PRACTICE QUIZ

MASS RELATIONSHIP

1. Propane (C_3H_8), the main component in LP gas for grills, burns with oxygen according to the following equation:

C_3H_8 + 5 O_2 ⇒ 3 CO_2 + 4 H_2O

f.w. 44.0962 f.w. 31.9988 f.w. 44.010 f.w. 18.015

How many grams of H_2O gas are released when 325.0 grams of C_3H_8 are combusted?

How to solve Stoichiometry

I've introduced stoichiometry problems as involving two substances at a time. Substance A is the one in the problem for which grams are given. Substance B is the one without grams provided; it's the one you will be calculating. On Practice Quiz, Substance A in this problem is 325.0 grams of C_3H_8 (a reactant). Substance B is H_2O (a product). The calculation involves three steps:

1. Convert Grams of A to moles of A by dividing by its formula weight
2. Convert moles of A to moles of B by multiplying by the coefficient of B/coefficient of A
3. Convert moles of B to grams of B by multiplying by its formula weight

These three steps can be done separately, in a chained fashion or plugged into a 5-term summary equation. Here's how the chained version would look:

$$325.0\ g\ C_3H_8\ x\ \frac{1\ mol\ C_3H_8}{44.0962\ g\ C_3H_8}\ x\ \frac{4\ mol\ H_2O}{1\ mol\ C_3H_8}\ x\ \frac{18.015\ g\ H_2O}{1\ mol\ H_2O} = 531.1\ g\ H_2O$$

Solve:

a. The detonation of nitroglycerine ($C_3H_5N_3O_9$) produces gaseous CO_2, H_2O, N_2 and O_2 according to the reaction:

4 $C_3H_5N_3O_9$(l) → 12 CO_2(g) + 10 H_2O(l) + 6 N_2(g) + O_2(g)

f.w. 227.09 f.w. 44.01 f.w. 18.02 f.w. 28.01 f.w. 32.00

For each 180.0 g of $C_3H_5N_3O_9$ that explodes, how many grams of N_2 are produced?

2. Hydrogen gas, H_2, can be produced in the lab by the following reaction:

Mg(s) + 2 HCl ⇒ $MgCl_2$ + H_2(g)

f.w. 24.3 f.w. 36.5 f.w. 95.3 f.w. 2.0

If you have 24.3 g of Mg and 65.0 g of HCl, which will be the limiting reagent? Support your answer with appropriate calculations.

How to solve Limiting Reagent problems

The best way to do limiting reagent problems is to perform the first two steps of a stoichiometry calculation for each reactant. I know that there are alternative ways to do this when you only have two reactants, but I prefer to show them the general approach that will work for any number of reactants. This quiz has two, so we'll let Mg(s) be Substance A for the first round and HCl be Substance A for the second round. The students can pick any product as Substance B. Whichever they choose, they should use that consistently. I'll work the problem using $MgCl_2$ as Substance B.

Calculations using Mg(s) as Substance A:

$$24.3\ g\ Mg(s)\ x\ \frac{1\ mol\ Mg(s)}{24.3\ g\ Mg(s)}\ x\ \frac{1\ mol\ MgCl_2}{1\ mol\ Mg(s)} = 1.00\ mol\ MgCl_2\ made$$

Calculations using HCl as Substance B:

$$65.0\ g\ HCl\ x\ \frac{1\ mol\ HCl}{36.5\ g\ Mg(s)}\ x\ \frac{1\ mol\ MgCl_2}{2\ mol\ HCl} = 0.890\ mol\ MgCl_2\ made$$

Since HCl leads to the production of less $MgCl_2$, it is the limiting reactant in this case.

Solve:

a. Consider the reaction:

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$
f.w. 2.0 g f.w. 32.0 g f.w. 18.0 g

If you have 4.0 grams of H_2 and 34 grams of O_2, which is the limiting reagent? Support your answer with appropriate calculations.

3. Nitric acid (HNO_3) in air pollution is produced by a reaction between nitrogen dioxide (NO_2) and water via the reaction below. Nitric oxide (NO) is also produced along with the nitric acid.

$3\ NO_2(g) + H_2O(l) \rightarrow 2\ HNO_3(l) + NO(g)$
f. w. 46.01 g f. w. 18.02 g f. w. 63.08 g f. w. 30.07 g

For each 50.00 g of NO_2 that reacts, how many grams of NO are produced?

How to solve

Here Substance A is NO_2; substance B is NO.

$$50.00g\ NO_2 \times \frac{1\ mol\ NO_2}{46.01g\ NO_2}\ x\ \frac{1\ mol\ NO}{3\ mol\ NO_2}\ x\ \frac{30.07g\ NO}{1\ mol\ NO} = 10.89g\ NO$$

5. a. Balance the equation below such that it has the **smallest, whole-number** coefficients.

$CH_3CH_2CH_2CH_2OH + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

Solved below

. $CH_3CH_2CH_2CH_2OH + 6\ O_2(g) \rightarrow 4\ CO_2(g) + 5\ H_2O(g)$

b. Balance the equation below such that it has the **smallest, whole-number** coefficients.

$CH_3CH_2CH_2CH_2CH_2OH + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

Solved below

$CH_3CH_2CH_2CH_2CH_2OH + 15/2\ O_2(g) \rightarrow 5\ CO_2(g) + 6\ H_2O(g)$

(balanced with fractional coefficient on O_2)

$2\ CH_3CH_2CH_2CH_2CH_2OH + 15\ O_2(g) \rightarrow 10\ CO_2(g) + 12\ H_2O(g)$

(all coefficients doubled to get smallest, whole-number coefficients)

Solve:

a. $CH_3COCH_3 + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

b. $CH_3COCH_2CH_3 + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

7. How many individual hydrogen atoms (not moles of atoms) are in 100.0 grams of water? (f.w. 18.015 g/mol)

Solution below

$$100.0g\ H_2O\ x\ \frac{1\ mol\ H_2O}{18.015g\ H_2O}\ x\ \frac{2\ mol\ H}{1\ mol\ H_2O}\ x\ \frac{6.02\ x\ 10^{23}\ H\ atoms}{1\ mol\ H} = 6.68\ x\ 10^{24}\ H\ atoms$$

8. All definitions in the chapter.