Identifying and Comparing Properties of Ionic and Covalent Compounds in Order to Classify Unknown Compounds.

Teacher Version

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Contents:

Lab Title:

Identifying and Comparing Properties of Ionic and Covalent Compounds in Order to Classify Unknown Compounds.

Where This Activity Fits into Curriculum:

This lab activity is an appropriate accompaniment for a high school general chemistry course for a unit involving *Aqueous Reactions and Solution Stoichiometry* which is typically covered early on in a general chemistry curriculum or *Intermolecular Forces, Liquid, and Solids* which is typically cover later in the year in a general chemistry curriculum. The lab allows students to perform a conductivity test on various substances dissolved in water to qualitatively determine if a substance is an electrolyte or a molecular compound. This aspect of the lab activity allows the student to observe the properties of both ionic and molecular compounds in solution and requires that the student interpret results to make a determination about the type of compound they are working with. The lab also allows students to determine the solubility of ionic compounds and molecular compounds in both polar and non-polar solvents. Lastly the lab requires allows students to qualitatively compare the melting points of both ionic and molecular compounds. This lab is strictly qualitative due to the fact that the goal of the lab is to have students collect data on three separate macroscopic phenomena that are influenced by the nanoscopic interactions (type of bonds) that each compound involved in the lab has. The student then must reason as to why a certain type of compound will behave a certain way based on the type or class of compound in which it belongs.

Prerequisite knowledge:

This lab has been designed as a guided inquiry activity in that its purpose is to allow students to explore and eventually determine the answer to a "big" question. The "big" question being proposed to the student is "how does the bonding involved in a compound (nanoscopic interactions) influence the macroscopic physical properties that can be observed of the compound?" The student is also being asked to apply knowledge gained about these macroscopic interactions to unknown samples that they are given during the lab in order to identify these substances as being covalently bonded or ionic bonded substances. In order for the student to benefit from this lab activity the student should have a good understanding of the difference between an ionic compound and a molecular compound. The student should also have a good understanding of the various physical properties that they will be exploring in the lab activity (conductivity, solubility, melting point). If the lab is being used in a unit on *Aqueous Reactions and Solution Stoichiometry*, then the student will need to do some research as to what intermolecular forces affect solubility and melting points. If the lab is being used during a unit on *Intermolecular Forces, Liquid, and Solids* than the student will need to revisit the properties of an electrolyte and factors influencing conductivity. It should be emphasized that this lab has been designed to encourage the student to perform their own research on each of the various physical properties that they will be observing during the activity.

Purpose and Objectives:

- Students will use critical thinking skills and previous (as well as gained) knowledge in order to solve a problem.
- Students will be able to explain how macroscopic observations are influenced by nanoscopic interactions.
- Students will be able to explain what influences the conductivity of a substance in solution and the properties of an electrolyte vs. a non electrolyte.
- Students will be able to describe how the type of bonding in a compound influences the solubility of a compound in polar and non-polar solvents.
- Students will be able to describe how intermolecular interactions influence the melting point of a compound.
- Students will be able to describe how bonding influences intermolecular interactions.

Master Materials List: Based on a class of 24 students working in groups of 4

- 24 student safety goggles
- 24 student aprons
- Fume hood
- 6 qualitative conductivity testers (see pg 11 for instructions on how to build these if your school does not have them)
- Aluminum foil
- 6 hot plates
- 6 spatulas
- (18) 20 mL glass containers with lids
- Adhesive labels
- (18) 50 mL beakers
- 6 glass stirring rods

Consumables:

- Approximately 150 g Naphthalene crystals divided equally into (6) 20 mL glass containers and labeled Unknown Sample A
- Approximately 150 g potassium chloride crystals divided equally into (6) 20 mL glass containers and labeled Unknown Sample B
- Approximately 150 g sodium bicarbonate powder divided equally into (6) 20 mL glass containers and labeled Unknown Sample C
- Approximately 360 mL cyclohexane - (3) 20 mL allotments per group.

