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Celebrating Chemistry

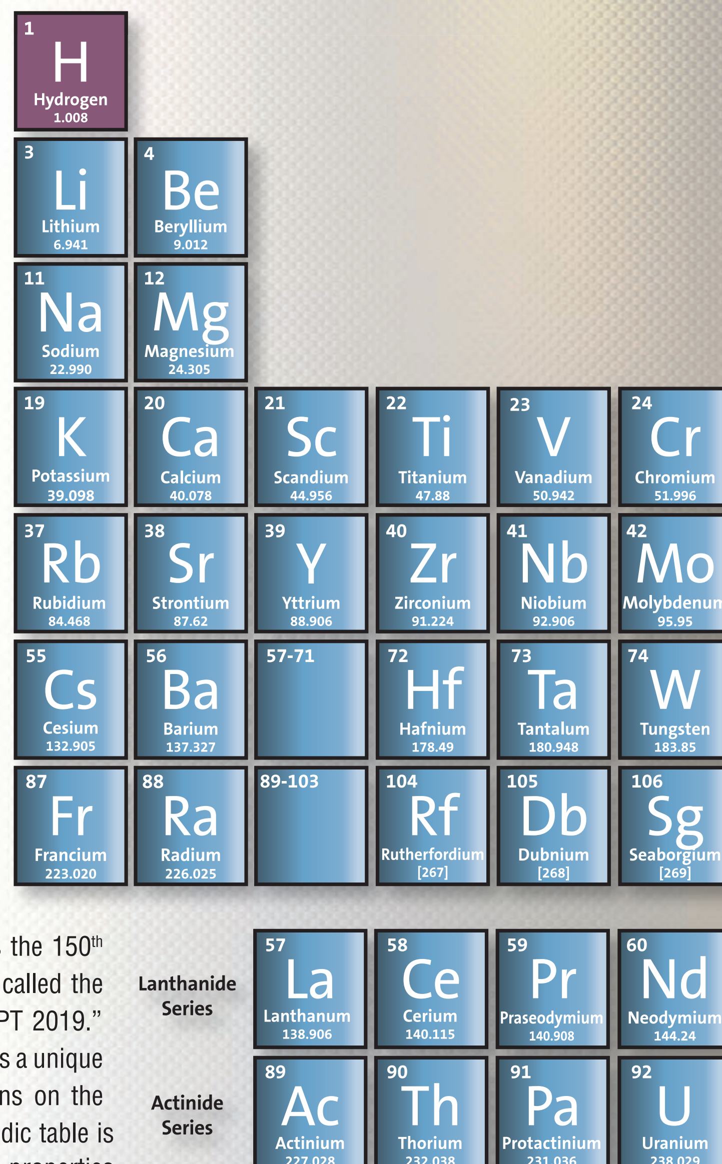
NATIONAL CHEMISTRY WEEK AMERICAN CHEMICAL SOCIETY

MARVELOUS METALS

NATIONAL CHEMISTRY WEEK

MARVELOUS METALS

By Verrill M. Norwood, III



Our eyes are naturally drawn to things that sparkle or shine. You can probably look around the room where you are reading this issue of *Celebrating Chemistry* right now and see some shiny objects. It's likely that these shiny objects are made from metals. What exactly is a **metal**? Metals are chemical **elements** or mixtures of elements that are good **conductors** of electricity and heat. A chemical element is a pure substance that can't be broken down or divided into any simpler form.

Precious metals such as gold, silver, and copper were some of the first elements identified by humans. This is because they are some of the few elements we can find in nature in their pure forms that have not combined with any other elements. Most of the other elements are very reactive and tend to combine with other elements to make compounds. The precious metals are different. They are so unreactive it's possible to find pieces of them just buried in the ground, like when miners find nuggets of pure gold.

Scientists have been studying the elements for hundreds of years. In fact, the modern **periodic table** is just a way to organize the elements and describe how they are related to each other. It is based on the work of a chemist named Dmitri Mendeleev. This year is the 150th anniversary of Mendeleev's periodic table! The yearlong celebration is called the "International Year of the Periodic Table of Chemical Elements" or "IYPT 2019." There are over 100 known elements in the periodic table, and each one has a unique name. Elements that are right above and below each other in columns on the periodic table are called families, and have similar properties. The periodic table is made up of **metals**, **nonmetals**, and **metalloids** (elements which have properties in between metals and nonmetals).

Did you know that 76% of the elements in the periodic table are metals? A periodic table gives the symbols for metals that are pure elements. Pure elements are made out of only one type of atom. Metals include many elements that you are probably already familiar with, like **iron** (Fe), **gold** (Au), **silver** (Ag), and **platinum** (Pt). Other metallic elements like **sodium** (Na) and **potassium** (K) are very reactive. There are different varieties of metallic elements in the periodic table, including alkali metals, alkaline earth metals, and transition metals, just to name a few.

