

Iron in Cereal

Section THE CHEMISTRY OF LIFE & EARTH SCIENCES

Estimated Time ⌚ Setup: 5 minutes; Procedure: 5-10 minutes

OVERVIEW

Separate iron from iron-enriched foods using a magnet!

In this activity, students learn about an essential part of our diet: iron. Through a simple separation process, they extract iron from cereal using a magnet. They can learn about the properties of metals and why some metals are intentionally added to foods to help us live healthier lives.

INQUIRY QUESTIONS

Getting Started:

🔍 What things are added to our foods to make us healthier?

Learning More:

🔍 What is the role of iron in our diets and where can we find iron-rich foods?

Diving Deeper:

🔍 What body processes use iron and how?

CONTENT TOPICS

This activity covers the following content topics: properties of matter, elements, compounds, mixtures, forces, magnetism, food chemistry, chemistry of the human body, health, properties of metals

This activity can be extended to discuss: anemia, sickle cell disease, circulatory system, nutrition, periodic table of elements, hemoglobin

NGSS CONNECTIONS

This activity can be used to achieve the following Performance Expectations of the Next Generation Science Standards:

- 💡 K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.
- 💡 5-PS1-3. Make observations and measurements to identify materials based on their properties.
- 💡 MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

MATERIALS

For one setup:

- ✔ Breakfast cereal with high iron content
- ✔ Bowl
- ✔ Large spoon
- ✔ Strong magnet or magnetic wand
- ✔ Plastic bag with zipper (quart size or larger)
- ✔ Water

ACTIVITY NOTES

This activity is good for:

- ✔ Pairs
- ✔ Small groups
- ✔ Large groups
- ✔ Demonstrations

Safety Tips & Reminders:





- ⚠ Review the Safety First section in the Resource Guide for additional information

Fun Fact #1

Iron-rich hemoglobin gives blood its red color. But not all animals have red blood! Octopuses have blue blood from copper-rich hemocyanin – which is their version of hemoglobin. Some fish have clear blood, and skinks (a type of lizard) have green blood!

ENGAGE

Use the following ideas to engage your students in learning about the chemistry of life and Earth sciences::

-  Provide examples of several foods that are “enriched with iron” or something similar. Ask students if they know what this means, and why we might want extra iron in our food. Can they name anything else that iron is used for? Is it safe to eat? What do they know about this topic already?
-  Cut out nutrition labels and lead a discussion about the items on the labels that students might not be familiar with. How many of the things listed on the nutrition label can they find on the periodic table?
-  Start with a deep dive into iron: what do students know about iron already? Where is iron found on the periodic table? What is it used for? How much iron is recommended in our diets each day? Do they know the foods that contain iron?
-  Explore a case study about a student who is feeling tired and has low energy. Provide students with some clues to figure out what might be wrong with the student. They can examine the student’s diet, behavior, exercise routines, home life, etc. and try to pinpoint what might be wrong. They should be able to narrow it down to anemia, which is due to low iron in the diet. You can then explore this activity to learn about foods that are enriched with iron, and foods that naturally have iron.

See the Elaborate section of this activity for more ideas to engage your students.

EXPLORE

Procedure:

1. In a bowl, crush 2 cups of cereal using your hands or a large spoon.
2. Pour the crushed cereal into a plastic bag.
3. Fill the plastic bag with water to about 1 inch below the seal, then seal the bag.
4. Wait a few minutes for the cereal to soften.
5. Gently shake the bag for a few minutes.
6. Hold the magnet in the palm of your hand and place the bag horizontally on top. (Or, work in pairs and have one person hold the magnet while the other places the bag on top.)
7. Gently swirl the bag for 30 seconds with the magnet still underneath it.
8. With the magnet still pressed to the bag, gently turn the bag over so the magnet is now on top.
9. Look closely and record your observations.

DATA COLLECTION & ANALYSIS

Analyze and discuss the results of this activity using the following questions:

- Look closely at the cereal at the start of the experiment. What physical properties do you notice? Can you see the iron?
- Based on the nutrition label, how much iron would you expect to find in a serving of cereal? Make an estimate of how much you will find in this experiment.
- Carefully remove the iron from the bag using the magnet. Weigh the iron and record your results. Compare these results to the amount of iron in each serving of cereal.
- At the end of the activity, describe what you see. Draw a picture of the iron. What physical properties do you notice?

