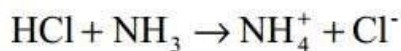


Chapter 14/ acids and bases

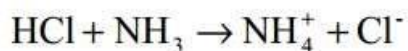
Q1) Multiple Choice

- d** 1. A strong acid
- ionizes completely in solution.
 - produces hydronium ions in solution.
 - reacts with metals that are more active than hydrogen.
 - All of the above
- a** 2. Which of the following substances is a weak base?
- NH₃
 - KOH
 - K₂O
 - NaOH
- a** 3. Hydroxides of Group 1 metals
- are all strong bases
 - are all weak bases
 - are all acids.
 - do not dissociate in solution.
- a** 4. Strong bases are
- strong electrolytes.
 - weak electrolytes.
 - nonelectrolytes.
 - also strong acids.
- d** 5. A highly polar molecule that contains a weak bond between a hydrogen atom and another element would be
- a weak acid.
 - unable to ionize completely.
 - a nonelectrolyte.
 - a strong acid.
- b** 6. Which of the following substances is both a Brønsted-Lowry base and an Arrhenius base?
- NH₃(s)
 - NH₃(aq)
 - HCl(g)
 - HCl(aq)
- a** 7. In the following reaction, which substance acts as a Brønsted-Lowry acid?



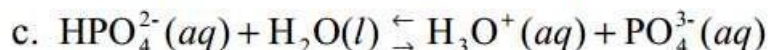
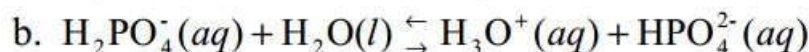
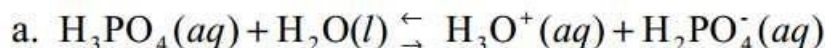
- HCl
- NH₃
- NH₄⁺
- Cl⁻

- b** 8. In the following reaction, which substance acts as a Brønsted-Lowry base?



- HCl
- NH₃
- NH₄⁺
- Cl⁻

___a___ 9. Which stage of ionization of H_3PO_4 produces the most ions in solution?



d. All stages produce the same number of ions in solution.

___a___ 10. Acetic acid is found in

a. vinegar

b. the stomach.

c. antacids.

d. oranges

___d___ 11. A characteristic of an Arrhenius base is that it

a. is an electrolyte

b. tastes bitter.

c. dissociates to form OH^- ions.

d. All of the above

___b___ 12. Which of the following is a Brønsted- Lowry base?

a. HCl

b. HCO_3^-

c. H_3O^+

d. H_3PO_4

___d___ 13. What is the correct acid name for an aqueous solution of HClO_4 ?

a. hypochlorous acid

b. chlorous acid

c. chloric acid

d. perchloric acid

___c___ 14. An Arrhenius acid in an aqueous solution

a. attracts negatively charged anions.

b. attracts positively charged cations.

c. gives up one or more of its hydrogen ions to water molecules.

d. forms ionic bonds with water molecules.

___b___ 15. Which of the following is an indication of acid strength?

a. the number of hydrogen atoms in the formula of the acid

b. how strongly an aqueous solution of the acid conducts an electric current

c. how quickly the acid dissolves in water

d. the number of total atoms in one molecule of the acid

___d___ 16. A strong base in an aqueous solution

a. is a weak electrolyte.

b. produces many H^+ ions.

c. will not dissolve.

d. completely dissociates into ions.

___c_17. In a Brønsted-Lowry acid-base reaction, what are transferred from one reactant to another?

- a. electrons
- b. water molecules
- c. protons
- d. OH^- ions

___a_18. How many protons per molecule can a monoprotic acid donate?

- a. one
- b. two
- c. three
- d. zero

___c_19. How many stages of ionization does phosphoric acid go through?

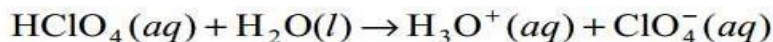
- a. one
- b. two
- c. three
- d. four

___d_20. Which is the stronger base in the reaction represented by the following equation?



- a. CH_3COOH
- b. CH_3COO^-
- c. H_3O^+
- d. H_2O

___c_21. Consider the reaction represented by the equation below.



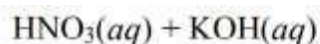
Which substances are present in the greatest concentrations?

- a. HClO_4 and H_2O
- b. HClO_4 and ClO_4^-
- c. H_3O^+ and ClO_4^-
- d. H_2O and H_3O^+

___b_22. Acid strength increases with

- a. increasing polarity and increasing bond strength.
- b. increasing polarity and decreasing bond strength.
- c. decreasing polarity and increasing bond strength.
- d. decreasing polarity and decreasing bond strength.