Periodic Table of the Elements

Atomic Number
Symbol
Name
Atomic Mass

- Metal
- Nonmetal
- Metalloid

											2 He Helium 4.003
						5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
						13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.80
43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
107 Bh Bohrium [270]	108 Hs Hassium [277]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [282]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [290]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Metals can do awesome things! We hope that you'll enjoy reading the articles, doing the hands-on chemistry activities, and learning more about "Marvelous Metals!" We also hope that you and your parents will participate in National Chemistry Week from October 20-26, 2019.

Additional articles and activities are available online on the Educational Resources page at www.acs.org/ncw.

***Verrill M. Norwood, III, Ph.D.**, is an Associate Professor of Chemistry at Cleveland State Community College in Cleveland, Tennessee.*

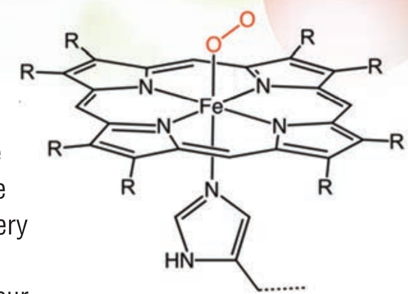
Metals and Health:
Requirements and Risks

By Regina Malczewski

We all know about solid metals that are shiny and bendable and that conduct electricity, but it turns out that small amounts of dissolved forms of metals also exist inside our bodies. They are very important to us! Like other chemicals, they interact with living things in many ways. Certain metals are important for good health, but other metals can be dangerous when they are present in the body.

The metals most commonly linked with human health are **iron** (Fe), **copper** (Cu), **zinc** (Zn), and **cobalt** (Co). These metals are an important part of enzymes, which are enormous molecules in the body that control the speed of chemical reactions. Enzymes do many things, including producing energy, healing wounds, and controlling infections.

Vitamins often contain metals, and they help enzymes to do their work. In fact, cobalt is at the core of vitamin B12. Copper is found in the active site of many enzymes, and is very important in the production of energy. Blood cells use zinc to protect us from viruses and bacteria. And speaking of blood, it wouldn't be red without the iron that is present in a subunit called a heme that is part of a huge molecule called hemoglobin. Hemoglobin is found in our red blood cells, where the iron binds to oxygen and carries it throughout the body. Hemoglobin is like a delivery truck bringing oxygen where it needs to go.



This is model of a heme. Can you find the iron (Fe) at the center? Iron is special because it can grab and let go of oxygen.

While small amounts of metals are important for good health, problems can occur if there is too much of a certain metal, or even certain forms of a metal. Metals like **chromium** (Cr), **nickel** (Ni) and **lead** (Pb) can be very hazardous. The effects depend on the metal, the form, the amount, and how it gets into the body. For example, lead can be present in drinking water, which leads to lead poisoning. This was a real problem recently in Flint, Michigan, where they had to clean the lead out of the water before people could drink it. Lead is especially harmful to young children, and can slow their brain development.

Chromium, meanwhile, helps control blood sugar and cholesterol, and has a role in treating some mental disorders. However, one form of chromium causes lung cancer and liver problems. Nickel is a metal that helps us to absorb iron if it is present in small amounts in the body. However, skin contact with nickel in jewelry, coins, and phones can cause skin rashes, swelling, blisters, allergies, and long-term health problems.

Metals are crucial to good health. In fact, a good diet includes vitamins and minerals, which are nutrients that include metals. Metals are also important in the health of other animals and also in all kinds of plants — they truly ARE marvelous!

Elements spotted

Regina Malczewski, Ph.D. *is a Midland section ACS officer and Outreach Chair in Midland, MI.*

Milli's Safety Tips Safety First!

ALWAYS:
- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Use all materials carefully, following the directions given.
- Follow safety warnings or precautions, such as wearing gloves or tying back long hair.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well after every activity.

NEVER eat or drink while conducting an experiment, and be careful to keep all of the materials away from your mouth, nose, and eyes!

NEVER experiment on your own!

Hunting for Metals

By Avrom Litin and David S. Heroux

Introduction

Everyone loves to go on a scavenger hunt! Did you know you can hunt for metals in your kitchen? Every packaged food is required by law to include a food label, where nutritional and calorie information are listed. Food labels also list all ingredients in that food, and that is where we can find out if there are any metals in that food. Substances containing metals can contribute to a healthy diet. Even vitamin B12 contains the metal **cobalt** (Co).

Check the picture of a food label below to see where you can hunt for the metals listed on a food package. We have also included a table below listing some common ingredients that contain metals. Let's see how many metals you can find, and if you can match them to their symbol on the periodic table!

