The Impact of the SIOP Model on Middle School Science and Language Learning

Chemical Interactions: Atoms and Bonding Unit

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References

Echevarria, J., Vogt, M.E. & Short, D. (2008). *Making content comprehensible for English learners: The SIOP® Model*, Third Edition. Boston: Allyn & Bacon.

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SIOP SCIENCE LESSON PLAN

SUBJECT: Chemical Interactions
UNIT FOCUS: Atoms and Bonding

Lesson # _1__ **Length of lesson _1 day (75 min)**

STANDARDS: 1.1.1) Explain why elements are sometimes called the building blocks of matter. **1.1.2)** Describe how atomic theory developed and changed.

LESSON TOPIC: Elements and Atoms - Introduction

OBJECTIVES:

Content

- Students will identify elements, mixtures, and compounds in order to show that different substances have different observable properties
- Students will compare and contrast types of matter in order to complete a Venn diagram

Language

- Students will define key terms in order to discuss different types of matter
- Students will read in order to identify the main idea and supporting details

KEY VOCABULARY: matter, elements, compound, substance, mixture, particle, atom, pure, simple

Review: *nucleus, ratio*

MATERIALS: overhead transparencies for class KWL, Word Strategies Checklist, Categories of Matter chart, and 3-way Venn diagram (uncompleted); student copies of Lesson 1 Notes Template; orange juice, salt, sugar, aluminum foil, soil, and metric rulers; *Science Explorer: Chemical Interactions* (pp. 5-7) student edition

PREPARATION:

1) Post the objectives.
2) Gather enough metric rulers for students to complete the Discover Activity in the Motivation section of the lesson.
3) Make copies for each student of the Lesson 1 Notes Template. Make transparencies of the Categories of Matter chart, KWL chart, 3-way Venn diagram, and Word Strategies Checklist.
4) Gather the supplies for the Practice/Application section of the lesson (container of soil, a piece of aluminum foil, a cup of orange juice, container of sugar, and a container of salt).

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MOTIVATION: (10 minutes)

**Read and explain the content and language objectives of this lesson to the students.
Say, "Let's look at our content objectives for today." (Read content objectives aloud and discuss.) "Now let's look at our language objectives for today." (Read language objectives aloud and discuss.)

Building Background:

- Pair students to complete the Discover Activity on page 6 in the text. Draw the size circle on the board students should work with and distribute a metric ruler to each pair. Have students follow the directions as listed on page 6 in the text. Ask one person from each pair to share out the prediction. Debrief with the students about the size of an atom. Help the students visualize how small an atom is by telling them that an ordinary atom has a diameter of about three-billionths of a meter. That means if you lined up a million atoms from shoulder to shoulder, they would be about as big as this dash: — (record for students to see). Tell students that elements are made up of **atoms.** An atom was considered the smallest piece of matter. Tell the class they are going to learn more about elements and atoms in weeks to come.

PRESENTATION: (45 minutes)

- As a class, ask the students to help you start a KWL for this chapter. First ask pairs to look at page 5 in the textbook and discuss what they would put in the "What I Know" column of the chart. After a few minutes of discussion, ask for responses from the students and record on the overhead transparency KWL diagram. Then ask them to turn to their partner again and discuss the "What I Want to Know" column. Repeat procedure. If there are some ideas you would like the students to focus upon that they didn't discuss, add those to the "W" section of the KWL. Tell them you will fill in as a class the "What I Learned" column as you go through this unit.
- Have students scan pages 6-7 in the Section 1 of the textbook to see if there are any words they do not understand but think will be important in understanding the passage. Record any words the students self-select and discuss. If the students do not pull out the following words, define them: **matter, elements, compound, substance, mixture,** and **particle.** Ask the groups what they think elements, the simplest form of matter, are made up of. Record students' responses and confirm or correct. Review *ratio* and teach *simple* and *pure*.
- Pass out the Lesson 1 Notes Template—Student Version. Tell the students the first column contains the main idea and the second column is where they write supporting ideas or details that explain the main ideas in the first column. Begin by modeling what to do with the first heading in the first column. Ask the students to identify what this chapter is about (their answer should correspond the title on the left hand side of their Notes Template). Then have them look at the supporting detail they must fill in on the right hand side: Matter is made up of elements and atoms are _____.
- Read the first paragraph on page 6 in the textbook and ask the students to complete the statement above based on what they heard. Ask a few students to share their answers. Record for the class to see. Tell students to continue taking notes on their Notes Template in this way.

- Have student pairs take notes for the rest of the reading (pp. 6-7) using the Lesson 1 Notes Template. When the pairs finish, go over the completed notes as a class and record on the overhead or board. Allow time for student corrections as necessary.
- Students will complete a Word Strategies Checklist for the new words. Show the Word Strategies Checklist overhead transparency to the students. Students will copy their own version into their notebooks (students will write the word, the definition, and the strategy they will use to help them remember the word). Tell students they will use the imagery strategy and they complete one for **matter**, **elements**, **compound**, **substance**, **mixture**, **particle**, and **atom**. Model for the students how to complete the Lesson 1 Word Strategies Checklist with the word **matter**. Explain to students that with the imagery strategy the picture they draw is not as important as what that picture means to them. The ultimate goal is to sketch a picture that will help them remember the word. Write these words on the board or add to the Word Wall.

PRACTICE/APPLICATION: (15 minutes)

- Review definitions of **matter** and its three forms (**element, mixture,** and **compound**).
- Divide students into five groups and assign each group one of the following substances: orange juice, salt, sugar, aluminum foil, or soil. Ask the groups to decide what form of matter their substance belongs to. Then ask them to tell you which heading to record it under on the Lesson 1 Categories of Matter Chart transparency. Discuss student responses with group.
- Then ask the groups what they think the simplest form of matter, elements, is made up of. Record students' idea and confirm or correct.
- Display the 3-way Venn diagram transparency and have students copy it in their notebooks. As a class, compare and contrast the three types of matter: elements, compounds, and mixtures. Explain the 3-way diagram: characteristics that all matter types share should be placed where all three circles overlap and characteristics that are different should be recorded outside of where the circles intersect. Some characteristics may be similar for just two of the matter types so these are placed in the part of the circle where just those two circles overlap. Record ideas on transparency and have students copy.

REVIEW/ASSESSMENT: (5 minutes)

- Revisit the KWL. Have students discuss in pairs what they have learned. Ask pairs for responses and write their answers in the L column.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read content objectives above). "Now let's see if we met our language objectives for today." (Read language objectives above)." Discuss.

Note: Keep the KWL and Word Strategies Checklist transparencies for future lessons.

Lesson 1 Word Strategies Checklist

Word	Definition

Strategy Checklist: Check the box of the strategy you will use to remember the word.

☐ Imagery (draw a picture)

☐ Spider Map (body is the word, details and examples are the legs)

☐ Synonym and antonym (same/opposite)

☐ Context (use the word in an original sentence)

In the box, show how you are using this strategy.

Directions: Record what you already know about elements and atoms under the "K" column. Next, think about what questions you have about elements and atoms and record your questions under the "W" column. When you find the answer to your question, record that under the "L" column.

