11.3 Gas Stoichiometry

By an extension of Avogadro's Principle, when gases react, coefficients in the balanced equation represent molar amounts AND relative volumes.

Example: $2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)}$

- 2 moles hydrogen gas will react with 1 mole of oxygen gas to produce 2 moles water vapor.
- 2 volumes hydrogen gas will react with 1 volume of oxygen gas to produce 2 volumes water vapor.

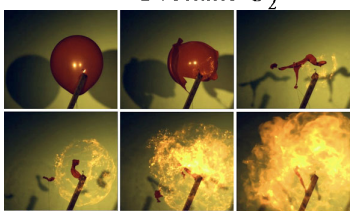
Gas laws can be used to calculate the stoichiometry of reactions where gases are reactants or products.

1. Volume-Volume Example A

How many liters of H_2 gas will react with 5.00 L of O_2 to form water?

$$2\ H_{2(g)} + O_{2(g)} \longrightarrow 2\ H_2O_{(g)}$$

$$5.00\ Liters\ O_2 \bullet \frac{2\ volumes\ H_2}{1\ volume\ O_2} = 10.0\ L\ H_2$$



2. Volume-Volume Example B

How many liters of water will be produced through the combustion of 15.6 L of propane?

$$\_\_\ C_3H_{8(g)} + \underline{5}\ O_{2(g)} \longrightarrow \underline{3}\ CO_{2(g)} + \underline{4}\ H_2O_{(g)}$$

$$15.6\ L\ C_3H_8 \bullet \frac{4\ volumes\ H_2O}{1\ volume\ C_3H_8} = 62.4\ L\ H_2$$

3. Volume-Mass Example(Slide 1)

If 7.00 L of N_2 reacts with H_2 at 298 K (P = 3.00 atm), what mass of ammonia is produced?

$$N_{2(g)} + 3\ H_{2(g)} \longrightarrow 2\ NH_{3(g)}$$

Step 1: Determine liters of gaseous ammonia made from 7.00 L of nitrogen gas.

$$7.00\ L\ N_2 \bullet \frac{2\ volumes\ NH_3}{1\ volumes\ N_2} = 14.0\ L\ NH_3$$

3. Volume-Mass Example(Slide 2)

7.00 L of N_2 produces 14.0 L of ammonia at 298 K and pressure of 3.00 atm.

Step 2: Use Ideal Gas Law to find moles.

Data:

V_{NH3} = 14.0 L

P = 3.00 atm

T = 298K

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{(3.00atm)(14.0L)}{\left(0.0821\frac{L \bullet atm}{K \bullet mol}\right)(298K)}$$

$$= 1.72\ mol\ NH_3$$

3. Volume-Mass Example(Slide 3)

Finally, find ammonia's molar mass, then make a moles to mass conversion.

Molar mass = 17.3 g/mol.

$$1.72 mol\ NH_3 \bullet \frac{17.04g\ NH_3}{1 mol\ NH_3} = \boxed{29.3g\ NH_3}$$

Homework:

11.3 Booklet Problems

Due: Next Class

Unit 11 Review Questions