Name: _____
Hour: ____ Date: _____

Chemistry: *pH and pOH calculations*

Part 1: *Fill in the missing information in the table below.*

pH	[H_3O^{1+}]	pOH	[OH^{1-}]	ACID or BASE?
3.78				
	3.89×10^{-4} M			
		5.19		
			4.88×10^{-6} M	
8.46				
	8.45×10^{-13} M			
		2.14		
			2.31×10^{-11} M	
10.91				
	7.49×10^{-6} M			
		9.94		
			2.57×10^{-8} M	
4.16				
	1.06×10^{-1} M			
		3.82		
			8.53×10^{-7} M	
7.05				
	4.73×10^{-10} M			
		1.33		
			9.87×10^{-3} M	
11.68				
	9.22×10^{-8} M			
		12.24		
			5.39×10^{-12} M	

Part 2: *For each of the problems below, assume 100% dissociation.*

1. A. Write the equation for the dissociation of hydrochloric acid.

   B. Find the pH of a 0.00476 M hydrochloric acid solution.

2. A. Write the equation for the dissociation of sulfuric acid.

   B. Find the pH of a solution that contains 3.25 g of H_2SO_4 dissolved in 2.75 liters of solution.

3. A. Write the equation for the dissociation of sodium hydroxide.

   B. Find the pH of a 0.000841 M solution of sodium hydroxide.

4. A. Write the equation for the dissociation of aluminum hydroxide.

   B. If the pH is 9.85, what is the concentration of the aluminum hydroxide solution?

5. A. Write the equation for the dissociation of calcium hydroxide.

   B. If the pH is 11.64 and you have 2.55 L of solution, how many grams of calcium hydroxide are in the solution?

KEY

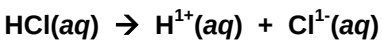
Chemistry: *pH and pOH calculations*

Part 1: *Fill in the missing information in the table below.*

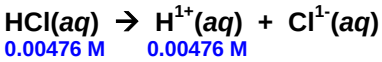
pH	[H_3O^{1+}]	pOH	[OH^{1-}]	ACID or BASE?
3.78	1.66×10^{-4} M	10.22	6.03×10^{-11} M	Acid
3.41	3.89×10^{-4} M	10.59	2.57×10^{-11} M	Acid
8.81	1.55×10^{-9} M	5.19	6.46×10^{-6} M	Base
8.69	2.04×10^{-9} M	5.31	4.88×10^{-6} M	Base
8.46	3.47×10^{-9} M	5.54	2.88×10^{-6} M	Base
12.1	8.45×10^{-13} M	1.90	1.26×10^{-2} M	Base
11.86	1.38×10^{-12} M	2.14	7.24×10^{-3} M	Base
3.40	3.98×10^{-4} M	10.6	2.31×10^{-11} M	Acid
10.91	1.23×10^{-11} M	3.09	8.13×10^{-4} M	Base
5.13	7.49×10^{-6} M	8.87	1.35×10^{-9} M	Acid
4.06	8.71×10^{-5} M	9.94	1.15×10^{-10} M	Acid
6.41	3.89×10^{-7} M	7.59	2.57×10^{-8} M	Acid
4.16	6.92×10^{-5} M	9.84	1.45×10^{-10} M	Acid
0.98	1.06×10^{-1} M	13.0	1.00×10^{-13} M	Acid
10.18	6.61×10^{-11} M	3.82	1.51×10^{-4} M	Base
7.93	1.17×10^{-8} M	6.07	8.53×10^{-7} M	Base
7.05	8.91×10^{-8} M	6.95	1.12×10^{-7} M	~Base
9.33	4.73×10^{-10} M	4.67	2.14×10^{-5} M	Base
12.67	2.14×10^{-13} M	1.33	4.68×10^{-2} M	Base
12.0	1.0×10^{-12} M	2.01	9.87×10^{-3} M	Base
11.68	2.09×10^{-12} M	2.32	4.79×10^{-3} M	Base
7.04	9.22×10^{-8} M	6.96	1.10×10^{-7} M	~Base
1.76	1.74×10^{-2} M	12.24	5.75×10^{-13} M	Acid
2.70	2.00×10^{-3} M	11.3	5.39×10^{-12} M	Acid

