Name: Date:

Acids, Bases and Salts Unit Review

Base your answers to questions 1 through 3 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

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

2. Determine *both* the total volume of HCl(aq) and the total volume of NaOH(aq) used in the titration.

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

Base your answers to questions 4 through 6 on the information below.

Some carbonated beverages are made by forcing carbon dioxide gas into a beverage solution. When a bottle of one kind of carbonated beverage is first opened, the beverage has a pH value of 3.

4. After the beverage bottle is left open for several hours, the hydronium ion concentration in the beverage solution decreases to $\frac{1}{1000}$ of the original concentration. Determine the new pH of the beverage solution.

5. State, in terms of the pH scale, why this beverage is classified as acidic.

6. Using Table *M*, identify *one* indicator that is yellow in a solution that has the same pH value as this beverage.

Base your answers to questions 7 through 11 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 x 10-2 gram of dissolved oxygen. Phenolphthalein tests colorless and bromthymol blue tests blue in samples of the fish-tank water.

7. When the fish-tank water has a pH of 8.0, the hydronium ion concentration is 1.0×10^{-8} mole per liter. What is the hydronium ion concentration when the water has a pH of 7.0?

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

9. When the fish-tank water has a pH of 8.0, the hydronium ion concentration is 1.0×10^{-8} mole per liter. What is the hydronium ion concentration when the water has a pH of 7.0?

10. State how an increase in the temperature of the fish-tank water affects the solubility of oxygen in the water.

11. Determine if the DO concentration in the fish tank is healthy for fish. Your response must include:
    - a correct numerical setup to calculate the DO concentration in the water in parts per million
    - the calculated result
    - a statement using your calculated result that tells why the DO concentration in the water is or is not healthy for fish

Base your answers to questions 12 and 13 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).

12. According to the data, to what number of significant figures should the calculated molarity of the HCl(aq) be expressed?

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

Base your answers to questions 14 through 17 on the information below.

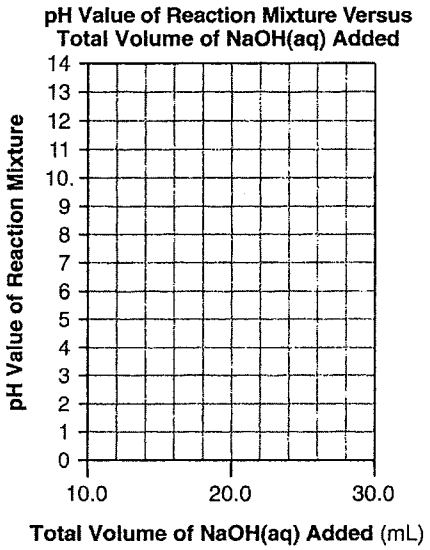
In one trial of an investigation, 50.0 milliliters of HCI(aq) of an unknown concentration is titrated with 0.10 M NaOH(aq). During the titration, the total volume of NaOH(aq) added and the corresponding pH value of the reaction mixture are measured and recorded in the table below.

Titration Data

Total Volume of NaOH(aq) Added (mL)	**pH Value of Reaction Mixture**
10.0	1.6
20.0	2.2
24.0	2.9
24.9	3.9
25.1	10.1
26.0	11.1
30.0	11.8

14. In another trial, 40.0 milliliters of HCI(aq) is completely neutralized by 20.0 milliliters of this 0.10 M NaOH(aq). Calculate the molarity of the titrated acid in this trial. Your response must include *both* a numerical setup and the calculated result.

15. On the grid below, plot the data from the table. Circle and connect the points.



16. Determine the total volume of NaOH(aq) added when the reaction mixture has a pH value of 7.0.

17. Write a balanced equation that represents this neutralization reaction.

Base your answers to questions 18 through 21 on the information below.