K What you Know	**W** What you Want to know	**L** What you Learned

Element	Compound	Mixture

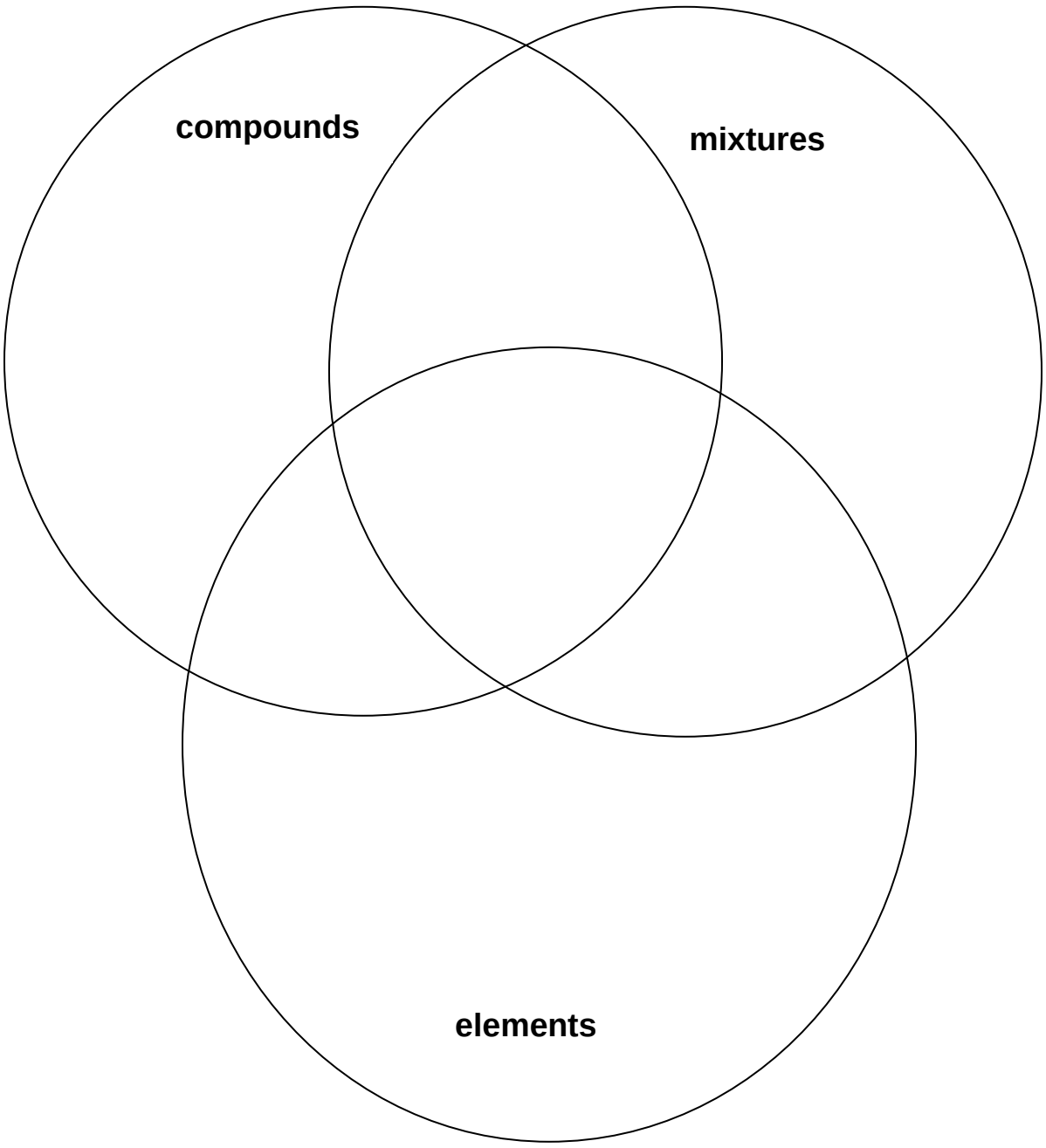
Lesson 1 Notes

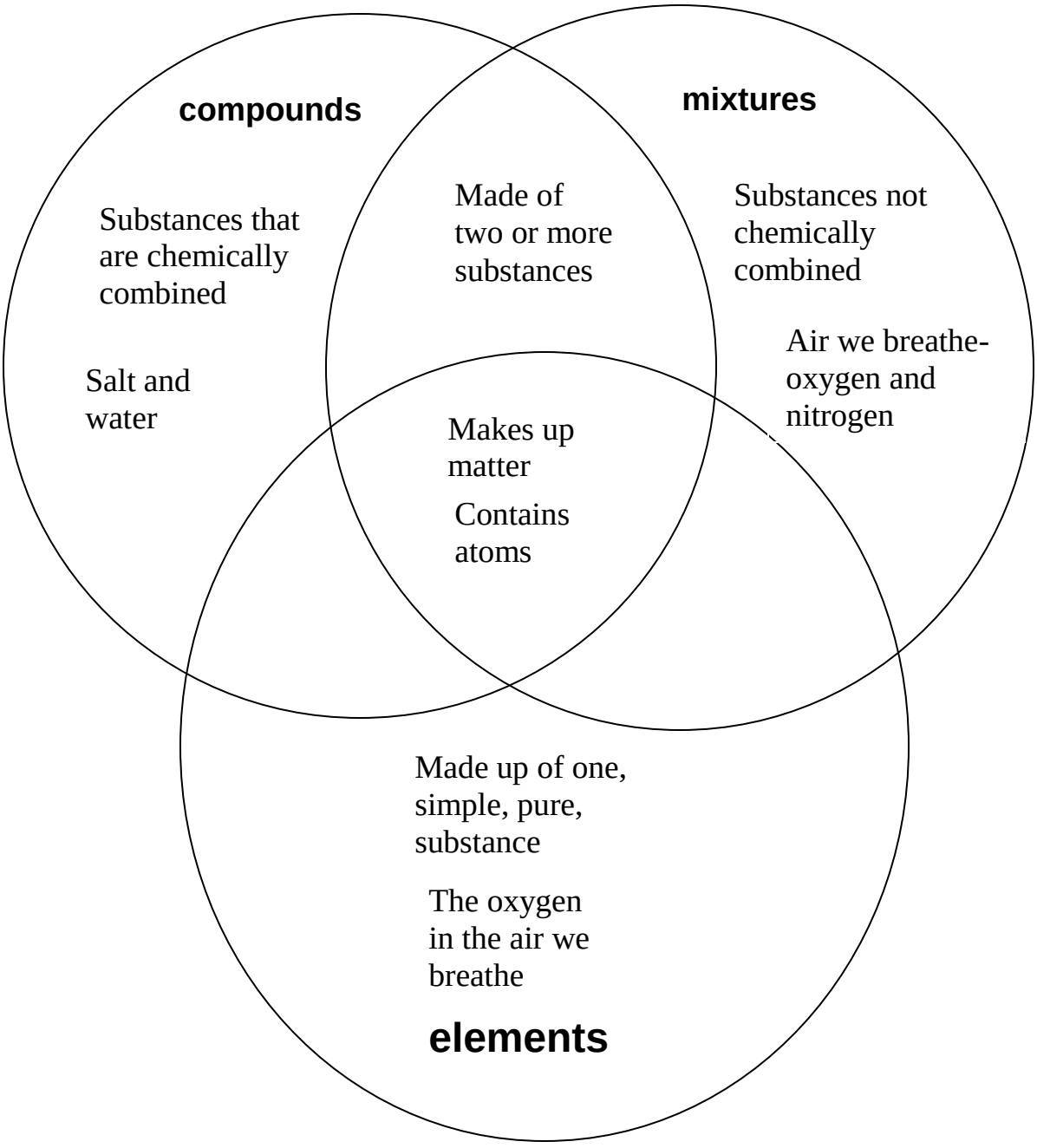
Directions: Read pages 5-7 in the textbook and complete the supporting ideas in the left hand column.

Elements and atoms	Matter is made up of elements and atoms are _____ _____. The Greeks believed that all matter was made up of four things: air, earth, fire, and water. Now, _____ _____ .
There are three categories of matter	1) Word: Definition: Example: 2) Word: Definition: Example: 3) Word: Definition: Example:

Lesson 1 Notes

Elements and atoms	Matter is made up of elements and atoms are the smallest part of an element. The Greeks believed that all matter was made up of four things: air, earth, fire, and water. Now, we know matter is anything that has mass and takes up space.
There are three categories of matter	1) Elements - pure substances that can't be broken down into other substances Example: oxygen, iron, copper 2) Compounds - pure substance made of two or more elements that are combined chemically Example: salt and water (sodium + chlorine) (hydrogen + oxygen) 3) Mixtures - two or more substances that are mixed together but are not chemically combined Example: salad dressing (oil, balsamic vinegar)





SIOP SCIENCE LESSON PLAN

SUBJECT: Chemical Interactions
UNIT FOCUS: Atoms and Bonding

Lesson # 2 **Length of lesson 2 days (150 min. total)**

STANDARDS: 1.1.1 Explain why elements are sometimes called the building blocks of matter.
1.1.2 Describe how atomic theory developed and changed.

LESSON TOPIC: Elements and Atoms - Atomic Theory and Model

OBJECTIVES:

Content

- Students will create an illustrated timeline in order to describe how atomic theory changed and developed
- Students will become an atom model in order to represent modern atomic theory

Language

- Students will read and ask questions of a text in order to identify the main ideas
- Students will use sequence words in order to orally retell important events on a timeline

KEY VOCABULARY: scientific theory, models, electrons, protons, negative, positive, deflect, repel, energy level, neutrons, initially, next, following, finally

Review: *atom, mass, nucleus, orbit*

MATERIALS: student copies of Atomic Theory and Models Notes, Concept Web outline, Plus Minus Question chart, Vocabulary sheet, and Alpha Boxes; overhead transparencies of *The Story of Science* passage, Word Strategy Checklist, KWL chart, and Sample Text Message; electric or battery powered fan, two magnets, signs for atom activity, a foldable example of the timeline; *Science Explorer: Chemical Interactions* (pp. 8-11), student and teacher editions

PREPARATION:

1) Post the objectives.
2) Make an overhead transparency of *The Story of Science* passage and Sample Text Message.
3) You will need 4 student groups in this lesson. Make copies for the number of students in each group: Group 1 - Vocabulary Sheet, Group 2 - Atomic Theory and Models Notes, Group 3 - Plus Minus Question Chart, and Group 4 - Concept Web graphic organizer.

4) Make copies of Alpha Boxes for each student.
5) Secure two magnets for the Motivation of Day One and an electric or battery-powered fan for the Teacher Demo in the Presentation of Day Two.
6) Make or print the signs with the words *electron*, *neutron*, *nucleus*, and *proton* on them. Cut in half. Individual students will hold one so make as many as needed for the number of students you want to participate but make sure the numbers of electron and proton signs are equal (e.g., three proton signs, three electron signs, two neutrons, one nucleus).

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Day One

MOTIVATION: (15 minutes)

**Read and explain the content and language objectives of this lesson to the students.
"Let's review our content objectives for today." (Read content objectives aloud and discuss.)
"Now let's review our language objectives." (Read language objectives aloud and discuss.)

- In their notebooks have the students write the definition of an *atom* in their own words.
- Pre-teach or review what happens when negatively and positively charged particles come together. Consider demonstrating this to the students by showing what happens when magnets come together. Tell students that the electrical charge of atoms is zero because each atom of any element has the same number of positively and negatively charged particles. Tell the students that positively charged particles are called **protons** and negatively charged particles are called **electrons.** Have students complete a Word Strategy checklist (using the context strategy) for these words.
- Tell the students they are going to learn how scientists developed the atomic theory we use today. Pre-teach the terms **scientific theory** and **atomic theory**.

PRESENTATION: (50 minutes)

- Pre-teach the word **model** and show the students an example of the early **models** of atoms (pp. 8 - 9 in textbook). Ask them to think about how a model like this can help scientists understand the world. They should discuss ideas with a partner and then share with the class.
- As students share, record main threads that you hear and summarize or extend their responses. Explain that **models** are representations of an idea that help people understand what they can't see directly.
- Read to the students an adapted passage about Dalton from *The Story of Science* (Hakim, 2005). Display the passage on the overhead projector or via PowerPoint and ask them follow along with you. Model self-questioning and self-selecting key vocabulary. Tell the students that Dalton is one of several scientists who contributed to the modern atomic theory and that they will learn about others. Emphasize and define bolded words (e.g., **surmises**) as you read. Some questions to model for the students as you read aloud are
    - What does the author mean here?
    - Does the author explain this clearly?
    - What does the author want me to know?
- When you finish reading the passage to the students, restate the main idea for the students and answer questions that the students have.

- Tell students that they are going to learn the information in pages 8-11 in the textbook. They will do a Jigsaw activity. Each group read the pages and then do a different task and become an expert of one part of the reading, then they will regroup so they can teach other. Put the students in small expert groups and assign each group a role:
    - Group 1 completes the Vocabulary sheet (identifying, defining, and using words in context).
    - Group 2 uses the Lesson 2 Notes Template to take notes.
    - Group 3 completes a PMQ (plus, minus, question) chart.
    - Group 4 makes a Concept Web of the reading.
- When each group finishes, regroup the students so that there each new group has at least one member of each expert group. Have the students who are now experts take turns presenting the information they learned in the first group. Have students write two things they learned from each group's presentation on the back of their handouts.
- When all groups finish presenting, go over their findings and confirm or correct their understanding of the chapter. Have students add information to their handouts as needed. Consider displaying a timeline with the years the scientists worked for the students to see.
- Have students complete Word Strategy checklists for any words the students in the first group didn't identify (e.g. **scientific theory, models, electrons, nucleus**, **protons, negative, positive, deflect, repel**, **energy level**, **neutrons)** using context.
- Write these words on the board or add to the Word Wall.

REVIEW/ASSESSMENT: (10 minutes)

- Have students stay in their groups to compose a Text Message in their notebooks in order to summarize the material they read. Tell them the text message must be 12 words or fewer. They can use complete sentences or short phrases, but what is most important is that they capture the gist of the passage. If students need help, model by showing them the overhead transparency of the Sample Text Message. Tell students to record their message in their science journals.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Review key vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

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Day Two

MOTIVATION: (10 minutes)

**Read and explain the content and language objectives of this lesson to the students.
"Let's review our content objectives from yesterday." (Read content objectives aloud and discuss.) "Now let's review our language objectives." (Read language objectives aloud and discuss.)

- Have students review chapter vocabulary by completing the Alpha Boxes handout. Have them record as many of the vocabulary terms they remember alphabetically in the appropriate Alpha Box. Check as a class when students are finished.

PRESENTATION: (15 minutes)

- Review the concept of an electron cloud. Ask the students how the electron cloud helps us develop our understanding of atomic models. Ask students to turn and tell a partner their thoughts on this. Students share responses and discuss as a class.
- Tell students you are going to demonstrate an electron cloud. Do the Teacher Demo on page 10 in the textbook's teacher edition. Afterwards, follow the next steps on page 10, asking the students to turn and tell a partner the answer to "How would you describe the blades?" Then ask them "How are the electrons in a 'cloud' of electrons like the blades of a fan?"

PRACTICE/APPLICATION: (35 minutes)

- Tell students to make a foldable timeline summarizing the changes to the atom theory. List on the board the topics that the students should address: Democritus, John Dalton, J.J. Thomson, Ernest Rutherford, Niels Bohr, the Electron Cloud, and James Chadwick. Tell them to include the dates, key points, and any illustrations that will help them tell the story of atomic theory better. They can refer to pages 8-11 in their text. Show the students a completed foldable example.
- Ask the students to use their illustrated timelines to tell a partner about the evolution of the modern atomic theory. Pre-teach (or review) some sequencing words they should use, such as **initially, next, following,** and **lastly.**
- Next tell students they will create a physical model of an atom. Pass out the signs to several students and tell them to come to the front of the classroom. Ask them to organize themselves so their physical positions correctly represent an atom in the modern atomic theory. Give the students the hint that they should consider the position of the electrons related to the position of the protons. Once the students are arranged, ask the remainder of the class if they did it correctly. Confirm and correct as needed with input from the students.

REVIEW/ASSESSMENT: (13 minutes)

- Have students write a few sentences comparing and contrasting how the modern atomic model is different from Bohr's model. Tell them to use at least three of the words from their Alpha Boxes chart. Students share answers in pairs and with the whole class as time allows.
- Revisit the KWL from the first lesson. Have students discuss in pairs what they have learned. Ask pairs for responses and write their answers in the L column.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Review key vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

Dalton and Atomic Theory

Adapted from Hakim, J. (2005).*The Story of Science: Newton at the Center*. Washington, D.C. : Smithsonian (pp. 281-287).

The field of science is **dramatically** changing when John Dalton is born in the year 1766. As a teenager, Dalton studies meteorology and becomes a professor at New College in Manchester, England but he doesn't teach for many years. His real interest is research and conducting experiments.

Through his studies Dalton knows that evaporated water remains in the air as a separate gas but he wonders how this happens. He **surmises** that if air and water are made up of separate particles, then evaporation could be the mixing of the water particles with air particles.

He also knows that basic elements like iron, oxygen, and carbon cannot be broken down into smaller pieces, but he wonders why carbon is carbon and not oxygen. This is the question Dalton sets out to answer.

Through more study and experimentation he begins to believe that all matter, not just gases, consist of small particles. He **hypothesizes** it is the weight of the atom that makes one element different from another. In other words, hydrogen is different from nitrogen because nitrogen is heavier than hydrogen. So how do you weigh an atom, something that you cannot see? Dalton knows this is not possible but he thinks he can find an approximate or, in other words, **relative** weight. Dalton knows if he weighs equal amounts of two different elements he can assume that each has their own special number of atoms. If he gets the ratio of the weights, he still won't know exactly what they weigh but he can compare it to another atom. He hypothesizes, and he is right, that hydrogen is the lightest element so he uses it as the basis for all the relative atomic weights. He did his best to calculate their weight and he also develops another important idea- that atoms can neither be created nor destroyed.

Dalton gets a few parts of the atomic story wrong, but overall, he has the main idea. He publishes his theories in 1808 and he becomes very well-known. Dalton dies in 1844. He has made a huge contribution to how we explain our world today.

