



- 310-1  
3
- 15) Which of the following statements *best* describes a solution with a pH of 3?  
 1) It has an  $\text{H}_3\text{O}^+$  ion concentration of  $1 \times 10^{-3}$  mol/L and is basic.  
 2) It has an  $\text{H}_3\text{O}^+$  ion concentration of  $1 \times 10^3$  mol/L and is acidic.  
 3) It has an  $\text{H}_3\text{O}^+$  ion concentration of  $1 \times 10^{-3}$  mol/L and is acidic.  
 4) It has an  $\text{H}_3\text{O}^+$  ion concentration of  $1 \times 10^3$  mol/L and is basic.
- 2  
16) What is the pH of an aqueous solution if the hydroxide ion concentration is  $1 \times 10^{-7}$  mole per liter?  
 1) 14  
 2) 7  
 3) 10  
 4) 1
- 2  
17) What is the pH of a solution that has a hydronium ion concentration of  $1 \times 10^{-8}$  mole per liter?  
 1) 1  
 2) 8  
 3) 7  
 4) 4
- 3  
18) What is the  $[\text{H}_3\text{O}^+]$  of a 0.001 M NaOH solution?  
 1)  $1 \times 10^{-14}$   
 2)  $1 \times 10^{-7}$   
 3)  $1 \times 10^{-11}$   
 4)  $1 \times 10^{-1}$
- 3  
19) The  $[\text{H}^+]$  of a solution is  $1 \times 10^{-2}$  at 298 K. What is the  $[\text{OH}^-]$  of this solution?  
 1)  $1 \times 10^{-2}$   
 2)  $1 \times 10^{-14}$   
 3)  $1 \times 10^{-12}$   
 4)  $1 \times 10^{-7}$
- 1  
20) What is the hydroxide ion concentration of a solution that has a hydronium ion concentration of  $1 \times 10^{-9}$  mole per liter at 298 K?  
 1)  $1 \times 10^{-5}$  mole per liter  
 2)  $1 \times 10^{-7}$  mole per liter  
 3)  $1 \times 10^{-9}$  mole per liter  
 4)  $1 \times 10^{-14}$  mole per liter
- 2  
21) The  $[\text{OH}^-]$  of a solution is  $1 \times 10^{-6}$ . At 298 K and 1 atmosphere, the product  $[\text{H}_3\text{O}^+][\text{OH}^-]$  is  
 1)  $1 \times 10^{-8}$   
 2)  $1 \times 10^{-14}$   
 3)  $1 \times 10^{-6}$   
 4)  $1 \times 10^{-2}$
- 2  
22) What is the hydroxide ion concentration of a solution with a pH of 4?  
 1)  $1 \times 10^{-4}$   
 2)  $1 \times 10^{-10}$   
 3)  $1 \times 10^{-7}$   
 4)  $1 \times 10^{-14}$
- 2  
23) If HCl and  $\text{H}_2\text{O}$  react together in an acid-base reaction to form their Bronsted-Lowry conjugates, the products would be  
 1) HCl and  $\text{H}_3\text{O}^+$   
 2)  $\text{Cl}^-$  and  $\text{H}_3\text{O}^+$   
 3)  $\text{Cl}^-$  and  $\text{OH}^-$   
 4)  $\text{Cl}_2$  and  $\text{H}_2$
- 4  
24) In the reaction  $\text{HCl} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{Cl}^-$ , a conjugate acid-base pair is  
 1) HCl and  $\text{H}_2\text{O}$   
 2) HCl and  $\text{H}_3\text{O}^+$   
 3)  $\text{H}_2\text{O}$  and  $\text{Cl}^-$   
 4) HCl and  $\text{Cl}^-$
- 2  
25) In the reaction  $\text{H}_2\text{O} + \text{CO}_3^{2-} \rightleftharpoons \text{OH}^- + \text{HCO}_3^-$ , the two Bronsted-Lowry acids are  
 1)  $\text{CO}_3^{2-}$  and  $\text{OH}^-$   
 2)  $\text{H}_2\text{O}$  and  $\text{HCO}_3^-$   
 3)  $\text{H}_2\text{O}$  and  $\text{OH}^-$   
 4)  $\text{CO}_3^{2-}$  and  $\text{HCO}_3^-$
- 26) Which Bronsted acid has the *strongest* conjugate base?  
 1) HF  
 2) HCl  
 3) HI  
 4) HBr  
*omit*
- 2  
27) What is the conjugate ~~base~~ <sup>ACID</sup> of  $\text{NH}_3$ ?  
 1)  $\text{NO}_2^-$   
 2)  $\text{NH}_4^+$   
 3)  $\text{NH}_2^-$   
 4)  $\text{NO}_3^-$
- 4  
28) The conjugate acid of the  $\text{F}^-$  ion is  
 1)  $\text{F}_2$   
 2)  $\text{H}^+$   
 3)  $\text{H}_2\text{F}^+$   
 4) HF
- 4  
29) What is the conjugate acid of the  $\text{HCO}_3^-$  ion?  
 1)  $\text{CO}_3^{2-}$   
 2)  $\text{H}^+$   
 3)  $\text{H}_3\text{CO}_3^+$   
 4)  $\text{H}_2\text{CO}_3$

