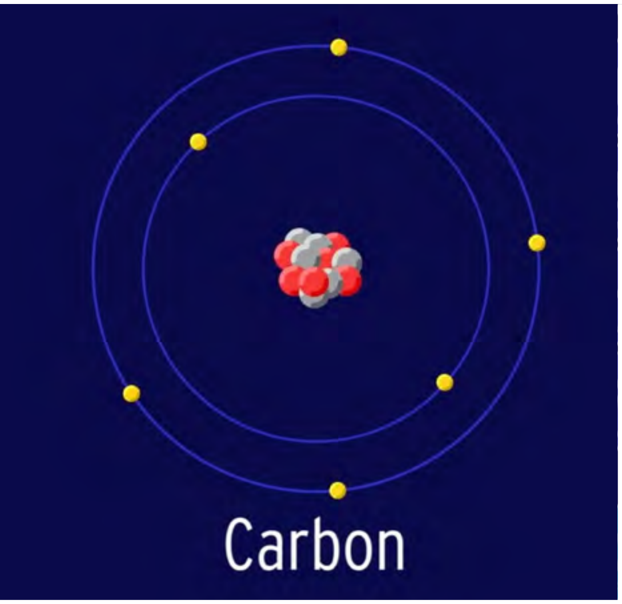
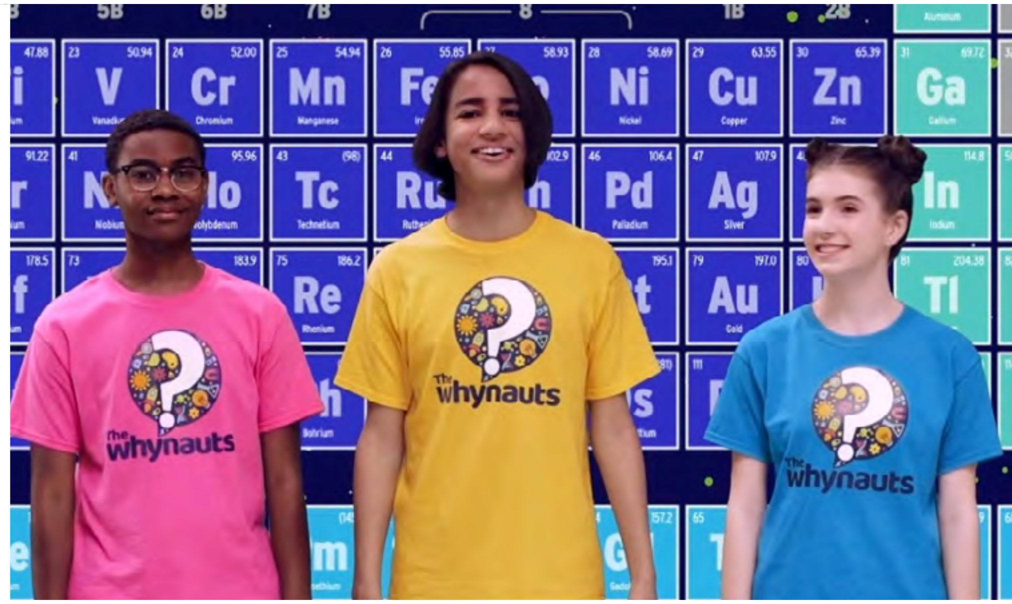
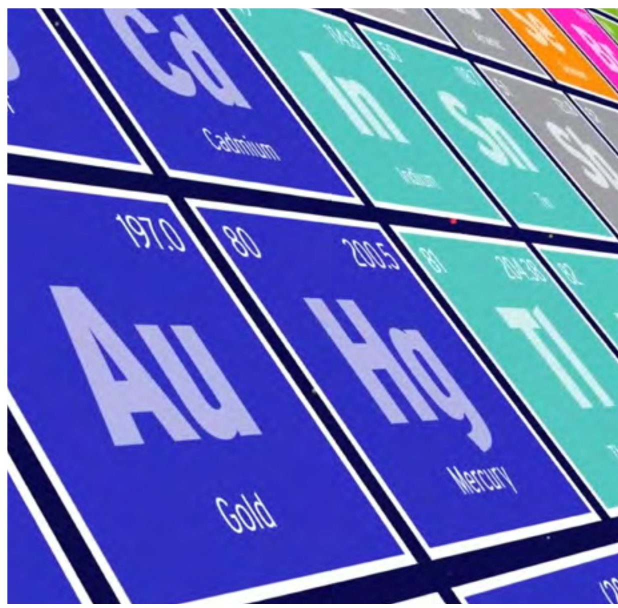
THE WHYNAUTS:

Episode 10: In My Element

EDUCATOR GUIDE SUGGESTED GRADE LEVELS 6-8







The Whynauts

Perot Museum of Nature and Science

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INTRODUCTION

HOW TO USE THIS GUIDE

The Whynauts **"In My Element" Video** explores the structure of atoms, the elements of the periodic table, and how the creation of new materials can impact society. This guide is designed to help you incorporate the video into a complete learning experience for your students. It is composed of three main sections:

The **Viewing Strategies and Tools** section includes suggested discussion questions and a pre- and post-assessment to track student learning.

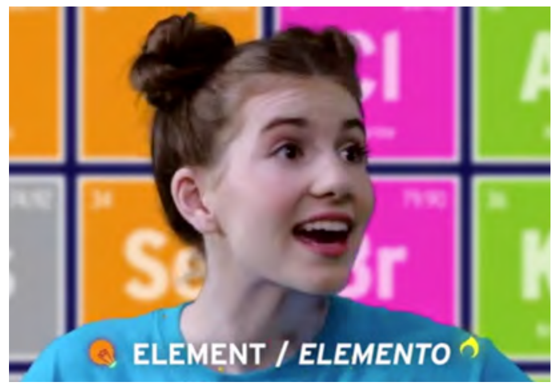
The **Supplemental Activities** section includes four activities that can be used in any order or combination.

The **Additional Resources** section includes a glossary, reading list, and links to continue learning.

LEARNING OBJECTIVES

Students will be able to:

- Describe the structure of atoms and simple molecules.
- Explain why the elements in the periodic table are arranged in a specific way.
- Identify examples of elements that make up the world and are used in everyday life.
- Describe how chemistry can impact society through the creation of new materials.



TEKS ALIGNMENT

SCIENCE

6.6C. Identify elements on the periodic table as metals, nonmetals, metalloids , and rare Earth elements based on their physical properties and importance to modern life.

7.6A. Compare and contrast elements and compounds in terms of atoms and molecules, chemical symbols, and chemical formulas.

Chem.5B. Predict the properties of elements in chemical families, including alkali metals, alkaline earth metals, halogens, noble gases, and transition metals, based on valence electrons patterns using the Periodic Table.

Chem.6B. Describe the structure of atoms and ions, including the masses, electrical charges, and locations of protons and neutrons in the nucleus and electrons in the electron cloud.

Chem.6E. Construct models to express the arrangement of electrons in atoms of representative elements using electron configurations and Lewis dot structures.

MATH

6.4E. Represent ratios and percents with concrete models, fractions, and decimals.

6.5B. Solve real-world problems to find the whole given a part and the percent, to find the part given the whole and the percent, and to find the percent given the part and the whole, including the use of concrete and pictorial models.

NGSS ALIGNMENT

MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

BACKGROUND INFORMATION

Everything around us is made from different types of **atoms** that combine with one another in a variety of ways. Atoms form **molecules** ranging in size from two atoms to *thousands* of atoms. The **periodic table of elements** classifies all of the different kinds of atoms into 118 types, called elements. An **element** is a pure substance that cannot be broken down into other substances. Every element has characteristic physical and chemical properties that make it unique.

Atomic Structure

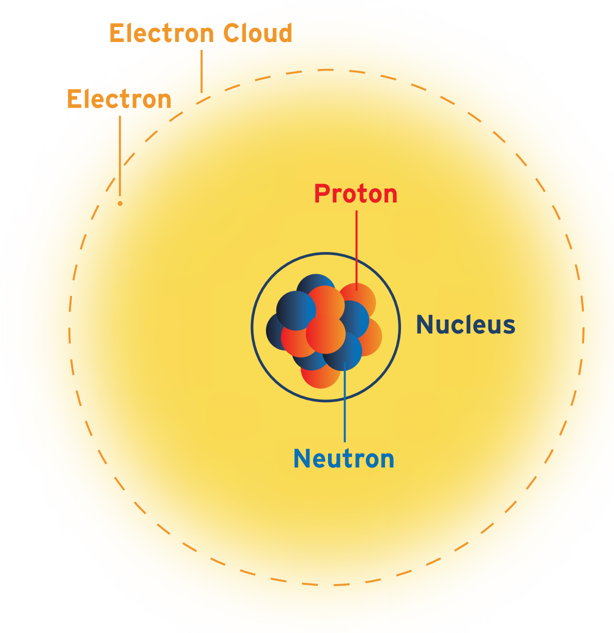
An atom is the smallest unit of **matter** that still has all of the properties of an element. Atoms are made of 3 particles: protons, neutrons, and electrons.

Protons and **neutrons** are found in the **nucleus** of the atom. Protons are positively charged, while neutrons are neutral (no charge). An element's **atomic number** is equal to the number of protons it has. This means that the number of protons an atom has determines that element's identity. For example, an atom with 6 protons is a carbon atom (atomic number 6). An element's **atomic mass** equals the total number of protons and neutrons in the nucleus.

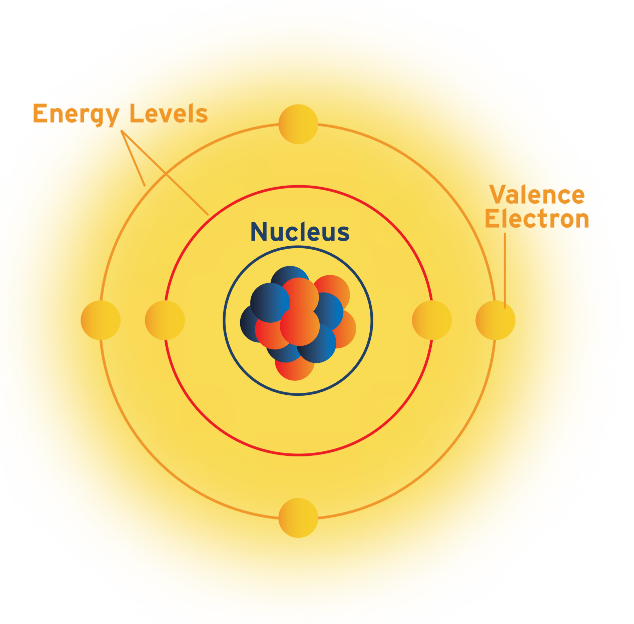
Electrons are found in the **electron cloud** surrounding the nucleus. **Electrons** are negatively charged particles with very little mass. In neutral atoms, the number of electrons equals the number of protons.

The **Bohr model**, named after the Danish physicist Niels Bohr, is a model of an atom in which electrons travel in fixed circular orbits (energy levels) around the nucleus.

Electron cloud model



Bohr model for carbon



The elements are arranged in the periodic table by increasing atomic number. They are also organized into rows called **periods** and columns called **groups** or families. Elements in the same period have the same number of **energy levels** in which electrons are arranged. Elements in period 1 have 1 energy level, elements in period 2 have 2 energy levels, and so on.

Group ▶ / Period ▼	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H 1																	He 2
2	Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
3	Na 11	Mg 12											Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
4	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
5	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
6	Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
7	Fr 87	Ra 88	Ac 89	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	Cn 112	Ce 113	Fl 114	Mc 115	Lv 116	Ts 117	Og 118
			Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71		
			Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103		

Electrons are always added to the lowest (innermost) energy level first, which can hold up to 2 electrons. Once an energy level is filled, electrons can be added to the next level. The second energy level can hold up to 8 electrons. The third energy level can hold up to 18 electrons.

