Strong Acid/Strong Base Reactions

1. What is a strong acid?

   Strong acids are substances that completely dissociate in solution.

2. List the 7 strong acids.

   a. HCl
   b. HBr
   c. HI
   d. HNO_3
   e. H_2SO_4
   f. $HClO_4$
   g. $HClO_3$

3. How do you identify a strong base?

   Strong bases are substances that bear a negative charge. Some exampes include; ^-OH, $^-NH_2$, $^-CH_3$, etc.

4. What is the net reaction in an acid base reaction?

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

5. A sol'n is prepared by dissolving 10.0 g of NaOH in 140.0 mL of 0.170 M HNO_3.

   a. Will the final sol'n be basic, acidic or neutral?

$$NaOH_{(aq)} + HNO_{3\,(aq)} \rightarrow NaNO_{3\,(aq)} + H_2O_{(l)}$$

   It is also very helpful to remember the net ionic reaction between a strong acid and strong base – as it highlights the 1:1 mole ratio between H^+ and ^-OH.

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

This is helpful because it shows that there is always a 1:1 mole ratio between H^+ and OH^-. So you can always directly compare the moles of H^+ and OH^- to establish which is the limiting reagent.

$$10.0 g\ NaOH \; \frac{1\ mol\ NaOH}{40.0\ g\ NaOH} \; \frac{1\ mol\ OH^-}{1\ mol\ NaOH} = 0.250\ mol\ OH^-$$

$$0.1400\ L\ of\ sol'n \; \frac{0.170\ mol\ HNO_3}{L\ of\ sol'n} \; \frac{1\ mol\ H^+}{1\ mol\ HNO_3} = 0.238\ mol\ H^+$$

mols of OH^- > mols of H^+ therefore the sol'n would be basic.

The primary point in these types of problems to be wary of it when the acid or base being used contained more than one mole of H^+ or OH^-. For example in H_3PO_4 there is a 3:1 mole ratio between H^+ and H_3PO_4, respectively. So you would have to remember that if you are reacting say, 2 M H_3PO_4… that really equates to using 6 M H^+.

b. Calculate the ion concentration after the reaction has gone to completion.

You will need to determine the identity of each ion in solution.

[limiting ion] = [H^+]

[spectator ions] = [NO_3^-] [Na^+]

[excess reacting ion] = [OH^-]

There is a slight variation in how to solve for the concentrations due to the way that the question was set up.

The main issue with this question is that the spectator ions were not diluted. This is because a solid was added to a liquid sol'n rather than 2 liquid solutions being added and changing the total volume. This being the case the method of solving would be as follows.

$[H^+] = \boxed{0}$

$$[Na^+] = \frac{0.250 \text{ mols } Na^+}{0.140 \text{ L of sol'n}} = \boxed{1.79 \text{ M } Na^+}$$

$[NO_3^-] = \boxed{0.170 \text{ M } NO_3^-}$

$$[OH^-] = \frac{(0.250 \text{ mols } OH^- \text{ initially} - {*}0.0238 \text{ mols } OH^- \text{ used})}{0.140 \text{ L}} = \boxed{1.62 \text{ M } OH^-}$$

*Remember because it is a 1:1 mol ratio between H^+ and OH^- the mols OH^- is equivalent to the mols H^+ used.

6. What volume of 0.0473 M $Ba(OH)_2$ is required to neutralize exactly 16.18 mL of 0.141M H_3PO_4?

First we write out the reaction between the acid and the base.

$$2H_3PO_4 + 3Ba(OH)_2 \rightarrow 6H_2O + Ba_3(PO_4)_2$$

It would also be helpful to keep the net ionic reaction in mind

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

The key word in this question is neutralize. Because we are dealing with a 1:1 reaction ration neutralize means we want to add exactly the same amount of ^-OH as H^+ contained in the solution.

So our first step will be to determine the number of moles acid we have in solution.

$$0.01618 \text{ L of sol'n } \frac{0.141 \text{ mol } H_3PO_4}{\text{L of sol'n}} \frac{3 \text{ mol } H^+}{1 \text{ mol } H_3PO_4} = 0.006844 \text{ mol } H^+$$

Now that we know the amount of H^+ in the solution, we know how much ^-OH we need. So we have to determine the amount of $Ba(OH)_2$

required to provide 0.006844 mol of ^{-}OH.

$$\frac{0.006844 \text{ mol } H^+}{} \; \frac{1 \text{ mol } OH^-}{1 \text{ mol } H^+} \; \frac{1 \text{ mol } Ba(OH)_2}{2 \text{ mol } OH^-} \; \frac{L \text{ of sol'n}}{0.0473 \text{ mol } Ba(OH)_2} \; \frac{1000 \text{ mL}}{L}$$

$$= \boxed{72.3 \text{ mL } Ba(OH)_2}$$

It would have been possible to solve this problem using the overall balanced equation.

$$2H_3PO_4 + 3Ba(OH)_2 \rightarrow 6H_2O + Ba_3(PO_4)_2$$

It can be a bit faster – I don't always prefer that method because it skips over important details about neutralization and moles ratios. It is best to have a few methods for solving – the specificity of the question asked may require you to solve it using one particular method.

Using the overall equation to solve we would get:

$$\frac{16.18 \text{ mL}}{} \; \frac{1 \text{ L}}{1000 \text{ mL}} \; \frac{0.141 \text{ moles } H_3PO_4}{L \text{ of sol'n}} \; \frac{3 \text{ mol } Ba(OH)_2}{2 \text{ mol } H_3PO_4} \; \frac{L \text{ of sol'n}}{0.0473 \text{ mol } Ba(OH)_2} \; \frac{1000 \text{ mL}}{1L} = 72.3 \text{ mL}$$