

Unit 9 Acids, Bases, & Salts

At the end of this unit, you'll be able to...

Unit Objectives:

- ✓ Compare and contrast properties of acids, bases, and salts
- ✓ Compare the Arrhenius and Bronsted-Lowry theories of acids and bases
- ✓ Explain and give examples of neutralization reactions
- ✓ Using the titration equation, determine the molarity of an unknown solution
- ✓ Understand how pH works
- ✓ Using Table M, determine the pH of a given solution

| Term | Definition |
|-----------------------|--|
| Amphoteric | A substance that can ACT LIKE AN ACID OR A BASE |
| Arrhenius acid | a substance whose water (aqueous) solution contains or yields HYDRONIUM IONS (H⁺ IONS) as the ONLY POSITIVE ION in solution |
| Arrhenius base | a substance whose water (aqueous) solution contains or yields/produces OH⁻ (HYDROXIDE IONS) as the ONLY NEGATIVE ION when dissolved in water. |
| Bronsted-Lowry acid | Proton Donor |
| Bronsted-Lowry base | Proton Acceptor |
| Electrolyte | substances that conduct electric current when dissolved in water |
| hydronium ion | H ₃ O ⁺ ION |
| hydroxide ion | OH ⁻ ION |
| indicator (acid/base) | substance that CHANGES COLOR as a result of a pH CHANGE |
| neutralization | when an Arrhenius acid and an Arrhenius base react to form WATER and a SALT |
| pH scale | designed to measure HOW ACIDIC or HOW BASIC an aqueous solution is |
| titration | used to CALCULATE THE CONCENTRATION (MOLARITY) OF AN UNKNOWN SOLUTION |

Acid/Base/Salt Characteristics:

On the line on the left, write **A** if the statement is a property of an **acidic** solution. Write **B** if it is a property of a **basic** solution. Write **X** if it is a property of **both** acidic and basic solutions.

- _____ 1) Often feels smooth and slippery
- _____ 2) Has a sour taste
- _____ 3) Stings in open wounds
- _____ 4) Typically reacts vigorously with metals
- _____ 5) Has a bitter taste
- _____ 6) Turns litmus paper from blue to red
- _____ 7) Is an electrolyte
- _____ 8) Often looks like pure water
- _____ 9) Turns litmus paper from red to blue
- _____ 10) Typically does not react with metals

11. Compare acids and bases in terms of H^+ and OH^- concentration.

12. Explain what it means to be an electrolyte and why acids, bases and salts are electrolytes.

Acids, Bases, and Salts

- Which laboratory test result can be used to determine if $\text{KCl}(s)$ is an electrolyte?
 - electrical conductivity of $\text{KCl}(aq)$
 - pH of $\text{KCl}(s)$
 - pH of $\text{KCl}(aq)$
 - electrical conductivity of $\text{KCl}(s)$
- Which substance is an electrolyte?
 - CCl_4
 - HCl
 - H_2O
 - C_2H_6
- Which sample of $\text{HCl}(aq)$ contains the greatest number of moles of solute particles?
 - 1.0 L of 2.0 M $\text{HCl}(aq)$
 - 2.0 L of 2.0 M $\text{HCl}(aq)$
 - 3.0 L of 0.50 M $\text{HCl}(aq)$
 - 4.0 L of 0.50 M $\text{HCl}(aq)$
- A substance is classified as an electrolyte because
 - its aqueous solution conducts an electric current
 - it contains covalent bonds
 - it has a high melting point
 - its aqueous solution has a pH value of 7
- Water containing dissolved electrolyte conducts electricity because the solution contains mobile
 - ions
 - atoms
 - electrons
 - molecules
- Which sample of HCl most readily conducts electricity?
 - $\text{HCl}(s)$
 - $\text{HCl}(g)$
 - $\text{HCl}(aq)$
 - $\text{HCl}(\ell)$
- A hydrogen ion, H^+ , in aqueous solution may also be written as
 - H_2O
 - H_2O_2
 - OH^-
 - H_3O^+
- Which statement correctly describes a solution with a pH of 9?
 - It has a higher concentration of H_3O^+ than OH^- and causes methyl orange to turn yellow.
 - It has a higher concentration of H_3O^+ than OH^- and causes litmus to turn blue.
 - It has a higher concentration of OH^- than H_3O^+ and causes litmus to turn blue.
 - It has a higher concentration of OH^- than H_3O^+ and causes methyl orange to turn red.
- Which pH indicates a basic solution?
 - 12
 - 1
 - 7
 - 5
- Which of these pH numbers indicates the highest level of acidity?
 - 12
 - 5
 - 8
 - 10
- 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^+ concentration?
 - C, A, B
 - B, A, C
 - C, B, A
 - A, B, C
- As an aqueous solution becomes more acidic, the hydroxide ion concentration
 - decreases
 - increases
 - remains the same
- Which of the following pH values indicates the highest concentration of hydronium ions in a solution?
 - pH = 1
 - pH = 2
 - pH = 3
 - pH = 4
- As $\text{HCl}(g)$ is added to water, the pH of the water solution
 - decreases
 - increases
 - remains the same

