Chemistry — Acid-Base Multiple Choice Questions

__C__ 1. Which of these substances is an Arrhenius acid?

    A. $C_2H_6(g)$ B. $CH_4(g)$ C. $HBr(g)$ D. $KOH(s)$

__B__ 2. Which statement is true?

    A. $BF_3(g) + NH_3(g) \rightarrow BF_3NH_3(s)$ is an example of a Brønsted-Lowry reaction.

    B. $H_3O^+(aq) + OH^-(aq) \rightarrow 2H_2O(l)$ is an example of a Brønsted-Lowry reaction.

    C. The Brønsted-Lowry Theory states that an acid and a base react through electron transfer.

    D. The hydroxide ion is normally a Brønsted-Lowry acid.

__B__ 3. If equal volumes of 0.10 mol/L $HCl(aq)$ solution and 0.10 mol/L $CH_3COOH(aq)$ solution are compared, which would be true of the $CH_3COOH(aq)$?

    A. It would have a higher hydronium ion concentration.

    B. It would have a higher pH.

    C. It would produce a larger volume of hydrogen gas when reacted with zinc.

    D. It would require a greater volume of 0.10 mol/L $NaOH(aq)$ solution for neutralization.

__A__ 4. Water can act as either an acid or a base. Which equation represents water reacting as an acid?

    A. $H_2O(l) + NH_3(g) \leftrightharpoons OH^-(aq) + NH_4^+(aq)$ C. $H_2O(l) + HCl(aq) \leftrightharpoons H_3O^+ + Cl^-(aq)$

    B. $H_2O(l) \leftrightharpoons H_2(g) + \frac{1}{2}O_2(g)$ D. $H_2O(l) + C(s) \leftrightharpoons CO(g) + H_2(g)$

__D__ 5. 11.2 g of potassium hydroxide (KOH) is dissolved in sufficient water to make 1 L of solution. What is the concentration of KOH in the solution?

    A. 0.01 mol/L   B 0.02 mol/L   C. 0.1 mol/L   D. 0.2 mol/L

__C__ 6. If 0.012 mol of solid sodium hydroxide is added to 1 L of 0.010 mol/L hydrochloric acid solution, what is the pH of the solution?

    A. 2.7   B. 3.3   C. 11.3   D. 13.1

__C__ 7. What is the pH of a 0.015 mol/L aqueous solution of HCl (hydrochloric acid)?

    A. 0.015   B. 0.085   C. 1.82   D. 2.18

__C__ 8. A student recorded observations regarding colours of various indicators in an unknown acid solution:

    I. The solution turns red with the addition of methyl red.

    II. The solution turns blue with the addition of indigo carmine.

    III. The solution turns blue with the addition of bromothymol blue.

    IV. The solution turns blue litmus paper red.

    Which observation is **inconsistent** with the other observations.

    A. Observation I   B. Observation II   C. Observation III   D. Observation IV

__C__ 9. If 46.25 mL of 0.861 M $CH_3COOH(aq)$ is required to titrate a 0.933 M $LiOH(aq)$ solution, what is the volume of the $LiOH(aq)$

