

LESSON 10: Iron in Cereal

ESTIMATED TIME Setup: 5 minutes | Procedure: 5–10 minutes



• DESCRIPTION

Use a magnet to remove particles of iron from a mixture containing iron-fortified breakfast cereal.

• OBJECTIVE

This lesson demonstrates the presence of iron in some foods and explains the importance of iron in human diets. Students will use magnets to pull the iron from the cereal mixture. The lesson can be simplified to illustrate the difference between pure substances and mixtures.

• CONTENT TOPICS

Scientific inquiry; properties of matter; elements and compounds; mixtures; attractive forces (magnetism); food chemistry; chemistry in the human body; health; metals

• MATERIALS

- A box of flaky breakfast cereal with a high iron content
- Bowl
- Large spoon
- Strong magnets or magnetic wands
- Ziploc® bags (quart size with easy zipper)



Other types of breakfast cereal with high iron content per serving will also work, but flakes are generally easier to crush.



Always remember to use the appropriate safety equipment when conducting your experiment. Refer to the **Safety First** section in the **Resource Guide** on pages 421–423 for more detailed information about safety in the classroom.



Jump ahead to page 132 to view the Experimental Procedure.

NATIONAL SCIENCE EDUCATION STANDARDS SUBJECT MATTER

This lesson applies both *Dimension 1: Scientific and Engineering Practices* and *Dimension 2: Crosscutting Concepts* from “A Framework for K–12 Science Education,” established as a guide for the updated National Science Education Standards. In addition, this lesson covers the following Disciplinary Core Ideas from that framework:

- PS1.A: Structure and Properties of Matter
- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- LS1.A: Growth and Development of Organisms
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World (see *Analysis & Conclusion*)

OBSERVATION & RESEARCH

BACKGROUND

Iron is a metal element that plays a vital role in the human body. It is needed to transport oxygen throughout the body. Iron is found in all cells and is used in energy metabolism, gene regulation, cell growth, enzyme reactions, protein synthesis, and more. Its most critical role is within hemoglobin. **Hemoglobin** is the protein molecule in red blood cells that picks up oxygen in the lungs and transports

it to different parts of the body. The oxygen is released by the hemoglobin when it is needed for functions in the body, such as converting sugars into energy.

Some people may experience an iron deficiency, which is a lack of iron in the body. When someone has an iron deficiency, he or she will have difficulty processing and transporting oxygen. An iron deficiency can result in a

Fun Fact

Iron is the main component of rust, which forms when iron reacts with moist air.

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Fun Fact

Iron-rich hemoglobin gives blood its red color.

general lack of energy and tiredness because of the lack of oxygen. It can be caused by inadequate amounts of iron in the diet or because of an insufficient amount of healthy red blood cells.

When the body has an insufficient amount of healthy red blood cells, the

condition is called **anemia**. Anemia may be indicated by red blood cells that are smaller in size than normal or by a lower than usual number of red blood cells.

When iron deficiencies are identified, it is important for a person to find out the reason. An iron deficiency may be a signal of illness, such as sickle cell anemia. A diet low in iron-rich foods, such as red meat and green leafy vegetables, is occasionally the cause. While it isn't a very common cause, it can be seen in rapidly growing adolescents who are picky about their diets or in vegetarians who do not make sure they are getting a balanced diet. Likewise, in countries with extreme poverty, lack of iron in the diet is a common cause of iron deficiency.

Many foods contain iron, but not all iron consumed can be easily used by the body. In addition, drinking black tea or coffee at mealtimes decreases iron absorption, while eating foods rich in vitamin C increases the absorption of iron. Foods that are considered to be rich in iron are red meats, egg yolks, leafy dark-green vegetables, and iron-enriched cereals and grains.

The iron found in iron-fortified cereals is pure iron. It is the same iron found in nails and automobiles. Iron is mixed in the cereal batter along with many other vitamins and minerals. The very tiny particles of iron quickly react with hydrochloric acid and other chemicals in the digestive tract, changing the iron into a form that can be absorbed by the body more easily.

A unique property of the element iron is that it is a strongly magnetic metal. **Magnetism** is a force of attraction or repulsion between various substances,

especially those made of iron and is caused by the motion of electric charges. Because iron has magnetic properties, during this experiment, a magnet is used to separate the iron particles from the cereal mixture.