Common metal-containing ingredients in foods

Name of food	Name of ingredient	Metal	Element Symbol
Iodized salt, salty snacks	Sodium chloride	Sodium	Na
Snacks	Ferrous sulfate or reduced Iron	Iron	Fe
Many foods	Calcium chloride	Calcium	Ca
Potatoes	Potassium	Potassium	K
Baked goods	Sodium bicarbonate (baking soda)	Sodium	Na

Nutrition Facts

Serving Size 5 oz. (144g)
Servings Per Container 4

Amount Per Serving

Calories 310 **Calories** from Fat 100

	% Daily Value*
Total Fat 15g	**21%**
Saturated Fat 2.6g	**17%**
Trans Fat 1g	
Cholesterol 118mg	**39%**
Sodium 560mg	**28%**
Total Carbohydrate 12g	**4%**
Dietary Fiber 1g	**4%**
Sugars 1g	
Protein 24g	

Vitamin A 1% • **Vitamin C** 2%

Calcium 2% • **Iron** 5%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

		Calories	2,000	2,500
Total Fat		Less Than	65g	80g
Saturated Fat		Less Than	20g	25g
Cholesterol		Less Than	300mg	300mg
Sodium		Less Than	2,400mg	2,400mg
Total Carbohydrate			300g	375g
Dietary Fiber			25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Materials

- Periodic table of elements (see pages 2-3)
- Data table (see below)
- Packages of food from your kitchen

Procedures

Gather some packaged foods from your kitchen; we recommend vitamin supplements, cereals, packaged snacks, and canned foods. Find both the nutritional label and the ingredient list on the packaging. See if you can find any of the metals from the periodic table on the list. Sometimes the metal will be listed as a compound, which is a substance where the metal is bound to other elements. Sometimes the label will just say "minerals," which also contain metals. Fill out the data table below, including the symbols for each metal from the periodic table.

What metals did you find?

Food name	Name of the ingredient containing a metal	Element symbol of the metal (from the periodic table)

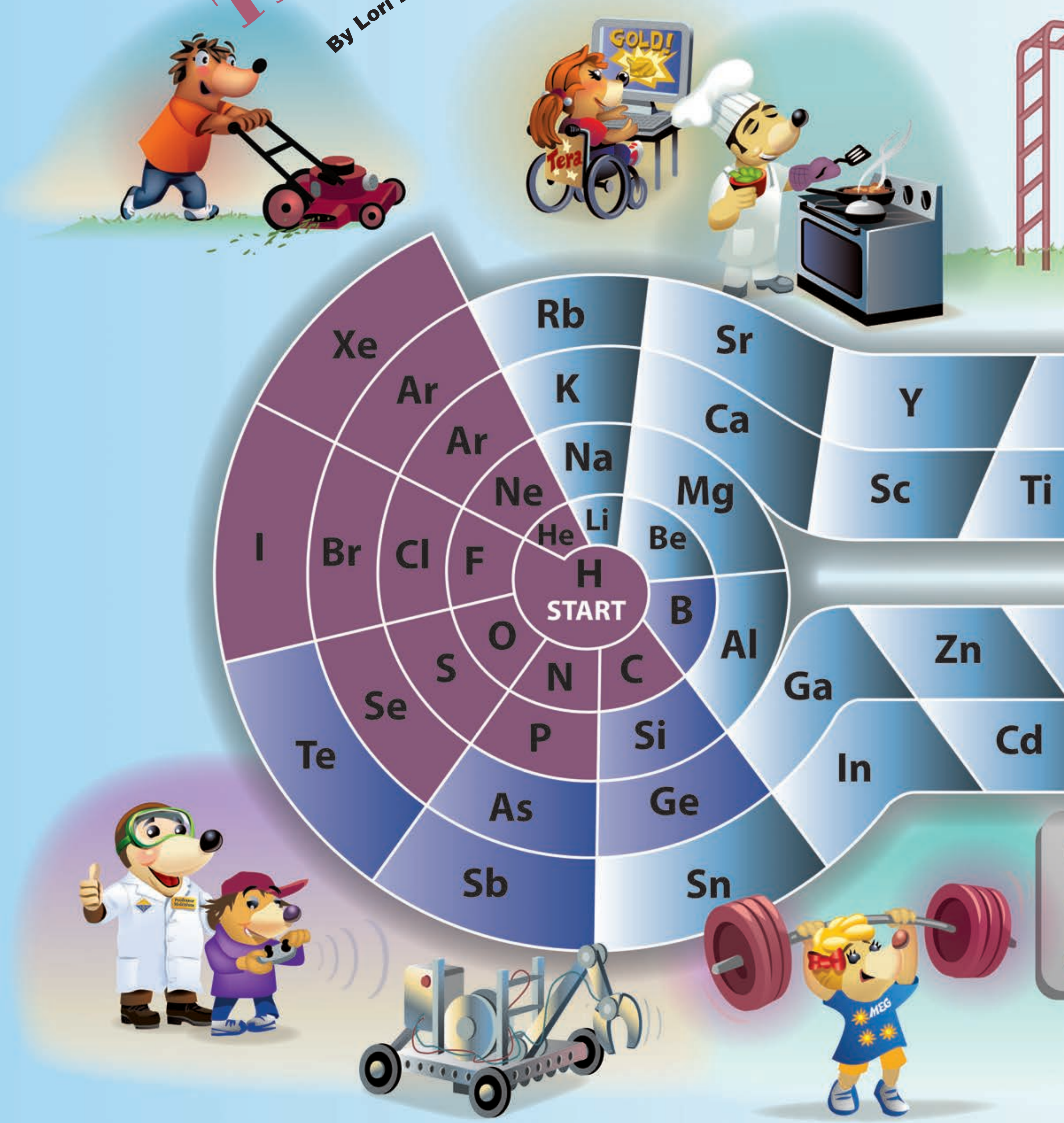
***Avrom Litin** is a Research Scientist at Oil-Dri Corporation of America in Vernon Hills, Illinois.*
***David S. Heroux, Ph.D.** is Associate Professor of Chemistry at Saint Michael's College in Vermont.*

