

Name \_\_\_\_\_

1. Calculate the **molar mass** of TNT, trinitrotoluene ( $C_7H_5N_3O_6$ ). [2 pts]

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

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

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

**TRUE**

b) Consider the combustion of hydrogen gas:  $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ . If 10.0 moles of  $H_2$  are reacted with excess  $O_2$ , 10.0 moles of  $H_2O$  will be produced assuming complete reaction.

**TRUE**

3. How many **O atoms** are in 3.0 moles of  $P_2O_5$ ? Circle the correct answer. [3 pts]

a)  $2.5 \times 10^{-23}$     b)  $1.8 \times 10^{23}$     c)  $3.0 \times 10^{24}$     **d)  $9.0 \times 10^{24}$**     e) none of these

$$3.0 \text{ mol } P_2O_5 \times \frac{5 \text{ mol O}}{1 \text{ mol } P_2O_5} \times \frac{6.022 \times 10^{23} \text{ O atoms}}{1 \text{ mol O}} = \mathbf{9.0 \times 10^{24} \text{ O atoms}}$$

4. 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. [4 pts]

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

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

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

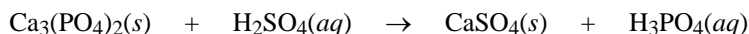
A correct formula for the compound is  $C_{3.33}H_{6.66}O_{3.33}$ ; however, this is not the empirical formula, which will have the simplest **whole** number ratio. Dividing each subscript by the smallest number of moles (3.33) gives the empirical formula, **CH<sub>2</sub>O**.

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

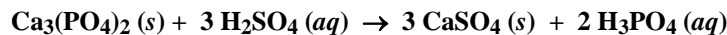
$$\frac{\text{molar mass}}{\text{empirical mass}} = \frac{90.08 \text{ g}}{30.03 \text{ g}} \approx 3$$

This means that the molecular formula is  $(CH_2O)_3$  or **C<sub>3</sub>H<sub>6</sub>O<sub>3</sub>**.

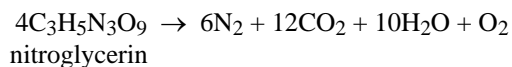
5. Balance the following equation with the *smallest* set of whole numbers. The sum of **all** the coefficients is? Don't forget to count coefficients of one. Circle the correct answer. [3 pts]



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



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.

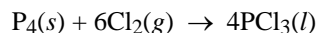
- a) What is the maximum amount of  $\text{O}_2$  in **grams** that can be obtained from 300.0 g of nitroglycerin (molar mass = 227.1 g/mol)? The molar mass of  $\text{O}_2$  is 32.00 g/mol. [4 pts]

$$300.0 \text{ g NG} \times \frac{1 \text{ mol NG}}{227.1 \text{ g NG}} \times \frac{1 \text{ mol O}_2}{4 \text{ mol NG}} \times \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} = \mathbf{10.57 \text{ g O}_2}$$

- b) Calculate the **percent yield** in this reaction if the amount of  $\text{O}_2$  generated is found to be 8.55 g. [2 pts]

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% = \frac{8.55 \text{ g}}{10.57 \text{ g}} \times 100 = \mathbf{80.9\%}$$

7. Phosphorus trichloride,  $\text{PCl}_3$ , 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 **1.50 moles of  $\text{P}_4$**  are reacted with **7.50 moles of  $\text{Cl}_2$** , answer the following questions.

Assuming complete reaction, how many **moles of  $\text{PCl}_3$**  are produced? [3 pts]

$$1.50 \text{ mol P}_4 \times \frac{4 \text{ mol PCl}_3}{1 \text{ mol P}_4} = 6.00 \text{ mol PCl}_3$$

$$7.50 \text{ mol Cl}_2 \times \frac{4 \text{ mol PCl}_3}{6 \text{ mol Cl}_2} = 5.00 \text{ mol PCl}_3$$

$\text{Cl}_2$  is the limiting reagent; it limits how much product can be produced. Therefore, **5.00 moles** of  $\text{PCl}_3$  are produced.