In liquid water, an equilibrium exists between $H_2O(\ell)$ molecules, $H^+(aq)$ ions, and $OH^-(aq)$ ions. A person experiencing acid indigestion after drinking tomato juice can ingest milk of magnesia to reduce the acidity of the stomach contents. Tomato juice has a pH value of 4. Milk of magnesia, a mixture of magnesium hydroxide and water, has a pH value of 10.

18. What is the color of thymol blue indicator when placed in a sample of milk of magnesia?

19. Complete the equation below for the equilibrium that exists in liquid water.

_____ $(\ell) \leftrightarrow$ _____ (aq) + _____ (aq)

20. Compare the hydrogen ion concentration in tomato juice to the hydrogen ion concentration in milk of magnesia.

21. Identify the negative ion found in milk of magnesia.

Base your answers to questions 22 through 24 on the information below.

A student used blue litmus paper and phenolphthalein paper as indicators to test the pH of distilled water and five aqueous household solutions. Then the student used a pH meter to measure the pH of the distilled water and each solution. The results of the student's work are recorded in the table below.

Testing Results

Liquid Tested	Color of Blue Litmus Paper	Color of Phenolphthalein Paper	Measured pH Value Using a pH Meter
2% milk	blue	colorless	6.4
distilled water	blue	colorless	7.0
household ammonia	blue	pink	11.5
lemon juice	red	colorless	2.3
tomato juice	red	colorless	4.3
vinegar	red	colorless	3.3

22. Based on the measured pH values, identify the liquid tested that is 10 times more acidic than vinegar.

23. Identify the liquid tested that has the *lowest* hydronium ion concentration.

24. Explain, using the reference table, in terms of the pH range for color change why litmus is *not* appropriate to differentiate the acidity levels of tomato juice and vinegar.

Base your answers to questions **25** and **26** on the information below.

In performing a titration, a student adds three drops of phenolphthalein to a flask containing 25.00 milliliters of HCl(aq). Using a buret, the student slowly adds 0.150 M NaOH(aq) to tile flask until one drop causes the indicator to turn light pink. The student determines that a total volume of 20.20 milliliters of NaOH(aq) was used in this titration.

25. Calculate the molarity of the HCl(aq) used in this titration. Your response must include *both* a correct numerical setup and the calculated result.

26. The concentration of the NaOH(aq) used in the titration is expressed to what number of significant figures?

Base your answers to questions 27 through 29 on the information below.

Soil pH can affect the development of plants. For example, a hydrangea plant produces blue flowers when grown in acidic soil but pink flowers when grown in basic soil. Evergreen plants can show a yellowing of foliage, called chlorosis, when grown in soil that is too basic.

Acidic soil can be neutralized by treating it with calcium hydroxide, $Ca(OH)_2$, commonly called slaked lime. Slaked lime is slightly soluble in water.

27. Write an equation, using symbols *or* words, for the neutralization of the ions in acidic soil by the ions released by slaked lime in water.

28. Compare the hydrogen ion concentration to the hydroxide ion concentration in soil when a hydrangea plant produces pink flowers.

29. An evergreen plant has yellowing foliage. The soil surrounding the plant is tested with methyl orange and bromthymol blue. Both indicators turn yellow in the soil tests. State, in terms of pH value, why the yellowing of the plant is *not* due to chlorosis.

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

When a person perspires (sweats), the body loses many sodium ions and potassium ions. The evaporation of sweat cools the skin.

After a strenuous workout, people often quench their thirst with sports drinks that contain NaCl and KCl. A single 250.-gram serving of one sports drink contains 0.055 gram of sodium ions.

State why the salts in sports drinks are classified as electrolytes.

Answer Key
[New Exam]

1. Examples: (0.10 M)(9.50 mL) = M_B (3.80 mL) *or* (0.1)(9.5)/3.8

2. Examples: - 9.50 ml HCl(aq) and 3.80 mL NaOH(aq) - 9.5 mL HCl(aq) and 3.8 mL NaOH(aq)

3. Examples: (0.10 M)(9.50 mL) = M_B (3.80 mL) *or* (0.1)(9.5)/3.8

4. - 6

5. - The beverage is acidic because its pH value is below 7. - A pH of 3 is in the acid range on the pH scale.

