Chemistry 1

Volume 3

Worksheet 1

Electrical Properties of Aqueous Solutions

1. Which of the following are examples of an aqueous solution? (Multiple answers possible)
    a. Sugar and water
    b. Salt and water
    c. Fructose and water
    d. HCl and water

2. Define the term “electrolyte”.

3. Circle all of the following that are anions.

    a. Na^{+} b. Cl^{-} c. H^{+} d. OH^{-} e. N^{3-}

4. Circle all of the following that are cations.

    a. Mg^{2+} b. Br^{-} c. Be^{2+} d. F^{-} e. SO_4^{2-}

5. Break apart the following compounds into their constituent ions and label each ion as either the anion or cation.

    a. $MgBr_2$

    b. $Al_2(SO_4)_3$

c. $LiNO_3$

d. $Ba(OH)_2$

6. Which of the following will produce an electrically-conductive solution when placed into water? (Circle all that apply.)

   a. NaCl b. $C_{12}H_{22}O_{11}$ c. HCl d. CH_4

7. Which of the following describes a weak electrolyte?
   a. A compound that completely dissociates in water
   b. A compound that only partially dissociates in water
   c. A compound that does not dissociate in water
   d. A compound that is an excellent conductor of electricity

8. Classify each of the following as a strong electrolyte, weak electrolyte, or a nonelectrolyte.

   a. LiCl b. $C_6H_{12}O_6$ c. NaOH

9. Write the equation for the dissociation of the following compounds in water:

    a. LiBr

    b. $NaNO_3$

    c. NaOH

    d. HCl

10. When a 0.5 M solution of $MgCl_2$ dissociates in water, what is the molarity of each ion?

11. When dissolved in water, an ionic compound produces PO_4^{3-} and Na^+.

    a. What was the original compound that was dissolved?

    b. Write the balanced equation for this process.

Answer Key

1. Which of the following are examples of an aqueous solution? (Multiple answers possible)
   a. Sugar and water
   b. Salt and water
   c. Fructose and water
   d. HCl and water

   An aqueous solution is generated when a compound dissociates when placed into water, which means that it breaks apart into its constituent ions. Even though sugar *dissolves* in water, it does not *dissociate* because the sugar molecules do not break apart in water.

   Salt (NaCl) breaks apart into Na^+ and Cl^- in water. HCl breaks apart into H^+ and Cl^-.

   Correct answer: b. Salt and water and d. HCl and water

2. Define the term "electrolyte."

   When placed into water, an electrolyte will dissolve to produce a solution that can conduct electricity. This is because the electrolyte dissociates into its constituent ions. There are both strong and weak electrolytes that produce solutions that are good and poor conductors of electricity, respectively.

   Correct answer: A compound that produces an electrically-conductive solution when placed into water.

3. Circle all of the following that are anions.

   a. Na^+ b. **Cl^-** c. H^+ d. **OH^-** e. **N^{3-}**

   Anions are negatively-charged ions.

4. Circle all of the following that are cations.

   a. **Mg^{2+}** b. Br^- c. **Be^{2+}** d. F^- e. SO_4^{2-}

   Cations are positively-charged ions.

5. Break apart the following compounds into their constituent ions and label each ion as either the anion or cation.

   a. $MgBr_2$

      To determine charges, look at the periodic table. Remember, metals (left-side of the periodic table) have positive charges, and nonmetals (right-side) have negative charges. Determine the magnitude (number) of the charge by looking at what group the element is in.

      Correct answer: Cation: Mg^{2+}; Anion: Br^-

   b. $Al_2(SO_4)_3$

      Correct answer: Cation: Al^{3+}; Anion: SO_4^{2-}

   c. $LiNO_3$

      Correct answer: Cation: Li^+; Anion: NO_3^-

   d. $Ba(OH)_2$

      Correct answer: Cation: Ba^{2+}; Anion: OH^-

6. Which of the following will produce an electrically-conductive solution when placed into water? (Circle all that apply.)

   a. **NaCl** b. $C_{12}H_{22}O_{11}$ c. **HCl** d. CH_4

   NaCl and HCl are compounds that completely dissociate when placed into water. This means that they break apart into their constituent ions, which allows the aqueous solution to conduct electricity. $C_{12}H_{22}O_{11}$ and CH_4 are molecular compounds that do not break apart in water. In fact, CH_4 isn't even soluble in water!

