

Aligning Indigenous Knowledge with Montana's Middle School Physical Science Standards

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2026

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

Date 6/29/26	Length of Lesson 10 days (50-minute class periods)
Course 8th Grade Physical Science	Unit/Theme Atomic Models
Teacher Name Heidi Schuster	Standard(s) MS-PS1-1 develop and critique models that describe the atomic composition of simple molecules and extended structures.
Key Vocabulary Atom: the smallest unit of matter that makes up all substances Molecule: two or more atoms bonded together Bond: a connection between atoms that holds them together Model: a representation used to show or explain a scientific idea Pattern: a repeated arrangement or design Property: a characteristic of a substance Composition: what something is made of	Content Objective(s) • I can model how atoms combine to form molecules and larger structures. • I can identify atoms, molecules, and the parts they contain in my model. • I can explain how the arrangement of atoms affects the structure and properties of matter. • I can connect patterns in science to patterns in nature and cultural designs.
	Essential Questions • How is matter made, and how are its parts connected? • How do relationships between small parts create larger systems? • How do patterns in nature and cultural designs help us understand scientific concepts? • In what ways do different knowledge systems help us understand the structure of matter?

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

Arrangement: how parts are organized	Materials ● Printed copies of the Fred Begay article ● Samples or images of: ○ Beadwork patterns ○ Elk tooth dresses ○ Snowflakes or crystals ● Construction Paper ● Colored Pencils ● Drawing compasses ● Beads of different colors ● Paper plates ● Glue guns ● Glue gun glue sticks ● Crystals, plants, pinecones, shells, images of snowflakes ● Periodic Tables ● Happy Atom classroom kit (optional) ● Skittles or M&Ms
	Resources Article "Fred Begay - Research Physicist" (ComPADRE. n.d.) Dr. Fred Begay on how Western and indigenous science can enrich/learn from one another (Millward, 2025) NOVA: The Long Walk of Fred Young (Prepared by the Center for the History of Physics at AIP 1, n.d.) Comparison chart Element Cards (Printed on cardstock, cut apart & laminated) Slide presentation Student worksheet

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	Everything is Connected – Modeling Matter Through Relationships Claims, Evidence, Reasoning
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Day	Lesson Sequence	Notes
Day 1 50 min Optional video: 59 min	Elder In this lesson, students will learn about the life and work of Fred Begay, also known as Fred Young and Clever Hunter, the first Native American to earn a PhD in physics. Read Article “Fred Begay - Research Physicist” (ComPADRE. n.d.) Summary Video: Dr. Fred Begay on how Western and indigenous science can enrich/learn from one another (Millward, 2025) Engagement Activity: “Two Ways of Explaining the World” Students connect Indigenous knowledge and Western science while building scientific explanations (such as rainbows) and identity in science, as with Fred Begay. - Display an image of a rainbow and ask: <i>“How does a rainbow form?”</i> <i>“How might different people or cultures explain this?”</i> - Students write a quick response in their notebooks. - Students share their explanation with a partner and discuss: <i>What is similar?</i> <i>What is different?</i>	Materials: Printed copies of the article “Fred Begay - Research Physicist” Summary Video: Dr. Fred Begay on how Western and indigenous science can enrich/learn from one another (Millward, 2025) Other Resources NOVA: The Long Walk of Fred Young (Barnes, 1979)

