

14. 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
15. In which 0.01 M solution is phenolphthalein pink?
- A) $\text{CH}_3\text{OH}(\text{aq})$
 - B) $\text{Ca}(\text{OH})_2(\text{aq})$
 - C) $\text{CH}_3\text{COOH}(\text{aq})$
 - D) $\text{HNO}_3(\text{aq})$
16. Three samples of the same solution are tested, each with a different indicator. All three indicators, bromthymol blue, bromcresol green and thymol blue, appear blue if the pH of the solution is
- A) 4.7
 - B) 6.0
 - C) 7.8
 - D) 9.9
17. In the reaction:
- $$\text{HNO}_3 + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+ + \text{NO}_3^-$$
- The two acids are
- A) H_2O and HNO_3
 - B) H_2O and NO_3^-
 - C) H_2O and H_3O^+
 - D) HNO_3 and H_3O^+
18. Which products are formed when an acid reacts with a base?
- A) an alcohol and carbon dioxide
 - B) an ester and water
 - C) a soap and glycerine
 - D) a salt and water
19. 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
20. Which element reacts spontaneously with 1.0 M HCl(aq) at room temperature?
- A) copper
 - B) gold
 - C) silver
 - D) zinc
21. Which compound is a salt?
- A) CH_3OH
 - B) $\text{C}_6\text{H}_{12}\text{O}_6$
 - C) $\text{H}_2\text{C}_2\text{O}_4$
 - D) $\text{KC}_2\text{H}_3\text{O}_2$
22. Which equation represents a neutralization reaction?
- A) $\text{Na}_2\text{CO}_3 + \text{CaCl}_2 \rightarrow 2 \text{NaCl} + \text{CaCO}_3$
 - B) $\text{Ni}(\text{NO}_3)_2 + \text{H}_2\text{S} \rightarrow \text{NiS} + 2 \text{HNO}_3$
 - C) $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{AgCl} + \text{NaNO}_3$
 - D) $\text{H}_2\text{SO}_4 + \text{Mg}(\text{OH})_2 \rightarrow \text{MgSO}_4 + 2 \text{H}_2\text{O}$
23. A 25.0-milliliter sample of $\text{HNO}_3(\text{aq})$ is neutralized by 32.1 milliliters of 0.150 M $\text{KOH}(\text{aq})$. What is the molarity of the $\text{HNO}_3(\text{aq})$?
- A) 0.117 M
 - B) 0.150 M
 - C) 0.193 M
 - D) 0.300 M
24. How many milliliters of 0.2 M NaOH are required to exactly neutralize 40 milliliters of 0.1 M HCl?
- A) 10
 - B) 20
 - C) 40
 - D) 80
25. During which process can 10.0 milliliters of a 0.05 M HCl(aq) solution be used to determine the unknown concentration of a given volume of NaOH(aq) solution?
- A) evaporation
 - B) distillation
 - C) filtration
 - D) titration
26. What is the pH of the solution formed by completely neutralizing 50 milliliters of 0.1 M HNO_3 with 50 milliliters of 0.1 M NaOH at 298 K?
- A) 1
 - B) 7
 - C) 10
 - D) 4
27. When additional solid NaCl dissolves in a solution of NaCl in water, the pH of the solution
- A) decreases
 - B) increases
 - C) remains the same

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28. Base your answer to the following question on the information below and on your knowledge of chemistry.

A company produces a colorless vinegar that is 5.0% $\text{HC}_2\text{H}_3\text{O}_2$ in water. Using thymol blue as an indicator, a student titrates a 15.0-milliliter sample of the vinegar with 43.1 milliliters of a 0.30 M NaOH (aq) solution until the acid is neutralized.

Identify the negative ion in the NaOH(aq) used in this titration.

29. Base your answer to the following question on information below and on your knowledge of chemistry.

A sample of nitric acid contains both H_3O^+ ions and NO_3^- ions. This sample has a pH value of 1.

Write a name of the positive ion present in this sample.

30. Identify *two* indicators from Reference Table M that are yellow in solutions with a pH of 5.5.

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

Using burets, a student titrated a sodium hydroxide solution of unknown concentration with a standard solution of 0.10 M hydrochloric acid. The data are recorded in the table below.

Titration Data

Solution	HCl(aq)	NaOH(aq)
Initial Buret Reading (mL)	15.50	5.00
Final Buret Reading (mL)	25.00	8.80

Show a correct numerical setup for calculating the molarity of the sodium hydroxide solution.

32. 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).