15. Which relationship is present in a solution that has a pH of 7?
- A) $[H^+] + [OH^-] = 7$ B) $[H^+] > [OH^-]$
 C) $[H^+] < [OH^-]$ D) $[H^+] = [OH^-]$
16. Which could be the pH of a solution whose H_3O^+ ion concentration is less than the OH^- ion concentration?
- A) 9 B) 2 C) 3 D) 4
17. What is the pH of an aqueous solution of $C_6H_{12}O_6$?
- A) 1 B) 7 C) 11 D) 14
18. Which solution reacts with $LiOH(aq)$ to produce a salt and water?
- A) $CaO(aq)$ B) $KCl(aq)$
 C) $H_2SO_4(aq)$ D) $NaOH(aq)$
19. Which word equation represents a neutralization reaction?
- A) salt + water \rightarrow acid + base
 B) salt + acid \rightarrow base + water
 C) base + acid \rightarrow salt + water
 D) base + salt \rightarrow water + acid
20. Which equation represents a neutralization reaction?
- A) $HNO_3(aq) + KOH(aq) \rightarrow KNO_3(aq) + H_2O(\ell)$
 B) $4Fe(s) + 3O_2(g) \rightarrow Fe_2O_3(s)$
 C) $2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$
 D) $AgNO_3(aq) + KCl(aq) \rightarrow KNO_3(aq) + AgCl(s)$
21. Which reactants form the salt $CaSO_4(s)$ in a neutralization reaction?
- A) $H_2SO_4(aq)$ and $Ca(OH)_2(aq)$
 B) $H_2S(g)$ and $Ca(ClO_4)_2(s)$
 C) $H_2SO_3(aq)$ and $Ca(NO_3)_2(aq)$
 D) $SO_2(g)$ and $CaO(s)$
22. Sulfuric acid, $H_2SO_4(aq)$, can be used to neutralize barium hydroxide, $Ba(OH)_2(aq)$. What is the formula for the salt produced by this neutralization?
- A) $BaSO_4$ B) $BaSO_3$
 C) BaS D) $BaSO_2$
23. Given the reaction:
- $$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2 H_2O(\ell) + \text{energy}$$
- As the barium hydroxide solution is added to the solution of sulfuric acid, the electrical conductivity of the acid solution decreases because the
- A) concentration of ions increases
 B) temperature of the reaction mixture decreases
 C) volume of the reaction mixture increases
 D) concentration of ions decreases
24. Which compound could serve as a reactant in a neutralization reaction?
- A) CH_3OH B) $NaCl$
 C) CH_3CHO D) KOH
25. Which reaction occurs when hydrogen ions react with hydroxide ions to form water?
- A) saponification B) neutralization
 C) substitution D) ionization
26. Which equation represents a neutralization reaction?
- A) $Na_2CO_3 + CaCl_2 \rightarrow 2 NaCl + CaCO_3$
 B) $H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2 H_2O$
 C) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
 D) $Ni(NO_3)_2 + H_2S \rightarrow NiS + 2 HNO_3$
27. What is the pH of a solution that results from the complete neutralization of an HCl solution with a KOH solution?
- A) 1 B) 7 C) 10 D) 4
28. As an acid solution is added to neutralize a base solution, the OH^- concentration of the base solution
- A) decreases B) increases
 C) remains the same

29. Given the neutralization reaction:



Which compound is a salt?

- A) K_2SO_4 B) KOH
C) H_2SO_4 D) HOH
30. An aqueous solution of an ionic compound turns red litmus blue, conducts electricity, and reacts with an acid to form a salt and water. This compound could be
- A) NaI B) HCl
C) KNO_3 D) LiOH
31. What is the name of the salt produced by the reaction of calcium hydroxide with sulfuric acid?
- A) calcium sulfite
B) calcium sulfide
C) calcium thiosulfate
D) calcium sulfate

Base your answers to questions 32 through 34 on the information below.

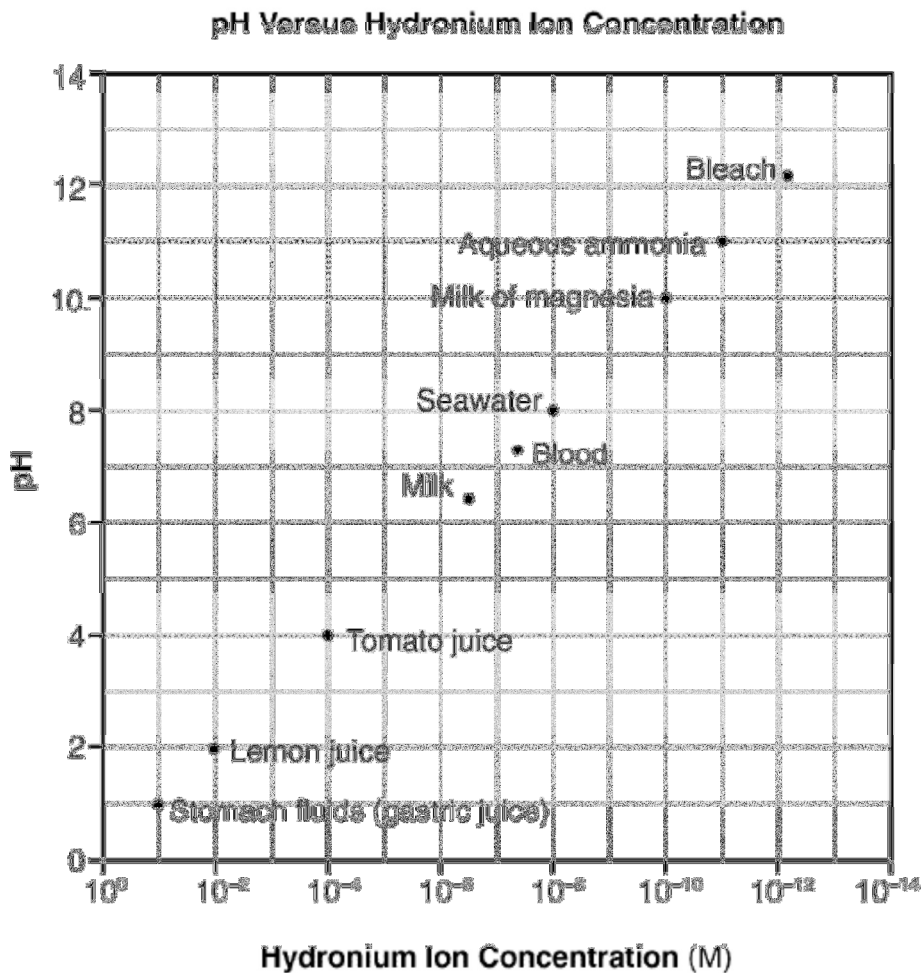
When a person perspires (sweats), the body loses many sodium ions and potassium ions. The evaporation of sweat cools the skin.

After a strenuous workout, people often quench their thirst with sports drinks that contain NaCl and KCl . A single 250.-gram serving of one sports drink contains 0.055 gram of sodium ions.

32. Draw a Lewis electron-dot diagram for *one* of the positive ions lost by the body as a person perspires.
33. State why the salts in sports drinks are classified as electrolytes.
34. Describe the transfer of energy between the skin and the surroundings as a person perspires and the sweat evaporates.

