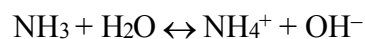


1. Which substance, when dissolved in water, forms a solution that conducts an electric current?  
 A) C<sub>2</sub>H<sub>5</sub>OH                      B) C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>  
 C) C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>                      D) CH<sub>3</sub>COOH
2. A substance 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
3. Which aqueous solution is the best conductor of an electrical current?  
 A) 0.01 M CH<sub>3</sub>OH    B) 0.01 M KOH  
 C) 0.1 M CH<sub>3</sub>OH    D) 0.1 M KOH
4. Which pair of formulas represents two compounds that are electrolytes?  
 A) HCl and CH<sub>3</sub>OH  
 B) HCl and NaOH  
 C) C<sub>5</sub>H<sub>12</sub> and CH<sub>3</sub>OH  
 D) C<sub>5</sub>H<sub>12</sub> and NaOH
5. An example of a nonelectrolyte is  
 A) C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>(aq)    B) K<sub>2</sub>SO<sub>4</sub>(aq)  
 C) NaCl(aq)                      D) HCl(aq)
6. Which compound is a nonelectrolyte?  
 A) HNO<sub>3</sub>                              B) H<sub>2</sub>SO<sub>4</sub>  
 C) NaOH                              D) CH<sub>3</sub>OH
7. Which compound is an Arrhenius acid?  
 A) H<sub>2</sub>SO<sub>4</sub>                              B) KCl  
 C) NaOH                              D) NH<sub>3</sub>
8. Which formula represents a hydronium ion?  
 A) H<sub>3</sub>O<sup>+</sup>                              B) NH<sub>4</sub><sup>+</sup>  
 C) OH<sup>-</sup>                                  D) HCO<sub>3</sub><sup>-</sup>
9. 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
10. Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?  
 A) HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>(aq) + NaOH(aq) → NaC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>(aq) + H<sub>2</sub>O(l)  
 B) C<sub>3</sub>H<sub>8</sub>(g) + 5 O<sub>2</sub>(g) → 3 CO<sub>2</sub>(g) + 4 H<sub>2</sub>O(l)  
 C) Zn(s) + 2 HCl(aq) → ZnCl<sub>2</sub>(aq) + H<sub>2</sub>(g)  
 D) BaCl<sub>2</sub>(aq) + Na<sub>2</sub>SO<sub>4</sub>(aq) → BaSO<sub>4</sub>(s) + 2 NaCl(aq)

11. Which compound is an Arrhenius base?  
 A) CH<sub>3</sub>OH                              B) CO<sub>2</sub>  
 C) LiOH                                  D) NO<sub>2</sub>
12. Hydrogen chloride, HCl, is classified as an Arrhenius acid because it produces  
 A) H<sup>+</sup> ions in aqueous solution  
 B) Cl<sup>-</sup> ions in aqueous solution  
 C) OH<sup>-</sup> ions in aqueous solution  
 D) NH<sub>4</sub><sup>+</sup> ions in aqueous solution
13. According to the Arrhenius theory, when a base dissolves in water it produces  
 A) CO<sub>3</sub><sup>2-</sup> as the only negative ion in solution  
 B) OH<sup>-</sup> as the only negative ion in solution  
 C) NH<sub>4</sub><sup>+</sup> as the only positive ion in solution  
 D) H<sup>+</sup> as the only positive ion in solution
14. Which substance is an Arrhenius acid?  
 A) LiF(aq)                              B) HBr(aq)  
 C) Mg(OH)<sub>2</sub>(aq)                      D) CH<sub>3</sub>CHO
15. What produces hydrogen ions as the only positive ions in aqueous solution?  
 A) KOH                                  B) HBr  
 C) NH<sub>3</sub>                                  D) NaCl
16. When HCl is dissolved in water, the only positive ion present in the solution is the  
 A) hydrogen ion                      B) hydroxide ion  
 C) hydride ion                          D) chloride ion
17. According to one acid-base theory, a water molecule acts as an acid when the water molecule  
 A) accepts an H<sup>+</sup>                      B) accepts an OH<sup>-</sup>  
 C) donates an H<sup>+</sup>                      D) donates an OH<sup>-</sup>
18. One acid-base theory states that an acid is  
 A) an H<sup>-</sup> donor                      B) an H<sup>-</sup> acceptor  
 C) an H<sup>+</sup> donor                      D) an H<sup>+</sup> acceptor
19. Given the reaction:



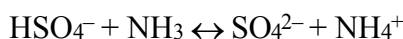
The water acts as the

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

20. According to "alternative theory" of acids and bases, an acid is any species that

- A) releases hydroxide ions into solution
- B) releases oxide ions into solution
- C) donates protons to another species
- D) accepts protons from another species

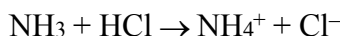
21. Given the reaction at equilibrium:



What are the two species that are acids?

- A)  $\text{NH}_3$  and  $\text{NH}_4^+$
- B)  $\text{NH}_3$  and  $\text{SO}_4^{2-}$
- C)  $\text{HSO}_4^-$  and  $\text{SO}_4^{2-}$
- D)  $\text{HSO}_4^-$  and  $\text{NH}_4^+$

22. In the reaction:



The  $\text{NH}_3$  acts as

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

23. According to an "alternative theory",  $\text{H}_2\text{O}$  is considered to be a base when it

- A) donates an electron
- B) accepts an electron
- C) donates a proton
- D) accepts a proton

24. According to Reference Table V, which ion is amphiprotic (amphoteric)?

- A)  $\text{HPO}_4^{2-}$       B)  $\text{PO}_4^{3-}$
- C)  $\text{NH}_2^-$       D)  $\text{S}^{2-}$

25. Which species is amphoteric (amphiprotic)?

- A)  $\text{H}_2$       B)  $\text{H}_2\text{SO}_4$
- C)  $\text{HSO}_4^-$       D)  $\text{SO}_4^{2-}$

26. Which species is amphoteric?

- A)  $\text{H}_2\text{S}$    B)  $\text{HS}^-$    C)  $\text{Cl}^-$    D)  $\text{HCl}$

27. What is the pH of a solution that has a hydronium ion concentration 100 times greater than a solution with a pH of 4?

- A) 5      B) 2      C) 3      D) 6

28. 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

29. Solution *A* has a pH of 3 and solution *Z* has a pH of 6. How many times greater is the hydronium ion concentration in solution *A* than the hydronium ion concentration in solution *Z*?

- A) 100      B) 2
- C) 3      D) 1000

30. A hydrogen ion,  $\text{H}^+$ , in aqueous solution may also be written as

- A)  $\text{H}_2\text{O}$       B)  $\text{H}_2\text{O}_2$
- C)  $\text{H}_3\text{O}^+$       D)  $\text{OH}^-$

31. Which statement correctly describes a solution with a pH of 9?

- A) It has a higher concentration of  $\text{H}_3\text{O}^+$  than  $\text{OH}^-$  and causes litmus to turn blue.
- B) It has a higher concentration of  $\text{OH}^-$  than  $\text{H}_3\text{O}^+$  and causes litmus to turn blue.
- C) It has a higher concentration of  $\text{H}_3\text{O}^+$  than  $\text{OH}^-$  and causes methyl orange to turn yellow.
- D) It has a higher concentration of  $\text{OH}^-$  than  $\text{H}_3\text{O}^+$  and causes methyl orange to turn red.

32. Which pH change represents a hundredfold increase in the concentration of  $\text{H}_3\text{O}^+$ ?

- A) pH 5 to pH 7      B) pH 13 to pH 14
- C) pH 3 to pH 1      D) pH 4 to pH 3

33. Which pH indicates a basic solution?

- A) 1      B) 5      C) 7      D) 12

34. Which of these pH numbers indicates the highest level of acidity?

- A) 5      B) 8      C) 10      D) 12

35. When the pH of a solution changes from a pH of 5 to a pH of 3, the hydronium ion concentration is

- A) 0.01 of the original content
- B) 0.1 of the original content
- C) 10 times the original content
- D) 100 times the original content

36. 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

37. Which of these 1 M solutions will have the highest pH?

A) NaOH                      B)  $CH_3OH$

C) HCl                      D) NaCl

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

A) It changes blue litmus to red and has a pH less than 7.

