EXPERIMENT # 3
ELECTROLYTES AND NON-ELECTROLYTES

Purpose:

1. To investigate the phenomenon of solution conductance.
2. To distinguish between compounds that form conducting solutions and compounds that form non-conducting solutions.
3. To gain an understanding of the role electrolytes play in the maintenance of the activities of body cells.

Principles:

Many substances have the ability to conduct an electric current because they contain electrically charged particles. In an electric field, charged particles are attracted and move toward oppositely charged plates, called electrodes. In this manner, a closed electrical circuit is created. Metallic conductors conduct electricity by a movement of electrons. Other substances conduct electricity by the movement of ions. Substances, which conduct electricity by ionic movement, are called **electrolytes**.

Substances, which are not able to conduct electricity by ionic movement, are called **non-electrolytes**.

A particular substance to be an electrolyte must meet two conditions:

- The substance must contain ions.
- The ions must be mobile (free to move).

It follows that any substance, which contains mobile ions, is an electrolyte and it will conduct electricity by ionic movement.

If an electric current passes through an electrolyte:

- The negative ions move toward the positively charged electrode called **ANODE (+)**. Hence, negative ions are called **ANIONS (-)**.
- The positive ions move toward the negatively charged electrode called **CATHODE (-)**. Hence, positive ions are called **CATIONS (+).**

Solid substances (both molecular and ionic) are non-electrolytes, either because they do not contain ions at all, or because although the ions are present, they are not mobile.

For example:

- Solid sucrose, $C_{12}H_{22}O_{11(s)}$, is a non-electrolyte because it does not contain ions. (Sucrose is a molecular substance made up of molecules).
- Solid sodium chloride (table salt), $Na^+Cl^-{}_{(s)}$ is also a non-electrolyte. Even though the crystal structure of table salt is made up of ions, these ions are not mobile in the solid phase.

It follows that in order for a substance to become electrolyte, mobile ions must be produced. The process by which mobile ions are produced is referred to as **dissociation**. Dissociation can take place in two different ways:

1. By melting solid ionic substances; the ions are freed and become mobile.

$$\underset{non-electrolyte}{Na^+Cl^-{}_{(s)}} \xrightarrow{melting} \underset{electrolyte}{Na^+{}_{(l)} + Cl^-{}_{(l)}}$$

2. By dissolving a soluble solid (ionic or molecular) substance in water. The interaction between the particles of the solid substance and the water molecules often causes the dissociation of the solid substance.

    a. Dissociation of soluble ionic substances in water

    The water molecules separate the ions of the ionic solid and hence the ions become free to move. All soluble ionic substances are completely separated into ions in aqueous solutions. Since such substances exist in aqueous solution only in the form of their **mobile ions**, their solutions will conduct electricity very well.

    Solutions such as these are called **strong electrolytes** and the process by which they are formed is referred to as **complete dissociation**.

$$\underset{non-electrolyte}{NaCl_{(s)}} \xrightarrow{H_2O} \underset{electrolyte}{Na^+{}_{(aq)} + Cl^-{}_{(aq)}}$$

$$\underset{non-electrolyte}{CaCl_{2(s)}} \xrightarrow{H_2O} \underset{electrolyte}{Ca^{2+}{}_{(aq)} + 2Cl^-{}_{(aq)}}$$

$$\underset{non-electrolyte}{K_2SO_{4(s)}} \xrightarrow{H_2O} \underset{electrolyte}{2K^+{}_{(aq)} + SO_4{}^{2-}{}_{(aq)}}$$

Please note that:

- **1 mole** of solid NaCl produces by complete dissociation

  2 moles of ions, 1 mole of Na^+ ions and 1 mole of Cl^- ions

- **1 mole** of solid $CaCl_2$ produces by complete dissociation

  3 moles of ions, 1 mole of Ca^{2+} ions and 2 moles of Cl^- ions

- **1 mole** of solid K_2SO_4 produces by complete dissociation

  3 moles of ions, 2 moles of K^+ ions and 1 mole of SO_4^{2-} ions

    b. Dissociation of soluble molecular substances in water

    Some molecular substances (not all) react chemically with water and produce ions. The extent to which a molecular substance interacts with water differs greatly among molecular substances and is determined by several factors, such as:

- The polarity of the molecular substance
- The ability to form hydrogen bonds
- The size of the molecule.