Activity Synopsis: (this lesson may be split in two separate days)
Students will:

1. PreLab (before class)- Answer questions from laboratory experiment report sheet and fill in the chart listing the properties of known compounds. Review concepts include: ionic compound composition, molecular compound composition, melting time, and electrical conductivity. Make predictions about the identity of various compounds based on their physical and chemical properties.
2. Laboratory experiment- Teacher demonstrates safety precautions and how to properly use the conductivity meters. **(5 min)** Gather the selected supplies from their lab station. Test unknown samples each separately for solubility, conductivity, and melting point. Students will follow all directions under the procedure section of lab manual. **(15 min)**
3. PostLab- After making observations and recording results, answer the POGIL questions on the experiment report sheet. Make conclusions about the compounds, whether they were ionic or covalent and observe any trends among them. **(15 min)**
4. Laboratory experiment #2- Upon finishing the experimental tests for Unknowns A, B, and C, students will then test unknown D. **(5 min)**
5. Clean up all lab equipment and materials and properly dispose of all materials as directed in the lab. **(5 min)**
6. Answer closing POGIL type questions at the end of the lab to test their understanding of the lab. **(20-30 min the following class period)**

Basic Rubric for scoring:

PRE-Lab Grading Rubric:

Requirement	Meets Expectations	Minor Errors	Serious Errors
Compound Research Chart	**All required information in chart is included and is accurate**	**Some information inaccurate.**	**Information missing or inaccurate.**
Venn Diagram			
Definitions			
Questions For Review			

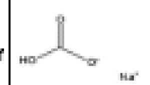
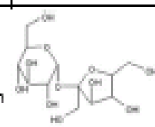
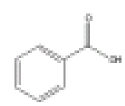
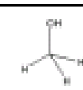
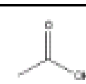
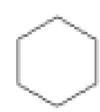
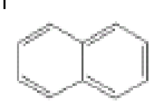
Teacher Introduction Notes:

- Students will bring their completed pre-lab chart and pre-lab questions answered before coming to lab.
- Students will be instructed what the objective of the lab is and where materials can be found.
- Safety precautions will be review with the particular materials we are using.
- A brief procedural introduction of the test will be given (especially for the conductivity test)
- Students will pair up in to 2-4 people (depending on size of class) and begin working **<u>only after</u>** all students have their safety goggles on.