    A. 0.0234 mL   B. 37.15 mL   C. 42.68 mL   D. 50.12 mL

__B__ 10. What is one property of acids?

    A. Acidic solutions feel slippery.   C. Acids taste bitter.

    B. Acids react with certain metals to generate hydrogen.   D. Acids turn red litmus paper blue.

__B__ 11. According to Arrhenius, what does the reaction $Ba(OH)_2(s) \rightarrow Ba^{2+}(aq) + 2OH^-(aq)$ represent?

    A. dissociation of an acid.   C. formation of an acidic solution

    B. dissociation of a base.   D. formation of a neutral solution

__A__ 12. According to the Brønsted-Lowry theory, what is a base?

    A. a hydrogen ion (proton) acceptor

    B. an electrolyte

    C. a nonelectrolyte

    D. a substance that increases the hydrogen (hydronium) ion concentration

__D__ 13. Which equation shows an acid-base neutralization reaction?

    A. $Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$ C. $H_2CO_3(aq) \rightarrow CO_2(aq) + H_2O(l)$

    B. $2NaOH(aq) + CaCl_2(aq) \rightarrow 2NaCl(aq) + Ca(OH)_2(s)$ D. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

__C__ 14. What are the Brønsted-Lowry acids in this reaction?

$$H_2O(l) + HPO_4^{2-}(aq) \leftrightharpoons H_2PO_4^-(aq) + OH^-(aq)$$

    A. $HPO_4^{2-}(aq)$ and $OH^-(aq)$ B. $H_2O(l)$ and $HPO_4^{2-}(aq)$ C. $H_2O(l)$ and $H_2PO_4^-(aq)$ D. $H_2O(l)$ and $OH^-(aq)$

__B__ 15. What does the strength of an acid depend upon?
- A. concentration of the acid
- B. extent to which the acid ionizes
- C. time it takes the acid to neutralize a base
- D. volume of the acid

__A__ 16. What is the hydrogen ion concentration in lemon juice that has a pH of 3.0?
- A. 1×10^{-3} mol/L
- B. 1×10^{-11} mol/L
- C. 1×10^{-14} mol/L
- D. 3×10^{-1} mol/L

__C__ 17. Which describes tap water that has a pH of 8?
- A. acidic with $[H^+] = 10^{-8}$ mol/L
- B. acidic with $[OH^-] = 10^{-8}$ mol/L
- C. basic with $[H^+] = 10^{-8}$ mol/L
- D. basic with $[OH^-] = 10^{-8}$ mol/L

__C__ 18. What is the pH of a 0.001 mol/L aqueous solution of NaOH?
- A. 3
- B. 4
- C. 11
- D. 14

__D__ 19. What does a K_a of 2.8×10^{-11} imply about an acid?
- A. It is a strong acid.
- B. It is extremely soluble.
- C. It is highly ionized.
- D. It is very slightly ionized.

__C__ 20. In a titration experiment, 18.62 mL of 0.0975 mol/L HNO_3 acid was needed to completely neutralize 20.0 mL of KOH(aq). What was the concentration of the KOH(aq)?
- A. 0.001 91 mol/L
- B. 0.00382 mol/L
- C. 0.0908 mol/L
- D. 0.105 mol/L

__A__ 21. Which is *not* and operational (i.e., empirical) definition of a base?
- A. decreases the hydrogen ion concentration
- B. feels slippery
- C. has a bitter taste
- D. turns red litmus paper blue.

__B__ 22. According to the Arrhenius theory, what causes the characteristic properties of bases?
- A. aqueous hydrogen ions
- B. aqueous hydroxide ions
- C. lone pairs of electrons in the base molecule
- D. proton donors in the base molecule

__C__ 23. According to the Brønsted-Lowry theory, what is a base?
- A. electron acceptor
- B. electron donor
- C. hydrogen ion acceptor
- D. hydrogen ion donor

__C__ 24. What are the Brønsted-Lowry bases in the following equation?
$$HSO_3^-(aq) + H_2O(l) \leftrightharpoons H_2SO_3(aq) + OH^-(aq)$$
- A. $H_2O(l)$ and $H_2SO_3(aq)$
- B. $HSO_3^-(aq)$ and $H_2O(l)$
- C. $HSO_3^-(aq)$ and $OH^-(aq)$
- D. $H_2SO_3(aq)$ and $OH^-(aq)$

__C__ 25. How would a 0.001 mol/L solution of an acid that ionizes completely in solution be classified?
- A. concentrated and strong
- B. concentrated and weak
- C. dilute and strong
- D. dilute and weak

__B__ 26. According to the Brønsted-Lowry concept, how would a substance that can act as an acid in some reactions and as a base in other reactions be classified?
- A. acid-base pair
- B. amphoteric
- C. conjugate
- D. neutral

__C__ 27. A drop in pH level of 2 in an aquarium would mean that the acidity, as measured by $[H^+]$, had changed by what factor?
- A. 2
- B. 10
- C. 100
- D. 1000

