CHem.G11-Q3W3-Acids and bases reactions-Qs. Bank

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. The total number of possible different kinds of acid-base reactions is _____.
a. 1
b. 2
c. 3
d. 4

____ 2. The reaction between an acid and a base always results in the formation of _____.
a. a salt
b. an acid anhydride
c. a basic anhydride
d. a spectator ion

____ 3. The type of acid-base reaction that always goes to completion is the reaction between _____.
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

____ 4. The best way to represent water in an ionic equation is as _____.
a. $H^+ + OH^-$
b. $H^+(aq) + OH^-(aq)$
c. $H_2O(l)$
d. $H_2O(aq)$

____ 5. The spectator ions in the reaction between HNO_3 and NH_4OH are _____.
a. $NH_4^+ + NO_3^-$
b. $H^+ + OH^-$
c. $NH_4^+ + OH^-$
d. $H^+ + NO_3^-$

____ 6. According to the Bronsted-Lowry definition, an acid is a substance that _____.
a. releases H^+ in solution
b. donates hydrogen atoms
c. accepts protons
d. donates protons

____ 7. In the reaction $CO_3^{2-} + H^+ \rightarrow HCO_3^-$, the base is _____.
a. CO_3^{2-}
b. H^+
c. HCO_3
d. not shown

____ 8. The effect of antacid on stomach fluids is to _____.
a. make them neutral
b. make them basic
c. increase their pH
d. decrease their pH

Yes/No
Indicate whether you agree with the statement.

____ 9. $NH_4CN + HCl$ could be combined to form a buffer solution.

____ 10. $NaOH + HCl$ could be combined to form a buffer solution.

____ 11. $KC_2H_3O_2 + HC_2H_3O_2$ could be combined to form a buffer solution.

____ 12. $HNO_3 + KNO_3$ could be combined to form a buffer solution.

____ 13. $HCN + KOH$ could be combined to form a buffer solution.

____ 14. $NH_4OH + NH_4Cl$ could be combined to form a buffer solution.

Completion
Complete each statement.

Consider this equation for the following questions:
$K^+(aq) + OH^-(aq) + H^+(aq) + Br^-(aq) \rightarrow H_2O(l) + K^+(aq) + Br^-(aq)$.

15. This equation, called a(n) _____, shows what actually happens when potassium hydroxide and hydrobromic acid are combined in a water solution.
16. You can tell from the equation that certain ions do not actually take part in the reaction. These ions are called _____.
17. If spectator ions are removed from the above equation, the resulting equation, called the _____, shows the only real change that takes place in the reaction.
18. If a reaction were conducted in such a way as to determine the concentration of potassium hydroxide or hydrobromic acid, the process would be called a(n) _____.
19. In order to conduct a titration reaction, you would have to begin with a(n) _____ of either the acid or base.
20. If you wanted to adjust the solution in a titration so that the pH changes very slowly, you could add a(n) _____ to the reaction mixture.

Short Answer

21. Why is the aqueous solution of ammonium chloride (NH_4Cl) acidic?

You have learned two definitions for acids and bases, the Arrhenius (ARR) theory and the Bronsted-Lowry (BL) theory. For each of the items listed below, state whether the substance would be considered an acid or a base by either or both definitions. Then write a balanced chemical equation that supports your answer.

22. HNO_3
23. NaOH
24. NH_3
25. OH^-
26. Write balanced ionic and net ionic equations for the following reaction: lithium hydroxide and nitric acid
27. Write balanced ionic and net ionic equations for the following reaction: sodium hydroxide and hydrosulfuric acid (H_2S).
28. Write balanced ionic and net ionic equations for the following reaction: rubidium hydroxide and formic acid (HCHO).
29. Write balanced ionic and net ionic equations for the following reaction: aluminum hydroxide and sulfuric acid.
30. Write equations that show what will happen when a hydrogen ion or hydroxide ion is added to the following buffer solution.
sodium formate and formic acid ($HCHO_2$).