6. $^-$(aq) + H_3O^+(aq) -water(ℓ) $\leftrightarrow$ hydrogen ion(aq) + hydroxide ion(aq) - bromthymol blue - bromcresol green - thymol blue

7. *Examples:*
   1×10^{-7} mol/L; 0.0000001 mol/L; 10^{-7} mol/L

8. *Examples*: -7.6 and 8.2 - 8.1 and 7.7

9. *Examples:*
   1×10^{-7} mol/L; 0.0000001 mol/L; 10^{-7} mol/L

10. *Examples:* - When the temperature of the water increases, oxygen is less soluble. - Oxygen is less soluble in warmer water.

11. $\text{ppm} = \frac{2.7 \times 10^{-2}}{3800\,\text{g}} \times 10^6$

    7.1 ppm

    The water is healthy for fish because the DO is 7.1 ppm, which is within the range of DO concentrations best for fish.

12. 2 *or* two.

13. • $^-$ → HOH hydrogen ions + hydroxide ions → water; hydroxide ions + hydronium ions → water
    • correct numerical setup. Acceptable responses include, but are not limited to:
    $(M_A)(20.0\text{ mL}) = (32.0\text{ mL})(0.50\text{ M})$
    $\frac{32(0.5)}{20.}$
    • O^- concentration is less than the OH^- concentration. $[OH^-] > [H_3O^+]$
    • 0.80 M or for a response consistent with the student's numerical setup.
    Significant figures do *not* need to be shown.
    Note: Do *not* allow credit for a numerical setup and calculated result that are not related to the concept assessed by the question.

14. A correct numerical set up is shown. A result of 0.050 M or a response consistent with the student's numerical setup is shown.
    $(M)(40.0\text{ mL}) = (0.10\text{ M})(20.0\text{ mL})$ *or* $\frac{(0.1)(20)}{40}$

15. All seven points are plotted correctly ± 0.3 grid spaces.

16. 25.0 mL ± 0.6 mL or a response consistent with the student's graph.

17. • NaOH(aq) + HCl(aq) → NaCl(aq) + $H_2O(\ell)$
    • HCl + NaOH → NaCl + H_2O
    • H^+(aq) + OH^-(aq) → $H_2O(\ell)$
    • $H_3O^+ + OH^- \rightarrow 2H_2O$

18. blue

19. -$H_2O(\ell) \leftrightarrow H^+$(aq) + OH^-(aq) -$2H_2O(\ell) \leftrightarrow$ OH

20. -The H^+ ion concentration in tomato juice is 10^6 times greater. -The hydrogen ion concentration in tomato juice is greater than that in milk of magnesia. -Milk of magnesia has a lower concentration of H_3O^+ ions.

21. OH^-(aq) *or* OH^- *or* hydroxide ion

22. Answer: lemon juice

23. Examples: household ammonia; NH_3(aq)

24. Examples: Because litmus changes color in a pH range of 5.5 to 8.2, litmus cannot be used to differentiate between a pH of 3.3 and 4.3; Litmus is red for all pH values below 5.5.

25. 0.121 M

26. 3; Three

27. *Examples:* H_3O^+(aq) + OH^-(aq) → $2H_2O(\ell)$; $H^+ + OH^-$ → HOH hydrogen ions + hydroxide ions → water; hydroxide ions + hydronium ions → water

28. *Examples:* - The hydroxide ion concentration is greater than the hydrogen ion concentration. - The H $^+$ concentration is less than the OH^- concentration. $[OH^-] > [H_3O^+]$

29. *Examples:* - The pH is between 4.4 and 6.0, which indicates an acidic soil. - The pH of the soil surrounding the plant is below 6.0. - For chlorosis, the soil pH must be above 7.

30. *Examples:* - Charged particles are free to move when salts dissolve in water. - The ions in the salts dissociate and are free to move. - The salts form aqueous solutions that can conduct electric current.