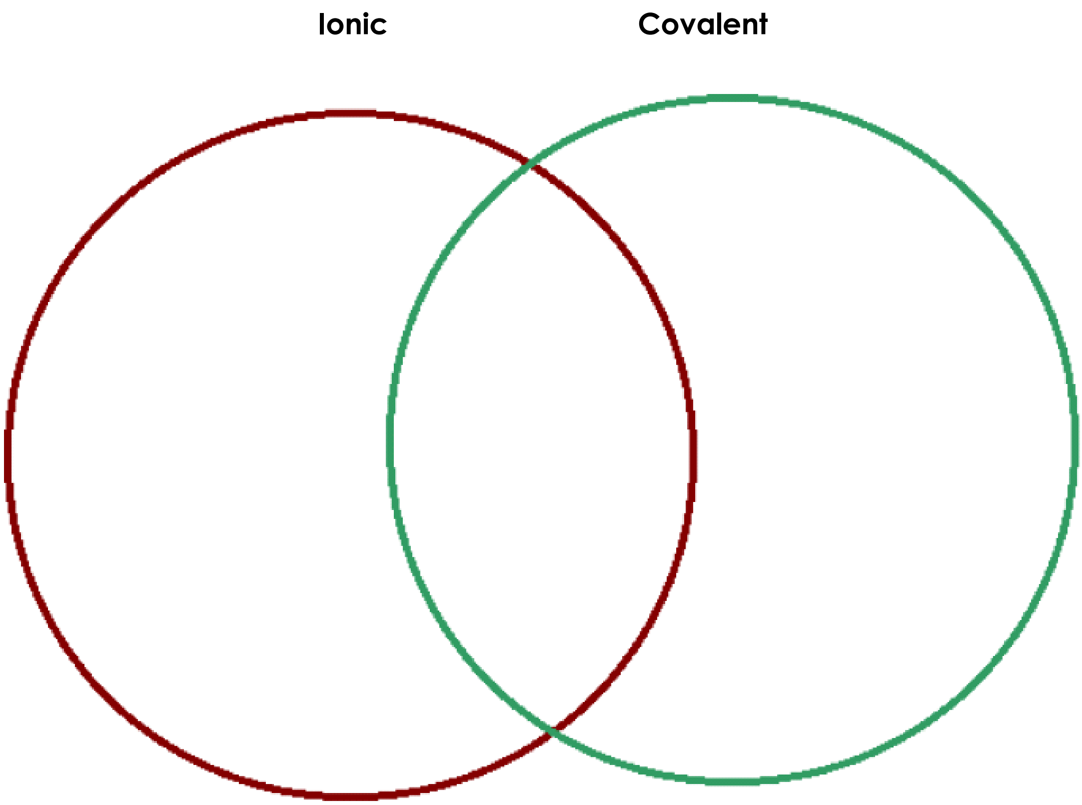
Pre-Lab: Teacher Version

Please complete the chart prior to coming into the lab. Be sure to include MSDS information, as well as the structure. Most structures can be found by visiting http://www.chemfinder.com/*. You can also find information on these structures by visiting* http://www.sigmaaldrich.com/Area_of_Interest/The_Americas/United_States.html.

Completed Student Chemical Research Chart:

Name of Compound	Chemical Formula	Cas #	Melting Point, °C	Boiling Point, °C	Solubility	Conductivity, µS/cm	Physical State	Physical Appearance	Safety Precautions, MSDS	Structure	Ionic or Covalent Compound
Sodium Chloride	NaCl	7647-14-5	801	1413	36g/100cc water	67200	Solid	White crystals	May cause eye irritation	$Na^+ Cl^-$	Ionic
Lithium Chloride	LiCl	7447-41-8	613	1360	1g/1.3mL water	41000	Solid	Colorless crystals or powder	Causes irritation to skin, eyes and respiratory tract if inhaled..	$Li^+ Cl^-$	Ionic
Potassium Iodide	KI	7681-11-0	680	1330	140g/100g water	33800	Solid	White odorless granules or crystals	May cause irritation to skin, eyes and respiratory tract.	$K^+ I^-$	Ionic
Baking Soda	$CHNaO_3$	144-55-8	60	N/A	7.8g/100g water	870	Solid	White crystalline powder or lumps.	High concentrations of dust may cause sneezing		Ionic
Sugar	$C_{12}H_{22}O_{11}$	57-50-1	160-186	N/A	1g/0.5mL water	3	Solid	Colorless crystals, crystalline masses or white crystalline powder	May form combustible nuisance dust concentrations in the air		Covalent
Benzoic Acid	$C_7H_6O_2$	65-85-0	249	122	29g/100mL water	0.003	Solid	White powder with faint pleasant odor	May cause skin and eye irritation. May form combustible dust in the air. Flammable		Covalent
Methanol	CH_4O	67-56-1	N/A	64.5	Miscible	0.44	Colorless liquid	Colorless liquid with a characteristic, pungent odor	Vapor Harmful. Flammable liquid and vapor. Causes irritation skin and eyes.		Covalent
Starch	$(C_6H_{10}O_5)_n$	9005-25-8	Decomposes	N/A	Dispersible in hot water	3000	Solid	White, amorphous powder or granules.	Nuisance dust may cause coughing and sneezing.		Covalent
Vinegar	CH_3COOH	64-19-7	16.6	118	Infinitely Soluble	318	Liquid	Colorless liquid or solid with a strong odor	Corrosive liquid and mist. Flammable		Covalent
Cyclohexane	C_6H_{12}	110-82-7	6.6	80.7	Slightly soluble. <0.1 g/100 mL		Liquid	Colorless liquid with a mild, sweet odor	Danger extremely flammable. Vapor may cause flash fire. Cuases irritation to skin eyes and respiratory tract.		Covalent
Napthalene	$C_{10}H_8$	91-20-3	80.6	218	Slightly soluble. 0.0031 g/100 mL		Solid	Colorless to brown solid with an odor of mothballs.	Harmful if swallowed or inhaled. Use in fume hood. Combustible. Causes irritation to eyes, skin and respiratory tract. Possible allergic skin reaction.		Covalent

Using the template below, and the data from your table diagram the trends found in ionic and covalent compounds.



Please Define the Following Terms:

1) Solubility

When we talk about the mixing of two or more substances together in solution we must consider solubility. Simply defined, it is a measure of how much solute will dissolve into the solvent. Not all substances will dissolve in all solvents. Understanding solubility properties will provide a basis for understanding the golden rule of solubility...Like dissolves like!