How does it work? / Where's the chemistry?

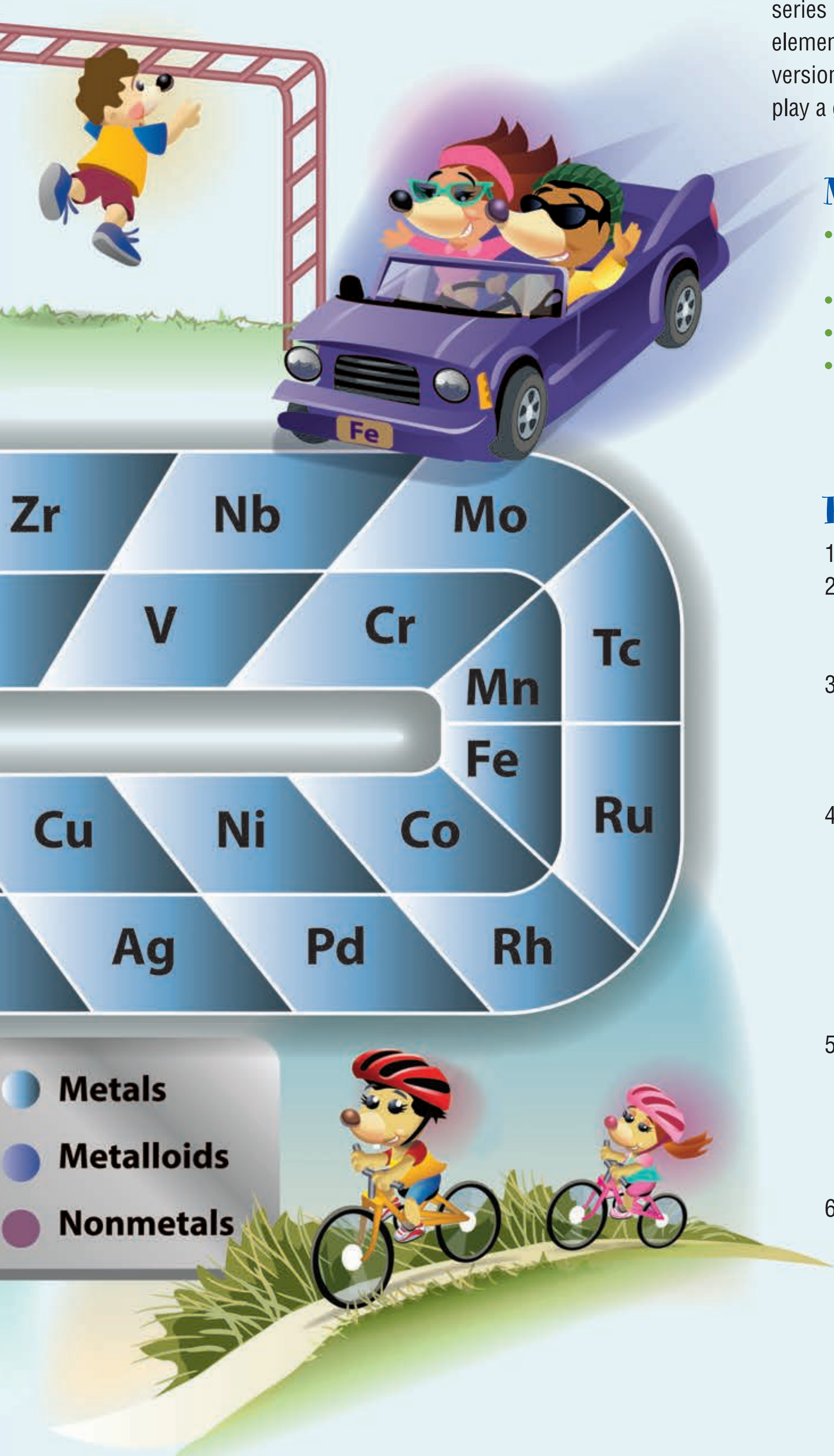
All matter is made up of elements on the periodic table, including foods. Many ingredients in foods contain common elements like carbon, oxygen, and hydrogen, but some ingredients contain metallic elements like iron, sodium, and zinc. These elements are found in smaller amounts in foods, but your body needs them just the same for good health. There is another story in this issue of *Celebrating Chemistry* that tells you about metals and health. Be sure to read it!

