NAME Key

CHEM 1301

Stoichiometry HMWK #10

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- **Moles to Moles**

Use the following reaction to answer the following questions. None of the problems are connected, so don't carry information from one problem to another!

$$4\ Na\ (s) + O_2(g) \rightarrow 2\ Na_2O(s)$$

1. For the reaction shown, calculate how many moles of Na_2O are formed when 0.967 moles of Na are reacted in the following reaction.

$$.967\ mol\ Na \left(\frac{2\ mol\ Na_2O}{4\ mol\ Na}\right) = \boxed{.484\ mol\ Na_2O}$$

2. When 2.19 moles of Na are reacted, how many moles of O_2 also react?

$$2.19\ mol\ Na \left(\frac{1\ mol\ O_2}{4\ mol\ Na}\right) = \boxed{.548\ mol\ O_2}$$

3. If you form 8.6943 mol Na_2O, how many moles of Na and how many moles of O_2 were reacted?

$$8.6943\ mol\ Na_2O \left(\frac{4\ mol\ Na}{2\ mol\ Na_2O}\right) = \boxed{17.389\ mol\ Na}$$

$$8.6943\ mol\ Na_2O \left(\frac{1\ mol\ O_2}{2\ mol\ Na_2O}\right) = \boxed{4.3472\ mol\ O_2}$$

- **Mass-to-mass Stoichiometry**

Refer to the following reaction to answer the next set of problems. (Balance the reaction before you start!)

$\underline{\ 2\ }\ Al(s) + \underline{\ 3\ }\ H_2SO_4(aq) \rightarrow \underline{\quad}\ Al_2(SO_4)_3\ (aq) + \underline{\ 3\ }\ H_2(g)$

1. A) How many grams of aluminum can be reacted using 23.65 g H_2SO_4?

$$23.65g\ H_2SO_4 \left(\frac{1mol\ H_2SO_4}{98.08g\ H_2SO_4}\right)\left(\frac{2mol\ Al}{3mol\ H_2SO_4}\right)\left(\frac{26.96g\ Al}{1mol\ Al}\right)$$

$$= 4.334g\ Al$$

B) As the reaction in part A progresses, how many grams of H_2 gas are produced?

$$23.65g\ H_2SO_4 \left(\frac{1mol\ H_2SO_4}{98.08g\ H_2SO_4}\right)\left(\frac{3mol\ H_2}{3mol\ H_2SO_4}\right)\left(\frac{2.02g\ H_2}{1mol\ H_2}\right)$$

$$=0.4871g\ H_2$$

2. In a completely separate setup, I need to make 10.00g $Al_2(SO_4)_3$. How many grams of Al should I begin the reaction with?

$$10.00g\ Al_2(SO_4)_3 \left(\frac{1mol\ Al_2(SO_4)_3}{342.1g\ Al_2(..)}\right)\left(\frac{2mol\ Al}{1mol\ Al_2(SO_4)_3}\right)\left(\frac{26.96g\ Al}{1mol\ Al}\right)$$

$$= 1.576g\ Al$$

3. If I begin with 9.72 mol H_2SO_4, how many grams of H_2 can I make?

$$9.72mol\ H_2SO_4 \left(\frac{3mol\ H_2}{3mol\ H_2SO_4}\right)\left(\frac{2.02g\ H_2}{1mol\ H_2}\right)$$

$$= 19.6g\ H_2$$

4. For the reaction shown, calculate how many grams of oxygen form when each quantity of reactants completely reacts.

$\underline{2}$ $KClO_3$(s) → $\underline{2}$ KCl (s) + $\underline{3}$ O_2 (g)

↑ Given ?g

A) 2.97 g $KClO_3$

$$2.97\text{g} KClO_3 \left(\frac{1\text{mol } KClO_3}{122.55\text{g } KClO_3}\right)\left(\frac{3\text{mol } O_2}{2\text{mol } KClO_3}\right)\left(\frac{32\text{g } O_2}{1\text{mol } O_2}\right) = 1.16\text{g } O_2$$

B) 0.7541 g $KClO_3$

$$0.7541\text{g} KClO_3 \left(\frac{1\text{mol } KClO_3}{122.55\text{g}}\right)\left(\frac{3\text{mol } O_2}{2\text{mol } KClO_3}\right)\left(\frac{32\text{g } O_2}{1\text{mol } O_2}\right) = .2954\text{g } O_2$$

C) 15.69 kg $KClO_3$ (NOTE THE kg!!)

↳ 1.569×10^4 g $KClO_3$

Same method as A+B

$= 6.145 \times 10^3$ g O_2

D) How many grams of KCl will also form when 0.7541g $KClO_3$ react? (Same mass as Part B)

$$.7541\text{g} KClO_3 \left(\frac{1\text{mol } KClO_3}{122.55\text{g}}\right)\left(\frac{2\text{mol } KCl}{2\text{mol } KClO_3}\right)\left(\frac{74.55\text{g } KCl}{1\text{mol } KCl}\right)$$

.4587g KCl

E) Use your answer for parts B and D to show that you have not violated the Law of Mass Conservation. (Add the masses of the 2 products that you calculated, is this equal to the mass of the reactant you began with?)

.4587g KCl + .2954g O_2 = .7541 g $KClO_3$

P mass = R mass

✓ COM

- **Theoretical Yield/Pecent Yield**

1. Consider the reaction below:

   __2__ N_2H_4 (g) + _____ N_2O_4 (g) → __3__ N_2 (g) + __4__ H_2O (g)

   A) A reaction initially contains 5.27g of N_2H_4, and excess N_2O_4. What is the theoretical yield of N_2 for the reaction?

   $$5.27g\ N_2H_4 \left(\frac{1\ mol\ N_2H_4}{32.06g}\right)\left(\frac{3\ mol\ N_2}{2\ mol\ N_2H_4}\right)\left(\frac{28.02g\ N_2}{1\ mol\ N_2}\right)$$

   $$= \boxed{6.91\ g\ N_2}$$

   B) You recover 4.95g of N_2 at the end of the reaction. What is the percent yield for the reaction?

   $$\frac{4.95g\ N_2}{6.91g\ N_2} \times 100\% = \boxed{71.6\%}$$

2. A scientist calculated that he should make 20.32g (TY) of a drug he is synthesizing from a reaction. The known percent yield of the reaction is 64.23%. How much of the drug can he expect to recover at the end of his reaction?

   $$64.23\% = \frac{AY}{TY} \times 100\%$$

   TY ← 20.32g

   $$.6423 = \frac{AY}{20.32g} \qquad AY = \boxed{13.05g\ Drug}$$

3. A different scientist calculated that she should synthesize 8.54g (TY) of her product but only recovers 2.98g (AY) of it. What is the percent yield of the reaction?

   $$\frac{2.98g}{8.54g} \times 100 = \boxed{34.9\%}$$