2) Ionic Bond

An ionic bond is an electrical attraction between two oppositely charged atoms. Normally, atoms are neutral and have no charge. However, in order to gain stability they will sacrifice their neutrality by either losing one or more of its outermost electrons thus becoming a positive ion (cation) or they will gain one or more electrons thus becoming a negative ion (anion). Elements that are described as "metallic" tend to lose electrons and elements that are described as "non-metallic" tend to gain electrons. Once this has happened then the resulting charged atoms will attract each other.

3) Covalent Bond

Covalent bonds are formed as a result of the sharing of one or more pairs of bonding electrons. Each atom donates half of the electrons to be shared. This sharing of electrons occurs if the electronegativity (electron attracting ability) of the two bonded atoms are equal, or if the difference is no greater than 1.7.

4) Conductivity

This is a measure of a materials ability to conduct an electric current. Conductivity has SI units of siemens per meter ($S{\cdot}m^{-1}$) Metals, which tend to readily ionize, are good conductors of electricity.

5) Polar Covalent Bond

This is a type of covalent bond. In Biological systems, polar covalent bonds are important because they allow the formation of another kind of weak bond called a hydrogen bond. Water is an example of a molecule that has polar covalent bonds and engages in hydrogen bonding.

Please answer the following questions in preparation for the lab you will be performing:

1. Ionic compounds are generally made up of what kind of elements

   A metal and a non-metal

2. Covalent compounds are generally made up of what kind of elements

   Two non-metals

3. Write the formula and predict whether each of the following is principally ionic or covalent by circling (I) or (C).

   sodium iodide ____NaI_____ *I* or C carbon tetrachloride _____CCl_4_____I or C

   ammonia _______NH_3____ I or C carbon dioxide ___CO_2______I or C

   potassium nitrate __KNO_3______ *I* or C calcium chloride__$CaCl_2$________ *I* or C

4. Based upon the compounds you researched, and your Venn diagram, are there any patterns with respect to the property of solubility? ________Yes________________

   Explain

   Answers will vary but should include statements of like dissolves like. Ionic compounds will be water soluble and molecular compounds will not be water soluble.

5. Based upon the compounds you researched, are there any patterns with respect to melting point? ______________Yes____

Explain

Answers will vary but should include statements that generally ionic compounds have high melting points.

6. Based upon the compounds you researched, are there any patterns with respect to conductivity?__________________Yes ____

   Explain.

Answers will vary but should include the statement that ionic compounds are good conductors of electricity.

7. Millenium falcon is a compound made from 2 elements, Millenium (Mi) and falcon (Fa). Millenium has a configuration similar to the alkali metals and falcon has a configuration similar to oxygen. Predict the following:

   a. solubility in water _________No________ b. conductivity_______Yes __________

   c. melting point ________High___________ d. formula ___________MiFa _______

8. Water (H_2O) is:
   a. Polar
   b. Nonpolar

   Explain why you chose the answer above: ___a-because there a overall net dipole from the very electronegative oxygen atom. There is an uneven distribution of electron charge on the whole molecule.

9. Cyclohexane is:
   a. Polar
   b. Nonpolar

   Explain why you chose the answer above: _____ b-because there no overall net dipole from the molecular compound. There is an even distribution of electron charge.

10. Based on the following answers in #8 and #9, explain what is meant by "like dissolves like". (Use words like polar, non-polar, water, and cyclohexane in your answer below)

    Polar substances (like water) will dissolve polar substances and nonpolar substances (like cyclohexane) will dissolve nonpolar substances.

PART A. Solubility in Water and Cyclohexane

Purpose:

Solubility is a complex phenomenon. For the purposes of this lab it is necessary to understand the golden rule of solubility "like dissolves like". What this means is that a solvent (the dissolving medium in a solution) will dissolve a solute (a substance that is dissolved into a liquid) that is similar in structure. More specifically a polar solvent will dissolve a polar solute and a non polar solvent will dissolve a non polar solute. Ionic compounds are compounds with extreme polarity. Ionic compounds will thus be dissolved by polar solvents and will not be dissolved by non-polar solvents. Molecular compounds with non-polar covalent bonds will not dissolve in polar solvents and will dissolve in non-polar solvents. By observing a compounds solubility in various solvents it is possible to better understand the nature of the bonding in the compound.