(A) Complete dissociation of molecular substances

For some molecular substances the interaction with the water molecules is essentially complete and as such they are completely dissociated. For example:

$$\underset{\text{hydrogen chloride}}{HCl_{(g)}} + \underset{\text{excess water}}{H_2O_{(l)}} \xrightarrow{\text{complete dissociation}} \underset{\text{hydronium ion}}{H_3O^{+}{}_{(aq)}} + \underset{\text{chloride ion}}{Cl^{-}{}_{(aq)}}$$

The resulting solution contains hydronium ions ($H_3O^+_{(aq)}$), chloride ions ($Cl^-_{(aq)}$) and excess unreacted water molecules ($H_2O_{(l)}$).

It follows that a solution of HCl in water does not contain any HCl molecules. Since the substance (HCl) exists in aqueous solution only in the form of its *mobile ions* ($H_3O^+_{(aq)}$ and $Cl^-_{(aq)}$), the electrical *conductance is high* and the aqueous solution of hydrochloric acid is referred to as a *strong electrolyte*.

(B) Partial dissociation of molecular substances.

For some other molecular substances the interaction with the water molecules is incomplete, and as such the substance is only partially dissociated. For example, pure liquid acetic acid, $HC_2H_3O_{2(l)}$, also referred to as glacial acetic acid, when dissolved in water to make a 0.1 M aqueous solution, dissociates into hydronium ions ($H_3O^+_{(aq)}$) and acetate ions, ($C_2H_3O^-_{(aq)}$) to the extent of only 1 molecule of acetic acid in every one hundred.

Before dissolving:

$$HC_2H_3O_{2(l)} + H_2O_{(l)}$$

100 molecules + excess

$$HC_2H_3O_{2(l)} + H_2O_{(l)} \xrightarrow{\text{partial}\cdot\text{dissociation}} H_3O^{+}_{(aq)} + C_2H_3O^{-}_{(aq)}$$

After dissolving

99 molecules + excess 1 ion + 1 ion

Since water is the solvent, the number of water molecules is huge compared to the other species. Consequently, the change in the number of water molecules (before and after the dissociation process) is negligible.

The predominant species in this aqueous solution are the molecules of acetic acid ($HC_2H_3O_{2(l)}$). The few ions present ($H_3O^+_{(aq)}$ and $C_2H_3O^-_{(aq)}$), will give the solution a relatively *low conductance*.

Molecular substances, which undergo partial dissociation in aqueous solution, are always present predominantly in *molecular form*, have a *low electrical conductivity* and are called *weak electrolytes*.

In Summary:

I. All solid substances (molecular and ionic) are non-electrolytes

They do not conduct and electric current because they:

- either do not contain ions, (molecular solids, for example solid sucrose, $C_{12}H_{22}O_{11(s)}$)
- or they contain ions, which are not free to move, (ionic solids, for example solid $Na^+Cl^-_{(s)}$).

II. All soluble ionic compounds dissolved in water are strong electrolytes

They are excellent conductors of electricity because they are completely dissociated in aqueous solutions, for example $Na^+Cl^-_{(aq)}$

III. Molecular substances dissolved in water may be

1. Non-electrolytes, if they do not dissociate at all in aqueous solutions.

   Their solutions do not conduct electricity at all, because only molecules are present. For example an aqueous solution of sucrose:

$$C_{12}H_{22}O_{11(s)} \xrightarrow{H_2O} C_{12}H_{22}O_{11(aq)}$$

2. Weak electrolytes, if they undergo partial dissociation in aqueous solution.

   Their solutions conduct electricity poorly because the predominant species present are molecules. For example an aqueous solution of acetic acid, ($HC_2H_3O_{2(l)}$).

3. Strong electrolytes, if they undergo complete dissociation in aqueous solution.

   Their solutions are excellent conductors of electricity because only ions are present. For example an aqueous solution of hydrochloric acid, ($HCl_{(aq)}$).

