

DETERMINATION OF IRON IN CEREAL

LAB VIS 11

INTRODUCTION

"Read the label, set a better table" is a saying that encourages consumers to use the information provided on food labels to select healthy foods and prepare healthy meals. The Percent Daily Values (%DV) listed on food labels tell adults what percentage of the DV is provided in one serving of the food. Daily Values are reference numbers based on a 2,000 calorie diet and Recommended Dietary Allowances (RDAs). Your Daily Values may be higher or lower, depending on your calorie needs. The DV for iron is 18 mg. One serving of a food that provides 100% of the DV of iron contains 18 mg of iron. The RDA for iron for 14-18 year old males is 11 mg and for 14-18 year old females is 15 mg.

In this experiment you will use a spectrophotometer to experimentally determine the amount of iron in one serving of a cereal. Iron (III) phosphate and iron (II) sulfate are commonly added to packaged food products, but some manufacturers dose your food with iron filings. This is OK! The acid in your stomach converts this iron into a form that your body can absorb.

The method used in this experiment detects iron by measuring the amount of light absorbed by the highly colored complex formed between iron (II) or ferrous ion (Fe^{2+}) in the sample and *o*-phenanthroline. This method was also used in "Determination of Iron in Water".

PURPOSE

The purpose of this experiment is to use spectrophotometry to determine the quantity of iron in an unknown sample of cereal.

SAFETY

Always wear goggles and an apron in the lab.

MATERIALS

standard iron solutions complexed with <i>o</i> -phenanthroline:	potassium citrate solution (80 mL/ group)
0.10 mg Fe/100 mL	<i>o</i> -phenanthroline solution (10 mL/group)
0.20 mg Fe/100 mL	2, 5-mL graduated cylinders
0.40 mg Fe/100 mL	2, 50- mL graduated cylinders
0.60 mg Fe/100 mL	2, 100 mL volumetric flasks
Kimwipes	1, 250-mL beaker
Spec 20	hydroquinone solution
wash bottle	mortar and pestle
deionized water	1 M HCl
cereal	1 watch glass
pH paper	1 short stem funnel
stirring rod	ring stand
hot plate	iron ring
filter paper	cuvettes and cuvette holders

PROCEDURE

Part I: Sample Preparation

(Day 1)

1. Record information about the cereal that you are using on the Data Sheet.
2. Fill a small mortar about 2/3 full with the cereal that you are using.
3. Crush the cereal with the pestle until it is a fine powder.
4. Place a 250 mL beaker on a balance and tare it. The balance should now read 0.000 g.
5. Transfer approximately 1 gram of crushed cereal to the beaker.
6. Record the exact mass of the crushed cereal in the beaker on the Data Sheet.
7. Add 50 mL of 1 M HCl to the beaker and stir with a stirring rod.
8. Cover the beaker with a watch glass and place it under a fume hood.
9. Heat the beaker on hot plate for 30 minutes at a medium-low setting (setting of 4 on the SIM hot plates). **Note:** Do not add a stir bar to the beaker.
10. After 30 minutes, turn off the hot plate and let the beaker cool until you can touch it.

(Day 2)