__C__ 28. A pH meter used to test a freshly opened carbonated soft drink gives a reading of 3.14. What is the $[H^+]$?
- A. 7.2×10^{-2} mol/L
- B. 3.1×10^{-3} mol/L
- C. 7.2×10^{-4} mol/L
- D. 3.1×10^{-5} mol/L

__D__ 29. Which numerical value of K_a indicates the *strongest* acid?
- A. 1×10^{-7}
- B. 1.7×10^{-4}
- C. 6.7×10^{-4}
- D. 7.1×10^{-3}

__A__ 30. For complete neutralization, 15.0 mL of 0.35 mol/L NaOH(aq) solution was required to react with 0.425 g of an acid. What is the possible identity of the acid?
- A. HBr(aq)
- B. HCl(aq)
- C. HNO_3(aq)
- D. H_2SO_4(aq)

__D__ 31. When a weak base such as NH_3(aq) is titrated with HCl(aq), what is the pH at the equivalence point?
- A. equal to 0
- B. equal to 7
- C. greater than 7
- D. less than 7

__B__ 32. A student found that orange IV indicator turned yellow and methyl orange turned red in samples of an unknown solution. What is the pH for the unknown solution likely to be?
- A. 1.2
- B. 3.0
- C. 5.3
- D. 9.0

__C__ 33 Which substance can be called an Arrhenius base?
- A. CH_3OH
- B. HBr
- C. KOH
- D. NaCl

__D__ 34. What is the pH of a solution if the OH^-(aq) ion concentration is 2.5×10^{-3} mol/L?
- A. 2.6
- B. 8.6
- C. 9.8
- D. 11.4

__A__ 35. According to the Arrhenius definition of acids and bases, what does an acid do when it is dissolved in water?
   A. increases the hydrogen ion concentration
   B. increases the hydroxide ion concentration
   C. turns blue litmus paper red
   D. turns red litmus paper blue

__D__ 36. Why is acetic acid classified as a weak acid?
   A. It does not ionize in water.
   B. It does not neutralize bases.
   C. It gives vinegar a sour taste.
   D. It ionizes slightly in water.

__A__ 37. In the Brønsted-Lowry theory, what must a base do?
   A. accept a proton during a collision with an acid
   B. dissociate in aqueous solution
   C. raise the hydrogen ion concentration of an aqueous solution above 1.0×10^{-7} mol/L
   D. taste bitter and feel slippery

__A__ 38. What are the two Brønsted-Lowry acids in the reaction:
$$HNO_2(aq) + H_2O(aq) \leftrightarrows H_3O^+(aq) + NO_2^-(aq)$$
   A. HNO_2 and H_3O^+
   B. H_2O and HNO_2
   C. H_2O and H_3O^+
   D. H_2O and NO_2^-

__C__ 39. If aluminum hydroxide is an amphoteric compound, what can be said about it?
   A. It can act as a base in the presence of strong bases.
   B. It can act as a base in the presence of weak bases.
   C. It can act as either an acid or a base.
   D. It is a strong base,

__B__ 40. What happens to the concentration of hydroxide ion if the pH decreases from 11.5 to 8.5 during a reaction?
   A. It decreases by a factor of 3.
   B. It decreases by a factor of 1000.
   C. It increases by a factor of 3.
   D. It increases by a factor of 1000.

__B__ 41. What is the hydroxide ion concentration in an aqueous solution in which the hydronium ion concentration is 1×10^{-5} mol/L?
   A. 1×10^{-14} mol/L
   B. 1×10^{-9} mol/L
   C. 1×10^{-7} mol/L
   D. 1×10^{-5} mol/L

__C__ 42. In a titration experiment, 20.0 mL of HBr was needed to completely neutralize 40.0 mL of 0.10 mol/L KOH. What was the concentration of the acid?
   A. 0.0080 mol/L
   B. 0.080 mol/L
   C. 0.20 mol/L
   D. 2.0 mol/L

__B__ 43. An unidentified aqueous solution is a strong electrolyte that causes blue litmus to turn red. Which of the following could be the solution?
   A. $CH_3OH(aq)$
   B. $HBr(aq)$
   C. $KOH(aq)$
   D. $NaCl(aq)$