It must be noted that electrical conductance depends greatly on the number of ions available to conduct electricity. It follows that a solution of a strong electrolyte may have low conductivity and appear to be a weak or possibly even a nonelectrolyte in very dilute solutions (very low concentrations of ions)

Electrolytes in the Cells of the Body

Electrolytes play an important role in the maintenance of the activities of the cells of the body. The cells of the body are bathed both inside and outside by fluids that contain specific and different amounts of electrolytes. Body fluids are commonly classified into:

I. Extracellular fluids

Body fluids that are not inside the cells are collectively known as extracellular fluids. The most abundant is the interstitial fluid, which surrounds most cells and fills the spaces between them. The interstitial fluid has a higher concentration of $Na^+_{(aq)}$ and $Cl^-_{(aq)}$ ions, relative to the inside of cells.

II. Intracellular fluids

The fluid within the cell is called intracellular fluid. The intracellular fluid has a higher concentration of $K^+_{(aq)}$, $SO_4^{2-}{}_{(aq)}$ and $PO_4^{3-}{}_{(aq)}$ ions, relative to the outside of cells.

III. Blood plasma

Blood plasma is the body fluid, which flows in the arteries and veins. Blood plasma has a high concentration of $Na^+_{(aq)}$ and $Cl^-_{(aq)}$ ions. Other ions commonly present in blood plasma in lower concentrations are:

- Cations: $K^+_{(aq)}$, $Ca^{2+}_{(aq)}$, and $Mg^{2+}_{(aq)}$
- Anions: $HCO_3^-{}_{(aq)}$ (hydrogen carbonate, or bicarbonate) and $SO_4^{2-}{}_{(aq)}$ (sulfate).

When there is a loss of fluid from the body or an imbalance of electrolytes, a parenteral solution (one given by means other than oral) may be administered. When giving parenteral solutions, such as intravenous solutions, one must keep in mind the effect of maintaining fluid balance in the body.

The red blood cells in the body are suspended in blood plasma that must have the same osmolarity as the red blood cells. Otherwise osmotic pressure would be generated across the cell membrane which may cause the red blood cell to swell or shrivel.

(Recall that osmolarity is the molarity of a solution multiplied by the number of particles produced by each mole of solute).

The red blood cells and blood plasma have the same osmolarity (0.30 osmol) and are said to be isotonic with each other.

Solutions with an **osmolarity lower** than that of normal human blood are called **hypotonic**.

Solutions with an **osmolarity higher** than that of normal human blood are called **hypertonic**.

Procedure

I. THE CONDUCTIVITY APPARATUS

The conductivity apparatus is a conductivity indicator (See Figure 1). It consists of a LIGHT EMITTING DIODE (LED) connected to two copper probes (electrodes).

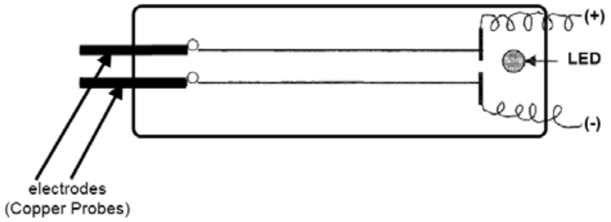

Figure 1: Conductivity Apparatus

Setting up the conductivity apparatus

The conductivity apparatus should be treated with care and concern. A 9-volt D.C. power supply is required for operation, which is available at the bench in the form of a raised electrical panel. The two posts of the conductivity apparatus are connected to the low power voltage power supply with two cords.

Touching the tips of the two copper electrodes to a coin or a piece of metal should test the circuit. If the LED glows red and blinks rapidly, the Conductivity Apparatus is working properly. If not, bring this to the attention of your laboratory instructor.

The response of the LED when both copper electrodes are directly in contact with a solid material or when immersed in a liquid will indicate the following types of conductivity:

STRONG CONDUCTOR	LED glows red and blinks rapidly	(+)
WEAK CONDUCTOR	LED glows a dull red glow (no blinking)	(+/-)
NON CONDUCTOR	LED does not light up	(-)

Using the conductivity apparatus

To test liquids, clean and dry spot plate (a plastic plate with 12 round depressions). Fill the depressions in the spot plate with several drops of the liquids to be tested. There should be enough liquid in the depression so that the conductivity apparatus electrodes are immersed in the liquid. Record in your notebook the name of the liquid you are testing.

In order to obtain consistent observations, each test should be performed in the same manner:

- The position of the conductivity indicator should be perfectly vertical (perpendicular to the spot plate).
- The green plastic plate that holds the conductivity indicator should be placed at the edge of the depression whose contents are being tested. This will ensure that the electrodes are always immersed in the liquid at the same depth.
- The same volume of liquid should be tested each time. In this experiment, each test will be performed with the same number of drops of liquid.

