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pH Calculations

Use the formulae to complete the table.



Normal: _____

$[H^+] = 10^{-pH}$ $pH = -\log[H^+]$ $[OH^-] = 10^{-pOH}$ $pOH = -\log[OH^-]$

	$[H^+]$	pH	$[OH^-]$	pOH	Acid or Base
1.	1×10^{-10}	10	1×10^{-4}	4	✓
2.	2.5×10^{-9}	8.6	4×10^{-6}	5.4	✓
3.	1×10^{-1}	1	1×10^{-13}	13	✓
4.	2×10^{-2}	3.7	2×10^{-12}	10.3	✓
5.	2×10^{-7}	6.7	5×10^{-8}	7.3	✓
6.	6.3×10^{-14}	13.2	1.6×10^{-1}	0.8	✓
7.	3.2×10^{-3}	2.5	3.2×10^{-12}	11.5	✓
8.	1×10^{-9}	9	1×10^{-5}	5	✓
9.	1.6×10^{-1}	0.8	6.3×10^{-14}	13.2	✓
10.	5×10^{-5}	4.3	2×10^{-10}	9.7	✓
11.	1.3×10^{-12}	12.9	7.9×10^{-3}	1.1	✓
12.	4×10^{-8}	7.4	2.5×10^{-7}	6.6	✓



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Worksheet 1 - Acid and Base pH Calculations and Stoichiometry
 For each weak acid solution in (1) - (11) calculate pH. Remember that you need to calculate K_a first.
 1. 0.20 M CN^- ($K_{a1} = 3.5 \times 10^{-4}$, $K_{a2} = 3.5 \times 10^{-5}$, $K_{a3} = 3.5 \times 10^{-6}$)
 After writing up (1) check your pH for 10^{-12} - 10^{-14} where the X is negligible and ignored or it passes the test of $(X - 500) < 4.20 \times 10^{-4}$ which is bigger than 500 so X is ignored in (0.200 - X).
 1.6×10^{-4} is K_b ($1.6 \times 10^{-4} = 10^{-14} / 6.25 \times 10^{-10}$)
 $1.6 \times 10^{-4} = X / 0.20$
 $3.2 \times 10^{-5} = X$
 3.2×10^{-5} is concentration of Base OH
 $pOH = 4.5$ and $pH = 9.5$ (0.05)
 2. 0.010 M NaBr (the base has $K_{a1} = 10^{-7}$, $K_{a2} = 10^{-8}$, $K_{a3} = 10^{-9}$)
 out of 10^{-7} - 1000 or 0.001 $1.6 \times 10^{-7} > 10000$ and is bigger than 500, X is ignored in (0.200 - X).
 1.6×10^{-7} is K_b ($1.6 \times 10^{-7} = 10^{-14} / 6.25 \times 10^{-8}$)
 $1.6 \times 10^{-7} = X / 0.010$
 $1.6 \times 10^{-9} = X$
 1.6×10^{-9} is concentration of Base OH
 $pOH = 8.2$ and $pH = 5.8$ (0.05)
 3. 0.010 M CH_3COO^- (CH_3COOH $K_a = 1.8 \times 10^{-5}$)
 out of 10^{-5} - 1000 or 0.001 $1.8 \times 10^{-5} > 10000$ and is bigger than 500, X is ignored in (0.200 - X).
 1.8×10^{-5} is K_b ($1.8 \times 10^{-5} = 10^{-14} / 5.56 \times 10^{-10}$)
 $1.8 \times 10^{-5} = X / 0.010$
 $1.8 \times 10^{-7} = X$
 1.8×10^{-7} is concentration of Base OH
 $pOH = 6.7$ and $pH = 7.3$ (0.05)
 4. 0.010 M NO_2^- (NO_2 $K_a = 10^{-4}$)
 out of 10^{-4} - 1000 or 0.001 $1.0 \times 10^{-4} > 1000$ and is bigger than 500, X is ignored in (0.200 - X).
 1.0×10^{-4} is K_b ($1.0 \times 10^{-4} = 10^{-14} / 1.0 \times 10^{-10}$)
 $1.0 \times 10^{-4} = X / 0.010$
 $1.0 \times 10^{-6} = X$
 1.0×10^{-6} is concentration of Base OH
 $pOH = 6.0$ and $pH = 8.0$ (0.05)
 5. 0.010 M NO_2^- (NO_2 $K_a = 10^{-4}$)
 out of 10^{-4} - 1000 or 0.001 $1.0 \times 10^{-4} > 1000$ and is bigger than 500, X is ignored in (0.200 - X).
 1.0×10^{-4} is K_b ($1.0 \times 10^{-4} = 10^{-14} / 1.0 \times 10^{-10}$)
 $1.0 \times 10^{-4} = X / 0.010$
 $1.0 \times 10^{-6} = X$
 1.0×10^{-6} is concentration of Base OH
 $pOH = 6.0$ and $pH = 8.0$ (0.05)
 6. If the pH of a 0.10 M weak acid HX is 3.05, calculate the K_a for the acid and identify the acid using your acid chart (the first 10 - 20 acids in the only qualitative chart).
 $pH = 3.05$ gives $[H^+] = 2.24 \times 10^{-4}$ $K_a = X^2 / (0.10 - 2.24 \times 10^{-4})$ which is X
 $4.1 \times 10^{-8} = X^2 / (0.10 - 2.24 \times 10^{-4})$
 $K_a = 4.1 \times 10^{-8}$ probably Carbonic acid as its K_a is 4.4×10^{-8}
 7. The pH of 0.10 M NaX is 12.46. Calculate the K_a for HX.
 $pH = 12.46$ so $pOH = 1.54$ hence $[OH^-] = 0.030$ which is X
 $K_b = X^2 / (0.10 - 0.030)$
 $0.030 = X^2 / (0.10 - 0.030)$
 $0.030 = X^2 / 0.07$ probably Carbonic acid as its K_b is 4.4×10^{-8}
 $K_a = (1.0 \times 10^{-14}) / (4.4 \times 10^{-8})$
 $K_a = 2.27 \times 10^{-7}$
 8. Consider the following reaction: $2Cl_2 + Be(OH)_2 \rightarrow BeCl_2 + 2H_2O$
 When 3.16g sample of $Be(OH)_2$ was stirred in the equivalence point with an HCl solution, the following data was recorded. Calculate the molar mass of $BeCl_2$.
 Total Volume of HCl added: 25.00 ml
 Volume of HCl used: 15.00 ml
 Molarity of HCl: 0.100 M
 Answer to 8: Total moles of 3.16g of $Be(OH)_2$ is $(3.16 / 44.01) = 0.0718$ moles and X is 2.1 which is moles of acid = 0.0359 moles and Cl- ions before volume is average of last 2 trials of HCl. $V = 30.00$ ml $C = 0.1000$ mol/L $n = 1$ (HCl is 1 mole of H+)

