

1. An example of a nonelectrolyte is
- A) $C_6H_{12}O_6(aq)$ B) $K_2SO_4(aq)$
C) $NaCl(aq)$ D) $HCl(aq)$
2. Which of the following aqueous solutions is the best conductor of electricity?
- A) 0.10 M CH_3OH B) 1.0 M CH_3OH
C) 0.10 M $NaOH$ D) 1.0 M $NaOH$
3. Which substance, when dissolved in water, forms a solution that conducts an electric current?
- A) C_2H_5OH B) $C_6H_{12}O_6$
C) $C_{12}H_{22}O_{11}$ D) CH_3COOH
4. Which compounds can be classified as electrolytes?
- A) alcohols
B) alkynes
C) organic acids
D) saturated hydrocarbons
5. A substance is classified as an electrolyte because
- A) it has a high melting point
B) it contains covalent bonds
C) its aqueous solution conducts an electric current
D) its aqueous solution has a pH value of 7
6. According to the Arrhenius theory, a substance that is classified as an acid will always yield
- A) $H^+(aq)$ B) $K^+(aq)$
C) $F^-(aq)$ D) $I^-(aq)$
7. Unlike an acid, an aqueous solution of a base
- A) causes some indicators to change color
B) conducts electricity
C) contains more H^+ ions than OH^- ions
D) contains more OH^- ions than H^+ ions
8. An Arrhenius base yields which ion as the only negative ion in an aqueous solution?
- A) hydride ion B) hydrogen ion
C) hydronium ion D) hydroxide ion
9. The only positive ion found in $H_2SO_4(aq)$ is the
- A) ammonium ion B) hydronium ion
C) hydroxide ion D) sulfate ion
10. How are $HNO_3(aq)$ and $CH_3COOH(aq)$ similar?
- A) They are Arrhenius acids and they turn blue litmus red.
B) They are Arrhenius acids and they turn red litmus blue.
C) They are Arrhenius bases and they turn blue litmus red.
D) They are Arrhenius bases and they turn red litmus blue.
11. Which pH change represents a hundredfold increase in the concentration of H_3O^+ ?
- A) pH 5 to pH 7 B) pH 13 to pH 14
C) pH 3 to pH 1 D) pH 4 to pH 3
12. Which of these pH numbers indicates the highest level of acidity?
- A) 5 B) 8 C) 10 D) 12
13. 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
14. Which substance, if added to a saturated solution of NH_4OH , would cause the pH of the solution to increase?
- A) HCl B) NH_4Cl
C) $LiOH$ D) CH_3OH
15. As the pH of a solution is changed from 3 to 6, the concentration of hydronium ions
- A) increases by a factor of 3
B) increases by a factor of 1000
C) decreases by a factor of 3
D) decreases by a factor of 1000
16. The ability of $H_2SO_4(aq)$ to change blue litmus red is mainly due to the presence of
- A) SO_2 molecules B) H_2O molecules
C) $H_3O^+(aq)$ ions D) $SO_4^{2-}(aq)$ ions

17. What color is phenolphthalein in a solution that has a pH of 9?

- A) blue B) pink
C) white D) colorless

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

- A) 0.1 M CH₃COOH B) 0.1 M KOH
C) 0.1 M HCl D) 0.1 M H₂SO₄

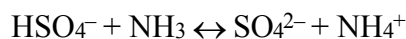
19. An indicator was used to test a water solution with a pH of 12. Which indicator color would be observed?

- A) colorless with litmus
B) red with litmus
C) colorless with phenolphthalein
D) pink with phenolphthalein

20. In a solution, litmus is blue. The pH of the solution could be

- A) 10 B) 2 C) 3 D) 4

21. Given the reaction at equilibrium:



What are the two species that are acids?

- A) NH₃ and NH₄⁺ B) NH₃ and SO₄²⁻
C) HSO₄⁻ and SO₄²⁻ D) HSO₄⁻ and NH₄⁺

22. One acid-base theory defines a base as an

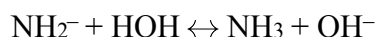
- A) H⁺ donor B) H⁺ acceptor
C) H donor D) H acceptor

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



- A) H₂S and H₂O B) H₂S and H₃O⁺
C) HS⁻ and H₂O D) HS⁻ and H₃O⁺

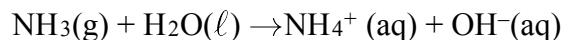
24. In the reaction:



The two acids are

- A) HOH and NH₂⁻ B) HOH and NH₃
C) OH⁻ and HOH D) OH⁻ and NH₃

25. Base your answer to the following question on Given the balanced equation representing a reaction:



According to one acid-base theory, the NH₃(g) molecules act as

- A) an acid because they accept H⁺ ions
B) an acid because they donate H⁺ ions
C) a base because they accept H⁺ ions
D) a base because they donate H⁺ ions

26. Which species is amphoteric (amphiprotic)?

- A) H₂ B) H₂SO₄
C) HSO₄⁻ D) SO₄²⁻

27. The formula for the calcium salt of sulfuric acid is

- A) CaS B) Ca₂S
C) CaSO₄ D) Ca₂SO₄

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

- A) NaCl B) KOH
C) CH₃OH D) CH₃CHO

29. Equal volumes of 0.1 M NaOH and 0.1 M HCl are thoroughly mixed. The resulting solution has a pH closest to

- A) 5 B) 7 C) 3 D) 9

30. Potassium chloride, KCl, is a salt derived from the neutralization of a

- A) weak acid and a weak base
B) weak acid and a strong base
C) strong acid and a weak base
D) strong acid and a strong base

31. Which reaction occurs when hydrogen ions react with hydroxide ions to form water?

- A) substitution B) saponification
C) ionization D) neutralization

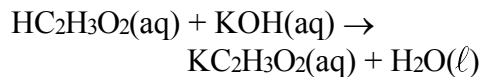
32. The acid and base in each of the following reactions completely neutralize each other. In which reaction is the final solution acidic?