B) It changes blue litmus to red and has a pH greater than 7.

C) It changes red litmus to blue and has a pH less than 7.

D) It changes red litmus to blue and has a pH greater than 7.

39. As an aqueous solution becomes more acidic, the hydroxide ion concentration

A) decreases                      B) increases

C) remains the same

40. As HCl(g) is added to water, the pH of the water solution

A) decreases                      B) increases

C) remains the same

41. Which 0.1-molar aqueous solution is the best conductor of electricity?

A)  $H_2S$                       B) HF

C)  $H_2SO_4$                       D)  $H_3PO_4$

42. Which solution is the best conductor of electricity?

A) 0.1 M HCl(aq)

B) 0.1 M  $CH_3OH$ (aq)

C) 0.1 M  $NH_3$ (aq)

D) 0.1 M  $CH_3COOH$ (aq)

43. What is the pH of a 0.0001 M aqueous solution of HCl?

A) 1    B) 2    C) 3    D) 4

44. What is the pH of a 0.001 M  $HNO_3$  solution?

A) 1    B) 2    C) 3    D) 11

45. The  $[H_3O^+]$  of a solution is  $1 \times 10^{-8}$ . This solution has a pH of

A) 6, which is acidic    B) 8, which is basic

C) 6, which is basic    D) 8, which is acidic

46. The table below shows the color of the indicators methyl orange and litmus in two samples of the same solution.

**Results of Acid-Base Indicator Tests**

Indicator	Color Results from the Indicator Test
methyl orange	yellow
litmus	red

Which pH value is consistent with the indicator results?

A) 1    B) 5    C) 3    D) 10

47. In which 0.01 M solution is phenolphthalein pink?

A)  $CH_3OH$ (aq)                      B)  $Ca(OH)_2$ (aq)

C)  $CH_3COOH$ (aq)                      D)  $HNO_3$ (aq)

48. Which indicator is yellow in a solution with a pH of 9.8?

A) methyl orange                      B) bromthymol blue

C) bromcresol green    D) thymol blue

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

A) 0.1 M  $CH_3COOH$

B) 0.1 M KOH

C) 0.1 M HCl

D) 0.1 M  $H_2SO_4$

50. According to Reference Table M, what is the color of the indicator methyl orange in a solution that has a pH of 2?

A) blue                      B) yellow

C) orange                      D) red

51. 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

52. A compound whose water solution conducts electricity and turns phenolphthalein pink is

A) HCl                      B)  $HC_2H_3O_2$

C) NaOH                      D)  $CH_3OH$

53. A solution with a pH of 11 is first tested with phenolphthalein and then with litmus. What is the color of each indicator in this solution?

- A) Phenolphthalein is colorless and litmus is blue.
- B) Phenolphthalein is colorless and litmus is red.
- C) Phenolphthalein is pink and litmus is blue.
- D) Phenolphthalein is pink and litmus is red.

54. A student dissolves a substance in water, tests the resulting solution, and observes that red litmus paper turns blue. Based on this result, the solution is

- A) organic                      B) inorganic
- C) basic                         D) acidic

55. Both  $\text{HNO}_3(\text{aq})$  and  $\text{CH}_3\text{COOH}(\text{aq})$  can be classified as

- A) Arrhenius acids that turn blue litmus red
- B) Arrhenius bases that turn blue litmus red
- C) Arrhenius acids that turn red litmus blue
- D) Arrhenius bases that turn red litmus blue

56. The ability of  $\text{H}_2\text{SO}_4(\text{aq})$  to change blue litmus red is mainly due to the presence of

- A)  $\text{SO}_2$  molecules      B)  $\text{H}_2\text{O}$  molecules
- C)  $\text{H}_3\text{O}^+(\text{aq})$  ions     D)  $\text{SO}_4^{2-}(\text{aq})$  ions

57. The results of testing a colorless solution with three indicators are shown in the table below.

Indicator	Result
red litmus	blue
blue litmus	blue
phenolphthalein	pink

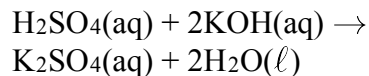
Which formula could represent the solution tested?

