

# **Acids and Bases Test**

## **60 Practice Problems**

Organic Chemistry Tutor

1. Which of the following is a strong acid?

- A.  $\text{NH}_3$
- B.  $\text{HC}_2\text{H}_3\text{O}_2$
- C.  $\text{NaOH}$
- D.  $\text{HClO}_4$
- E.  $\text{HF}$

2. The  $[\text{H}_3\text{O}^+]$  concentration is  $4.7 \times 10^{-3} \text{ M}$ . Calculate the pH of the solution.

- A) 1.46
- B) 2.33
- C) 3.72
- D) 5.21
- E) 6.84

3. The pH of the solution is 5.4. What is the pOH of the solution?

- A) 4.1
- B) 6.5
- C) 8.6
- D) 9.7
- E) 11.9

4. Which of the following is the Bronsted Lowry base in the reaction shown below?



- A.  $\text{HF}$
- B.  $\text{H}_2\text{O}$
- C.  $\text{F}^-$
- D.  $\text{H}_3\text{O}^+$
- E. None of the above

5. The  $[\text{OH}^-]$  concentration is  $3.7 \times 10^{-4} \text{ M}$ . Calculate the  $[\text{H}_3\text{O}^+]$  concentration.

- A)  $4.6 \times 10^{-5} \text{ M}$
- B)  $7.3 \times 10^{-7} \text{ M}$
- C)  $5.4 \times 10^{-9} \text{ M}$
- D)  $2.7 \times 10^{-11} \text{ M}$
- E)  $6.3 \times 10^{-2} \text{ M}$

6. The pH of the solution is 4.2. Calculate the  $[\text{H}_3\text{O}^+]$  concentration.

- A)  $3.1 \times 10^{-2} \text{ M}$
- B)  $4.6 \times 10^{-3} \text{ M}$
- C)  $1.8 \times 10^{-4} \text{ M}$
- D)  $6.3 \times 10^{-5} \text{ M}$
- E)  $2.5 \times 10^{-6} \text{ M}$

7. The pH of the solution is 9.5 at 25° C. Is the solution acidic, basic, or neutral?

- A. Acidic
- B. Basic
- C. Neutral
- D. None of the above

8. The  $[\text{OH}^-]$  concentration is  $2.6 \times 10^{-9}$  M. Calculate the pH of the solution.

- A) 3.7
- B) 5.4
- C) 7.6
- D) 8.6
- E) 10.5

9. The concentration of  $[\text{H}_3\text{O}^+]$  is  $2.7 \times 10^{-4}$  M in a solution. Is the solution acidic, basic, or neutral?

- A. Acidic
- B. Basic
- C. Neutral
- D. None of the above

10. Which acid is stronger? HF or HCN? (The  $K_a$  values for HF and HCN are  $7.2 \times 10^{-4}$  and  $6.2 \times 10^{-10}$  respectively)

- A. HF is the stronger acid because it has a higher  $K_a$  value.
- B. HCN is the stronger acid because it has a higher  $K_a$  value.
- C. HF is the stronger acid because it has a lower  $K_a$  value.
- D. HCN is the stronger acid because it has a lower  $K_a$  value.

E. None of the above

11. What is the pH of a 0.025 M HCl solution?

- A) 1.6
- B) 2.3
- C) 2.9
- D) 3.6
- E) 4.5

12. Calculate the pH of a 0.75 M HOCl solution. The  $K_a$  of HOCl is  $3.5 \times 10^{-8}$ .

- A) 2.4
- B) 2.8
- C) 3.2
- D) 3.8
- E) 4.6

13. Which acid is stronger? HCl or HBr?

- A. HCl is the stronger acid because Chlorine has a higher electronegativity value than Bromine.
- B. HBr is the stronger acid because Bromine has a lower electronegativity value than Chlorine.
- C. HCl is the stronger acid because the Chloride ion is smaller than the Bromide ion.
- D. HBr is the stronger acid because the Bromide ion is larger than the Chloride ion.
- E. None of the above.