Materials:

- Fume hood
- 3 50 mL beakers
- Glass stirring rod
- Deionized water
- Cyclohexane
- Unknown Sample A
- Unknown Sample B
- Unknown Sample C
- Spatula

Safety:

- **These procedures should be performed under a fume hood for cyclohexane.**
- **Cyclohexane must be kept away from all sources of heat and open flame.**
- **Safety goggles must be worn at all times**
- **Lab aprons should be worn at all times.**
- **Cyclohexane must be disposed of in organic material collection container provided by instructor.**
- **Unknown Sample A should not be inhaled and all unknown containers should be kept closed at when not being used**

Procedure:

1. Under a fume hood, fill three beakers (50 mL or greater) with approximately 20 mL cyclohexane each. Label each beaker with identity of Unknown sample that you will be placing into the beaker (A,B, or C)
2. Place a small scoop (tip of spatula smaller than a pea size) of Unknown Sample A into beaker containing cyclohexane and CAREFULLY stir with glass stirring rod. Material should be stirred for approximately 1-3 min.
3. Repeat procedure #2 for unknown B and unknown C.
4. Record observations.
5. Dump cyclohexane into collection container provided by your teacher. **(DO NOT DUMP DOWN THE DRAIN).**
6. Thoroughly wash each beaker with soap and water and **THOROUGHLY** rinse with deionized water.
7. Fill each beaker with 20 mL deionized water.
8. Place a small scoop of Unknown sample A into beaker containing deionized water. Stir with glass stirring rod. Material should be stirred for approximately 1-3 min.
9. Repeat procedure #8 for unknown B and unknown C.
10. Record observations.
11. SAVE SOLUTIONS FOR PART B OF LAB.

PART B: Conductivity Test for Ions in Solution

Purpose:

A substance that conducts electricity when it is dissolved in water is referred to as an electrolyte. If a compound is ionic, then when it dissolves in water it will form ions which will allow electric current to flow through the solution. The conductivity of a solution depends directly on the number of ions present in the solution. If a compound is not ionic then when it dissolves in water it will not form ions but will instead break up into molecules. A solution of molecules will not conduct electricity.

Materials:

- Electric conductivity apparatus (can be commercial or home- made) – **WARNING: If the conductivity tester to be used is powered by a 120-V source then this test should only be performed only by a teacher and should be performed very carefully as to avoid electric shock.**
- (3) beakers 50 mL or greater
- Spatula
- Glass stirring rod
- Unknown sample A
- Unknown sample B
- Unknown Sample C

SAFETY:

- **Safety goggles must be worn at all times**
- **Lab aprons should be worn at all times.**
- **Unknown Sample A should not be inhaled and all unknown containers should be kept closed at when not being used.**

Procedure:

1. Using the solutions prepared in part A of the lab, add 20 mL more deionized water.
2. Add a small scoop (pea sized) unknown sample A to labeled beaker and stir with glass stirring rod.
3. Add a small scoop (pea sized) of Unknown Sample B to beaker and stir with glass stirring rod.
4. Add a small scoop (pea sized) of unknown Sample C to beaker and stir with glass stirring rod.
5. Make sure the bare wires of the conductivity tester are clean. Rinse with deionized water before performing test.
6. If using a home-made conductivity tester, hold the battery end of the tester and dip exposed ends of red and black wire into each beaker filled with solution. Do not touch sides of beaker. Wires should be approximately 2 cm apart and should not touch. If LED goes on than the solution is conducting electricity. If the LED stays dark than the solution is not conducting electricity.
7. **CAUTION**: **Exposed wires on conductivity tester must be cleaned with deionized water before performing <u>next</u> conductivity test.**
8. If at first none of the solutions are conducting electricity then add another small scoop of the unknown to the solution.