pH Review

Name \_\_\_\_\_ Per. \_\_\_\_\_ Date \_\_\_\_\_

Determine the  $[H^+]$  for each of the following and state whether each is acidic, basic or neutral.

1.  $[OH^-] = 1.0 \times 10^{-3} M$   $[H^+] = 1.0 \times 10^{-11}$  Base  
 2.  $[OH^-] = 1.0 \times 10^{-9} M$   $[H^+] = 1.0 \times 10^{-5}$  Acid  
 3.  $pH = 7$   $[H^+] = 1.0 \times 10^{-7}$  Neutral  
 4.  $pOH = 2$   $pH = 12$   $[H^+] = 1.0 \times 10^{-2}$  Base

Determine the pH for each of the following and state whether each is acidic, base or neutral.

5.  $[H^+] = 1.0 \times 10^{-1} M$   $pH = 1$  Acid  
 6.  $pOH = 3$   $pH = 11$  Base  
 7.  $[OH^-] = 1.0 \times 10^{-3} M$   $pH = 11$  Base  
 8.  $[OH^-] = 1.0 \times 10^{-8} M$   $pH = 6$  Acid

Predict the pH of the following solutions.

9. 0.01 M  $HNO_3$   $1.0 \times 10^{-2}$   $pH = 2$   
 10. 0.1 M NaOH  $1.0 \times 10^{-1}$   $pH = 13$   
 11. 0.001 M KOH  $1.0 \times 10^{-3}$   $pH = 11$   
 12. 0.0001 M HCl  $1.0 \times 10^{-4}$   $pH = 4$

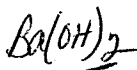
13. What volume of 0.2 M sulfuric acid will neutralize 200 mL of 0.5 M potassium (KOH) hydroxide solution?  $H_2SO_4$

$$\begin{aligned} V_a &= x \\ M_a &= .4 M \\ V_b &= 200 mL \\ M_b &= 0.5 M \end{aligned}$$

$$(0.4)(x) = (0.5)(200)$$

$$x = 250 mL$$

14. What is the molarity of 50.0 mL of nitric acid is it is neutralized by 30.0 mL of 2.0 M barium hydroxide solution?



$$\begin{aligned} M_a &= x \\ V_a &= 50.0 mL \\ M_b &= 4.0 M \\ V_b &= 30.0 mL \end{aligned}$$

$$(x)(50.0) = (4.0)(30.0)$$

$$x = 2.4 M$$

Titration

Name \_\_\_\_\_ Per. \_\_\_\_\_ Date \_\_\_\_\_

4

1) Which of the following is a net ionic equation for a neutralization reaction?

- 1)  $\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$       3)  $\text{H}^+ + \text{HCO}_3^- \rightarrow \text{H}_2\text{CO}_3$   
 2)  $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_4\text{OH}$       4)  $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$

3

2) What products are formed when an acid reacts with a base?

