Activities Guide

Workshop 2. Macro to Micro Structures

Comment

1. All activities have been peer-reviewed but not tested.
2. Some safety considerations are suggested in the activities. For full safety information, consult the MSDS sheets (go to http://msds.pdc.cornell.edu/) before doing the experiment.
3. A concise source book for further assignments, activities, and background information is *ChemSource,* version 2.1 (Orna, Mary Virginia, O.S.U.; Schreck, James O. & Heikkinen, Henry, eds.), 1998. Visit the Web site at http://intro.chem.okstate.edu/ChemSource/chemsource.html.

Glue-Ball Laboratory: Felix Muhiga

Teacher's Guide

Goals

- To introduce chemical change and the reactivity of matter
- To practice observation skills in the laboratory

The Activity

In this activity, students use white glue and soap to create a new substance—a glue-ball. They experience chemical reactivity and investigate the properties of the new material formed, by observation. Thus they are introduced to basic laboratory skills.

Materials for Each Group

- Safety goggles
- 4% borax solution (sodium borate)
- 55% Elmer's glue solution in water
- Ziplock sandwich bags

SAFETY

Make sure that both you and your students wear safety goggles at all times during the laboratory.

Make sure that the students zip the bags to prevent spills.

This activity requires no other special safety precautions. It can be done on the bench, with no additional ventilation.

Teaching Tips From Mr. Pratuch

Here at Annandale, one of the things we've set out to do in the last couple of years is to try to integrate all of the teachers and get more of a team approach. Felix Muhiga was one of the team members in setting up what we do.

So for the very first lab, what we did was the glue-ball lab. The students don't expect to come in and see glue and soap become something that you can play with for 10-14 days. They expect glue to dry after a couple of hours, they expect soap to be wet and liquidy, and dry off of their hands and that's it.

They don't know what the outcome is going to be. That shows that you don't know where things are going unless you see it.

The students are not very good at observing. They look, they see, but they don't really observe.

There's actually an advanced concept that students don't even come near to understanding on the first day of chemistry: polymerization and cross-linking issues. But on the basic level, that is exactly what the first day is like.

If you ask the guys what they want to see they go "poof"—and if you ask the gals, they want to see something become something so they get the feeling of it. Starting out with this the first day, they get the feeling that they were in chemistry class; they did something chemically.

References: Links

http://www.uh.edu/hti/curriculum_units/chemistry/Essien_Unit.htm
A complete unit of study on phase change, thermochemistry, and the gas laws, with activities. The unit was designed for the college level, but can be done easily in a high school class. The unit relates observations to the Kinetic Theory of Matter.

Glue-Ball Laboratory: Felix Muhiga Students' Guide

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In this activity, you will use white glue and soap to create a new substance—a glue-ball. You will experience chemical reactivity and investigate the properties of the new material formed, by observation.

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- Safety goggles
- 4% borax solution (sodium borate)
- 55% Elmer's glue solution in water
- Ziplock sandwich bags

SAFETY

Make sure that you wear safety goggles at all times during the laboratory.

Make sure that you zip the bags to prevent spills.

This activity requires no other special safety precautions. It can be done on the bench, with no additional ventilation.

Instructions

Squirt some white glue into a ziplock bag.

Add some borax solution to the bag.

Zip the bag to prevent spills, and mold the substance in the bag with your hands.

What are the physical changes that you observe? _____

_____

_____

_____

When a white material is formed, take it out of the bag, observe it, and list its properties: _____

_____

_____

_____

Compare the properties of your own glue-ball with your friends' glue-balls and list them in the table below.

Properties of My Glue-Ball	Properties of Other Glue-Balls

Why do you think that you have variations in the properties of the glue-balls?_____

_____

_____

Summary

What substances did you use? _____

_____

_____

What did you get from their mixing?_____

_____

_____

What do you call this change of matter? _____

_____

_____

Diluting Color Demonstration and Activity: Pernell Williams

Teacher's Guide

Goals

- To understand the relationship between phenomena on the macro scale and chemical properties on the molecular level
- To relate color and concentration through dilution

The Activity

This activity has two parts. The first part consists of a classroom demonstration in which the qualitative properties of the colored solutions are emphasized. In the second part, there is a class activity, in which students are asked to calculate the color content of the test tubes. Then, they are given an unknown solution, and they have to estimate its color content, using the dilution series.