EXPLAIN

What's happening in this Activity?

First review the Chemistry of Life & Earth Sciences Background section to gain a deeper understanding of the scientific principles behind this activity.

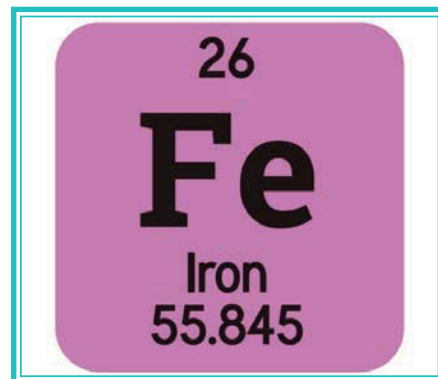
Humans need a variety of vitamins, minerals, and elements in our diet to stay healthy. One such essential piece of our diet is iron. Iron, Fe, is element 26 on the periodic table of elements:

An **element** is a pure substance that cannot be broken down any further. Elements are the building blocks for all the matter in our world. Over half of the elements, includes iron, are metals. **Metals** are grouped together because they have many properties in common, like those below. **Non-metal** elements also have a specific set of properties, as shown in the table below:

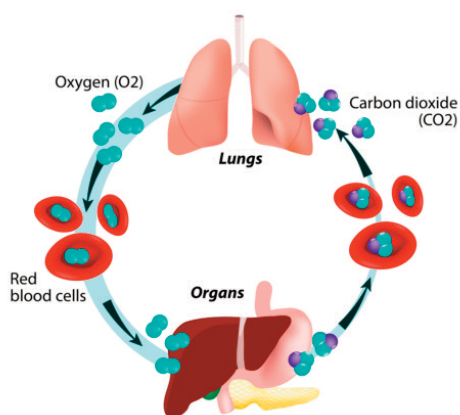
Metals	Non-Metals
Shiny	Not shiny
Good conductor of heat	Poor conductor of heat
Good conductor of electricity	Poor conductor of electricity
Malleable	Not malleable
Ductile	Not ductile

Iron is also one of the most abundant metals on Earth. About 5.6% of the earth's crust is made of iron, and the core of the earth is molten (liquid) iron. We use iron to make magnets, pots, pans, steel, and for many engineering and manufacturing processes.

Humans also need iron in our daily diet, and the average human naturally contains around four grams of iron! Iron is used by the protein **hemoglobin**, which is in our red blood cells. Hemoglobin transports oxygen (O_2) around the body, first picking it up from the air we breathe into our lungs, and then transporting it to the tissues and organs around the body. Hemoglobin picks carbon dioxide (CO_2) up in the body, then returns it to the lungs where we exhale it out as waste.



GAS EXCHANGE IN HUMANS



Iron is also needed for a variety of other body processes, including enzyme reactions, protein synthesis, and more. Humans need around 10-18 milligrams of iron each day. Without enough iron in the body, we cannot effectively transport oxygen and maintain dozens of other essential body functions. Many foods naturally contain iron, such as dark leafy greens, egg yolks, and red meat. Some foods have iron added in, such as certain cereals and grains. Eating vitamin C along with iron-rich foods helps the body to absorb as much iron as possible.

EXPLAIN continued

Since iron-enriched foods are **mixtures**, the parts of the mixture can be separated using their different properties. The pure iron in cereal is magnetic, meaning it is attracted to magnets. **Magnetism** is a force that can either pull objects together or push them apart, even if the objects aren't touching. Only some metals are magnetic, including iron, nickel, and cobalt. Since the iron is magnetic, but the other parts of the cereal are not, we can remove the iron using its attraction to another magnet. To learn more about magnetism, check out the Forces & Interactions Activity Guide section.

Differentiation for Younger or More Advanced Students

You can differentiate this activity for students of different grade levels by focusing on the concepts outlined below.

GETTING STARTED	DIVING DEEPER
<p>For younger students, emphasize the following concepts:</p> <ul style="list-style-type: none">• Humans need a variety of elements, vitamins, and minerals in our food to stay healthy.• Iron can be found in many foods naturally and is added to some cereals and grains.• Iron is an element and a metal.	<p>For more advanced students, emphasize the following concepts:</p> <ul style="list-style-type: none">• Iron is needed to help transport oxygen around the body.• Iron is an essential part of hemoglobin, which is the protein that carries oxygen and carbon dioxide in red blood cells.• Iron can be separated from foods it is added into through magnetism.