Elements in the same group have the same number of **valence electrons**. These are the electrons in the outermost energy level and determine the **reactivity** of an element. The number of valence electrons is equal to the number in the ones place of the group number. This means elements in group 1 have 1 valence electron, while elements in group 14 have 4 valence electrons.

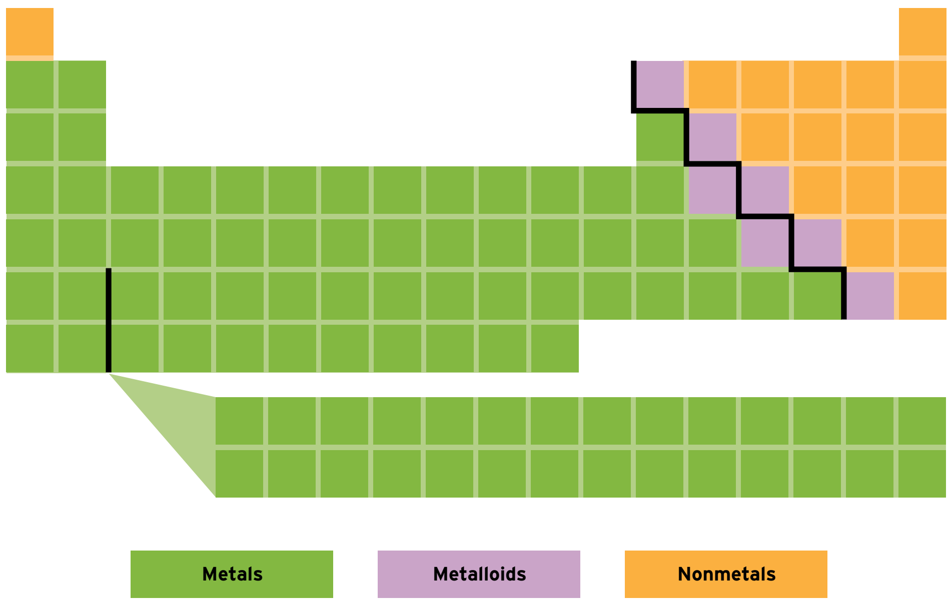
The Bohr model is useful for representing atoms of different elements and understanding how they interact. However, this model cannot explain all of the behaviors of electrons. Scientists now know that electrons do not actually circle the nucleus at fixed energy levels as Bohr thought. The electron cloud model is more accurate – we cannot know exactly where an electron is in the cloud at any given moment, but there are specific areas where electrons are more likely to be.

Meet The Elements

The 118 elements found in the periodic table make up all of the known matter in the universe. A few of these elements – like hydrogen, carbon, nitrogen, oxygen, and silicon – make up most of the Earth's crust, the oceans, the atmosphere, and even living things, like us!

The arrangement of the periodic table into periods and groups allows us to visualize patterns in the properties of the elements. It also organizes elements into three categories: metals, metalloids, and nonmetals.

Metals are located to the left of the stair step and are shiny, malleable, and good conductors of heat and electricity. With the exception of hydrogen, **nonmetals** are located to the right of the stair step and are dull, brittle, and poor conductors. **Metalloids** are located along the stair step and have properties between those of metals and nonmetals.



Chemistry and Society

Chemists develop new materials and technologies that benefit society, such as medicines, fuels, and fabrics. **Synthetic** materials are made by humans from natural resources. Usually, the atoms and/or molecules of the starting materials are rearranged through chemical reactions to create a material with different, desirable characteristics. The creation and use of synthetic materials can have both positive and negative impacts.

For example, plastics play an important role in our society. We use them every day for medical equipment, safety gear, food packaging, fabrics, and many other applications. However, plastic takes a long time to decompose, leaving behind pollution that negatively impacts the environment. Chemists are actively designing new plastics that more easily degrade in our natural environment to help reduce plastic waste, and even new ways to recycle the plastic that already exists.

VIEWING STRATEGIES AND TOOLS

DISCUSSION QUESTIONS

■ SECTION 1: ATOMS AND MOLECULES [BEGINNING – 5:31]

1. What makes elements different from each other?
   - Each element has characteristic physical and chemical properties that make it unique. Atoms of different elements have a different number of protons.
2. Why do you think elements are organized into the periodic table in a certain way?
   - Answers will vary.

■ SECTION 2: ELEMENTS AND THE PERIODIC TABLE [5:32 – 10:19]

1. Why is the periodic table a useful tool?
   - The periodic table gives us information about the properties of each element and allows us to classify the elements based on these properties.
2. Which of the elements featured in the video do you most relate to? Why?
   - Answers will vary.
3. Newly discovered elements can be named after a mythological concept, a mineral, a place or country, a property (of the element), or a scientist. If you discovered a new element, what would you name it?
   - Answers will vary.

■ SECTION 3: MEET A CHEMIST [10:20 – END]

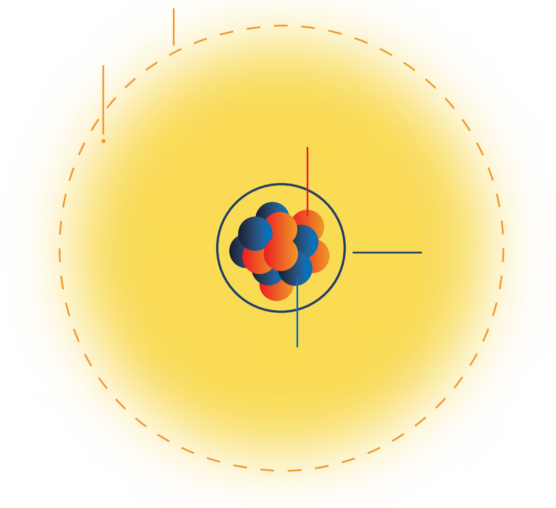
1. What is a synthetic material that you use every day? How does it affect your life?
   - Answers will vary but could include medicines, foods, synthetic fibers, or plastics.
2. If you could design a new molecule or material, what would it be? Why?
   - Answers will vary.
3. The Whynauts love to make chemistry puns. Do you know any? Can you come up with a chemistry pun of your own?
   - Answers will vary.

Pre- and Post-Video Assessment

1. Label the parts of the atom:

WORD BANK

Electron
Electron Cloud
Neutron
Nucleus
Proton



2. Fill in the chart:

PARTICLE	PROTON	NEUTRON	ELECTRON
CHARGE			
LOCATION			

Which particle(s) determine the identity of an atom? ______________________

Which particle(s) determine the reactivity of an atom? ______________________

3. An element is dull, brittle, and a poor conductor of heat and electricity. In which section of the periodic table would the element most likely be found?

A. Section 1
B. Section 2
C. Section 3
D. Section 4

4. Match the following terms about the periodic table to their description:

1. ________ Atomic Number
2. ________ Element
3. ________ Group
4. ________ Metal
5. ________ Metalloid
6. ________ Nonmetal
7. ________ Period

A. Pure substance that cannot be broken down into other substances

B. Element that is dull, brittle, and a poor conductor

C. Element that is shiny, malleable, and a good conductor

D. Element that shares properties with both metals and nonmetals

E. Equal to the number of protons an atom has

F. A column in the periodic table

G. A row in the periodic table

5. Where do you find elements in your everyday life? Name 2 examples:

____

____

____

____

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____

6. How does chemistry impact society?

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Pre- and Post-Video Assessment

1. Label the parts of the atom:

WORD BANK

Electron
Electron Cloud
Neutron
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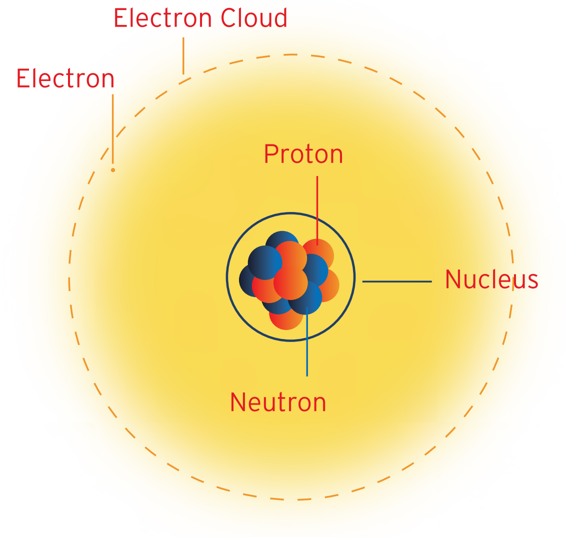
Proton



2. Fill in the chart:

PARTICLE	PROTON	NEUTRON	ELECTRON
CHARGE	Positive (+)	Neutral	Negative (-)
LOCATION	Nucleus	Nucleus	Electron Cloud

Which particle(s) determine the identity of an atom? Proton

Which particle(s) determine the reactivity of an atom? Valence Electrons

3. An element is dull, brittle, and a poor conductor of heat and electricity. In which section of the periodic table would the element most likely be found?

A. Section 1
B. Section 2
C. Section 3
D. Section 4

4. Match the following terms about the periodic table to their description:

1. __E__ Atomic Number
2. __A__ Element
3. __F__ Group
4. __C__ Metal
5. __D__ Metalloid
6. __B__ Nonmetal
7. __G__ Period

A. Pure substance that cannot be broken down into other substances

B. Element that is dull, brittle, and a poor conductor

C. Element that is shiny, malleable, and a good conductor

D. Element that shares properties with both metals and nonmetals

E. Equal to the number of protons an atom has

F. A column in the periodic table

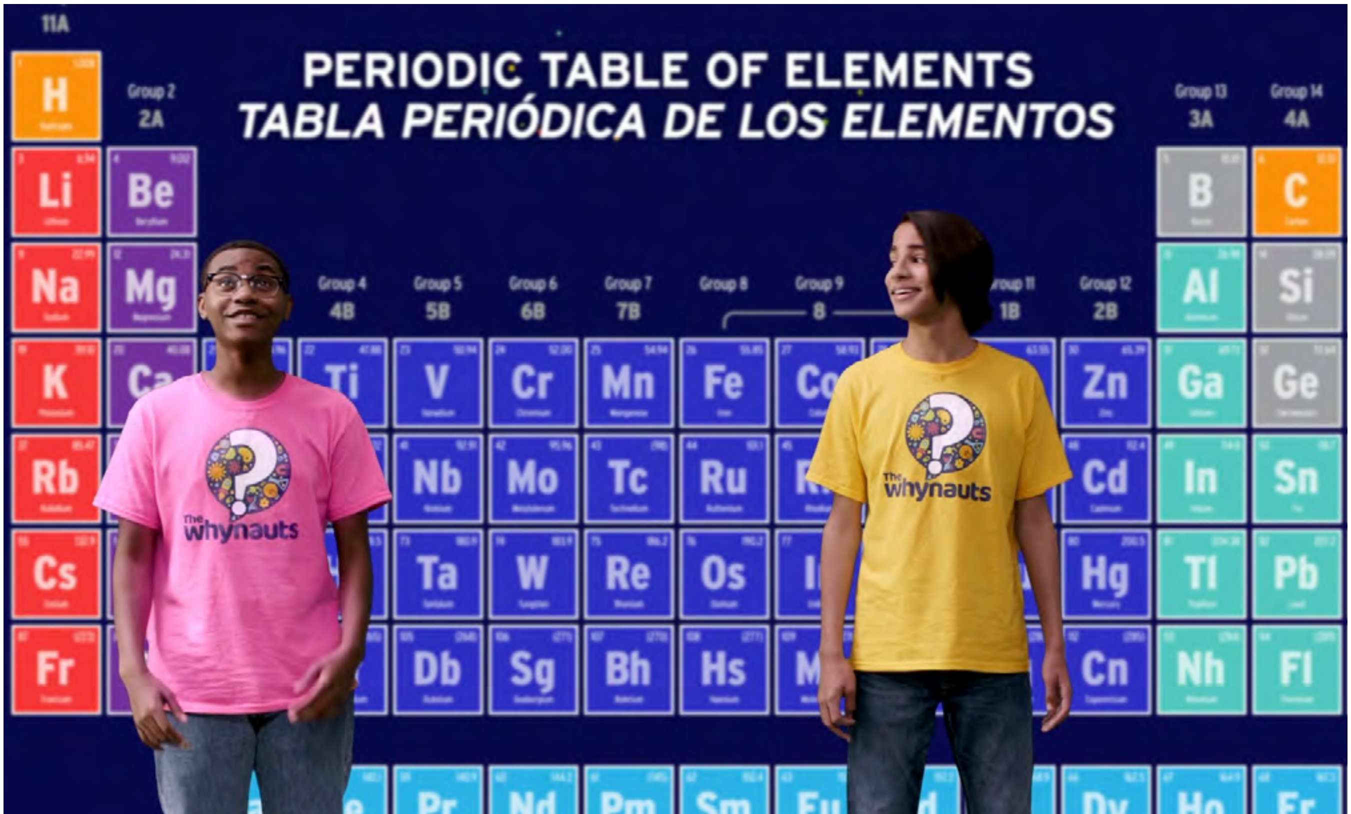
G. A row in the periodic table

5. Where do you find elements in your everyday life? Name 2 examples:

Answers will vary.