FORMULAS & EQUATIONS

Iron is one of the most abundant metals on the earth, forming about 5.6% of the earth's crust.

The chemical symbol for iron is **Fe**. Its atomic number is 26, and its atomic weight is approximately 55.8 atomic mass units (amu).

The core of the earth is believed to be mostly made up of molten iron.



CONNECT TO THE YOU BE THE CHEMIST CHALLENGE

For additional background information, please review CEF's Challenge study materials online at <http://www.chemed.org/ybtc/challenge/study.aspx>.

- Additional information on mixtures can be found in the Classification of Matter section of CEF's *Passport to Science Exploration: The Core of Chemistry*.
- Additional information on elements, including iron, can be found in the Atomic Structure and Periodic Table sections of CEF's *Passport to Science Exploration: The Core of Chemistry*.
- Additional information on food chemistry and health can be found in the Organic Chemistry and Applications of Chemistry in Everyday Life sections of CEF's *Passport to Science Exploration: Chemistry Concepts in Action*.

HYPOTHESIS

► Iron-fortified cereal contains pure iron, which can be separated from a mixture of the cereal and water.



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DIFFERENTIATION IN THE CLASSROOM

LOWER GRADE LEVELS/BEGINNERS

DESCRIPTION

Use a magnet to remove particles of iron from a mixture containing iron-fortified breakfast cereal.

OBJECTIVE

This lesson demonstrates the ways to classify matter and identify properties of matter. Students use a magnet to remove particles of the element iron from a mixture.

OBSERVATION & RESEARCH

Matter is often classified as either a pure substance or a mixture. All matter is made up of basic elements.

Elements are pure substances that cannot be broken down further by normal chemical means. They are known as the building blocks of matter. Iron is a metal element. A **compound** is a pure substance made up of two or more elements joined in a defined ratio. For example, water is a compound made up of the elements hydrogen and oxygen in a 2:1 ratio. Two hydrogen atoms and one oxygen atom join together, giving water the chemical formula H_2O .

A **mixture** is made of two or more substances that are combined physically. The different parts of a mixture have different properties. The chemical structure of each part of the mixture remains the same when they are combined. Scientists are able to separate mixtures into their original parts through a physical separation process.

Most of the things around you are mixtures. Tossed salad is a mixture because it is made of different parts—lettuce, carrots, and dressing. Salt water is a mixture too. It is made of salt and water. In the experiment, the iron-fortified cereal is a mixture. A new mixture is made when the cereal is combined with water.

In a mixture, the chemical structure of each part of the mixture remains the same. Therefore, scientists are able to separate mixtures into their original parts. Separating a mixture of substances into two or more distinct products is called a **separation process**. A separation process uses the different properties of a mixture's parts to get them to separate. The iron can be separated from the mixture using a magnet.

HIGHER GRADE LEVELS/ADVANCED STUDENTS

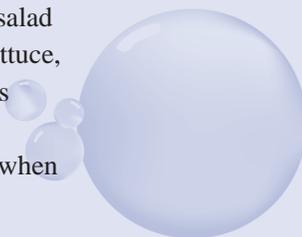
Explore the force of magnetism. Discuss different types of forces and what makes magnetism unique. Conduct a simple activity with different metals to determine which metals exhibit magnetic properties. Iron, cobalt, and nickel are the only elements known to produce a magnetic field. Use this information to determine what elements make up certain substances. Is a nickel made of nickel? What are the components of a penny? What about a paper clip? Have the students conduct research to find out the answers.



CONNECT TO THE *YOU BE THE CHEMIST CHALLENGE*

For additional background information, please review CEF's Challenge study materials online at <http://www.chemed.org/ybtc/challenge/study.aspx>.

- Additional information on elements, compounds, and mixtures can be found in the Classification of Matter section of CEF's *Passport to Science Exploration: The Core of Chemistry*.
- Additional information on magnetism can be found in the Forces of Attraction section of CEF's *Passport to Science Exploration: Chemistry Connections*.



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ANALYSIS & CONCLUSION

Use the questions from the activity sheet or your own questions to discuss the experimental data. Ask students to determine whether they should accept or reject their hypotheses. Review the information in the *Scientific Inquiry* section on pages 14–16 to discuss valid and invalid hypotheses.

ASSESSMENT/GOALS

Upon completion of this lesson, students should be able to ...