- 1) an alcohol and carbon dioxide      3) a salt and water  
 2) a soap and glycerine      4) an ester and water

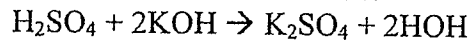
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3) What salt is formed when hydrochloric acid is neutralized by a potassium hydroxide solution?

- 1) potassium perchlorate      3) potassium chlorite  
 2) potassium chloride      4) potassium chlorate

1

4) Given the neutralization reaction:



Which compound is a salt?

- 1)  $\text{K}_2\text{SO}_4$       2)  $\text{H}_2\text{SO}_4$       3)  $\text{KOH}$       4)  $\text{HOH}$

3

5) When  $\text{HCl}_{(aq)}$  is exactly neutralized by  $\text{NaOH}_{(aq)}$ , the hydrogen ion concentration of the resulting mixture is

- 1) sometimes greater and sometimes less than the concentration of the hydroxide ions  
 2) always greater than the concentration of the hydroxide ions  
 3) always equal to the concentration of the hydroxide ions  
 4) always less than the concentration of the hydroxide ions

4

6) A water solution contains 0.50 mole of  $\text{HCl}$ . How much  $\text{KOH}$  should be added to the  $\text{HCl}$  solution to exactly neutralize it?

- 1) 1.0 mole      2) 2.0 mole      3) 0.25 mole      4) 0.50 mole

3

7) If 50. mL of a 1.0 M  $\text{NaOH}$  solution is needed to exactly neutralize 10. mL of an  $\text{HCl}$  solution, the molarity of the  $\text{HCl}$  solution is

- 1) 5.0 M      2) 10. M      3) 0.20 M      4) 1.0 M

1

8) In a titration, the endpoint of a neutralization reaction was reached when 37.6 mL of an  $\text{HCl}$  solution was added to 17.3 mL of a 0.250 M  $\text{NaOH}$  solution. What was the molarity of the  $\text{HCl}$  solution?

- 1) 0.115 M      2) 0.250 M      3) .203 M      4) 0.543 M       $(\times)(37.6) = (17.3)(.250)$

2

9) What is the molarity of a  $\text{KOH}$  solution if it requires 20. mL of 2.0 M  $\text{HCl}$  to exactly neutralize 20. mL of the  $\text{KOH}$  solution?

- 1) 1.0 M      2) 2.0 M      3) 10. M      4) 20. M

1

10) A 3.0 mL sample of  $\text{HNO}_3$  solution is exactly neutralized by 6.0 mL of 0.50 M  $\text{KOH}$ . What is the molarity of the  $\text{HNO}_3$  sample?

- 1) 1.0 M      2) 0.50 M      3) 3.0 M      4) 1.5 M

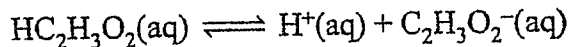
# ACID/BASE REFERENCE TABLE PRACTICE

## Set 1 — Common Acids

1. Of the following, which is an acid?
- (1) NaOH(aq)  
 (2) NH<sub>3</sub>(aq)  
 (3) HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>(aq)  
 (4) Ca(OH)<sub>2</sub>(aq)      1 3
2. According to the Arrhenius theory, an acid is a substance that
- (1) changes litmus from red to blue  
 (2) changes phenolphthalein from colorless to pink  
 (3) produces hydronium ions as the only positive ions in an aqueous solution  
 (4) produces hydroxide ions as the only negative ions in an aqueous solution      2 3
3. Which two formulas represent Arrhenius acids? (H<sup>+</sup>)
- (1) CH<sub>3</sub>COOH and CH<sub>3</sub>CH<sub>2</sub>OH  
 (2) HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> and H<sub>3</sub>PO<sub>4</sub>  
 (3) KHCO<sub>3</sub> and KHSO<sub>4</sub>  
 (4) NaSCN and Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>      3 2
4. What is the possible pH of a 0.001 M ~~NHO~~<sub>3</sub>? <sup>HNO</sup><sub>3</sub>
- (1) ~~3~~ <sup>2</sup>      (3) 8  
 (2) 7      (4) 15      4 1
5. As HCl(g) is added to water, the pH of the water solution
- (1) decreases  
 (2) increases  
 (3) remains the same      5 1
6. What is the pH of a solution that results from the complete neutralization of an HCl solution with a KOH solution?
- (1) 1      (3) 10  
 (2) 7      (4) 4      6 2
7. Given the following solutions:
- Solution A: pH of 10  
 Solution B: pH of 7  
 Solution C: pH of 5
- Which list has the solutions placed in order of increasing H<sup>+</sup> concentration?
- (1) A, B, C      (3) C, A, B  
 (2) B, A, C      (4) C, B, A      7 1
8. According to one acid-base theory, a water molecule acts as an acid when the water molecule
- (1) accepts an H<sup>+</sup>  
 (2) accepts an OH<sup>-</sup>  
 (3) donates an H<sup>+</sup>  
 (4) donates an OH<sup>-</sup>      8 3