6. How does chemistry impact society?

Answers will vary but could include how chemists create new materials and technologies to help people.



SUPPLEMENTAL ACTIVITIES

Build Your Own Atomic Model

Periodic Table of Creature Features

Elements are Everywhere

DIY Plastic

Build Your own Atomic Model

WHAT ARE THE DIFFERENT PARTS OF AN ATOM?

Objective

- Students will build a 3-D Bohr model representing an atom of an element that they relate to or find interesting. They will then consider how the atom might combine with other atoms to form a molecule.

Materials

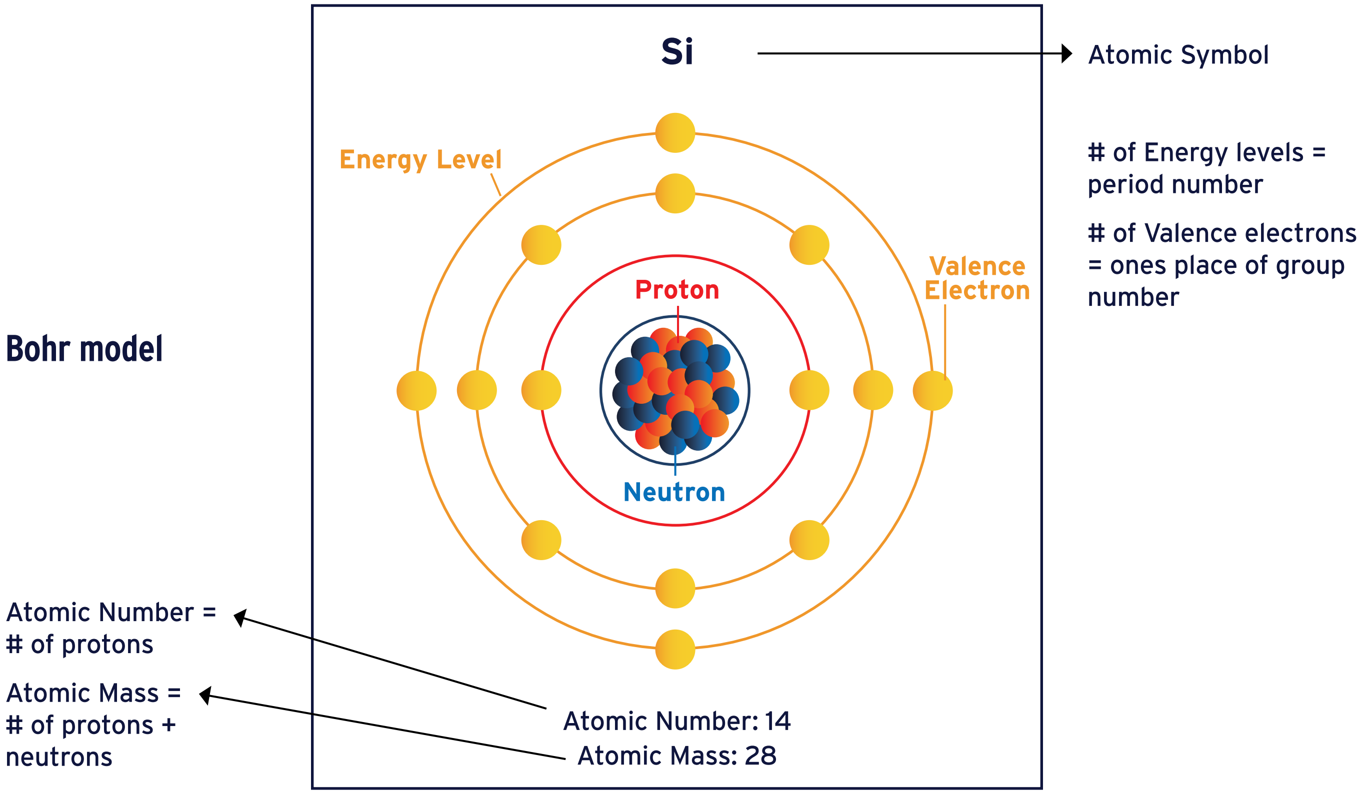
- Pipe cleaners (1-4 per model, depending on the element)
- 3 different colors of pony beads (1-22 of each color per model, depending on the element)
- Cardboard, cardstock, or a paper plate
- Glue
- Periodic table

Lesson Outline:

1. Engage students by watching a music video such as The Periodic Table Song from AsapSCIENCE or Meet the Elements by They Might Be Giants.

2. Have students research the first 18 **elements** in the **periodic table**, then choose an element they relate to or find interesting. Have students share their chosen element and reasoning. Examples could include:
   - I relate to beryllium because it is found in emeralds, which is my birthstone.
   - I relate to boron because it is used to make tennis rackets, and I play tennis.
   - I relate to carbon, because sometimes I feel tough and hard like diamonds, but sometimes I feel soft and vulnerable like graphite.

3. Introduce or review the **Bohr model** of an **atom** using silicon as an example. Refer to the Background Information section of this guide for more detailed information.
   - Silicon has an **atomic number** of 14, so a silicon atom has 14 **protons** in its nucleus (atomic number = number of protons).
   - Silicon has an **atomic mass** of 28, so a silicon atom has 14 **neutrons** in its nucleus (28 total – 14 protons = 14 neutrons).
   - Silicon is a neutral atom, so it also has 14 **electrons** (number of protons = number of electrons).
   - Silicon is found in the third **period** (row) of the periodic table, so the atom has 3 **energy levels** where its electrons are arranged (period number = number of energy levels).
   - Silicon is found in the 14th **group** (column), so the atom has 4 **valence electrons** (number of valence electrons = the ones digit place in 14).
   - The innermost energy level can hold up to 2 electrons, so it holds 2 of the atom's 14 electrons. The second energy level can hold up to 8 electrons, so it holds 8 of the atom's 14 electrons. The third and outermost energy level holds the atom's remaining 4 electrons (the valence electrons).



4. Tell students that they will be making a 3-D Bohr model of an atom of their chosen element. Give them time to work through the procedure.

- Modification: instead of pipe cleaners and pony beads, you can use other materials in the classroom. Or, ask students to select their own materials for their models and explain why they chose them.

5. Remind students that atoms combine in different ways to form **molecules**.

- Ask students if they can think of any molecules containing some of the first 18 elements. Examples could include water (H_2O), carbon dioxide (CO_2), oxygen (O_2), nitrogen (N_2), or sodium chloride (NaCl).
- Give students time to interact with other students to see if they can find other atoms to "bond with" to form a molecule. Students may need to research what molecules contain their element.
- Ask students if they noticed any patterns when trying to form molecules. Was it easier for some elements than others? Why do they think that is?
- Sample Observations:
  - My element was oxygen. I knew a lot of ways to make molecules using my atom, like water and carbon dioxide.
  - My element was sodium from group 1. My atom was able to combine with chlorine from group 7.
  - My element was neon. I couldn't combine with any other atoms.
  - I think how the elements combine has to do with what group they are in or the number of valence electrons they have.

Extensions:

- Have students explore the PhET interactive simulation Build an Atom.
- Create a periodic table scavenger hunt. Each student should contribute a set of clues for their element. Then, they should try to solve the clues contributed by other students.

Build Your Own Atomic Model

WHAT ARE THE DIFFERENT PARTS OF AN ATOM?

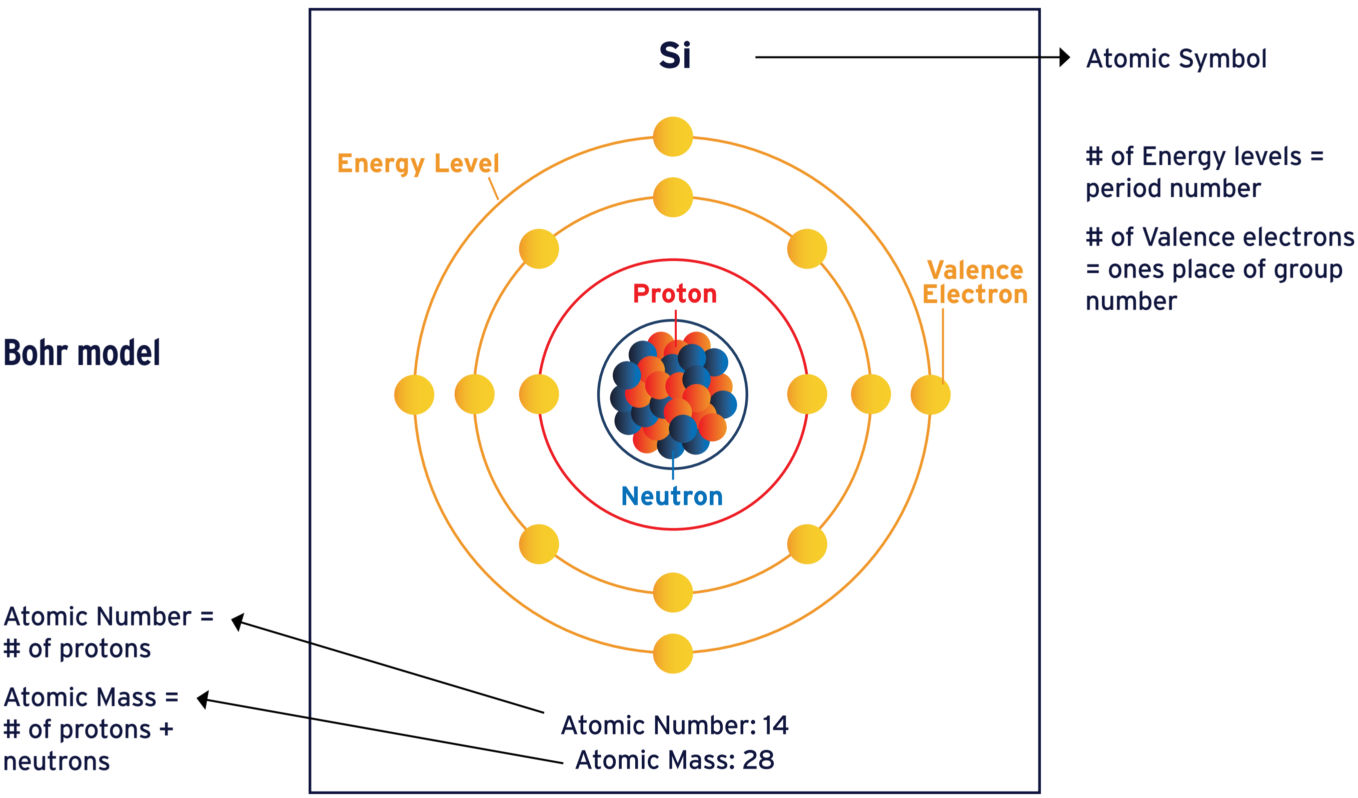
Materials

- Pipe cleaners (1-4, depending on the element)
- 3 different colors of pony beads (1-22 of each color, depending on element)
- Cardboard, cardstock, or a paper plate
- Glue
- Periodic table

INTRODUCTION:

The **Bohr model**, named after the Danish physicist Niels Bohr, is a model of an **atom** in which electrons travel in fixed circular orbits (energy levels) around a central **nucleus**.