- A) HCl(aq) + KOH(aq) → KCl(aq) + H₂O
B) H₂SO₄(aq) + 2 KOH(aq) → K₂SO₄(aq) + 2 H₂O
C) H₂S(aq) + 2 NaOH(aq) → Na₂S(aq) + 2 H₂O
D) HNO₃(aq) + NH₄OH(aq) → NH₄NO₃(aq) + H₂O

33. An aqueous solution of $\text{NaC}_2\text{H}_3\text{O}_2$ is basic. The salt $\text{NaC}_2\text{H}_3\text{O}_2$ can be derived from the reaction of a

- A) strong acid with a weak base
- B) strong acid with a strong base
- C) weak acid with a weak base
- D) weak acid with a strong base

34. Given the reaction:



The products of this reaction form a salt solution that is

- A) acidic and turns litmus blue
- B) acidic and turns litmus red
- C) basic and turns litmus blue
- D) basic and turns litmus red

35. Which volume of 0.10 M $\text{NaOH}(\text{aq})$ exactly neutralizes 15.0 milliliters of 0.20 M $\text{HNO}_3(\text{aq})$?

- A) 1.5 mL
- B) 7.5 mL
- C) 3.0 mL
- D) 30. mL

36. What volume of 0.500 M $\text{HNO}_3(\text{aq})$ must completely react to neutralize 100.0 milliliters of 0.100 M $\text{KOH}(\text{aq})$?

- A) 10.0 mL
- B) 20.0 mL
- C) 50.0 mL
- D) 500. mL

37. A student neutralized 16.4 milliliters of HCl by adding 12.7 milliliters of 0.620 M KOH . What was the molarity of the HCl acid?

- A) 0.168 M
- B) 0.480 M
- C) 0.620 M
- D) 0.801 M

38. During which process can 10.0 milliliters of a 0.05 M $\text{HCl}(\text{aq})$ solution be used to determine the unknown concentration of a given volume of $\text{NaOH}(\text{aq})$ solution?

- A) evaporation
- B) distillation
- C) filtration
- D) titration

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

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

40. The table below shows the color of an indicator in specific pH ranges.

Color	pH Range
Red	1–4
Orange	5–6
Green	6–7
Blue	8–10
Violet	11–14

If this indicator is used when titrating an unknown strong base by adding a strong acid, the color of the indicator will change from

- A) blue to green
- B) green to blue
- C) orange to green
- D) green to orange

41. When the salt NaHCO_3 is dissolved in water, the solution becomes

- A) basic due to the production of H_3O^+ ions
- B) acidic due to the production of H_3O^+ ions
- C) basic due to the production of OH^- ions
- D) acidic due to the production of OH^- ions

42. Which aqueous solution has a pH greater than 7?

- A) NaCl
- B) NaNO_3
- C) Na_2SO_4
- D) Na_2CO_3

43. Base your answer to the following question on the information below.

Vitamin C, also known as ascorbic acid, is water soluble and cannot be produced by the human body. Each day, a person's diet should include a source of vitamin C, such as orange juice. Ascorbic acid has a molecular formula of $C_6H_8O_6$ and a gram-formula mass of 176 grams per mole.

What is the color of the indicator thymol blue after it is added to an aqueous solution of vitamin C?

44. Base your answer to the following question on the information below.

A 20.0-milliliter sample of $HCl(aq)$ is completely neutralized by 32.0 milliliters of 0.50 M $KOH(aq)$.

According to the data, to what number of significant figures should the calculated molarity of the $HCl(aq)$ be expressed?

Base your answers to questions **45** and **46** on the information below.

In one trial of an investigation, 50.0 milliliters of $HCl(aq)$ of an unknown concentration is titrated with 0.10 M $NaOH(aq)$. During the titration, the total volume of $NaOH(aq)$ added and the corresponding pH value of the reaction mixture are measured and recorded in the table below.

Titration Data

Total Volume of $NaOH(aq)$ Added (mL)	pH Value of Reaction Mixture
10.0	1.6
20.0	2.2
24.0	2.9
24.9	3.9
25.1	10.1
26.0	11.1
30.0	11.8

45. In another trial, 40.0 milliliters of $HCl(aq)$ is completely neutralized by 20.0 milliliters of this 0.10 M $NaOH(aq)$. Calculate the molarity of the titrated acid in this trial. Your response must include *both* a numerical setup and the calculated result.

46. Write a balanced equation that represents this neutralization reaction.

Base your answers to questions **47** and **48** 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.

47. Sulfur dioxide, SO_2 , is one of the gases that reacts with water to produce acid rain. According to Reference Table *G*, describe how the solubility of sulfur dioxide in water is affected by an increase in water temperature.
48. Using information in the passage, describe *one* effect of acid rain on future generations of fish species in ponds and lakes.

Base your answers to questions **49** through **51** on the information below.

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.

49. Identify *one* compound that could be used to neutralize the sample from stream A.
50. Compare the hydronium ion concentration in stream A to the hydronium ion concentration in stream B.
51. What is the color of bromthymol blue in the sample from stream A?
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