

## CHEMISTRY LESSONS IN CONCRETE

Subject Area: Chemistry

Grade Level: 10th to 12th

Length of Lesson: 5 days

Lesson Overview: Students will become familiar with the ingredients and the percentages of the ingredients in concrete, make concrete samples, and determine the densities of these samples.

### Materials Needed for the Lessons

set of sieves

supply of concrete

balance

paper and plastic cups

graduated cylinders

1/2" plastic pipe insulation

duct tape

thermometer

kitty litter

small glass or plastic jars

pH paper

clean sand

50/50 mixture of dirt and sand

perlite

Video from Portland Cement Association "A New Stone Age"

Websites references needed:

Materials Science Technology (MAST)

<http://matse1.mse.uiuc.edu/concrete/concrete.html>

Portland Cement Association

[http://www.cement.org/basics/concretebasics\\_classroom.asp](http://www.cement.org/basics/concretebasics_classroom.asp)

### Skills the Students Will Learn

- To be able to write a complete lab report based on the problems presented
- To be able to determine the percent by mass of sand, gravel, and cement in a sample of concrete
- To be able to make a cylinder of concrete with a particular aggregate, and after it sets, to measure its density.
- To compare the densities of concrete samples, each with different aggregates.

### Student Deliverables

Two complete lab reports

Cylinders of concrete

### Activity Day One:

Students are introduced to the lessons in concrete. We started with the question: What did they try to plug the oil leak with off the Gulf Coast? --At that time, BP said they would try to plug the leak with golf balls, old tire bits and cement. This led to the

discussion of cement and its purpose in concrete--to bind the other materials it is mixed with. I introduced the terms concrete and cement. I showed the Video: "A New Stone Age" from the Portland Cement Association. This video shows the processes in making portland cement. This video is 10 minutes long, and can be ordered from the website referenced above. After the video, I introduced the problem we will be exploring tomorrow--how to determine the percent by mass of cement, sand, and gravel in a sample of concrete (Home-Depot concrete mix).

The students spent the rest of the period preparing for the lab--writing the title, purpose, materials, procedure, and data table. They were to design their own procedures and data table. I told them and showed them the set of sieves they would be able to use.

### Activity Day Two

This lesson was modified from Lesson Two ("What are the Parts of Concrete?" from the Portland Cement Association from the website reference above.

The students separated about 140g of concrete into three fractions--cement, sand, gravel. They were left on their own to do their own procedures. I had a balance in the room along with paper cups for massing each fraction. The concept of percent by mass is a familiar one in chemistry, and difficult for some students. The lesson was a nice review of information we had previously learned

Note on Sieves: I made ten sets of sieves myself. This was a rather time-consuming process, but it saved money. One professional set of sieves cost from \$30-\$70. I needed eight

sets, one for each lab group. Not counting the time invested, which was many hours, the materials cost about \$2-\$3 each to make each set.

Students designed their entire lab report, with procedures, calculations, and conclusions.

### Activity Day 3

Re-showed the video “A New Stone Age”. I did this because the first day I showed it, I did not have a good set of speakers, and it was very hard to hear. I obtained a good set of speakers for this day, and showed it again. If I did this lesson again, I would show it again anyway; it was a nice repeat of information.

After 10 minute video, I had some interactive demonstrations, taken from the website referenced above “Materials Science Technology” (MAST):

- “Making a Silt Test”: I set up two jars, one with kitty litter and water, the other with sand and water.
- “Conducting An Organic Matter Test”: I set up two jars, one with 50/50 mixture sand and dirt, and one with sand, prepared as the website suggests
- “It’s Heating Up”: I mixed some cement and water and took the temperature for several minutes and called out the temperature to the students.
- “pH of Cement”: Took the pH of cement and water and students observed.

These experiments are explained on the MAST website. I had the students walk around the room and observe these

demonstrations. I had them do various kinds of activities, like they plotted the temperature versus time for the “It’s Heating Up”, and had them comment on the pH of the cement and water, and we discussed exothermic chemical reactions after observing the temperature rise of the cement and water.

### Activity Day 4

Students made cylinders of concrete. I essentially did Experiment 2 “How Dense Is It” from the Material Science Technology website, with the students making the cylinders themselves instead of having them pre-made. I made the forms for them (plastic pipe insulation and duct tape). The students made the cylinders. How to make these cylinder is shown on the MAST website. I have five classes of chemistry and each class made one type of concrete. One class used sand as the aggregate, one used gravel, one used perlite, one used Home-Depot pre-mixed concrete, and one class made pure cement cylinders. For the sand and gravel aggregates, we used the previous days’ sievings. I halved the “recipes” given on the website; students made 2” by 1/2” cylinders.

We let the cylinders set overnight. I told them the “setting” of concrete is a chemical reaction, not a drying of the water added.

### Activity Day Five

Students followed the procedures in Experiment 2 “How Dense Is It?” from the MAST website. Each lab group measured the densities of the five different composition cylinders. This was a

nice review of how to calculate density. They used a balance to measure the mass, and used the water displacement method to determine the volume, which was quite difficult for some students. The students wrote up a complete lab report on their own with title, purpose, materials, procedure, data table, and conclusions.

### Enrichment Suggestions

These lessons could be greatly extended; the two websites have many additional lessons that are relevant.

### Student Resources

Students need their own paper and ideas--there were no worksheets to give to them. They did their own write-ups.

### State Standards Met

From the California State Standards in Chemistry  
(underlining mine)

- Students know how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.
- Students know chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
- Students know how to use the pH scale to characterize acid and base solutions.
- Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

## Lesson Plan Relevance To Externship

I worked in the concrete business (at Rescue Concrete) for one week during the summer of 2009. Each day in the lessons above I mentioned this, and I mentioned the job opportunities. I learned last summer that if you want to work in this field, you have to develop the skills. The people I talked to in the field told me that it takes at least a year or of apprenticeship to become skilled in this field. I told the students it's good paying job, and a lifelong skill to be able to lay concrete. I also told the students that engineers study the chemistry of concrete, just like we did by measuring the density of various kinds of concrete (differing by the aggregates added). We have a masonry class at Rosemont High School, and some of my students were in the masonry classes. These students related particularly well to the lessons.

## Rubric for the Concrete Project

<b>Student Deliverable</b>	<b>Exceeds Expectations</b>	<b>Meets Expectations</b>	<b>Approaches Expectations</b>	<b>Fails to Meet Expectations</b>
Lab: Concrete Components		XX		
Lab: Density of Concrete		XX		
Concrete Cylinders	XX			