Calculate the molarity of the HCl(aq). Your response must include *both* a numerical setup and the calculated result.

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

The health of fish depends on the amount of oxygen dissolved in the water. A dissolved oxygen (DO) concentration between 6 parts per million and 8 parts per million is best for fish health. A DO concentration greater than 1 part per million is necessary for fish survival.

Fish health is also affected by water temperature and concentrations of dissolved ammonia, hydrogen sulfide, chloride compounds, and nitrate compounds. Most freshwater fish thrive in water with a pH between 6.5 and 8.5.

A student's fish tank contains fish, green plants, and 3800 grams of fish-tank water with 2.7×10^{-2} gram of dissolved oxygen. Phenolphthalein tests colorless and bromthymol blue tests blue in samples of the fish-tank water.

Based on the test results for the indicators phenolphthalein and bromthymol blue, what is the pH range of the fish-tank water?

34. Base your answers to the following questions on the information below.

The relative amount of acid or base in the soil can affect the flowers and plants that grow there. Hydrangeas, commonly called "snow ball" bushes, will have blue flowers if the soil is acidic and pink blossoms if the soil is basic.

a A Hydrangea plant is producing blue flowers. Is the pH of the soil above, below, or at the pH of 7? Explain your answer.

b An indicator, bromthymol blue was used to test the soil. What color would you expect the indicator to be?

35. Base your answer to the following question on the information below and on your knowledge of chemistry.

A $\text{NaOH}(\text{aq})$ solution and an acid-base indicator are used to determine the molarity of an $\text{HCl}(\text{aq})$ solution. A 25.0-milliliter sample of the $\text{HCl}(\text{aq})$ is exactly neutralized by 15.0 milliliters of 0.20 M $\text{NaOH}(\text{aq})$.

Based on the data, the calculated molarity of the $\text{HCl}(\text{aq})$ should be expressed to what number of significant figures?

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

Three bottles of liquids labeled 1, 2, and 3 were found in a storeroom. One of the liquids is known to be drain cleaner. Drain cleaners commonly contain KOH or NaOH. The pH of each liquid at 25°C was determined with a pH meter. The table below shows the test results.