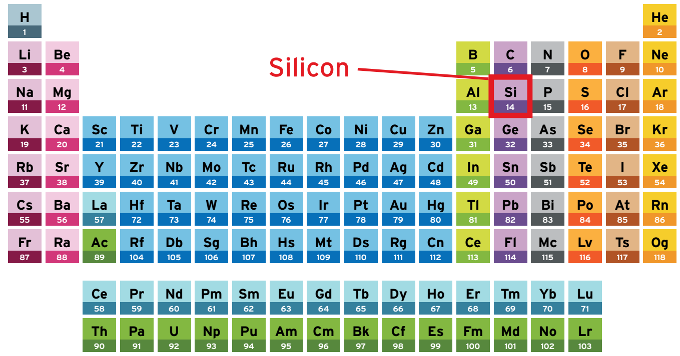
Take a look at the Bohr model for a silicon atom:



An element's **atomic number** is equal to the number of **protons** it has, so silicon has 14 protons. The element's **atomic mass** equals the total number of protons and **neutrons** in the nucleus, so silicon must also have 14 neutrons (28 total – 14 protons = 14 neutrons). In neutral atoms, the number of protons equals the number of **electrons**, so silicon also has 14 electrons.

Elements in the same **period** (row) in the periodic table have the same number of **energy levels** where electrons are arranged. Silicon is in period 3, so it has 3 energy levels.

Electrons are always added to the lowest (innermost) energy level first. This level can hold up to 2 electrons, so it holds 2 of the silicon atom's 14 electrons. The second energy level can hold up to 8 electrons, so it holds 8 of the atom's 14 electrons. The third and outermost energy level holds the atom's remaining 4 electrons.



Elements in the same **group** (column) have the same number of **valence electrons**. These are the electrons in the outermost energy level and determine the **reactivity** of an element. The number of valence electrons is equal to the number in the ones place of the group number. Silicon is in group 14, so it has 4 valence electrons.

PROCEDURE:

1. Using the resources below, research the first 18 elements in the periodic table. Choose an element that you relate to or find interesting. Fill out the Element Info Sheet with information about your element.

- The Periodic Table of the Elements, in Pictures and Words
- Royal Society of Chemistry Periodic Table
- Ptable

2. It's time to build an atomic model of your element! First, gather your protons, neutrons, and electrons:

- Choose one color of pony beads to represent protons. How many protons does your element have? (Hint: Atomic Number = # of protons). Count out the number of beads you need for your element.
- Choose a second color of pony beads to represent neutrons. How many neutrons does your element have? (Hint: Atomic Mass = # of protons + # of neutrons). Count out the number of beads needed for your element.
- Choose a third color of pony beads to represent electrons. How many electrons does your element have? (Hint: for a neutral atom # of electrons = # of protons). Count out the number of beads needed for your element.

3. Assemble the nucleus:

- Cut a 2-inch circle out of cardboard, cardstock, or a paper plate.
- Glue the beads representing protons and neutrons onto the circle (you can layer and glue the beads on top of each other if needed).

4. Arrange the electrons:

- How many energy levels does your element have? (Hint: period number = # of energy levels). Count out one pipe cleaner per energy level.
- Use the first pipe cleaner to form a small circle around the cardboard nucleus. You may want to cut or fold the pipe cleaner to make it shorter. Put two beads representing electrons on this level. (If your element is hydrogen, you will only put one).
- If your element has more than one energy level, use a second pipe cleaner to form a second circle outside the first. Put up to 8 electrons on this level, depending on how many your element has.
- Continue adding energy levels and electrons as needed. You may need to string together two pipe cleaners for the outermost energy level.

5. Glue your nucleus and energy levels filled with electrons onto a piece of cardboard, cardstock, or a paper plate. Now your model is complete!

ELEMENT INFO SHEET

Element: ______________________________

Atomic Number:
Atomic Symbol:
Atomic Mass:

Period number: ____________________

Group number: ____________________

# of protons	
# of neutrons	
# of electrons	
# of energy levels	
# of valence electrons	

Circle one: Metal Nonmetal Metalloid

Element uses:

____

____

____

Fun fact:

____

____

____

QUESTIONS:

1. Why did you choose your element?

2. Describe your model. What are the different parts, and how are they represented?

3. How well does your model represent the structure of an atom? What are your model's advantages and limitations?

4. Why do you think chemists use Bohr models?

QUESTIONS:

1. Why did you choose your element?

Answers will vary.

2. Describe your model. What are the different parts, and how are they represented?

One color of pony beads represents protons. A second color of pony beads represents neutrons. A third color of pony beads represents electrons. The cardboard circle in the center of the model represents the nucleus. Each pipe cleaner ring represents an energy level.

3. How well does your model represent the structure of an atom? What are your model's advantages and limitations?

Answers will vary, but the advantages of the model could include that it does a good job showing how many valence electrons their element has, which helps us understand that element's reactivity. Limitations could include that the model does not do a very good job showing the relative sizes of the different particles or that the atom is mostly empty space.

4. Why do you think chemists use Bohr models?

Answers will vary but could include that the Bohr model is helpful in representing atoms of different elements and understanding how they interact.

Periodic Table of Creature Features

WHY ARE THE ELEMENTS IN THE PERIODIC TABLE ARRANGED IN A SPECIFIC WAY?

Objective

- Students will categorize and arrange cards, each of which shows a creature with various characteristics, to build a table based on patterns. They will then use their arrangement to sketch a missing creature and compare their table to the periodic table of elements.

Materials

- Set of Creature Cards
- Periodic table
- Optional: scissors

Background Information:

The 118 **elements** are arranged in the **periodic table** by increasing **atomic number**. They are also organized into rows called **periods** and columns called **groups**, or families. Two patterns emerge from this arrangement: elements in the same period have the same number of **energy levels** in which electrons are arranged, and elements in the same group have the same number of **valence electrons**, or electrons in the outermost energy level. The term "periodic" refers to properties that appear or occur at certain intervals.

Lesson Outline:

1. Introduce or review the periodic table of elements.
   - Divide students into small groups. Give each group a copy of the periodic table of elements. Ask students to look at the arrangement of the elements and list things they notice. Do any patterns emerge?
   - Discuss as a class:
     - Why do you think the periodic table is organized the way it is?
     - Why do you think the term "periodic" is used to describe the table?

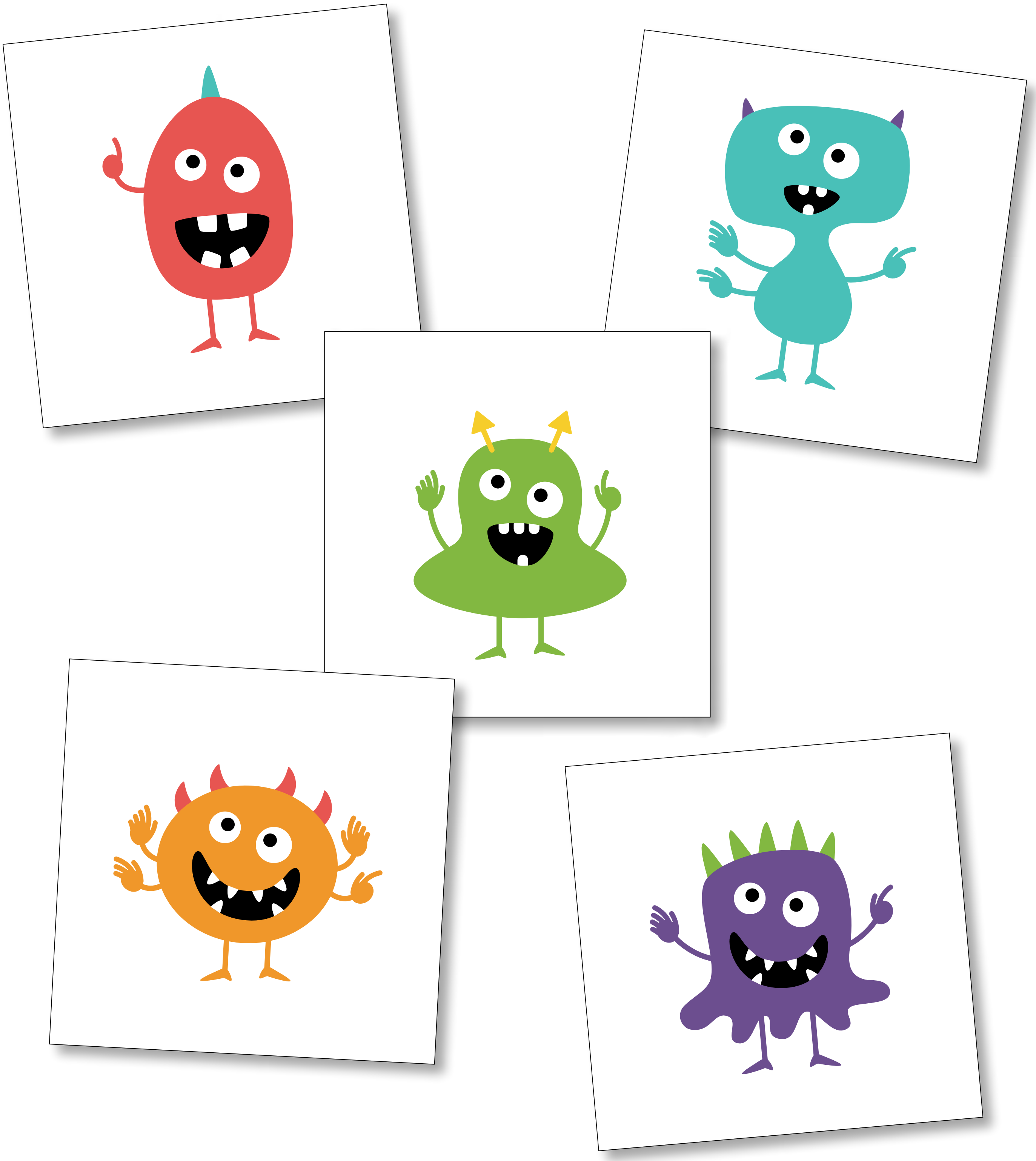
2. Pass out a set of Creature Cards to each group. You may pre-cut the cards or ask students to cut the cards out themselves. Give students time to complete the activity.

3. Ask students to compare their table of creatures with the periodic table of elements. Discuss what the patterns in the creatures' features could represent in the periodic table:
   - What might the body shape represent? *Group/Family*
   - What might the number of fingers represent? *Atomic Number*
   - What might the number of arms represent? *Period/number of energy levels*
   - What might the number of antennae represent? *Number of valence electrons*

4. When developing his periodic table, Dmitri Mendeleev originally arranged the elements by only looking at atomic mass but then decided to arrange them into columns and rows based on similar physical and chemical properties. Later, scientists used new findings of the structure of atoms to rearrange Mendeleev's table. Ask students how they decided to arrange the creatures and if their plan changed as they noticed more patterns or gained new information.