The Spiral Periodic Table

By Lori R. Stepan



Game!



Did you know that scientists have arranged the periodic table in many ways? A table of elements can be arranged in a rectangle, a ring, a tower, a series of diamonds, a spiral, or other shapes, with similar elements appearing near each other. We have used a simple version of Theodore Benfey's spiral table so that you can play a game naming the first 54 elements.

Materials

- Center spread gameboard from this issue of *Celebrating Chemistry*
- A different coin for each player
- 1 die to roll
- A common rectangular periodic table as reference when checking for correctness (see pages 2-3)

Procedure

1. Each player chooses a coin marker.
2. Everyone starts on H (hydrogen). The person with the birthday closest to January 1st goes first. Play rotates clockwise.
3. The first player rolls one die, moves forward that number of spaces, and tries to name the element they land on by matching the symbol to the name on the periodic table.
4. The player must say the name of the element out loud. If they correctly name the element on their first try, they move ahead 4 spaces. All other players must agree that they are correct. If another player can prove that they are wrong by checking the reference periodic table, the first player must go back one space.
5. The player also must say whether the element is a metal or not. If they are correct, they go ahead one more space. All other players must agree that they are correct. If another player can prove that they are wrong, the first player stays where they are.
6. The winner is the first person to reach Xe and correctly name it. If they roll a number to go past Xe, they stay on Xe.

Lori R. Stepan, Ph.D. *is an Associate Teaching Professor of Chemistry at Penn State University in State College, PA.*

A Pocket Full of Metal

By David S. Heroux

Put a handful of change in your pocket, and I bet you can identify the coins just by feeling them. If you can, it is because of the properties of the coins and the metals from which they were made. The easiest way to tell the difference is that they are different sizes.

Many years ago, the dollar, half dollar, quarter, dime, and half dime were all made with the metal called **silver** (Ag). Have you ever heard of a half dime before? These coins were different sizes because the more valuable coins had to be made from more of the valuable silver. Silver coins also had rough edges in the beginning to prevent people from stealing some of the silver by shaving bits off the edge. Today the rough edges help visually impaired people identify coins. While all coins used to be made of precious metals such as gold, silver, or copper, now almost all coins are made of less expensive metals.

Over the years, coins and the metals in them changed. In 1866 the silver half dime was replaced with a new five-cent piece made from a cheaper metal mixture of **copper** (Cu) and **nickel** (Ni). The nickel that we have now was named after the metal that it is made from! Since the coin was not made of silver, it could be larger and didn't need rough edges.

The penny has also undergone many changes in its history. It was first made from copper, which is a metal less valuable than silver. Two hundred years ago, the penny was four times heavier than a modern penny and was almost the size of a half dollar.

Over the next 50 years, the penny continued to shrink until it became the size it is today. In 1982 the penny was switched from nearly pure copper to copper-coated zinc. The **zinc** (Zn) is hidden from sight by a copper coating that is thinner than a piece of paper. Think of the zinc like the ice cream in a Klondike® bar: you can't see it because it is covered on all sides with chocolate. If you get a new penny and have an adult help you scratch the side of the penny, you will be able to see the shiny gray zinc inside. If you scratch a penny made before 1982 you will only see shiny copper metal — there is no zinc.

Now, examine the side of a quarter. What do you see? The reddish line in the quarter is actually the copper center of the quarter, with a zinc-copper mixture on the outside. When you look at the edge, you can see the copper-colored middle of the sandwich, just like you can see the filling in a sandwich you eat. Today coins in the United States are mostly made of a mixture of 75% copper and 25% nickel. Small amounts of **manganese** (Mn) are used in modern gold-colored dollar coins, and other countries around the world use **aluminum** (Al) and other metals.