Assembly Instructions for Home-Made Conductivity Tester (all materials used can be purchased at Radio Shack):

1. For each tester you will need the following:
    a. (1) 9V battery
    b. (1) 9V Battery Snap connector
    c. (1) 5mm Red or Blue LED (12VDC, 20mA,1.5mcd, with integrated resistor)
    d. ~ 15 cm Spare electrical wire (4 conductor, 24 gauge, solid black)
    e. ~ 15 cm Spare electrical wire (4 conductor, 24 gauge, solid red)
    f. Electrical tape
2. Snap the battery snap connector to the 9 V battery.
3. Attach the red wire from the battery snap connector to one side of the LED and twist to secure. It is also advisable to bend the LED wire around the red wire from the battery snap connector so the wires will not separate.
4. Wrap electrical tape around the connection.
5. Touch black wire to other end of LED to make sure that the orientation is correct.
6. Attach the 15 cm spare red electrical wire to opposite side of LED and twist to secure.
7. Wrap electrical tape around the connection.
8. Connect (wrap or use wire connecter) 15 cm black spare wire to black wire on battery snap connector.
9. Wrap electrical tape around connection.
10. Test the all connections by touching the exposed terminal end of the black wire to the exposed terminal end of the red wire and see that LED comes on. IF LED doesn't come on than one of the connection is not secure.
11. Wrap wires around 9 V battery and orientate the LED and the terminal connecting wires so that they are on the same side of the battery and point to the top of the battery where the connection is made.
12. Wrap all wires and LED in electrical tape to secure.
13. Test connections by touching the black wire connected to the red wire. The LED should go on. If light does not go on then you have not constructed the tester correctly and/or one of the connections is bad.

PART C: Melting Time for Unknowns

Purpose:

Many substances remain in a solid state at room temperature. When the temperature of a solid substance increases, it will melt at a particular temperature. The point at which a substance melts depends upon several factors. You will be investigating the time it takes for a substance to melt or change its physical appearance.

Materials:

- Hot plate
- Aluminum Foil
- Spatula
- Unknown sample A
- Unknown sample B
- Unknown sample C

SAFETY:

- **Safety goggles must be worn at all times**
- **Lab aprons should be worn at all times.**
- **Unknown Sample A should not be inhaled and all unknown containers should be kept closed at when not being used.**
- **<u>Do not touch the surface of the hot plate at any time, it is very hot! Do not place any chemical substance directly on the hotplate!</u>**

Procedure:

1. Plug in and turn on the hot plat to “500 V” and wait approximately 5 minutes until the hot plate has heated up. **<u>Do not touch the surface of the hot plate at any time, it is very hot! Do not place any chemical substance directly on the hotplate!</u>**
2. While you are waiting, construct 3 mini “boat like” devices to hold each unknown sample using aluminum foil. The aluminum foil needs to be flat on the bottom with 1/2” sides to prevent any compound from spilling on the hot plate surface.
3. Once you have constructed 3 “boat like” devices, scoop a pea size amount of Unknown A onto the first aluminum boat. Repeat for Unknown B and C, each unknown having <u>their own</u> boat.
4. Once all three aluminum boats have separate unknowns on them and your hot plate is heated up, place the three boats onto the hot plate <u>at the same time</u>.
5. Record the starting time and observe each unknown for a minimum of 10 minutes.
6. Record **<u>any physical changes</u>** you observe and the time it takes for the change to occur.
7. Record the final appearance of each unknown after 10 minutes as well.
8. After 10 minutes, turn the hot plate off. After an additional 10 minutes of cooling, remove the aluminum boats and substances. They all can be placed in the trash for safe disposal.

POGIL questions for the following day:

Melting time

1. Did you notice any patterns in your pre-lab data with respect to the melting point? (As the melting point increased…)
   Certain substances have much higher melting points than others. Substances with high melting points are typically conductive.
2. Sodium chloride and lithium chloride are typical ionic compounds, while sugar represents a typical nonionic compound. In general, how do these two types of compounds compare in their melting points?
   The ionic compounds, sodium chloride and lithium chloride, have much higher melting points than the nonionic compounds.
3. Write down the unknowns and the time it too to melt or change their physical appearance.
   Unknown A: Naphthalene. Took milliseconds to melt.
   Unknown B: Potassium Chloride. Did not melt or change physical appearance.
   Unknown C: Sodium Bicarbonate. Did not melt or change physical appearance.
4. Which known substance(s) had a higher melting point?
   Unknown B and C
5. Which unknown had a longer time to melting (thus a higher melting point?)
   Unknown B and C.
6. What would a longer melting time for a substance indicate?
   A longer melting point would indicate that there is some "force" preventing the substances from melting.
7. Why would a substance have higher melting point?
   Id have a higher melting point if it had a stronger bond due to stronger intermolecular forces.
9. What information would the melting point give you in terms of the bonding of a compound?
   A high melting point would indicate a strong bond.
10. All ionic compounds exist in only one state at room temperature. From what you learned in this investigation, what is that state and why do you think they do not exist in the other states at room temperature?
    Ionic compounds are solids at room temperature and are not liquids because they have high melting points.

