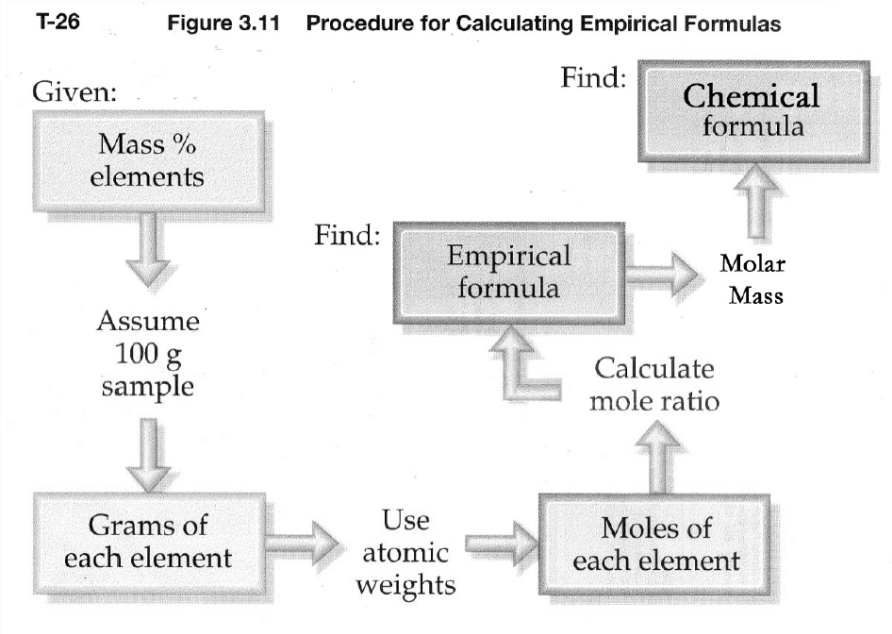
Name: _____ Due: Tues, Feb 22 in tutorial

Flipped lecture worksheet #1 – This worksheet accompanies the online lecture "How to find an empirical formula from a combustion reaction"

1. Balance these combustion reactions:

   (a) $CH_4\ (g) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$
   (b) $C_2H_6\ (g) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$
   (c) $C_6H_{12}O_6\ (s) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$
   (d) $C_2H_5OH\ (l) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$

2. In a reaction where the empirical formula is to be determined from combustion analysis, circle the starting point of the road map. [Review slide 5]



3. (a) How many grams of carbon do I have if I am given 0.35534 g of CO_2?
Show your work using dimensional analysis. [Consult slide 7 when attempting this question.]

Verify that your answer is 0.096980 g carbon. Follow the steps in the box and copy the steps in the space below to arrive at this answer.

If your answer is not the same as mine, here are the steps. Pay attention to how the units are converted from the mass of CO_2 to the mass of carbon.

(i) What did you get for the moles of CO_2? It should be 0.00807426 moles CO_2 because

$$\frac{0.35534\ g\ CO_2}{\frac{44.009 g\ CO_2}{mole}} = 0.00807425 \text{ moles } CO_2$$

(ii) The next step is to take the moles of CO_2 and multiply it by the number of moles of carbon in 1 mole of CO_2.

$$0.00807425 \text{ moles } CO_2 \cdot \frac{1 \text{ mole of carbon}}{1 \text{ mole of } CO_2} = 0.00807425 \text{ moles carbon}$$

(iii) The last step is to take the moles of carbon and multiply it by the atomic mass of carbon to arrive at the mass of carbon.

$$0.00807425 \text{ moles carbon} \cdot 12.011 \frac{g}{mole} = 0.096980 \text{ g carbon}$$

(b) How many grams of carbon do I have if I am given 7.3587 g of CO_2?
Show your work using dimensional analysis. [Review slide 7]

4. (a) How many grams of hydrogen do I have if I am given 0.12534 g of H_2O?
Show your work using dimensional analysis. [Consult slide 7 when attempting this question.]

Verify that your answer is 0.01403 g hydrogen. Follow the steps in the box and copy the steps in the space below to arrive at this answer.

If your answer is not the same as mine, here are the steps. Pay attention to how the units are converted from the mass of H_2O to the mass of carbon.

(i) What did you get for the moles of H_2O? It should be 0.0069575 moles H_2O because

$$\frac{0.12534\ g\ H_2O}{\frac{18.015\ g\ H_2O}{mole}} = 0.0069575 \text{ moles } H_2O$$

(ii) The next step is to take the moles of H_2O and multiply it by the number of moles of hydrogen in 1 mole of H_2O.

$$0.0069575 \text{ moles } H_2O \cdot \frac{2 \text{ mole of hydrogen}}{1 \text{ mole of } H_2O} = 0.013915 \text{ moles hydrogen}$$

(iii) The last step is to take the moles of hydrogen and multiply it by the atomic mass of hydrogen to arrive at the mass of hydrogen.

$$0.013915 \text{ moles hydrogen} \cdot 1.008 \frac{g}{mole} = 0.01403 \text{ g hydrogen}$$

(b) How many grams of hydrogen do I have if I am given 0.76534 g of H_2O?
Show your work using dimensional analysis. [Consult slide 7 when attempting this question.]

5. In the video, we determined the mass of oxygen in the compound that was burned. Explain mathematically how the mass of oxygen was determined. [Review slide 7]

6. Compounds containing Carbon-Hydrogen-Oxygen can be analysed by burning a sample of the compound in the presence of excess oxygen gas. As a result of the combustion of the compound, all of the carbon in the compound is converted to carbon dioxide gas and all of the hydrogen in the compound is converted to water vapour. Combustion of 0.4500 g of the compound produced 0.61814 g CO_2 and 0.50607 g H_2O. What is the empirical formula of the compound?
   [Hint: Combustion involves O_2 as a reactant. The oxygen in CO_2 and H_2O contains oxygen from the sample and the oxygen from the air. You need to subtract off the oxygen from the air.]

   (a) What is the mass of carbon in 0.4500 g of this compound?

   (b) What is the mass of hydrogen in 0.4500 g of this compound?

   (c) What is the mass of oxygen in 0.4500 g of this compound?

   (d) What is the empirical formula of this compound?

7. Compounds containing Carbon-Hydrogen-Oxygen can be analysed by burning a sample of the compound in the presence of excess oxygen gas. As a result of the combustion of the compound, all of the carbon in the compound is converted to carbon dioxide gas and all of the hydrogen in the compound is converted to water vapour.

   (a) Combustion of 0.4960 g of the compound produced 0.92395 g CO_2 and 0.37822 g H_2O.

   [Hint: Combustion involves O_2 as a reactant. The oxygen in CO_2 and H_2O contains oxygen from the sample and the oxygen from the air. You need to subtract off the oxygen from the air.]

   (i) What is the mass of carbon in 0.4960 g of this compound?

   (ii) What is the mass of hydrogen in 0.4960 g of this compound?

   (iii) What is the mass of oxygen in 0.4960 g of this compound?

   (iv) What is the empirical formula of this compound?

   (b) The molar mass of the compound is 118.135 g/mole. What is the chemical formula of the compound?