Materials for Each Group

- Graphing paper or computer with Excel
- Eight test tubes
- Test tube rack
- Red color solution

SAFETY

Wear goggles at all times when handling chemicals.

The Demonstration

Show the students a set of test tubes with following dilutions of red color, prepared as described.

Preparation

Put eight test tubes in a test tube rack.

In the first test tube, put 25 ml of water and five drops of red color.

In the other test tubes, make a dilution series in which each test tube contains 5 ml of the solution in the previous test tube and 20 ml of water.

Lecture Notes

Tell me which one is more concentrated? How do you know?

Call up a student: Pull out the last test tube and look at it. Please tell us if it's clear.

How about the next one?

I will tell you that these solutions may or may not be clear.

Call up another student (just to make sure the students accept it).

You're looking at an example of what concentration is.

(Explain the preparation of the solutions in the test tubes.)

Even though it doesn't show, there is red color in it.

Lecture Notes for the Activity

Give to each group of students a test tube with a solution with a different amount of red color.

Determine the amount of color in your test tubes. Be as exact as you can.

Calculate how many drops of red there are in each of the test tubes in the rack.

Figure out how to calculate the first dilution, then go on to the second and third.

Example of a calculation: In the first test tube there are five drops of color.

In the next test tube there are 5 ml from solution 1:

5 [drops of color] x 5 ml [volume of color solution]/25 ml [new volume of color solution] = 1 [drop of color]

Draw a graph of the data, on logarithmic scale as well, and explain.

Teaching Tips From Mr. Williams

Emphasize the relation between color and concentration

When you talk about dilution, you talk about very small amounts which cannot be seen, so you can relate macro to micro structures.

The lesson turned out to include a great deal of math. Math is necessary to understand the basics of science. It is used to describe it.

Let the students explain how they calculated.

The goal of the activity is to let the students start thinking.

It's a teaser activity; it is graded but it is just enough for the students to articulate with following activities.

Comment

If you have a spectrophotometer in hand, it is advisable to use it to show the students the real application of absorbance measurements, using the same solutions.

References: Links

http://www.science.uwaterloo.ca/~cchieh/cact/c123/concolor.html
A lab-related activity that uses color to monitor an equilibrium system.

References: Readings

"Using Chemistry and Color To Analyze Household Products: A 10-12 Hour Laboratory Project at the General Chemistry Level," *Journal of Chemical Education,* Vol. 75, pp: 214-215.

Diluting Color Activity: Pernell Williams

Students' Guide

Goals

- To understand the relationship between phenomena on the macro scale and the chemical properties on the molecular level
- To relate color and concentration through dilution

The Activity

This activity has two parts. First, there is the classroom demonstration in which the qualitative properties of the color solutions are demonstrated. In the second half, you will calculate the color content of solutions in test tubes. Then, given an unknown solution, you will estimate its color content, using the dilution series.

Materials for Each Group

- Graphing paper or computer with Excel
- Eight test tubes in test tube rack:
  - In the first test tube, there are 25 ml of water and five drops of red color
  - The other test tubes contains a dilution series in which each test tube contains 5 ml of the solution in the former test tube and 20 ml of water

SAFETY

Wear goggles at all times when handling chemicals.

Instructions

Calculate the amount of color (in drops) and write it down in the following table:

# of test tube	Calculations	Amount of color (in drops)	Log [# of drops]
1			
2			
3			
4			
5			
6			
7			
8			

Diluting Color Activity: Students' Guide, page 2

Is there color in all of the test tubes? _____

Graph the test tube numbers against the amount of color (number of drops) and explain what you see: _____

_____

_____

Graph the test tube numbers against the amount of color and explain what you see: _____

_____

_____

Try to estimate, as closely as possible, the amount of color in your test tube. Use the graph and explain how you estimated it: _____

_____

_____

Summary

Explain why you don't see color in the last test tube(s): _____

_____

_____

_____

_____

Polarity and Solubility Demonstrations: Dr. Leslie Pierce

Teacher's Guide

Goals

- To teach the basics of polarity and solubility of molecules
- To use different ways of teaching to enhance understanding

The Demonstrations

These demonstrations serve to help students visualize the effect of polarity on mutual solubility of liquids. Different models are used in order to explain these principles.

