0 mol of hydrogen react with excess nitrogen?

$$\frac{14.0 \text{ mol } H_2}{3 \text{ mol } H_2} \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} \times 17.034 \text{ g } NH_3 = 159 \text{ g } NH_3$$

7. How many grams of sodium will react with water to produce 8.0 mol of hydrogen in the following reaction?  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$

$$\frac{8.0 \text{ mol H}_2}{1 \text{ mol H}_2} \times \frac{2 \text{ mol Na}}{1 \text{ mol H}_2} \times \frac{22.99 \text{ g Na}}{1 \text{ mol Na}} = 370 \text{ g Na}$$

8. How many mole of lithium chloride will be formed by the reaction of chlorine with 36.0 grams of lithium bromide in the following reaction?  
 $2\text{LiBr} + \text{Cl}_2 \rightarrow 2\text{LiCl} + \text{Br}_2$

$$\frac{36.0 \text{ g LiBr}}{86.841 \text{ g LiBr}} \times \frac{1 \text{ mol LiBr}}{2 \text{ mol LiBr}} \times \frac{2 \text{ mol LiCl}}{2 \text{ mol LiBr}} = 0.414 \text{ mol LiCl}$$

9. How many grams of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  are formed from 7.26 mol of propane?  
 $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$

$$\frac{7.26 \text{ mol C}_3\text{H}_8}{1 \text{ mol C}_3\text{H}_8} \times \frac{3 \text{ mol CO}_2}{1 \text{ mol C}_3\text{H}_8} \times \frac{44.01 \text{ g CO}_2}{1 \text{ mol CO}_2} = 959 \text{ g CO}_2$$

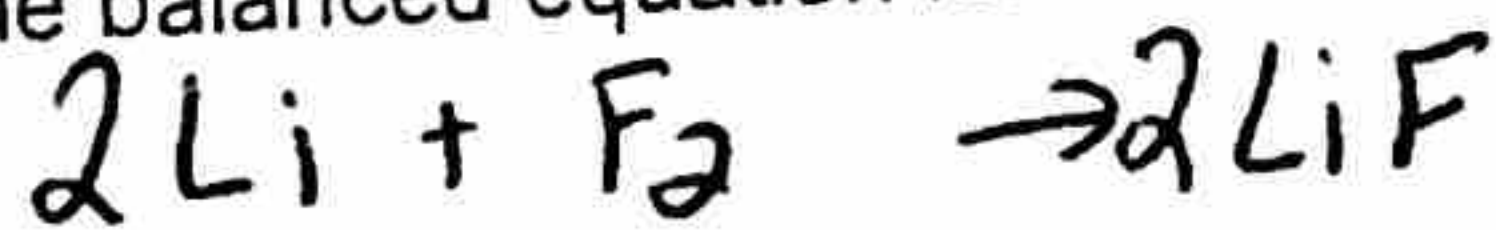
$$\frac{7.26 \text{ mol C}_3\text{H}_8}{1 \text{ mol C}_3\text{H}_8} \times \frac{4 \text{ mol H}_2\text{O}}{1 \text{ mol C}_3\text{H}_8} \times \frac{18.016 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 523 \text{ g H}_2\text{O}$$

10. What mass of potassium chlorate is needed to produce 8.50 mol of oxygen?  $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$

$$\frac{8.50 \text{ mol O}_2}{3 \text{ mol O}_2} \times \frac{2 \text{ mol KClO}_3}{1 \text{ mol KClO}_3} \times \frac{122.55 \text{ g KClO}_3}{1 \text{ mol KClO}_3} = 694 \text{ g KClO}_3$$

Part 2: grams → grams and all other two step Stoichiometry

1. Write the balanced equation for the reaction of lithium and fluorine.



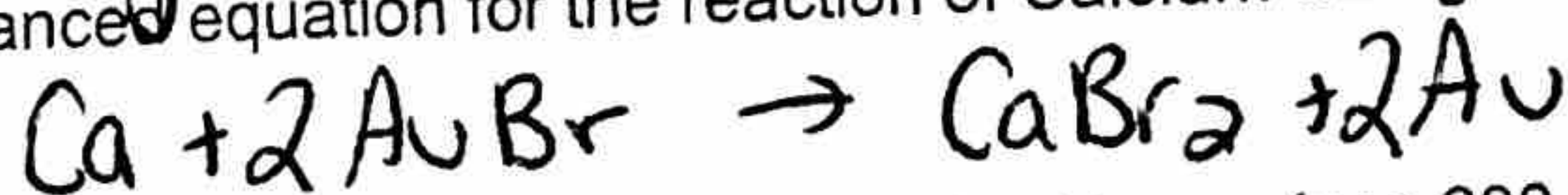
a. Calculate the mass of lithium required to produce 59.5 g of lithium fluoride.

