1. What volume of CO_2 is produced when 32g of ethane is burned in excess O_2? 100kPa, 120'C

$C_2H_6 + 3.5\ O_2 \rightarrow 2CO_2 + 3H_2O$

For every mole C_2H_6 of you get 2 moles CO_2.

Moles C_2H_6 — 2 C → 24g; 6 H → 6g; 30g — 1 mol → 30g; x mol → 32g — $x = \frac{32}{30} = 1.07$ moles C_2H_6

There fore 2.14 moles CO_2.

Volume CO_2

PV=nRT

$$V = \frac{nRT}{P} = \frac{(2.14\ \text{mole})(8.314\ \frac{\text{kPa*L}}{\text{mol*K}})(393\text{K})}{100\ \text{kPa}}$$

V = 69.92 L

2. A compound is made of C, H, O. When 39.6g of the sample is burned in excess O_2 we obtain 84.4g of CO_2 and 11.5g of H_2O. What is the empirical formula?

$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$

CO_2

1 mole CO_2 → 1 C → 12g; 2 O → 32g; 44g/mol — $\frac{84.4g}{44g} = 1.92$ moles CO_2

Therefore 1.92 moles C originally

H_2O

1 mole H_2O → 2 H → 2g; 1 O → 16g; 18g/mol — $\frac{11.5g}{18g} = 0.64$ moles H_2O

Therefore 1.28 moles of H originally (not H_2)

O

Mass O = total mass – mass C – mass H
= 39.6-12(1.92)-1(1.28)
= 39.6-23-1.28
= 15.32g

$\frac{15.32g}{16\ g/mol} = 0.958$ moles O

EF = $C_6H_4O_3$

C		H		O	
1.92		1.28		0.958	percent to mass
0.958		0.958		0.958	mass to moles
2	:	1.337	:	1	divide by small
6	:	4	:	3	mult 'til whole

b) It was found that at STP the sample was a gas and occupied a volume of 3.575L. What is the molecular formula?

STP T=273 K
P =101.3 kPa

$n = \frac{PV}{RT} = \frac{101.3 * 3.575}{8.314 * 273} = 0.1595$ moles

39.6g → 0.1595 moles
x g → 1 mole

$x = \frac{39.6}{0.1595} = 248.3$g/mol

1 mol $C_6H_4O_3$ → 6 C → 72g
4 H → 4g
3 O → 48g
124 g/mol for EF

$MF = \frac{MFM}{EFM}(EF)$

$MF = \frac{248.3}{124}(C_6H_4O_3)$

$MF = C_{12}H_8O_6$

Extra Questions

1. What is the percentage composition by mass of a) ammonia (NH_3) b) glucose $C_6H_{12}O_6$?

2. Given $CH_3CH_2CH_2CH_3 + Br_2 \rightarrow CH_3CHBrCH_2CH_3 + HBr$

   a) What is the theoretical yield of 2-bromobutane if one mole of butane reacts with one mole of bromine? What if only 0.65 moles of 2-bromobutane is produced then what is the percentage yield of 2-bromobutane?

   b) What is the theoretical yield of 2-bromobutane in grams if one mole of butane reacts with 0.5 moles of bromine? What if only 0.2 moles of 2-bromobutane is produced then what is the percentage yield of 2-bromobutane?

3. Adrenaline is 56.8% C, 6.5% H, 28.4% O and 8.28% N by mass. Find the empirical formula.

4. A chemist new to the behaviour of chlorine with hydrocarbons tried to make dichloromethane (CH_2Cl_2) by mixing 0.25 moles of chloromethane (CH_3Cl) and 0.25 moles of chlorine (Cl_2) expecting the following reaction:

$$CH_3Cl + Cl_2 \rightarrow CH_2Cl_2 + HCl$$

Inevitably some chloroform ($CHCl_3$) and carbon tetrachloride (CCl_4) formed along with CH_2Cl_2. Also some CH_3Cl remained unchanged. When the mixture of products was separated a yield of 12.8g of dichloromethane was obtained. Calculate the percentage yield of dichloromethane. (Ans =60.4%)

5. It was found that 500 mL of an unknown gas had a mass of 3.00g at 20'C and 95kPa. Further analysis showed the gas was 86% C and 14% H by mass. Find the molecular formula. (Ans = $C_{11}H_{22}$)

6. A solution of Br_2 in CCl_4 is 0.08 mol/L. If the reaction is a 1 to 1 ratio then what volume of this solution will react with 0.196g of 3-methyl-2-hexene? (Ans = 25 mL)

