

Solution Stoichiometry

Name _____ Section _____

DCI14.1a. How many grams of magnesium sulfate are required to prepare 500.00 mLs of 0.500 M NaOH?

$$.500 \text{ L} \left(\frac{0.500 \text{ mol NaOH}}{1 \text{ L}} \right) = 0.250 \text{ mol NaOH}$$

$$0.250 \text{ mol NaOH} \left(\frac{40.0 \text{ g NaOH}}{1 \text{ mol NaOH}} \right) = 10.0 \text{ g NaOH}$$

b) Describe how you would prepare this solution?

Weigh 10.00 g NaOH_(s) using a balance. Add some water, about 300 mL to a 500 mL volumetric flask, then add the NaOH_(s) to the flask. and mix the solution until all the NaOH dissolves. Then add enough water so the final volume is 500.00 mL.

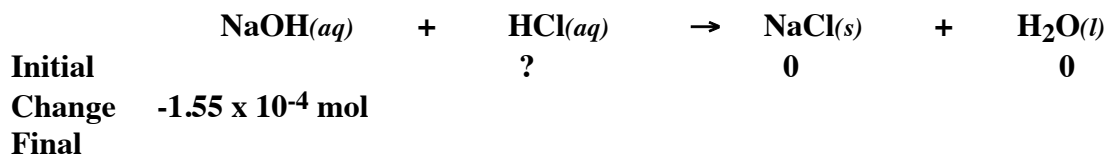
DCI14.2. Calculate the volume of 0.750 M KNO₃ that contains 17.0 g of KNO₃.

$$17.0 \text{ g of KNO}_3 \left(\frac{1 \text{ mol KNO}_3}{101 \text{ g KNO}_3} \right) = 0.168 \text{ mol KNO}_3$$

$$0.168 \text{ mol KNO}_3 \left(\frac{1 \text{ Liter}}{0.750 \text{ mol}} \right) = 0.224 \text{ L}$$

DCI14.3. What is the concentration of HCl in a 250.0 mL sample of hydrochloric acid if 15.5 mL of 0.0100 M NaOH is needed to react with all of the hydrochloric acid.

$$0.0155 \text{ L NaOH} \left(\frac{0.0100 \text{ mol NaOH}}{1 \text{ L}} \right) = 1.55 \times 10^{-4} \text{ mol NaOH reacting}$$



$$1.55 \times 10^{-4} \text{ mol NaOH} \left(\frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} \right) = 1.55 \times 10^{-4} \text{ mol HCl}$$

$$1.55 \times 10^{-4} \text{ mol NaOH} \left(\frac{1 \text{ mol H}_2\text{O}}{1 \text{ mol NaOH}} \right) = 1.55 \times 10^{-4} \text{ mol H}_2\text{O}$$

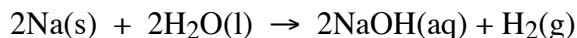
$$1.55 \times 10^{-4} \text{ mol NaOH} \left(\frac{1 \text{ mol NaCl}}{1 \text{ mol NaOH}} \right) = 1.55 \times 10^{-4} \text{ mol NaCl}$$



Initial	$1.55 \times 10^{-4} \text{ mol}$	$1.55 \times 10^{-4} \text{ mol}$	0	0
Change	$-1.55 \times 10^{-4} \text{ mol}$	$-1.55 \times 10^{-4} \text{ mol}$	$+1.55 \times 10^{-4} \text{ mol}$	$+1.55 \times 10^{-4} \text{ mol}$
Final				

$$\frac{1.55 \times 10^{-4} \text{ mol HCl}}{0.250 \text{ L}} = 6.20 \times 10^{-4} \text{ M HCl}$$

DCI14.4. Given the reaction



- a) If a piece of sodium weighing 1.25 grams is added to 450 mL of water, calculate the grams of H_2 produced.

$$1.25 \text{ g Na} \left(\frac{1 \text{ mol Na}}{23.0 \text{ g Na}} \right) = 0.0543 \text{ mol Na}$$

$$450 \text{ mL H}_2\text{O} \left(\frac{1.00 \text{ g H}_2\text{O}}{1 \text{ mL H}_2\text{O}} \right) \left(\frac{1 \text{ mol H}_2\text{O}}{18 \text{ g H}_2\text{O}} \right) = 25.0 \text{ mol H}_2\text{O}$$

	2Na(s)	+	$2\text{H}_2\text{O(l)}$	\rightarrow	2NaOH(aq)	+	$\text{H}_2\text{(g)}$
Initial	0.0543 mol		25.0 mol		0		0
Change							
Final							

Clearly Sodium is the limiting reagent when there are 25.0 mole of H_2O present initially.