|           |              |           |            |             |
|-----------|--------------|-----------|------------|-------------|
| 59.5g LiF | 1 mol LiF    | 2 mol Li  | 6.941 g Li | = 15.9 g Li |
|           | 25.941 g LiF | 2 mol LiF | 1 mol Li   |             |

b. How many grams of lithium fluoride can be produced from 300.0 g of fluorine?

|                       |                        |                      |              |               |
|-----------------------|------------------------|----------------------|--------------|---------------|
| 300.0g F <sub>2</sub> | 1 mol F <sub>2</sub>   | 2 mol LiF            | 25.941 g LiF | = 409.6 g LiF |
|                       | 38.00 g F <sub>2</sub> | 1 mol F <sub>2</sub> | 1 mol LiF    |               |

2. Write the balanced equation for the reaction of Calcium with gold (I) bromide.



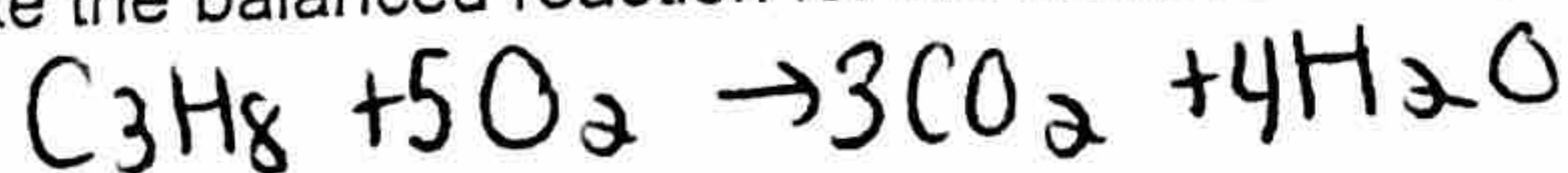
a. How many grams of calcium are required to produce 200.0 g of gold?

|           |             |          |            |              |
|-----------|-------------|----------|------------|--------------|
| 200.0g Au | 1 mol Au    | 1 mol Ca | 40.08 g Ca | = 20.35 g Ca |
|           | 196.97 g Au | 2 mol Au | 1 mol Ca   |              |

b. How many grams of calcium bromide can be produced when 350.0 g of gold (I) bromide react?

|             |               |                         |                            |                             |
|-------------|---------------|-------------------------|----------------------------|-----------------------------|
| 350.0g AuBr | 1 mol AuBr    | 1 mol CaBr <sub>2</sub> | 199.88 g CaBr <sub>2</sub> | = 126.3 g CaBr <sub>2</sub> |
|             | 276.87 g AuBr | 2 mol AuBr              | 1 mol CaBr <sub>2</sub>    |                             |

3. Write the balanced reaction for the combustion of propane (C<sub>3</sub>H<sub>8</sub>).



a. Calculate the mass of each product produced when 180.0 g of propane react.

|                                      |                                       |                                     |                         |  |                                     |                                       |                                     |
|--------------------------------------|---------------------------------------|-------------------------------------|-------------------------|--|-------------------------------------|---------------------------------------|-------------------------------------|
| 180.0g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub>   | 3 mol CO <sub>2</sub>               | 44.01 g CO <sub>2</sub> | } 180.0g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub> | 4 mol H <sub>2</sub> O                | 18.016 g H <sub>2</sub> O           |
|                                      | 44.094g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub> | 1 mol CO <sub>2</sub>   |  |                                     | 44.094g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub> |

b. How many liters of oxygen are required to react with 99.0 g of propane?

|                                     |  |                                     |                       |                                       |                                     |  |                                     |
|-------------------------------------|--|-------------------------------------|-----------------------|---------------------------------------|-------------------------------------|--|-------------------------------------|
| 99.0g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub>    | 5 mol O <sub>2</sub>                | 22.4 L O <sub>2</sub> | } 99.0g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub> | 5 mol O <sub>2</sub>                   | 22.4 L O <sub>2</sub>               |
|                                     | 44.094 g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub> | 1 mol O <sub>2</sub>  |                                       |                                     | 44.094 g C <sub>3</sub> H <sub>8</sub> | 1 mol C <sub>3</sub> H <sub>8</sub> |

= 251 L O<sub>2</sub>