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	4. Give students 6–8 short statements (on cards or slides), for example: a. Light bends and separates into colors. (Scientific) b. Rainbows are a sign or message. (Cultural) c. Water droplets act like prisms. (Scientific) d. Rainbows connect the sky and Earth. (Both) e. Rainbows form when sunlight is refracted, reflected, and dispersed by water droplets in the air. (Scientific) f. Some cultures view rainbows as a bridge or pathway connecting the physical world to the spirit world. (Cultural) g. A rainbow always appears opposite the sun from the viewer’s perspective. (Scientific) h. Rainbows can represent balance and harmony between natural elements like water and light. (Both) i. The colors of a rainbow appear in a specific order because different wavelengths of light bend at different angles. (Scientific) j. In some traditions, seeing a rainbow can be a sign of renewal, hope, or a message from nature. (Cultural) k. Rainbows appear only when water droplets are in the air and sunlight hits at the right angle, showing how natural conditions must work together. (Both) l. Observing rainbows can help people understand both the physical properties of light and their connection to the natural world. (Both)	
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Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	5. Students sort the statements into: a. Scientific explanation b. Cultural explanation c. Both 6. Connect to Begay: <i>Why do you think Fred Begay wanted to understand rainbows?</i> <i>Can both ways of understanding be valuable? Why?</i> <i>“How can different ways of knowing help us better understand the world?”</i> 7. Have students draw a rainbow and label it with: a. A scientific explanation b. A cultural meaning 8. This connection reinforces the lesson theme of relationships and interconnectedness, linking: a. Begay’s curiosity and lived experience b. Multiple ways of knowing c. And the scientific concept that matter is made of connected parts working together The rainbow phenomenon provides a natural bridge into learning about atoms and molecules. Scientifically, a rainbow forms when light interacts with water droplets, bending and separating into different colors. This happens because light interacts with matter on a very small scale. Students can begin to understand that all matter, including water droplets, is made of atoms and molecules, and that the way these tiny particles are arranged and interact affects what we observe. <i>“Fred Begay asked how rainbows work because he wanted to understand the world more deeply. We’re going to do the</i>	
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Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	<i>same thing, but by looking even closer at the tiny pieces of matter—atoms and molecules—that make everything, including water droplets and light interactions, possible.”</i>	
Day 2 25 min	Engage (Phenomena) Students examine beadwork, elk tooth dresses, and snowflake images to recognize how complex objects are made from smaller, connected parts. (These patterns are important to the Crow Tribe.) Purpose: Activate prior knowledge and introduce the idea of small parts forming complex systems. Procedure: 1. Display images one at a time (beadwork, dresses, snowflakes). 2. Ask students: a. <i>What do you notice about these objects?</i> b. <i>What patterns do you see?</i> c. <i>What smaller parts make up the whole object?</i> 3. Have students do a quick Think–Pair–Share. 4. Guide discussion toward the idea that complex objects are made of repeating smaller parts. 5. Introduce guiding question: a. <i>How can tiny parts connect to form everything we see in the world?</i>	Materials: Crow tribal beadwork samples Elk tooth dress sample Snowflake photographs Optional: images of beadwork or other materials Modification suggestion: Consider patterns important in your specific culture or community: leatherwork, beadwork, rugs, fabrics, carvings, etc.
Day 3-5 150 min	Explore Students build models of atoms using beads to represent subatomic particles. Procedure:	Materials: Construction Paper Colored Pencils Drawing compasses

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	1. Introduce idea: atoms are organized on the periodic table in many different ways. The periodic table has many patterns: a. Atomic number is the number of protons and is unique to each element b. Period or Row represents how many energy levels the atom has. c. Group or column represents how many valence electrons an atom has. d. Atoms in the same column have similar properties. e. You can predict chemical bonds if you know an atom's placement on the periodic table. 2. Show a simple model example (Neon). 3. Assign each student an atom. a. Students research their atom - the following are some of the necessary properties students need to know about their atom: i. Atomic number ii. Symbol iii. Atomic Mass iv. Number of protons, neutrons, electrons v. Period, Group vi. Number of energy levels vii. Number of electrons on each energy level viii. Isotopes b. Students create a Periodic Table block of their atom.	Beads of different colors Paper plates Glue guns Glue gun glue sticks Modification suggestion: Materials other than beads could be used to create an atom model.
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Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	c. Students draw a two-dimensional model of their atom. d. Students build their atom using beads to represent the subatomic particles. 4. Circulate and prompt: a. How are the atoms connected? b. What pattern do you notice in your atoms? c. What pattern do you notice in the periodic table? 5. Have students compare models with other students. 6. Students will turn in for assessment: a. Completed research b. Completed Periodic Table Block c. Completed two-dimensional model d. Completed three-dimensional bead model	
Day 6 25 min	Environment Connect molecular patterns to natural systems Students compare their models to patterns found in nature, such as crystals or plant structures. Procedure: 1. Place naturally patterned items at each table (Crystals, plants, pinecones, shells, images of snowflakes). 2. Ask: ○ <i>Where do you see repetition or structure?</i> ○ <i>How are these similar to your atom models?</i> 3. Students rotate through tables comparing natural items to their models. 4. Students record observations in a comparison chart:	Materials: Crystals, plants, pinecones, shells, images of snowflakes Students' bead models Resources: Comparison chart Modification suggestion:

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	○ Nature example ○ Pattern observed ○ Similarity to the atom model 5. The comparison chart in the lab notebook is submitted for evaluation of the ability to identify patterns and make connections between systems.	Choose natural items found in your specific area.
Day 7 50 min	Explain Students will use their models, research, and comparison chart to write a description of their atom and the patterns they see. They should describe the following patterns: 1. Relationship between atomic number and protons 2. Relationship between atomic mass, protons, and neutrons 3. Relationship between period and energy levels 4. Relationship between group and valence electrons 5. Relationship between neutrons and isotopes Students will also write about the relationships between atoms and all matter. They should describe how everything can be divided into the smallest parts of atoms and molecules, which illustrates how everything is linked together, and how we are connected to the natural world on an atomic level.	
Day 8-9 100 min	Elaborate Bonding Basics: Students use atomic models to show how atoms connect to form covalent and ionic bonds. This activity is adapted from a lesson found on The Science Spot website (Tomm, 2026). Purpose As a result of this activity, students will be able to:	Materials: Happy Atom classroom kit (optional) Skittles or M&Ms Periodic Tables (laminated)

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	● Identify the number of valence electrons in a given atom. ● Describe and demonstrate how an ionic bond forms. ● Describe and demonstrate how a covalent bond forms. ● Predict the type of bond that will occur between two elements. Preparation: This activity can be presented using sets of Happy Atoms or element cards, placed in a baggie, with another baggie containing Skittles, M&Ms, or Smarties. If using element cards, kids will use the candy pieces to represent valence electrons. The description below uses the element cards. Procedure: Use the slide presentation to guide students through the following steps: 1. Have students work together to complete the chart on their worksheet related to valence electrons and oxidation numbers (how many electrons it should lose or gain), and then discuss their answers. They may use the element cards to create Electron Dot Diagrams for each element, making it easier to visualize how many electrons each needs to gain or lose. If they use the same colors for each atom, such as all yellow on one atom and red on the other. This will make it easier for them to see what happens in each bond. 2. Review the basics of ionic bonds by completing the Ionic bonding comprehension questions. 3. Have the students select the element cards for Sodium and Chlorine. Instruct them to use the candy pieces to create electron dot diagrams for each, placing the correct number of valence	Resources Element Cards (Printed on cardstock, cut apart & laminated) Slide presentation Student worksheet
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Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	electrons on each card. In this example, Sodium needs 1 candy, and Chlorine needs 7. 4. To demonstrate the formation of an ionic bond using these elements, ask the following questions as they complete the bond: a. <i>How many valence electrons does Sodium have? (1)</i> b. <i>How many valence electrons does Chlorine have? (7)</i> c. <i>How many electrons does Chlorine need to complete its outer shell? (1)</i> d. <i>How many electrons does Sodium need to lose to be left with a complete shell? (1)</i> 5. Have the students take the candy piece from Sodium and place it in the empty circle on the Chlorine atom. They should also draw this on the worksheet. a. <i>Since Sodium lost one electron, what is its charge? (1+)</i> b. <i>What do we call a positively charged ion? (Cation)</i> c. <i>Since Chlorine gained one electron, what is its charge? (1-)</i> d. <i>What do we call a negatively charged ion? (Anion)</i> e. <i>Do the charges balance? (Yes)</i> f. <i>What is the chemical formula for this compound? (NaCl)</i> g. <i>What is the name of this compound? (Sodium Chloride or salt)</i> 6. Repeat this process for the other ionic bond examples using the element cards.	
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Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	7. Review the basics of covalent bonds by completing the covalent bonding comprehension questions. 8. To demonstrate the formation of a covalent bond using Hydrogen and Chlorine, ask the students the following: a. <i>How many valence electrons does Hydrogen have? (1) Students place one candy piece in one of the circles on the Hydrogen atom.</i> b. <i>How many valence electrons does Chlorine have? (1) Students place seven candy pieces in the circles on the Chlorine atom.</i> c. <i>How many electrons does each atom need to have a complete shell? (1)</i> 9. Since Hydrogen isn't likely to give up an electron, it must share one with another atom. Have the students move the Hydrogen atom so its two circles overlap those on the left side of the Chlorine atom. to allow each atom to share one electron with the other. 10. Have the students draw this on their worksheets. a. <i>How many electrons does the Hydrogen atom now have? (2 – 1 of its own and 1 that is shared)</i> b. <i>How many do the Chlorine atoms have? (8 - 7 of its own and 1 that is shared)</i> 11. Have the students draw a circle around the Hydrogen atom and the 2 electrons in its outer shell, and another circle around the Chlorine atom to show the 8 electrons in its outer shell. a. <i>What is the chemical formula for this compound? (HCl)</i> 12. Extension: The element card set includes elements through Argon, as well as six blank atoms. Students	
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Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships

	can use these extra cards to make their own ionic and covalent bonds.	
Day 10 25 min	Evaluate Using the Claims, Evidence, Reasoning (CER) format, Students create and explain models of atoms, showing how atoms connect and form patterns. 1. Give the students the following guiding question: <i>How do the patterns we see in the periodic table determine the properties of matter?</i> 2. Give the students the following statement to use as the Claim: <i>Matter is made of atoms that combine in specific patterns using chemical bonds. The way atoms are arranged determines the properties of the material.</i> 3. Using all of the information gained from this lesson, students write a statement of Evidence. They may use the sketch part of the CER to illustrate their evidence. 4. Using all the information gained from this lesson and critical thinking, students will write their Reasoning, illustrating their ideas with a drawing.	Resources Everything is Connected – Modeling Matter Through Relationships Claims, Evidence, Reasoning

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships - Resources

Article:

Fred Begay - Research Physicist (Fred Begay - Physicist Profile Detail Page, n.d.)

Clever Fox was a Navajo child born in the Shiprock settlement around 1932. No one knows the exact year he was born, though. Clever Fox was raised in a very traditional Navajo way, learning to hunt and farm. He was named Clever Fox for his innovative hunting ideas. Clever Fox was heavily interested in his Navajo religion and would often ask probing questions about how the world around him worked. He particularly wanted to understand how rainbows were made. All the answers he received from the medicine men of his tribe didn't satisfy him enough.

As Clever Fox grew older, he and his family would travel to nearby cities to trade. He was "impressed with the standard of living of white people." He was surprised to see how the people in the city always had food and even threw away good food, while he and his family were starving. At times, Clever Fox would sneak into the city and rummage through the trash, searching for food people had thrown out.

Eventually, Clever Fox's parents decided to send him to a boarding school in town run by missionaries. His parents sent him because the school offered free food to the children. The school's leaders assigned him a new name, Fred Young, and estimated he was around 10 years old. His parents had no say in his education, and the school decided he should learn things they thought would help him in the Navajo tribe, so Young learned primarily how to farm for over 10 years. The school was "run like an army camp". The children were not allowed to speak Navajo or practice any Navajo religious ceremonies, and were harshly punished if they were caught. The school would have him and the other Navajo children dress up as Indians for school plays and parades, but they "weren't allowed to be real Indians, just play as them." Over the years, Young lost contact with his family.

Because of his farm-based education, Young barely knew how to read or write when he graduated. The tribal council of the Navajo tribe had just come into money to send some of their people to university, and still chose Young. The tribal council decided Young would go to the University of New Mexico to study engineering. While he was studying there, Young found an optics book that finally explained to him how rainbows worked. Soon after, Young changed his major to physics.

During his studies, his teachers described him as constantly anxious and on edge. Young would leave school for days at a time to go back to the reservation. Young received weekly cleansing rituals said to protect him from the influence of the white man. Young was fiercely protective of his tribe's way of life and was known to get into fights with anyone who criticized it.