Base your answer to question 9 using the information below and your knowledge of chemistry.

A beaker contains 100.0 milliliters of a dilute aqueous solution of an acid at equilibrium.  
The equation below represents this system



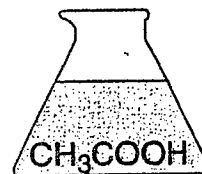
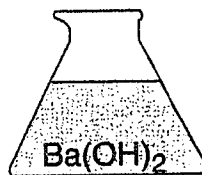
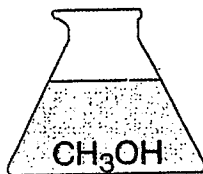
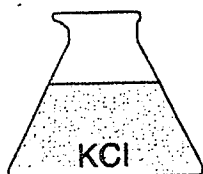
9. a) Name this acid. acetic acid
- b) Describe what happens to the concentration of  $\text{H}^+(\text{aq})$  and to the pH when 10 drops of concentrated  $\text{HC}_2\text{H}_3\text{O}_2(\text{aq})$  are added to this system.

$[\text{H}^+]$  increases

pH decreases

Base your answers to question 10 using the diagrams below and your knowledge of chemistry.

10. Four flasks each contain 100 milliliters of aqueous solutions of equal concentrations at  $25^\circ\text{C}$  and 1 atm.



- a) Which solution is an acidic electrolyte?  $\text{CH}_3\text{COOH}$
- b) Which solution has the lowest pH?  $\text{CH}_3\text{COOH}$
- c) What causes aqueous solutions to have a low pH? high  $[\text{H}^+]$
- d) Give the formulas of the two beakers that would cause a neutralization reaction.  
 $\text{Ba}(\text{OH})_2 + \text{CH}_3\text{COOH}$
- e) What ~~reactants~~ <sup>products</sup> are produced in a neutralization reaction?  
salt and  $\text{H}_2\text{O}$

Set 1 — Common Bases

1. Which pH indicates a basic solution?

- (1) 1                      (3) 7  
(2) 5                      (4) 12

1 4

2. An Arrhenius base yields which ion as the only negative ion in an aqueous solution?

- (1) hydride ion  
(2) hydrogen ion  
(3) hydronium ion  
(4) hydroxide ion

2 4

3. Which of these 1 M solutions will have the highest pH? *base*

- (1) NaOH                  (3) HCl  
(2) CH<sub>3</sub>OH                (4) NaCl

3 1

4. Which substance is an Arrhenius base?

- (1) KCl                      (3) KOH  
(2) CH<sub>3</sub>Cl                  (4) CH<sub>3</sub>OH

4 3

5. Which compound could serve as a reactant in a neutralization reaction?

- (1) NaCl                    (3) CH<sub>3</sub>OH  
(2) Ca(OH)<sub>2</sub>                (4) CH<sub>3</sub>CHO