___b_23. What is the correct net ionic equation for the neutralization reaction between the substances below?



- a. $\text{NO}_3^-(aq) + \text{K}^+(aq) \rightarrow \text{KNO}_3(aq)$
- b. $\text{H}_3\text{O}^+(aq) + \text{OH}^-(aq) \rightarrow 2\text{H}_2\text{O}(l)$
- c. $\text{H}_3\text{O}^+(aq) + \text{NO}_3^-(aq) + \text{K}^+(aq) + \text{OH}^-(aq) \rightarrow \text{NO}_3^-(aq) + \text{K}^+(aq) + 2\text{H}_2\text{O}(l)$
- d. $\text{HNO}_3(aq) + \text{KOH}(aq) \rightarrow \text{KNO}_3(aq) + \text{H}_2\text{O}(l)$

- ___ **b** _24. Which of the following characteristics describes a base?
- reacts with oils in the skin and converts them to acids.
 - forms alkaline solutions.
 - is a nonelectrolyte.
 - None of the above.
- ___ **c** _25. Which of the following is not a strong acid?
- HCl
 - H₂SO₄
 - CH₃COOH
 - HBr
- ___ **c** _26. All Brønsted- Lowry acids
- are aqueous solutions.
 - can act as Arrhenius acids.
 - donate protons
 - All of the above
- ___ **c** _27. Which of the following is a polyprotic acid?
- HCl
 - H₂SO₄
 - HNO₃
 - HF.
- ___ **d** _28. Which of the following can act as a Lewis acid?
- NH₃(aq)
 - Cl⁻ (aq)
 - BF₄⁻ (aq)
 - Ag⁺ (aq)
- ___ **c** _29. A Lewis acid
- is an anion.
 - donates an electron pair to form a covalent bond.
 - can be a substance that does not contain a hydrogen atom.
 - All of the above.
- ___ **b** _30. Which of the following substances can act as an Arrhenius base, a Brønsted- Lowry base, and a Lewis base?
- F⁻ (aq)
 - NH₃(aq)
 - H⁺ (aq)
 - NaOH(aq)
- ___ **d** _31. Which of the following will be present in an aqueous solution of H₂SO₄?
- H₃O⁺ (aq)
 - HSO₄⁻ (aq)
 - SO₄²⁻ (aq)
 - All of the above
- ___ **c** _32. What is the conjugate base of the hydronium ion, H₃O⁺?
- OH⁻
 - H⁺
 - H₂O
 - H₃O²⁺
- ___ **c** _33. The conjugate acid of the chloride ion, Cl⁻, is
- Cl₂.
 - H⁺.
 - HCl.
 - ClO.

- ___ **c** ___ 34. A conjugate acid is an acid that forms when
a. the acid gains a proton. c. a base gains a proton.
b. a base loses a proton. d. an atom accepts an electron pair.
- ___ **d** ___ 35. Ions that are present before and after a neutralization reaction are
a. nonelectrolytes. c. neutral ions.
b. metal ions. d. spectator ions.
- ___ **b** ___ 36. In an acid- base reaction, the conjugate base of the weaker acid is the
a. stronger acid. c. weaker base.
b. stronger base. d. None of the above.
- ___ **d** ___ 37. A conjugate base is the species that
a. remains after a base has given up a proton.
b. is formed by the addition of a proton.
c. is formed by the addition of a proton to a base.
d. remains after an acid has given up a proton.
- ___ **c** ___ 38. In the following reaction, which substance is the conjugate base of HClO_4 ?
$$\text{HClO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l}) \longrightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{ClO}_4^-(\text{aq})$$

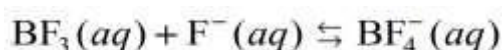
a. $\text{H}_2\text{O}(\text{l})$ c. $\text{ClO}_4^-(\text{aq})$
b. $\text{H}_3\text{O}^+(\text{aq})$ d. Both (a) and (b)
- ___ **b** ___ 39. Which of the properties listed below is not characteristic of an acid?
a. a sour taste c. the ability to conduct an electric current
b. a slippery feel d. reactivity with metals
- ___ **c** ___ 40. In the reaction represented by the equation
$$\text{H}_2\text{C}_2\text{O}_4(\text{aq}) + \text{CH}_3\text{NH}_2(\text{aq}) \rightleftharpoons \text{HC}_2\text{O}_4^-(\text{aq}) + \text{CH}_3\text{NH}_3^+(\text{aq})$$

Which of these is a conjugate acid-base pair?
a. $\text{H}_2\text{C}_2\text{O}_4(\text{aq})$ and $\text{CH}_3\text{NH}_2(\text{aq})$
b. $\text{H}_2\text{C}_2\text{O}_4(\text{aq})$ and $\text{CH}_3\text{NH}_3^+(\text{aq})$
c. $\text{CH}_3\text{NH}_2(\text{aq})$ and $\text{CH}_3\text{NH}_3^+(\text{aq})$
d. $\text{HC}_2\text{O}_4^-(\text{aq})$ and $\text{CH}_3\text{NH}_3^+(\text{aq})$
- ___ **b** ___ 41. A substance that increases the concentration of OH^- ions in an aqueous solution is known as a(n)
a. Arrhenius acid. c. Lewis acid.
b. Arrhenius base. d. Lewis base.
- ___ **d** ___ 42. A strong base in an aqueous solution
a. is a weak electrolyte. c. will not dissolve.
b. produces many H^+ ions d. completely dissociates into ions.