Ag
Silver

Cu
Copper

Ni
Nickel

Zn
Zinc

Mn
Manganese

Al
Aluminum

Elements spotted

David S. Heroux, Ph.D. *is Associate Professor of Chemistry at Saint Michael's College in Vermont.*

Let's Do Chemistry with a Penny!

By Alexsa Silva

Introduction

We can do a lot of cool experiments with pennies. Pennies are copper-plated zinc coins, with about 2.5% of **copper** (Cu) per coin. It is the copper that gives the reddish color to the penny. In this activity, we will observe what happens to the copper when we expose the penny to common household solutions of vinegar, salt, and water.

Materials

- 3 pennies
  (NOTE: pennies dated before 1982 work best)
- ½ cup (about 120 mL) of white vinegar
- 3 small plastic cups or bowls and a marker for labels
  (write on a piece of tape if desired)
- 1 teaspoon (about 5 mL) of table salt (NaCl)
- three pieces of aluminum foil
  (½ inch x ½ inch, or 1.2 cm x 1.2 cm)
- 3 plastic spoons
- water
- timer or clock
- paper towels
- optional: lemon juice, red vinegar, more salt

Procedures

1. Label the cups as follows:
   water
   vinegar
   vinegar and salt
2. Add ¼ cup (about 60 mL) of water to the first cup.
3. Add ¼ cup of vinegar to the second cup.
4. Add ¼ cup of vinegar and 1 teaspoon of salt to the third cup, and stir until dissolved.
5. Add a penny to each of the three cups.
6. Observe what happens to the pennies in each of the solutions. Use the first table below to write down your observations at the beginning of the experiment.
7. After the period of time listed in the table, use a clean spoon for each cup to remove the pennies and place them on a paper towel.
8. Use the second table below to record your observations of the pennies on the paper towel.

How does it work?/ Where's the chemistry?

Most pennies that have been around for a while have dark spots of a compound called copper oxide. Copper oxide forms when the copper on the penny reacts with oxygen from the air.

This activity uses a combination of vinegar (a weak acid) and table salt (sodium chloride) to remove this layer of copper oxide. When the copper oxide comes off the penny, it goes into the solution as the blue copper(II) ion. Bubbles of oxygen gas are made, too. With the copper oxide gone, the shiny copper that was hiding underneath is revealed!

Over time, the pennies that were in the vinegar solutions will react with oxygen in the air to form more copper oxide. Some of it may even be a blue-green copper oxide compound. This is the same substance that makes the Statue of Liberty green!

What did you experience?

Describe each penny. (What color is it? Does it have dark spots? Is it shiny or dull?)

Time in solution	Cup with water	Cup with vinegar	Cup with vinegar and salt
Before you put it in the cup			
After 1 minute (min.)			
After 5 min.			
After 10 min.			
After 30 min. (if time allows)			
After 1 hour (if time allows)			

Describe each penny after you remove it from the cup. (What color is it? Does it have dark spots? Is it shiny or dull?)

Time on the paper towel	Penny from water	Penny from vinegar	Penny from vinegar and salt
After 1 min.			
After 5 min.			
After 10 min.			
After 30 min. (if time allows)			
After 1 hour (if time allows)			

You can do even more!

Repeat this experiment by replacing the white vinegar with red vinegar or lemon juice. How are things different?

Alexsa Silva, Ph.D. *is the Director of Instruction and Outreach at the Department of Chemistry at Binghamton University in Binghamton, New York.*

The Adventures of Meg A. Mole, Future Chemist

Dr. Stan Whittingham

In honor of this year's National Chemistry Week theme, "Marvelous Metals," I traveled all the way to The State University of New York at Binghamton (SUNY) to meet Dr. Stan Whittingham, Distinguished Professor of Chemistry and Materials Science & Engineering, and inventor of lithium batteries!

As soon as I arrived, I could not wait to learn more. I first asked Dr. Whittingham to tell me about the work he does with batteries. He explained, "I make new batteries that might be used in your phone or in cars that will make them last longer or go further before you need to plug them in." He explained, "You would not have a smartphone without the batteries we invented." I thought, how neat! I could not wait to learn more about his work and what made him decide to be a scientist.

Dr. Whittingham told me that he was very interested in science when he was growing up. I asked him to tell me more about what types of science experiments he did at school and home. He told me that he and his fellow students "made new chemicals and did new experiments each week in both chemistry and physics labs." He credits his decision to go into science to two teachers. "I had two outstanding science teachers at Stamford School in Lincolnshire, England: Major Lamb, who taught chemistry, and Squibbs Bowman, who taught physics. They were excited about science and passed that on to me," he added. I am quite sure this is why he told me his two favorite subjects in school were chemistry and physics.