31. Write equations that show what will happen when a hydrogen ion or hydroxide ion is added to the following buffer solution:
lactic acid ($HC_3H_5O_3$) and sodium lactate.

32. Write equations that show what will happen when a hydrogen ion or hydroxide ion is added to the following buffer solution:
ammonia and ammonium nitrate.

33. If you place a piece of blue litmus paper in 200 mL of dilute hydrochloric acid, the litmus paper turns pink. If you then add two drops of phenolphthalein, the solution remains colorless. If you add a few drops of dilute calcium hydroxide solution, the litmus returns to its blue color, but the solution remains colorless. Now if you add a few more drops of calcium hydroxide, the entire solution turns red. Does litmus or phenolphthalein indicate a higher pH? Explain.

34. For the following reaction, predict whether the pH of the product solution is acidic, basic, or neutral, and explain your prediction: hydrochloric acid, HCl, and calcium hydroxide, $Ca(OH)_2$

35. Identify the spectator ions in the following reaction:
sulfuric acid, H_2SO_4, and aluminum hydroxide, $Al(OH)_3$

36. A 0.800*M* NaOH solution was used to titrate an HCl solution of unknown concentration. At the endpoint, 17.2 mL of NaOH solution had neutralized 50.0 mL of HCl. What is the molarity of the HCl solution?

37. A student finds that 104.7 mL of 1.25*M* sodium hydroxide are required to neutralize 25.0 mL of a sulfuric acid solution. What is the molarity of the sulfuric acid?

38. An NaOH solution of unknown concentration was used to titrate 20.0 mL of a 0.200*M* solution of oxalic acid, $H_2C_2O_4$. If 48.1 mL of NaOH are used to reach the endpoint, what is the concentration of the NaOH solution?

39. A 25.0-mL sample of a solution of acetic acid, $HC_2H_3O_2$, is titrated to the endpoint with 232 mL of 0.100*M* $Ca(OH)_2$. What is the molarity of the acetic acid?

40. How many milliliters of 0.110*M* $Ca(OH)_2$ are needed to neutralize 30.0 mL of 0.500*M* HNO_3?

41. What volume of 0.100*M* $HClO_4$ is needed to neutralize 75.0 mL of 5.00*M* KOH?

42. A 35.0-mL sample of an unknown triprotic acid is titrated to the endpoint with 168.4 mL of 0.0700*M* $Sr(OH)_2$. What is the molarity of the acid solution?

43. A 42.0-mL sample of an ammonia solution of unknown molarity is titrated to the endpoint with 13.2 mL of 0.750*M* H_2SO_4. What is the molarity of the ammonia? (Use Figure 15.17 on page 540 of your textbook to select the best indicator for the reaction.)

44. How does a solution that contains dissolved formic acid and sodium formate act as a buffer? Use net ionic equations to show how this buffer responds to added H^+ and OH^-.

45. An antacid tablet containing $NaHCO_3$ is titrated with 0.400*M* HCl. If 0.500 g of the tablet requires 11.8 mL of HCl to reach the endpoint, what is the mass percent of $NaHCO_3$ in the tablet?

46. Stomach acid is approximately 0.0200*M* HCl. What volume of stomach acid is neutralized by an antacid tablet that contains 35.0 percent aluminum hydroxide and has a mass of 325 mg?

47. Tartaric acid is often added to artificial fruit drinks to increase tartness. A sample of a certain beverage contains 0.655 g of tartaric acid, $H_2C_4H_4O_6$. The beverage is titrated with 0.250*M* NaOH. Assuming no other acids are present, how many milliliters of base are required to neutralize the tartaric acid?

Problem

48. Write a chemical equation for the neutralization of sodium hydroxide and hydrochloric acid.

49. Calculate the buffer pH of CH_3COOH/CH_3COO^- buffer solution with an equal molar concentration of CH_3COOH and CH_3COO^-. Given the ionization constant of acetic acid, K_a, is 1.73×10^{-5}.

