Research Experience For Teachers (RET) – 2011

Module - The Nature of Allotropes

Module Topic: The Nature of Allotropes

Rationale:
Allotropes are similar to polymorphs which was the basis of my summer project in Dr. Iqbal's lab. Like polymorphs, the structural variations of allotropes and the resulting differences in physical properties can have significant commercial impact.

Standards:
5.1.12.A.2. Develop and use mathematical, physical, and computational tools to build evidence-based models and to pose theories
5.2.12.A.2. Account for the differences in the physical properties of solids, liquids, and gases.

Objectives:
Students will be able to:
1. Describe how elements can exist as 2 or more different structures.
2. Distinguish between different allotropes based on structural analysis and properties.
3. Analyze how the bonding structure could influence the properties.
4. Distinguish between crystalline and amorphous structures.
5. Compare and contrast the 3 different carbon allotropes.
6. Compare and contrast 3 different sulfur allotropes.

Materials:
Sulfur Allotrope Lab

Safety goggles	Bunsen burner	Sulfur (powdered)
Filter Paper	Test Tube	Test Tube Holder
Vegetable Oil	Microscope	Cold Distilled Water
Beakers (50,100,250)	Microscope slides	Dropper
Graduated Cylinder	Spatula	Funnel
Ring Stand	Clamp	Stirring Rod
Wire Gauze		

Carbon Allotrope Lab
Molecular Model Kits

Handouts:
Lab Procedure
Lab Questionnaire

Background:
Elements like carbon and sulfur can exist in several different forms known as allotropes. These allotropes occur due to differences in bonding patterns. Examples of carbon allotropes are graphite, diamond and fullerenes.

Graphite and diamonds have been known for millennium, but fullerenes have only recently (1980's) been discovered and their potential commercial applications are currently being explored.

My summer project in Dr. Iqbal's focused on identifying possible polymorphs of ibuprofen. Polymorphs are different molecular forms of the same molecule with possibly different properties similar to allotropes.

Classroom Activities: This module is broken up into two 80 minutes lessons.

Lesson 1: Introduction to Allotropes
- Pictures/videos comparing graphite and diamonds.
- Inquiry Question – These substances are made up of the same element, what accounts for their differences?
- Lecture – Definition, elemental forms, properties.
- Lab Activity – Building Carbon Allotropes.

Lesson 2: Sulfur Allotropes
- Introduction to sulfur – its forms and uses.
- Teacher demonstrates creation of sulfur allotropes in hood.
- Lab Activity – Students microscopically examine sulfur allotropes, make drawings and answer questions based on observations.

Discussion Questions
- Given that graphite and diamonds are made up of the same element – carbon- what accounts for their differences in properties?
- Which would have a higher melting point - graphite or diamonds? Why?
- What is required to form sulfur allotropes?
- What is another name for fullerene? Why did it get this name?
- How is a snowflake similar to an allotrope? How is it different?

Homework/Practice Exercises – attached

Evaluation Parameters –
- Models of carbon allotropes using photographs and a written report on carbon allotropes.
- Analysis relating bond structure and properties of carbon allotropes.
- Description, including diagrams, of each sulfur allotrope.

References:
Modern Chemistry, Davis, R.; Frey, R; Sarquis, M; Sarquis, Jerry; Holt, Rinehart and Winston
Dr. Daniel Steinberg, Princeton Center for Complex Materials, 316 Bowen Hall, Princeton Univ.

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