35. Base your answer to the following question on the graph below.

The graph shows the relationship between pH value and hydronium ion concentration for common aqueous solutions and mixtures.



What is the hydronium ion concentration of tomato juice?

Naming Acids and Bases

| Substance | Acid, Base, or Salt? | Name |
|--|----------------------|------|
| 1. NaOH | | |
| 2. NH ₃ | | |
| 3. HCl | | |
| 4. NaCl | | |
| 5. HF | | |
| 6. K ₂ SO ₄ | | |
| 7. AlPO ₄ | | |
| 8. Fe(OH) ₃ | | |
| 9. H ₂ SO ₄ | | |
| 10. H ₂ CO ₃ | | |
| 11. LiC ₂ H ₃ O ₂ | | |
| 12. H ₃ PO ₄ | | |
| 13. Ca(NO ₃) ₂ | | |
| 14. KOH | | |
| 15. MgCO ₃ | | |
| 16. NH ₄ Br | | |
| 17. HNO ₃ | | |

| Substance | Acid, Base, or Salt? | Name |
|---------------------------------------|----------------------|------|
| 18. $\text{Ca}(\text{OH})_2$ | | |
| 19. MgCO_3 | | |
| 20. NaNO_3 | | |
| 21. HCl | | |
| 22. KCl | | |
| 23. $\text{Ba}(\text{OH})_2$ | | |
| 24. KOH | | |
| 25. H_2S | | |
| 26. $\text{Al}(\text{NO}_2)_3$ | | |
| 27. CaCl_2 | | |
| 28. Na_2SO_4 | | |
| 29. $\text{Mg}(\text{OH})_2$ | | |
| 30. NH_4OH | | |
| 31. NH_4Cl | | |
| 32. HBr | | |
| 33. FeBr_3 | | |
| 34. $\text{HC}_2\text{H}_3\text{O}_2$ | | |
| 35. CuCl_2 | | |

Name _____

Date _____

9-10

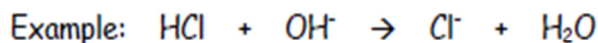
Period _____

| Substance | Acid, Base, or Salt? | Name |
|------------------------------|----------------------|------|
| 36. HNO_2 | | |
| 37. HClO | | |
| 38. HClO_2 | | |
| 39. HClO_3 | | |
| 40. HClO_4 | | |
| 41. H_2SO_3 | | |
| 42. $\text{Al}(\text{OH})_3$ | | |
| 43. LiOH | | |
| 44. HI | | |
| 45. H_2Se | | |
| 46. H_2CrO_4 | | |
| 47. AgOH | | |
| 48. $\text{Fe}(\text{OH})_2$ | | |

Acid/Base Theories

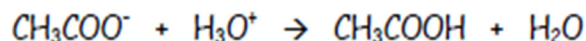
Bronsted-Lowry Problems:

According to the Bronsted-Lowry theory, an acid is a proton (H^+) donor and a base is a proton (H^+) acceptor.

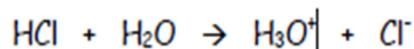


In the following equations, draw brackets between conjugate acid-base pairs and label each species as a Bronsted-Lowry acid or base, and answer the question.

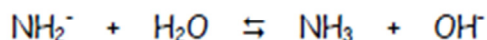
- 1) According to the Bronsted-Lowry theory, what does H_3O^+ act as in the following reaction?



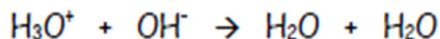
- 2) According to the Bronsted-Lowry theory, what does H_2O act as in the following reaction?



- 3) According to the Bronsted-Lowry theory, what does NH_3 act as in the following reaction?



- 4) According to the Bronsted-Lowry theory, what does H_3O^+ act as in the following reaction?



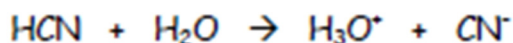
- 5) According to the Bronsted-Lowry theory, what does CN^- act as in the following reaction?



- 6) According to the Bronsted-Lowry theory, what does CH_3COOH act as in the following reaction?



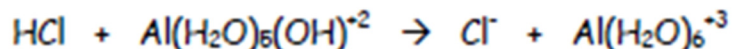
- 7) According to the Bronsted-Lowry theory, what does HCN act as in the following reaction?



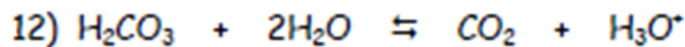
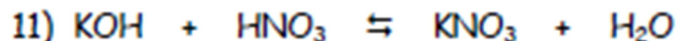
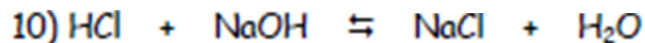
- 8) According to the Bronsted-Lowry theory, what does NH_4^+ act as in the following reaction?

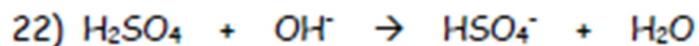
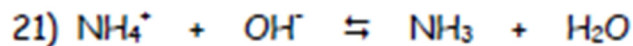
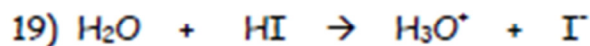
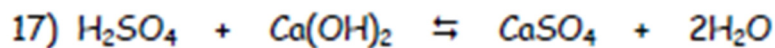
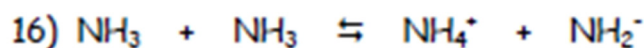
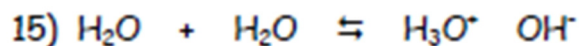
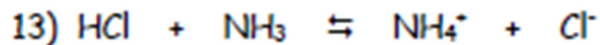


- 9) According to the Bronsted-Lowry theory, what does $\text{Al}(\text{H}_2\text{O})_5(\text{OH})^{+2}$ act as in the following reaction?



Challenge Problems: Identify the Acid, Base, Conjugate Base, and Conjugate Acid





Acid Base Theory Questions

Regents Chemistry
Mr. Dolgos

Acid-Base Theories

1. In the reaction



A conjugate acid-base pair is

- A) H_2O and OH^- B) H_2O and NH_4^+
 C) NH_3 and H_2O D) NH_3 and OH^-

2. Which is the conjugate acid of HSO_4^- ?

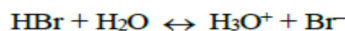
- A) H_3O^+ B) HSO_3^-
 C) SO_4^{2-} D) H_2SO_4

3. What are the bases that accept protons in the reaction?



- A) HS^- and H_3O^+ B) H_2S and H_3O^+
 C) HS^- and H_2O D) H_2S and H_2O

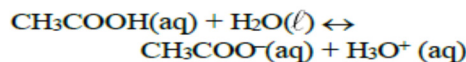
4. In the reaction:



Which is a conjugate acid-base pair?