- A)  $\text{NaOH}(\text{aq})$                 B)  $\text{HCl}(\text{aq})$
- C)  $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq})$          D)  $\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{aq})$

58. If the pH of a solution is 9, the solution is

- A) acidic, which turns phenolphthalein pink
- B) acidic, which turns phenolphthalein colorless
- C) basic, which turns phenolphthalein pink
- D) basic, which turns phenolphthalein colorless

59. Given the balanced equation representing a reaction:



Which type of reaction is represented by this equation?

- A) decomposition
- B) neutralization
- C) single replacement
- D) synthesis

60. Which equation represents a neutralization reaction?

- A)  $4\text{Fe}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s})$
- B)  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\ell)$
- C)  $\text{HNO}_3(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{KNO}_3(\text{aq}) + \text{H}_2\text{O}(\ell)$
- D)  $\text{AgNO}_3(\text{aq}) + \text{KCl}(\text{aq}) \rightarrow \text{KNO}_3(\text{aq}) + \text{AgCl}(\text{s})$

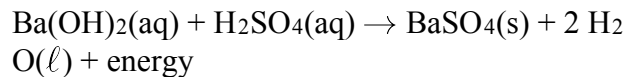
61. Which reactants form the salt  $\text{CaSO}_4(\text{s})$  in a neutralization reaction?

- A)  $\text{H}_2\text{S}(\text{g})$  and  $\text{Ca}(\text{ClO}_4)_2(\text{s})$
- B)  $\text{H}_2\text{SO}_3(\text{aq})$  and  $\text{Ca}(\text{NO}_3)_2(\text{aq})$
- C)  $\text{H}_2\text{SO}_4(\text{aq})$  and  $\text{Ca}(\text{OH})_2(\text{aq})$
- D)  $\text{SO}_2(\text{g})$  and  $\text{CaO}(\text{s})$

62. Sulfuric acid,  $\text{H}_2\text{SO}_4(\text{aq})$ , can be used to neutralize barium hydroxide,  $\text{Ba}(\text{OH})_2(\text{aq})$ . What is the formula for the salt produced by this neutralization?

- A)  $\text{BaS}$                                 B)  $\text{BaSO}_2$
- C)  $\text{BaSO}_3$                             D)  $\text{BaSO}_4$

63. Given the reaction:



As the barium hydroxide solution is added to the solution of sulfuric acid, the electrical conductivity of the acid solution decreases because the

- A) volume of the reaction mixture increases
- B) temperature of the reaction mixture decreases
- C) concentration of ions increases
- D) concentration of ions decreases

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

- A) NaCl                      B) KOH  
C) CH<sub>3</sub>OH                  D) CH<sub>3</sub>CHO

65. Which equation represents a neutralization reaction?

- A) Na<sub>2</sub>CO<sub>3</sub> + CaCl<sub>2</sub> → 2 NaCl + CaCO<sub>3</sub>  
B) Ni(NO<sub>3</sub>)<sub>2</sub> + H<sub>2</sub>S → NiS + 2 HNO<sub>3</sub>  
C) NaCl + AgNO<sub>3</sub> → AgCl + NaNO<sub>3</sub>  
D) H<sub>2</sub>SO<sub>4</sub> + Mg(OH)<sub>2</sub> → MgSO<sub>4</sub> + 2 H<sub>2</sub>O

