1. Which laboratory test result can be used to determine if KCl(s) is an electrolyte?

   A) pH of KCl(aq)
   B) pH of KCl(s)
   C) electrical conductivity of KCl(aq)
   D) electrical conductivity of KCl(s)

2. Which substance is an electrolyte?

   A) CCl_4 B) C_2H_6
   C) HCl   D) H_2O

3. Which two compounds are electrolytes?

   A) $C_6H_{12}O_6$ and CH_3CH_2OH
   B) $C_6H_{12}O_6$ and HCl
   C) NaOH and HCl
   D) NaOH and CH_3CH_2OH

4. A substance is classified as an electrolyte because

   A) it has a high melting point
   B) it contains covalent bonds
   C) its aqueous solution conducts an electric current
   D) its aqueous solution has a pH value of 7

5. Which of the following aqueous solutions is the best conductor of electricity?

   A) 0.10 M CH_3OH B) 1.0 M CH_3OH
   C) 0.10 M NaOH   **D) 1.0 M NaOH**

6. A student was given four unknown solutions. Each solution was checked for conductivity and tested with phenolphthalein. The results are shown in the data table below.

Solution	Conductivity	Color with Phenolphthalein
A	Good	Colorless
B	Poor	Colorless
C	Good	Pink
D	Poor	Pink

   Based on the data table, which unknown solution could be 0.1 M NaOH?

   A) *A*   B) *B*   **C) *C***   D) *D*

7. Which compound is an Arrhenius acid?

   A) CaO   **B) HCl**   C) K_2O D) NH_3

8. When one compound dissolves in water, the only positive ion produced in the solution is H_3O^+ (aq). This compound is classified as

   A) a salt
   B) a hydrocarbon
   C) an Arrhenius acid
   D) an Arrhenius base

9. Which substance is always a product when an Arrhenius acid in an aqueous solution reacts with an Arrhenius base in an aqueous solution?

   A) HBr   **B) H_2O**
   C) KBr   D) KOH

10. Given the equation:

    $$HCl(g) + H_2O(\ell) \rightarrow X(aq) + Cl^-(aq)$$

    Which ion is represented by *X*?

    A) hydroxide   **B) hydronium**
    C) hypochlorite   D) perchlorate

11. An aqueous solution of lithium hydroxide contains hydroxide ions as the only negative ion in the solution. Lithium hydroxide is classified as an

    A) aldehyde   B) alcohol
    C) Arrhenius acid   **D) Arrhenius base**

12. According to the Arrhenius theory, an acid is a substance that

    A) changes litmus from red to blue
    B) changes phenolphthalein from colorless to pink
    C) produces hydronium ions as the only positive ions in an aqueous solution
    D) produces hydroxide ions as the only negative ions in an aqueous solution

13. Which compound releases hydroxide ions in an aqueous solution?

    A) CH_3COOH B) CH_3OH
    C) HCl   **D) KOH**

14. Which formula represents a hydronium ion?

    A) H_3O^+   B) NH_4+
    C) OH^- D) HCO_3^-

15. A solution with a pH of 2.0 has a hydronium ion concentration ten times greater than a solution with a pH of

   A) 1.0   B) 0.20   **C) 3.0**   D) 20

16. Which change in pH represents a hundredfold increase in the concentration of hydronium ions in a solution?

   A) pH1 to pH 2   B) pH 1 to pH 3
   C) pH 2 to pH 1   **D) pH 3 to pH 1**

17. What is the pH of a solution that has a hydronium ion concentration 100 times greater than a solution with a pH of 4?

   A) 5   **B) 2**   C) 3   D) 6

18. Which pH indicates a basic solution?

   A) 1   B) 5   C) 7   **D) 12**

19. Which of these pH numbers indicates the highest level of acidity?

   A) 5   B) 8   C) 10   D) 12

20. Based on the results of testing colorless solutions with indicators, which solution is most acidic?

   A) a solution in which bromthymol blue is blue
   B) a solution in which bromcresol green is blue
   C) a solution in which phenolphthalein is pink
   D) a solution in which methyl orange is red

21. Which indicator would best distinguish between a solution with a pH of 3.5 and a solution with a pH of 5.5

   A) bromthyrnol blue
   B) bromcresol green
   C) litmus
   D) thymol blue

22. Which indicator, when added to a solution, changes color from yellow to blue as the pH of the solution is changed from 5.5 to 8.0?

   A) bromcresol green
   B) bromthymol blue
   C) litmus
   D) methyl orange

23. The table below shows the color of the indicators methyl orange and litmus in two samples of the same solution.

   Results of Acid-Base Indicator Tests

Indicator	Color Result from the Indicator Test
methyl orange	yellow
litmus	red

   Which pH value is consistent with the indicator results?