50. Calculate the pH of a buffer solution that is 0.250 *M* in formic acid, HCOOH, and 0.200 *M* in formate ion, $HCOO^-$. The ionization constant for formic acid is 1.80×10^{-4}.

Each of the following salts is dissolved in water. Predict whether the solution formed would be acidic, basic, or neutral.

51. $(NH_4)_2SO_4$

52. LiCl

53. NaCN

54. K_2SO_4

55. K_2CO_3

The table shows the data collected in a series of five titration experiments between samples of nitric acid and sodium hydroxide. From the information in the table, determine the missing values.

Experiment	**Acid**		**Base**	
	molarity	**volume**	**molarity**	**volume**
101	0.10*M*	40.0 mL	0.20*M*	**a. _____**
102	**b. _____**	50.0 mL	0.14*M*	70.0 mL
103	0.40*M*	30.0 mL	**c. _____**	25.0 mL
104	0.010*M*	**d. _____**	0.0077*M*	65.0 mL
105	2.0*M*	16.0 mL	**e. _____**	25.0 mL

56. a. _____

57. b. _____

58. c. _____

59. d. _____

60. e. _____

61. Write overall, ionic, and net ionic equations for the following reaction: sulfuric acid, H_2SO_4, and aluminum hydroxide, $Al(OH)_3$.

62. Write overall, ionic, and net ionic equations for the following reaction: hydrochloric acid, HCl, and calcium hydroxide, $Ca(OH)_2$.

63. Write overall, ionic, and net ionic equations for the following reaction: sulfurous acid, H_2SO_3, and sodium hydroxide, NaOH.

64. Malic acid, $H_2C_4H_4O_5$, is found in apples and other fruits. Write the overall, ionic, and net ionic equations for the reaction of malic acid with sodium hydroxide. Will the pH of the product solution be greater than 7, exactly 7, or less than 7? Explain.

65. An amphoteric substance may act as either an acid or a base. The dihydrogen phosphite ion is amphoteric. Write reactions that demonstrate this property of $H_2PO_3^-$.

66. Write an overall equation for the acid-base reaction that would be required to produce the following salt: $Mg(ClO_4)_2$.

Essay

67. When an acid reacts with a base, neutralization takes place.
    a. Name the technique to determine the concentration of an acid by reacting it with a base of a known volume and a known concentration.
    b. Provide specific details of the technique used.
    c. What do you understand by the end point of the titration?

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Answer Section

MULTIPLE CHOICE

1.	ANS:	D	PTS: 1	DIF:	B	OBJ:	15-3
2.	ANS:	A	PTS: 1	DIF:	B	OBJ:	15-3
3.	ANS:	D	PTS: 1	DIF:	B	OBJ:	15-3
4.	ANS:	C	PTS: 1	DIF:	B	OBJ:	15-1
5.	ANS:	A	PTS: 1	DIF:	B	OBJ:	15-1
6.	ANS:	D	PTS: 1	DIF:	B	OBJ:	15-2
7.	ANS:	A	PTS: 1	DIF:	B	OBJ:	15-2
8.	ANS:	C	PTS: 1	DIF:	B	OBJ:	15-3

YES/NO

9.	ANS:	N	PTS: 1	DIF:	B	OBJ:	15-4
10.	ANS:	N	PTS: 1	DIF:	B	OBJ:	15-4
11.	ANS:	Y	PTS: 1	DIF:	B	OBJ:	15-4
12.	ANS:	N	PTS: 1	DIF:	B	OBJ:	15-4
13.	ANS:	N	PTS: 1	DIF:	B	OBJ:	15-4
14.	ANS:	Y	PTS: 1	DIF:	B	OBJ:	15-4