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships - Resources

In 1971, Young became the first Native American in history to earn a PhD in physics. Young specialized in nuclear physics and began working in the nearby Los Alamos Laboratory. Sometime during this point in his life, Young changed his name to Fred Begay. Begay's research at Los Alamos focused on advancing nuclear fusion as an energy source and searching for sources of high-energy gamma rays and solar neutrinos. Nuclear fusion is predicted to be a nearly unlimited energy source with little to no environmental consequences. Gamma rays and neutrinos are high-energy particles that scientists know very little about, but are studying as they predict they could be key to faster communication systems in the future. Begay would return to the Navajo schools and college to discuss his work and encourage students to pursue degrees in science. While Begay was constantly uncomfortable living with white people, he was also anxious in his own tribe. Begay felt a disconnect from being unable to explain his work in Navajo himself and having to rely on a translator. Begay felt constantly on edge, worrying about whether he was acting correctly and being a proper Navajo. He kept trying to spark interest in physics, but many people in the tribe, including the medicine men, found Begay's work impractical and useless. Begay knew this was because understanding rainbows didn't help the Navajo people in their day-to-day struggle to survive and find food. Still, he continued working with the tribe and Los Alamos labs to try to increase Navajo participation, though he was largely unsuccessful.

Despite all the work he has done, Fred Begay lived largely in obscurity for most of his life. Navajo culture places a strong emphasis on the accomplishments of the whole and disparages someone who is too self-absorbed. Though Begay tried to speak and participate in interviews and documentaries, he was always uncomfortable. Film crews recalled how Begay would leave for days during filming, either for the reservation or someplace else the film crew didn't know. He would always come back, insisting they continue.

Fred Begay died in 2013.

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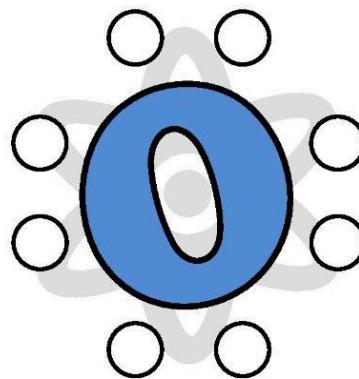
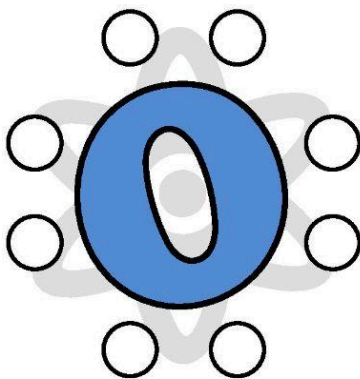
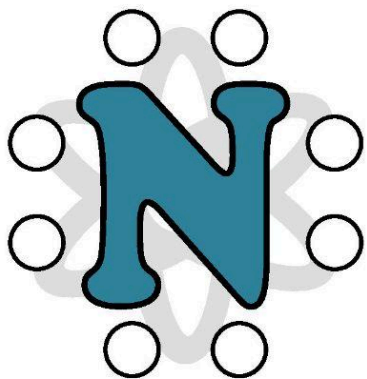
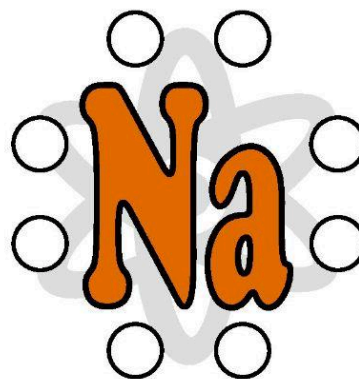
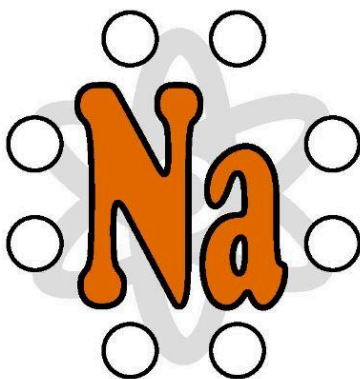
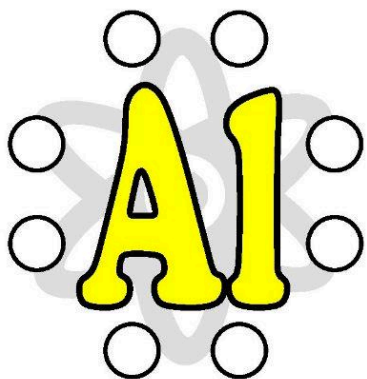
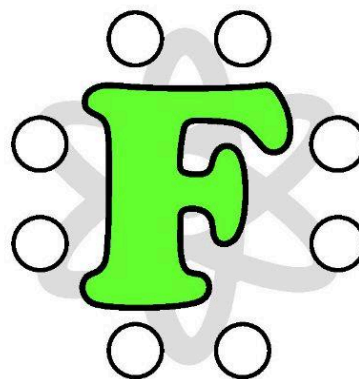
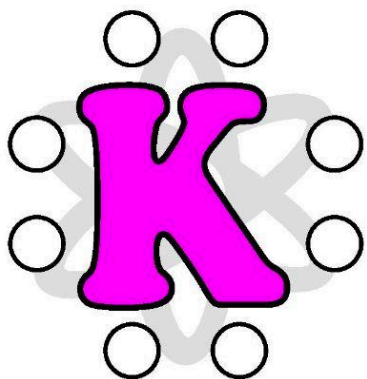
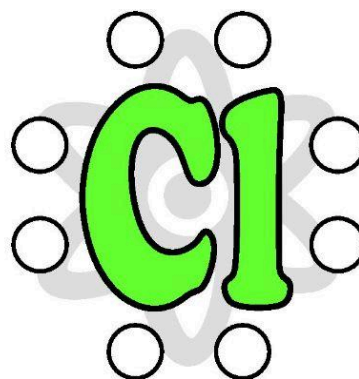
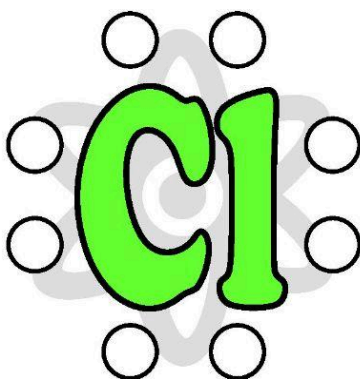
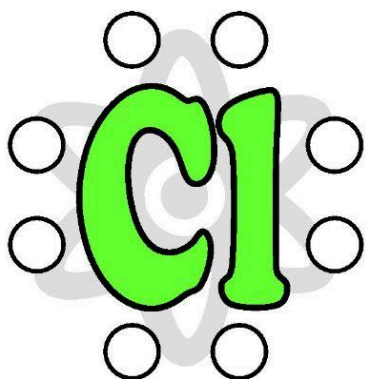
Pattern Observation Comparison Chart