	2Na(s)	+	$2\text{H}_2\text{O(l)}$	\rightarrow	2NaOH(aq)	+	$\text{H}_2\text{(g)}$
Initial	0.0543 mol		25.0 mol		0		0
Change	-0.0543 mol		-0.0543 mol		+0.0543 mol		+0.0272 mol
Final							

$$0.0543 \text{ mol Na} \left(\frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol Na}} \right) = 0.0543 \text{ mol H}_2\text{O reacting}$$

$$0.0543 \text{ mol Na} \left(\frac{2 \text{ mol NaOH}}{2 \text{ mol Na}} \right) = 0.0543 \text{ mol NaOH forming}$$

$$0.0543 \text{ mol Na} \left(\frac{1 \text{ mol H}_2}{2 \text{ mol Na}} \right) = 0.0272 \text{ mol H}_2 \text{ forming}$$

	2Na(s)	+	$2\text{H}_2\text{O(l)}$	\rightarrow	2NaOH(aq)	+	$\text{H}_2\text{(g)}$
Initial	0.0543 mol		25.0 mol		0		0
Change	-0.0543 mol		-0.0543 mol		+0.0543 mol		+0.0272 mol
Final	0 mol		25.0 mol		+0.0543 mol		+0.0272 mol

$$0.0543 \text{ mol Na} \left(\frac{1 \text{ mol H}_2}{2 \text{ mol Na}} \right) \left(\frac{2.02 \text{ g}}{1 \text{ mol H}_2} \right) = 0.0548 \text{ g H}_2$$

- b) Calculate the concentration of NaOH in the solution after the reaction is complete, assume a negligible volume change.

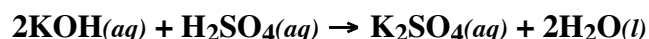
$$0.0543 \text{ mol Na} \left(\frac{2 \text{ mol NaOH}}{2 \text{ mol Na}} \right) = 0.0543 \text{ mol NaOH}$$

$$\frac{0.0543 \text{ mol NaOH}}{0.450 \text{ L H}_2\text{O}} = 0.121 \text{ M NaOH}$$

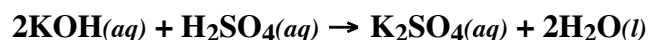
NOTE: The amount of water that reacts is negligible compared to the amount of water present, so the volume of solution is the same as the volume of water initially present. Since the amount of sodium added is very small compared to the amount of water we will assume the volume of the solution is the same as the volume of water. We can only do this when the amount of solute is very, very much smaller than the volume of water.

- DCI14.4. What volume of 0.406 M KOH is required to completely react with 18.50 mL of 0.287 M H₂SO₄

Important reaction is



We can use an ICE table to solve this problem:

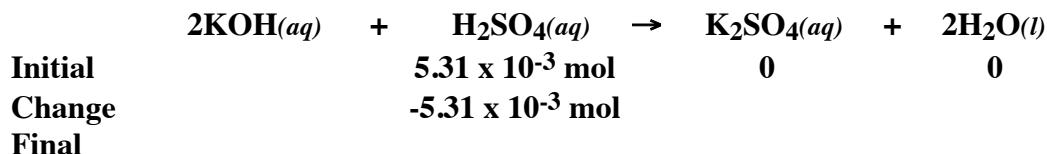


Initial
Change
Final

The initial amount of H₂SO₄ can be determined,

$$0.01850 \text{ L H}_2\text{SO}_4 \left(\frac{0.287 \text{ mol H}_2\text{SO}_4}{1 \text{ L}} \right) = 5.31 \times 10^{-3} \text{ mol H}_2\text{SO}_4$$

add this amount of H₂SO₄ to the ICE table



Determine the amount of KOH that will react,

$$5.31 \times 10^{-3} \text{ mol H}_2\text{SO}_4 \left(\frac{2 \text{ mol KOH}}{1 \text{ mol H}_2\text{SO}_4} \right) = 1.06 \times 10^{-2} \text{ mol KOH}$$

and add to the ICE table and complete the ICE table,



Initial	$1.06 \times 10^{-2} \text{ mol}$	$5.31 \times 10^{-3} \text{ mol}$	0	0
Change	$-1.06 \times 10^{-2} \text{ mol}$	$-5.31 \times 10^{-3} \text{ mol}$	$+5.31 \times 10^{-3} \text{ mol}$	$+1.06 \times 10^{-2} \text{ mol}$
Final	0	0	0	0

$$1.06 \times 10^{-2} \text{ mol KOH} \left(\frac{1 \text{ L}}{0.406 \text{ mol KOH}} \right) = 2.62 \times 10^{-2} \text{ L or } 26.2 \text{ mL}$$