5 2

6. Which reactants form the salt CaSO<sub>4</sub>(s) in a neutralization reaction?

- (1) H<sub>2</sub>S(g) and Ca(ClO<sub>4</sub>)<sub>2</sub>(s)  
(2) H<sub>2</sub>SO<sub>3</sub>(aq) and Ca(NO<sub>3</sub>)<sub>2</sub>(aq)  
(3) H<sub>2</sub>SO<sub>4</sub>(aq) and Ca(OH)<sub>2</sub>(aq)  
(4) SO<sub>2</sub>(g) and CaO(s)

6 3

7. Which pair of formulas represents two compounds that are electrolytes?

- (1) HCl and CH<sub>3</sub>OH  
(2) HCl and NaOH  
(3) C<sub>5</sub>H<sub>12</sub> and CH<sub>3</sub>OH  
(4) C<sub>5</sub>H<sub>12</sub> and NaOH

7 2

Base your answers to question 8 using the information below and your knowledge of chemistry.

Calcium hydroxide is commonly known as agricultural lime and is used to adjust the soil pH. Before the lime was added to a field, the soil pH was 5. After the lime was added, the soil underwent a 100-fold decrease in hydronium ion concentration.

8. a) What ion caused the decrease of hydronium ion?

OH<sup>-</sup>

b) Give the formula for the base used in this passage.

Ca(OH)<sub>2</sub>

**Set 1 — Common Acid - Base Indicators**

1. In which 0.01 M solution is phenolphthalein pink?

- (1)  $\text{CH}_3\text{OH}(\text{aq})$
- (2)  $\text{Ca}(\text{OH})_2(\text{aq})$
- (3)  $\text{CH}_3\text{COOH}(\text{aq})$
- (4)  $\text{HNO}_3(\text{aq})$

1 2

2. In which solution will thymol blue indicator appear blue?

- (1) 0.1 M  $\text{CH}_3\text{COOH}$
- (2) 0.1 M KOH
- (3) 0.1 M HCl
- (4) 0.1 M  $\text{H}_2\text{SO}_4$

2 2

3. Which statement describes the characteristics of an Arrhenius base?

- (1) It changes blue litmus to red and has a pH less than 7.
- (2) It changes blue litmus to red and has a pH greater than 7.
- (3) It changes red litmus to blue and has a pH less than 7.
- (4) It changes red litmus to blue and has a pH greater than 7.

3 4

4. Which indicator, when added to a solution, changes color from yellow to blue as the pH of the solution is changed from 5.5 to 8.0?

- (1) bromcresol green
- (2) bromthymol blue
- (3) litmus
- (4) methyl orange

4 2

5. A student was given four unknown solutions. Each solution was checked for conductivity and tested with phenolphthalein. The results are shown in the data table below.

Solution	Conductivity	Color with Phenolphthalein
A	Good	Colorless
B	Poor	Colorless
C	Good	Pink
D	Poor	Pink

Based on the data table, which unknown solution could be 0.1 M NaOH?

- (1) A
- (2) B
- (3) C
- (4) D

5 3

6. A student tested a 0.1 M aqueous solution and made the following observations:

- conducts electricity
- turns blue litmus to red *Acid*
- reacts with Zn(s) to produce gas bubbles

Which compound could be the solute in this solution?

- (1)  $\text{CH}_3\text{OH}$
- (2) LiBr
- (3) HBr
- (4) LiOH

6 3

7. As the pH of a solution is changed from 3 to 6, the concentration of hydronium ions

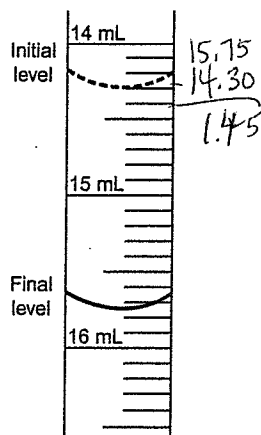
- (1) increases by a factor of 3
- (2) increases by a factor of 1000
- (3) decreases by a factor of 3
- (4) decreases by a factor of 1000

7 4



## Set 1 — Titration

1. The diagram represents a section of a buret containing acid used in an acid-base titration. What is the total volume of acid that was used?



