Titration

CΛeMis+ry: http://genest.weebly.com

Stop in for help every day at lunch and Tues, Weds., &Thurs after school!

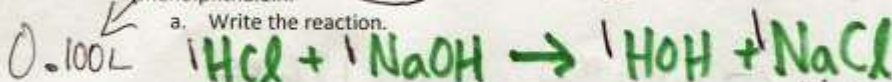After-hours question? Email me at home: eagenest@madison.k12.wi.us

Name ___

Period ___

ANS

Titration problems:

$\to 0.50 \dfrac{\text{moles HCl}}{\text{L HCl}}$ $\to 0.10 \dfrac{\text{mol NaOH}}{\text{Liter NaOH}}$

1. A 100.0 mL sample of 0.50 M HCl is titrated with 0.10 M NaOH. The indicator used was phenolphthalein.

   a. Write the reaction.

 $0.100 L$ $1 HCl + 1 NaOH \to 1 HOH + 1 NaCl$

   b. Write what color phenolphthalein would be in the beginning colorless At the end pink

   c. What volume of the NaOH solution is required to reach the endpoint of the titration?

$$0.100 \text{ L HCl} \times \frac{0.5 \text{ mol HCl}}{1 \text{ L HCl}} \times \frac{1 \frac{\text{mol}}{\text{NaOH}}}{1 \frac{\text{mol}}{\text{HCl}}} \times \frac{1 \text{ L NaOH}}{0.1 \frac{\text{mol}}{\text{NaOH}}} = 0.5 \text{ liters of NaOH}$$

2. If 26.5 mL of a 0.20 M solution of NaOH is required to titrate 50.0 mL of sulfuric acid (H_2SO_4)), what is the concentration of the sulfuric acid solution? The indicator used was bromothymol blue.

   a. Write the reaction.

   $2 NaOH + 1 H_2SO_4 \to 2 HOH + 1 Na_2SO_4$
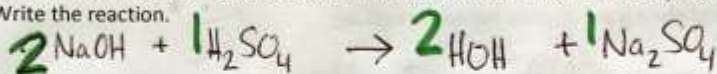
   ← these green numbers will be useful in (c)

   b. Write what color bromothymol blue would be in the beginning _____ At the end _____

   c. ~~What volume of the NaOH solution is required to reach the endpoint of the titration?~~
   What is the concentration of H_2SO_4?

$$\frac{0.0265 \text{ L NaOH}}{0.050 \text{ L } H_2SO_4} \times \frac{0.20 \text{ mol NaOH}}{1 \text{ L NaOH}} \times \frac{1 \frac{\text{mol}}{H_2SO_4}}{2 \frac{\text{mol}}{NaOH}} \times \frac{}{} = 0.053 \frac{\text{mol}}{\text{L}} \; H_2SO_4$$

3. If 26.5 mL of a 0.20 M solution of NaOH is required to titrate 50.0 mL of phosphoric acid (H_3PO_4), what is the concentration of the phosphoric acid solution?

   $3 NaOH + H_3PO_4 \to 3 HOH + Na_3PO_4$
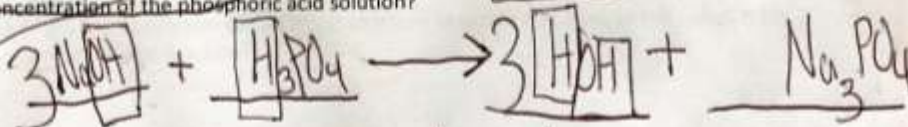
$$\frac{0.0265 \text{ L NaOH}}{0.0500 \text{ L } H_3PO_4} \times \frac{0.20 \text{ mol NaOH}}{1 \text{ L NaOH}} \times \frac{1 \frac{\text{mol}}{H_3PO_4}}{3 \frac{\text{mol}}{NaOH}} \times = 0.035 \frac{\text{mol}}{\text{L}} \; H_3PO_4$$

Review:

4. Calculate the hydrogen ion concentration and the hydroxide ion concentration for the following pH values.

	[H⁺]	[OH⁻]

$[H^+]$ $[OH^-]$

a. pH = 1.04 $\quad 0.091 \frac{mol}{L} \quad\quad 1.099 \times 10^{-13} \frac{mol}{L}$

b. pH = 13.1 $\quad 7.94 \times 10^{-14} \frac{mol}{L} \quad\quad 0.126 \frac{mol}{L}$