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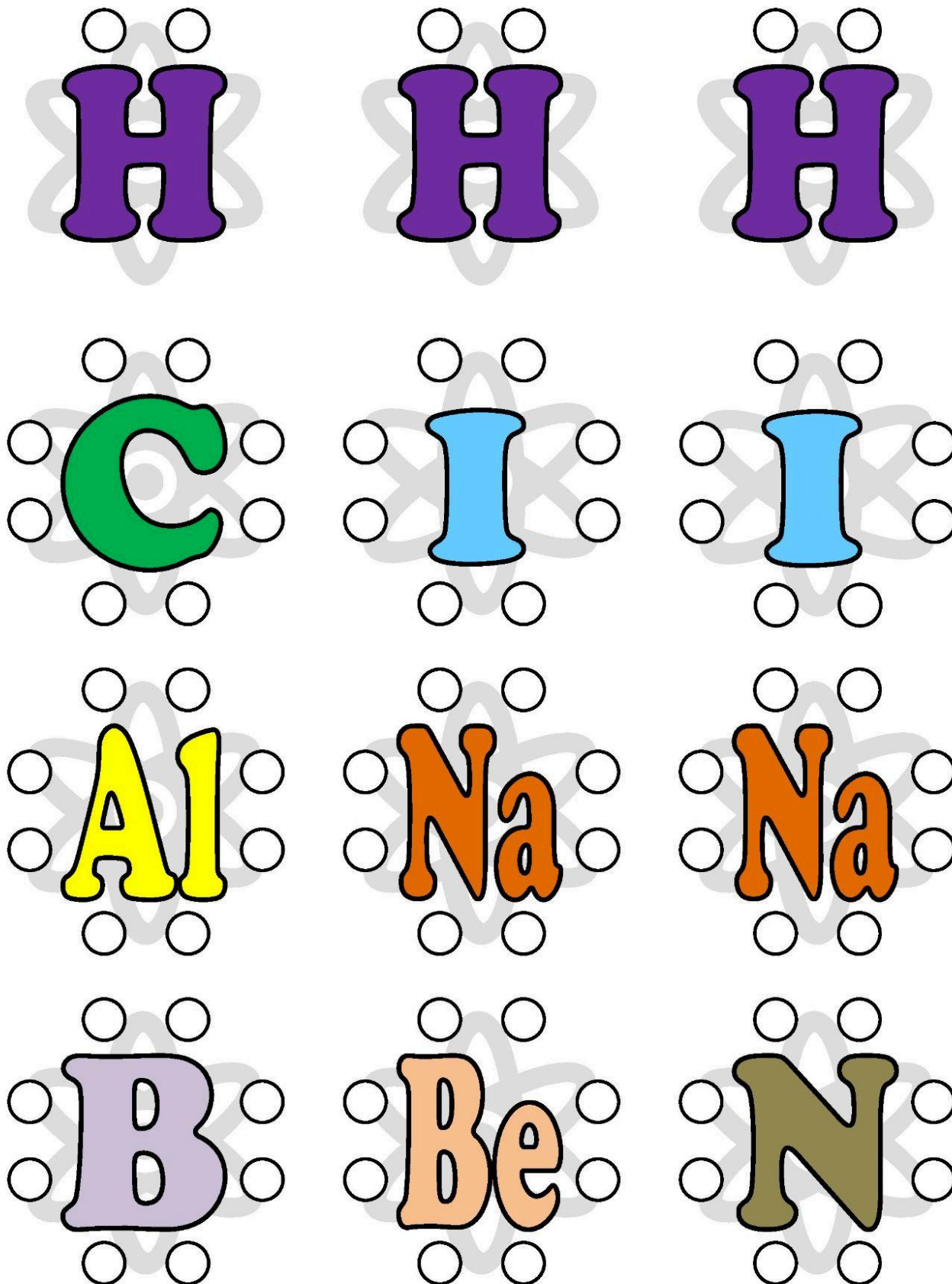
Bonding Basics Element Cards