Notes

This image shows a single page from a notebook or ledger. It features ten evenly spaced horizontal blue lines across its entire width. The lines are thin and light blue, set against a plain white background. There are no margins, text, or other markings present on the page.

ELABORATE

Elaborate on your students' new ideas and encourage them to apply them to different situations. The section below provides some alternative methods, modifications, and extensions for this activity.

- Having trouble getting results? Try using a stronger magnet, crush the cereal into finer pieces using a blender first, or find a cereal that has 100% the daily recommended serving of iron per cup!
- This experiment can also be done without a bag. Instead, crush the cereal and add water to a large bowl. Attach the magnet to the end of a ruler, rod, or use a magnetic wand. Dip the magnet into the mixture and move it slowly back and forth. Then remove the magnet, gently dip it into a cup or bowl of clean water to wash away any cereal pieces, then observe.
- If there is iron in cereal, is the cereal itself magnetic? Try passing a magnet over the cereal before crushing it. Does this work? Why or why not? (Hint: think of how small the pieces of iron are and how big and heavy the flakes are!)
- Which cereal has the most iron? Test a variety of cereals or grains – or any other foods that claim to be enriched with iron. Which sample has the most iron? Are your results reflected in the nutritional label? Be sure to control for as many variables as possible, such as using the same amount of cereal and water.
- Weigh your results to determine exactly how much iron you extracted! Or, before the experiment have each student make an estimate as to the amount of iron they will be able to extract per serving size based on the nutrition label.
- If you have access to a blender, try using that to break up the cereal. With finer cereal particles you might be able to extract more iron from.

CHEMISTRY IN ACTION

Share the following real-world connections with your students to demonstrate how chemistry is all around us.

Real-World Applications

Many iron-rich foods are meats or animal products, so people on vegetarian or vegan diets need to make sure they get enough iron from other sources, such as other iron-rich foods or by taking supplement iron and vitamin C, which helps the body absorb iron. Without enough iron in the body, a person can't carry oxygen to parts of the body that need it, making them excessively tired and short of breath. This is called anemia. Luckily this condition can be easily avoided by eating iron-rich foods or taking supplemental iron and vitamin C.

The iron added to our food is different from the iron found in things like nails. The iron in your breakfast cereal is food-grade iron, which is a form of iron that can be readily absorbed by the body and is safe for consumption.

Iron metal is formed inside the core of stars in space. When a star creates iron, it uses so much energy that the star begins to implode. When the star eventually collapses and explodes, iron is scattered into space and eventually forms meteorites that fall down to planets like Earth.



Careers in Chemistry

- Pharmacists are tasked with developing dietary supplements for important things like iron. They must make sure supplements can be easily administered, are at proper dosages, and can be easily absorbed by the body without any negative side effects.
- Nutritionists make recommendations based on data and experiments about how much iron people need to consume. These recommendations depend on someone's age, sex, lifestyle, diet, and many other factors. Nutritionists also need to be the experts on which foods contain which nutrients so they can advise their patients .
- Part of a food chemist's job is make their products healthier, such as by adding in substances like iron that are necessary for a healthy diet.



EVALUATE

- Ask students to make a list of things they notice are added to their food to keep them healthy. They can look at food packaging at home, in the local grocery store, or online. Are there common items they notice added to certain products? If they don't know what each of these items does or what they look like, create a research project so they can learn more and share their findings with their peers.
- Task students with determining how much cereal they would have to eat each day to get the daily recommended amount of iron. First have them look up the recommendations, then using the nutrition label or the results from their experiment, how much cereal would they have to eat to satisfy that requirement? They should show their thinking and calculations.
- Where else is iron found in our world – especially in our food? Ask students to bring in samples of different foods they think might be enriched with iron and try the experiment again in groups. They can record their results as a class and see what patterns they observe.
- Have students research other nutrients commonly added to food and present their results to their peers, including how much of the nutrient humans need each day, in what food products it can be found naturally or as an additive, and what happens if we do not get enough (or too much!) of this nutrient. See if students can think of ways to separate different kinds of nutrients from food using physical properties.