- A) HBr and H_2O B) H_3O^+ and HBr
 C) H_3O^+ and Br^- D) HBr and Br^-

5. Given the reaction:



In this reaction, which substances are accepting protons?

- A) $\text{H}_2\text{O}(\ell)$ and $\text{H}_3\text{O}^+(\text{aq})$
 B) $\text{H}_2\text{O}(\ell)$ and $\text{CH}_3\text{COO}^-(\text{aq})$
 C) $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{CH}_3\text{COO}^-(\text{aq})$
 D) $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{H}_2\text{O}(\ell)$

6. In the reaction:



Which pair represents an acid and its conjugate base?

- A) H_2O and H_2PO_4
 B) H_3PO_4 and OH^-
 C) H_2O and H_3PO_4
 D) H_3PO_4 and H_2PO_4^-

7. Given the reaction at equilibrium:



What are the two species that are acids?

- A) NH_3 and SO_4^{2-} B) NH_3 and NH_4^+
 C) HSO_4^- and SO_4^{2-} D) HSO_4^- and NH_4^+

8. In the reaction:



The water is

- A) a proton donor, only
 B) a proton acceptor, only
 C) both a proton donor and a proton acceptor
 D) neither a proton donor nor a proton acceptor

9. The compound HNO_3 can be described as an

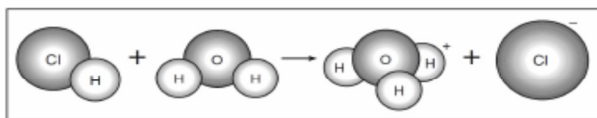
- A) Arrhenius base and a nonelectrolyte
 B) Arrhenius acid and a nonelectrolyte
 C) Arrhenius acid and an electrolyte
 D) Arrhenius base and an electrolyte

10. Which compound releases hydroxide ions in an aqueous solution?

- A) KOH B) CH_3OH
 C) HCl D) CH_3COOH

Acid-Base Theories

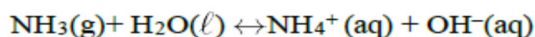
11. Given the diagram representing a reaction:



According to one acid-base theory, the water acts as

- A) an acid because it accepts an H⁺
 - B) an acid because it donates an H⁺
 - C) a base because it donates an H⁺
 - D) a base because it accepts an H⁺
12. Which substance is always a product when an Arrhenius acid in an aqueous solution reacts with an Arrhenius base in an aqueous solution?
- A) KOH
 - B) KBr
 - C) H₂O
 - D) HBr
13. According to the Arrhenius theory, an acid is a substance that
- A) changes litmus from red to blue
 - B) changes phenolphthalein from colorless to pink
 - C) produces hydronium ions as the only positive ions in an aqueous solution
 - D) produces hydroxide ions as the only negative ions in an aqueous solution
14. An aqueous solution of lithium hydroxide contains hydroxide ions as the only negative ion in the solution. Lithium hydroxide is classified as an
- A) Arrhenius acid
 - B) alcohol
 - C) aldehyde
 - D) Arrhenius base
15. The OH⁻ ion concentration is greater than the H₃O⁺ ion concentration in a water solution of
- A) HCl
 - B) Ba(OH)₂
 - C) H₂SO₄
 - D) CH₃OH

16. Given the equation representing a reaction at equilibrium:

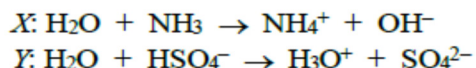


The H⁺ acceptor for the forward reaction is

- A) H₂O(ℓ)
 - B) NH₃(g)
 - C) NH₄⁺(aq)
 - D) OH⁻(aq)
17. Potassium hydroxide is classified as an Arrhenius base because KOH contains
- A) K⁺ ions
 - B) H⁺ ions
 - C) O²⁻ ions
 - D) OH⁻ ions
18. In which forward reaction is water acting only as a proton acceptor?
- A) NH₃(g) + H₂O(ℓ) ↔ NH₄⁺(aq) + OH⁻(aq)
 - B) H₂SO₄(aq) + H₂O(ℓ) ↔ HSO₄⁻(aq) + H₃O⁺(aq)
 - C) H₂O(ℓ) + H₂O(l) ↔ H₃O(ℓ) + OH⁻(aq)
 - D) CH₃COO⁻(aq) + H₂O(ℓ) ↔ CH₃COOH(aq) + OH⁻(aq)
19. Given the equation representing a reversible reaction:
- $$\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\ell) \leftrightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$$
- According to one acid-base theory, the reactant that donates an H⁺ ion in the forward reaction is
- A) OH⁻(aq)
 - B) NH₄⁺(aq)
 - C) H₂O(ℓ)
 - D) NH₃(g)
20. Which compound is an Arrhenius acid?
- A) CaO
 - B) NH₃
 - C) K₂O
 - D) HCl
21. Which compound is an Arrhenius acid?
- A) H₂SO₄
 - B) KCl
 - C) NH₃
 - D) NaOH
22. When dissolved in water, an Arrhenius base yields
- A) hydronium ions
 - B) oxide ions
 - C) hydroxide ions
 - D) hydrogen ions

Acid-Base Theories

23. Given the reactions *X* and *Y* below:



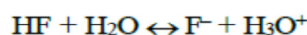
Which statement describes the behavior of the H₂O in these reactions?

- A) Water acts as an acid in both reactions.
- B) Water acts as a base in reaction *X* and as an acid in reaction *Y*.
- C) Water acts as a base in both reactions.
- D) Water acts as an acid in reaction *X* and as a base in reaction *Y*.

24. Which of the following Brønsted bases has the strongest conjugate acid?

- A) HS⁻
- B) F⁻
- C) OH⁻
- D) NO₃⁻

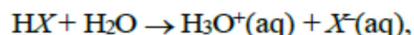
25. Given the reaction:



Which species is acting as the acid in the reverse reaction?