After graduating from Oxford with his doctorate, Dr. Whittingham "went to Stanford University to do research in the Materials Department." He was able to "lead the group there for the next couple of years" and learned a lot about "materials for energy applications — which is beginning to be a hot area of science." Specifically, he said, "we were looking into the question of how fast ions move in solids, which got me involved in energy storage and production." He then moved to a position at Exxon Research & Engineering Company, where the lithium battery was invented.

Although he enjoyed the work, Dr. Whittingham told me that "after spending more than 15 great years in industry, I yearned to get back to doing research and working with enthusiastic young minds. A new batch comes in every year, so I become rejuvenated too. I was excited to bring what I had learned in industry to the classroom and the lab." He enjoyed bringing the "real world" into the curriculum.

As a professor at SUNY, Dr. Whittingham said he enjoys "working with young inquisitive students" the most. As a scientist, he explained, the best thing is that "you do new challenging things every day; you get to meet with a lot of people, and you get to travel around the world." He further explained that he "would not be still around if science did not still excite me and present a challenge."

I really enjoyed my trip to New York to visit Dr. Whittingham. His invention of lithium batteries is definitely the perfect fit for National Chemistry Week's "Marvelous Metals!"

Personal Profile

Favorite pastime/hobby?
Seeing new places
Accomplishment you are proud of?
Invention of the lithium battery
Birthdate? December 22

Word Search

Try to find the words listed below — they can be horizontal, vertical, or diagonal, and read either forward or backward.

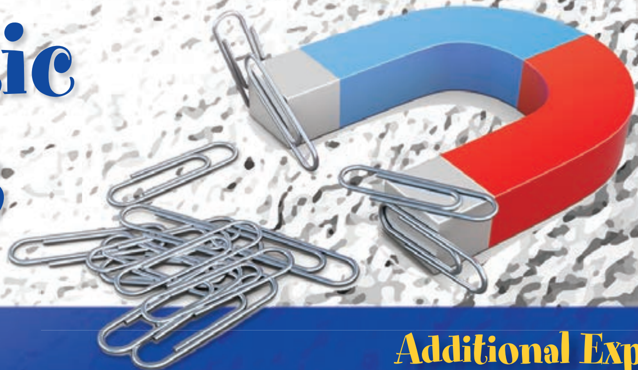
M	X	N	J	C	T	F	U	O	R	A	N	N	B	H
D	O	D	I	O	L	L	A	T	E	M	O	U	E	T
N	N	T	C	L	B	M	V	M	H	V	R	C	T	E
C	U	U	A	X	W	Y	B	B	V	Z	T	L	C	O
O	I	U	O	S	S	H	C	C	H	O	C	E	E	J
F	Y	Z	L	P	Q	X	O	S	L	E	E	U	D	U
J	L	H	K	J	M	N	X	T	V	L	L	S	A	R
M	O	E	V	Z	D	O	R	A	A	D	E	Q	G	M
Z	I	F	R	U	P	Q	C	T	L	P	Y	N	A	N
E	L	N	C	S	E	L	E	M	E	N	T	G	T	O
L	A	T	E	M	G	M	I	Y	L	G	N	K	A	I
U	O	T	N	R	N	Q	A	B	X	E	Z	Y	U	I
R	C	O	D	O	A	B	V	V	T	D	V	N	Z	F
D	J	V	N	C	P	L	T	I	U	A	C	Q	A	D
S	D	R	Z	A	W	T	K	B	C	J	W	B	I	D

ATOM	ELECTRON	MAGNET	MINERAL
COMPOUND	ELEMENT	METAL	NONMETAL
CONDUCTOR	ION	METALLOID	NUCLEUS

For answers to the word search, please visit the *Celebrating Chemistry* Archive at **www.acs.org/ncw**.

Magnetic Metals

By David S. Heroux



SAFETY SUGGESTIONS

- Do not eat or drink any of the materials used in this activity.
- Check with an adult before testing any materials, as magnets can sometimes scratch surfaces. Be sure not to test electronic equipment.

Introduction

In this activity, you will use a magnet to explore household items to determine which ones are magnetic. Several metals are attracted to magnets — the most common of which is iron. Many household items are made of steel, which is mostly made up of iron. You will then use your magnet to create a temporary magnet out of paperclips. A magnetic field is a force that can attract some metals.

Materials

- small magnet from a craft store or other location (not a soft "sheet magnet")
- household items listed in the table below
- 3-4 small metal paperclips
- marker

Procedures

PART I

1. Use a magnet to determine which items are attracted to the magnet and which are not attracted. Enter your data in the table below.
2. Find at least two other metal things in your house that are attracted to your magnet and add them to your data table.

