

Gas Stoichiometry: At STP and non-STP

3. 0.500 L of $\text{H}_2(\text{g})$ reacts with excess $\text{O}_2(\text{g})$ at STP according to the equation: $2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g})$
 What volume of water is produced?

$$0.500 \text{ L H}_2 \times \frac{2 \text{ L H}_2\text{O}}{2 \text{ L H}_2} = 0.500 \text{ L H}_2\text{O}$$

$\text{L} \rightarrow \text{L}$ (just like mol \rightarrow mol!)

4. 0.500 L of $\text{H}_2(\text{g})$ reacts with excess $\text{O}_2(\text{g})$ 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!

$$n_{\text{H}_2} = \frac{PV}{RT} = \frac{(1.00 \text{ atm})(0.500 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(623 \text{ K})} = 0.0098 \text{ mol H}_2 \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2} = 0.0098 \text{ mol H}_2\text{O}$$

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

$$0.0098 \text{ mol H}_2\text{O} \times \frac{18.016 \text{ g}}{1 \text{ mol}} = \boxed{0.18 \text{ g H}_2\text{O}}$$

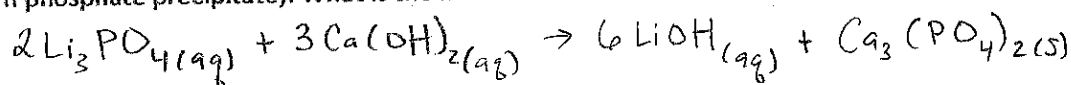
Same n, T, P
 \Rightarrow same V !

Molarity Stoichiometry: Solutions to All Your Problems

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

$$\frac{\text{mmol}}{\text{mL}} = M \quad \left\{ \begin{array}{l} \text{M} \times \text{mL} = \text{mmol} \end{array} \right.$$

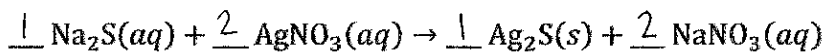
1. 250 mL of 0.70 M Li_3PO_4 and 250 mL of excess $\text{Ca}(\text{OH})_2$ are mixed, producing an aqueous LiOH solution (and a calcium phosphate precipitate). What is the molar concentration of LiOH in this solution?



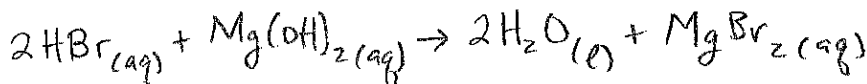
$$0.70 \text{ M} \times 250 \text{ mL} = 175 \text{ mmol Li}_3\text{PO}_4 \times \frac{6 \text{ mol LiOH}}{2 \text{ mol Li}_3\text{PO}_4} = 525 \text{ mmol LiOH}$$

$$[\text{LiOH}] = \frac{525 \text{ mmol}}{250 + 250 \text{ mL}} = 1.05 = \boxed{1.1 \text{ M LiOH}}$$

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



$$0.200 \text{ M} \times 0.125 \text{ L} = 0.0250 \text{ mol AgNO}_3 \times \frac{1 \text{ mol Ag}_2\text{S}}{2 \text{ mol AgNO}_3} \times \frac{247.8 \text{ g Ag}_2\text{S}}{1 \text{ mol Ag}_2\text{S}} = \boxed{3.10 \text{ g Ag}_2\text{S}}$$



3. 50.0 mL of $\text{Mg}(\text{OH})_2$ is used to neutralize 35.0 mL of 0.60 M HBr . What is the molarity of the $\text{Mg}(\text{OH})_2$?
 WAS initial

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

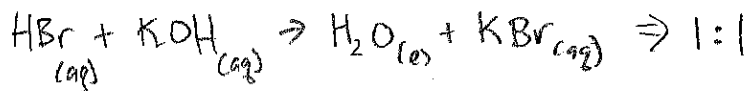
$$[\text{Mg}(\text{OH})_2] = \frac{10.5 \text{ mmol}}{50.0 \text{ mL}} = \boxed{0.21 \text{ M Mg}(\text{OH})_2}$$

Molarity Stoich Shortcut: $M_1V_1 = M_2V_2$

This shortcut is useful if:

- 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 .



$$(1.20 \text{ M})(57.0 \text{ mL}) = M(125 \text{ mL})$$

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