# 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

- 3.90g/.0721 moles = 54.09g/mol

# Problem continued?

- The unknown gas is burned, producing a mixture of 76.5% $CO_2$ and 23.5% $H_2O$. What is the empirical formula of the hydrocarbon?
- 1$^{st}$ 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?

$$C_?H_? + O_2 \rightarrow CO_2 + H_2O$$

- 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?

$C_?O_?H_?$

# Where's the carbon?

$$C_?H_? + O_2 \rightarrow CO_2 + H_2O$$

- 76.5g $CO_2$
- If you determine the number moles of $CO_2$ then that would equal the moles of C in the beginning. (There is 1 carbon in every $CO_2$)
- 76.5g $CO_2$ / 44g = 1.73 moles $CO_2$ = C

# Where's the Hydrogen?

$$C_?H_? + O_2 \rightarrow CO_2 + H_2O$$

- 23.5g $H_2O$
- 23.5g/18 = 1.305 moles $H_2O$ *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 = 1½
- 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
- $C_2H_3$ = 27g/mol
- $C_4H_6$ = 54g/mol
- $C_6H_9$ = 81g/mol

- We calculated the molar mass earlier to be 54g/mol $C_4H_6$ = 54g/mol