- (1) 1.10 mL  
 (2) 1.30 mL  
 (3) 1.40 mL  
 (4) 1.45 mL

1 4

2. If 5.0 milliliters of a 0.20 M HCl solution is required to neutralize exactly 10. milliliters of NaOH, what is the concentration of the base?

- (1) 0.10 M      (3) 0.30 M  
 (2) 0.20 M      (4) 0.40 M

2 1

3. What volume of 0.500 M HNO<sub>3</sub>(aq) must completely react to neutralize 100.0 milliliters of 0.100 M KOH(aq)?

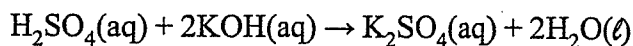
- (1) 10.0 mL      (3) 50.0 mL  
 (2) 20.0 mL      (4) 500. mL

3 2

4. Information related to a titration experiment is given in the balanced equation and table below.

Titration Experiment Results

volume of H <sub>2</sub> SO <sub>4</sub> (aq) used	12.0 mL
concentration of H <sub>2</sub> SO <sub>4</sub> (aq)	?
volume of KOH(aq) used	36.0 mL
concentration of KOH(aq)	0.16 M



Based on the equation and the titration results, what is the concentration of the H<sub>2</sub>SO<sub>4</sub>(aq)?

- (1) 0.12 M      (3) 0.24 M  
 (2) 0.16 M      (4) 0.96 M

4 3

$$(x)(12.0) = (0.16)(36.0) \quad 48 = [H^+]$$

5. Samples of acid rain are brought to a laboratory for analysis. Several titrations are performed and it is determined that a 20.0-milliliter sample of acid rain is neutralized with 6.50 milliliters of 0.010 M NaOH. What is the molarity of the H<sup>+</sup> ions in the acid rain?

$$V_a = 20.0 \text{ mL} \quad M_a = x$$

$$V_b = 6.50 \text{ mL} \quad M_b = 0.010 \text{ M}$$

$$(x)(20.0 \text{ mL}) = (0.010 \text{ M})(6.50 \text{ mL})$$

$$[H^+] = 0.0033 \text{ M}$$

Base your answers to question 6 using the information below and your knowledge of chemistry.

A student titrates 60.0 mL of HNO<sub>3</sub>(aq) with 0.30 M NaOH(aq). Phenolphthalein is used as the indicator. After adding 42.2 mL of NaOH(aq), a color change remains for 25 seconds, and the student stops the titration.

6. a) What color change does phenolphthalein undergo during this titration?

colorless - pink

- b) Show a correct numerical setup for calculating the molarity of the HNO<sub>3</sub>(aq).

$$x(60.0) = (0.30)(42.2)$$



7. A student recorded the following buret readings during a titration of a base with an acid:

	Standard <u>0.100 M HCl</u>	Unknown <u>KOH</u>
Initial reading	9.08 mL	0.55 mL
Final reading	19.09 mL	5.56 mL

a) Calculate the molarity of the KOH. Show all work.

$V_a = 10.01$        $V_b = 5.01$

$$M_a V_a = M_b V_b$$

$$(0.100)(10.01) = (x)(5.01)$$

$$x = 0.200M$$

b) Record your answer to the correct number of significant figures. \_\_\_\_\_

Base your answers to question 8 using the information below and your knowledge of chemistry.

In a titration, 3.00 M NaOH(aq) was added to an Erlenmeyer flask containing 25.00 milliliters of HCl(aq) and three drops of phenolphthalein until one drop of the NaOH(aq) turned the solution a light-pink color. The following data were collected by a student performing this titration:

Initial NaOH(aq) buret reading: 14.45 milliliters

Final NaOH(aq) buret reading: 32.66 milliliters

8. a) What is the total volume of NaOH(aq) that was used in this titration? \_\_\_\_\_

18.21 mL

b) Show a correct numerical setup for calculating the molarity of the HCl(aq).

$$(x)(25.00 \text{ mL}) = (3.00M)(18.21 \text{ mL})$$

c) Based on the data given, what is the correct number of significant figures that should be shown in the molarity of the HCl(aq)? \_\_\_\_\_

3