Word	Definition

Strategy Checklist: Check the box of the strategy you will use to remember the word.

☐ Imagery (draw a picture)

☐ Spider Map (body is the word, details and examples are the legs)

☐ Synonym and antonym (same/opposite)

☐ Context (use the word in an original sentence)

In the box show how you are using this strategy.

	Word:
Definition:	
Sentence:	

	Word:
Definition:	
Sentence:	

	Word:
Definition:	
Sentence:	

	Word:
Definition:	
Sentence:	

	Word:
Definition:	
Sentence:	

	Word:
Definition:	
Sentence:	

Atomic Theory and Models

The modern atomic model is based on the _____ _____ that developed as scientists collected evidence from experiments. There were four different versions of an atomic model before the modern model we use today.

Dalton's Atomic Theory

Dalton's ideas about atomic theory have changed a little but are most accepted today. He believed

- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____

Thomson's Ideas

J. J. Thomson discovered that atoms _____. However, scientists knew that atoms didn't have _____ so Thomson believed that _____. His model described an atom that had _____ _____ scattered throughout a ball that contained _____ _____. The negatively charged particles were later called _____.

Rutherford and the Nucleus

In 1911 Thomson's student, Ernest Rutherford, conducted an experiment that showed that most of the particles passed through the gold foil but a few _____ _____. He concluded that _____. In his model the atoms were _____. Rutherford later named the positively charged particles in the nucleus _____.

Bohr's Model

In 1913, the Danish scientist Niels Bohr showed that _____ _____ and that this made them move in certain _____.

A Cloud of Electrons

Now scientists don't believe that electrons orbit the _____ like planets. They now think that _____ can be anywhere and decided that a _____ is the best visual model to represent this. This _____ represented where _____ will most likely be located. These scientists said that the movement of an _____.

In other words, if an electron has more energy, then the nucleus holds it less strongly. This is important because the differences in energy level will affect the way _____.

The Modern Atomic Model

The model we use today was formed when James Chadwick discovered another particle. This new particle had the same _____ as a proton and was electrically _____. It was therefore called a _____.

Today we know that the nucleus _____ _____. The only exception is _____.

We also know that

- Atoms of a single element _____.
- Atoms of different elements _____.
- Atoms have _____ because each atom has the _____.

Atomic Theory and Models

The modern atomic model is based on the *scientific theory* that developed as scientists collected evidence from experiments. There were four different versions of an atomic model before the modern model that we use today.

Dalton's Atomic Theory

Dalton's ideas about atomic theory have changed a little but are most accepted He believed

- *All elements are made of atoms that can't be divided.*
- *All atoms of the same element are exactly alike and have same mass. Atoms of different elements are not alike and have different masses.*
- *An atom of one element can't be changed into an atom of a different element. They can't be created or destroyed, only rearranged.*
- *Every compound is made of atoms of different elements combined in a specific ratio.*

Thomson's Ideas

J. J. Thomson discovered that atoms *have negatively charged particles*. However, scientists knew that atoms didn't have *an electrical charge* so Thomson believed that *the atoms must also have a positive charge*. His model described an atom that had *negative charges* scattered throughout a ball that contained *positive charges*. The negatively charged particles were later called *electrons*.

Rutherford and the Nucleus

In 1911 Thomson's student, Ernest Rutherford, conducted an experiment that showed that most of the particles passed through the gold foil but a few *deflected*

strongly. He concluded that *the atom's positive charge was located in the nucleus*. In this model the atoms *were empty spaces with electrons moving around the nucleus*. Rutherford later named the positively charged particles in the nucleus *protons*.

Bohr's Model

In 1913, the Danish scientist Niels Bohr showed that *electrons could only have specific amounts of energy* and that this made them move in certain *orbits*.

A Cloud of Electrons

Now scientists don't believe that electrons orbit the *nucleus* like planets. They now think that *electrons* can be anywhere and decided that a *cloud* is the best visual model to represent this. This *model* represented where *electrons* will most likely be located. These scientists said that the movement of an *electron depends on its energy level*. In other words, if an electron has more energy, then the nucleus holds it less strongly. This is important because the differences in energy level will affect the way *the atom reacts with other atoms.*

The Modern Atomic Model

The model we use today was formed when James Chadwick discovered another particle. This new particle had the same *mass* as a proton and was electrically *neutral*. It was therefore called a *neutron*.

Today we know that the nucleus *has protons and neutrons that make up almost all of an atom's mass.* The only exception is *hydrogen.*

We also know that

- Atoms of a single element *have the same number of protons.*
- Atoms of different elements *have different number of protons.*

- Atoms *have no electrical charge* because each atom has the *same number of electrons as protons.*

Lesson 2 Plus Minus Question Chart

Directions: Read pages 8-11 in the textbook and record notes under the appropriate headings. P is for something that is positive regarding atom theory, such as a good idea someone had about atoms that we still believe today. M is for minus, such as an idea someone had about atoms that we later learned was not true. Q is for any questions you have after reading the passage.

P +	M -	Q ?

Text Message:

Different atomic models
Dalton - atoms not created or destroyed
Thomson - atoms have negative and positive charges
Rutherford - positively charged particles in the nucleus are protons

Instructions: Write vocabulary words in the boxes below to use in your writing later.
Alpha Boxes Topic: ***Atoms and Elements***

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

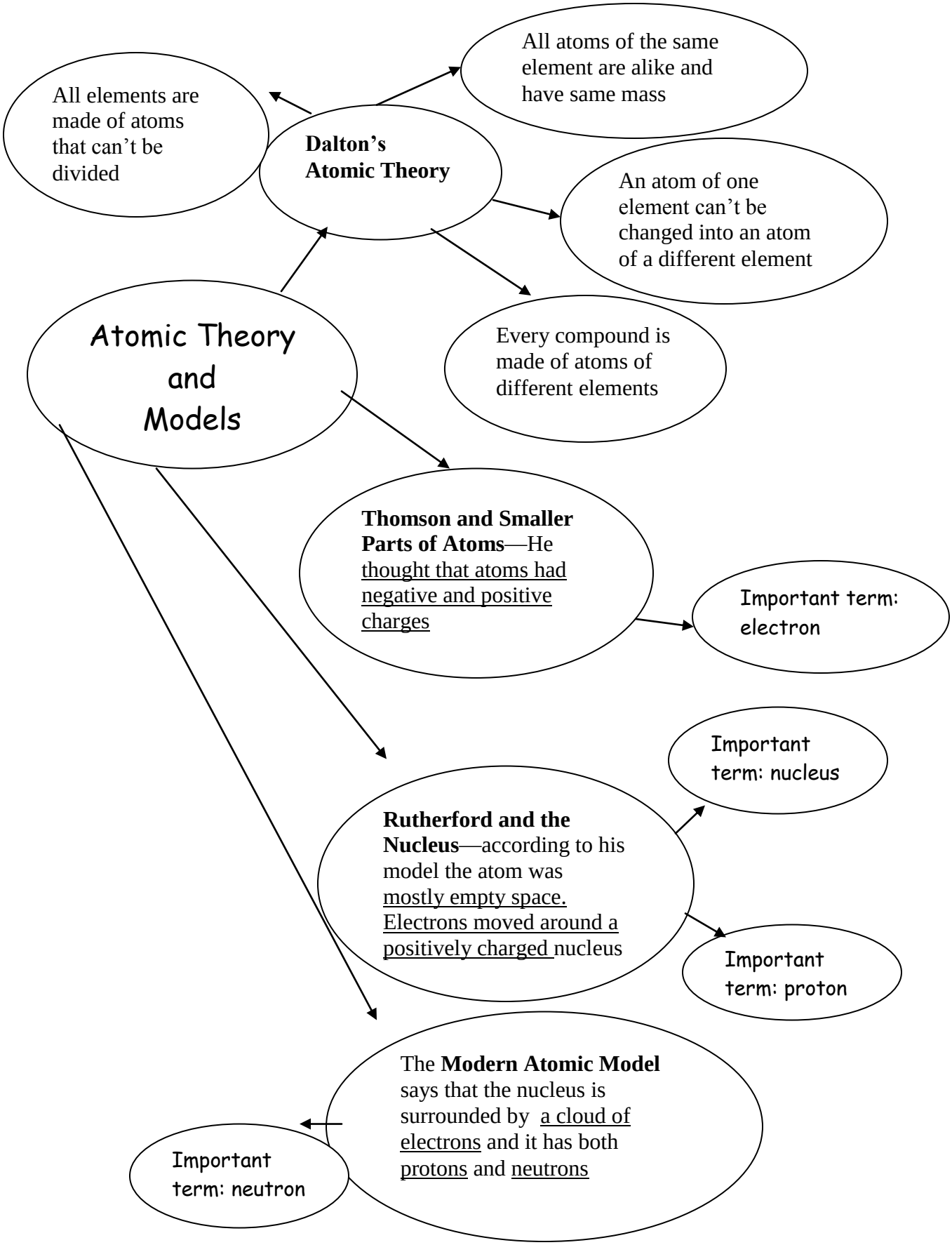
Proton

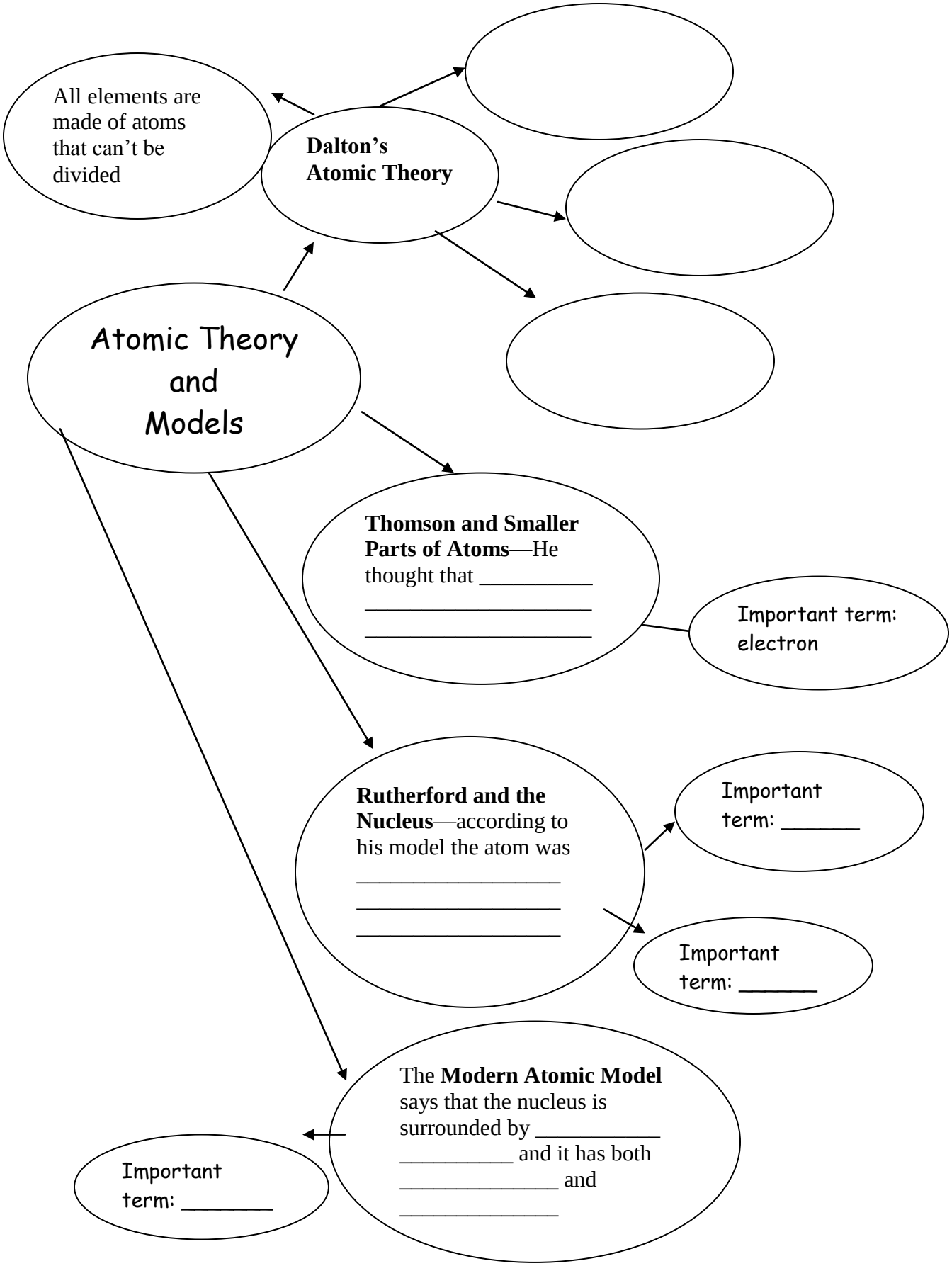
Electron

Neutron

- - - - - - - - -

Nucleus





SIOP SCIENCE LESSON PLAN

SUBJECT: Chemical Interactions
UNIT FOCUS: Atoms and Bonding

Lesson # 3 **Length of lesson 2 days (150 min. total)**

STANDARDS: 1.2.1) Explain how the reactivity of elements is related to valence electrons in atoms. **1.2.2)** State what the periodic table tells you about atoms and the properties of elements.