14. What is the pH of a 3.0 M  $\text{NH}_3$  solution. The  $K_b$  of  $\text{NH}_3$  is  $1.8 \times 10^{-5}$ .

- A) 9.25
- B) 10.6
- C) 11.2
- D) 11.9
- E) 12.7

15. What is the pH of a 1.0 M NaF solution. The  $K_a$  of HF is  $7.2 \times 10^{-4}$ .

- A) 7.92
- B) 8.57
- C) 9.34
- D) 9.96
- E) 10.5

16. Which of the following substances is not amphoteric?

- A.  $\text{H}_2\text{O}$
- B.  $\text{H}_2\text{PO}_4^-$
- C.  $\text{HCO}_3^-$
- D.  $\text{SO}_4^{2-}$
- E. None of the above

17. Which acid is stronger?  $\text{HClO}_3$  or  $\text{HClO}_2$ ?

18. The pH of a 0.40 M HX solution is 3.5. What is the  $K_a$  value of HX?

- A)  $4.5 \times 10^{-4}$
- B)  $6.1 \times 10^{-5}$
- C)  $9.3 \times 10^{-6}$
- D)  $2.5 \times 10^{-7}$
- E)  $1.4 \times 10^{-9}$

19. The pH of a 0.25 M weak base solution is 9.75. What is the  $K_b$  value of the weak base?

- A)  $4.9 \times 10^{-4}$
- B)  $2.3 \times 10^{-6}$
- C)  $1.27 \times 10^{-8}$
- D)  $7.5 \times 10^{-9}$
- E)  $3.6 \times 10^{-11}$

20. Which base is stronger?  $\text{NH}_3$  or  $\text{CH}_3\text{NH}_2$ ? (The  $K_b$  value for  $\text{NH}_3$  and  $\text{CH}_3\text{NH}_2$  are  $1.8 \times 10^{-5}$  and  $4.4 \times 10^{-4}$  respectively)

21. The  $\text{p}K_a$  values of four acids HA, HB, HC, and HD are 4.6, 2.5, 7.3, and 6.4. Which of these acids is the strongest acid?

- A. HA
- B. HB
- C. HC
- D. HD
- E. None of the above

22. Which of the following salts will produce a basic solution ( $\text{pH} > 7$ )?

- A. NaCl
- B.  $\text{NH}_4\text{Cl}$
- C.  $\text{AlCl}_3$
- D. NaI
- E.  $\text{NaNO}_2$

23. Calculate the pH of a 0.50 M  $\text{NH}_4\text{Cl}$  solution. The  $K_b$  for  $\text{NH}_3$  is  $1.8 \times 10^{-5}$ .

- A) 3.6
- B) 4.8
- C) 5.4
- D) 5.9
- E) 6.4

24. Calculate the % dissociation of a 2 M  $\text{HC}_2\text{H}_3\text{O}_2$  solution. The  $K_a$  for Acetic Acid is  $1.8 \times 10^{-5}$ .

- A) 0.15%
- B) 0.30%
- C) 0.75%
- D) 1.4%
- E) 2.1%

25. The % dissociation of a 0.25 M HX solution is 0.13%. Calculate the  $K_a$  value of HX.

- A)  $7.4 \times 10^{-3}$
- B)  $8.1 \times 10^{-4}$
- C)  $5.6 \times 10^{-5}$
- D)  $2.7 \times 10^{-6}$
- E)  $4.2 \times 10^{-7}$

26. Which acid is stronger? HOCl or HOBr?

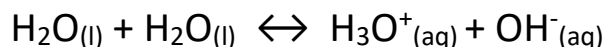
27. Which of the following statements is not true?

- A. An Arrhenius acid is a substance that generates hydronium ions in solution.
- B. A Bronsted-Lowry acid is a proton donor.
- C. The percent dissociation of an acid decreases with increasing acid concentration.
- D. A Lewis acid is an electron pair donor.
- E. The conjugate base of a strong acid will produce a neutral solution.

28. The auto-ionization constant  $K_w$  for water is  $2.92 \times 10^{-14}$  at  $40^\circ\text{C}$ . What is the pH of water at  $40^\circ\text{C}$ ?

- A) 6.43
- B) 6.77
- C) 7.00
- D) 7.21
- E) 7.45

29. As the temperature increases,  $K_w$  for water increases. Based on this information, would you expect the reaction shown below to be endothermic or exothermic?