- A) H₃O⁺
- B) F⁻
- C) HF
- D) H₂O

26. Given the reaction:



Based on the equation, HX would be classified as

- A) an acid, because it accepts a proton
- B) a base, because it donates a proton
- C) a base, because it accepts a proton
- D) an acid, because it donates a proton

27. Which of the following is the strongest base (proton acceptor)?

- A) F⁻
- B) I⁻
- C) Br⁻
- D) Cl⁻

28. When one compound dissolves in water, the only positive ion produced in the solution is H₃O⁺ (aq). This compound is classified as

- A) an Arrhenius acid
- B) a hydrocarbon
- C) a salt
- D) an Arrhenius base

29. What are the relative ion concentrations in an acid solution?

- A) more H⁺ ions than OH⁻ ions
- B) fewer H⁺ ions than OH⁻ ions
- C) an equal number of H⁺ ions and OH⁻ ions
- D) H⁺ ions but no OH⁻ ions

30. The conjugate base of NH₄⁺ is

- A) H₂O
- B) H₃O⁺
- C) NH₃
- D) OH⁻

31. Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?

- A) $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2 \text{NaCl}(\text{aq})$
- B) $\text{HC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\ell)$
- C) $\text{C}_3\text{H}_8(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 3 \text{CO}_2(\text{g}) + 4 \text{H}_2\text{O}(\ell)$
- D) $\text{Zn}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$

32. Which substance is an Arrhenius base?

- A) CH₃Cl
- B) CH₃OH
- C) LiOH
- D) LiCl

33. The compound NaOH(s) dissolves in water to yield

- A) hydroxide ions as the only positive ions
- B) hydronium ions as the only negative ions
- C) hydroxide ions as the only negative ions
- D) hydronium ions as the only positive ions

34. Which substance is an Arrhenius acid?

- A) CH₃COOCH₃
- B) Ba(OH)₂
- C) H₃PO₄
- D) NaCl

35. Which formula represents a hydronium ion?

- A) NH₄⁺
- B) HCO₃⁻
- C) H₃O⁺
- D) OH⁻

Acid-Base Theories

36. Given the reaction:



The water acts as the

- A) base B) electron donor
 C) proton acceptor D) acid

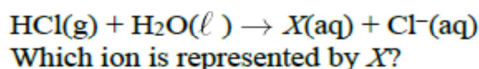
37. Which ion is the only negative ion present in an Arrhenius base?

- A) hydride ion B) hydroxide ion
 C) hydronium ion D) hydrogen ion

38. How are $\text{HNO}_3(\text{aq})$ and $\text{CH}_3\text{COOH}(\text{aq})$ similar?

- A) They are Arrhenius bases and they turn red litmus blue.
 B) They are Arrhenius acids and they turn blue litmus red.
 C) They are Arrhenius acids and they turn red litmus blue.
 D) They are Arrhenius bases and they turn blue litmus red.

39. Given the equation:

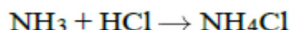


- A) hydroxide B) hydronium
 C) perchlorate D) hypochlorite

40. Which two formulas represent Arrhenius acids?

- A) CH_3COOH and $\text{CH}_3\text{CH}_2\text{OH}$
 B) KHCO_3 and KHSO_4
 C) $\text{HC}_2\text{H}_3\text{O}_2$ and H_3PO_4
 D) NaSCN and $\text{Na}_2\text{S}_2\text{O}$

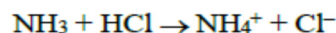
41. Given the reaction:



In this reaction ammonia molecules (NH_3) act as a base because they

- A) accept hydroxide ions (OH^-)
 B) donate hydroxide ions (OH^-)
 C) donate hydrogen ions (H^+)
 D) accept hydrogen ions (H^+)

42. In the reaction:



The NH_3 acts as

- A) a Brønsted base, only
 B) a Brønsted acid, only
 C) neither a Brønsted acid nor a Brønsted base
 D) both a Brønsted acid and a Brønsted base

43. The conjugate acid of the HS^- ion is

- A) H_2S B) H_2O C) S D) H^+

44. Which statement describes an alternate theory of acids and bases?

- A) Acids and bases are both H^+ acceptors.
 B) Acids are H^+ acceptors, and bases are H^+ donors.
 C) Acids and bases are both H^+ donors.
 D) Acids are H^+ donors, and bases are H^+ acceptors.

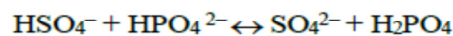
45. A compound that can act as an acid or a base is referred to as

- A) a neutral substance
 B) an isomer
 C) a monomer
 D) an amphoteric substance

46. Which Bronsted acid has a conjugate base that has amphoteric properties?

- A) HCl B) H_3O^+
 C) HNO_3 D) HSO_4^-

47. Given the reaction:



Which pair represents an acid and its conjugate base?

- A) SO_4^{2-} and HPO_4^{2-}
 B) HSO_4^- and HPO_4^{2-}
 C) SO_4^{2-} and H_2PO_4^-
 D) HSO_4^- and SO_4^{2-}

pH

The Power of pH:

For each question, the two pH values are being compared. How many times more acidic or basic does the pH of the solution become?

1) pH 5 → pH 3 _____

2) pH 8 → pH 4 _____

3) pH 10 → pH 7 _____

4) pH 14 → pH 7 _____

5) pH 4 → pH 3 _____

6) pH 7 → pH 3 _____

7) pH 5 → pH 1 _____

8) pH 9 → pH 3 _____

9) pH 8 → pH 6 _____

10) pH 3 → pH 6 _____

11) pH 1 → pH 3 _____

12) pH 2 → pH 7 _____

Circle the answer the best completes the following sentences:

13) The pH scale was developed to express $([H^+]/[OH^-])$ as a number between 0 and 14.

14) A pH of 1 is a (strong/weak) (acid/base).

15) A pH of 8 is a (strong/weak) (acid/base).

16) In an acid, the $[H^+] </> [OH^-]$.

17) In a base, the $[H^+] </> [OH^-]$.

18) A decrease from 5 to 4 on the pH scale represents a tenfold (increase/decrease) in the concentration of $([H^+] / [OH^-])$.