11. Set up a filtering system using a ring stand, iron ring, short-stem funnel, 50 mL graduated cylinder, and piece of filter paper.
12. Pour the cereal solution into the funnel. If necessary, rinse the beaker with a small amount of deionized water until all of the cereal is rinsed into the funnel. **Note:** If the filtered cereal solution is not clear, it must be filtered again.
13. After all of the liquid has run through the funnel, remove the funnel from the graduated cylinder.
14. Record the total volume of the cereal solution in the graduated cylinder, V_T , on the Data Sheet.
15. Transfer exactly 1/2 of the cereal solution to a clean 100 mL beaker.
16. Measure the pH of the cereal solution in the beaker with pH paper. The pH of the solution will probably be about 1.
17. Add 35 mL of potassium citrate solution to the cereal solution in the beaker and stir.
18. Measure the pH of the cereal solution in the beaker again. The pH of the solution should be between 3 and 4. If necessary, add more potassium citrate, 5 mL at a time, until the pH is in this range. Keep track of how much potassium citrate was added.
19. Record the total volume of potassium citrate added on the Data Sheet.
20. Transfer the solution in the beaker to a 100 mL volumetric flask labeled "Blank".
21. Add 2.00 mL of hydroquinone solution to the "Blank" flask, dilute to the mark with deionized water and mix well. This is the "Blank" solution.
22. Transfer the cereal solution left in the graduated cylinder to a 100 mL volumetric flask labeled "Cereal".
23. Add the following to the "Cereal" flask, in order:
 - a) 35 mL of potassium citrate (or the volume used in step 18)
 - b) 2.00 mL of hydroquinone solution
 - c) 5.00 mL of *o*-phenanthroline solution
24. Dilute the solution in the "Cereal" flask to the mark with deionized water and mix well. If there is iron in this solution it will start to turn orange almost immediately after the *o*-phenanthroline solution is added.
25. Allow the solution to stand for at least 15 minutes before measuring its absorbance at 510 nm with the Spec 20.

Part II: Forming the standard curve

1. Adjust the wavelength of the Spec 20 to 510 nm.
2. Fill a cuvette $\frac{3}{4}$ full with deionized water. This is the blank cuvette.
3. Using a Kimwipe, wipe off the cuvette containing the deionized water and place this cuvette in the sample compartment, with the triangle on the cuvette facing the front of the instrument. Do not touch the clear sides of the cuvette.
4. Press **0 ABS 100%T**.
5. Remove the cuvette from the instrument.
6. Fill a cuvette $\frac{3}{4}$ full with the 0.10 mg/100 mL iron standard.
7. Place this cuvette into the sample compartment of the Spec 20 and close the lid. **Do not press 0 ABS 100%T**. Record the absorbance of this solution in the Data Table.
8. Repeat steps 6 and 7 to obtain absorbance readings for each of the other standard solutions. Record your results in the Data Table.

Part III. Determining the amount of iron in the cereal solution

1. Fill a cuvette about $\frac{3}{4}$ full with the “Blank” solution that you prepared in Part I. Insert this cuvette into the spectrophotometer and press **0 ABS 100%T**.
2. Remove the blank cuvette from the instrument.
3. Fill a cuvette about $\frac{3}{4}$ full with the “Cereal” solution that you prepared in Part I. **Do not press 0 ABS 100%T**.
4. Record the absorbance of the Cereal solution in the Data Table.

DATA SHEET

Name _____

Name _____

Period _____ Class _____

Date _____

DETERMINATION OF IRON IN CEREAL

INFORMATION ABOUT CEREAL

Type and Brand _____

% DV of Iron in one serving _____ %

Mass of one serving _____ g

DATA TABLE

Concentration mg/100 mL	Absorbance
0.10	
0.20	
0.40	
0.60	
Cereal _____	

Mass of cereal sample _____ g

Total volume of cereal solution (V_T) _____ mL

Total volume of potassium citrate added _____ mL

DATA ANALYSIS

1. Make a graph of absorbance (y-axis) vs. iron concentration (x-axis). Draw a line-of-fit.

2. From your graph, determine the concentration of iron in the cereal solution. To do this, locate the absorbance of the cereal solution on the y-axis. The corresponding iron concentration can be found on the x-axis. The concentration of the unknown can also be found using the slope and intercept of the line-of-fit.

3. The 100 mL cereal solution that you prepared in Part I contained only $\frac{1}{2}$ of the iron that was in the original cereal sample. The other $\frac{1}{2}$ was in the blank solution that you prepared. Multiply your result from step 2 by 2 to find the amount of iron in the original cereal sample.

4. Use your result from step 3 and the mass of your cereal sample to determine the amount of iron in one serving of cereal. This is your experimental result.

5. Use the DV for iron and the % DV of Iron for your cereal to determine the theoretical mass of iron in one serving of your cereal.