30. (a) What is the pH of a 0.05 M HCl solution?  
(b) What is the pH of a  $4 \times 10^{-7}$  M HCl solution?

31. Calculate the pH of a 0.035 M NaOH solution.

- A) 4.65
- B) 7.24
- C) 9.87
- D) 11.4
- E) 12.5

32. Calculate the pH of a 0.0045 M Ba(OH)<sub>2</sub> solution.

- A) 2.05
- B) 4.93
- C) 9.15
- D) 12.0
- E) 13.6

33. What is the pH of a 4.0 M H<sub>2</sub>SO<sub>4</sub> solution? The K<sub>a</sub> for HSO<sub>4</sub><sup>-</sup> is 1.2 x 10<sup>-2</sup>.

- A) -0.603
- B) 0.603
- C) 1.25
- D) 1.86
- E) 2.41

34. What is the pH of A 0.03 M H<sub>2</sub>SO<sub>4</sub> solution? The K<sub>a</sub> value for HSO<sub>4</sub><sup>-</sup> is 1.2 x 10<sup>-2</sup>.

- A) 0.475
- B) 0.726
- C) 1.22
- D) 1.43
- E) 1.86

35. Calculate the [PO<sub>4</sub><sup>3-</sup>] concentration in a 4 M H<sub>3</sub>PO<sub>4</sub> solution. The K<sub>a</sub> values for H<sub>3</sub>PO<sub>4</sub> are 7.5 x 10<sup>-3</sup>, 6.2 x 10<sup>-8</sup>, and 4.8 x 10<sup>-13</sup>.

- A) 4.5 x 10<sup>-4</sup> M
- B) 6.2 x 10<sup>-8</sup> M
- C) 7.5 x 10<sup>-12</sup> M
- D) 3.5 x 10<sup>-16</sup> M
- E) 1.8 x 10<sup>-19</sup> M

36. What mass of NaF should be dissolved to make a 5.00 L solution with a pH of 8.9? The K<sub>a</sub> value for HF is 7.2 x 10<sup>-4</sup>.

- A) 275 g
- B) 425 g
- C) 678 g
- D) 814 g
- E) 954 g

37. 80 mL of a 0.05 M HCl solution was mixed with 120 mL of a 0.04 M HNO<sub>3</sub> solution. What is the pH of the mixture?

- A) 0.748
- B) 1.36
- C) 1.76
- D) 2.05
- E) 2.49

38. Calculate the pH of a solution composed of 4.00 M HF and 5.00 M HCN. (The K<sub>a</sub> values for HF and HCN are  $7.2 \times 10^{-4}$  and  $6.2 \times 10^{-10}$ )

- A) 0.825
- B) 1.27
- C) 1.68
- D) 1.94
- E) 2.31

39. Which base is stronger? CN<sup>-</sup> or OCl<sup>-</sup>? (The K<sub>a</sub> values for HCN and HOCl are  $6.2 \times 10^{-10}$  and  $3.5 \times 10^{-8}$ )

40. Which of the following substances will produce a basic solution when mixed with water?

- A. CO<sub>2</sub>
- B. SO<sub>3</sub>
- C. CaO
- D. NaH
- E. C and D

41. What is the pH of a solution consisting of 0.5 M HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> and 0.75 M NaC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>? (The K<sub>a</sub> for HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> is  $1.8 \times 10^{-5}$ )

- A) 4.26
- B) 4.57
- C) 4.74
- D) 4.92
- E) 5.12

42. What is the pH of a solution consisting of 0.400 M NH<sub>3</sub> and 0.500 M NH<sub>4</sub>Cl? The K<sub>b</sub> value for NH<sub>3</sub> is  $1.8 \times 10^{-5}$ .