Extensions:

- Watch a video or read about the development of the periodic table of elements. Construct a Venn diagram comparing Mendeleev's periodic table and the modern-day periodic table.
- Ask students to design their own periodic table of items, such as movies, desserts, or dog breeds. Encourage them to be creative! Have students identify the patterns shown in their table and explain their thought process when arranging the items.



Periodic Table of Creature Features

WHY ARE THE ELEMENTS IN THE PERIODIC TABLE ARRANGED IN A SPECIFIC WAY?

Materials (per group):

- Set of Creature Cards
- Periodic table

INTRODUCTION:

As scientists began discovering more and more **elements**, they needed a way to organize them. When the first **periodic tables** were being developed in the late 1700s, scientists began finding patterns in the properties of elements. In 1869, a Russian chemist named Dmitri Mendeleev arranged the 63 known elements at the time by increasing **atomic mass**. He also placed the elements in columns according to similar properties.

			Ti=50	Zr=90	?=180.
			V=51	Nb=94	Ta=182.
			Cr=52	Mo=96	W=186.
			Mn=55	Rh=104,4	Pt=197,4
			Fe=56	Ru=104,4	Ir=198.
			Ni=Co=59	Pl=106,6,	Os=199.
H=1			Cu=63,4	Ag=108	Hg=200.
	Be=9,4	Mg=24	Zn=65,2	Cd=112	
	B=11	Al=27,4	?=68	Ur=116	Au=197?
	C=12	Si=28	?=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210
	O=16	S=32	Se=79,4	Te=128?	
	F=19	Cl=35,5	Br=80	I=127	
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204
		Ca=40	Sr=87,6	Ba=137	Pb=207.
		?=45	Ce=92		
		?Er=56	La=94		
		?Yt=60	Di=95		
		?In=75,6	Th=118?		

1869 Periodic Table

Unlike previous periodic tables, Mendeleev recognized that there were many other elements that had yet to be discovered and left gaps for those elements to be added. He was even able to use the patterns in his table to predict the properties of some of the missing elements. In 1913, English physicist Henry Mosely used new information about the structure of atoms to rearrange the elements by increasing **atomic number** instead of atomic mass.

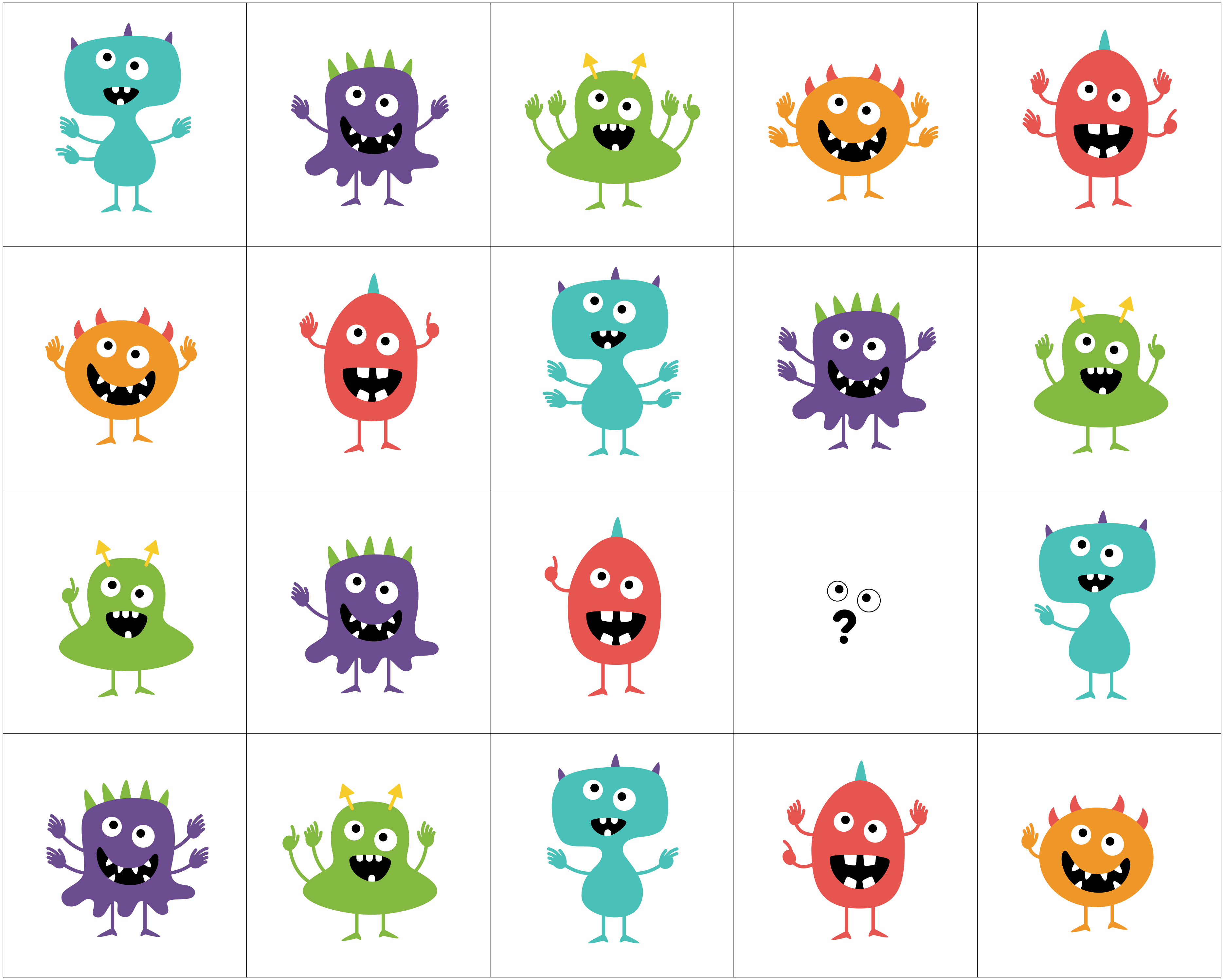
Many scientists contributed to the development of the modern periodic table of elements, and it took them almost a century to put together the arrangement that we know and use today. Now it is your turn to experience the thought processes these scientists used to develop the periodic table! In this activity, you will examine the properties of different creatures and organize them into a table based on the patterns that emerge.

PROCEDURE:

1. Look at the creatures on the Creature Cards. Do any of them have similar features? Look for patterns that could help you categorize the creatures into different groups. List all of the patterns you can find:

2. Arrange the cards in a logical pattern to form a table. Your table should reflect at least two patterns – one arranged horizontally into rows and another arranged vertically into columns.

3. Use the clues from the patterns in your table to sketch the missing creature:



QUESTIONS:

1. How did you arrange your table of creatures? Why did you arrange it this way?

2. What pattern(s) do you see as you look across a row? What pattern(s) do you see as you look down a column?

3. How did your table of creatures help you sketch the missing creature?

4. Compare your table of creatures with the periodic table of elements. What does this tell you about how the elements are arranged?

ANSWER KEY

QUESTIONS:

1. How did you arrange your table of creatures? Why did you arrange it this way?

Answers will vary but should be related to an arrangement based on patterns in the features of the creatures.

2. What pattern(s) do you see as you look across a row? What pattern(s) do you see as you look down a column?

As you look across a row, the number of fingers and antennae increases by 1. All of the creatures in the row have the same number of arms.
As you look down a column, the number of arms increases by 1. All of the creatures in the column have the same body shape and the same number of antennae.

3. How did your table of creatures help you sketch the missing creature?

The creature was in the same row as creatures who all had 3 arms, so it must also have 3 arms. The creature was in the same column as creatures who all had a pentagon body shape and 4 antennae, so it must have these features as well. The creature was between a creature with 13 fingers and a creature with 15 fingers, so it must have 14 fingers.

4. Compare your table of creatures with the periodic table of elements. What does this tell you about how the elements are arranged?

Answers will vary, but similarities include:

- The creatures are arranged in order of increasing number of fingers, which is similar to how the elements are arranged in order of increasing atomic number.
- The creatures in a row all have the same number of arms, similar to how elements in a period have the same number of energy levels.
- The creatures in a column all have the same body shape, similar to how the elements in a group are in the same family and have similar properties. They also have the same number of antennae, which increases by 1 as you look across a row. This is similar to the number of valence electrons for elements.
- The patterns in the properties of the creatures allowed us to predict the properties of the missing creature, similar to how Mendeleev was able to predict the properties of undiscovered elements.

This tells us that the elements are arranged in a way that gives us information about the properties of each element and allows us to classify the elements based on these properties.

Elements are Everywhere

WHAT ELEMENTS MAKE UP THE WORLD AROUND US?

Objective

- Students will use data to visually represent the percentage of different elements in Earth's crust, the human body, and the atmosphere of Earth or another planet. To do so, they will need to calculate how many parts of a whole are represented by each element.

Materials

- Colored pencils
- Printed activity pages or blank paper

Lesson Outline:

1. Review with students how to convert a percentage to a decimal. To do so, divide the percent by 100 and remove the percent sign. For example, 50% is equal to 0.50.

2. Review with students how to find a part given the whole and the percent. For example, if there are 24 students in a class and 50% of them have brown hair, then 12 students have brown hair.

   Part = % x Whole

   = 0.50 x 24 students

   = 12 students

3. Ask students why they think you are reviewing math concepts when they are learning about science. Remind them that scientists use math all the time! For example, a scientist might use math to measure something, analyze data, or show the relationship between two variables.

4. Explain to students that they will be given the percentage of the most common **elements** in Earth's crust, the human body, and the atmosphere of Earth or another planet. It is their job to calculate how many parts of a whole are represented by each element and create a visual representation of the data.

Extensions:

- Have students calculate the percentages of metals, nonmetals, and metalloids in the periodic table.
- Challenge students to write their names using only atomic symbols. If their name doesn't work, have them try writing a sibling, friend, or pet's name. Have students research where the elements they used are found in the world or everyday life.

74	1	39	11	92	117
W	**H**	**Y**	**Na**	**U**	**Ts**
Tungsten	Hydrogen	Yttrium	Sodium	Uranium	Tennessine

Elements are Everywhere

WHAT ELEMENTS MAKE UP THE WORLD AROUND US?

