

Name _____

1. During physical activity, lactic acid forms in muscle tissue and is responsible for muscle soreness. Elemental analysis shows that it contains by mass 40.0% C, 6.71% H, and 53.3% O.

a) Determine the **empirical formula** of lactic acid. [5 pts]

Assume 100g.

$$40.0 \text{ g C} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 3.33 \text{ mol C}$$

$$6.71 \text{ g H} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 6.66 \text{ mol H}$$

$$53.3 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 3.33 \text{ mol O}$$

A correct formula for the compound is $\text{C}_{3.33}\text{H}_{6.66}\text{O}_{3.33}$; however, this is not the empirical formula, which will have the simplest *whole* number ratio. Dividing each subscript by the smallest number of moles (3.33) gives the empirical formula, **CH_2O** .

b) If the molar mass of lactic acid is 90.08 g/mol, what is its **molecular formula**? [2 pts]

$$\frac{\text{molar mass}}{\text{empirical mass}} = \frac{90.08 \text{ g}}{30.03 \text{ g}} \approx 3$$

This means that the molecular formula is $(\text{CH}_2\text{O})_3$ or **$\text{C}_3\text{H}_6\text{O}_3$** .

2. Calculate the **molar mass** of TNT, trinitrotoluene ($\text{C}_7\text{H}_5\text{N}_3\text{O}_6$). [2 pts]

$$(7)(12.01 \text{ g}) + (5)(1.008 \text{ g}) + (3)(14.01 \text{ g}) + (6)(16.00 \text{ g}) = \mathbf{227.14 \text{ g}}$$

3. **True or False?** [2 pts]

a) Consider the combustion of hydrogen gas: $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$. If 10.0 moles of H_2 are reacted with excess O_2 , 20.0 moles of H_2O will be produced assuming complete reaction.

FALSE. If 10.0 mol of H_2 are reacted, 10.0 mol of H_2O will be produced.

b) Ionic compounds are composed of ions that are held together by electrostatic attraction.

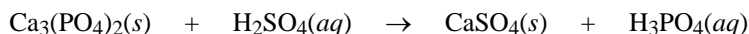
TRUE

4. How many **O atoms** are in 4.0 moles of P_2O_5 ? Circle the correct answer. [3 pts]

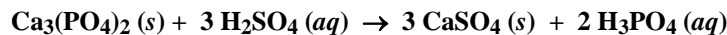
a) 1.2×10^{25} b) 3.0×10^{24} c) 2.4×10^{24} d) 3.3×10^{-23} e) none of these

$$4.0 \text{ mol P}_2\text{O}_5 \times \frac{5 \text{ mol O}}{1 \text{ mol P}_2\text{O}_5} \times \frac{6.022 \times 10^{23} \text{ O atoms}}{1 \text{ mol O}} = \mathbf{1.2 \times 10^{25} \text{ O atoms}}$$

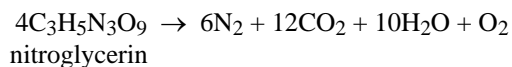
5. Balance the following equation with the *smallest* set of whole numbers. The sum of **all** the coefficients is? Don't forget to count coefficients of one. Circle the correct answer. [3 pts]



- a) 18 b) **9** c) 7 d) 6 e) 4



6. Nitroglycerin ($\text{C}_3\text{H}_5\text{N}_3\text{O}_9$) is a powerful explosive. Its decomposition may be represented by



This reaction generates a large amount of heat and many gaseous products. It is the sudden formation of these gases, together with their rapid expansion, that produces the explosion.

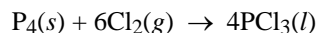
- a) What is the maximum amount of O_2 in **grams** that can be obtained from 500.0 g of nitroglycerin (molar mass = 227.1 g/mol)? The molar mass of O_2 is 32.00 g/mol. [4 pts]

$$500.0 \text{ g NG} \times \frac{1 \text{ mol NG}}{227.1 \text{ g NG}} \times \frac{1 \text{ mol O}_2}{4 \text{ mol NG}} \times \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} = \mathbf{17.61 \text{ g O}_2}$$

- b) Calculate the **percent yield** in this reaction if the amount of O_2 generated is found to be 13.5 g. [2 pts]

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% = \frac{13.5 \text{ g}}{17.61 \text{ g}} \times 100 = \mathbf{76.7\%}$$

7. Phosphorus trichloride, PCl_3 , is a commercially important compound used in the manufacture of pesticides, gasoline additives, and a number of other products. It is made by the direct combination of phosphorus and chlorine.



Given that **2.50 moles of P_4** are reacted with **12.5 moles of Cl_2** , answer the following questions.

Assuming complete reaction, how many **moles of PCl_3** are produced? [3 pts]

$$2.50 \text{ mol P}_4 \times \frac{4 \text{ mol PCl}_3}{1 \text{ mol P}_4} = 10.0 \text{ mol PCl}_3$$

$$12.50 \text{ mol Cl}_2 \times \frac{4 \text{ mol PCl}_3}{6 \text{ mol Cl}_2} = 8.33 \text{ mol PCl}_3$$

Cl_2 is the limiting reagent; it limits how much product can be produced. Therefore, **8.33 moles** of PCl_3 are produced.