1. Which substance is an electrolyte?
   A) \( \text{C}_6\text{H}_12\text{O}_6(s) \)  B) \( \text{C}_2\text{H}_5\text{OH}(\ell) \)
   C) \( \text{NaOH}(s) \)  D) \( \text{H}_2(\text{g}) \)

2. Which of the following liquids is the best conductor of electricity?
   A) \( \text{CCl}_4(\ell) \)  B) \( \text{H}_2\text{O}(\ell) \)
   C) \( \text{CH}_3\text{OH}(\ell) \)  D) \( \text{NaOH(aq)} \)

3. Which formula represents a compound that is a strong electrolyte?
   A) \( \text{C}_6\text{H}_12\text{O}_6 \)  B) \( \text{C}_{12}\text{H}_{22}\text{O}_{11} \)
   C) \( \text{HNO}_2 \)  D) \( \text{HNO}_3 \)

4. Which substance, when dissolved in water, forms a solution that conducts an electric current?
   A) \( \text{C}_2\text{H}_5\text{OH} \)  B) \( \text{C}_6\text{H}_12\text{O}_6 \)
   C) \( \text{C}_{12}\text{H}_{22}\text{O}_{11} \)  D) \( \text{CH}_3\text{COOH} \)

5. Which two compounds are electrolytes?
   A) \( \text{C}_6\text{H}_12\text{O}_6 \) and \( \text{CH}_3\text{CH}_2\text{OH} \)
   B) \( \text{C}_6\text{H}_12\text{O}_6 \) and \( \text{HCl} \)
   C) \( \text{NaOH} \) and \( \text{HCl} \)
   D) \( \text{NaOH} \) and \( \text{CH}_3\text{CH}_2\text{OH} \)

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.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Conductivity</th>
<th>Color with Phenolphthalein</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Good</td>
<td>Colorless</td>
</tr>
<tr>
<td>B</td>
<td>Poor</td>
<td>Colorless</td>
</tr>
<tr>
<td>C</td>
<td>Good</td>
<td>Pink</td>
</tr>
<tr>
<td>D</td>
<td>Poor</td>
<td>Pink</td>
</tr>
</tbody>
</table>

Based on the data table, which unknown solution could be 0.1 M NaOH?
A) \( A \)  B) \( B \)  C) \( C \)  D) \( D \)

7. A substance that conducts an electrical current when dissolved in water is called
   A) a catalyst  B) a metalloid  C) a nonelectrolyte  D) an electrolyte

8. Which substance is an electrolyte?
   A) \( \text{CCl}_4 \)  B) \( \text{C}_2\text{H}_6 \)  C) \( \text{HCl} \)  D) \( \text{H}_2\text{O} \)

9. Which compounds are both classified as electrolytes?
   A) \( \text{NH}_4\text{Cl} \) and \( \text{KCl} \)
   B) \( \text{C}_6\text{H}_12\text{O}_6 \) and \( \text{CH}_3\text{OH} \)
   C) \( \text{NH}_4\text{Cl} \) and \( \text{C}_6\text{H}_12\text{O}_6 \)
   D) \( \text{KCl} \) and \( \text{CH}_3\text{OH} \)
10. Which is a characteristic of an aqueous solution of HNO₃?
   A) It conducts electricity.
   B) It forms OH⁻ ions.
   C) It turns litmus blue.
   D) It turns phenolphthalein pink.

11. Which substance is an Arrhenius acid?
   A) Ba(OH)₂  
   B) CH₃COOCH₃ 
   C) H₃PO₄  
   D) NaCl

12. The only positive ion found in H₂SO₄(aq) is the
   A) ammonium ion  
   B) hydronium ion  
   C) hydroxide ion  
   D) sulfate ion

13. Which ion is the only negative ion produced by an Arrhenius base in water?
   A) CH₃OH  
   B) CO₂  
   C) LiOH  
   D) NO₂

14. Which compound is an Arrhenius base?
   A) H⁺ ions in aqueous solution  
   B) Cl⁻ ions in aqueous solution  
   C) OH⁻ ions in aqueous solution  
   D) NH₄⁺ ions in aqueous solution

15. Hydrogen chloride, HCl, is classified as an Arrhenius acid because it produces
   A) H⁺ ions in aqueous solution  
   B) Cl⁻ ions in aqueous solution  
   C) OH⁻ ions in aqueous solution  
   D) NH₄⁺ ions in aqueous solution

16. Which substance is an Arrhenius base?
   A) CH₃OH  
   B) CH₃Cl  
   C) LiOH  
   D) LiCl

17. Which compound is produced when HCl(aq) is neutralized by Ca(OH)₂(aq)?
   A) CaCl₂  
   B) CaH₂  
   C) HClO  
   D) HClO₂

18. What is the pH of a solution that results from the complete neutralization of an HCl solution with a KOH solution?
   A) 1  
   B) 7  
   C) 10  
   D) 4

19. What are the products when potassium hydroxide reacts with hydrochloric acid?
   A) KH(s), Cl⁺(aq), and OH⁻(aq)
   B) K(s), Cl₂(g), and H₂O(ℓ)
   C) KCl(aq) and H₂O(ℓ)
   D) KOH(aq) and Cl₂(g)

20. Which type of reaction will occur when equal volumes of 0.1 M HCl and 0.1 M NaOH are mixed?
   A) neutralization  
   B) ionization  
   C) electrolysis  
   D) hydrolysis

21. Given the balanced equation representing a reaction:
   H₂SO₄(aq) + 2KOH(aq) → K₂SO₄(aq) + 2H₂O(ℓ)
   Which type of reaction is represented by this equation?
   A) decomposition  
   B) neutralization  
   C) single replacement  
   D) synthesis