__A__ 44. Which of the four statements are true?
   1. Acids increase the concentration of hydrogen ions in solution.
   2. Acids increase the concentration of hydroxide ions in solution.
   3. Acids increase the pH of a solution.
   4. Acids react with magnesium to produce hydrogen gas.
   A. 1 and 4
   B. 2 and 4
   C. 1, 2, and 4
   D. 2, 3, and 4

__D__ 45. Which equation represents the reaction of $HSO_3^-(aq)$ as an acid?
   A. $HSO_3^-(aq) + H^+(aq) \leftrightarrows H_2SO_3(aq)$
   B. $HSO_3^-(aq) + H_2O(l) \leftrightarrows H_2SO_3(aq) + OH^-(aq)$
   C. $HSO_3^-(aq) + H_3O^+(aq) \leftrightarrows H_2SO_3(aq) + H_2O(l)$
   D. $HSO_3^-(aq) + NH_3(aq) \leftrightarrows SO_3^{2-}(aq) + NH_4^+(aq)$

__D__ 46. Which equation shows an acid-base neutralization reaction?
   A. $Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$
   B. $2NaOH(aq) + CaCl_2(aq) \rightarrow 2NaCl(aq) + Ca(OH)_2(s)$
   C. $H_2CO_3(aq) \rightarrow CO_2(g) + H_2O(l)$
   D. $NaOH(aq) + HCl(aq) + NaCl(aq) + H_2O(l)$

__B__ 47. Which phrase describes a weak aqueous acid?
   A. highly dissociated
   B. partially ionized
   C. unreactive with zinc
   D. very dilute

__A__ 48. Which property is characteristic of solutions of both strong acids and strong bases?
   A. are good conductors of electricity
   B. have a pH of 7
   C. react with zinc to produce hydrogen gas
   D. turn red litmus blue

__D__ 49. If egg whites have a hydroxide ion concentration of 3.3×10^{-7} mol/L, what is the hydrogen ion concentration?
   A. 3.3×10^7 mol/L
   B. 1.0×10^{-7} mol/L
   C. 6.7×10^{-8} mol/L
   D. 3.0×10^{-8} mol/L

__C__ 50. A weak acid, HA, ionizes according to the equation: $HA(aq) \leftrightarrows H^+(aq) + A^-(aq)$
If a 0.10 mol/L HA(aq) solution has $[H^+] = 0.0010$ mol/L, what is the numerical value of K_a?
   A. 1.0×10^{-1} mol/L
   B. 1.0×10^{-3} mol/L
   C. 1.0×10^{-5} mol/L
   D. 1.0×10^{-6} mol/L

__D__ 51. What is the concentration of NaOH(aq) solution, if 30.0 mL of 1.0 mol/L HCN(aq) neutralizes 25.0 mL of the NaOH(aq) solution?
   A. 0.25 mol/L
   B. 0.83 mol/L
   C. 1.0 mol/L
   D. 1.2 mol/L

__C__ 52. The Ka values of some monoprotic acids are shown in the table:

Acid	K_a value
Acetic acid	1.8×10^{-5} mol/L
Benzoic acid	6.4×10^{-5} mol/L
Formic acid	1.8×10^{-4} mol/L
Hydrocyanic acid	6.2×10^{-10} mol/L

A 0.10 mol/L solution of which acid would contain the most ions?

A. acetic acid   B. benzoic acid   C. formic acid   D. hydrocyanic acid

__A__ 53. What is the pH of the equivalence point of a titration of HCl(aq) with NaOH(aq)?

A. equals 7   B. greater than 7.0   C. less than 7   D. unknown

__B__ 54. Which statements are characteristic of acids?

1. They turn blue litmus red.   3. They taste sour.
2. They react with bases to produce a salt and hydrogen.   4. They neutralize bases.