SAFETY

Wear goggles at all times when handling chemicals.

Materials for Each Group

- A petri dish
- 100 ml water with food coloring
- 100 ml isopropyl alcohol
- Test tube with rubber stopper
- Models:
  - Ball and stick models of water and alcohol
  - A jar with table-tennis balls for describing molecular motion
  - Computer modeling of molecules (on CD or Web)

Demonstration #1

Put some water with food coloring on the overhead projector.

Next to it, put some rubbing alcohol (isopropyl alcohol), so that the liquids are CLOSE TO EACH OTHER but DO NOT MIX. Watch what happens, and try to explain what you see.

1. The liquids reject each other
2. The alcohol evaporates before the water

Lecture Notes

Water is a polar substance?

"Like dissolves like."

Oil is non-polar, so it doesn't dissolve in water.

Alcohol evaporates faster than water so it feels cold.

Why does alcohol evaporate faster?

Watch the molecules in the jar: when they leave the liquid it means that they evaporate.

Why don't the liquids mix?

Can we get them to mix?

It says on the bottle: 70% isopropyl alcohol. 70% in what?

The liquids do dissolve. If I shake them, they mix, because they are both polar. Their polarity is different, so they don't mix readily.

Demonstration #2

Put some water in a test tube, then put isopropyl alcohol on top.

Watch what happens, and try to explain.

Homework

Draw a ball and stick model of the water and isopropyl alcohol molecules.

You have three ways of approaching this:

1. Draw a dot diagram of the atoms and work it from there.
2. Use actual ball and stick models to draw the molecules.
3. Enter an Internet site where there are models of the molecules, rotate them and study the structure.

Teaching Tips From Dr. Pierce

If we show the kids different representations of the same idea, it will help them learn it.

The students don't see matter the same way the teachers do.

It is all very new. We have to help them construct an image of this.

References: Links

http://www.chem.vt.edu/RVGS/ACT/lab/Experiments/Exp_15-Polarity.html
A lab procedure on solubility and bonding.

http://www.scienceteacherprogram.org/physics/Flomberg01.html
A series of demonstrations to extend those shown by Dr. Pierce in the video.

References: Readings

Beall, H. Report on the WPI Conference "Demonstrations as a Teaching Tool in Chemistry: Pro and Con," *Journal of Chemical Education,* Vol. 73, No. 7, p: 641.

Furio, C. and Calatayud, M.L. (1996) "Difficulties With the Geometry and Polarity of Molecules: Beyond Misconceptions," *Journal of Chemical Education,* Vol. 73, No. 1, p: 36.

Sanger, M.J. and Badger II, S.M. (2001) "Using Computer-Based Visualization Strategies to Improve Students' Understanding of Molecular Polarity and Miscibility," *Journal of Chemical Education,* Vol. 78, No. 10, pp: 1412-1416.

Machado, C. (2001) "An Easy and Versatile Experiment to Demonstrate Solvent Polarity Using Solvatochromic Dyes," *Journal of Chemical Education,* Vol. 78, No. 5, pp: 649-651.

Letcher, T.M. and Battino, R. (2001) "An Introduction to the Understanding of Solubility," *Journal of Chemical Education,* Vol. 78, No. 1, p: 103.

Light and Color Demonstrations: Al DeGennaro

Teacher's Guide

Goals

- To demonstrate the concepts of atoms and electronic structure
- To apply these concepts in the real world

The Demonstrations

The demonstrations are intended to strengthen the understanding of basic concepts about the atom and its electronic structure by demonstrating light energy given off by excited electrons.

Materials

- White lamp
- Red lamp
- Diffraction gratings for each student
- 3-4 UV beads for each student
- Classroom technologies:
    - Computerized presentation
    - Overhead projector

SAFETY

Do not look directly at strong light.

If you use UV lamps, use safety goggles and avoid exposure to radiation.