19) Strong acids and bases will dissociate (completely/slightly).

1. Given the pH scale below shade acids red, bases blue, and any neutral values green.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|

2. Will an acidic solution have more $[H^+]$ or $[OH^-]$ in solution?

3. Will a basic solution have more $[H^+]$ or $[OH^-]$ in solution?

4. Will a neutral solution have more $[H^+]$ or $[OH^-]$ in solution?

5. A pH change from 5 to 6 will result in a decrease in how much $[H^+]$?

6. A pH change from 9 to 7 will result in an increase in how much $[H^+]$?

7. What is a pH indicator?

pH & Indicators:

Given the pH of the following common substances determine what color the indicator will turn when placed in each substance.

| Substance | pH | Methyl Orange | Bromthymol Blue | Phenolphthalein | Litmus | Bromcresol green | Thymol blue |
|--------------------|-----|---------------|-----------------|-----------------|--------|------------------|-------------|
| Stomach Acid | 2 | | | | | | |
| Cola Drink | 3 | | | | | | |
| Blood | 7.5 | | | | | | |
| Pure Water | 7.0 | | | | | | |
| Oven Cleaner | 14 | | | | | | |
| Tomatoes | 4 | | | | | | |
| Milk | 6.5 | | | | | | |
| Detergent | 10 | | | | | | |
| Coffee | 5 | | | | | | |
| Household Cleaners | 11 | | | | | | |

Name _____

Date _____

9-22

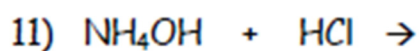
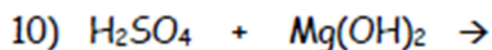
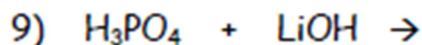
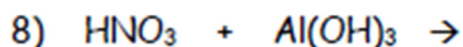
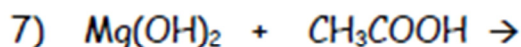
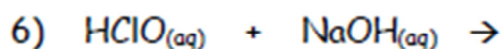
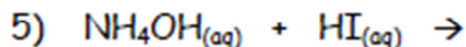
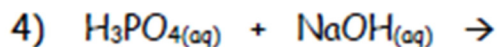
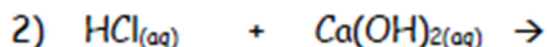
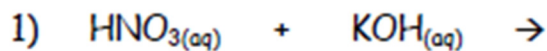
Period _____

| Solution | PH range | Methyl Orange | Thymol Blue | Litmus | Brom-Cresol Green | Phenol-Phthalein | Bromo Thymol blue | Acid or Base? |
|------------------|----------|---------------|-------------|--------|-------------------|------------------|-------------------|---------------|
| Vinegar | 1.3 | | | | | | | |
| Soap | 8.4 | | | | | | | |
| Cola | 3.2 | | | | | | | |
| Ammonia | 12 | | | | | | | |
| Rain | 6.4 | | | | | | | |
| Milk of Magnesia | 8.1 | | | | | | | |
| Milk | 6.6 | | | | | | | |
| Saliva | 6.5 | | | | | | | |
| Coffee | 5.2 | | | | | | | |
| Gastric juices | 1.5 | | | | | | | |
| Human blood | 7.4 | | | | | | | |
| OJ | 2.1 | | | | | | | |
| Kool-Aid | 6.4 | | | | | | | |
| Drain cleaner | 1.8 | | | | | | | |
| Bleach | 6.2 | | | | | | | |
| Shampoo | 6.3 | | | | | | | |

Neutralization Reactions:

Remember that: Acid + Base → Salt + Water

Using the above general reaction, complete the following reactions with correct formulas. Then balance the entire double replacement reaction. Also name the salt that is produced in the space provided below the product side of the reaction.



Writing Balanced Reactions:

Directions: In the following reactions an acid is reacting with a base in neutralization reactions. Write out the reaction and balance the equation.

| | |
|--|--|
| 1. Hydrochloric acid reacts with potassium hydroxide | 2. A sample of hydrochloric acid neutralizes calcium hydroxide |
| 3. Ammonia reacts with perchloric acid | 4. Aluminum hydroxide is mixed with sulfuric acid |
| 5. Hydrobromic acid neutralizes a sample of sodium hydroxide | 6. A solution of HCl reacts with a solution of Ba(OH) ₂ |
| 7. KCN neutralizes HClO | 8. HBr neutralizes calcium hydroxide |
| 9. HCN reacts with NaOH | |

Titration

$$M_A V_A = M_B V_B$$

1. A 25 mL sample of HCl was titrated to the end point with 15 ml of 2M NaOH. What is the molarity of the HCl?
2. How many liters of .3M H₃PO₄ are needed to neutralize 3.5L of 3M NaOH?
3. A 10 ml sample of H₂SO₄ was exactly neutralized by 13.5 ml of 1M KOH. What is the molarity of H₂SO₄?
4. How many liters of .5M KOH are needed to completely neutralize 7L of 1M H₂SO₄?
5. How much 1.5M NaOH is necessary to exactly neutralize 25 ml of 2.5M H₃PO₄?

6. How much .5M HNO_3 is necessary to titrate 25 ml of .05 M $\text{Ca}(\text{OH})_2$?

7. What is the molarity of a NaOH solution if 15 ml is exactly neutralized by 7.5 ml of a .002M $\text{HC}_2\text{H}_3\text{O}_2$ solution?

8. How many milliliters of 1.5M HCl are needed to neutralize 4L of 1.5M $\text{Ca}(\text{OH})_2$?

9. *** How many grams of 1.3M $\text{Ca}(\text{OH})_2$ are needed to completely neutralize 3.5L of 4M HCl?

