



<b>Lesson Title</b>	Solutions
<b>Length of Lesson</b>	90 minutes
<b>Created By</b>	David Wilson
<b>Subject</b>	Chemistry
<b>Grade Level</b>	9-12 <sup>th</sup> Grade
<b>State Standards</b>	4(a,d,e)
<b>DOK Level</b>	(3, 2, 2)
<b>DOK Application</b>	(Analyze, Explain, Describe)
<b>National Standards</b>	9-12: B: Physical Science
<b>Graduate Research Element</b>	A study of the properties of solutions is a fundamental area of all hard sciences. Scientists take advantage of these properties when performing tasks as simple as mixing solutions to certain concentrations or as complex as studying the physical process by which the kidneys filter blood.

**Student Learning Goal:**

State Standards: (Chemistry)

- 4) Analyze the relationship between microscopic and macroscopic models of matter.
- a. Analyze the nature and behavior of gaseous, liquid, and solid substances using the kinetic molecular theory. (DOK 3)
  - d. Explain the thermodynamics associated with physical and chemical concepts related to temperature, entropy, enthalpy, and heat energy. (DOK 2)
  - e. Describe and identify factors affecting the solution process, rates of reaction, and equilibrium. (DOK 2)

National Science Standards: (9-12)

B: Physical Science: Structure and Properties of Matter.

- Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.

**Materials Needed (supplies, hand-outs, resources):**

{**WARNING:** Please read the MSDS of any chemical before using it.}

[Quantities of the following supplies listed are per each group.]

DEMO 1 – Supersaturated sodium acetate

- Water
- Sodium acetate
- Directions: Heat the water to 95°C, and add as much sodium acetate as will dissolve. Then slowly cool the sodium acetate. You must avoid dropping any



solid crystals into the solution, or it will all crystallize. Reheat the solution if this happens.

DEMO 2 – Nitinol wire (Memory Wire)

- Nitinol wire

“Hands-on” DEMO 3 – Cu, Ag, Au Pennies

- Sodium hydroxide
- Water
- Shiny new pennies
- Mossy zinc

“Hands-on” DEMO 4 – Silicate Garden

- Sodium silicate solution
- Water
- Colored metal salts

“Hands-on” DEMO 5 – Silver Christmas Tree

- 0.1M Silver nitrate
- bare copper wire

DEMO 6 – Heat Packs

- Heat Pack (Sold by American Scientific LLC among other vendors:  
<http://www.american-scientific.com/~3227-02.html>)

“Hands-on” DEMO 7 – Cobalt Barometer

- Cobalt chloride
- Filter paper

“Hands-on” DEMO 8 – Crystal Christmas Tree

- Blotting Paper (cut to the shape of a small Christmas tree)
- Mrs. Stewart’s Bluing
- Ammonia (household, dilute)
- Ammonium sulfate (or any ammonium salt, other than ammonium nitrate – it’s explosive)

“Hands-on” DEMO 9 – Borax Snowflakes

- Borax
- Water
- Pipe cleaners

{ See the Teachers Notes at the end of the lesson plan for directions. }

**Lesson Performance Task/Assessment:**

- 1) Students will describe and explain the demonstrations shown them in terms of dilution, diffusion, osmosis, solubility, and the kinetic molecular theory.
- 2) Students will relate the demonstrations to the properties of solutions, which they have learned previously.



**Lesson Relevance to Performance Task and Students:**

The students have learned the properties of solutions and the methods for determining the concentrations of solutions. In this lesson, they will experience the practical results of those properties through simple observations and logical deductions.

**Anticipatory Set/Capture Interest:**

The students will see a seemingly plain, straight piece of wire disfigure spontaneously in a warmed beaker of water. From this point, they will be introduced to the properties of unusual types of solutions like alloys.

**Guided Practice:**

As a class, each demonstration will be discussed without my giving the students a concrete explanation of the properties. The students' thinking will be probed and guided with each demonstration.

**Independent Practice:**

Their logical deductions will be used to evaluate their understanding. This lesson is a series of guided demonstrations. They are too dangerous to allow students to toy with them unguided. (Optional: Students can draw what they observe in the demonstrations and make short notes about the science behind it.)

**Remediation and/or Enrichment:**

Remediation: Individual IEP.

Enrichment: The students will relate the silver Christmas tree to the practical problem of corrosion and the solutions addressing this problem.

**Check(s) for Understanding:**

Class discussions and students' written explanations will be used to evaluate students' understanding.

**Closure:**

Students will explain each demonstration orally as a class.

**Possible Alternate Subject Integrations:**

This lesson is purely physical science.

**Teacher Notes:**

Instructions:

- 1) Supersaturated sodium acetate
  - a. <http://www.youtube.com/watch?v=nvHrXr5Jajg>
  - b. <http://www.youtube.com/watch?v=HnSg2cl09PI>
  - c. <http://www.youtube.com/watch?v=21IcpkxgBVY>
- 2) Nitinol wire

## INSPIRE GK12 Lesson Plan



- a. <http://www.youtube.com/watch?v=CiErseFED8>
  - i. A beaker of water over  $50^{\circ}\text{C}$  can be used to reach the baked-in shape also. No need for the torch after the shape is baked-in.
- 3) Cu, Ag, Au Pennies
  - a. <http://youtu.be/mkIPG51NNo0>
  - b. Alternative Method (Safer)
    - i. [http://www.youtube.com/watch?v=g\\_ml8tAnWE](http://www.youtube.com/watch?v=g_ml8tAnWE)
- 4) Silicate Garden
  - a. Advice: I would not buy solid sodium silicate. I would buy sodium silicate solution and dilute it 1:4 with water. It's hard to dissolve.
    - i. <http://youtu.be/a45jZOc7PRY>
- 5) Silver Christmas Tree
  - a. <http://youtu.be/JNpFCIUtk0>
- 6) Heat Packs
  - a. <http://youtu.be/fJeL3hLYLak>
  - b. <http://youtu.be/LmKFyFbY2KQ>
- 7) Cobalt Barometer
  - a. Make a solution of 0.1 M  $\text{CoCl}_2$ . Either use coloring book pages, or have students draw pictures on filter paper and cut them out. Soak the paper (from the book or filter paper) in the solution. Dry the papers. When dried, they will become they will be purple. When it is humid, they will be pink.
- 8) Crystal Christmas Tree
  - a. <http://www.instructables.com/id/Grow-your-own-Magic-Crystal-Tree-or-any-other-sha/>
- 9) Borax Snowflakes
  - a. Optional: You can add food coloring for colored crystals.
    - i. <http://youtu.be/nhg4uQyN7w4>