- A) 8.99
- B) 9.16
- C) 9.26
- D) 9.35
- E) 9.67



43. How many grams of  $\text{NaNO}_2$  should be dissolved in a 0.25 M  $\text{HNO}_2$  solution to create a 2.0L buffered solution at a pH of 3.6? The  $K_a$  value for  $\text{HNO}_2$  is  $4 \times 10^{-4}$ . (Assume constant volume)

- A) 17 g
- B) 26 g
- C) 38 g
- D) 44 g
- E) 55 g

44. Which of the following represents a buffer solution?

- A) 0.5 M  $\text{HCl}$  and 0.5 M  $\text{NaCl}$  solution
- B) 1.0 M  $\text{NaOH}$  and 1.0 M  $\text{NH}_3$  solution
- C) 0.75 M  $\text{HF}$  and 0.75 M  $\text{NaF}$  solution
- D) 0.25 M  $\text{HNO}_2$  and 0.25 M  $\text{NaCN}$  solution
- E) 0.10 M  $\text{HCN}$  and 0.10 M  $\text{HI}$  solution.

45. A solution contains  $\text{H}_3\text{PO}_4$ ,  $\text{H}_2\text{PO}_4^-$ ,  $\text{HPO}_4^{2-}$ , and  $\text{PO}_4^{3-}$ . What is the predominant species at a pH of 9? (The  $pK_a$  values for  $\text{H}_3\text{PO}_4$  are 2.12, 7.21, and 12.32)

- A.  $\text{H}_3\text{PO}_4$
- B.  $\text{H}_2\text{PO}_4^-$
- C.  $\text{HPO}_4^{2-}$
- D.  $\text{PO}_4^{3-}$

46. What is the pH of a solution consisting of 0.5 M  $\text{NaH}_2\text{PO}_4$  and 0.5 M  $\text{Na}_2\text{HPO}_4$ ? (The  $pK_a$  values for  $\text{H}_3\text{PO}_4$  are 2.12, 7.21, and 12.32)

- A) 2.12
- B) 4.67
- C) 7.21
- D) 9.77
- E) 12.32

47. What is the pH of a solution consisting of 0.75 M  $\text{Na}_2\text{HPO}_4$  and 0.75 M  $\text{Na}_3\text{PO}_4$ ? (The  $pK_a$  values for  $\text{H}_3\text{PO}_4$  are 2.12, 7.21, and 12.32)

- A) 2.12
- B) 4.67
- C) 7.21
- D) 9.77
- E) 12.32

48. What is the pH of a solution consisting of 1.0 M  $\text{NaH}_2\text{PO}_4$ ? (The  $pK_a$  values for  $\text{H}_3\text{PO}_4$  are 2.12, 7.21, and 12.32)

- A) 2.12
- B) 4.67
- C) 7.21
- D) 9.77
- E) 12.32

49. What is the pH of a solution consisting of 1.0 M  $\text{NaH}_2\text{PO}_4$  and 0.1 M  $\text{Na}_2\text{HPO}_4$ ? (The  $\text{pK}_a$  values for  $\text{H}_3\text{PO}_4$  are 2.12, 7.21, and 12.32)

- A) 5.21
- B) 6.21
- C) 7.21
- D) 8.21
- E) 9.21

51. 20 mL of a 0.75 M NaOH solution is added to 50 mL of a 0.45 M HCl solution. What is the pH of the resulting solution?

- A) 0.97
- B) 2.5
- C) 6.9
- D) 9.4
- E) 12.8

50. Which of the following statements is not true?

- A. The pH of the equivalence point of a strong acid – strong base titration is 7.
- B. The pH at the equivalence point of a weak acid – strong base titration is greater than 7.
- C. The pH at the equivalence point of a weak base – strong acid titration is less than 7.
- D. The end point occurs at the same volume as the equivalence point of a titration.
- E. None of the above.

52. A 50 mL solution of 0.5 M HF is titrated with 0.20 M NaOH. What volume of the 0.25 M NaOH solution must be added to reach the equivalence point?

- A. 25 mL
- B. 50 mL
- C. 75 mL
- D. 100 mL
- E. 200 mL

53. A 50 mL solution of 0.5 M HF is titrated with 0.25 M NaOH. What is the pH of the solution before any NaOH is added? (The  $K_a$  for HF is  $7.2 \times 10^{-4}$ )

- A) 1.2
- B) 1.7
- C) 2.3
- D) 2.9
- E) 3.7

54. A 50 mL solution of 0.5 M HF is titrated with 0.25 M NaOH. What is the pH of the solution after 40 mL of NaOH has been added to it? (The  $K_a$  for HF is  $7.2 \times 10^{-4}$ )

