SCH3U

**Stoichiometric Calculations: Gram to Gram Calculations**

The type of problems involved here can be solved easily with 2-3 simple steps. Use the Bridge Method for solving only after the equation is balanced.

Never, ever assume that an equation is balanced.

Example Solution #1

During its combustion, ethane C_2H_6, combines with oxygen O_2 to give carbon dioxide and water. A sample of ethane was burned completely and the water that formed has a mass of 1.61 grams. How much ethane, in moles and in grams, was in the sample?

Solution: 1. Set up the equation based on the words in the problem. Then balance it correctly.

$$2 \; C_2H_6 + 7 \; O_2 \text{ --------> } 4 \; CO_2 + 6 \; H_2O$$
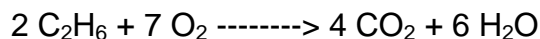
2. Compute the needed formula molecular masses. We need the molecular mass for water and for ethane. H_2O = 18.02 g.mol; C_2H_6 = 30.08 g/mol

3. Draw a roadmap outline the math steps that need to be taken:

moles of water ---------> moles of ethane
^ |
| V
grams of water   grams of ethane

Therefore this type of question requires a three step solution.

Step #1 Convert 1.61 grams of water to moles of water.

Step #2 Using the equation, compare the moles of water made from moles of ethane.

Step #3 Convert the moles of ethane back into grams of ethane.

Draw a roadmap outlining the mathematical steps that need to be taken:

moles of water ---------> moles of ethane
^ |
| V
grams of water   grams of ethane

Math Step #1 Convert 1.61 grams of water into moles of water
Moles = g/mm = 1.61 g/ 18.02 g/mol = 0.09 mol of water were used.

Math Step #2 The chemical equation shows us that 2 moles of C_2H_6 is needed to make 6 moles of water. Setup a ratio:

$\underline{6 \text{ mol } H_2O} = \underline{2 \text{ mol } C_2H_6}$
$0.09 \text{ mol} \qquad x$

x = 0.03 moles of ethane are needed.

Math Step #3 Convert the moles of ethane back into grams of ethane.
g = n * mm = 0.03 mol * 30.08 g/mol = 0.90 grams of ethane
Finish off the question with a statement. 1.61 grams of water can be made from 0.03 moles of ethane or 0.90 grams of ethane.

Example Question #2 Calculate how many grams of $K_2Cr_2O_7$ are needed to make 35.8 grams of I_2 according to the following equation.

$K_2Cr_2O_7 + 6 \text{ NaI} + 7 H_2SO_4 \text{ -------> } Cr_2(SO_4)_3 + 3 I_2 + 7 H_2O + 3 Na_2SO_4 + K_2SO_4$
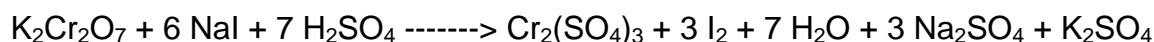
The equation is already balanced but you should check it over just to be sure. Next calculate the molecular masses that you need. The question deals with iodine, I_2, and potassium dichromate, $K_2Cr_2O_7$. Calculate the molecular masses for these only. The other parts of the equation can be forgotten about.
$\qquad I_2 = 253.82 \text{ g/mol } K_2Cr_2O_7 = 294.20 \text{ g/mol}$

Draw a roadmap outlining the mathematical steps that need to be taken:

moles of iodine ---------> moles of potassium dichromate
^ |
| V
grams of iodine   grams of potassium dichromate
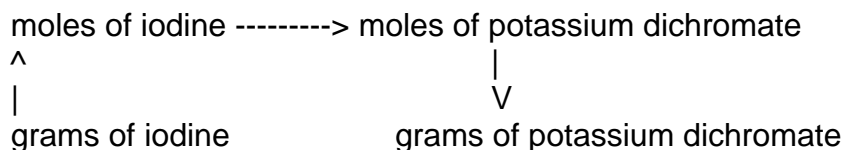
Math Step #1 Convert grams of iodine into moles of iodine.

moles = g/mm = 35.8 g / 253.82 g/mol = 0.14 moles of iodine

Math Step #2 Compare using the equation coefficients, the number of moles of potassium dichromate is need to make how many moles of iodine.

$\underline{3 I_2} = \underline{1 K_2Cr_2O_7}$
$0.14 \text{ mol} \qquad x$

x = 0.05 moles of potassium dichromate

SCH3U

Math Step #3 Convert the moles of potassium dichromate back into grams of potassium dichromate.

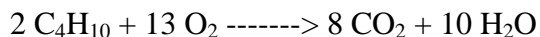g = n * mm = 0.05 mol * 294.20 g/mol = 14.71 grams

To make 35.8 grams of iodine you must start with 14.71 grams of potassium dichromate.

SCH3U
Worksheet 3.4: Stoichiometric Gram to Gram Calculations

1. The combustion of a sample of butane, C_4H_{10} (lighter fluid), produced 2.46 grams of water.

$2 C_4H_{10} + 13 O_2$ -------> $8 CO_2 + 10 H_2O$

(a) How many moles of water formed?
(b) How many moles of butane burned?
(c) How many grams of butane burned?
(d) How much oxygen was used up in moles? In grams?

2. Terephthalic acid, an important raw material for making Dacron, a synthetic fibre, is made from para-xylene by the following reaction.

$C_8H_{10} + 3 O_2$ -----------------------> $C_8H_6O_4 + 2 H_2O$
para-   special conditions   terephthalic
xylene   acid
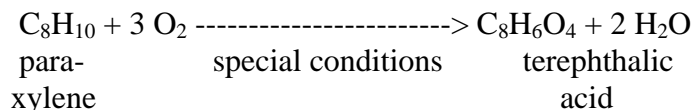
How much terephthalic acid could be made from 154 grams of para-xylene in moles? In grams?

3. Adipic acid, a raw material for nylon, is made industrially by the oxidation of cyclohexane.

$5 O_2 + 2 C_6H_{12}$ ---------------------> $2 C_6H_{10}O_4 + 2 H_2O$
                cyclohexane   special conditions   adipic acid
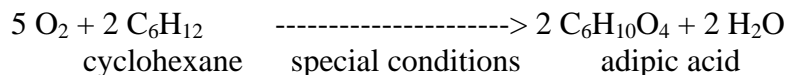
(a) How many moles of oxygen would be needed to make 40.0 moles of adipic acid by this reaction?
(b) If 164 grams of cyclohexane is used, what is the theoretical yield of adipic acid in moles? In grams?

4. Aluminum oxide, Al_2O_3, a buffing powder, is to be made by combining 5.00 grams of aluminum with oxygen, O_2. How much oxygen is needed in moles? In grams?

5. Calculate how many grams of iron can be made from 16.5 grams of Fe_2O_3 by the following equation.

$Fe_2O_3 + 3 H_2$ -------------> $2 Fe + 3 H_2O$
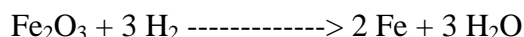
6. Iodine chloride, ICl, can be made by the following reaction between iodine, I_2, potassium iodate, KIO_3, and hydrochloric acid.

$2 I_2$ + KIO_3 + 6 HCl ---------> $5 ICl$ + KCl + $3 H_2O$
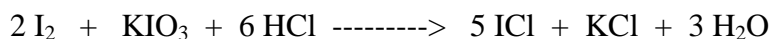
Calculate how many grams of iodine are needed to prepare 28.6 grams of ICl by this reaction.