Before testing, you must ensure that the electrodes are clean. Immersing the electrodes in deionized water does this. It is convenient to use a 250 mL beaker with deionized water for this purpose.

The electrodes are clean if the LED does not light up when the electrodes are immersed in D.I. water.

If the LED does light up, discard the D.I. water, refill with fresh D.I. water and test again until the LED does not light up. Gently blot the excess water from the electrodes with tissue. Record in your notebook the name of the liquid you are testing. Perform the test and record your observation (+, +/-, or -).

Repeat the cleaning procedure every time you proceed to another test. It is convenient to keep the beaker with D.I. water handy since it is needed every time another liquid is tested. The D.I. water should be changed as needed.

Some tests (not all) require that the electrodes be dry. Drying is done by gently blotting the electrodes with tissue. Pay attention not to damage the electrodes. Since corrosion may cause a short in the circuit, the section between the contacts of the electrodes on the circuit board must be kept free of corrosion.

Rinsing and blotting the electrodes dry after each use may prevent corrosion.

II. GENERAL INSTRUCTIONS

There are several stations set-up in the lab corresponding to the different parts of the experiment. Most of the stations are in duplicate or triplicate. You may start working at any station and may go from station to station, in any order, depending on availability. As you move from station to station:

DO: - take with you your spot plate (rinse and dry between tests)

- take with you a 250 mL beaker with D.I. water

- take with you a stirring rod

- check if the electrodes are clean before testing (D.I. water test)

- rinse and dry the electrodes after testing

DO NOT: - remove reagents from stations

- leave reagent bottles open

- switch droppers from dropper bottles

- remove or disconnect the conductivity indicator

Observe and record the **CONDUCTANCE** of each substance using the following abbreviations:

+	→ **strong conductor**	→ **corresponds to a strong electrolyte**	→ **(SE)**
+/-	→ **weak conductor**	→ **corresponds to a weak electrolyte**	→ **(WE)**
-	→ **non-conductor**	→ **corresponds to a non- electrolyte**	→ **(NE)**

Recall that:

- If the solute is a **WEAK** or a **NON-ELECTROLYTE**, the predominant solute particles are **molecules** and the formula of the solute in written in MOLECULAR FORM **(AB)**

- If the solute is a **STRONG ELECTROLYTE**, the predominant solute particles are **ions** and the formula of the solute in written in IONIC FORM **(A^+ and B^-)**

PART I: Pure Substances

For the tests that follow the electrodes and the spot plate must be dry! Test the following substances:

1. Pure (glacial) acetic acid, 100% pure, $HC_2H_3O_{2(l)}$.

   CAUTION: DO NOT INHALE THE GLACIAL ACETIC ACID

2. Pure ethanol (absolute ethyl alcohol), $C_2H_5OH_{(l)}$.

3. Deionized water

PART II: Aqueous Solutions

For the tests that follow the electrodes and the spot plate must be well rinsed between tests with deionized water. They do not need to be dry.

1. Tap water

2. 95% Ethanol

3. Aqueous ammonia, $NH_{3(aq)}$ 1M, or $NH_4OH_{(aq)}$ 1M

4. Nitric acid, $HNO_{3(aq)}$, 1M

5. Sucrose, $C_{12}H_{22}O_{11(aq)}$, 1M

6. Sodium chloride, $NaCl_{(aq)}$, 1M

7. Urea, $NH_2CONH_{2(aq)}$, 1M

8. Sodium sulfate, $Na_2SO_{4(aq)}$, 1M

9. Ammonium chloride, $NH_4Cl_{(aq)}$, 1M

PART III: The Effect of Concentration on Conductance

Solution 1: Test 30 drops of hydrochloric acid, $HCl_{(aq)}$, 1M. Leave Solution 1 in the spot plate.

Solution 2: Place 3 drops of $HCl_{(aq)}$, 1M in a second depression. Add 27 drops of deionized water from the dropper bottle mix well but gently with your stirring rod. Test the solution and record the conductance. Leave Solution 2 in the spot plate.

Rinse the stirring rod with plenty of tap water and then with D.I. water. Make sure no acid is left on the stirring rod by testing it with blue litmus paper.

