

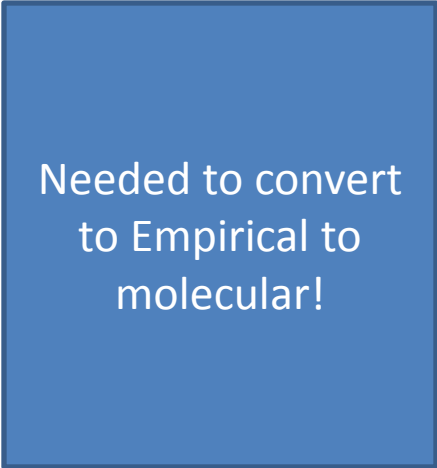
# Conservation of mass

# Conservation of Mass

- An unknown Hydrocarbon,  $C_xH_y$ , When **3.90grams** of this hydrocarbon is placed in a **3.00Liter** container and heated to **800K**, no liquid remains and the pressure becomes **1.58 atm**.
- This is a VERY common start to a typical AP problem.

# General progression of question

- Empirical formula
- Molecular Weight  
(Molar mass)
- Molecular formula



Needed to convert  
to Empirical to  
molecular!

# What is the molar mass?

- The molar mass is a very common value.
- It can very often determine the identity of the substance.
- It is a ratio of the mass per mole or mass per individual
- We need two pieces of information.
  1. Mass
  2. Moles

# Finding molar mass

- Mass = **3.90g** Given in the problem.
- Moles:
  - In this case we are going to use  $PV=nRT$  to solve for the moles.
  - This is a common Gas Law that you will be expected to use from day 1.
  - Solve for  $n = PV/RT$
  - $P =$  pressure (1.58 atm);  $V = 3L$ ;  $R = .0821$ ;  $T = 800K$
  - $n$ : **.0721 moles**

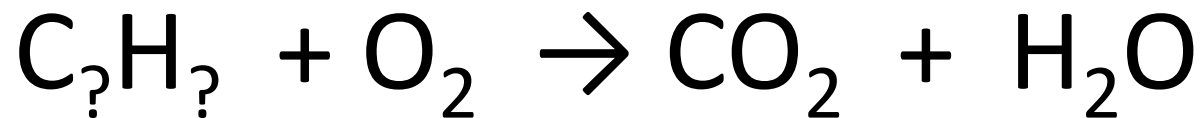
# Lets Calculate the molar mass

- $3.90\text{g}/.0721 \text{ moles} = 54.09\text{g/mol}$

# Problem continued?

- The unknown gas is burned, producing a mixture of 76.5%  $\text{CO}_2$  and 23.5%  $\text{H}_2\text{O}$ . What is the empirical formula of the hydrocarbon?
- 1<sup>st</sup> they did not give us the total mass of the end product but in this case the sample size does not matter. Set it at 100g.
- Plan: mass = moles = simplest ratio atoms

# What is the equation?

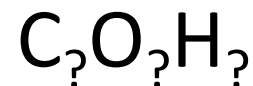


- No mass is either gained nor lost we are simply rearranging the atoms.

C: ALL the carbon in the hydrocarbon is now in the form of Carbon Dioxide.

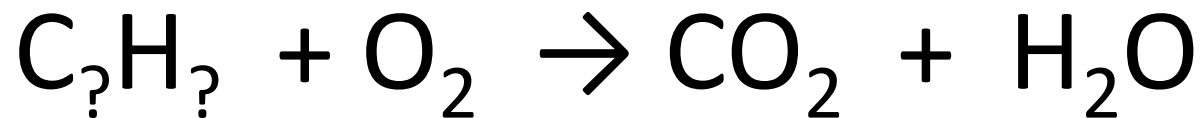
H: All the Hydrogen is in the form of water.

O: It is possible for your unknown to also contain Oxygen. Where does it end up?



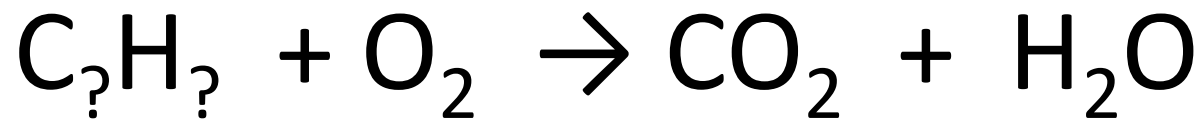


# Where's the carbon?



- 76.5g  $\text{CO}_2$
- If you determine the number moles of  $\text{CO}_2$  then that would equal the moles of C in the beginning. (There is 1 carbon in every  $\text{CO}_2$ )
- $76.5\text{g } \text{CO}_2 / 44\text{g} = 1.73 \text{ moles } \text{CO}_2 = \text{C}$

# Where's the Hydrogen?



- 23.5g H<sub>2</sub>O
- 23.5g/18 = 1.305 moles H<sub>2</sub>O \* 2 = 2.61 moles H
  - The H is doubled because there is 2 H in water.

# Simplest Ratio

- C: 1.73 moles
- H: 2.61 moles
- Divide out by the smallest. Set to 1
  - C = 1
  - H =  $1\frac{1}{2}$
- Multiply by reciprocal of fraction
- $C_2H_3$

# What is the Molecular formula

- The empirical formula is some ratio of the actual formula or molecular formula
- $C_2H_3 = 27\text{g/mol}$
- $C_4H_6 = 54\text{g/mol}$
- $C_6H_9 = 81\text{g/mol}$
  
- We calculated the molar mass earlier to be  $54\text{g/mol}$   $C_4H_6 = 54\text{g/mol}$