**Topic 8 Practice**

# **8.1 Theories of Acids and Bases**

1. Tell whether it is an acid or a base.
   1. HBr
   2. NaOH
   3. HNO3
   4. H2SO4
   5. NH3
   6. KOH
   7. HCl
2. Write equations to show why H2PO4- is an amphiprotic species.
3. Identify the two acid-base conjugate pairs in each of the following reactions.
   1. NH2OH + HCl  NH3OH + Cl-
   2. HSO3-  + H3PO3  H2SO3  + H2PO3-
4. Complete the following table according to the Brønsted-Lowry definition of acids and bases:

**ACID** **BASE**  **CONJ. ACID** **CONJ. BASE**

A) \_\_\_\_\_ + \_\_\_\_\_  NH4+ + OH-

B) CH3OH + NH2-  \_\_\_\_\_ + \_\_\_\_\_

C) HClO4 + \_\_\_\_\_  H3O+ + \_\_\_\_\_

D) HNO2 + H2O  \_\_\_\_\_ + \_\_\_\_\_

E) \_\_\_\_\_ + \_\_\_\_\_  NH4+ + Cl-

1. Which **one** of the following species can act as both a Brønsted-Lowry acid and base in aqueous solution?

A. CH3COOH

B. 

C. H2

D. OH−

1. Which is a conjugate acid-base pair in the following reaction?

HNO3 +H2SO4  H2 +H

A. HNO3 and H2SO4

B. HNO3 and H2

C. HNO3 and H

D. H2NO3 and H

# **8.2 Properties of Acids and Bases**

1. Write equations for the following reactions:
   1. Sulfuric acid + copper oxide
   2. Nitric acid + sodium bicarbonate
   3. Phosphoric acid + potassium hydroxide
   4. Ethanoic acid + aluminum
2. An aqueous solution of which of the following reacts with magnesium metal?
   1. Ammonia
   2. Hydrogen chloride
   3. Potassium hydroxide
   4. Sodium hydrogencarbonate
3. Which of the following is/are formed when a metal oxide reacts with dilute acid?
   * 1. A metal salt
     2. Water
     3. Hydrogen gas
4. I only
5. I and II only
6. II and III only
7. I, II and III only
8. Suggest by name a parent acid and parent base that could be used to make the following salts. Write equations for each reaction.
   1. Sodium nitrate
   2. Ammonium chloride
   3. Copper(II) sulfate
   4. Potassium methanoate
9. For each indicator below, what is the expected color change and when would it be appropriate to use that indicator (think equivalence point).
   1. Methyl orange
   2. Methyl red
   3. Phenolphthalein

# **8.3 The pH Scale**

1. Put the following substances in order of increasing pH, explain why:

CH3COOH(aq), NaOH(aq), NaCl(aq), HCl(aq) C2H5NH2(aq)

1. Lime was added to a sample of solid and the pH changed from 4 to 6. What was the corresponding change in the hydrogen ion concentration?
   1. Increased by a factor of 2
   2. Increased by a factor of 100
   3. Decreased by a factor of 2
   4. Decreased by a factor of 100
2. A 0.01 mol dm-3 solution of hydrochloric acid has a pH value of 2. Suggest, with a reason, the pH values of:
   1. 0.10 mol dm-3 hydrochloric acid
   2. 0.10 mol dm-3 ethanoic acid
3. When the following 1.0 mol dm-3 solutions are arranged in order of increasing pH, which is the correct order?
   * 1. Ammonium chloride
     2. Ammonium ethanoate
     3. Sodium ethanoate
4. I, II, III
5. II, I, III
6. III, I, II
7. III, II, I
8. For each of the following aqueous solutions, calculate [OH-] from [H+] or [H+] from [OH-]. Classify each solution as acidic, basic, or neutral at 298K
   1. [H+] = 3.4x10-9 mol dm-3
   2. [OH-] = 0.010 mol dm-3
   3. [OH-] = 1.0x10-10 mol dm-3
   4. [H+] = 8.6x10-5 mol dm-3
9. Calculate the [H+], [OH-] and pH of 0.25M HCl (assume full dissociation of ions).
10. Calculate the [H+], [OH-] and pH of 5.5x10-4 KOH (assume full dissociation of ions).
11. What is the concentration of OH- ions (in mol dm-3) in an aqueous solution in which  
    [H+] = 2.0 × 10-3 mol dm-3? (*K*w = 1.0 × 10-3 mol2 dm-6)