Acids and Bases Worksheet 1

1. Finish the following reactions when acids are added to water.
 a. $H_2SO_4 + H_2O \rightarrow$
 b. $HCl + OH^- \rightarrow$
 c. $NH_3 + H_2O \rightarrow$
 d. $HCl + NH_3 \rightarrow$

2. What are the conjugate bases of these acids?

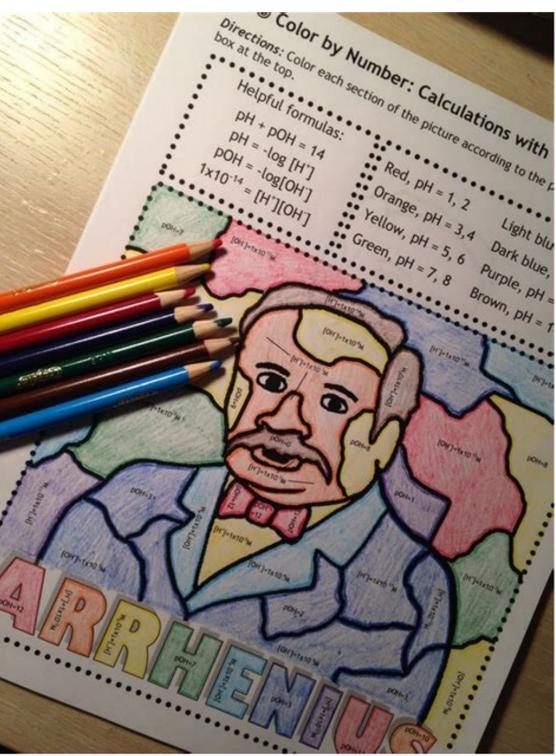
original acid	conjugate base
HNO_3	
H_2O	
HCO_3^-	
HBr	
HCO_2^-	

3. What are the conjugate acids of these bases?

original base	conjugate acid
OH^-	
H_2O	
HCO_3^-	
SO_3^{2-}	
ClO_2^-	

4. Which of the following represent conjugate acid-base pairs?
 a. HCl, H_2O
 b. OH^-, HNO_3
 c. H_2SO_4, SO_4^{2-}
 d. $HC_2H_3O_2, C_2H_3O_2^-$

5. Calculate the $[H^+]$ in a solution in which $[OH^-] = 2.0 \times 10^{-4} M$. Is this solution acidic, neutral, or basic?
6. Calculate the $[OH^-]$ in a solution in which $[H^+] = 3.99 \times 10^{-4} M$. Is this solution acidic, neutral, or basic?



Name _____ Date _____ Class _____

TEACHING TRANSPARENCY WORKSHEET **54**

The pH Scale

Use with Chapter 18, Section 18.3

1. What is the pH of a solution with a $[H^+]$ of 10^{-8} ? _____
2. What is the pOH of a solution with a $[OH^-]$ of 10^{-11} ? _____
3. What is the pH of a solution that has a $[OH^-]$ of 10^{-2} ? _____
4. What is the pOH of a solution that has a $[H^+]$ of 10^{-3} ? _____
5. What do you notice about the product of $[H^+]$ and $[OH^-]$ for any aqueous solution?

6. What do you notice about the sum of pH and pOH for any aqueous solution?

7. Which is more acidic, a solution with a pH of 6 or one with a pH of 9?

8. Which is more basic, a solution with a pOH of 7 or one with a pOH of 12?

9. Which is more acidic, a solution with a pH of 5 or one with a pOH of 10?

10. Which is more basic, a solution with a pH of 8 or one with a pOH of 12?

11. Stomach contents can have a pH of 3. Are stomach contents acidic, basic, or neutral?

12. Pure water has a pOH of 7. Is pure water acidic, basic, or neutral?

13. Normal rain has a pH of approximately 6. Is normal rain strongly acidic, slightly acidic, neutral, slightly basic, or strongly basic?

14. Acid precipitation is often a problem in industrialized areas. What might you expect the pH of acid rain to be?

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