Titration Calculation Chart:

| | M_A | V_A | M_B | V_B |
|----|-------|-------|-------|-------|
| 1 | 1.00M | 25mL | 4.00M | |
| 2 | 2.00M | 25mL | | 50mL |
| 3 | 3.00M | 50mL | | 100mL |
| 4 | | 1L | 3.00M | 2L |
| 5 | 1.50M | | 3.00M | 500mL |
| 6 | 6.00M | | 2.00M | 75mL |
| 7 | | 200mL | 4.00M | 150mL |
| 8 | 5.00M | 100mL | 2.50M | |
| 9 | 3.5M | | 7.00M | 200mL |
| 10 | 2.50M | 250mL | 5.00M | |

*Assume all acids and bases are MONOPROTIC

Name: _____

Teacher: Mr. Roderick

9 Acid Base Pretest MC

- A solution of a base differs from a solution of an acid in that the solution of a base
 - is able to conduct electricity
 - is able to cause an indicator color change
 - has a greater $[\text{H}_3\text{O}^+]$
 - has a greater $[\text{OH}^-]$
- According to the Arrhenius Theory, the acidic property of an aqueous solution is due to an excess of
 - H_2
 - H^+
 - H_2O
 - OH^-
- Which pH value indicates the most basic solution?
 - 7
 - 8
 - 3
 - 11
- A 3.0-milliliter sample of HNO_3 solution is exactly neutralized by 6.0 milliliters of 0.50 M KOH. What is the molarity of the HNO_3 sample?
 - 1.0 M
 - 0.50 M
 - 3.0 M
 - 1.5 M
- As 100 milliliters of 0.10 molar KOH is added to 100 milliliters of 0.10 molar HCl at 298 K, the pH of the resulting solution will
 - decrease to 3
 - decrease to 4
 - increase to 7
 - increase to 13
- Which formula represents a salt?
 - KOH
 - KCl
 - CH_3OH
 - CH_3COOH

7. Which solution will turn litmus from red to blue?
- A. $\text{H}_2\text{S}(aq)$
 - B. $\text{NH}_3(aq)$
 - C. $\text{SO}_2(aq)$
 - D. $\text{CO}_2(aq)$
8. Which substance is always produced in the reaction between hydrochloric acid and sodium hydroxide?
- A. water
 - B. hydrogen gas
 - C. oxygen gas
 - D. a precipitate
9. Which species can act as an Arrhenius acid in aqueous solution?
- A. Cl^-
 - B. KH
 - C. Li^+
 - D. HCl
10. According to the Brønsted-Lowry theory, an acid is
- A. a proton donor only
 - B. a proton acceptor only
 - C. a proton donor and a proton acceptor
 - D. neither a proton donor nor a proton acceptor
11. Which salt is formed when hydrochloric acid is neutralized by a potassium hydroxide solution?
- A. potassium chloride
 - B. potassium chlorate
 - C. potassium chlorite
 - D. potassium perchlorate
12. When an Arrhenius base is placed in H_2O , the only negative ion present in the solution is
- A. OH^-
 - B. H_3O^-
 - C. H^-
 - D. O^{2-}
13. How many milliliters of 0.2 M NaOH are required to exactly neutralize 40 milliliters of 0.1 M HCl ?
- A. 10
 - B. 20
 - C. 40
 - D. 80

14. A neutral solution of a salt in water contains
- A. fewer H_3O^+ ions than OH^- ions
 - B. more H_3O^+ ions than OH^- ions
 - C. an equal number of H_3O^+ ions and OH^- ions
 - D. neither H_3O^+ ions nor OH^- ions
15. Which balanced equation represents a neutralization reaction?
- A. $\text{H}_2\text{SO}_4 + 2\text{LiOH} \rightarrow \text{Li}_2\text{SO}_4 + 2\text{H}_2\text{O}$
 - B. $\text{BaCl}_2 + \text{Cu}(\text{NO}_3)_2 \rightarrow \text{Ba}(\text{NO}_3)_2 + \text{CuCl}_2$
 - C. $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$
 - D. $\text{Mg} + \text{NiCl}_2 \rightarrow \text{MgCl}_2 + \text{Ni}$
16. When phenolphthalein indicator is added to a colorless solution with a pH of 10, a student observes and concludes that the tested solution
- A. remains colorless and is basic
 - B. remains colorless and is acidic
 - C. turns pink and is basic
 - D. turns pink and is acidic
17. Which equation represents a neutralization reaction?
- A. $\text{Ca}(\text{OH})_2 \rightarrow \text{Ca}^{2+} + 2\text{OH}^-$
 - B. $\text{CaCl}_2 \rightarrow \text{Ca}^{2+} + 2\text{Cl}^-$
 - C. $\text{H}^+ + \text{OH}^- \rightarrow \text{HOH}$
 - D. $\text{H}^+ + \text{F}^- \rightarrow \text{HF}$
18. Which substance is an electrolyte?
- A. $\text{C}_2\text{H}_5\text{OH}$
 - B. $\text{C}_6\text{H}_{12}\text{O}_6$
 - C. $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
 - D. CH_3COOH
19. In the reaction $\text{HNO}_3 + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+ + \text{NO}_3^-$, the two Brønsted acids are
- A. H_2O and HNO_3
 - B. H_2O and NO_3^-
 - C. H_2O and H_3O^+
 - D. HNO_3 and H_3O^+

20. An acidic solution could have a pH of

- A. 7
- B. 10
- C. 3
- D. 14

21. Which compound is a nonelectrolyte?

- A. HNO_3
- B. H_2SO_4
- C. NaOH
- D. CH_3OH

22. 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^+ concentration?

- A. *A, B, C*
- B. *B, A, C*
- C. *C, A, B*
- D. *C, B, A*

23. Which solution when mixed with a drop of bromthymol blue will cause the indicator to change from blue to yellow?

- A. 0.1 M HCl
- B. 0.1 M NH_3
- C. 0.1 M CH_3OH
- D. 0.1 M NaOH

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

- A. HCl and CH_3OH
- B. HCl and NaOH
- C. C_5H_{12} and CH_3OH
- D. C_5H_{12} and NaOH

25. Which process uses a volume of solution of known concentration to determine the concentration of another solution?

- A. distillation
- B. transmutation
- C. substitution
- D. titration

Name: _____

Teacher: Mr. Roderick

9 Acid Base Pretest CR

Figure 1

Acid rain is a problem in industrialized countries around the world. Oxides of sulfur and nitrogen are formed when various fuels are burned. These oxides dissolve in atmospheric water droplets that fall to earth as acid rain or acid snow.

While normal rain has a pH between 5.0 and 6.0 due to the presence of dissolved carbon dioxide, acid rain often has a pH of 4.0 or lower. This level of acidity can damage trees and plants, leach minerals from the soil, and cause the death of aquatic animals and plants.