22. Given the neutralization reaction:
   H₂SO₄ + 2 KOH → K₂SO₄ + 2 HOH
   Which compound is a salt?
   A) copper  
   B) gold  
   C) silver  
   D) zinc

23. Which element reacts spontaneously with 1.0 M HCl(aq) at room temperature?
   A) volume of the reaction mixture increases  
   B) temperature of the reaction mixture decreases  
   C) concentration of ions increases  
   D) concentration of ions decreases

24. Given the reaction:
   Ba(OH)₂(aq) + H₂SO₄(aq) → BaSO₄(s) + 2 H₂O(ℓ) + energy
   As the barium hydroxide solution is added to the solution of sulfuric acid, the electrical conductivity of the acid solution decreases because the
   A) volume of the reaction mixture increases  
   B) temperature of the reaction mixture decreases  
   C) concentration of ions increases  
   D) concentration of ions decreases

25. Which acid-base pair will always undergo a reaction that produces a neutral solution?
   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
26. Given the reaction:

\[
\text{HC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{KC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{H}_2\text{O}(l)
\]

The products of this reaction form a salt solution that is
A) acidic and turns litmus blue
B) acidic and turns litmus red
C) basic and turns litmus blue
D) basic and turns litmus red

27. For each of the following reactions, the base is precisely titrated to the endpoint by the acid. In which reaction would the resulting mixture of products have a pH of less than 7?
A) \(3 \text{HCl} + \text{Al(OH)}_3 \rightarrow \text{AlCl}_3 + 3 \text{H}_2\text{O}\)
B) \(\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}\)
C) \(\text{HNO}_3 + \text{NaOH} \rightarrow \text{NaNO}_3 + \text{H}_2\text{O}\)
D) \(\text{HC}_2\text{H}_3\text{O}_2 + \text{NaOH} \rightarrow \text{NaC}_2\text{H}_3\text{O}_2 + \text{H}_2\text{O}\)

28. During a titration, a student used 50 milliliters of 0.1 M acid. How many moles of acid, expressed to proper significance, were used?
A) 0.005
B) 0.0050
C) 0.00500
D) 0.005000

29. How many milliliters of 0.010 M NaOH are required to exactly neutralize 20.0 milliliters of 0.020 M HCl?
A) 10. mL
B) 20. mL
C) 30. mL
D) 40. mL

30. How many liters of 2.5 M HCl are required to exactly neutralize 1.5 liters of 5.0 M NaOH?
A) 1.0
B) 2.0
C) 3.0
D) 4.0

31. 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

32. How many liters of 2.5 M HCl are required to exactly neutralize 1.5 liters of 5.0 M NaOH?
A) 1.0 L
B) 2.0 L
C) 3.0 L
D) 4.0 L

33. If 25. milliliters of 0.80 M HCl is used to completely neutralize 40. milliliters of NaOH solution, what is the molarity of the base?
A) 5.0 M
B) 0.50 M
C) 0.050 M
D) 5.0 M

34. If 5.0 milliliters of a 0.20 M HCl solution is required to neutralize exactly 10. milliliters of NaOH, what is the concentration of the base?
A) 0.10 M
B) 0.20 M
C) 0.30 M
D) 0.40 M

35. A 3.0-milliliter sample of HNO₃ solution is exactly neutralized by 6.0 milliliters of 0.50 M KOH. What is the molarity of the HNO₃ sample?
A) 1.0 M
B) 0.50 M
C) 3.0 M
D) 15 M

36. When 50. milliliters of an HNO₃ solution is exactly neutralized by 150 milliliters of a 0.50 M solution of KOH, what is the concentration of HNO₃?
A) 1.0 M
B) 1.5 M
C) 3.0 M
D) 0.5 M

37. A student wishes to determine the concentration of a weak acid by titration with a base of known concentration. What is the most important property of the base?
A) It should be weak.
B) It should be strong.
C) It should be of known molarity.
D) It should not react with carbon dioxide.

38. What volume of 0.120 M HNO₃(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

39. Given the balanced equation representing a reaction:

\[\text{H}_2\text{O}(ℓ) + \text{HCl}(g) \rightarrow \text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq)\]

According to one acid-base theory, the H₂O(ℓ) molecules
A) accept H⁺ ions
B) accept OH⁻ ions
C) donate H⁺ ions
D) donate OH⁻ ions
40. The table below shows the results produced when two drops of phenolphthalein are added to 0.1 M solutions of three salts.

<table>
<thead>
<tr>
<th>Salt</th>
<th>Resulting Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaNO₃</td>
<td>colorless</td>
</tr>
<tr>
<td>KI</td>
<td>colorless</td>
</tr>
<tr>
<td>NaC₂H₃O₂</td>
<td>pink</td>
</tr>
</tbody>
</table>

Which ion hydrolyzed when the salt was dissolved in water?
A) K⁺  B) NO₃⁻  C) I⁻  D) C₂H₃O₂⁻

41. The table below gives data on the conductivity and pH of solutions A, B, C, and D.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Conductivity</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>good</td>
<td>greater than 7</td>
</tr>
<tr>
<td>B</td>
<td>good</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>good</td>
<td>less than 7</td>
</tr>
<tr>
<td>D</td>
<td>poor</td>
<td>less than 7</td>
</tr>
</tbody>
</table>

Which solution is most likely ammonium chloride?
A) A  B) B  C) C  D) D

42. When the salt NH₄NO₃ is dissolved in water, it produces a solution that is
A) acidic, with a pH less than 7
B) acidic, with a pH greater than 7
C) basic, with a pH less than 7
D) basic, with a pH greater than 7

43. Which aqueous solution has a pH greater than 7?
A) NaCl  B) NaNO₃
C) Na₂SO₄  D) Na₂CO₃