Gas Stoichiometry: At STP and non-STP

3. 0.500 L of $H_2(g)$ reacts with excess $O_2(g)$ at STP according to the equation: $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$

   What volume of water is produced?

$$0.500\ L\ H_2 \times \frac{2\ L\ H_2O}{2\ L\ H_2} = 0.500\ L\ H_2O$$

L → L (just like mol → mol!)

4. 0.500 L of $H_2(g)$ reacts with excess $O_2(g)$ at 1.00 atm and 350°C according to the same equation.

   a. Would you expect the volume of water to be less than, equal to, or greater than the amount of water produced at STP in question #3? Justify your answer.

Equal to!

$$n_{H_2} = \frac{PV}{RT} = \frac{(1.00\ atm)(0.500\ L)}{(0.08206\ \frac{L \cdot atm}{mol \cdot K})(623\ K)} = 0.0098\ mol\ H_2 \times \frac{2\ mol\ H_2O}{2\ mol\ H_2} = 0.0098\ mol\ H_2O$$

Sam n, T, P ⇒ same V!

   b. Calculate the ~~volume~~ grams of water produced under these conditions.

$$0.0098\ mol\ H_2O \times \frac{18.016\ g}{1\ mol} = \boxed{0.18\ g\ H_2O}$$

Molarity Stoichiometry: Solutions to All Your Problems

***Note:** millimoles (or mmol) can be your BEST friend during solution stoich!

$$\frac{mmol}{mL} = M \quad \} \quad M \times mL = mmol$$

1. 250 mL of 0.70 M Li_3PO_4 and 250 mL of excess $Ca(OH)_2$ are mixed, producing an aqueous LiOH solution (and a calcium phosphate precipitate). What is the molar concentration of LiOH in this solution?

$$2\ Li_3PO_{4(aq)} + 3\ Ca(OH)_{2(aq)} \rightarrow 6\ LiOH_{(aq)} + Ca_3(PO_4)_{2(s)}$$

$$0.70M \times 250\ mL = 175\ mmol\ Li_3PO_4 \times \frac{6\ mol\ LiOH}{2\ mol\ Li_3PO_4} = 525\ mmol\ LiOH$$

$$[LiOH] = \frac{525\ mmol}{500\ mL} = 1.05 = \boxed{1.1\ M\ LiOH}$$

500 mL = 250 + 250

2. Calculate the mass (in grams) of Ag_2S produced when 125 mL of 0.200 M $AgNO_3$ is added to excess Na_2S solution.

$$\underline{1}\ Na_2S(aq) + \underline{2}\ AgNO_3(aq) \rightarrow \underline{1}\ Ag_2S(s) + \underline{2}\ NaNO_3(aq)$$

$$0.200\ M \times 0.125\ L = 0.0250\ mol\ AgNO_3 \times \frac{1\ mol\ Ag_2S}{2\ mol\ AgNO_3} \times \frac{247.8\ g\ Ag_2S}{1\ mol\ Ag_2S} = \boxed{3.10\ g\ Ag_2S}$$

$$2HBr_{(aq)} + Mg(OH)_{2(aq)} \rightarrow 2H_2O_{(l)} + MgBr_{2(aq)}$$

3. 50.0 mL of $Mg(OH)_2$ is used to neutralize 35.0 mL of 0.60 M HBr. What ~~is~~ was the initial molarity of the $Mg(OH)_2$?

$$0.60\ M \times 35.0\ mL = 21\ mmol\ HBr \times \frac{1\ mol\ Mg(OH)_2}{2\ mol\ HBr} = 10.5\ mmol\ Mg(OH)_2$$

$$[Mg(OH)_2] = \frac{10.5\ mmol}{50.0\ mL} = \boxed{0.21\ M\ Mg(OH)_2}$$

Molarity Stoich Shortcut: $M_1V_1 = M_2V_2$

This shortcut is useful iif:

- IF you are starting and ending with molarity, and
- the species compared have a 1:1 mole ratio

4. 125 mL of KOH completely neutralizes 57.0 mL of 1.20 M HBr. Calculate the initial concentration of KOH.

$$HBr_{(aq)} + KOH_{(aq)} \rightarrow H_2O_{(l)} + KBr_{(aq)} \Rightarrow 1:1$$

$$(1.20\ M)(57.0\ mL) = M(125\ mL)$$

$$M = \frac{1.20 \times 57.0}{125} = \boxed{0.547\ M\ KOH}$$