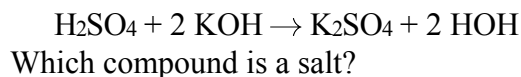
66. Equal volumes of 0.1 M NaOH and 0.1 M HCl are thoroughly mixed. The resulting solution has a pH closest to

- A) 5    B) 7    C) 3    D) 9

67. As an acid solution is added to neutralize a base solution, the OH<sup>-</sup> concentration of the base solution

- A) decreases                  B) increases  
C) remains the same

68. Given the neutralization reaction:

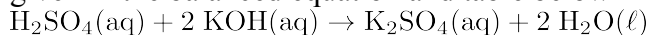


- A) KOH                      B) H<sub>2</sub>SO<sub>4</sub>  
C) K<sub>2</sub>SO<sub>4</sub>                  D) HOH

69. Which acid-base pair will always undergo a reaction that produces a neutral solution?

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

70. 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)?

- A) 0.12 M                      B) 0.16 M  
C) 0.24 M                      D) 0.96 M

71. 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)?

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

72. How many milliliters of 0.100 M NaOH(aq) would be needed to completely neutralize 50.0 milliliters of 0.300 M HCl(aq)?

- A) 16.7 mL                  B) 50.0 mL  
C) 150. mL                  D) 300. mL

73. 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

74. 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

75. When 50. milliliters of an HNO<sub>3</sub> solution is exactly neutralized by 150 milliliters of a 0.50 M solution of KOH, what is the concentration of HNO<sub>3</sub>?

- A) 1.0 M                      B) 1.5 M  
C) 3.0 M                      D) 0.5 M

76. 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?

- A) 0.10 M                  B) 0.20 M  
C) 0.30 M                  D) 0.40 M

77. How many liters of 2.5 M HCl are required to exactly neutralize 1.5 liters of 5.0 M NaOH?

- A) 1.0 L                      B) 2.0 L  
C) 3.0 L                      D) 4.0 L

78. How many milliliters of 0.600 M H<sub>2</sub>SO<sub>4</sub> are required to exactly neutralize 100. milliliters of 0.300 M Ba(OH)<sub>2</sub>?

- A) 25.0 mL                  B) 50.0 mL  
C) 100. mL                  D) 200. mL

79. How many hydroxide ions are needed to completely neutralize 1.0 liter of 0.50 M HCl?

- A) 1.5 × 10<sup>23</sup> ions          B) 3.0 × 10<sup>23</sup> ions  
C) 6.0 × 10<sup>23</sup> ions          D) 12 × 10<sup>23</sup> ions

## Acid Base Review

80. How many milliliters of 0.20 M KOH are needed to completely neutralize 90.0 milliliters of 0.10 M HCl?

- A) 25 mL                      B) 45 mL  
C) 90. mL                     D) 180 mL

81. What is the molarity of a nitric acid solution, HNO<sub>3</sub>, if 20.0 mL of the solution is needed to exactly neutralize 10.0 mL of a 1.67 M NaOH solution?

- A) 3.34 M                      B) 1.67 M  
C) 0.835 M                    D) 0.334 M

82. The pH of a solution that is formed by the neutralization of 1.0 M H<sub>2</sub>SO<sub>4</sub> and 1.0 M KOH is closest to

- A) 1    B) 7    C) 10    D) 4

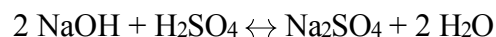
83. If equal volumes of 0.1 M NaOH and 0.1 M HCl are mixed, the resulting solution will contain a salt and

- A) HCl                          B) NaOH  
C) H<sub>2</sub>O                          D) NaCl

84. How many milliliters of 0.010 M NaOH are required to exactly neutralize 20.0 milliliters of 0.020 M HCl?

- A) 10. mL                      B) 20. mL  
C) 30. mL                      D) 40. mL

85. Given the reaction:



How many milliliters of 1 M NaOH are needed to exactly neutralize 100 milliliters of 1 M H<sub>2</sub>SO<sub>4</sub>?

- A) 50 ml                        B) 200 ml  
C) 300 ml                      D) 400 ml