LESSON TOPIC: Atoms, Bonding, and the Periodic Table

OBJECTIVES:

Content

- Students will interpret data in order to explain what the periodic table tells us about elements and their properties
- Students will recognize patterns in the periodic table in order to demonstrate their understanding of its organization and purpose
- Students will identify the number of valence electrons of elements in order to explain the reactivity of elements

Language

- Students will use the language of prediction in order to discuss a science demonstration
- Students will use transitional phrases in order to write a summary
- Students will define and visually represent key vocabulary in order to develop academic language proficiency
- Students will read an extended passage in a textbook and take notes in order to identify main idea and supporting details

KEY VOCABULARY: valence electrons, electron dot diagram, chemical bond, chemical reaction, stability, symbol, atomic number, period, group, family, noble gases, halogens, alkali metal, eventually, unique, next, then, in addition, last, I predict …, Most likely…..will occur

Review: *density, gravity*

MATERIALS: student copies of Periodic Table Graphic Organizer and Periodic Table Notes; supplies for Teacher Demo (magnesium, calcium, 2 beakers of cold water, 1 beaker of hot water); transparencies of Mendeleyev passage, Word Strategy Checklist, Prediction/Results Chart, GIST, and KWL; pictures of table salt, neon lights, helium balloons, and aluminum cans (or real objects); *Science Explorer: Chemical Interactions (*pp.

12-20) student edition and teacher edition; United streaming video *Atomic Structure and the Periodic Table*

PREPARATION:

1) Post the objectives.
2) Make copies of the Periodic Table Graphic Organizer and Periodic Table Notes for each student.
3) Make a transparencies of the Mendeleyev passage (Day 1), Prediction/Result Chart and GIST (Day 2). Gather materials for Teacher Demo on page 18 of teacher edition.
4) Ready the United streaming video, *Atomic Structure and the Periodic Table.*
5) Cut the Can Questions so that each question is on a different strip of paper and put the strips in a can.

- -

Day One

MOTIVATION: (15 minutes)

**Read and explain the content and language objectives of this lesson to the students.
Say this, "Let's look at our content objectives for today." (Read content objectives aloud and discuss.) "Now let's look at our language objectives." (Read language objectives aloud and discuss.)

Building Background/Review

- In their notebooks, have the students record the definition of *electron*. Ask them to compare their definition with a partner. Then go over it as a class, allowing students to make corrections or additions as necessary. Ask a student to act like an electron, using a table or desk as the nucleus.
- Tell the students that you are going to talk more about electrons and learn two new terms associated with electrons: **electron valence** and **electron dot diagrams**. Pre-teach these words and have students do a Word Strategy Checklist in the notebooks using the imagery strategy.
- Ask the students to discuss their understanding of the word **bond.** Record some of their responses on the board. Then discuss the meaning of the word **chemical bond** with the students. Have students do another Word Strategy Checklist in their notebooks using the imagery strategy for **chemical bond.**
- Add those terms to the Word Wall.

PRESENTATION: (50 minutes)

- Organize students into small groups and have them take out a piece of paper to do a round robin writing activity. Have students turn to pages 14 and 15 in the textbook to view the periodic table. Model making an observation about the periodic table and writing it down. Tell the students to make observations and take turns passing the paper around their groups in order to record their observations. After giving the students a set amount of time to complete the round robin writing activity, ask a member of each group to read their responses to you. Record for all to see.
- Next lead the students through the Discover Activity on page 12 in the text. Students can discuss the questions orally in pairs. Debrief with the class. Then, liken the **periodic**

table to characteristics of a **family**. Remind the students of what "characteristics" means and ask the student to do a Think-Pair-Share and explain how these elements can be organized into families as people are.

- Tell the students we are going to learn how the periodic table was developed and how scientists use it to learn about matter in the world.
- Guide students through the organization of the periodic table. Tell the students that the periodic table was first conceptualized in 1869 by Dmitry Mendeleyev to show the similarities and differences of all the elements. The elements are arranged in increasing order of **atomic number (Z)** from left to right across the table. The horizontal rows are called **periods** and the vertical rows, **groups** or **families.** Discuss these words in terms of their more familiar definitions and their specialized meanings for this science topic. There is a progression from metals to non-metals across each period and a **noble gas** is found at the right hand side of each period. Elements in certain **groups** (e.g., alkali, halogens) have a similar electronic configuration.
- Show the transparency with the Mendeleyev passage and read it aloud to the students. Consider making a timeline so students can see Mendeleyev's work is in relation to the other scientists discussed. Draw students' attention to highlighted words (e.g., **unique**) and discuss meanings. Model some questioning techniques with the student as you do this (e.g., What is the author trying to say here? What is the author's message?)
- Have students complete Word Strategy Checklists in their notebooks for **atomic number, period,** and **group/family.** Write these words on the board and add to the Word Wall.
- Have students scan section two (pp. 12-15 of text) to see if there are any other words they do not understand but think will be important in understanding the passage. Model this by reading the first paragraph under Valence Electrons and Bonding section on page 12 in the textbook to the students. Tell the students you know the term "electron" but you are not sure about "**valence electrons**" so you will record this as a new, important word. Tell the students to do this process for the rest of the pages of the assigned reading. Record any words the students self-select and discuss.
- Divide students into groups and pass out the graphic organizer based on the three reading sections on pages 12-13. Tell students that they will read the graphic organizer and as a group create their own summary paragraphs based on the information in the graphic organizer. Make sure they know they will be transforming the graphic organizer of the reading into an expanded version. Demonstrate the process by modeling for the students how you would introduce the topic (e.g., The periodic table helps us understand properties of elements. For example, the valence electrons of an atom can tell us how it will bond with other atoms.) Suggest other transition phrases to use, such as next, then, in addition, last.
- After the students finish writing their summaries as a whole class, go over the summaries and elaborate and explain as necessary.

PRACTICE/APPLICATION: (5 minutes)

- Put students into groups to identify the period and group of several elements in the periodic table. Call out an element (e.g., magnesium) and the first group that can tell you its symbol, period, and group number gets a point.

REVIEW/ASSESSMENT: (5 minutes)

- Students complete a 3-2-1 review (three things they learned, two things they have questions about, and one thing that was interesting to them) on a piece of paper. Have a few share out, then collect.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Review new vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

- -

Day Two

MOTIVATION: (20 minutes)

**Read and explain the content and language objectives of this lesson to the students.
Say, "Let's review our content objectives." (Read and discuss content objectives above.) "Now let's review our language objectives." (Read and discuss language objectives above.)

Building Background/Review

- Read aloud some of the 3-2-1s from previous day.
- Next, show students pictures of elements they have prior knowledge of or experience with such as table salt, neon lights, helium balloons, and aluminum cans and ask them to identify and tell anything they know about them. Then ask the students if they are familiar with any other elements. Record. Discuss and clarify ideas as necessary
- Do the Build Inquiry exercise on page 15 of the teacher edition of the text. Have students answer the questions in pair and write the answers in their notebooks.
- Do the Can Questions Activity. Divide students into four groups. Have one student from each group pick a question from the can. Have the students in that group discuss their question and write the answer in their notebooks. Have each group pick a presenter and have the presenter share the group's answer with the class.

PRESENTATION: (30 minutes)

- Before beginning the demonstration, display the Predictions/Results Chart transparency for students to copy into their notebooks. Ask the students, in pairs if preferred, to make three predictions about the demonstration which will involve magnesium, calcium and water. Activate their thinking by asking them to look at the materials you have set up and consider what you might do and what they might learn from the demonstration. Give students some sentence starters like "I predict…" and "Most likely …. will occur."
- Do Teacher Demo on page 18 in the teacher edition of the text.
- After the demonstration, as a class, debrief on what actually happened in the demonstration. Talk about the predictions and results and answer questions as they arise. Have students fill out the results sections of the chart.
- Tell the students they will take notes in pairs, as they did in Lesson 1, using the Periodic Table Notes for pages 16-20 in the text. After the pairs finish, review their notes and correct, confirm, and elaborate as necessary.
- Display the GIST transparency and tell students that after watching a video, they will complete a GIST in their notebook. They will record 10 key phrases or words about the

video and then summarize it. Show the United streaming video, *Atomic Structure and the Periodic Table*.

- Have students do the Word Strategy checklist in their notebooks for key words (noble gases, halogens, alkali metal).

PRACTICE/APPLICATION: (20 minutes)

- Distribute slips of paper to 12 students with the following elements: Krypton (Kr), Phosphorus (P), Potassium (K), Magnesium (Mg), Silicon (Si), Oxygen (O), Sodium, (Na), Neon (Ne), Calcium (Ca), Sulfur (S), Nitrogen (N), and Carbon (C).
- Ask those students to find their partner, someone who has an element with chemical properties similar to theirs. Students can do this with the input from other students and by looking at the periodic table. Once the students are matched, check if their pairings are correct.
- Next have students draw a visual model of an element of their own choice. Show them an example of beryllium and ask how we know its beryllium. (The dots in red are the four protons). Tell students to look at the periodic table on pages 14-15 for assistance.
- Ask students to share their models with the class.

REVIEW/ASSESSMENT: (5 minutes)

- Revisit the KWL from Lesson 1. Have students discuss in pairs what they have learned in this lesson. Have partners share their ideas and record responses on the KWL.
- Review the objectives. Say, “Let’s see if we met our content objectives for today.” (Read and assess content objectives). Review key vocabulary. “Now let’s see if we met our language objectives for today.” (Read and assess language objectives).”

Mendeleyev passage

The Periodic Table: A Chemical Family Tree

Adapted from *The Story of Science: Newton at the Center* (Hakim, 2005 pp. 309-310)

Dmitri Mendeleyev was born in Siberia in 1834, the youngest of 14 children. Mendeleyev was not the best student but he **eventually** gets accepted to the Central Pedagogical Institute. He studied there and added to John Dalton's ideas about atomic weight. (Atomic weight is the number that describes the mass of an atom in any given element.)

At the time there was no known way to organize the elements—63 had been identified but no one saw how they could be grouped—so this became Mendeleyev's challenge. He saw that atomic weight is important because each of the 63 elements has atoms with its own **unique** mass. Therefore mass is one way to categorize elements. He also believed there must be some reason why some elements share properties and some don't. So he began to search for clues to this puzzle. He listed the elements by their atomic weights and by other characteristics like **gravity**, heat, **density**, and valence. But after looking at his lists he saw the elements don't seem to relate to one another.

After working with the elements all day, Mendeleyev put his head on this table in exhaustion. He fell asleep and had a dream. He saw the answer to this puzzle in his dream. When he awakened he drew a large rectangle with vertical columns and horizontal rows and in the columns he listed the elements from lightest to heaviest according to their atomic weight. In the rows, he lined the elements up that had similar properties. Reading from left to right he saw that the weights increase by regular amounts. In some places, where the pattern didn't continue, he wrote a "?". He believed those elements were missing but one day would be found. He was correct—while Mendeleyev was alive, the elements gallium, scandium, and germanium were discovered and the spaces in the table were filled in—having the properties Mendeleyev predicted they would. Mendeleyev called this grid a **periodic table**.

Word	Definition

Word Strategy Checklist: Check the box of the strategy you will use to remember the word.

