SNC1D/1P Atoms, Elements, and Compounds/Exploring Matter

Teacher Demo/Student Activity: Disappearing Volume

Topics	Timing
physical changes: dissolving, solubility	preparation: 5 min demonstration: 5 min

Specific Expectations

SNC1D

A.1.1 formulate scientific question about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

C2.2 conduct an inquiry to identify the physical and chemical properties of common elements and compounds (e.g., magnesium sulfate, water, carbon, copper II) [PR]

SNC1P

A.1.1 formulate scientific question about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

C2.2 use an inquiry process to identify the physical and chemical properties of common elements and simple common compounds, including gaseous substances (e.g. sulfur is a yellow solid; sodium chloride is water soluble; nitrogen gas is colourless, odourless, and very unreactive) [PR, AI]

C2.4 investigate and distinguish between the physical and chemical properties of household substances (e.g. starch, table salt, wax, toothpaste) [PR, AI]

C3.5 describe the characteristic physical and chemical properties of common elements (e.g., density, texture, odour, combustibility, solubility, ability to conduct or absorb heat)

Introduction

In this activity, student mix a given quantity of salt with a fixed volume of water. Mass and volume measurements are made before and after mixing to determine if these quantities change. Students observe that mass is conserved during dissolving while volume is not.

Materials

5 mL of solid sodium chloride or salt, NaCl(s)	digital scale
100 mL of water	100 mL graduated cylinder
10 mL graduated cylinder	stirring rod

Safety Considerations

- The materials used in this lab are safe to handle.

- Appropriate precautions should be taken to avoid breaking glassware. Do not use any glassware that is cracked or chipped.
- Students should not handle broken glassware. Dispose of any broken glassware in a proper hard-sided container with a lid.

Procedure

Wear appropriate PPE: safety goggles.

1. Place the 10 mL graduated cylinder on the scale, and tare/zero it.
2. Remove the cylinder from the scale and measure 5 mL of sodium chloride into the cylinder. Return the cylinder to the scale and record the mass. Then remove the graduated cylinder from the scale.
3. Place the 100 mL graduated cylinder on the scale and tare the scale again.
4. Add 95 mL of water to the graduated cylinder, record the mass, and then remove the graduated cylinder and its contents from the scale.

Part One – Volume

5. **Predict/Explain**
   Have the students predict what will happen to the volume of the graduated cylinder's contents when the salt is added. Ask students to explain their predictions.
6. **Observe**
   Pour the solute from the 10 mL graduated cylinder into the water and stir with the stirring rod until the salt dissolves. Have students measure the volume of the solution.
7. **Explain**
   Ask students why the total volume is not 100 mL.

Part Two – Mass

8. **Predict/Explain**
   Ask the students to predict the mass of the solution in the 100 mL graduated cylinder, and justify their predictions.
9. **Observe**
   Return the graduated cylinder to the scale to determine the mass.
10. **Explain**
    Have the students brainstorm ideas to explain why the mass of the solution is the sum of the mass of the water and the mass of the salt.

Disposal

The solution can be poured down the sink safely.

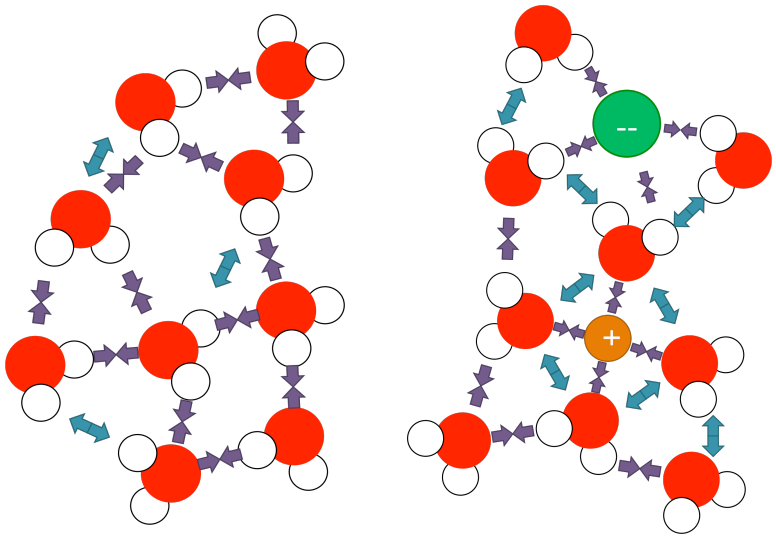
What Happens?

The volume of the solution will be less than the sum of the volume of the water and the salt. The mass of the solution will be equal to the sum of the mass of the water and the salt. This is an interesting discrepancy for the students to observe and try to explain.

How does it work?

Liquid water is semi-organized by a network of hydrogen bonds, which attract the slightly negatively charged oxygen atom on one water molecule to a slightly positively charged hydrogen

atom on another water molecule (purple arrows in Fig.1). At the same time the like-charged poles of the water dipole will repel one another (blue arrows). Ions, released when sodium chloride dissolves, fit into the spaces between the molecules of water. The negative end of the water molecule attracts the sodium cation, and the positive end of the water molecule attracts the chloride anion. This allows the ions to fit into the pockets of space between the water molecules.



Pure water Salt dissolved in water

Fig.1 Forces of attraction and repulsion among water molecules and ions

Teaching Suggestions/Hints

1. Sequencing the predictions first with volume and then with mass is more likely to catch the students off guard. Make sure the graduated cylinder is removed from the scale before adding any solute to avoid prematurely revealing the result. Then, once the solute has been completely dissolved, get the students to predict the mass of the solution. Return the graduated cylinder to the scale to test their predictions.
2. Measuring the mass of the graduated cylinder, which doesn't appear to have undergone a volume change after the addition of the salt to the water, proves that the salt is still there even though it is invisible to the unaided eye.

Next Steps

This demonstration, in addition to highlighting dissolution as a physical change, leads nicely into the concept of density, since the students can see that pure water and the solution have the same volume but have different masses. Therefore, their densities are different.

Additional Resources

1. This short animation shows how water molecules interact with the positive sodium ions and the negative chloride ions when sodium chloride, NaCl(s), is placed in water. http://www.youtube.com/watch?v=CLHP4r0E7hg&feature=related