Lecture Notes

We will be talking about the chemistry of light, and that's because you guys are so bright.

Talk about the colors of visible light, about photons, and about how atoms can give off light.

In the ground state, the electrons are at their lowest energy level.

There's a special name for an electron that has been moved to a higher energy level—the excited state.

Summarize different possible excited states: 2S1, 2S2, etc.

The electrons will only go to the excited state if you give them energy like flame or electricity.

They will go down to the ground state, 1S2, as soon as possible.

This is related to light.

Demonstration # 1—Diffracting Light

Turn on a white lamp.

What color does the lamp give off?

Give out diffraction gratings. Instruct the students to look at the light through the grating.

What colors do you see?

The white light is separated into colors.

The first scientist who actually saw this was Isaac Newton.

He was amazed because all of these colors were always in sunlight.

Turn off the white lamp and turn on a red one. Watch the light through grating.

What color do you see now?

You only see several colors, mostly red.

Discussion

Have any of you ever seen a rainbow anywhere in your house?

Any v-shaped piece of glass would have the same effect.

ROY G. BIV—the abbreviation for the colors of light.

The energy of different colors of light was measured by carefully shining them on thermometers, although most people could not tell the difference between different energies of light.

Photons are little pieces of light.

"Black light" is UV light, which you see only when it glows off different chemicals.

Demonstration # 2—UV Beads

UV beads are beads that glow when UV light shines on them.

There are chemicals inside the beads that absorb UV light from the sun and give off visible light in various colors.

Teaching Tips From Mr. DeGennaro

Try to give the students an understanding of different kinds of light and different colors

This should help the students understand what they've learned about atoms and how electrons move within atoms.

References: Links

http://scifun.chem.wisc.edu/chemweek/fallcolr/fallcolr.html
The chemistry of autumn leaf colors.

References: Readings

Trupp, T. (2001) "Putting UV-Sensitive Beads to the Test," *Journal of Chemical Education,* Vol. 78, No. 5, p: 648A.

Anthony, G. (1997) "Housing Electrons: Relating Quantum Numbers, Energy Levels, and Electron Configuration," *Journal of Chemical Education,* Vol. 74, p: 709.

Featuring Molecules Class: Veatta Berry Teacher's Guide

Goals

- To help students visualize concepts
- To let students be creative in presenting new concepts such as solutions and dissolving

The Class

In this class, students use their imagination to act out molecules in solution. They have to visualize the dissolution of molecules and the factors affecting it.

Lecture Notes—Molar Concentration

Draw two flasks on the blackboard: One large flask with 20 moles of NaCl and one small flask with five moles of NaCl.

Which flask is going to weigh less?

Does this automatically mean that in the small flask there is a more dilute solution?

We need a better way to compare the concentration in both flasks.

If we calculate the number of moles, relative to the volume of liters, we get the MOLAR concentration of solutions in the flask.

Activity

Instruct the students to imagine how a single molecule of sucrose is:

Taken out of the container

Made into a cup of Kool-Aid

Put on some ice

Create a skit, a poem, or a short story to present in class.

Teaching Tips From Ms. Berry

The activity allows non-science majors to use their imagination.

The students express their ideas and reveal their misconceptions.

The activity helps to relate between the solution and molecules.

References: Links

http://www.external.ameslab.gov/News/Inquiry/fall97/action.html
New technology to track the behavior of a single molecule.

References: Readings

Ponnadurai, R. (2000) "Students as Solids, Liquids, and Gases," *Journal of Chemical Education,* Vol. 77, p: 485.

Nicoll, G., Francisco, J.S., and Nakhleh, M. (2001) "An Investigation of the Value of Using Concept Maps in General Chemistry," *Journal of Chemical Education,* Vol. 78, No. 8, pp: 1111-1117.

Russell, J. W., Kozma, R.B., Jones, T. Wykoff, J., Marx, N., and Davis, J. (1997) "Use of Simultaneous-Synchronized Macroscopic, Microscopic, and Symbolic Representations To Enhance the Teaching and Learning of Chemical Concepts," *Journal of Chemical Education,* Vol. 74, No. 3, p: 330.