☐ Imagery (draw a picture)

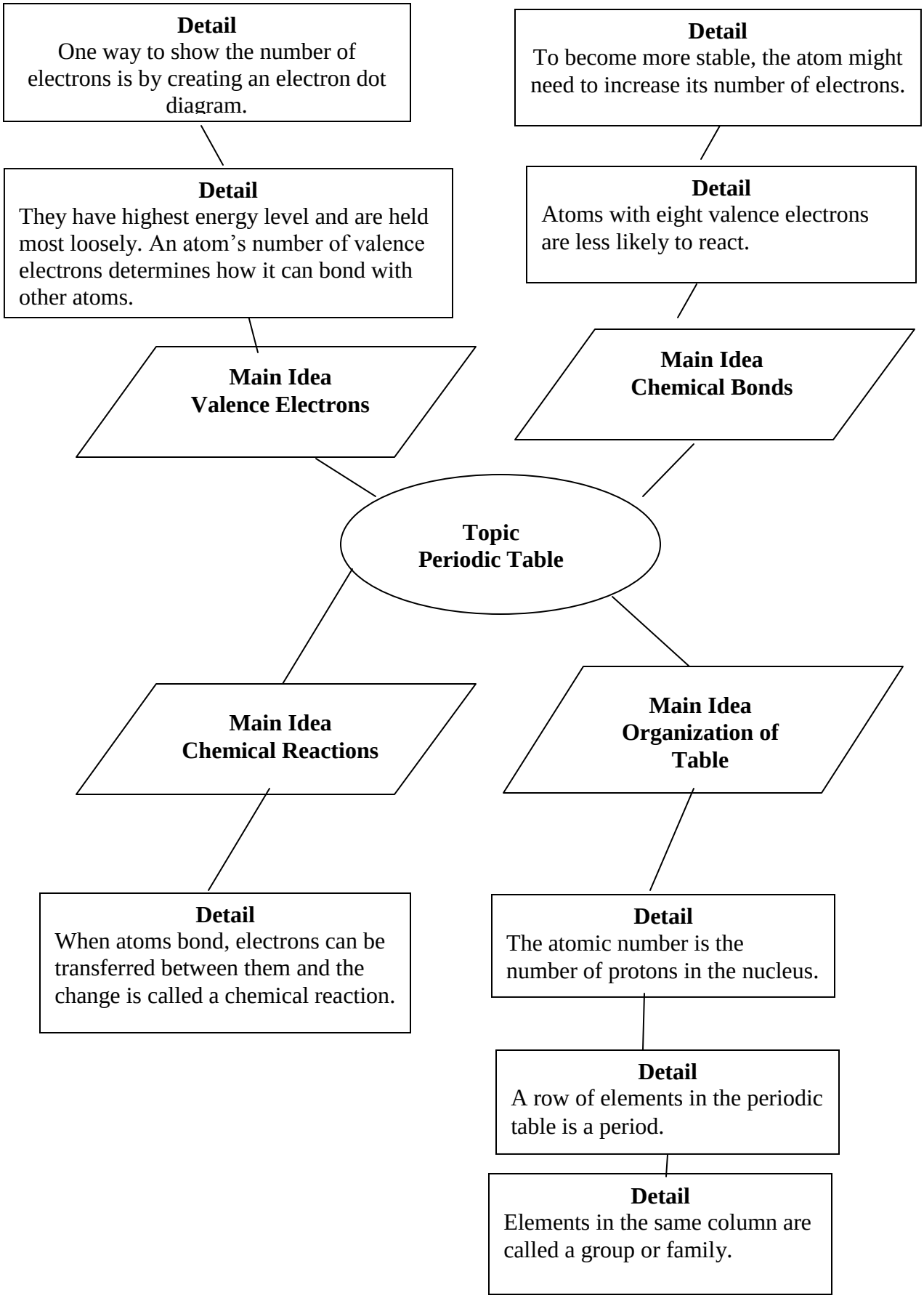
☐ Spider Map (body is the word, details and examples are the legs)

☐ Synonym and antonym (same/opposite)

☐ Context (use the word in an original sentence)

In the box show how you are using this strategy.

Lesson 3 Periodic Table Graphic Organizer



Predictions	Results (What Really Happens)

How are the terms chemical bond and chemical reaction related?
How many protons does chromium have?
Which two types of particles contribute most to an atom's mass?
What patterns are displayed in a row and in a period of the Periodic Table?

Periodic Table Notes Outline

Directions: Read pages 16-20 to complete the notes outline.

How the Periodic Table Works	Atoms change from left to right across a period. As the number of protons _____, the number of _____. Except for _____, the period ends when the _____. The next period has atoms with _____ _____.
Noble Gases	_____ _____ These gases are _____, so they don't _____with other elements. Example: _____
Reactive Nonmetals and Metals	The group to the left of noble gases are elements called_ _____. _____valence electrons. Gaining one makes them _____. _____ _____with other elements whose atoms can give up or share electrons. Example: _____
Alkali Metal	_____ _____more stable if they lose their one valence electron. They are very _____. Example: _____ There are other metal elements in groups 2 through 12. Nonmetals, like _____ _____.

Periodic Table Notes Outline

How the periodic table works	Atoms change from left to right across a period. As the number of protons *increases,* the number of *electrons increases.* Except for *period one,* the period ends when the *valence electrons reach eight.* The next period has atoms with *higher energy than the period before it.*
Noble Gases	*Noble gases have eight valence electrons, except helium.* These gases are *stable* so they don't react easily with other elements. Example: *Neon*
Reactive Nonmetals and Metals	The group to the left of nobles gases are elements called *halogens. They have seven* valence electrons. Gaining one makes them *stable. Elements in this family react easily* with other elements whose atoms can give up or share electrons. Example: *Bromine*
Alkali Metal	*This group has only one valence electron so they can become* more stable if they lose their one valence electron. They are very *reactive.* Example: *Sodium* There are other metal elements in groups 2 through 12. Nonmetals, like *carbon, have four or more valence electrons.*

GIST

List 10 key words or terms from the video.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

Write a brief summary about what you learned from the video:

SIOP SCIENCE LESSON PLAN

SUBJECT: Chemical Interactions
UNIT FOCUS: Atoms and Bonding

Lesson # 4 **Length of lesson 2 days (150 min. total)**

STANDARDS: 1.3.1 Describe ions, and explain how they form bonds. **1.3.2** Explain how the formulas and names of ionic compounds are written. **1.3.3** Identify the properties of ionic compounds.

LESSON TOPIC: Ionic Bonds

OBJECTIVES:

Content

- Students will create concept maps in order to explain ions and how they form bonds
- Students will observe a science investigation to learn about the properties of ionic compounds

Language

- Students will express opinions in order to predict how ionic bonds form
- Students will list observations and inferences in order to record information from a scientific demonstration
- Students will orally interact with peers in order to demonstrate ionic bonding

KEY VOCABULARY: ion, ionic bond, ionic compound, chemical formula, subscript, transfer, crystal, solution, conductivity, My opinion is …, It seems that …

MATERIALS: Supplies for Day 1 stations (balloons, aluminum cans, red and black checkers) and Day 2 Teacher Demo (p. 26 in the teacher edition - heavy pot, hot plate, wooden spoon, 100 mL salt); Ion Concept Map, Prediction/Results chart, and Word Checklist Strategy transparencies; copies of Ions and Ionic Bonds Notes Outline, Stations 1 & 2 worksheet, Chemical Formula and Names Notes Outline, Alpha summary worksheet, and Bond with a Classmate Data Table; Bond with a Classmate tags, Zip-A-Round cards, concentration cards, and envelope; *Science Explorer: Chemical Interactions* (pp. 22-27) student edition and teacher edition

PREPARATION:

1) Post the objectives.
2) For Day 1, make student copies of the Chemical Formula and Names Notes Outline, Ion and Ionic Bonds Notes Outline, Stations 1 & 2 Worksheet, and Alpha Summary. Make a transparency of the Ion Concept Map. Decide how many groups you will have for the

Discover Activity and gather enough checkers for Station 1. Blow up three or four balloons and collect three or four aluminum cans. Cut the concentration document into individual pieces and secure and place in an envelope. Gather supplies and set up for Teacher Demo on page 26 in the teacher edition of the textbook (heavy pot, hot plate, wooden spoon, 100 mL salt). Retrieve the Word Checklist Strategy transparency.

3) For Day 2 cut the Zip-A-Round cards into strips (one word and a different word's definition). Retrieve transparency of the Prediction/Results Chart. Make students copies of the note-taking template (Chemical Formulas and Names) and Bond with a Classmate Data Table. Cut out the ion tags for the Bond with a Classmate activity.

- -

Day One

MOTIVATION: (12 minutes)

**Read and explain the content and language objectives of this lesson to the students.
"Let's look at our content objectives for today." (Read content objectives aloud and discuss.)
"Now let's look at our language objectives." (Read language objectives aloud and discuss.)

Review/Building Background:

- Do a Word Splash (Ur, 1995) to review previous key vocabulary. Write six words from the unit for the students to see on board or transparency (e.g., compound, electron, group, halogen, model, proton). Tell the students to look at the words very carefully because you will erase one of them. Ask the students to close their eyes, then erase a word. The first person who can say the word, spell it, and use it in a sentence correctly will get a point. Continue until all the words have been erased. If desired, have students play in groups.
- Tell students to look at the cartoon on page 23 in the textbook. Ask them to consider what the cartoon means in order to predict what they will study today. Discuss student ideas and elaborate with an emphasis on academic vocabulary when appropriate.

PRESENTATION: (40 minutes)

- Pass out the Station Chart and tell the students they are going to learn about how and why electrons are transferred between atoms. Demonstrate the word **transfer** with the picture of money exchange on page 22 in the text or by a demonstration between two students.
- Organize students into groups and assign each group to a station. Each group stays at a station for about 12 minutes. Have groups rotate when you call time.
    - Station 1: Students complete the Discover Activity by following the directions on page 22 in the textbook. Students fill out the Station 1 Chart with their observations and inferences.
    - Station 2: Students take a balloon, rub it on their heads and record on the Station 2 Chart what happens (observation). Then they rub it on their heads again and bring it close to the empty aluminum can. They record these observations and inferences based on what they observed. Let them explore other possible attractions with a rubbed balloon, such as if it will stick to a wall, or if it is attracted to a book or to an item made of a different metal (not aluminum).
    - Station 3: Students complete Ions and Ionic Bonds Notes Outline for pages 23-24 in text.

  - Station 4: Students play Concentration. They form two groups and spread the concentration pieces out on a desk with the blank side up. Then student groups take turns turning over the pieces until they match the term with the example of the term. When done, they return pieces to the envelope.
- When groups finish all stations, debrief with the class and record any important points that are raised. Highlight key concepts and words. Define new words for the students and have students do a Word Strategy Checklist in their notebooks. Add the new words **(ion, ionic bond)** to Word Wall.

PRACTICE/APPLICATION: (13 minutes)

- Have groups do the Build Inquiry activity on page 24 of the teacher edition of the text to predict how ions will bond. Follow the directions on page 24 of the teacher edition–you will need a list of positive and negative ions (see Figure 16 on p. 23 in the teacher edition). Emphasize the difference between fact and opinion in science. Pre-teach some phrases that indicate opinion such as: "I believe …," "It seems that …," and "My opinion is …." Have students share out predictions.
- Display the Ion Concept Map transparency. Have students discuss the questions with a partner. Review student responses as a class.

REVIEW/ASSESSMENT: (10 minutes)

- Students complete an Alpha Summary to recall what they learned about ionic bonds.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Go over new vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

- -

Day Two

MOTIVATION: (10 minutes)

**Read and explain the content and language objectives of this lesson to the students.
Say, "Let's review our content objectives for today." (Read and discuss content objectives above.) "Now let's review our language objectives." (Read and discuss language objectives above.)

Review:

- Do a Zip-A-Round to review chapter vocabulary and concepts. Pass out cards to students and have one student begin. Tell the students that they need to ask "Who has" along with the single word on the card. The person who has the matching card should say "I have…" and then read the answer (definition on his or her card). This continues until the student who read the first question answers. If time permits, the game could be re-played with an emphasis upon speed and/or accuracy.

PRESENTATION: (30 minutes)

- Have students get into groups to complete the Skills Activity on page 25 in the textbook. Do the first problem with the students. Have groups share out their answers in a quick Round Robin.

- Then do the Teacher Demo on page 26 in the in the teacher edition of the text. Pass out the Predictions/Results chart prior to the demonstration and tell the students to complete the Predictions column before you start. Have them complete the "What Happened" column afterwards. Go over student predictions and observations as a class.
- Put students into heterogeneous pairs (e.g., stronger with weaker, English learners with non-English learners) and ask them to read assigned passage (pp. 25-27 in the text) and take notes on the Chemical Formula and Names Notes Outline. When pairs finish, have pairs form a group of four to share their outlines. Review the outlines as a class and make note of new vocabulary. Record on board as you or students identify key words (**chemical formula, crystal, ionic compounds, conductivity**) to learn.
- Have students add to the Alpha Summary from the previous day and add new words to Word Wall.