7. Which of the following describes a weak electrolyte?
    a. A compound that completely dissociates in water
    b. A compound that only partially dissociates in water
    c. A compound that does not dissociate in water
    d. A compound that is an excellent conductor of electricity

    Weak electrolytes only partially dissociate when placed into water, which means that a large portion of the electrolyte will remain in a solid, unionized form. Weak electrolytes produce only weakly electrically-conducting solutions when placed into water.

    Correct answer: b. A compound that only partially dissociates in water

8. Classify each of the following as a strong electrolyte, weak electrolyte, or a nonelectrolyte.

    a. LiCl

    LiCl is an ionic compound and completely dissociates when placed into water. Therefore, it is a strong electrolyte.

    Correct answer: strong electrolyte

    b. $C_6H_{12}O_6$

    The formula above represents sugar (glucose), which is a molecular compound. These do not tend to dissociate when placed into water and are nonelectrolytes.

    Correct answer: nonelectrolyte

    c. NaOH

    NaOH is an ionic compound and a strong base that completely dissociates when placed into water. Therefore, it is a strong electrolyte.

    Correct answer: strong electrolyte

9. Write the equation for the dissociation of the following compounds in water:

   a. LiBr

      When dissolved in water, ionic compounds break apart into their constituent ions. When they are dissolved and break apart into ions, their correct state of matter is aqueous, represented by the (aq) next to each ion.

      Correct answer: $\mathbf{LiBr\ (s) \xrightarrow{H_2O\ (l)} Li^+\ (aq) + Br^-\ (aq)}$

   b. $NaNO_3$

      Correct answer: $\mathbf{NaNO_3\ (s) \xrightarrow{H_2O\ (l)} Na^+(aq) + NO_3^-\ (aq)}$

   c. NaOH

      Correct answer: $\mathbf{NaOH\ (s) \xrightarrow{H_2O\ (l)} Na^+\ (aq) + OH^-\ (aq)}$

   d. HCl

      Correct answer: $\mathbf{HCl\ (g) \xrightarrow{H_2O\ (l)} H^+\ (aq) + Cl^-\ (aq)}$

10. When a 0.5 M solution of $MgCl_2$ dissociates in water, what is the molarity of each ion?

To solve this, write the equation for the dissociation of $MgCl_2$ in water.

$$MgCl_2\ (s) \xrightarrow{H_2O\ (l)} Mg^{2+}\ (aq) + 2\ Cl^{-}\ (aq)$$

Based on the stoichiometric coefficients, for every mole of $MgCl_2$ that dissociates in water, one mole of Mg^{2+} and 2 moles of Cl^- are produced. Thus, the molarity of Mg^{2+} will be the same as the $MgCl_2$ since there is a 1:1 molar ratio. However, since there are twice as many Cl^- ions, the molarity will be doubled.

You can calculate the numbers to check.

0.5 ~~mol $MgCl_2$~~	1 mol Mg^{2+}	= 0.5 mol/L Mg^{2+}
1 L	1 ~~mol $MgCl_2$~~	

Since the liters (L) didn't cancel out, the final answer has units of mol/L.

0.5 ~~mol $MgCl_2$~~	2 mol Cl^-	= 1 mol/L Cl^-
1 L	1 ~~mol $MgCl_2$~~	

Correct answers: Mg^{2+}: 0.5 M and Cl^-: 1 M.

11. When dissolved in water, an ionic compound produces PO_4^{3-} and Na^+.

a. What was the original compound that was dissolved?

Use the magnitude of the charge of each compound as the subscript in the original ionic compound. The charge of PO_4^{3-} becomes the subscript 3 for Na.

Correct answer: Na_3PO_4

b. Write the balanced equation for this process.

Correct answer: $Na_3PO_4\ (s) \xrightarrow{H_2O\ (l)} 3\ Na^+\ (aq) + PO_4^{3-}\ (aq)$