A. 2.0 × 10-3

B. 4.0 × 10-6

C. 5.0 ×10-12

D. 2.0 × 10-1

# **8.4 Strong and Weak Acids and Bases**

1. What is the difference between strong acids and weak acids?
2. HCl is a strong acid, whereas HF is a weak acid. Explain how 1.0M solutions of these acids would differ in terms of pH, electrical conductivity, and reaction with the base calcium carbonate.
3. Ammonia behaves as a weak base in aqueous solution.
   1. Write a balanced equation for the interaction of ammonia with water and explain why it produces an alkaline solution.
   2. Using ammonia as an example, explain what is meant by the terms **weak** and **base**.
   3. Would you expect a 1.0 mol dm-3 solution of ammonia to have a higher or lower pH than a 1.0 mol dm-3 solution of potassium hydroxide? Explain.
4. Which substance can be dissolved in water to give a 0.1 mol dm-3. Solution with a high pH and a high electrical conductivity?
   1. HCl
   2. NaCl
   3. NH3
   4. NaOH
5. Which of the following 1 mol dm-3 solutions will be the poorest conductor of electricity?
   1. HCl
   2. CH3COOH
   3. NaOH
   4. NaCl
6. Consider the following equilibriua in 0.10 mol dm-3 carbonic acid. Which species is present in the highest concentration?

H2CO3(aq) ↔ H+(aq) + HCO3-(aq)

HCO3-(aq) ↔ H+(aq) + CO3-2(aq)

* 1. H2CO3 (aq)
  2. H+(aq)
  3. HCO3-(aq)
  4. CO32-

1. Which methods will distinguish between equimolar solutions of a strong base and a strong acid?
   * 1. Add magnesium to each solution and look for the formation of gas bubbles
     2. Add aqueous sodium hydroxide to each solution and measure the temperature change.
     3. Use each solution in a circuit with a battery and lamp and see how brightly the lamp glows
2. I and II only
3. I and III only
4. II and III only
5. I, II and III only
6. Which acid in each of the following pairs has the stronger conjugate base and why?
   1. H2CO3 or H2SO4
   2. HCl or HCOOH

# **8.5 Acid Deposition**

1. Answer the following questions:
   1. Explain why natural rain has a pH of around 5.6. Give a chemical equation to support your answer.
   2. Acid rain may be 50 times more acidic than natural rain. One of the major acids present in acid rain originates mainly from burning coal. State the name of the acid and give equations to show how it is formed.
   3. The second major acid responsible for acid rain originates mainly from internal combustion engines. State the name of this acid and state two different ways in which its production can be reduced.
   4. Acid rain has caused considerable damage to buildings and statues made of marble (CaCO3). Write an equation to represent the reaction of acid rain with marble.
   5. State three consequences of acid rain.
   6. Suggest a method of controlling acid rain, not involving a chemical reaction, for reducing sulfur dioxide emissions from power stations.
2. The table gives some substance found in air.

|  |  |
| --- | --- |
| **Name** | **Formula** |
| Sulfur dioxide | SO2 |
| Nitrogen monoxide | NO |
| Particulates | - |

* 1. Identify the pollutant(s) which contribute(s) to acid rain.
  2. Identify the pollutant(s) which come(s) mainly from power stations.
  3. The presences of one of these pollutants makes the ill effects of the other worse. Identify the pollutant and explain why it has this effect.
  4. Emissions of one of these pollutants have been controlled by reaction with calcium oxide. Identify this pollutant and write an equation for the reaction with calcium oxide.
  5. Identify the pollutants that come primarily from motor vehicles and describe the basis for their production.

1. Answer the following:
   1. Describe the difference in dispersion between dry acid deposition and wet acid deposition.
   2. Explain the physical and chemical processes involved in the development of wet acid deposition.
2. Identify the free radical involved in the formation of sulfuric acid and nitric acid in acid rain and explain how it is formed.