COMPLETION

15. ANS: ionic equation

    PTS: 1 DIF: B OBJ: 15-1
16. ANS: spectator ions

    PTS: 1 DIF: B OBJ: 15-1
17. ANS: net ionic equation

    PTS: 1 DIF: B OBJ: 15-1
18. ANS: titration

    PTS: 1 DIF: B OBJ: 15-5
19. ANS: standard solution

    PTS: 1 DIF: B OBJ: 15-5
20. ANS: buffer

    PTS: 1 DIF: B OBJ: 15-4

SHORT ANSWER

21. ANS:
In an aqueous solution, NH_4Cl dissociates into ammonium ion and chloride ion.

$NH_4Cl(s) \longrightarrow NH_4^+(aq) + Cl^-(aq)$
The ammonium ions react with the water molecule to establish equilibrium.
$NH_4^+(aq) + H_2O(l) \leftrightarrows NH_3(aq) + H_3O^+(aq)$
The solution contains more hydronium ions than hydroxide ions. Thus, the aqueous solution of ammonium chloride (NH_4Cl) is acidic.

PTS: 1 DIF: 2 REF: Page 526 | Page 527
OBJ: 15.1.3 Predict and explain the final results of an acid-base reaction.
TOP: Predict and explain the final results of an acid-base reaction.
KEY: Salt hydrolysis MSC: 2

22. ANS:
Both ARR and BL acid
ARR: $HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$
BL: $HNO_3(aq) + H_2O(l) \rightarrow H_3O^+(aq) + NO_3^-(aq)$

PTS: 1 DIF: A OBJ: 15-2

23. ANS:
ARR base
$NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$

PTS: 1 DIF: A OBJ: 15-2

24. ANS:
Both ARR and BL base
ARR + BL: $NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

PTS: 1 DIF: A OBJ: 15-2

25. ANS:
BL base
$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$

PTS: 1 DIF: A OBJ: 15-2

26. ANS:
$Li^+(aq) + OH^-(aq) + H^+ + NO_3^-(aq) \rightarrow Li^+(aq) + NO_3^-(aq) + H_2O(l)$
$OH^-(aq) + H^+ \rightarrow H_2O(l)$

PTS: 1 DIF: B OBJ: 15-1

27. ANS:
$2Na^+(aq) + 2OH^-(aq) + H_2S(aq) \rightarrow 2Na^+(aq) + 2H_2O(l) + S^{2-}(aq)$
$2OH^-(aq) + H_2S(aq) \rightarrow 2H_2O(l) + S^{2-}(aq)$

PTS: 1 DIF: B OBJ: 15-1

28. ANS:
$Rb^+(aq) + OH^-(aq) + HCHO_2(aq) \rightarrow Rb^+(aq) + H_2O(l) + CHO_2^-(aq)$
$OH^-(aq) + HCHO_2(aq) \rightarrow H_2O(l) + CHO_2^-(aq)$

PTS: 1 DIF: B OBJ: 15-1

29. ANS:
$2Al(OH)_3(aq) + 6H^+(aq) + 3SO_4^{2-}(aq) \rightarrow 2Al^{3+}(aq) + 3SO_4^{2-}(aq) + 6H_2O(l)$
$2Al(OH)_3(aq) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 6H_2O(l)$

PTS: 1 DIF: B OBJ: 15-1

30. ANS:
$H^+(aq) + CHO_2^-(aq) \rightarrow HCHO_2(aq)$
$OH^-(aq) + HCHO_2(aq) \rightarrow H_2O(l) + CHO_2^-(aq)$

PTS: 1 DIF: A OBJ: 15-3

31. ANS:
$H^+(aq) + C_3H_5O_3^-(aq) \rightarrow HC_3H_5O_3(aq)$
$OH^-(aq) + HC_3H_5O_3(aq) \rightarrow H_2O(l) + C_3H_5O_3^-(aq)$

PTS: 1 DIF: A OBJ: 15-3

32. ANS:
$H^+(aq) + NH_3(aq) \rightarrow NH_4^+(aq)$
$OH^-(aq) + NH_4^+(aq) \rightarrow NH_3(aq) + H_2O(l)$

PTS: 1 DIF: A OBJ: 15-3

33. ANS:
As it required more hydroxide ions from the calcium hydroxide solution to bring about a color change in the phenolphthalein than in the litmus, the phenolphthalein must change color at a higher pH, indicating a higher pH of the solution.

