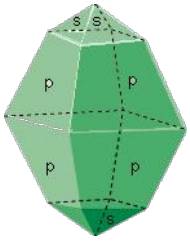
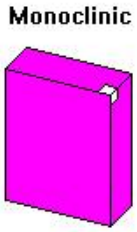
Regents Chemistry Lab

Name:

Allotropes of Sulfur (20)

Prelab discussion: Allotropes are different structural forms of the same element. In the case of solids, differences in the visible form are due to differences in the crystalline structure. In other cases, differences in form may be due to differences in the number of atoms in a molecule of the substance, as in oxygen gas (O2) and ozone gas (O3). In this experiment, you will prepare two allotropic forms of sulfur, and observe another that was prepared for you. These different forms are prepared by changing the conditions under which the crystals grow. Sulfur has three allotropes: Rhombic, Monoclinic (needle like) and amorphous (no shape, plastic)

Rhombic: 

Monoclinic: 

Problem: Which allotrope was made based on examination of the crystal shape?

Hypothesis: Answer the question above, based on what you think the crystal will look like for each of the three allotropes once made. (3)

Procedure: Parts I and II should be performed in a fume hood or a well ventilated room.
Part I

1. Fold a piece of filter paper into a cone, place it in a funnel and wet it slightly so it will lay flat. Place the paper/funnel into an iron ring on a ring stand.
2. Cover the tip of a spatula with powdered sulfur and place it into a pyrex test tube. Using a test tube holder, heat the sulfur gently and slowly with a Bunsen burner flame until all sulfur has melted to form a viscous, pale yellow liquid.
3. Extinguish the burner and pour the molten sulfur into the filter paper. Immediately take the paper out of the funnel (careful! – do not touch the hot sulfur) unfold the paper and observe the formation of the crystals. Examine the crystals with a stereomicroscope and record your observations under the results section.

Part II

1. Half fill a 250 ml beaker with tap water and set it to one side. Using the same test tube as in part I, add about the same amount of powdered sulfur to the test tube – about the tip of a spatula.
2. Using the test tube holder, heat the sulfur gently until it is boiling and dark red in color.
3. Extinguish the burner, and pour the boiling sulfur into the beaker of water. If the sulfur starts to burn, continue pouring until the test tube is empty, and extinguish any remaining flame on the test tube with a damp paper towel. Do not place the test tube under water – you will crack the glass!
4. Examine the solid formed in the water with a glass stirring rod and a stereomicroscope, and record your observations in the results section.

Part III

1. Observe the crystals made previously by me on the front lab table. These were made by dissolving sulfur in toluene and letting the solvent evaporate over several hours.
2. Record your observations in the results section.

Results:

1. Diagram the shape of the sulfur from part one below: (2)

2. Diagram the shape of the sulfur from part two below: (2)

3. Diagram the shape of the sulfur from part three below: (2)

Conclusions:

1. Match the shapes of rhombic, monoclinic and amorphous crystals with the products from parts one, two and three. (3)

2. Why do you think we needed to melt or boil the sulfur first?(2)

3. Differentiate between the terms allotrope and isotope. (4)

4. Based on evidence from this experiment, what do you think the relationship is between rate of cooling and crystal size? (2)

Allotrope Lab - Teacher Supplement

Conclusions:

1. Part I – should make monoclinic crystals
   Part II - should make amorphous crystals
   Part III – should make rhombic crystals

2. The powdered sulfur will have a crystal shape to it even though is has been powdered. Melting (and boiling) changes the phase and the crystalline shape is lost.
3. allotropes are arrangements of atoms that differ for the same element (different structural forms). Isotopes are atoms that have a different nucleus (atomic mass, number of neutrons)
4. Slower cooling results in larger crystals.

Rhombic sulfur is the stable allotrope at room temperature. By controlling the conditions, other allotropes can be grown.

Rhombic sulfur is made by dissolving a tip of a spatula of sulfur in 5 ml of toluene. Place into a hood and let the toluene evaporate. I would recommend making 4 or 5 of these for student observation at least one day ahead of the lab period.

Safety:

- Toluene is an irritant and toxic. No one should inhale the vapors
- Sulfur fumes and SO2 are produced, both of which are respiratory irritants if inhaled. Direct students to not have test tube near their face, open the windows in the room, or better yet perform the experiment under a fume hood.
- This lab can be done in entirety as a demonstration.
- Test tubes should be discarded at the end of class.

Each lab station should have a stereomicroscope, or a traditional microscope on low power.

Numbers in parenthesis are point values for grading of lab.