- Apply a scientific inquiry process and perform an experiment.
- Explain how the human body uses iron.
- Understand that iron is found in most foods and is vital to a human's diet.
- Describe the causes and effects of iron deficiencies.
- Distinguish between pure substances and mixtures (see *Differentiation in the Classroom*).
- Understand the magnetic properties of some substances (see *Differentiation in the Classroom*).

MODIFICATIONS/EXTENSIONS

Modifications and extensions provide alternative methods for performing the lesson or similar lessons. They also introduce ways to expand on the content topics presented and think beyond those topics. Use the following examples, or have a discussion to generate other ideas as a class.

- Before the start of the activity, tell the students that they probably eat iron every day. Then present an iron (steel) object, such as a nail, and ask if anyone would eat it. Ask them if they know how the iron gets into their bodies and if it is the same iron that is found in the nail.
- If you do not wish to perform the experiment using Ziploc® bags or if you want to do one group demonstration, use a large bowl to collect the iron. Fill the bowl halfway with cereal, and crush the

cereal as much as possible. Add water, and stir to make a soupy mixture. Attach the magnet to the end of a ruler or rod (or use a magnetic wand). Dip the magnet into the mixture, and move it slowly back and forth. Then, pull the magnet out of the mixture and observe. If necessary, dip the magnet in water to carefully rinse away the cereal, and then observe the iron particles left behind.



It may be helpful to use a colored magnet, so the iron particles can be seen more easily.

REAL-WORLD APPLICATIONS

- Restrictive vegetarian or vegan diets can be associated with iron-deficiency anemia. Therefore, people on such diets should make sure they are getting the proper nutrients. Including iron-fortified cereals or iron supplements in their diets may help to make sure they are getting the necessary amount of iron. In addition, eating foods high in vitamin C, such as oranges, strawberries, and broccoli, helps the body to absorb iron.
- Too much iron in the blood can be toxic to humans. The body normally absorbs less iron if it has enough, but some individuals have lower defenses against excess iron. Iron overload is usually caused by a gene that enhances iron absorption.

COMMUNICATION

Discuss the results as a class and review the activity sheet. Review the information in the *Scientific Inquiry* section on pages 14–16 to discuss the importance of communication to scientific progress.



LESSON 10 ACTIVITY SHEET: Iron in Cereal

OBSERVE & RESEARCH

1. Write down the materials you observe. _____

2. Predict how these materials may be used. _____

3. Define the following key terms. Then, provide an example of each by writing the example or drawing/pasting an image of the example.

Term	Definition	Example (write or add image)
Hemoglobin		
Anemia		
Mixture		

4. Consider how iron can be separated by its magnetic properties from iron-fortified cereal.

► Write your hypothesis. _____



LESSON 10 ACTIVITY SHEET: Iron in Cereal

PERFORM YOUR EXPERIMENT

1. In a bowl, crush one to two servings of cereal using your hands or a large spoon.



Do not crush the dry cereal inside the Ziploc® bag because the cereal will puncture the bag.

2. Place the crushed cereal into a quart-sized Ziploc® bag. Then, fill the bag with water to about an inch below the seal. Seal the bag.
3. Let the cereal dissolve and soften a bit. Gently shake the contents of the bag for a few minutes.
4. Hold the magnet in the palm of your hand, and place the bag on top of the magnet. Keeping the bag flat (horizontal) in your hand, gently move the bag around to swirl the contents of the bag for 15–30 seconds.
5. Keeping the magnet touching the bag, carefully turn the bag and the magnet over so that the magnet is now on top of the bag. Squeeze the bag slightly so the magnet is lifted above the cereal mixture to see what it has collected.
6. Be sure the magnet is still touching the bag. Look closely at the magnet and on the inside of the bag.

ANALYZE & CONCLUDE

1. Describe the dry cereal. _____

2. Describe the cereal and water mixture. _____

3. Do you see anything collecting on the magnet? If so, what do you think it is? _____

4. Is your hypothesis valid? Why or why not? If not, what would be your next steps? _____

LESSON 10 ACTIVITY SHEET: Iron in Cereal

SHARE YOUR KNOWLEDGE

1. Define the following key terms. Then, provide an example of each by writing the example or drawing/pasting an image of the example.

Term	Definition	Example (write or add image)
Element		
Compound		
Separation process		

2. Why is iron important in our diets? What is its function in the body? _____

3. What are other sources of iron that can be added to our diets? _____

4. List other separation processes and why they are used. _____

LESSON 10 ACTIVITY SHEET: Iron in Cereal

ANSWER KEY: Below are suggested answers. Other answers may also be acceptable.