- A) 2.74
- B) 2.97
- C) 3.14
- D) 3.29
- E) 3.45

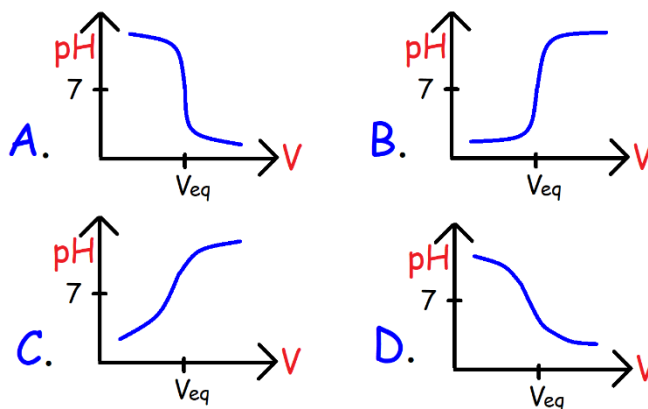
55. A 50 mL solution of 0.5 M HF is titrated with 0.25 M NaOH. What is the pH of the solution after 100 mL of NaOH has been added to it? (The  $K_a$  for HF is  $7.2 \times 10^{-4}$ )

- A) 4.74
- B) 5.82
- C) 7.00
- D) 8.18
- E) 9.26

56. A 50 mL solution of 0.5 M HF is titrated with 0.25 M NaOH. What is the pH of the solution after 120 mL of NaOH has been added to it? (The  $K_a$  for HF is  $7.2 \times 10^{-4}$ )

- A) 7.65
- B) 9.25
- C) 10.9
- D) 12.5
- E) 13.7

57. Which of the following graphs represent a weak base – strong acid titration?



58. The table below shows the volume of NaOH that is added to a monoprotic weak acid (HX) solution as well as the pH of the solution. If the equivalence point is reached at a volume of 20 mL, what is the  $K_a$  value for HX?

Volume	pH
0 mL	2.39
5 mL	3.41
10 mL	5.52
15 mL	7.46
18 mL	8.92
19 mL	9.31
20 mL	9.76
21 mL	11.9

- A)  $2 \times 10^{-4}$
- B)  $4 \times 10^{-5}$
- C)  $3 \times 10^{-6}$
- D)  $7 \times 10^{-8}$
- E)  $5 \times 10^{-9}$

59. A student wishes to prepare a buffer with a pH of 9.00. Which acid should the student choose from?

Acid	$K_a$
HF	$7.2 \times 10^{-4}$
HOCl	$3.5 \times 10^{-8}$
HCN	$6.2 \times 10^{-10}$
$H_2CO_3$	$4.3 \times 10^{-7}$
$HC_2H_3O_2$	$1.8 \times 10^{-5}$

- A. HF
- B. HOCl
- C. HCN
- D.  $H_2CO_3$
- E.  $HC_2H_3O_2$

60. Bromthymol blue is an indicator with a  $K_a$  value of  $1 \times 10^{-7}$ . The acidic form (HIn) is yellow and the basic form ( $In^-$ ) is blue. For a weak base – strong acid titration, at what pH will the first color change be visible?

- A. pH = 5
- B. pH = 6
- C. pH = 7
- D. pH = 8
- E. pH = 9

## Answers:

1. D
2. B
3. C
4. B
5. D
6. D
7. B
8. B
9. A
10. A
11. A
12. D
13. D
14. D
15. B
16. D
17.  $\text{HClO}_3$
18. D
19. C
20.  $\text{CH}_3\text{NH}_2$
21. B
22. D
23. B
24. B
25. E
26. HOCl
27. D
28. B
29. Endothermic
- 30a. 1.3
- 30b. 6.37
31. E
32. D
33. A
34. D
35. E
36. E
37. B
38. B
39.  $\text{CN}^-$
40. E
41. D
42. B

- 43. E
- 44. C
- 45. C
- 46. C
- 47. E
- 48. B
- 49. B
- 50. D
- 51. A
- 52. D
- 53. B
- 54. B
- 55. D
- 56. D
- 57. D
- 58. C
- 59. C
- 60. D