- If the litmus paper does not change color, the stirring rod is free of hydrochloric acid.

- If the litmus paper turns red, more washing is required.

Solution 3: Place 3 drops of Solution 2 in a third depression. Add 27 drops of deionized water from the dropper bottle and repeat the steps outlined above for Solution 2.

Solutions 4, 5 & 6: are prepared and tested in the same manner (See Report Form).

CAUTION: FOR CORRECT OBSERVATIONS, BOTH THE STIRRING ROD AND THE DROPPER MUST BE VERY WELL RINSED BETWEEN TESTS (TEST WITH LITMUS TEST).

PART IV: Tonicity of Solutions

The following solutions will be tested:

1. $NaCl_{(aq)}$,0.89%
2. $NaCl_{(aq)}$,0.45%
3. Glucose (also referred to as Dextrose), $C_6H_{12}O_{6(aq)}$, 8.1%
4. Sodium carbonate, $Na_2CO_{3(aq)}$, 1.1%
5. Sodium bicarbonate (sodium hydrogen carbonate), $NaHCO_{3(aq)}$, 2.0%
6. Fructose, $C_6H_{12}O_{6(aq),}$ 3.6%
7. Magnesium chloride, $MgCl_{(aq)}$, 0.95%
8. Potassium phosphate, $K_3PO_{4(aq)}$, 0.80%

NOTE: All concentrations are given in w/v (weight/volume); (g solute/mL solution)

(A) Record the conductance for each substance tested

Record the electrolyte character

Record the type of predominant particles present

Give the formula of the predominant particles present

Record the number of particles produced per formula unit of solute

(B) Calculate the molar mass (mass of 1 mol) for each solute in g/mol

(C) Calculate the molarity of each solution

A sample calculation is shown. What is the molarity of a 3.3% w/v $Na_3PO_{4(aq)}$ solution?

The molar mass is: (23.0 x 3) + (31.0 x 1) + (16.0 x 4) = 164.0 g/mol

$$?\frac{moles}{L} = \frac{3.3g}{100mL} \times \frac{1mol}{164.0g} \times \frac{1000mL}{1L} = 0.20M$$

(D) Calculate the osmolarity of each solution.

A sample calculation is shown. What is the osmolarity of a 0.20 M, $Na_3PO_{4(aq)}$, solution?

Observation: $Na_3PO_{4(aq)}$ is a strong electrolyte in aqueous solution and therefore it is completely dissociated:

$$\underset{1-mole}{Na_3PO_{4(aq)}} \rightarrow \underset{3-moles}{3Na^{+}_{(aq)}} + \underset{1-mole}{PO^{3-}_{4(aq)}}$$

1 mole of $Na_3PO_{4(aq)}$ produces by dissociation 4 moles of particles

Osmolarity = Molarity x 4 = 0.20 x 4 = 0.80 osmol

(E) State the tonicity of the solution by comparing its osmolarity to the osmolarity of normal human blood.

The osmolarity of normal human blood is 0.30 osmol.

Using the above example, solution D, is hypertonic.

EXPERIMENT #13

Name: ____________________________
Date: _____________________________
Partner: ___________________________

Part I: Pure Substances

	Conductance	Electrolyte Character	Type of predominant particles	Formula of predominate particles
Acetic Acid	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
Ethanol	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
D.I.Water	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	

Part II: Aqueous Solutions

	Conductance	Electrolyte Character	Type of predominant particles	Formula of predominate particles
Tap Water	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
95% Ethanol	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
Ammonia, 1M	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
Nitric Acid, 1M	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
Sucrose, 1M	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
Sodium Chloride, 1M	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	

Part II: Aqueous Solutions (continued)

	Conductance	Electrolyte Character	Type of predominant particles	Formula of predominate particles
Urea, 1M	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
Sodium sulfate, 1M	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	
Ammonium chloride, 1M	☐ + ☐ +/- ☐ -	☐ SE ☐ WE ☐ NE	☐ Ions ☐ Molecules	

Part III: The Effect of Concentration on Conductance

Volume(s) Used	Solution	Concentration (Molarity)	Conductance
30 drops $HCl_{(aq)}$, 1.0M	Solution 1		☐ + ☐ +/- ☐ -
3 drops Solution 1 + 27 drops D.I. water	Solution 2		☐ + ☐ +/- ☐ -
3 drops Solution 2 + 27 drops D.I. water	Solution 3		☐ + ☐ +/- ☐ -
3 drops Solution 3 + 27 drops D.I. water	Solution 4		☐ + ☐ +/- ☐ -
3 drops Solution 4 + 27 drops D.I. water	Solution 5		☐ + ☐ +/- ☐ -
3 drops Solution 5 + 27 drops D.I. water	Solution 6		☐ + ☐ +/- ☐ -

* Show on the next page the calculations for the molarities of your solutions.
The proper set up of the calculations is shown for Solution, as an example.

