Amgen Award for Science Teaching EXCELLENCE

2007
Winning Lesson Plan from Mt. Olivet , Kentucky

Introduction to Physical Sciences, Chemistry

by Josh Underwood
Deming School

Subject: Chemistry
Grade Level: 9–12
Duration: Two 90-Minute Class Periods

Overview and Purpose

Students are constantly asking where they are going to use what they learn. By using cement as the focus of the lab, students are seeing science in terms of a real life substance used in structures all about them. This lesson focuses on students learning about the properties of cement. They will make different batches of cement, varying the amounts of water added. They will determine the appropriate amount of water by doing strength tests on the cement samples and comparing them. They will also address what is wrong with people saying, “Don’t bother the cement until it dries.”

Educational Standards: (KY Core Content)

Students will explain the importance of chemical reactions in a real-world context.

Students will give examples of conservation of matter and energy.

Objectives

- Students will recognize that the curing of cement is a chemical change.
- Students will determine the appropriate ratio of water to cement.
- Students will collect data to verify the law of conservation of matter.
- Students will learn the meaning of limiting reagents.

Materials

- Cement
- Water
- Measuring Cups
- Electronic Temperature Probe
- Gloves
- Stirring Sticks
- Mixing Cups
- Masks
- Breaking Device with Quantitative Capabilities
- Small Plastic Bag
- Balances
- 2.5cm thick blocks of wood
- Cardboard
- 1 cup Milk Cartons

2007
Winning Lesson Plan from Mt. Olivet , Kentucky

Introduction to Physical Sciences, Chemistry

by Josh Underwood
Deming School

Subject: Chemistry
Grade Level: 9–12
Duration: Two 90-Minute Class Periods

Procedures

Explain to the students the goals of the lesson. They are to try to make the strongest cement possible by varying only the amounts of water. They will make three samples for each amount of water. They will also keep track of the mass of the water and cement used and compare it to the mass of the mixture after it cures. They will also be choosing one of the mixtures to use to make a fourth sample. This sample will not be strength tested but will be used to record the temperature while curing. They will be recording observations of their samples as they go through the lab.

After they understand what they will be doing, have them set up their CBLs (Vernier) to collect temperature data over the next two days. One point every three minutes will be fine, but this can be varied. The temperature probes are then set aside until the students are ready to insert them in the cement.

Next, have the students come up with 4 different ratios of cement to water. Once you check them to make sure they have a good range, have them get started making their samples. Remind them to keep record of the masses. While some in each group are mixing the cement, the others can start cutting the bottoms out of the milk cartons. They want to make them 1cm tall. Mark them and place them on the cardboard. This enables them to move them without making a mess later on. When they fill their samples, have them fill their small milk boxes to the top and then take a stirring stick to smooth it across the top. This helps to ensure that all the samples will be the same. Set the filled samples some place where they will not be disturbed.

For the temperature sample, take one uncut carton and fill it half full with the cement. Take the temperature probe, cover the end with the plastic bag and place it in the sample. As the teacher, you can set up a temperature probe and leave it out in the room to serve as the control.

When the students return the next block, have them find the mass of all of their samples. Have them record their findings. Then bring the groups up to break their samples. If you have a large class, you may want to have multiple breaking devices. The one I use consists of a metal bar hinged one end. That end is braced to a table. It is like having ½ of a nutcracker. The samples are placed on small blocks under the bar near the hinged end. Force scales are attached to the other end of the bar and the forces required to break the samples are recorded. NOTE: All samples need to be placed the same distance from the end and set on the blocks the same way. Otherwise, the mechanical advantage of the lever is changed and you cannot compare results. You may or may not want to discuss levers at this point with your students.

2007
Winning Lesson Plan from Mt. Olivet , Kentucky

Introduction to Physical Sciences, Chemistry

by Josh Underwood
Deming School

Subject: Chemistry
Grade Level: 9–12
Duration: Two 90-Minute Class Periods

Procedures (Cont'd)

While groups are breaking their samples, the other groups can be checking their temperature graphs and comparing them to the control and the other groups'. They should sketch the graphs in their notes.

Once everyone has collected all of their data, they are to decide on the best ratio of cement to water. This can be discussed as a class and the best ratios can be compared. Then you can discuss with them their findings about the temperature of the cement. They will note that it did change while curing. This will be evidence of curing of **cement being a chemical change**. Then discuss the masses they recorded. They will find that they remained the same before and after the mixing. This tells them that the water is **incorporated into the cement, not evaporated** as people means times mean when they talk about the cement 'drying'. This will reinforce the concept of **conservation of mass** in chemical reactions. Lastly, you can discuss what they saw when they compared the different mixtures. Most likely, they had at least one that was really hard to work with because there was to little water. It was weak when they tested it. This can be a nice time to discuss **limiting reagents**. In this case, water was the limiting reagent. Had there been more, the cement would have reacted more and it would have been stronger. This can be likened to baking and using too much flour. Most students can relate to eating a cake and hitting patches of flour where there was too much and not mixed well. The last thing I like to do is have the students make a list of everything they can think of that entails the use of cement. They come up with a long list of common items. **This helps them to explain the importance of chemical reactions in real-life settings.**

Extension:

I like to have them contact someone they know that works in cement and find out how much water they use. They can compare this to their findings. I have also sent students home to bring back different samples of cement. Small samples can be found around almost anything that cement was used to make. They generally bring back concrete (cement and added aggregates) and this leads into discussions and labs on why they add the aggregates to cement.