PTS: 1 DIF: A OBJ: 15-5

34. ANS:
neutral; only water is produced in the net reaction

PTS: 1 DIF: B OBJ: 15-3

35. ANS:
SO_4^{2-}

PTS: 1 DIF: B OBJ: 15-1

36. ANS:
0.275*M*

PTS: 1 DIF: B OBJ: 15-5

37. ANS:
2.62*M*

PTS: 1 DIF: B OBJ: 15-5

38. ANS:
0.166*M*

PTS: 1 DIF: B OBJ: 15-5

39. ANS:
1.86*M*

PTS: 1 DIF: B OBJ: 15-5

40. ANS:
68.2 mL

PTS: 1 DIF: B OBJ: 15-5

41. ANS:
3750 mL

PTS: 1 DIF: B OBJ: 15-5

42. ANS:
0.225*M*

PTS: 1 DIF: B OBJ: 15-5

43. ANS:
0.471*M*. This is a titration of a weak base with a strong acid, so the endpoint pH is expected to be less than 7. Methyl red is probably a good indicator.

PTS: 1 DIF: B OBJ: 15-5

44. ANS:
If an acid is added, the formate ion from sodium formate reacts to neutralize the added H^+:
$CHO_2^-(aq) + H^+(aq) \rightarrow HCHO_2(aq)$
If a base is added, the formic acid reacts to neutralize the added OH^-:
$HCHO_2(aq) + OH^-(aq) \rightarrow CHO_2^-(aq) + H_2O(l)$

PTS: 1 DIF: B OBJ: 15-4

45. ANS:
79.3%

PTS: 1 DIF: A OBJ: 15-5

46. ANS:
219 mL

PTS: 1 DIF: A OBJ: 15-5

47. ANS:
34.9 mL

PTS: 1 DIF: A OBJ: 15-5

PROBLEM

48. ANS:
$NaOH + HCl \longrightarrow NaCl + H_2O$

PTS: 1 DIF: 1 REF: Page 528
OBJ: 15.1.3 Predict and explain the final results of an acid-base reaction.
TOP: Predict and explain the final results of an acid-base reaction.
KEY: Neutralization reaction MSC: 2
NOT: When an acid reacts with a base, salt and water are produced. This reaction is called neutralization reaction.

49. ANS:
4.76

PTS: 1 DIF: 2 REF: Page 531
OBJ: 15.2.1 Evaluate the importance of a buffer in controlling pH.
TOP: Evaluate the importance of a buffer in controlling pH. KEY: Buffer
MSC: 3
NOT: Ionization constant of acetic acid = concentration of hydrogen ion * concentration of acetate ion/concentration of acetic acid. pH = -log (hydrogen ion concentration).

50. ANS:
3.64

PTS: 1 DIF: 2 REF: Page 531
OBJ: 15.2.1 Evaluate the importance of a buffer in controlling pH.
TOP: Evaluate the importance of a buffer in controlling pH. KEY: Buffer
MSC: 3
NOT: Ionization constant of formic acid = concentration of hydrogen ion * concentration of formate ion/concentration of formic acid. pH = -log (concentration of hydrogen ion).