Solubility in Water and Cyclohexane

1. Is an ionic compound considered to be a polar or non polar compound? Explain why.
   Polar. An ionic compound exhibits extreme polarity because there is literally a transfer of electrons from the metal element to the nonmetal element creating a positive cation and negative anion.
2. What type of solvent will dissolve an ionic compound? Explain why.
   A polar solvent because ionic compounds are polar and like dissolves like.
3. What type of solvent will dissolve a non-polar covalent compound? Explain Why.
   A non polar solvent because these compounds are non-polar and like dissolves like.
4. Is water a polar solvent or a non polar solvent?

Polar

5. Is cyclohexane a polar solvent or a non-polar solvent?
   Non-polar
6. Propose a hypothesis as to what type of compounds (ionic or covalent) Unknown A and Unknown B are based on the results obtained in your solubility experiment.
   Ionic unknown dissolves in water and does not dissolve in cyclohexane
   Covalent molecular dissolves in mineral oil (may or may not dissolve in water depending on what is used)
7. Explain the reasoning behind your hypothesis for each of your unknown samples in question #6.
   Water is polar and will dissolve polar compounds
   cyclohexane is non-polar and will dissolve non-polar compounds. cyclohexane will not dissolve non polar compounds.

Conductivity:

1. Describe the electrical conductivity of each of your unknowns in solution.
   Ionic Unknown sample should conduct electricity
   Covalent molecular unknown should not conduct electricity
2. What must be true of a solution if the solution conducts electricity? How can the conductivity of a solution be increased?
   The solution contains ions. The number of ions in the solution must be increased.
3. What must be true of a solution that does not conduct electricity?
   The solution does not contain ions.
4. Propose a hypothesis as to what type of compounds (ionic or covalent) Unknown A and Unknown B are based on the results obtained in your conductivity experiment.
   Unknown that conducts is an ionic compound. Unknown that does not conduct is a molecular covalent compound.
5. Explain the reasoning behind your hypothesis for each unknown sample in question #4.
   In order for a solution to conduct electricity there must be ions present. When an ionic compound dissolves in water there will be ions present in the water solution and the solution will conduct electricity. When a covalent molecular compound dissolves in water there will only be molecules and no ions, therefore the solution will not conduct electricity.

Data Chart with Explanations

Unknown Substance	***Ionic?***	***Covalent?***	***Why?*** ***(base answers on data obtained from experimental tests)***
Unknown A			
Unknown B			
Unknown C			
Unknown D			

Extension (Unknown D): This can be used as a follow up extension or as a lab practical/assessment

Instruction for unknown D:

- After you have completed the three tests for Unknowns A, B, and C, and have completed discussion questions in the lab report, you will obtain a final unknown (Unknown D).
- You will be expected to any necessary tests provided to you on Unknown D to determine whether or not it is an ionic or covalent compound.
- Based on your previous data collection in the pre-lab and the knowledge gained from the lab, be sure to defend your answer.
- You will need to complete all procedures and clean up for Unknown D in 10 minutes.

Closing Questions

1. Describe the observations you used to identify your unknown powder.

   Student answers may vary.

2. Why might the results not prove conclusively the identity (ionic or covalently bonded) of the unknown?

   The results might give a general indication but one might not be able to conclusively determine if the unknown is ionic or covalently bonded.

3. What could be done to improve the precision and accuracy of your investigation?

   Student answer s may vary. Students may want to complete more tests than allowed.

4. The human body is mainly composed of nonionic compounds, such as water, carbohydrates, lipids, and proteins. Why then are people such good conductors of electricity?

   People must have more than just nonionic compounds in their body, such as conductive ionic compounds.

5. Magnesium carbonate, an ionic compound, is sometimes used as a thermal insulator in buildings. Why would you expect ionic compounds to be good thermal insulators?

   Ionic solids do not tend to conduct electricity because their ions are not free to move in a solution.

References:

Laboratory Manual. Chemistry Matter and Change. Glencoe, 2005.