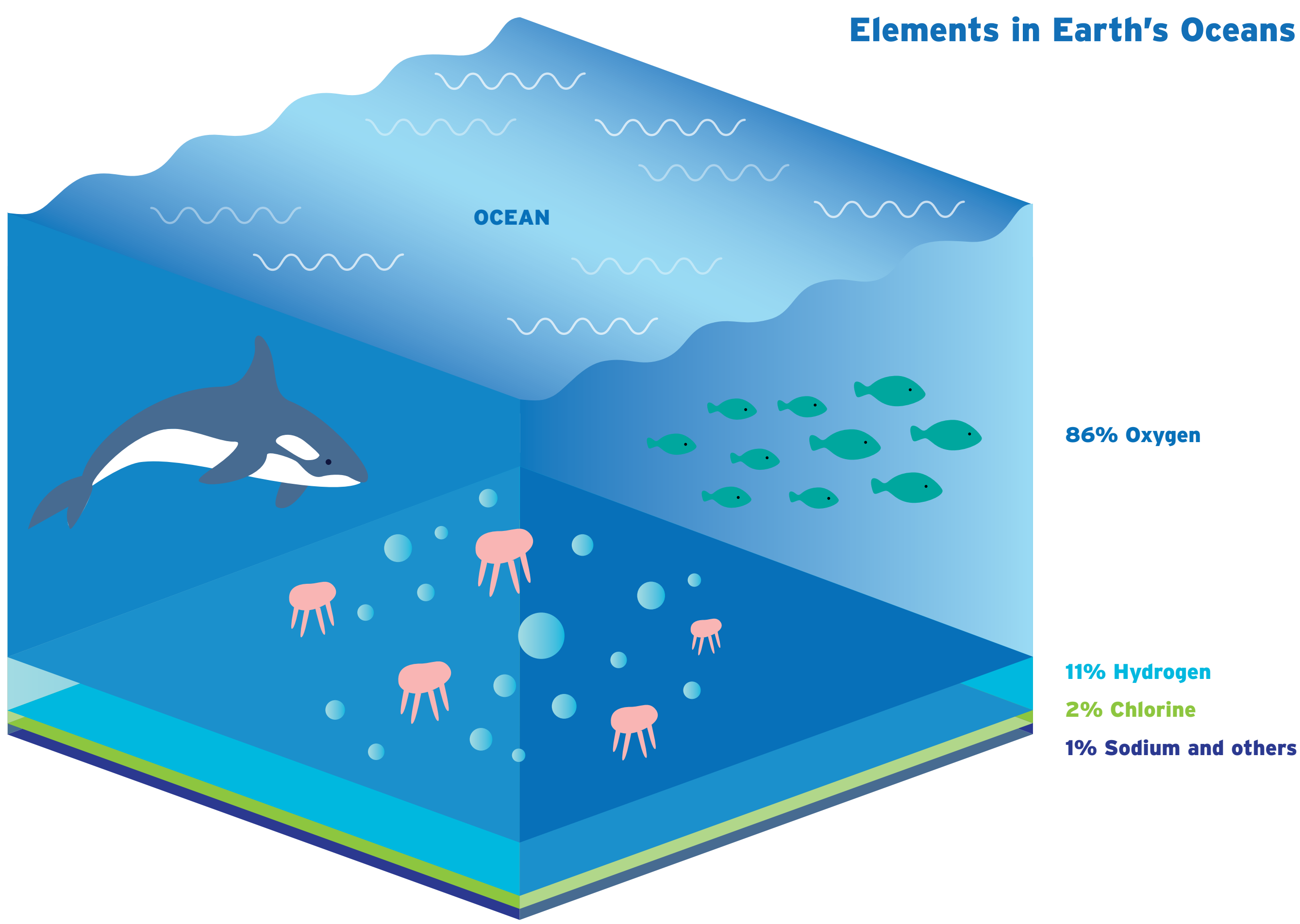
Materials (per group):

- Colored pencils
- Printed activity pages or blank paper to recreate them

INTRODUCTION:

The 118 **elements** found in the **periodic table** make up all of the known matter in the universe. A few of these elements – like hydrogen, carbon, nitrogen, oxygen, and silicon – make up most of the Earth's crust, the oceans, the atmosphere, and even living things, like you!

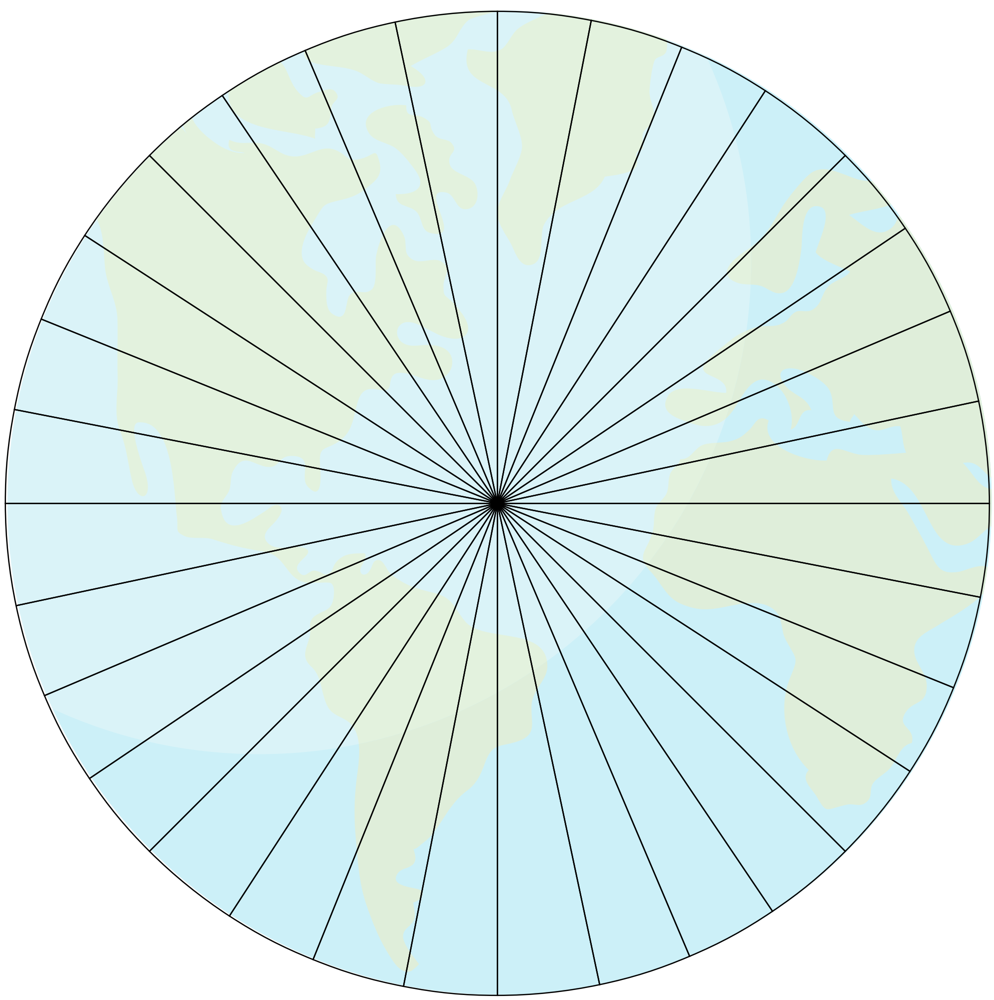
Scientists use tables and graphs to display information in different ways. In this activity, you will use the percentage of elements in different examples to construct visual representations of the data. For each representation, you will calculate how many parts of a whole are represented by each element.



PROCEDURE:

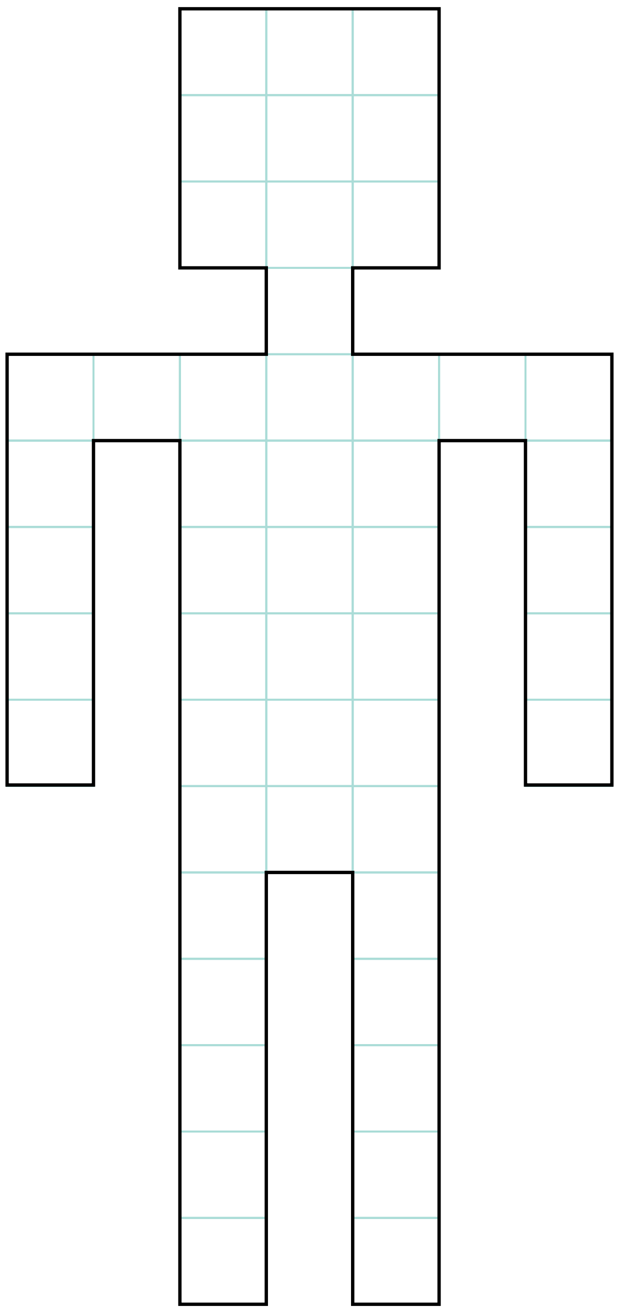
1. Create a representation showing the composition of Earth's crust using the data below. Fill out the chart to determine how many wedges to color for each element. Be sure to include a key.

Element	**Percentage of Earth's crust**	**Decimal = Percentage/100**	**# of Wedges = Decimal*32 (round to nearest half)**
Oxygen	46.6		
Silicon	27.7		
Aluminum	8.1		
Iron	5.0		
Calcium	3.6		
Sodium	2.8		
Potassium	2.6		
Magnesium	2.1		
Other	1.5		



2. Create a representation showing the composition of the human body using the data below. Fill out the chart to determine how many squares to color for each element. Be sure to include a key.

Element	**Percentage of human body**	**Decimal = Percentage/100**	**# of Squares = Decimal*50 (round to nearest half)**
Oxygen	65		
Carbon	18		
Hydrogen	10		
Nitrogen	3		
Other	4		



3. Research the composition of the atmosphere of Earth or another planet. Design your own representation showing the composition of the atmosphere of the planet you chose. Be sure to include a key.

Element	Percentage of __________'s Atmosphere	Decimal = Percentage/100	# of Parts = Decimal*_____ (round to nearest half)

QUESTIONS:

1. Compare and contrast the elements found in Earth's crust and the human body.

2. Compare and contrast the elements found in Earth's atmosphere and the atmosphere of another planet.

3. Describe how you designed your atmospheric representation.

4. Why do you think it is important for scientists to represent data in more than one way?

Earth's Crust:

Element	Percentage of Earth's crust	Decimal = Percentage/100	# of Wedges = Decimal*32 (round to nearest half)
Oxygen	46.6	.466	15
Silicon	27.7	.277	9
Aluminum	8.1	.081	2.5
Iron	5.0	.050	1.5
Calcium	3.6	.036	1
Sodium	2.8	.028	1
Potassium	2.6	.026	1
Magnesium	2.1	.021	0.5
Other	1.5	.015	0.5

Note: percentages are by mass

Human Body:

Element	Percentage of human body	Decimal = Percentage/100	# of Squares = Decimal*50 (round to nearest half)
Oxygen	65	.65	32.5
Carbon	18	.18	9
Hydrogen	10	.10	5
Nitrogen	3	.03	1.5
Other	4	.04	2

Note: percentages are by mass

Earth's Atmosphere:

Element	Percentage of Earth's atmosphere	Decimal = Percentage/100	# of Parts = Decimal*_____ (round to nearest half)
Nitrogen	78	0.78	Answers will vary
Oxygen	21	0.21	
Argon	0.9	0.009	
Other	0.1	0.001	

Note: percentages are by volume

Answers will vary for the composition of the atmosphere on other planets.