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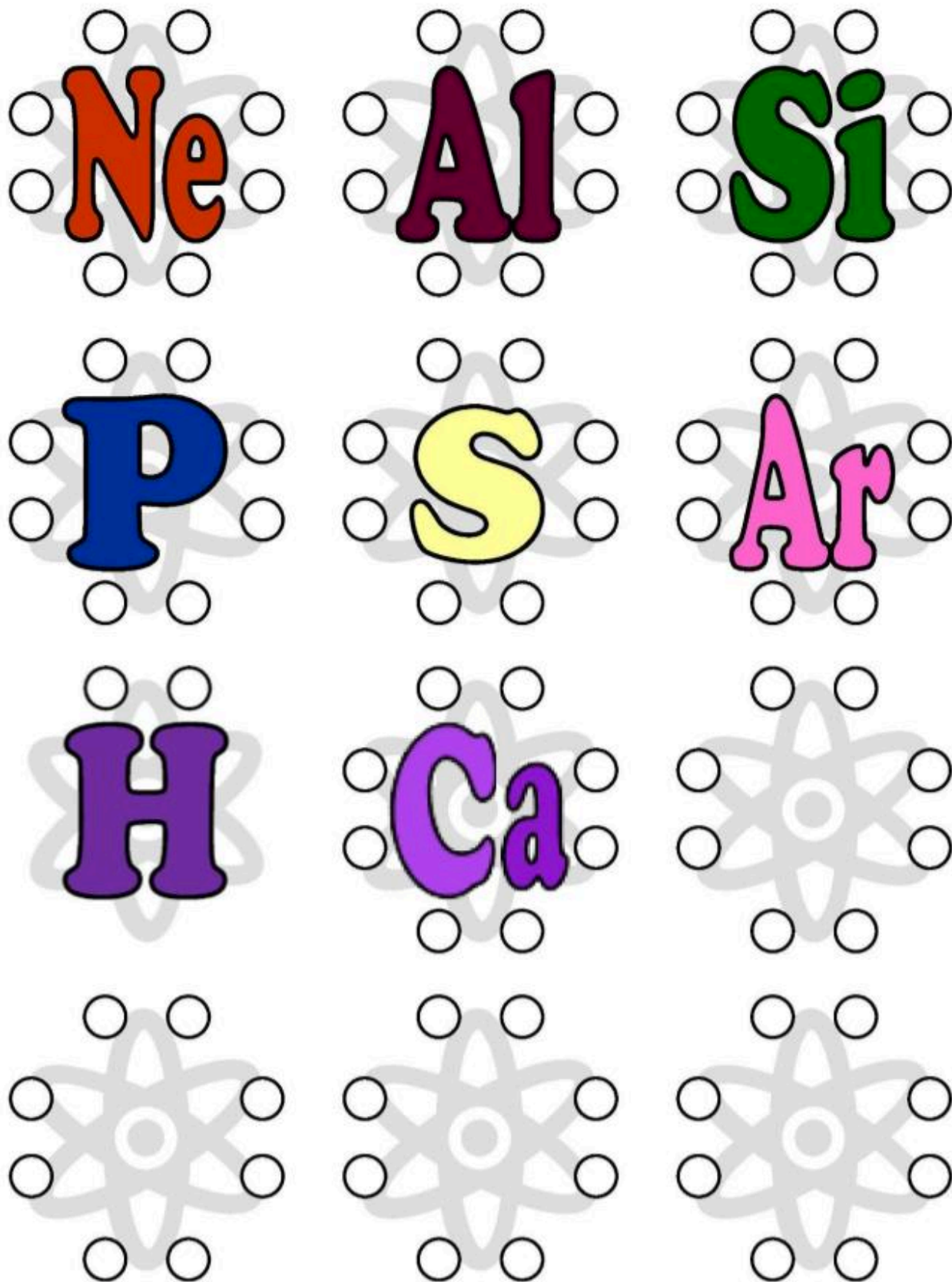
Bonding Basics Element Cards



