1. Which compounds can be classified as electrolytes?
   1) alcohols
   2) alkynes
   3) organic acids
   4) saturated hydrocarbons

2. Which compound is an electrolyte?
   1) butene
   2) propane
   3) dimethyl ether
   4) methanoic acid

3. Which laboratory test result can be used to determine if KCl(s) is an electrolyte?
   1) pH of KCl(aq)
   2) pH of KCl(s)
   3) electrical conductivity of KCl(aq)
   4) electrical conductivity of KCl(s)

4. Which substance is an electrolyte?
   1) CCl_4
   2) C_2H_6
   3) HCl
   4) H_2O

5. Which sample of HCl(aq) contains the greatest number of moles of solute particles?
   1) 1.0 L of 2.0 M HCl(aq)
   2) 2.0 L of 2.0 M HCl(aq)
   3) 3.0 L of 0.50 M HCl(aq)
   4) 4.0 L of 0.50 M HCl(aq)

6. Which two compounds are electrolytes?
   1) $C_6H_{12}O_6$ and CH_3CH_2OH
   2) $C_6H_{12}O_6$ and HCl
   3) NaOH and HCl
   4) NaOH and CH_3CH_2OH

7. Potassium hydroxide is classified as an Arrhenius base because KOH contains
   1) OH^- ions
   2) O^{2-} ions
   3) K^+ ions
   4) H^+ ions

8. According to the Arrhenius theory, a base reacts with an acid to produce
   1) ammonia and methane
   2) ammonia and a salt
   3) water and methane
   4) water and a salt

9. Which compound is an Arrhenius acid?
   1) CaO
   2) HCl
   3) K_2O
   4) NH_3

10. Which compound when dissolved in water is an Arrhenius acid?
    1) CH_3OH
    2) HCl
    3) NaCl
    4) NaOH

11. When one compound dissolves in water, the only positive ion produced in the solution is H_3O^+ (aq). This compound is classified as
    1) a salt
    2) a hydrocarbon
    3) an Arrhenius acid
    4) an Arrhenius base

12. Which substance is always a product when an Arrhenius acid in an aqueous solution reacts with an Arrhenius base in an aqueous solution?
    1) HBr
    2) H_2O
    3) KBr
    4) KOH

13. Given the equation:

$$HCl(g) + H_2O(\ell) \rightarrow X(aq) + Cl^-(aq)$$
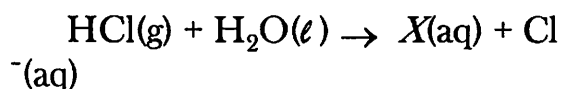
Which ion is represented by X?
1) hydroxide
2) hydronium
3) hypochlorite
4) perchlorate

14. A solution with a pH of 2.0 has a hydronium ion concentration ten times greater than a solution with a pH of
1) 1.0
2) 0.20
3) 3.0
4) 20

15. Which change in pH represents a hundredfold increase in the concentration of hydronium ions in a solution?
1) pH1 to pH 2
2) pH 1 to pH 3
3) pH 2 to pH 1
4) pH 3 to pH 1

16. What is the pH of a solution that has a hydronium ion concentration 100 times greater than a solution with a pH of 4?
1) 5
2) 2
3) 3
4) 6

17. As the pH of a solution is changed from 3 to 6, the concentration of hydronium ions
1) increases by a factor of 3
2) increases by a factor of 1000
3) decreases by a factor of 3
4) decreases by a factor of 1000

18. Solution A has a pH of 3 and solution Z has a pH of 6. How many times greater is the hydronium ion concentration in solution A than the hydronium ion concentration in solution Z?
1) 100
2) 2
3) 3
4) 1000

19. A hydrogen ion, H^+, in aqueous solution may also be written as
1) H_2O
2) H_2O_2
3) H_3O^+
4) OH^-

20. Based on the results of testing colorless solutions with indicators, which solution is most acidic?
1) a solution in which bromthymol blue is blue
2) a solution in which bromcresol green is blue
3) a solution in which phenolphthalein is pink
4) 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
1) bromthymol blue
2) bromcresol green
3) litmus
4) thymol blue

22. Which indicator is blue in a solution that has a pH of 5.6?
1) bromcresol green
2) bromthymol blue
3) methyl orange
4) thymol blue

23. 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?
1) bromcresol green 3) litmus
2) bromthymol blue 4) methyl orange

24. 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?
1) 1   3) 3
2) 5   4) 10

25. In which 0.01 M solution is phenolphthalein pink?
1) $CH_3OH(aq)$ 3) $CH_3COOH(aq)$
2) $Ca(OH)_2(aq)$ 4) $HNO_3(aq)$

26. One acid-base theory defines a base as an
1) H^+ donor   3) H donor
2) H^+ acceptor   4) H acceptor

27. One alternate acid-base theory states that an acid is an
1) H^+ donor   3) OH^- donor
2) H^+ acceptor   4) OH^- acceptor

28. Which statement describes an alternate theory of acids and bases?
1) Acids and bases are both H^+ acceptors.
2) Acids and bases are both H^+ donors.
3) Acids are H^+ acceptors, and bases are H^+ donors.
4) Acids are H^+ donors, and bases are H^+ acceptors.

29. Given the balanced equation representing a reaction:

$$NH_3(g) + H_2O(l) \rightarrow NH_4^+ (aq) + OH^- (aq)$$
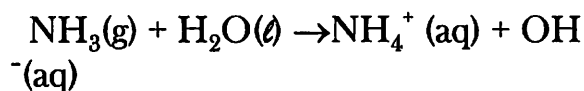
According to one acid-base theory, the $NH_3(g)$ molecules act as
1) an acid because they accept H^+ ions
2) an acid because they donate H^+ ions
3) a base because they accept H^+ ions
4) a base because they donate H^+ ions

30. According to one acid-base theory, a water molecule acts as an acid when the water molecule
1) accepts an H^+ 3) donates an H^+
2) accepts an OH^- 4) donates an OH^-

31. Given the equation:

$$H^+_{(aq)} + OH^-(aq) \rightarrow H_2O_{(l)}$$
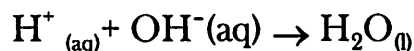
Why does this reaction go to completion?
1) a gas is formed
2) a precipitate is formed
3) it can reach equilibrium
4) water is formed

32. Which solution reacts with LiOH(aq) to produce a salt and water?
   1) KCl(aq)   3) NaOH(aq)
   2) CaO(aq)   4) H_2SO_4(aq)

33. Which compound is produced when HCl(aq) is neutralized by Ca(OH)$_2$(aq)?
   1) $CaCl_2$ 3) HClO
   2) CaH_2 4) $HClO_2$

34. Which volume of 2.0 M NaOH(aq) is needed to completely neutralize 24 milliliters of 1.0 M HCl(aq)?
   1) 6.0 mL   3) 24 mL
   2) 12 mL   4) 48 mL

35. In which laboratory process is a volume of solution of known concentration used to determine the concentration of another solution?
   1) deposition   3) filtration
   2) distillation   4) titration

36. 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?
   1) evaporation   3) filtration
   2) distillation   4) titration

37. 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)?
   1) 0.11 M   3) 1.1 M
   2) 0.20 M   4) 5.0 M

38. 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)?
   1) 0.117 M   3) 0.193 M
   2) 0.150 M   4) 0.300 M

Base your answers to questions 39 through 41 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.

39. 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.

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

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

45. 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.

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?

Base your answers to questions 42 and 43 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).

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

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

44. 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 and calculating the molarity of the sodium hydroxide solution.