QUESTIONS:

1. Compare and contrast the elements found in Earth's crust and the human body.

Oxygen is the most abundant element in both Earth's crust and the human body. Out of the other elements listed, the ones that make up Earth's crust and the human body do not overlap. However, some of the elements abundant in Earth's crust could be included in the "other" portion of the human body and vice versa. For example, students may know that iron, calcium, sodium, potassium, and magnesium are all present in small amounts in the human body.

2. Compare and contrast the elements found in Earth's atmosphere and the atmosphere of another planet.

Answers will vary based on the planet. See The Atmospheres of the Solar System by CompoundChem for reference.

3. Describe how you designed your atmospheric representation:

Answers will vary.

4. Why do you think it is important for scientists to represent data in more than one way?

Different representations are useful for different purposes. Representing data in tables makes it easy to use numbers and perform calculations. Representing data in graphs or pictures makes it easy to understand and identify patterns.

DIY Plastic

HOW DO SYNTHETIC MATERIALS IMPACT SOCIETY?

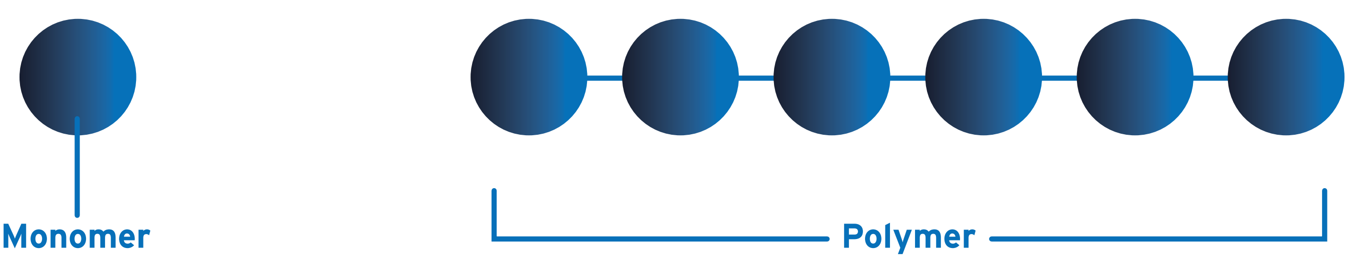
Objective

- Students will learn about polymers and create their own bio-based plastic. They will also investigate how chemistry is involved in reducing plastic waste.

Materials

- 2 tablespoons cornstarch
- 2 tablespoons water
- 2 drops of corn oil or vegetable oil
- Small plastic bag
- Small microwave-safe bowl
- Optional: 3-4 drops food coloring
- Optional: balance or kitchen scale
- Optional: cookie cutter
- For the teacher:
  - Microwave
  - Oven mitt

Background Information:
Synthetic materials, such as plastics, are made by humans from natural resources. Plastic is an example of a **polymer**. Polymers are **molecules** that consist of repeating units (called **monomers**) that join together to form long, chain-like structures or networks. Some polymers occur naturally, such as DNA. Plastics are synthetic polymers and are traditionally made from fossil fuels. Plastics made using biological material, such as plants, are called bio-based plastics.



Lesson Outline:

1. Ask students for examples of how chemistry could affect society. How does chemistry help people or make our lives better? Can chemistry ever be harmful?
   - Tell students that chemists create new materials to benefit society, such as medicines or fuels. Another example is the development of polymers like plastics, which are used for many purposes. These synthetic materials are made from natural resources, such as fossil fuels or plant matter.

2. Introduce the concept of polymers with a video or game of Polymer Rover:
   - Take the class outside or to the gym and divide students into two teams. Ask each time to form a single file line facing the other team, leaving several yards of space between the two lines. Instruct one team to stand side by side, but not touching. Instruct the other team to join hands.

- The first group will call "Polymer Rover, Polymer Rover, send _________ (name) on over." The person called will run towards the team and try to pass through the line. If they are successful, they will take a member of the opposite team back with them to their original line. If they are unsuccessful, they must join the team that called them. Have groups take turns playing the game for a set amount of time.
- Return to the classroom to debrief. Ask students which line was easier to break through. Discuss how the students standing alone could represent chemical units called monomers, while the group joining hands could represent a polymer, a molecule made of many chemical units linked together to form a chain.

3. Tell students that they will be making their own bio-based plastic from corn.

- Divide the class into small groups, and have a materials manager from each group gather the needed materials. Guide groups through the process of making their corn starch mixture. Have them record their observations.
- Help students with the microwave step so that only an adult is handling the bowl when it is hot. Use an oven mitt if needed and set the bowls aside to cool.
- Once cooled, have groups collect their bowls and record their observations about the plastic.
- Allow groups to mold their plastic into a shape, using a cookie cutter if available. Place the plastic shapes aside to set and harden for at least 24 hours. Have students record their observations.

4. Have students do their own research on how chemists are developing new materials and technologies to help reduce plastic waste.

- Encourage students to use resources that discuss both the advantages and disadvantages of different materials or methods.
- Have groups come back together to discuss if their views on plastics or recycling have changed.

Extensions:

- **Career Connection** – connect your students with a chemist or chemical engineer. You can reach out to professionals in your community or use one of the resources listed at the end of this guide.
- Have students investigate how biodegradable their bio-based plastic is:
  1. Make two sets of bio-based plastic and allow them to set for at least 24 hours. Save the two plastic bags that were used in the procedure.
  2. Bury one of the bio-based plastics and one of the plastic bags in a hole outside or in a pot or other container filled with soil.
  3. Keep the second corn plastic and plastic bag in an unburied, room temperature location as a control.
  4. Make a hypothesis: Which type of plastic will degrade faster?
  5. Examine and record observations once a week over several weeks.
  6. Analyze the data: Which type of plastic broke down faster?
  7. Use the data to form a conclusion.

DIY Plastic

HOW DO SYNTHETIC MATERIALS IMPACT SOCIETY?

Materials:

- 2 tablespoons cornstarch
- 2 tablespoons water
- 2 drops of corn oil or vegetable oil
- Small plastic bag
- Small microwave-safe bowl
- Microwave
- Optional: 3-4 drops food coloring
- Optional: kitchen scale
- Optional: cookie cutter

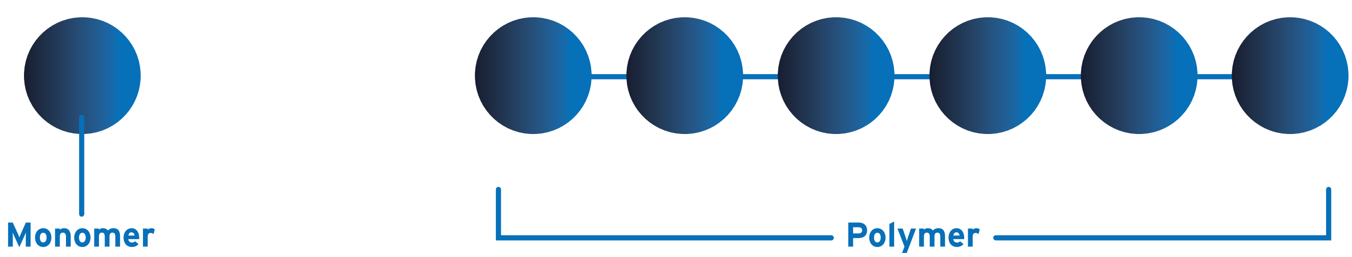
INTRODUCTION:

Chemists develop new materials and technologies that benefit society, such as medicines, fuels, and fabrics. **Synthetic** materials are made by humans from natural resources. Usually, the **atoms** and/or **molecules** of the starting materials are rearranged through chemical reactions to create a material with different, desirable characteristics. The creation and use of synthetic materials can have both positive and negative impacts.

For example, plastics play an important role in our society. Look around – you are probably surrounded by many examples of plastics. We use them every day for medical equipment, safety gear, food packaging, fabrics, and many other applications. However, plastic takes a long time to decompose, leaving behind pollution that negatively impacts the environment. Chemists are actively designing new plastics that more easily degrade in our natural environment to help reduce plastic waste, and even new ways to recycle the plastic that already exists.

Plastic is an example of a **polymer**. Polymers are molecules that consist of repeating units called **monomers** that join together to form long, chain-like structures or networks. Some polymers occur naturally, such as DNA. Plastics are synthetic polymers and are traditionally made from fossil fuels. Plastics made using living material, such as plants, are called bio-based plastics.

In this activity, you will create a bio-based plastic using corn starch!



PROCEDURE:

1. Open the plastic bag. Add the cornstarch, water, and corn (or vegetable) oil to the bag. You can also add food coloring to the mixture to make a colorful plastic.
2. Seal the bag. Knead the bag by massaging the materials between your hands until the ingredients are completely mixed.
3. Record your observations about the mixture. If you have a balance or kitchen scale, measure the mass of the bag and mixed ingredients.
4. Open the bag and sit it up in a microwave-safe bowl. ***Make sure the bag is open***.
5. Ask an adult to supervise the heating process. Place the microwave-safe bowl with the open bag into the microwave. Heat on high for 25 seconds.
6. Set the bowl aside for 5-10 minutes to allow the resulting plastic to cool down.
7. Record your observations about the plastic. How did the mixture change after heating? If you have a balance or kitchen scale, measure the mass once again. Did the mass change? Why do you think it did or did not change?
8. Once the plastic is thoroughly cooled, you can remove the plastic from the bag and mold it into a shape. You may want to use a cookie cutter to help shape your plastic.
9. Place the plastic somewhere where it can sit for at least 24 hours to set completely.

OBSERVATIONS:

WHAT'S HAPPENING?

Starch is a polymer made up of units called glucose ($C_6H_{12}O_6$). Heating the corn starch mixture allows shorter polymer chains to join together to form longer ones, resulting in a simple plastic. Your corn-based plastic is much softer than commercial bioplastics. One advantage of this is that your plastic takes less time to biodegrade. One disadvantage of this is that your plastic isn't very durable and probably wouldn't last long if put to use.

QUESTIONS:

Do some research on how chemistry is involved in reducing plastic waste. Be sure to get information from a variety of viewpoints. Here are some resources to get started:

Articles:

- New recycling technologies could keep more plastic out of landfills
- Here's how to make flip-flops biodegradable
- Help for a world drowning in microplastics
- LEGO makes bricks from recycled plastic bottles

Videos:

- How Avocado Waste is Turned Into Plastic
- Can Plastic Be Composted?

1. What are some ways chemistry is involved in reducing plastic waste?

2. What are the advantages and disadvantages of bio-based plastics compared to traditional plastics?

3. After your research, do you feel any differently about your recycling habits or use of plastics? Explain why or why not.

QUESTIONS:

1. What are some ways chemistry is involved in reducing plastic waste?

Chemists are developing new plastics that biodegrade or are easier to recycle. They are also developing new recycling technologies, such as better ways to sort and combine different types of plastics.

2. What are the advantages and disadvantages of bio-based plastics compared to traditional plastics?

An advantage of bio-based plastics is that they can be made from renewable resources, while traditional plastics are made from fossils fuels. Many bio-based plastics are also biodegradable.
A disadvantage of bio-based plastics is that they are not as durable as traditional plastics. They can also be difficult to recycle and may require specific conditions to biodegrade quickly.

3. After your research, do you feel any differently about your recycling habits or use of plastics? Explain why or why not.

Answers will vary.