   A) 1   **B) 5**   C) 3   D) 10

24. Which indicator is yellow in a solution with a pH of 9.8?

   A) methyl orange   B) bromthymol blue
   C) bromcresol green   D) thymol blue

25. One acid-base theory defines a base as an

   A) H^+ donor   **B) H^+ acceptor**
   C) H donor   D) H acceptor

26. One alternate acid-base theory states that an acid is an

   A) H^+ donor   B) H^+ acceptor
   C) OH^- donor   D) OH^- acceptor

27. Which statement describes an alternate theory of acids and bases?

   A) Acids and bases are both H^+ acceptors.
   B) Acids and bases are both H^+ donors.
   C) Acids are H^+ acceptors, and bases are H^+ donors.
   D) Acids are H^+ donors, and bases are H^+ acceptors.

28. Given the reaction at equilibrium:

   $$HSO_4^- + NH_3 \leftrightarrow SO_4^{2-} + NH_4^+$$
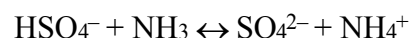
   What are the two species that are acids?

   A) NH_3 and NH_4^+
   B) NH_3 and SO_4^{2-}
   C) HSO_4^- and SO_4^{2-}
   D) HSO_4^- and NH_4^+

29. According to one acid-base theory, water acts as an acid when an H_2O molecule

   A) accepts an H^+ **B) donates an H^+**
   C) accepts an H^- D) donates an H^-

30. Which compound is produced when HCl(aq) is neutralized by $Ca(OH)_2(aq)$?

   A) $CaCl_2$　　　　B) CaH_2
   C) HClO　　　　　　D) $HClO_2$

31. Which word equation represents a neutralization reaction?

   A) base + acid → salt + water
   B) base + salt → water + acid
   C) salt + acid → base + water
   D) salt + water → acid + base

32. Which equation represents a neutralization reaction?

   A) $4Fe(s) + 3O_2(g) → Fe_2O_3(s)$
   B) $2H_2(g) + O_2(g) → 2H_2O(\ell)$
   C) $HNO_3(aq) + KOH(aq) → KNO_3(aq) + H_2O(\ell)$
   D) $AgNO_3(aq) + KCl(aq) → KNO_3(aq) + AgCl(s)$

33. 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**

34. A student completes a titration by adding 12.0 milliliters of NaOH(aq) of unknown concentration to 16.0 milliliters of 0.15 M HCl(aq). What is the molar concentration of the NaOH(aq)?

   A) 0.11 M　　　　　**B) 0.20 M**
   C) 1.1 M　　　　　D) 5.0 M

35. A 25.0-milliliter sample of $HNO_3(aq)$ is neutralized by 32.1 milliliters of 0.150 M KOH(aq). What is the molarity of the $HNO_3(aq)$?

   A) 0.117 M　　　　B) 0.150 M
   C) 0.193 M　　　　D) 0.300 M

36. Which volume of 0.10 M NaOH(aq) exactly neutralizes 15.0 milliliters of 0.20 M $HNO_3(aq)$?

   A) 1.5 mL　　　　　B) 7.5 mL
   C) 3.0 mL　　　　　**D) 30. mL**

37. What volume of 0.120 M $HNO_3(aq)$ is needed to completely neutralize 150.0 milliliters of 0.100 M NaOH(aq)?

   A) 62.5 mL　　　　**B) 125 mL**
   C) 180. mL　　　　D) 360. mL

Base your answers to questions **38** and **39** on the information below.

In one trial of an investigation, 50.0 milliliters of HCl(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

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

39. In another trial, 40.0 milliliters of HCl(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.

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40. Base your answer to the following question 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.

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

Base your answers to questions **41** through **43** 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

41. 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.

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

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

Answer Key
Acids Base Review

1.   **C**
2.   **C**
3.   **C**
4.   **C**
5.   **D**
6.   **C**
7.   **B**
8.   **C**
9.   **B**
10.   **B**
11.   **D**
12.   **C**
13.   **D**
14.   **A**
15.   **C**
16.   **D**
17.   **B**
18.   **D**
19.   **A**
20.   **D**
21.   **B**
22.   **B**
23.   **omit**
24.   **A**
25.   **B**
26.   **A**
27.   **D**
28.   **D**
29.   **B**
30.   **A**
31.   **A**
32.   **C**
33.   **D**
34.   **B**
35.   **C**
36.   **D**

37.   **B**

38.
- $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell)$
- $HCl + NaOH \rightarrow NaCl + H_2O$
- $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$
- $H_3O^+ + OH^- \rightarrow 2H_2O$

39. 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.
$(M)(40.0\ mL) = (0.10\ M)(20.0\ mL)$
or $\frac{(0.1)(20)}{40}$

40.
−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.

41. 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.

42. Examples: household ammonia; $NH_3(aq)$

43. Answer: lemon juice