OBSERVE & RESEARCH

1. Write down the materials you observe. Flaky breakfast cereal with high iron content, water, magnets ...

2. Predict how these materials may be used. The cereal may be eaten for breakfast. Water may be used to drink, clean, or bathe.

A magnet may be used to attract an object made from iron. These materials may be used together to investigate the composition of a cereal.

3. Define the following key terms. Then, provide an example of each by writing the example or drawing/pasting an image of the example.

Term	Definition	Example (write or add image)
Hemoglobin	A protein found in red blood cells that contains iron and transports oxygen from the lungs to different parts of the body.	
Anemia	A condition in which the red blood cell count or the hemoglobin in red blood cells is abnormally low.	
Mixture	A physical combination of two or more substances that can be physically separated.	

4. Consider how iron can be separated by its magnetic properties from iron-fortified cereal and why.

► Write your hypothesis. A magnet held to a sealed bag filled with a mixture of water and iron-fortified cereal will attract tiny iron particles from the mixture.



LESSON 10 ACTIVITY SHEET: Iron in Cereal

ANSWER KEY: Below are suggested answers. Other answers may also be acceptable.

PERFORM YOUR EXPERIMENT

1. In a bowl, crush one to two servings of cereal using your hands or a large spoon.



Do not crush the dry cereal inside the Ziploc® bag because the cereal will puncture the bag.

2. Place the crushed cereal into a quart-sized Ziploc® bag. Then, fill the bag with water to about an inch below the seal. Seal the bag.
3. Let the cereal dissolve and soften a bit. Gently shake the contents of the bag for a few minutes.
4. Hold the magnet in the palm of your hand, and place the bag on top of the magnet. Keeping the bag flat (horizontal) in your hand, gently move the bag around to swirl the contents of the bag for 15–30 seconds.
5. Keeping the magnet touching the bag, carefully turn the bag and the magnet over so that the magnet is now on top of the bag. Squeeze the bag slightly so the magnet is lifted above the cereal mixture to see what it has collected.
6. Be sure the magnet is still touching the bag. Look closely at the magnet and on the inside of the bag.

ANALYZE & CONCLUDE

1. Describe the dry cereal. The cereal is brown, dry, and flaky. The pieces look about the same, but each piece has a slightly different size and shape. The cereal would be crunchy if eaten.
2. Describe the cereal and water mixture. The cereal and water mixture is wet and brown. You cannot see through the mixture. If the mixture was eaten, it would be mushy.
3. Do you see anything collecting on the magnet? If so, what do you think it is? Tiny gray/black particles are visible on the magnet. These particles are tiny pieces of iron, which are being drawn from the mixture by the magnet. The iron particles move as the magnet is moved around the bag.
4. Is your hypothesis valid? Why or why not? If not, what would be your next steps? Answer 1: Valid because the data support my hypothesis.
Answer 2: Invalid because the data do not support my hypothesis. I would reject my hypothesis and could form a new one, such as ...

LESSON 10 ACTIVITY SHEET: Iron in Cereal

ANSWER KEY: Below are suggested answers. Other answers may also be acceptable.

SHARE YOUR KNOWLEDGE—BEGINNERS

Have students complete this section if you used the beginners' differentiation information, or challenge them to find the answers to these questions at home and discuss how these terms relate to the experiment in class the next day.

1. Define the following key terms. Then, provide an example of each by writing the example or drawing/pasting an image of the example.

Term	Definition	Example (write or add image)
Element	A pure substance that cannot be broken down into simpler substances by ordinary chemical or physical means; an element is made up of only one type of atom.	
Compound	A pure substance made up of two or more elements joined in a defined ratio.	
Separation process	A process that divides a mixture into two or more distinct substances.	

2. Why is iron important in our diets? What is its function in the body? Iron is vital to the transportation of oxygen throughout the human body. Iron is found in every cell, but its most critical role is within the protein called hemoglobin that is carried by red blood cells.

3. What are other sources of iron that can be added to our diets? Foods high in iron content include red meat, egg yolks, mollusks, turkey, and artichokes.

4. List other separation processes and why they are used. Distillation and filtration are processes that can be used to separate solid particles from liquids, such as removing salt from sea water.