PART II

Now you are ready to turn one of your items into a temporary magnet!

1. Make sure your paperclip is attracted to the magnet. Plastic paperclips don't work at all, and plastic-coated ones don't work well.
2. Use a marker to mark one end of the paperclip.
3. Hold the marked end of the paperclip in one hand and the magnet in the other.
4. Slide the end of the magnet along the paperclip.
5. Lift the paperclip slightly away from the magnet and bring it back to the start.
6. Very quickly repeat the motions for 30 to 60 seconds. Time or count how many swipes it takes.
7. Repeat steps 3 through 6 with another paperclip.
8. Now test your paperclip. Pick up one of the paperclips and touch it to either end of the paperclip. Test an untreated paperclip the same way. Use the box to the right to write what you observe. Did you create a magnet?

Additional Experiments

- How long does the temporary magnet last (how long are the two attracted)?
- How many paperclips can you get to attract to each other?
- What is the minimum number of strokes it takes to make them attract?

How does it work? / Where's the chemistry?

Most magnets are made of an iron compound call magnetite. Several metals are attracted to magnetic fields. Magnets are also made from metals such as **iron** (Fe), **cobalt** (Co), and **nickel** (Ni). Natural magnets are called lodestones and are made mostly of iron. Magnets work because they have electrons that interact with each other and with a magnetic field. In Part II of this activity, you used a magnet to make something magnetic by lining up the electrons in the iron atoms of the paperclip.

What did you observe?

PART I

Item	Attracted to magnet? (Yes or No)
Soda can	
Soup can	
Frying pan	
Spoon	
Glass jar lid	
Coin	
Metal paperclip	
Aluminum foil	

PART II

What did you notice happened to the paperclip in Part II?

David S. Heroux, Ph.D. *is Associate Professor of Chemistry at Saint Michael's College in Vermont.*

Words to Know

Atom – the smallest part of an element that has the characteristics of the element.

Chemical reaction – the process of rearranging atoms between substances to make different substances.

Compound – a pure material that combines two or more elements in a specific, stable form.

Conductor – a material that allows heat or electricity to flow through it.

Electron – a part of the atom that has a negative charge and is attracted to protons. Electrons move freely in metals.

Element – a pure substance, such as copper, which is made from a single type of atom.

Ion – an atom that has lost or gained electrons, giving it a positive or negative charge. Ions are found in many places, including crystals of salt and similar compounds.

Magnet – a material that creates a magnetic field and attracts or repels other magnets.

Metal – chemical elements that are shiny and flexible in their pure form, and are good conductors of heat and electricity. They are found in the left and middle sections of the periodic table.

Metalloid – elements that have properties in between metals and non-metals.

Mineral – a solid chemical compound that contains metals and occurs naturally in pure form. Rocks contain various minerals.

Nonmetal – chemical elements that usually have low melting and boiling points, and low density. Non-metals are poor conductors of heat and electricity. They are found on the right side of the periodic table.

Nucleus – the tiny central core of an atom.

Periodic Table – a table of all of the chemical elements, arranged by atomic number and similar chemical properties.

Celebrating Chemistry

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About the American Chemical Society?

The American Chemical Society (ACS) is the largest scientific organization in the world. ACS members are mostly chemists, chemical engineers, and other professionals who work in chemistry or chemistry-related jobs. The ACS has over 150,000 members. ACS members live in the United States and different countries around the world. Members of the ACS share ideas with each other and learn about important discoveries in chemistry during scientific meetings held around the United States several times a year, through the use of the ACS website, and through the many peer-reviewed scientific journals the ACS publishes. The members of the ACS carry out many programs that help the public learn about chemistry. One of these programs is National Chemistry Week, held annually during the third week in October. ACS members celebrate by holding events in schools, shopping malls, science museums, libraries, and even train stations! Activities at these events include carrying out chemistry investigations and participating in contests and games. If you'd like more information about these programs, please contact us at **outreach@acs.org.**

United Nations Educational, Scientific and Cultural Organization

International Year of the Periodic Table of Chemical Elements

About the International Year of the Periodic Table

The United Nations General Assembly proclaimed 2019 as the International Year of the Periodic Table of Chemical Elements (IYPT), commemorating milestones in the history of the periodic table, its development, and its importance in science, technology, and sustainable development. ACS and chemical societies around the world will be celebrating throughout the year. IYPT celebrations will include contests, technical programming, themed gifts and giveaways, public engagement campaigns, and more.
Visit **www.acs.org/iypt** to learn more.

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The activities described in this publication are intended for children under the direct supervision of adults. The American Chemical Society cannot be responsible for any accidents or injuries that may result from conducting the activities without proper supervision, from not specifically following directions, or from ignoring the cautions contained in the text.

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