Molarity of Solution 2

Solution 1 $M_1 = 1.0$ M $V_1 = 3$ drops	Solution 2 $M_2 =?$ $V_2 = 30$ drops	Calculations	Answer $M_2 =$

Molarity of Solution 3

Solution 2 $M_2 =$ M $V_2 = 3$ drops	Solution 3 $M_3 =?$ $V_3 = 30$ drops	Calculations	Answer $M_3 =$

Molarity of Solution 4

Solution 3 $M_3 =$ M $V_3 = 3$ drops	Solution 4 $M_4 =?$ $V_4 = 30$ drops	Calculations	Answer $M_4 =$

Molarity of Solution 5

Solution 4 $M_4 =$ M $V_4 = 3$ drops	Solution 5 $M_5 =?$ $V_5 = 30$ drops	Calculations	Answer $M_5 =$

Molarity of Solution 6

Solution 5	Solution 6	Calculations	Answer $M_6 =$

What is the relationship between the concentration of a strong electrolyte and its electrical conductance?

Provide and explanation that supports your statement above:

Part IV: Tonicity of Solutions

Solute	NaCl	NaCl	Glucose	Na_2CO_3	$NaHCO_3$	Fructose	$MgCl_2$	K_3PO_4
Concentration (g solute/mL solution)	0.89%	0.45%	8.1%	1.1%	2.0%	3.6%	0.95%	0.80%
Conductance	☐ + ☐ +/- ☐ -	☐ + ☐ +/- ☐ -	☐ + ☐ +/- ☐ -	☐ + ☐ +/- ☐ -	☐ + ☐ +/- ☐ -	☐ + ☐ +/- ☐ -	☐ + ☐ +/- ☐ -	☐ + ☐ +/- ☐ -
Electrolyte Character	☐ SE ☐ WE ☐ NE	☐ SE ☐ WE ☐ NE	☐ SE ☐ WE ☐ NE	☐ SE ☐ WE ☐ NE	☐ SE ☐ WE ☐ NE	☐ SE ☐ WE ☐ NE	☐ SE ☐ WE ☐ NE	☐ SE ☐ WE ☐ NE
Type of Predominant Particles	☐ Ions ☐ Molecules	☐ Ions ☐ Molecules	☐ Ions ☐ Molecules	☐ Ions ☐ Molecules	☐ Ions ☐ Molecules	☐ Ions ☐ Molecules	☐ Ions ☐ Molecules	☐ Ions ☐ Molecules
Formula of Predominant Particles								
Number of Particles Produced per Formula unit								
Molar Mass (g/mol)								
Molarity (moles/L) Show calculations on next page								
Osmolarity (osmols)								
Tonicity	☐ Isotonic ☐Hypotonic ☐Hypertonic	☐ Isotonic ☐Hypotonic ☐Hypertonic	☐ Isotonic ☐Hypotonic ☐Hypertonic	☐ Isotonic ☐Hypotonic ☐Hypertonic	☐ Isotonic ☐Hypotonic ☐Hypertonic	☐ Isotonic ☐Hypotonic ☐Hypertonic	☐ Isotonic ☐Hypotonic ☐Hypertonic	☐ Isotonic ☐Hypotonic ☐Hypertonic

Show calculations for molarities below:

1. Molarity of the sodium chloride solution, 0.89%
2. Molarity of the sodium chloride solution, 0.45%
3. Molarity of the glucose solution, 8.1%
4. Molarity of the sodium carbonate solution, 1.1%
5. Molarity of the sodium bicarbonate solution, 2.0%
6. Molarity of the fructose solution, 3.6%
7. Molarity of the magnesium chloride solution, 0.95%
8. Molarity of the potassium phosphate solution, 0.80%