Stoichiometry of Gases

Examples form notes:

Example 1:

Propane (C_3H_8) combusts in the presence of oxygen according to the following chemical equation:

$$C_3H_{8\,(g)} + 5O_{2\,(g)} \rightarrow 3CO_{2\,(g)} + 4H_2O_{\,(g)}$$

a) What volume of oxygen gas (O_2) is needed for the combustion of 35L of propane (gas) if temperature and pressure are kept constant ?

$$C_3H_{8\,(g)} + 5O_{2\,(g)} \rightarrow 3CO_{2\,(g)} + 4H_2O_{\,(g)}$$

1 mole — 5 mole

35L — ***x***

$1x = (35)(5)$

$x = 175\text{L of } O_2$

b) What volume of Carbon dioxide (CO_2) will be produced if 155g of propane react with oxygen at SATP ?

C_3H_8 (g) + $5O_2$ (g) → $3CO_2$ (g) + $4H_2O$ (g)

1 mole — 3 mole

155g

n = m/M

n = 155/44

n = 3.53moles — ***x***

$1x = (3.52)(3)$

$x = 10.56$ moles CO_2

Solve for Volume of Carbon Dioxide

Note: Molar mass of CO_2 is 44g/mole

SATP: T = 298K
P = 101.3 kPa

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{(10.56)(8.31)(298)}{(101.3)}$$

$\underline{V = 258.3\ L}$

b) What volume of Carbon dioxide (CO_2) will be produced if 155g of propane react with oxygen at SATP ?

C_3H_8 (g) + $5O_2$ (g) → $3CO_2$ (g) + $4H_2O$ (g)

1 mole — 3 mole

155g

n = m/M

n = 155/44

n = 3.53moles — ***x***

$1x = (3.52)(3)$

$x = 10.56$ moles CO_2

At SATP: 1mole CO_2 gas = 24.5L

10.56 moles CO_2 gas = ***y***

y = 258.7 L of CO_2

Example 2:

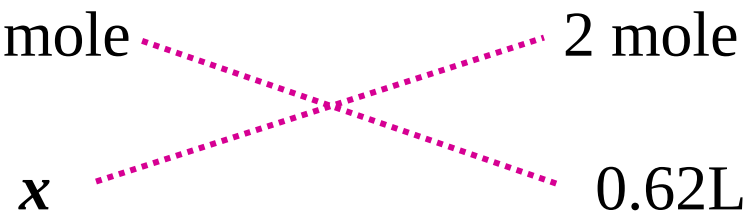
Given the following: $H_{2\,(g)} + O_{2\,(g)} \rightarrow H_2O_{(g)}$

What mass of oxygen (O_2) reacts to produce 0.62 L of water vapour at 100°C and at 101.3kPa?

Note: These are Not STP or SATP conditions

Step 1: Balance $2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{(g)}$

Step 2: Solve for Volume using stochiometry



$2x = (1)(0.62)$

$x = 0.31$ L of O_2

<u>Step 3</u>:Solve for mass of Oxygen

note: Molar mass of O_2 is 32g/mole

T = 100^{o}C → 373K
P = 101.3 kPa

$$PV = \frac{mRT}{M}$$

$$\frac{PVM}{RT} = m$$

$$\frac{(101.3)(0.31)(32)}{(8.31)(373)} = m$$

<u>m = 0.32g</u>

Example 3:

If 60g of ammonia (NH_3) is burned at 30°C and 104kPa, what volume of water vapour (H_2O) will form ?

Given the following: $4NH_3\ (g) + 5O_2\ (g) \rightarrow 4NO\ (g) + 6H_2O\ (g)$

Step 1:Solve for volume of NH_3

note: Molar mass of NH_3 is 17g/mole

T = 30°C → 303K
P = 104 kPa

$$PV = \frac{mRT}{M}$$

$$V = \frac{mRT}{MP}$$

$$V = \frac{(60)(8.31)(303)}{(17)(104)}$$

$$V = 85.45\ L$$

Example 3:

If 60g of ammonia (NH_3) is burned at 30°C and 104kPa, what volume of water vapour (H_2O) will form ?

Given the following: $4NH_3\ (g) + 5O_2\ (g) \rightarrow 4NO\ (g) + 6H_2O\ (g)$

Step 2: Solve for Volume of H_2O using stochiometry

$4NH_3\ (g) + 5O_2\ (g) \rightarrow 4NO\ (g) + 6H_2O\ (g)$

4 mole — 6 mole

85.45L — x

$$4x = (6)(85.45)$$

$$x = 128.2 \text{ L of } H_2O$$