PRACTICE/APPLICATION: (25 minutes)

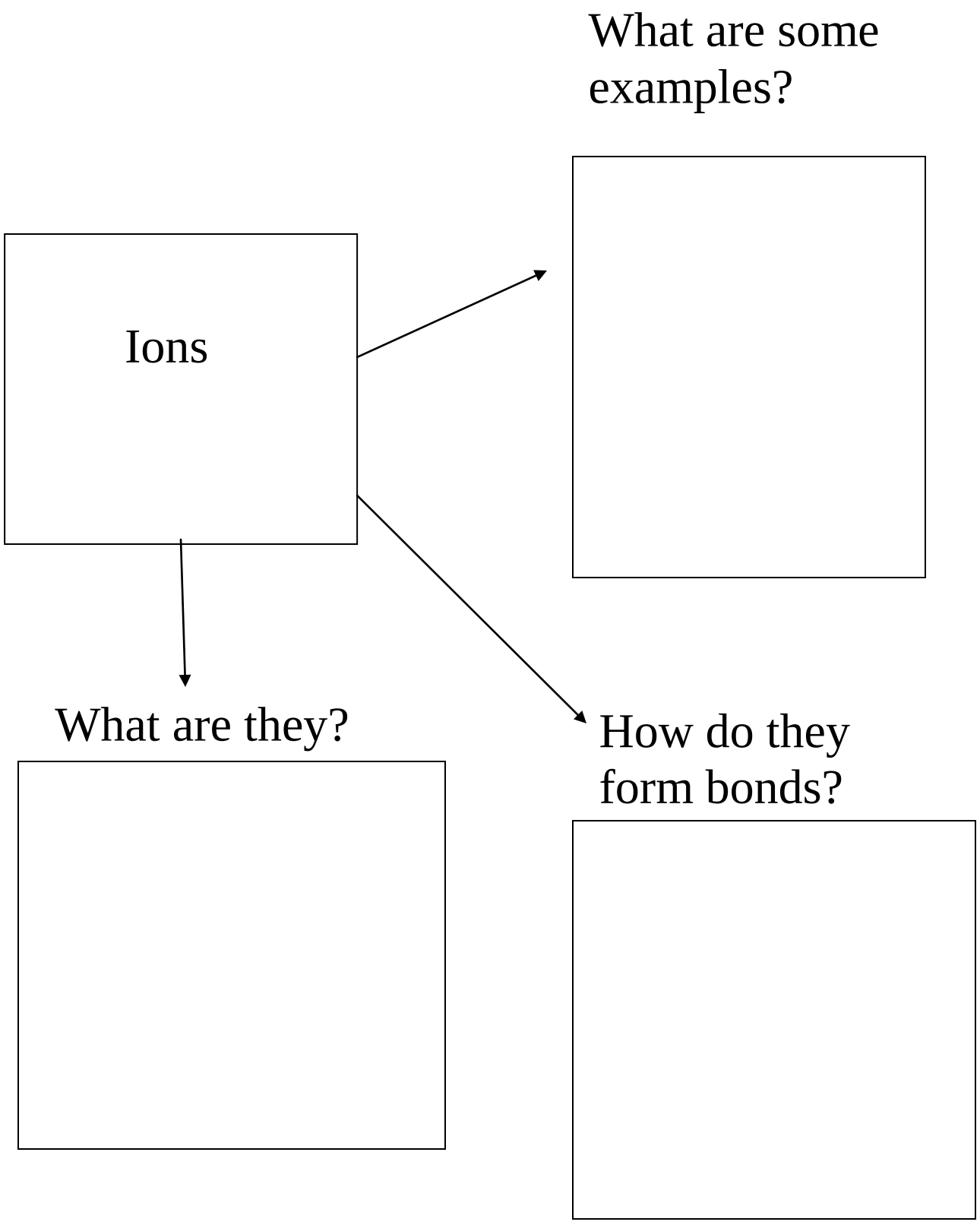
- Have students do the "Bond with a Classmate" activity. Tell the students they are going to become an ion.
  - Pass out the ion tags and ask the students to hold them.
  - Ask each student to decide whether she or he is a negative ion.
  - Then tell the students to find a partner of the opposite ion charge.
  - Give students a couple of minutes to find her or his partner.
  - Tell them to write their element symbol and charge in the Bond with a Classmate Data Table along with their partner's (each student must fill out his or her own notes page).
  - Next instruct the students to write the compound into the data table and tell them to criss-cross their oxidation numbers to make them subscripts. Model how to do this. Remind the students that the positive ion is written first. At this point ask some of the pairs to share what they have written to make sure everyone is on task.
  - Now ask them to name the new compound using the **–ide** ending. Students share out their new compound names. Check to confirm or correct.
  - Next have students find a new partner and repeat the procedure. If there is time students can get a new ion tag and do the process again.

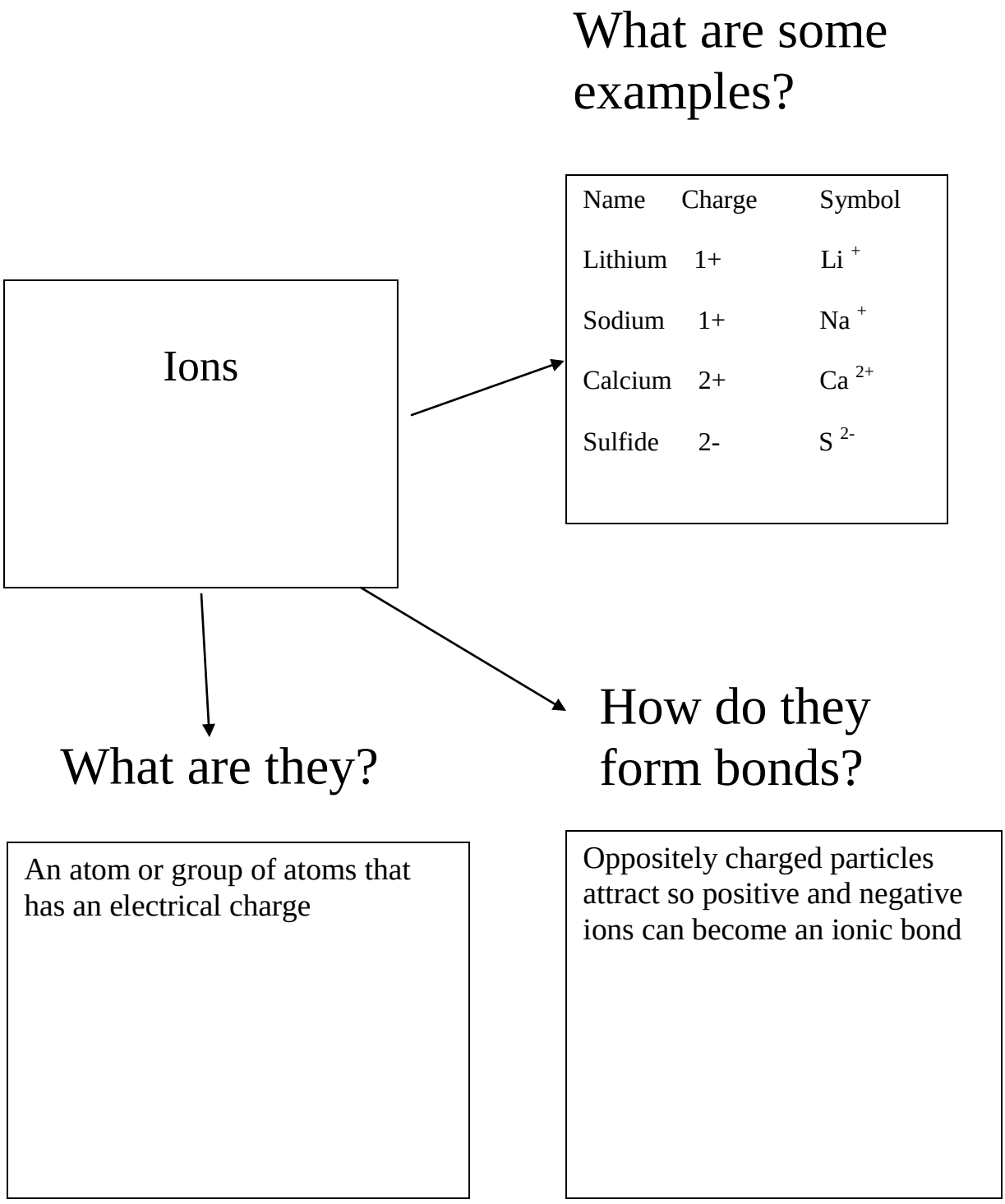
REVIEW/ASSESSMENT: (10 minutes)

- Play Alphabet Soup using Numbered Heads. Divide students into groups and have them number themselves 1 to 4 or 5 depending on size of the class. Tell the students that you are going write a letter of the alphabet on the board and that the first team that can think of a vocabulary word from the unit that begins with that letter, correctly define it, and use it in a sentence gets a point. The team with the most points at the end wins the game. Emphasize that once the whole team has the answer, they must all raise their hands and you will call a number. Only the student with that number can answer so it is important that everyone knows the answer before the team members raise their hands. Play as long as time allows.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Go over new vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

Prediction/Results Chart

Predictions	What Really Happens





Alpha Summary for Ions

What did you learn about ions? List words or phrases about ions that begin with these letters of the alphabet.

A _____
B _____
C _____
D _____
E _____
F _____
G _____
F _____
G _____
H *hydrogen is often an ion*_____
I _____
J _____
K _____
L _____
M _____
N *negative*
O _____
P _____
Q _____
R _____
S _____
T _____
U _____
V _____
W _____
X _____
Y _____
Z _____

Stations 1 & 2 Worksheet

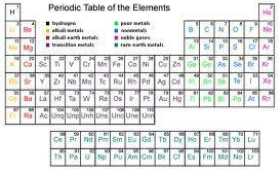
Station 1 chart

1. Place three red checkers and three black checkers on your desk. The red checkers are electrons and the black checkers are protons.
2. Put nine pairs of red and black checkers in another group on your desk.
3. Move a red checker from the small group of red checkers to the large group.
4. Count the number of positive charges (protons) and negative charges (electron) in each group.
   # ___ black checkers in small group # ___ black checkers in big group
   # ___ red checkers in small group # ___ red checkers in big group
5. Sort checkers into a group of four black-red pairs and a group of eight black-red pairs. Repeat steps 3 and 4, but this time move two red checkers from smaller group to larger group.
   # ___ red checkers in small group # ___ red checkers in big group
   # ___ black checkers in small group # ___ black checkers in big group
6. Answer the following questions:
   - What was the total charge on each group before you moved the red checkers (the electrons)? _____
   - What was the charge on each group after you moved the checkers? _____
   - What do you think happens to the charge on an atom when it loses electrons? _____
   - What happens when it gain electrons? _____
     _____

Station 2 chart

1. Rub the balloon on your head and pull the balloon away slowly.
2. What happened? _____
3. Why do you think this happened? _____
   _____
4. Rub the balloon on your head again and then slowly bring it close to the empty aluminum can.
5. What happened? _____
6. Why do you think this happened? _____
   _____

Station 4: Concentration

element	**hydrogen**	**compound**	Sodium chloride 	**electron dot diagram**	**H▪**
atomic number	5 **B** **Boron** **10.81**	**ions**	**lithium**	**mixture**	**sand**
Periodic Table		**atom**		**electron**	**- charge**
Proton	**+ charge**	**neutron**	**electrically neutral**	**polyatomic ions**	**Made of more than 2 ions, ex: NH**
halogens	**Bromine - Group 17**	**chemical formula**	**MgO**	**noble gases**	**Xenon - Group 18**

Station 3: Ion and Ionic Bonds Notes Outline

Directions: Read pages 23-24 in the text and complete the outline

Ions and Ionic Bonds

Atoms become more _____ as their valence electron number increases to eight.

Atoms with three or fewer valence electrons will _____ and become more stable.

Ions form by

Some ions are polyatomic. This means

Give an example of this:

Ionic bonds form by

Station 3: Ion and Ionic Bonds Notes Outline

Ions and Ionic Bonds

Atoms become more *stable* as their valence electron number increases to eight.

Atoms with three or fewer valence electrons will *lose electrons* and become more stable.

Ions form by either losing an electron and losing a negative charge to become a positive ion, or gaining an electron and gaining a negative charge to become a negative ion.