ADDITIONAL RESOURCES

GLOSSARY

Atom – the smallest unit of matter that still has all of the properties of a chemical element

Atomic mass – the total number of protons and neutrons in the nucleus of an atom

Atomic number – the number of protons in the nucleus of an atom; determines a chemical element's identity

Atomic symbol – a one- to two-letter abbreviation for a chemical element

Atomic weight – the weighted average of the atomic masses of all naturally occurring isotopes (atoms with the same number of protons but different number of neutrons) of a chemical element

Bohr model – atomic model in which electrons travel in fixed circular orbits (energy levels) around a central nucleus

Chemistry – the study of matter and the changes it undergoes

Electron – negatively charged particle with very little mass found in the electron cloud of an atom

Electron cloud – region surrounding the nucleus of an atom where electrons are found

Element – a pure substance that cannot be broken down into other substances; a substance containing only one kind of atom

Energy level – in the Bohr model of the atom, energy levels are fixed distances from the nucleus, where electrons can be found

Group (or Family) – a vertical column of chemical elements in the periodic table; elements in the same group have similar properties

Matter – anything that has mass or takes up space

Metals – chemical elements that are shiny, malleable, and good conductors of heat and electricity; located to the left of the stair step in the periodic table

Metalloids – chemical elements with properties between those of metals and nonmetals; located along the stair step of the periodic table

Molecule – two or more atoms bonded together; a molecule can be made up of atoms of the same element or different elements

Monomer – a molecule that can join together with other monomers to form a polymer

Neutron – neutral particle found in the nucleus of an atom

Nonmetals – chemical elements that are dull, brittle, and poor conductors of heat and electricity; located to the right of the stair step in the periodic table (with the exception of hydrogen)

Nucleus – small, dense region at the center of the atom where protons and neutrons are found

Period – a horizontal row of chemical elements in the periodic table; elements in the same period have the same number of energy levels

Periodic Table of Elements – a table of 118 chemical elements arranged in order of increasing atomic number

Polymer – a molecule consisting of repeating units (called monomers) joined together in a chain or network

Proton – positively charged particle found in the nucleus of an atom

Reactivity – how easily a substance undergoes a chemical reaction

Synthetic material – a material constructed by humans from natural resources

Valence electron – electron in an atom's outermost energy level; number of valence electrons determines a chemical element's reactivity

STAAR GRADE 8 SCIENCE REFERENCE MATERIALS

PERIODIC TABLE OF THE ELEMENTS

Key:

Atomic number	14
Symbol	Si
Atomic mass	28.085
Name	Silicon

	1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 **H** 1.008 Hydrogen																	2 **He** 4.0026 Helium
2	3 **Li** 6.94 Lithium	4 **Be** 9.0122 Beryllium											5 **B** 10.81 Boron	6 **C** 12.011 Carbon	7 **N** 14.007 Nitrogen	8 **O** 15.999 Oxygen	9 **F** 18.998 Fluorine	10 **Ne** 20.180 Neon
3	11 **Na** 22.990 Sodium	12 **Mg** 24.305 Magnesium											13 **Al** 26.982 Aluminum	14 **Si** 28.085 Silicon	15 **P** 30.974 Phosphorus	16 **S** 32.06 Sulfur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.948 Argon
4	19 **K** 39.098 Potassium	20 **Ca** 40.078 Calcium	21 **Sc** 44.956 Scandium	22 **Ti** 47.867 Titanium	23 **V** 50.942 Vanadium	24 **Cr** 51.996 Chromium	25 **Mn** 54.938 Manganese	26 **Fe** 55.845 Iron	27 **Co** 58.933 Cobalt	28 **Ni** 58.693 Nickel	29 **Cu** 63.546 Copper	30 **Zn** 65.38 Zinc	31 **Ga** 69.723 Gallium	32 **Ge** 72.630 Germanium	33 **As** 74.922 Arsenic	34 **Se** 78.971 Selenium	35 **Br** 79.904 Bromine	36 **Kr** 83.798 Krypton
5	37 **Rb** 85.468 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.906 Yttrium	40 **Zr** 91.224 Zirconium	41 **Nb** 92.906 Niobium	42 **Mo** 95.95 Molybdenum	43 **Tc** Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.91 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.41 Cadmium	49 **In** 114.82 Indium	50 **Sn** 118.71 Tin	51 **Sb** 121.76 Antimony	52 **Te** 127.60 Tellurium	53 **I** 126.90 Iodine	54 **Xe** 131.29 Xenon
6	55 **Cs** 132.91 Cesium	56 **Ba** 137.33 Barium	71 **Lu** 174.97 Lutetium	72 **Hf** 178.49 Hafnium	73 **Ta** 180.95 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.21 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.22 Iridium	78 **Pt** 195.08 Platinum	79 **Au** 196.97 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.38 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98 Bismuth	84 **Po** Polonium	85 **At** Astatine	86 **Rn** Radon
7	87 **Fr** Francium	88 **Ra** Radium	103 **Lr** Lawrencium	104 **Rf** Rutherfordium	105 **Db** Dubnium	106 **Sg** Seaborgium	107 **Bh** Bohrium	108 **Hs** Hassium	109 **Mt** Meitnerium	110 **Ds** Darmstadtium	111 **Rg** Roentgenium	112 **Cn** Copernicium	113 **Nh** Nihonium	114 **Fl** Flerovium	115 **Mc** Moscovium	116 **Lv** Livermorium	117 **Ts** Tennessine	118 **Og** Oganesson

Atomic masses are not listed for elements with no stable or common isotopes.

Lanthanide Series	57 **La** 138.91 Lanthanum	58 **Ce** 140.12 Cerium	59 **Pr** 140.91 Praseodymium	60 **Nd** 144.24 Neodymium	61 **Pm** Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.96 Europium	64 **Gd** 157.25 Gadolinium	65 **Tb** 158.93 Terbium	66 **Dy** 162.50 Dysprosium	67 **Ho** 164.93 Holmium	68 **Er** 167.26 Erbium	69 **Tm** 168.93 Thulium	70 **Yb** 173.05 Ytterbium
Actinide Series	89 **Ac** Actinium	90 **Th** 232.04 Thorium	91 **Pa** 231.04 Protactinium	92 **U** 238.03 Uranium	93 **Np** Neptunium	94 **Pu** Plutonium	95 **Am** Americium	96 **Cm** Curium	97 **Bk** Berkelium	98 **Cf** Californium	99 **Es** Einsteinium	100 **Fm** Fermium	101 **Md** Mendelevium	102 **No** Nobelium

Updated 2017

Source: International Union of Pure and Applied Chemistry

HELEN TRAN

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PERSONAL STATEMENT

Hi, I'm Helen Tran. I am a chemist, but I always thought I would be an artist growing up.

I love design, photography, and pottery. I am really interested in making things and figuring out the best way to put things together. When I went to college, I took a chemistry class and was amazed by all the intricate ways of putting molecules together. It reminded me of how architects use simple materials to construct beautiful buildings. This was the turning point for me.

Now I can design a brand-new molecule and go into lab to make it. Sometimes, it doesn't work out perfectly, but when it does, it is the most amazing feeling in the world. You realize that you created a molecule just the way you designed it. Also, I am showing how we design molecules is really important for creating new materials to address our society's challenges in health and sustainability.

Now I consider myself a molecular architect. I guess that's a type of artist.

BIOGRAPHY

Helen Tran has spent over a decade curious about the role of design and architecture in chemistry. Like putting together Lego pieces, Helen connects molecules together to build a larger polymer. How and which of these Lego pieces are connected makes a big impact on the properties of the polymer.

Helen will be a Professor of Chemistry, cross-appointed in Chemical Engineering and Applied Chemistry, at the University of Toronto starting January 2021. Before, she was a scientist at Stanford University and worked on making electronics stretchable and recyclable. She has presented her research all over the world, from San Diego (USA) to the United Kingdom to Korea to Austria. Interacting with scientists and building friendships around the world is one of the most exciting part of her job. Helen holds a Doctor of Philosophy in Chemistry from Columbia University and a Bachelor of Science in Chemistry with a Chemical Engineering minor from UC Berkeley. She has over 30 species of plants in her apartment in San Francisco and enjoys biking, interactive art projections, and snow camping.

SPEAKER TOPICS

1. Stretchable electronics
2. Degradable electronics
3. Polymers can be creatively designed

SEGMENT PITCHES

We are about to enter a plastic revolution.

Plastic is part of everyday lives. From our food containers to cell phones to clothes, plastic plays an important role in modern society. We need to figure out what to do with this plastic after we are done using it. Our current solution is to recycle the plastic. This can be done to some extent, but it has some limitations because the plastic needs to be properly sorted. How about the plastic in the environment? Although plastics have importantly changed our society, we now need to think about our future plastics and alternatives. Our future plastic will be designed to degrade in our natural environment after a certain about of time. There has been a lot of progress in this field, but not as much in electronic plastics. I am working on pushing this field so that our future electronics can be fully degradable.

ADDITIONAL LINKS

Team Tran

Under The Skin, with Zhenan Bao, Stanford University

READING LIST

- Barfield, Mike. *The Element in the Room: Investigating the Atomic Ingredients that Make Up Your Home.* Laurence King Publishing, 2018.
- Biberdorf, Kate. *It's Elemental: The Hidden Chemistry in Everything.* Park Row, 2021.
- DK. *The Elements Book: A Visual Encyclopedia of the Periodic Table.* DK Children, 2017.
- DK. *Super Simple Chemistry: The Ultimate Bitesize Study Guide.* DK Children, 2020.
- Brunning, Andy. *Why Does Asparagus Make Your Pee Smell?: Fascinating Food Trivia Explained with Science.* Ulysses Press, 2016.
- Gray, Theodore. *Elements: A Visual Exploration of Every Known Atom in the Universe.* Black Dog & Leventhal, 2009.
- Gray, Theodore. *Molecules: The Elements and the Architecture of Everything.* Black Dog & Leventhal, 2014.
- Ignotofsky, Rachel. *Women in Science: 50 Fearless Pioneers Who Changed the World.* Ten Speed Press, 2016.
- Kean, Sam. *The Disappearing Spoon: And Other True Tales of Rivalry, Adventure, and the History of the World from the Periodic Table of the Elements (Young Readers Edition).* Little, Brown Books for Young Readers, 2018.
- Knutson, Julie. *The Science and Technology of Marie Curie.* Nomad Press, 2021.
- Miodownik , Mark. *Stuff Matters: Exploring the Marvelous Materials That Shape Our Man-Made World.* Houghton Mifflin Harcourt, 2015.
- Nguyen-Kim, Mai Thi. *Chemistry for Breakfast: The Amazing Science of Everyday Life.* Greystone Books, 2021.
- Ramirez, Ainissa. *The Alchemy of Us: How Humans and Matter Transformed One Another.* MIT Press, 2020.
- Thomas, Isabel. *Exploring the Elements: A Complete Guide to the Periodic Table.* Phaidon Press, 2020.
- Zovinka, Edward P., PhD and Clark, Rose A., PhD. *A Kids' Guide to the Periodic Table: Everything You Need to Know about the Elements.* Rockridge Press, 2020.

ONLINE RESOURCES

Perot Museum

American Chemical Society

- ACS Reactions – chemistry science videos
- ACS Chemistry for Life – resources for students and educators

Royal Society of Chemistry

- Education Resources – Periodic Table of Elements
- Interactive Periodic Table

TedEd

- Periodic Videos – a lesson about every single element on the periodic table
- Just How Small is an Atom?
- The Genius of Mendeleev's Periodic Table
- From DNA to Silly Putty, the Diverse World of Polymers

PhET Interactive Simulations | Build an Atom

Interactive Tables

- JLab Periodic Table of Elements
- Nature Interactive Periodic Table
- The Periodic Table of the Elements, in Pictures and Words
- Ptable

Periodic Table Songs

- AsapSCIENCE – The Periodic Table Song
- They Might be Giants – Meet the Elements

Compound Interest | Chemistry infographics

Science News for Students

- New recycling technologies could keep more plastic out of landfills
- Here's how to make flip-flops biodegradable
- Help for a world drowning in microplastics

STEM Careers

- IF/THEN Collection
  - Dr. Helen Tran – Chemist and Molecular Architect
- Skype a Scientist

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