- ___ **b** ___ 43. Which of the following is an indication of acid strength?
- the number of hydrogen atoms in the formula of the acid
 - how strongly an aqueous solution of the acid conducts an electric current
 - how quickly the acid dissolves in water
 - the number of total atoms in one molecule of the acid

- ___ **a** ___ 44. The neutralization of any strong acid and strong base produces
- H_2O molecules.
 - H_3O^+ ions
 - OH^- ions
 - Both (b) and (c)

- ___ **a** ___ 45. Which substance is a Lewis acid in the reaction shown by the equation below?



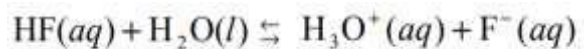
- BF_3 .
- F^-
- BF_4^-
- None of the above

- ___ **c** ___ 46. What is the conjugate acid of the water?
- OH^-
 - H^+
 - H_3O^+
 - H_3O^{2+}

- ___ **a** ___ 47. Sulfur trioxide gas dissolves in atmospheric water. The product of the reaction, which falls to the ground as a component of acid rain or snow, is
- $\text{H}_2\text{SO}_4(aq)$.
 - $\text{H}_2\text{S}(aq)$.
 - $\text{H}_3\text{O}^+(aq)$.
 - $\text{SO}_4^{2-}(aq)$

- ___ **d** ___ 48. Which of the following is an oxyacid?
- HCl
 - H_2S
 - H_2O
 - $\text{H}_2\text{SO}_4(aq)$.

- ___ **c** ___ 49. In the reaction represented by the equation



Which of these is a conjugate acid-base pair?

- F^- and H_2O .
- H_3O^+ and HF .
- HF and F^-
- HF and H_2O .

- ___ **b** ___ 50. Proton-transfer reactions favor production of the
- stronger acid and stronger base.
 - weaker acid and weaker base.
 - stronger acid and weaker base.
 - weaker acid and stronger base.

- ___ **a** ___ 51. Aqueous solutions of most bases contain
- hydroxide ions and cations.
 - hydroxide ions and anions.
 - hydrogen ions and anions.
 - hydrogen ions and cations

Q2) Completion

1. A substance that ionizes almost completely in aqueous solutions, producing H_3O^+ ions, is a(n) strong acid.
2. An acid that can donate two protons per molecule is called a(n) diprotic acid.
3. Bases are said to be neutralized when they react with acid to yield water and a(n) salt.
4. Write the name of each of the following acids in the space provided.
 - a. nitrous acid HNO_2
 - b. hydrochloric acid HCl
 - c. carbonic acid H_2CO_3
 - d. sulfuric acid H_2SO_4
 - e. hydriodic acid HI
 - f. hypobromous acid HBrO
5. Write the formula for each of the following acids in the space provided.
 - a. H_2S hydrosulfuric acid
 - b. HNO_3 nitric acid
 - c. H_3PO_3 phosphorous acid
 - d. HClO_4 perchloric acid.
6. An acid that contains hydrogen and only one other element is called a(n) binary acid.
7. The species that forms when an acid has given up a proton is called the acid's conjugate base.
8. Barium carbonate will react with hydrochloric acid to produce carbon dioxide, Barium Chloride, and water.

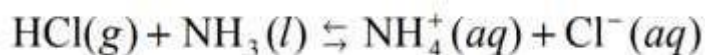
Q3) Short Answer

1. Explain the difference between strong acids and weak acids.

A strong acid ionizes completely in an aqueous solution. A weak acid does not ionize completely in aqueous solution. Its aqueous solution contains hydronium ions, anions, and dissolved acid molecules.

2. List five properties of aqueous acids.

Have a sour taste; change the color of acid-base indicators; some react with active metals to release hydrogen gas; react with bases to produce salts and water; conduct electric current

3. Refer to the equation below to answer (a) and (b).**a. List the conjugate acid-base pairs.**

HCl and Cl^-

NH_3 and NH_4^+

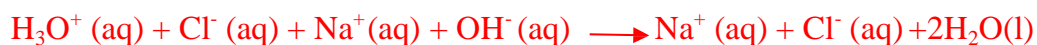
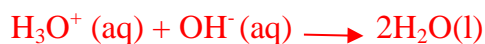
b. Identify each reactant and product as acidic or basic.

Acidic HCl and NH_4^+

Basic Cl^- and NH_3

4. Refer to the statement below to answer (a), (b), and (c).

Dilute $\text{HCl}(aq)$ and $\text{NaOH}(aq)$ are mixed in chemically equivalent quantities.

a. Write the chemical equation for the reaction.**b. Write the overall ionic equation for the reaction.****c. Write the net ionic equation.****5. Explain how the production of sulfur trioxide, SO_3 , in industrial processes can result in acid rain. Write an equation for the reaction.**

Sulfur trioxide, SO_3 , is produced as a gas and dissolves in atmospheric water to produce a sulfuric acid solution that falls to the ground as rain or snow.