Part 2: *For each of the problems below, assume 100% dissociation.*

1. A. Write the equation for the dissociation of hydrochloric acid.

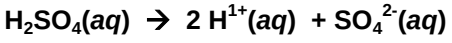


B. Find the pH of a 0.00476 M hydrochloric acid solution.



$$pH = -\log[H^+]$$
$$pH = -\log[0.00476\ M]$$
$$pH = 2.32$$

2. A. Write the equation for the dissociation of sulfuric acid.



B. Find the pH of a solution that contains 3.25 g of H_2SO_4 dissolved in 2.75 liters of solution.

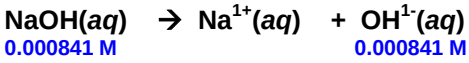
$$\text{Step 1: } x\,\text{mol}\,H_2SO_4 = 3.25\,\text{g}\,H_2SO_4\left(\frac{1\,\text{mol}\,H_2SO_4}{98\,\text{g}\,H_2SO_4}\right) = 0.033\,\text{mol}\,H_2SO_4$$

$$\text{Step 2: } M = \frac{\text{mol}}{\text{L}} \Rightarrow M = \frac{0.033\,\text{mol}\,H_2SO_4}{2.75\,\text{L}} \Rightarrow M = 0.0121\,\text{M}\,H_2SO_4$$

$$\text{Step 3: } H_2SO_4(aq) \rightarrow 2H^+ + SO_4^{2-}(aq)$$
$$0.0121\,\text{M} \quad \therefore 0.0242\text{M}$$

$$\text{Step 4: } pH = -\log[H^+] \Rightarrow pH = -\log[0.0242\ M] \Rightarrow pH = 1.62$$

3. A. Write the equation for the dissociation of sodium hydroxide.



B. Find the pH of a 0.000841 M solution of sodium hydroxide.

$$pOH = -\log[OH^-]$$
$$pOH = -\log[0.000841\ M]$$
$$pOH = 3.08$$

$$pH + pOH = 14$$
$$pH + 3.08 = 14$$
$$pH = 10.92$$

or

$$K_w = [H^+][OH^-]$$
$$1\times10^{-14} = [H^+][0.000841\ M]$$
$$[H^+] = [1.19\times10^{-11}\ M]$$

$$pH = -\log[H^+]$$
$$pH = -\log[1.19\times10^{-11}\ M]$$
$$pH = 10.92$$

***Part 2*: continued**

4. A. Write the equation for the dissociation of aluminum hydroxide.

$$\underset{2.36\times10^{-5}\ M}{Al(OH)_3(aq)} \rightarrow \underset{}{Al^{3+}(aq)} + \underset{7.08\times10^{-5}\ M}{3\ OH^{1-}(aq)}$$

B. If the pH is 9.85, what is the concentration of the aluminum hydroxide solution?

$$pH + pOH = 14$$
$$9.85 + pOH = 14$$
$$pOH = 4.15$$

$$pOH = -\log[OH^-]$$
$$4.15 = -\log[OH^-]$$
$$\boxed{2^{nd}}\ \boxed{\log}\ -4.15 = [OH^-]$$
$$[OH^-] = 7.08\times10^{-5}\ M$$

$$\frac{7.08\times10^{-5}\ M}{3} = 2.36\times10^{-5}\ M$$

5. A. Write the equation for the dissociation of calcium hydroxide.

$$\underset{2.18\times10^{-3}\ M}{Ca(OH)_2(aq)} \rightarrow \underset{}{Ca^{2+}(aq)} + \underset{4.37\times10^{-5}\ M}{2\ OH^{1-}(aq)}$$