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Everything Is Connected – Modeling Matter Through Relationships - Resources

Bonding Basics Element Cards



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Bonding Basics Student Worksheet

Complete the chart using a periodic table to help you.

Element	Atomic Symbol	Metal or Nonmetal	# of Valence Electrons	Electrons Needed to Gain / Lose (to Fill Outer Shell)	Oxidation Number
Aluminum					
Potassium					
Magnesium					
Sodium					
Chlorine					
Fluorine					
Nitrogen					
Oxygen					
Hydrogen					
Carbon					
Iodine					
Calcium					
Sulfur					

Answer these questions:

An atom that gains one or more electrons will have a _____ charge.

An atom that loses one or more electrons will have a _____ charge.

An atom that gains or loses one or more electrons is called an _____.

A positive ion is called a _____ and a negative ion is called an _____.

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships - Resources

Bonding Basics Student Worksheet

What is an ionic bond?

Atoms will transfer one or more _____ to another to form the bond.

Each atom is left with a _____ outer shell.

An ionic bond forms between a _____ ion with a positive charge and a _____ ion with a negative charge.

Examples:

1. Sodium + Chlorine Electron dot diagram: Chemical Formula _____	2. Magnesium + Iodine Electron dot diagram: Chemical Formula _____
3. Potassium + Iodine Electron dot diagram: Chemical Formula _____	4. Sodium + Oxygen Electron dot diagram: Chemical Formula _____
5. Calcium + Chlorine Electron dot diagram: Chemical Formula _____	6. Aluminum + Chlorine Electron dot diagram: Chemical Formula _____

Challenge: What are some other ionic bonds that can be formed by the elements you see? Remember that you need a metal and a nonmetal to make an ionic bond. Write the chemical formula for the compound and its name.

Lesson Plan 1:

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Bonding Basics Student Worksheet

What is a covalent bond?

Atoms _____ one or more electrons with each other to form the bond.

Each atom is left with a _____ outer shell.

A covalent bond forms between two _____.

Examples:

7. Hydrogen + Chlorine Electron dot diagram: Chemical Formula_____	8. 2 Hydrogen + Oxygen Electron dot diagram: Chemical Formula_____
9. Chlorine + Chlorine Electron dot diagram: Chemical Formula_____	10. Oxygen + Oxygen Electron dot diagram: Chemical Formula_____
11. Carbon + 2 Oxygen Electron dot diagram: Chemical Formula_____	12. Carbon + 4 Hydrogen Electron dot diagram: Chemical Formula_____

Challenge: What are some other covalent bonds that can be formed by the elements you see? Remember that you need two or more nonmetals to make a covalent bond. Write the chemical formula for the compound and its name if you know it.

Lesson Plan 1:

Everything Is Connected – Modeling Matter Through Relationships - Resources

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