7. Analysis revealed 40.7% C, 8.5% H, 23.7% N and the remainder oxygen for an organic compound. When vapourized 0.25 g of the compound gave 52.3 mL of gas at 98.6 kPa and 20'C. Find the molar mass of the compound. (Ans = 118.1 g/mol)

8. When a hydrocarbon is burned the carbon dioxide's mass is 1.83 times as much as the water formed. Assuming complete combustion find the molecular formula of the hydrocarbon. (Ans = C_3H_8)

9. When 32.0 mL of benzene is reacted with 79.9g of liquid bromine 30.0g of bromobenzene is formed.
   a) Find theoretical yield of bromobenzene. (Ans = 56.6g)
   b) What is the percentage yield? (Ans = 52.2%)

   Note: the density of liquid benzene is 879 kg/m^3

10. When 0.601 g of an organic compound with the empirical formula CH_2O is vapourized at 200ºC and 101.3 kPa the gas volume is 388 mL. This same volume is occupied by ethane under the same conditions.
    a) What is the molecular formula of the compound? (Ans = $C_2H_4O_2$)
    b) If 1 mol of the same compound reacts slowly with Zn to yield 0.5 mol $H_{2(g)}$ what is the compound's name and structural formula? (ethanoic acid CH_3COOH)

11. A 100 mg sample of a compound containing C, H, and O was found to give 149 mg of CO_2 and 45.5 mg of H_2O when burned completely. Find the empirical formula. (Ans = $C_2H_3O_2$)

12. What mass of ethanol can be made by reacting NaOH (aq) with 50 g of bromoethane? What assumption is made in this calculation? (Ans = 21.12g)

Organic Problems Assignment

1) Write chemical equations for the following:
   a)2,2-dimethyl-1-propanol reacting with butanoic acid
   b)2,2,3-trimethylpentane (the "octane" in gasoline) burning completely in air
   c)hydroiodic acid reacting with 1-butene
   d)show the formation of N-ethyl ethanamide from ethanol and any inorganic reagents (not just one reaction)

2) A sample of liquid consisting of only C, H and O has a mass of 0.5438g. This sample was burned in pure oxygen with the release of 1.039g of CO_2 and 0.6369g of H_2O. What is the empirical formula of the compound?

3) When 1 mole of a hydrocarbon is burned, the carbon dioxide released has a mass equal to 2.09524 times the mass of the water released. Assuming complete combustion, what is the molecular formula for the hydrocarbon?

4) One mole of NaCN reacts with one mole of bromoethane to form 45g of cyanoethane.
   a) What is the theoretical yield of cyanoethane in grams?
   b) What is the percentage yield of cyanoethane?
   c) Given 8.53g of NaCN and 10.98g of bromoethane and taking into account the percentage yield, find the volume of liquid cyanoethane (C_2H_5CN) (d=0.783g/mL)?

5) When 1.202g of an organic compound with empirical formula $C_3H_6O_2$ is vapourized at 673'C and 2 atm pressure, the gas volume is 630.5mL.
   a) What is the molecular formula of the compound?
   b) If one mole of the same compound reacts slowly with Zn to yield 0.5 mol of $H_{2(g)}$, what is the compound's name and structural formula?

   $R=0.08206\ L*atm*K^{-1}*mol^{-1}$

6) Sodium hydroxide reacts with bromoethane to give ethanol. If the percentage yield for this reaction is 72%, what mass of ethanol can be made by reacting $NaOH_{(aq)}$ with 85g of bromoethane? (bromoethane is the limiting reagent)

7) 20 mL of a Br_2 (solute) solution in CCl_4 (solvent) react with 0.23g of 4-methyl-2-heptene. What is the concentration of the Br_2 solution?

8) The motor of an airplane is equipped with a condenser so that all of the steam formed during the complete combustion of fuel can be used on board while the CO_2 is released (into the atmosphere, increasing the CO_2 concentration there, thus increasing the greenhouse effect, inevitably destroying all life on earth). Will the plane gain or lose mass? Calculate the gain or loss per 50kg of 2,2,4-trimethylpentane fuel burned.

9) Analysis of an organic compound revealed %O=36.36, %C=27.27%, %N=31.82 and the rest hydrogen. When vapourized a 0.4g sample of the compound gave 139.13mL at 100'C and 1 atm pressure. Find the molecular formula of the compound.

10) Write equations using structural formula for:
   i) 2-hexyne + 1 mole of $H_{2(g)}$
   ii) benzoic acid + ethanol
   iii) oxidation of butanal
   iv) 2-pentane + HCl