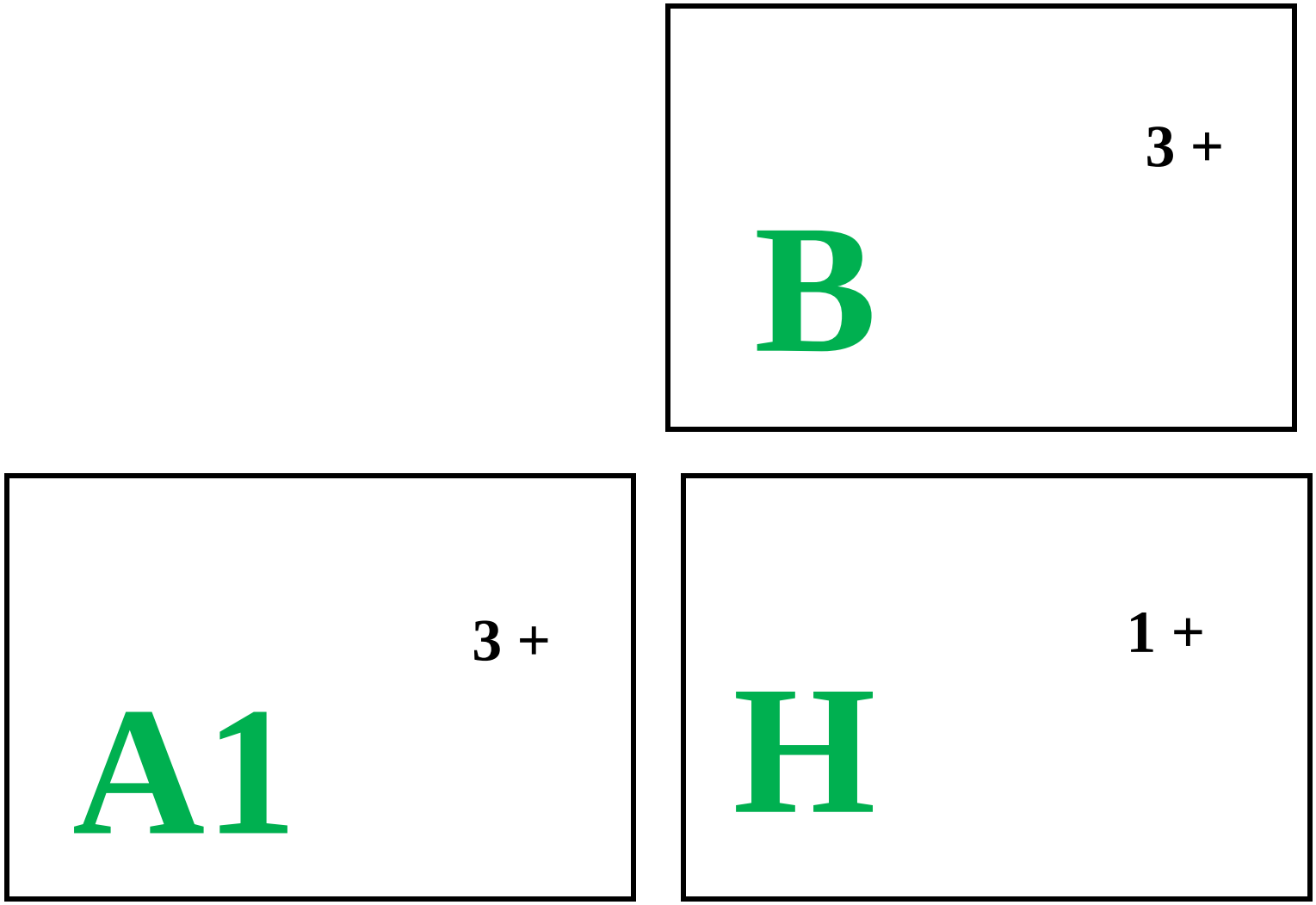
Some ions are polyatomic. This means that they have many atoms.

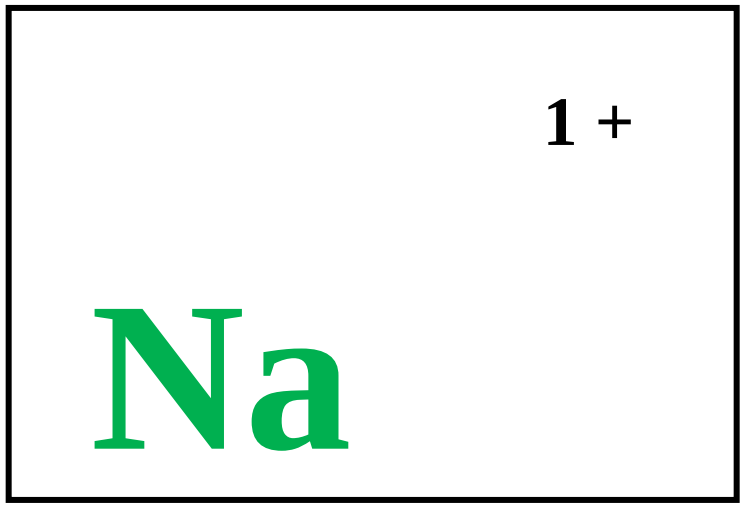
Give an example of this: an ammonium ion is made of nitrogen and hydrogen atoms

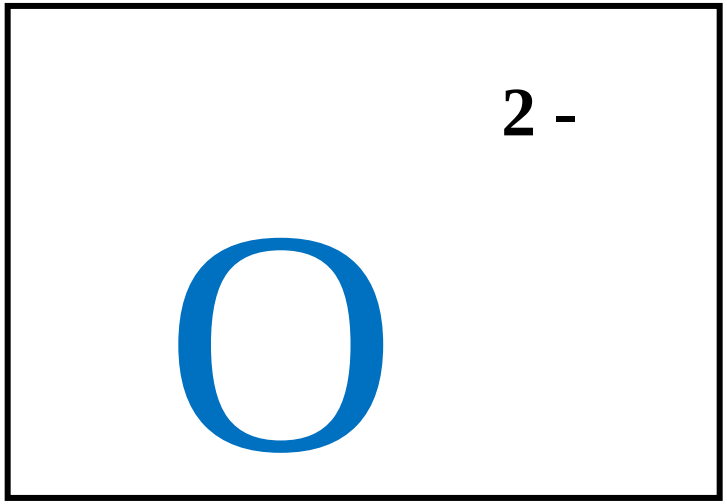
Ionic bonds form by the attraction between positive and negative ions.

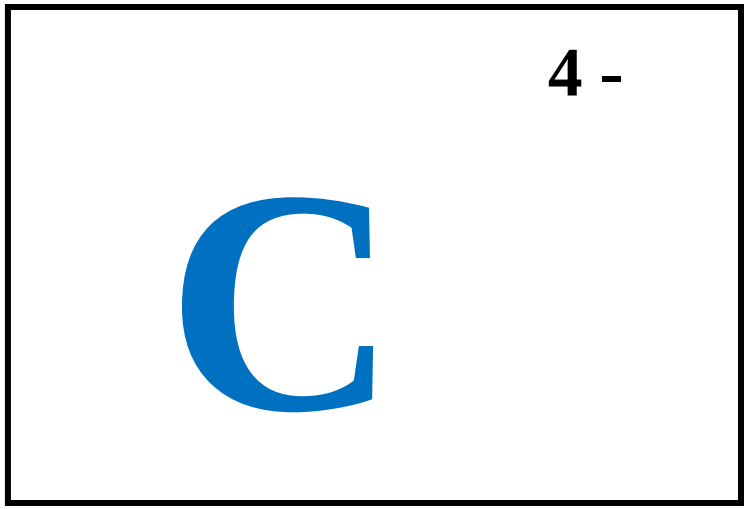
element	the attraction between positive and negative ions
matter	simple and pure substance- the building blocks of matter
compound	anything that has mass and takes up space
mixture	a pure substance made of two or more elements that are chemically combined in a specific ratio
atom	two or more substances that come together but are not chemically combined
scientific theory	smallest particle of a particle
electron	a well-tested idea that can explain and connect different observations
proton	negatively charged particles in an atom

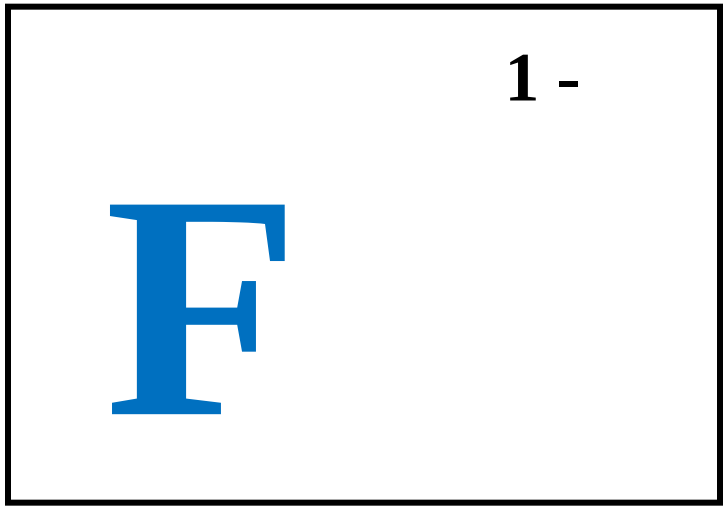
energy level	positively charged particle in the nucleus of an atom
neutron	the specific amount of energy the electron has
valence electrons	a electrically neutral particle in the nucleus of an atom
chemical bond	particles in the atom that have the highest energy level and are held loosely, they determine which atoms can bond with other atoms
atomic number	the force of attraction that holds two atoms together because of the electrons that were rearranged between them
group	the number of protons in the nucleus of an atom
ion	elements in the same column of the periodic table
ionic bond	an atom or group of atoms that has an electrical charge