pH Test Results

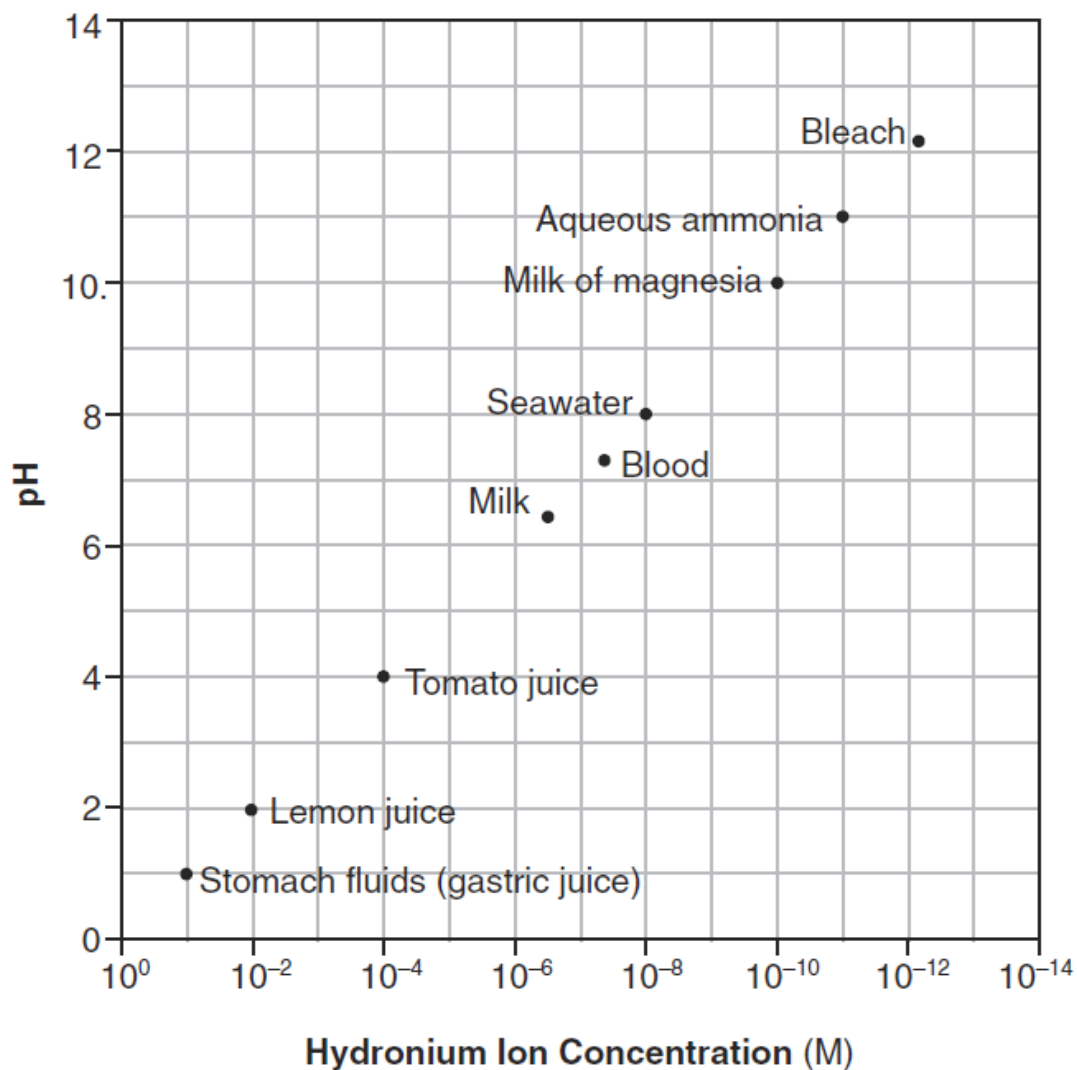
Bottle	pH of Liquid
1	3.8
2	7.0
3	12.8

Explain, in terms of the pH values, why thymol blue is *not* a suitable indicator to distinguish between the contents of bottle 1 and bottle 2.

Base your answers to questions 37 and 38 on the graph below.

The graph shows the relationship between pH value and hydronium ion concentration for common aqueous solutions and mixtures.

pH Versus Hydronium Ion Concentration



37. According to this graph, which mixture is approximately 100 times more acidic than milk of magnesia?

38. What is the hydronium ion concentration of tomato juice?

Answer Key
Acids and Bases 2017

- | | | |
|---|---|---|
| 1. <u>C</u> | 31. Examples: $(0.10 \text{ M})(9.50 \text{ mL}) = M_B (3.80 \text{ mL})$ <i>or</i> $(0.1)(9.5)/3.8$ | 36. Examples: – The liquids in bottle 1 and bottle 2 both have a pH below 8, but thymol blue does not change color until the pH value reaches at least 8.0.
– The pH range for the thymol blue color change is too high. |
| 2. <u>A</u> | 32. • correct numerical setup. Acceptable responses include, but are not limited to:
$(M_A)(20.0 \text{ mL}) = (32.0 \text{ mL})(0.50 \text{ M})$
$\frac{32(0.5)}{20}$
• 0.80 M <i>or</i> for a response consistent with the student's numerical setup. Significant figures do <i>not</i> need to be shown.
Note: Do <i>not</i> allow credit for a numerical setup and calculated result that are not related to the concept assessed by the question. | 37. seawater |
| 3. <u>C</u> | | 38. 0.0001 M |
| 4. <u>A</u> | | |
| 5. <u>B</u> | | |
| 6. <u>D</u> | | |
| 7. <u>C</u> | | |
| 8. <u>C</u> | | |
| 9. <u>C</u> | | |
| 10. <u>A</u> | | |
| 11. <u>C</u> | | |
| 12. <u>D</u> | | |
| 13. <u>A</u> | | |
| 14. <u>A</u> | | |
| 15. <u>B</u> | | |
| 16. <u>D</u> | | |
| 17. <u>D</u> | | |
| 18. <u>D</u> | | |
| 19. <u>B</u> | | |
| 20. <u>D</u> | | |
| 21. <u>D</u> | 33. <i>Examples:</i> –7.6 and 8.2 – 8.1 and 7.7 | |
| 22. <u>D</u> | 34. <i>a</i> The pH is below 7 because blue flowers are expressed in acidic soil.
<i>b</i> Yellow, if the answer for <i>a</i> above is below 7; Blue, if the answer above is basic. | |
| 23. <u>C</u> | | |
| 24. <u>B</u> | | |
| 25. <u>D</u> | | |
| 26. <u>B</u> | | |
| 27. <u>C</u> | | |
| 28. — OH ⁻ <i>or</i> hydroxide | 35. 2 <i>or</i> two | |
| 29. — hydronium ion — hydronium — hydrogen ion — hydrogen | | |
| 30. <i>Examples:</i> —methyl orange — bromthymol blue — thymol blue | | |