B. If the pH is 11.64 and you have 2.55 L of solution, how many grams of calcium hydroxide are in the solution?

$$pH + pOH = 14$$
$$11.64 + pOH = 14$$
$$pOH = 2.36$$

$$pOH = -\log[OH^-]$$
$$2.36 = -\log[OH^-]$$
$$\boxed{2^{nd}}\ \boxed{\log}\ -2.36 = [OH^-]$$
$$[OH^-] = 4.37\times10^{-3}\ M$$

$$2\overline{)4.37\times10^{-3}\ M} \quad \frac{2.18\times10^{-3}\ M}{}$$

$$M = \frac{mol}{L} \Rightarrow 2.18\times10^{-3}\ M \Rightarrow \frac{x\ mol\ Ca(OH)_2}{L} \Rightarrow x = 5.57\times10^{-3}\ mol\ Ca(OH)_2$$

$$x\ g\ Ca(OH)_2 = 5.57\times10^{-3}\ M\left(\frac{74\ g\ Ca(OH)_2}{1\ mol\ Ca(OH)_2}\right) = 0.412\ g\ Ca(OH)_2$$

pH and pOH

1a. $HCl(aq) \rightarrow H^{1+}(aq) + Cl^{1-}(aq)$

b. $HCl(aq) \rightarrow H^{1+}(aq) + Cl^{1-}(aq)$
0.00476 M 0.00476 M

$pH = -\log[H^+]$
$pH = -\log[0.00476\ M]$
$pH = 2.32$

Step 1: $x\,mol\,H_2SO_4 = 325\,g\,H_2SO_4\left(\frac{1\,mol\,H_2SO_4}{98\,g\,H_2SO_4}\right) = 0.03\,mol\,H_2SO_4$

Step 2: $M = \frac{mol}{L} \Rightarrow M = \frac{0.03\,mol\,H_2SO_4}{2.75\,L} \Rightarrow M = 0.01\,M\,H_2SO_4$

2a. Step 3: $H_2SO_4(aq) \rightarrow 2H^+ + SO_4^{2-}(aq)$
$0.01\,M \quad \therefore 0.02\,M$

Step 4: $pH = -\log[H^+] \Rightarrow pH = -\log[0.02\,M] \Rightarrow pH = 1.70$

3. $NaOH(aq) \rightarrow Na^{1+}(aq) + OH^{1-}(aq)$
0.000841 M 0.000841 M

$pOH = -\log[OH^-]$
$pOH = -\log[0.000841\ M]$
$pOH = 3.08$

$pH + pOH = 14$
$pH + 3.08 = 14$
$pH = 10.92$

or

$K_w = [H^+][OH^-]$
$1\times10^{-14} = [H^+][0.000841\ M]$
$[H^+] = [1.19\times10^{-11}\ M]$

$pH = -\log[H^+]$
$pH = -\log[1.19\times10^{-11}\ M]$
$pH = 10.92$

4. $Al(OH)_3(aq) \rightarrow Al^{3+}(aq) + 3\,OH^{1-}(aq)$
2.36x10^{-5} M 7.08x10^{-5} M

$pH + pOH = 14$
$9.85 + pOH = 14$
$pOH = 4.15$

$pOH = -\log[OH^-]$
$4.15 = -\log[OH^-]$
$2^{nd}\ \log\ -4.15 = [OH^-]$
$[OH^-] = 7.08\times10^{-5}\ M$

$\frac{7.08\times10^{-5}\ M}{3} = 2.36\times10^{-5}\ M$

5. $Ca(OH)_2(aq) \rightarrow Ca^{2+}(aq) + 2\,OH^{1-}(aq)$
2.18x10^{-3} M 4.37x10^{-5} M

$pH + pOH = 14$
$11.64 + pOH = 14$
$pOH = 2.36$

$pOH = -\log[OH^-]$
$2.36 = -\log[OH^-]$
$2^{nd}\ \log\ -2.36 = [OH^-]$
$[OH^-] = 4.37\times10^{-3}\ M$

$2\overline{)4.37\times10^{-3}\ M}\ \ 2.18\times10^{-3}\ M$

$M = \frac{mol}{L} \Rightarrow 2.18\times10^{-3}\ M \Rightarrow \frac{x\,mol\,Ca(OH)_2}{L} \Rightarrow x = 5.57\times10^{-3}\,mol\,Ca(OH)_2$

$x\,g\,Ca(OH)_2 = 5.57\times10^{-3}\,M\left(\frac{74\,g\,Ca(OH)_2}{1\,mol\,Ca(OH)_2}\right) = 0.412\,g\,Ca(OH)_2$