

# Chemistry

## Scarsdale High School

### Crystal Structure of Iron (Fe)

Objective:

Determine the crystal structure of a sample of iron based upon its physical properties after various heat treatments

Task:

Perform the attached lab.

Materials:

1. See the lab procedure

Lab Report

2. Abstract
3. Observations
4. Include a photo of each hairpin used in your experiments before and after each heat treatment
  - a. CLEARLY label each hairpin in each image
5. Conclusion
6. References (Use MLA format)

Due Date:

One week after the completion of the lab period.

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#### Introduction

Metals are often found and fabricated in a number of different crystal structures. The metal's properties can be manipulated to meet the demands of the requirements imposed by the user. For example, steel used for a kitchen knife will have very different properties (inelastic) than steel used as girders in the construction of an office building (elastic). At ordinary temperatures, iron has a body-centered cubic (bcc) crystal structure. If the temperature of the iron is raised above 910° C, it changes to a face-centered cubic (fcc) crystal structure. Impurities mixed into the crystal (alloys) also affect the metal's properties and characteristics. For example, addition of a small amount of carbon in the iron forms steel and greatly affects its structure and properties. To demonstrate these types of changes and manipulations, we can use a simple hairpin to gain a better understanding of the metallurgy of iron.

#### Procedure

##### **Note:**

**This lab is all about your ability to record your observations and to propose rationale and scientifically based explanations regarding your experiences. This requires you to actually think about the observation and to apply your knowledge. I want to see your best work!!!**

1. Time allocated: 2 lab periods.
2. CAUTION: We will be using Bunsen burners to heat the iron to red hot: **DO NOT TOUCH** the hairpin or the tongs until you are sure it is cool enough.
3. This lab is to be completed with only 1 lab partner. Each group will be given 4 hairpins for the testing.
4. In your lab report, draw, to scale, the unit cell of iron (Fe) in both of its configurations listed above (refer to the textbook for help). Label each atom and the distance and angle between each atom. BE NEAT and CLEAR!
5. Obtain 4 hairpins from the instructor. This is all you will be given so do not lose them.
6. REMEMBER: Take pre and post pictures of the hairpins at each step of the experiment.
7. Grasp the open end of one of the hairpins and attempt to open it about 2 cm. Describe what you observe and feel. I want details in your description and BE THOROUGH.

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8. With the other 3 hairpins, put the curved end in the flame of the Bunsen burner and heat them until they are red hot. Use tongs to hold the hairpins so that you do not burn your fingers. When it becomes red hot, use a second pair of tongs to straighten each hairpin. Allow the hot hair pin to cool on a wire mess.
9. With the tongs, hold the straightened hairpin **vertically** in the flame until the entire hairpin becomes red-hot. Slowly raise the hairpin out of the flame so that the cooling process will be very slow (take more than 5 minutes to remove the hairpin from the flame).
10. Let the hairpin cool slowly on top of a wire mess piece until it reaches room temperature. Make sure that the hairpin is in a safe place!
11. The iron in the hairpins is now annealed and is in a body-centered cubic (bcc) structure. (How can you determine if this is the bcc structure? What properties of the hairpin are consistent with this structure?)
12. Bend all three of the annealed hairpins into a fishhook or “J” configuration. Describe this process and compare it to your observations recorded in step 2 above. Based upon the unit cells that were drawn in step 1, explain why the hairpin behaves differently after annealing.
13. With the tongs, hold one of the annealed hairpins **vertically** in the flame until it is red-hot. Quickly drop it into a beaker of tap water so that it will cool quickly. Repeat this process with the second hair pin.
14. Try to unbend one of the hairpins. Describe what happens. Include an explanation of your observation. I want details. Be thorough.
15. With the last hairpin held in the tongs, slowly lower it into the upper part of the flame. When the gray color of the hairpin changes to a gunmetal blue color, slowly remove the hairpin from the flame before it turns red hot. Allow the hairpin to cool slowly on the lab bench.
16. Try to straighten this hairpin. Describe what happens. Include an explanation of your observation. Compare your results to your observations of the other hairpins.
17. Make sure to have photographs of each step in this experiment. Discard the used hairpins and pieces in the trash can by the door. Put away all of the laboratory equipment that was used in this lab.