A. 1 and 4   B. 1, 3, and 4   C. 2 and 4   D. 2, 3, and 4

__B__ 55. Which are the Brønsted-Lowry bases in this reaction?

$$HCOO^-(aq) + H_2O(l) \leftrightarrows HCOOH(aq) + OH^-(aq)$$
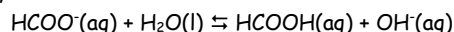
A. $HCOO^-$ and $HCOOH$ B. $HCOO^-$ and OH^- C. H_2O and $HCOOH$ D. H_2O and OH^-

__C__ 56. What is the conjugate base of $H_2PO_3^-$(aq)

A. $H_3PO_3(aq)$ B. $H_2PO_4^-(aq)$ C. $HPO_3^{2-}(aq)$ D. $PO_3^{2-}(aq)$

__A__ 57. Which acts as an amphoteric species in aqueous solution?

A. HCO_3^- B. HNO_3 C. PO_4^{3-} D. SO_4^{2-}

__C__ 58. If a 0.1 mol/L solution has a pH of 4, what is the solution likely to be?

A. a strong acid   B. a strong base   C. a weak acid   D. a weak base

__B__ 59. Which solution would have the lowest pH?

A. 0.1 mol/L $CH_3COOH(aq)$ C. 0.1 mol/L $NaOH(aq)$
B. 0.1 mol/L $HCl(aq)$ D. 0.1 mol/L $NH_3(aq)$

__A__ 60. What is the $[H_3O^+]$ of seawater that has a pH of 8.10?

A. 7.9×10^{-9} mol/L   B. 1.0×10^{-8} mol/L   C. 1.3×10^{-6} mol/L   D. 8.0×10^{-1} mol/L

__D__ 61. A solution of milk of magnesia, $Mg(OH)_2$(aq), has a pH of 10.40. What is its $[OH^-]$?

A. 4.0×10^{-11} mol/L   B. 1.0×10^{-7} mol/L   C. 1.0×10^{-4} mol/L   D. 2.5×10^{-4} mol/L

__D__ 62. Which of the following solutions has the greatest hydroxide ion concentration?

A. a buffer solution with pH = 5   C. 0.1 mol/L HCl
B. 0.1 mol/L CH_3COOH D. pure water

__C__ 63. What is the main reaction that occurs when hydrochloric acid is added to the Na_CH_3COO-CH_3COOH buffer?

A. $CH_3COOH(aq) + Cl^-(aq) \leftrightarrows HCl(aq) + CH_3COO^-$ C. $H_3O^+(aq) + CH_3COO^-(aq) \leftrightarrows CH_3COOH(aq) + H_2O(l)$
B. $HCl(aq) + OH^-(aq) \leftrightarrows H_2O(l) + Cl^-(aq)$ D. $H_3O^+(aq) + OH^-(aq) \leftrightarrows 2H_2O(l)$

__B__ 64. Why does the addition of a small volume of dilute HCl(aq) to a mixture of aqueous solutions of CH_3COOH and $NaCH_3COO$ have little effect on the pH?

A. $H_3O^+(aq)$ ions in the buffer solution inhibit the ionization of the HCl(aq)
B. The $CH_3COO^-(aq)$ ions in the buffer solution react with the $H_3O^+(aq)$ ions from the HCl(aq)
C. The quantity of $H_3O^+(aq)$ ions produced by the $CH_3COOH(aq)$ approximately equals the $H_3O^+(aq)$ ions produced by the HCl(aq)
D. The volume of the solution is not increased to a significant extent.

__B__ 65. Which of the following is amphiprotic (amphoteric)?

A. Cl^- B. HCO_3^- C. HCl D. NH_4^+

__B__ 66. What is the pH of a solution that contains 0.25 mol of HBr in 750 mL of solution?

A. 0.33   B. 0.48   C. 0.60   D. 3.5

__A__ 67. A solution of sodium hydroxide, NaOH(aq), contains the indicator bromothymol blue. If hydrochloric acid, HCl(aq), is added drop by drop to the NaOH(aq), what will be the order of the color changes?

A. blue to green to yellow   B. blue to yellow to green   C. green to blue to yellow   D. yellow to green to blue

__B__ 68. The juice of the lime has a hydronium ion concentration which is about 100 000 times greater than that of pure water. What is the approximate pH of lime juice?

A. 1.0   B. 2.1   C. 3.6   D. 5.2