51. ANS:
acidic

PTS: 1 DIF: B OBJ: 15-2

52. ANS:
neutral

PTS: 1 DIF: B OBJ: 15-2

53. ANS:
basic

PTS: 1 DIF: B OBJ: 15-2

54. ANS:
neutral

PTS: 1 DIF: B OBJ: 15-2

55. ANS:
basic

PTS: 1 DIF: B OBJ: 15-2

56. ANS:
20.0 mL

PTS: 1 DIF: B OBJ: 15-5

57. ANS:
0.20*M*

PTS: 1 DIF: B OBJ: 15-5

58. ANS:
0.48*M*

PTS: 1 DIF: B OBJ: 15-5

59. ANS:
50.0 mL

PTS: 1 DIF: B OBJ: 15-5

60. ANS:
1.3*M*

PTS: 1 DIF: B OBJ: 15-5

61. ANS:
$3H_2SO_4(aq) + 2Al(OH)_3(s) \rightarrow Al_2(SO_4)_3(aq) + 6H_2O(l)$
$6H^+(aq) + 3SO_4^{2-}(aq) + 2Al(OH)_3(s) \rightarrow$
$2Al^{3+}(aq) + 3SO_4^{2-}(aq) + 6H_2O(l)$
$6H^+(aq) + 2Al(OH)_3(s) \rightarrow 2Al^{3+}(aq) + 6H_2O(l)$

PTS: 1 DIF: B OBJ: 15-1

62. ANS:
$2HCl(aq) + Ca(OH)_2(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$
$2H^+(aq) + 2Cl^-(aq) + Ca^{2+}(aq) + 2OH^-(aq) \rightarrow$
$Ca^{2+}(aq) + 2Cl^-(aq) + 2H_2O(l)$
$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

PTS: 1 DIF: B OBJ: 15-1

63. ANS:
$H_2SO_3(aq) + 2NaOH(aq) \rightarrow Na_2SO_3(aq) + 2H_2O(l)$
$H_2SO_3(aq) + 2Na^+(aq) + 2OH^-(aq) \rightarrow 2Na^+(aq) + SO_3^{2-}(aq) + 2H_2O(l)$
$H_2SO_3(aq) + 2OH^-(aq) \rightarrow SO_3^{2-}(aq) + 2H_2O(l)$

PTS: 1 DIF: B OBJ: 15-1

64. ANS:
$H_2C_4H_4O_5(aq) + 2NaOH(aq) \rightarrow Na_2C_4H_4O_5(aq) + 2H_2O(l)$
$H_2C_4H_4O_5(aq) + 2Na^+(aq) + 2OH^-(aq) \rightarrow$
$2Na^+(aq) + C_4H_4O_5^{2-}(aq) + 2H_2O(l)$
$H_2C_4H_4O_5(aq) + 2OH^-(aq) \rightarrow C_4H_4O_5^{2-}(aq) + 2H_2O(l)$
The final pH should be greater than 7, since $C_4H_4O_5^{2-}$ is a weak base.

PTS: 1 DIF: B OBJ: 15-3

65. ANS:
$H_2PO_3^-$ + $H_2O \rightarrow H_3PO_3 + OH^-$; $H_2PO_3^-$ acts as a base
$H_2PO_3^-$ + $H_2O \rightarrow HPO_3^{2-} + H_3O^+$; $H_2PO_3^-$ acts as an acid

PTS: 1 DIF: B OBJ: 15-2

66. ANS:
$2HClO_4(aq) + Mg(OH)_2(aq) \rightarrow Mg(ClO_4)_2(aq) + 2H_2O(l)$

PTS: 1 DIF: B OBJ: 15-1

ESSAY

67. ANS:

a. Acid-base titration is a technique to determine the concentration of an acid by reacting it with a base of a known volume and a known concentration.

b. Acid base titration is a technique in which measured volume of an acidic or basic solution of unknown concentration is placed in a beaker. The burette is filled with the titrating solution of known concentration. This solution is called the standard solution. Add the measured volumes of the standard solution constantly until the reaction reaches the neutralization point.

c. The point at which the indicator used in a titration changes color is called the end point of the titration.

PTS: 1 DIF: 3 REF: Page 539 | Page 540 | Page 541
OBJ: 15.2.2 Design strategies for doing acid-base titrations, and calculate results from titration data.
TOP: Design strategies for doing acid-base titrations, and calculate results from titration data.
KEY: Neutralization reaction | Titration MSC: 2