If the pH of the soil is too low, then quicklime, CaO, can be added to the soil to increase the pH. Quicklime produces calcium hydroxide when it dissolves in water.

1. [Refer to figure 1]

Base your answer to the question on the passage.

A sample of wet soil has a pH of 4.0. After the addition of quicklime, the H^+ ion concentration of the soil is $\frac{1}{100}$ of the original

H^+ ion concentration of the soil.

The new pH of the soil sample is .

2. [Refer to figure 1]

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.

The molarity of the H^+ ions in the acid rain is $\times 10^{-3}$ M.

Figure 2

A student was studying the pH differences in samples from two Adirondack streams. The student measured a pH of 4 in stream A and a pH of 6 in stream B.

3. [Refer to figure 2]

What is the color of bromthymol blue in the sample from stream A?

Answer:

4. What color is bromcresol green after it is added to a sample of NaOH(aq)?

Answer:

5.

A student is given two beakers, each containing an equal amount of clear, odorless liquid. One solution is acidic and the other is basic.

State *two* safe methods of distinguishing the acid solution from the base solution.

Answer for #5:

Figure 3

Base your answer to the question on the passage below.

Acid rain lowers the pH in ponds and lakes and over time can cause the death of some aquatic life. Acid rain is caused in large part by the burning of fossil fuels in power plants and by gasoline-powered vehicles. The acids commonly associated with acid rain are sulfurous acid, sulfuric acid, and nitric acid.

In general, fish can tolerate a pH range between 5 and 9. However, even small changes in pH can significantly affect the solubility and toxicity of common pollutants. Increased concentrations of these pollutants can adversely affect the behavior and normal life processes of fish and cause deformity, lower egg production, and less egg hatching.

6. **[Refer to figure 3]**

Acid rain caused the pH of a body of water to decrease. Explain this pH decrease in terms of the change in concentration of hydronium ions.

Answer for #6:

7.

Identify *two* indicators from Reference Table *M* that are yellow in solutions with a pH of 5.5.

Answer for #7:

Figure 4

Base your answer to the question on the information below.

Sulfur dioxide, SO_2 , is one gas produced when fossil fuels are burned. When this gas reacts with water in the atmosphere, an acid is produced forming acid rain. The pH of the water in a lake changes when acid rain collects in the lake.

Two samples of the same rainwater are tested using two indicators. Methyl orange is yellow in one sample of this rainwater. Litmus is red in the other sample of this rainwater.

8. [Refer to figure 4]

Identify a possible pH value for the rainwater that was tested.

Answer for #8:

9. [Refer to figure 4]

Write the formula for *one* substance that can neutralize the lake water affected by acid rain.

Answer for #9:

Figure 5

Base your answer to this question on the information below.

When a person perspires (sweats), the body loses many sodium ions and potassium ions. The evaporation of sweat cools the skin.

After a strenuous workout, people often quench their thirst with sports drinks that contain NaCl and KCl. A single 250.-gram serving of one sports drink contains 0.055 gram of sodium ions.

10. [Refer to figure 5]

State why the salts in sports drinks are classified as electrolytes.

Answer for #10:

Figure 6

Base your answer to this question on the information below.

In liquid water, an equilibrium exists between $\text{H}_2\text{O}(\ell)$ molecules, $\text{H}^+(\text{aq})$ ions, and $\text{OH}^-(\text{aq})$ ions. A person experiencing acid indigestion after drinking tomato juice can ingest milk of magnesia to reduce the acidity of the stomach contents.

Tomato juice has a pH value of 4. Milk of magnesia, a mixture of magnesium hydroxide and water, has a pH value of 10.

11. [Refer to figure 6]

Compare the hydrogen ion concentration in tomato juice to the hydrogen ion concentration in milk of magnesia.

Answer for #11:

12. [Refer to figure 6]

What is the color of thymol blue indicator when placed in a sample of milk of magnesia?

Answer for #12:

Figure 7

Base your answer to this question on the information below.

A student, wearing chemical safety goggles and a lab apron, is to perform a laboratory test to determine the pH value of two different solutions. The student is given one bottle containing a solution with a pH of 2.0 and another bottle containing a solution with a pH of 5.0. The student is also given six dropping bottles, each containing a different indicator listed in Reference Table *M*.

13. [Refer to figure 7]

Identify an indicator in Reference Table *M* that would differentiate the two solutions.

Answer for #13:

14. [Refer to figure 7]

Compare the hydronium ion concentration of the solution having a pH of 2.0 to the hydronium ion concentration of the other solution given to the student.

Answer for #14:

Figure 8

Base your answer to the question on the information below.

Some carbonated beverages are made by forcing carbon dioxide gas into a beverage solution. When a bottle of one kind of carbonated beverage is first opened, the beverage has a pH value of 3.

15. [Refer to figure 8]

After the beverage bottle is left open for several hours, the hydronium ion concentration in the beverage solution decreases to $\frac{1}{1000}$ of the original concentration. Determine the new pH of the beverage solution.

Answer:

16. [Refer to figure 8]

State, in terms of the pH scale, why this beverage is classified as acidic.

Answer for #16:

17. [Refer to figure 8]

Using Table M, identify *one* indicator that is yellow in a solution that has the same pH value as this beverage.

Answer for #17:

Figure 9

Base your answer to the question on the information below.

In preparing to titrate an acid with a base, a student puts on goggles and an apron. The student uses burets to dispense and measure the acid and the base in the titration. In each of two trials, a 0.500 M NaOH(aq) solution is added to a flask containing a volume of HCl(aq) solution of unknown concentration. Phenolphthalein is the indicator used in the titration. The calculated volumes used for the two trials are recorded in the table below.

Volumes of Base and Acid Used in Titration Trials

| Solution (aq) | Molarity (M) | Trial 1 | Trial 2 |
|---------------|--------------|------------------|------------------|
| | | Volume Used (mL) | Volume Used (mL) |
| NaOH | 0.500 | 17.03 | 16.87 |
| HCl | ? | 10.22 | 10.12 |

18. [Refer to figure 9]

Using the volumes from trial 1, determine the molarity of the HCl(aq) solution.

Answer: M