5. What volume of 0.200 M hydrochloric acid solution is needed to neutralize 25.0 mL of 0.150 M sodium hydroxide solution?

$$0.025\ L\ NaOH \times \left(\frac{.150\ mol\ NaOH}{1\ L\ NaOH}\right) \times \left(\frac{1\ mol\ HCl}{1\ mol\ NaOH}\right) \times \left(\frac{1\ L\ HCl}{.200\ mol\ HCl}\right) = 0.019\ L\ HCl$$

15. Write a balanced chemical equation for each reaction

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

$$H_3PO_4 + 3\,NaOH \rightarrow 3\,HOH + Na_3PO_4$$
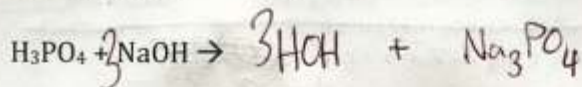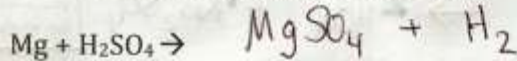
22. What would be the **pH** of each of the following:

a) 0.0010 M HCl $\quad pH = 3$

b) 0.0010 M HNO₃ $\quad pH = 3$

c) 0.010 M NaOH $\quad pH = 12 \leftarrow$ because $\dfrac{1.0 \times 10^{-14}}{0.01} = 1 \times 10^{-12}$

d) pure water $\quad pH = 7$

f) 0.000000000001M HCl $\quad pH = 12$

12

Metal with Acid

Remembering that <u>Acid</u> + <u>Metal</u> → <u>hydrogen gas</u> + <u>salt</u>, fill in the missing substances for each reaction below

6. $HBr + Na \rightarrow \underline{H_2} + \underline{NaBr}$

7. $HNO_3 + Mg \rightarrow \underline{H_2} + \underline{Mg(NO_3)_2}$

8. $2H_3PO_4 + 3Ca \rightarrow \underline{3H_2} + \underline{Ca_3(PO_4)_2}$
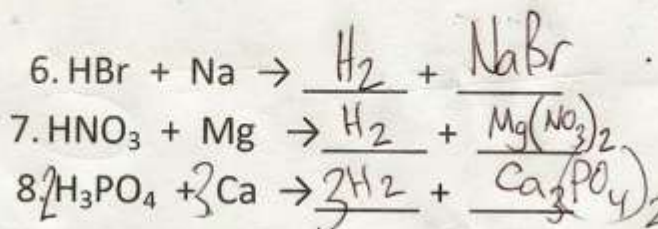
9. We have three equations which we have been using in this chapter. :

Write the equation you have memorized that describes what number you get when you multiply the molarity of H+ by the molarity of OH-	Write the equation you have memorized that describes how H+ molarity is related to pH	Write the equation that you have been using since March to relate moles of solute, volume of solution, and molarity of a solution.
$[OH^-][H^+] = 1 \times 10^{-14}$	$pH = -\log[H^+]$	$Concentration = \dfrac{moles}{Volume}$

volume units must be LITERS

$0.788L$

10. If a solution contains 4.115 moles of HNO_3 dissolved to make 788 mL of solution, what is the molarity?

$Concentration = \dfrac{moles}{Volume}$

$Concentration = \dfrac{4.115\,moles}{0.788L}$

$Concentration = 5.22\,M$

11. If 335 mL of a 0.20 M solution of $Ca(OH)_2$ is required to titrate 450.0 mL of HBr, what is the concentration of the acid solution?

$$\dfrac{.335\,L\ Ca(OH)_2}{.450\,L\ HBr} \times \dfrac{0.20\,mol\ Ca(OH)_2}{1\,L\ Ca(OH)_2} \times \dfrac{2\,\frac{mol}{HBr}}{1\,\frac{mol}{Ca(OH)_2}} = 0.30\,\frac{mol}{L}$$

12. If 3.59 mL of a 0.040 M solution of $Ca(OH)_2$ is required to titrate 840.0 mL of HBr, what is the concentration of the acid solution?

$$\dfrac{0.00359\,L\ Ca(OH)_2}{0.8400\,L\ HBr} \times \dfrac{0.040\,mol\ Ca(OH)_2}{1\,L\ Ca(OH)_2} \times \dfrac{2\,\frac{mol}{HBr}}{1\,\frac{mol}{Ca(OH)_2}} = 3.4 \times 10^{-4}$$