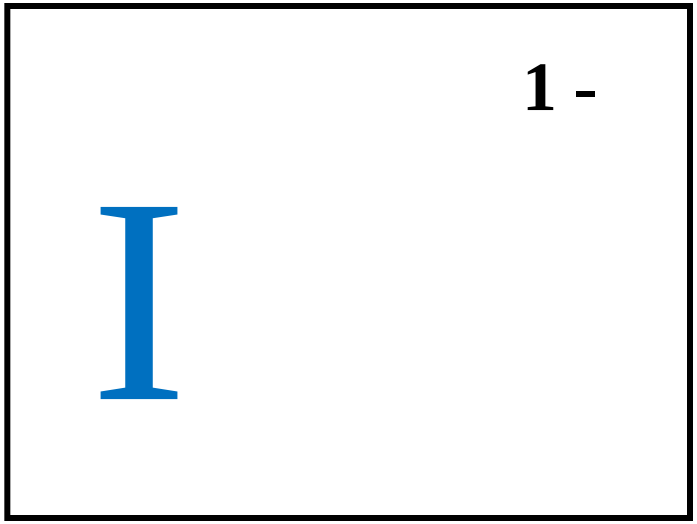


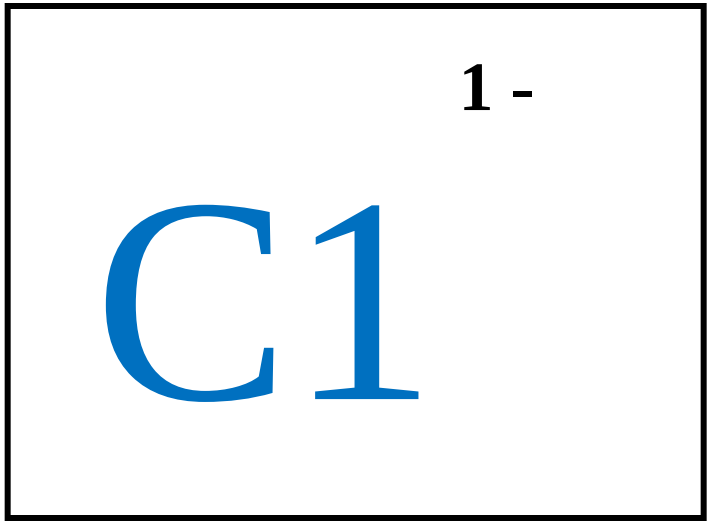


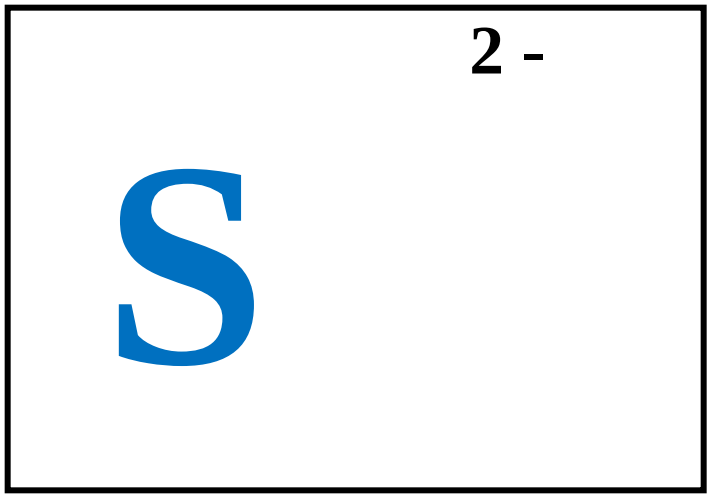












4 -

Si

3 -

N

2 -

Se

3 -

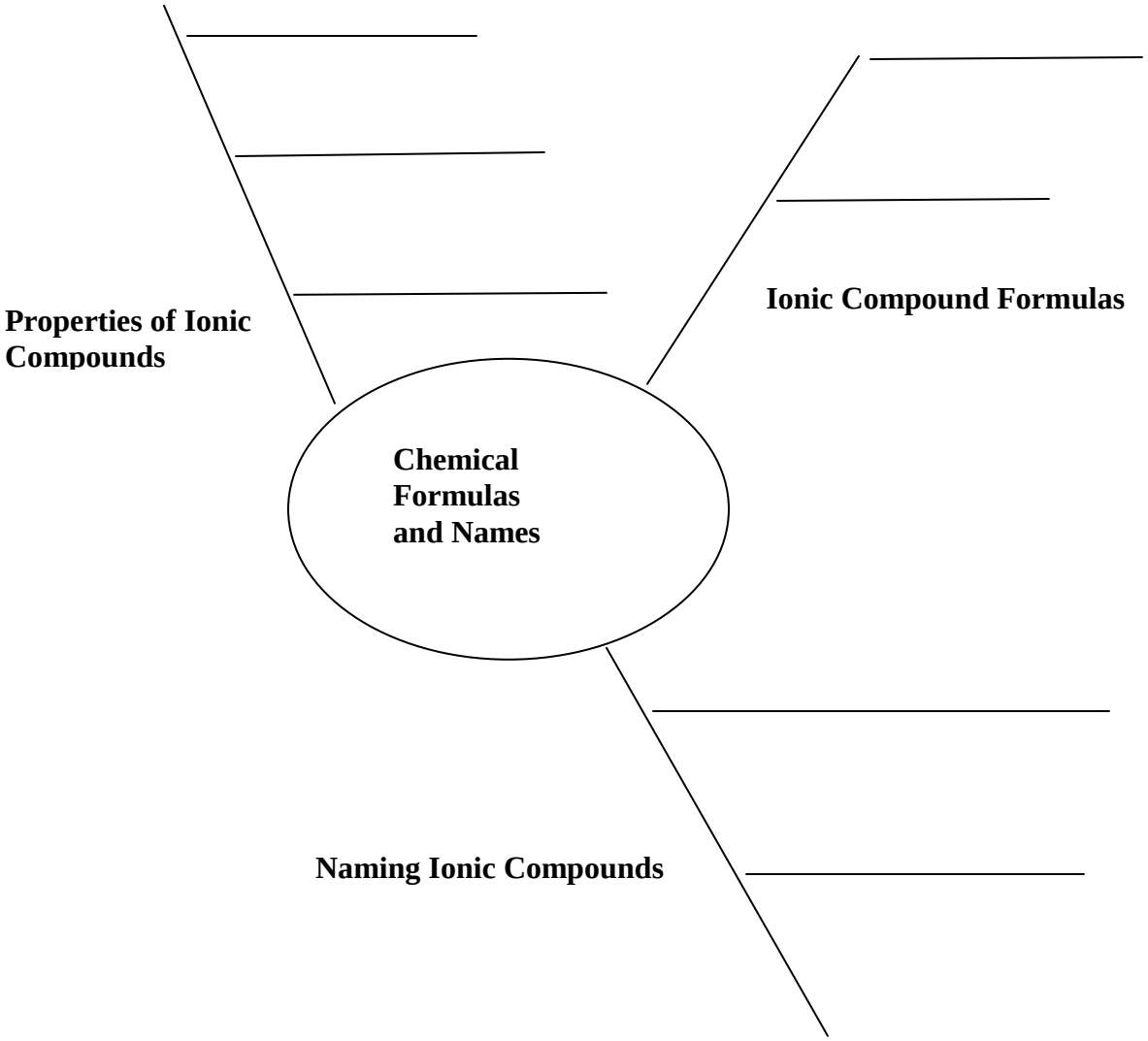
P

Bond With a Classmate Data Table

+ Ion	- Ion	Compound	Name
Mg^{2+}	Cl^{1-}	$MgCl_2$	Magnesium Chloride

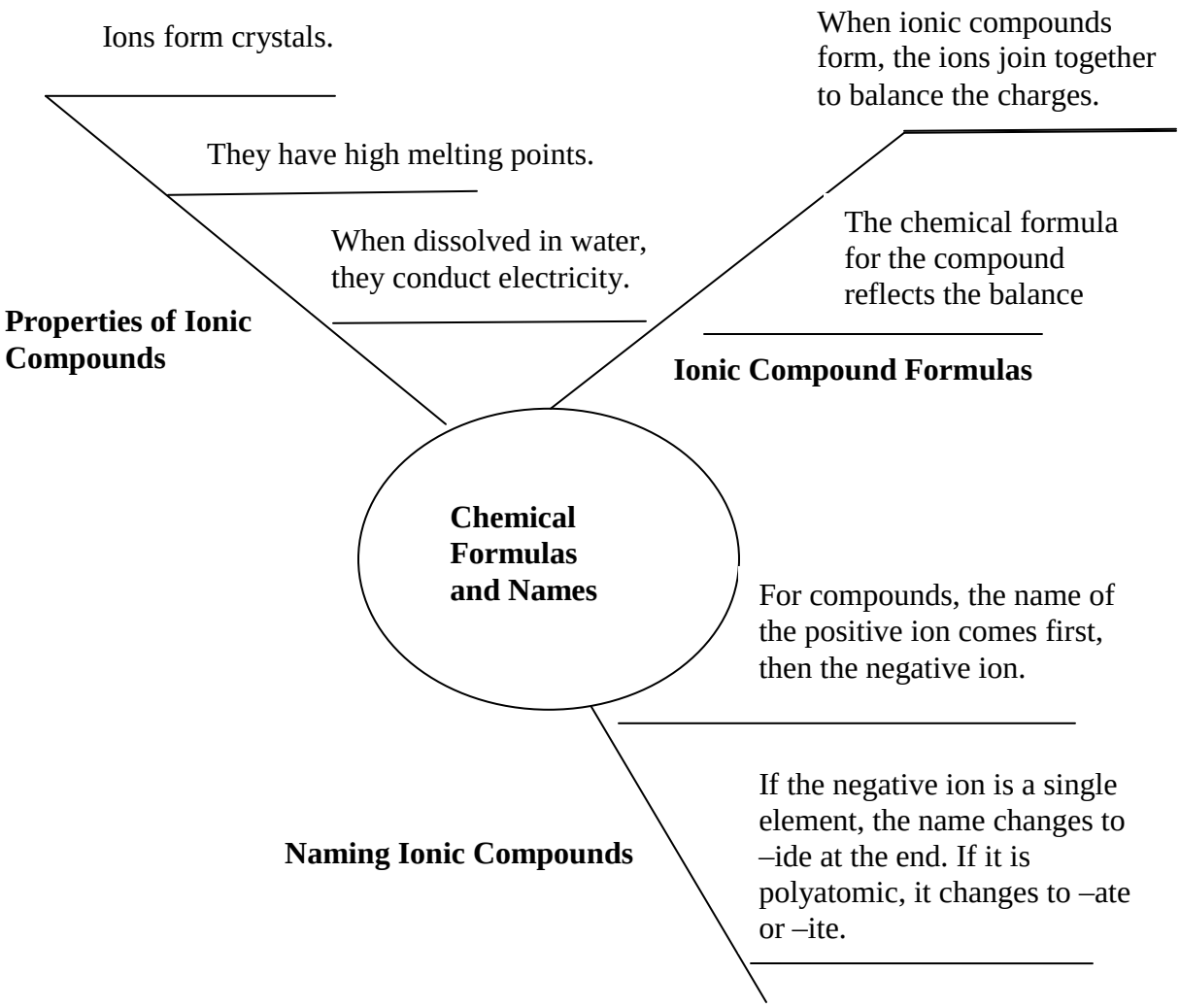
Chemical Formulas and Names Notes Outline

Directions: Read pages 25-27 in the text and complete the chart



Chemical Formulas and Names Notes Outline

Directions: Read pages 25-27 in the text and complete the chart



SIOP SCIENCE LESSON PLAN

SUBJECT: Chemical Interactions
UNIT FOCUS: Atoms and Bonding

Lesson # 5 **Length of lesson 2 days (150 min. total)**

STANDARDS: 1.3.1 Describe ions, and explain how they form bonds. **1.3.2** Explain how the formulas and names of ionic compounds are written. **1.3.3** Identify the properties of ionic compounds.

LESSON TOPIC: Ionic Bonds

OBJECTIVES:

Content

- Students will interpret data in order to identify the properties of ionic compounds
- Students will perform a scientific investigation to determine which kinds of compounds produce ions in a solution
- Students will analyze the results of a scientific investigation to answer research questions

Language

- Students will write an hypothesis to predict what will happen in a science investigation
- Students will write a paragraph to summarize the results of a scientific investigation
- Students will deliver an oral presentation to their peers to share their analysis and conclusion of a scientific investigation

KEY VOCABULARY: I predict that …, I hypothesize that…, lastly, in conclusion, in summary, to sum up, in the final analysis

Review: next, finally, first, after that

MATERIALS: copies of Shedding Light on Ions Lab Report and Bingo cards; supplies for lab (see p. 28 in text); Tic Tac Toe questions; Mix and Match cards; *Science Explorer: Chemical Interactions* (pp. 28-29) student edition and teacher edition

PREPARATION:

1) Post the objectives.
2) Make student copies of the Shedding Light on Ions Lab Report and the Bingo cards. Have student tear up recycled paper to make Bingo pieces.
3) Read page 28 in teacher edition of the textbook to assist with advance planning for the lab. Gather materials and set it up.

4) Prepare Mix and Match cards. (Print page on card stock and cut into cards.)

- -

Day 1

MOTIVATION: **(5 minutes)**

**Read and explain the content and language objectives of this lesson to the students.
Say, "Let's look at our content objectives for today." (Read and discuss content objectives above.) "Now let's look at our language objectives." (Read and discuss language objectives above.)

Review:

- Have students respond to this question with a Quickwrite in their notebooks: What are three properties of ionic compounds, such as NaCl? Have students share out responses when all finish. Allow students to correct their entry as needed.

PRESENTATION: (15 minutes)

- Divide students into small groups for the Shedding Light on Ions lab. Assign roles to the students such as materials gatherer, time keeper, facilitator, investigator, and presenter.
- Begin student lab on pages 28-29 in the text. Do the Guide Inquiry "Invitation" step on page 28 in the teacher edition first.
- Ask students to look at the Problem in the lab and think about what might happen. Have them make a hypothesis. Record suggested hypotheses for students to see and ensure wording is appropriate with expressions like *I predict that or I hypothesize that….* Ask them to select the hypothesis that makes the most sense to them and record it on their lab report. Tell students you will revisit this at the end of the lab.

PRACTICE/APPLICATION: (40 minutes)

- Have student groups work on the lab. Model each step of the procedure in turn, before the students do it themselves.

REVIEW/ASSESSMENT: (10 minutes)

- Play Periodic Table Bingo. Distribute the Bingo cards and tell the students to fill in their cards with the symbols from different elements on the Periodic Table. (You may want to limit them to the first 36 elements.) If needed, remind students how to play bingo. Play the game by calling out an element (e.g., Hydrogen) and if students have it on their card, they mark it off. The first student to get a straight line filled with pieces (horizontal, diagonal, or vertical) wins.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Go over new vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

- -

Day 2

MOTIVATION: **(10 minutes)**

**Read and explain the content and language objectives of this lesson to the students.

Say, "Let's review our content objectives for today." (Read and discuss content objectives above.) "Now let's review our language objectives." (Read and discuss language objectives.)

Review:

- Review vocabulary with Mix and Match. Pass out mix and match cards and tell students they have a few minutes to "mix" with other students. As they move around the room, they should meet up, read their card to a peer, and then exchange cards. After students have mixed for several minutes, tell them it is time to "match." They should find the student who has the card that matches theirs (either by definition or example).
- Explain to students that their partnership represents one of three categories: Atoms and Elements, Periodic Table, or Ions. Give them time to think which they belong to and why. Then call out one category and let students who think their partnership fits best in that category explain why. Encourage explanation and justification.

PRESENTATION (10 minutes)

- Teach summary words (**in conclusion, to sum up, in summary, in the final analysis**) and review how to write a lab report. Go over sequence words (**first, next, then, after that, lastly, finally**) and model how you would like the report to look. Have the students assess whether or not their hypotheses were proven and remind them to include that information in the report.

PRACTICE/APPLICATION: (40 minutes)

- Have students write their report.
- Have students share their reports using the Inside/Outside circle technique. Divide students into two groups. The first group will make an inner circle facing outwards and the second group will make an outer circle facing inwards so they line up facing one of the students in the inner circle. Consider putting your students with better language skills in the inner circle and ask them to share first. When these students finish, tell the students in the outer circle to share. When they finish, those students in the second group to take one step clockwise so they have a new partner. The students repeat the process one or two more times. Model this technique first, if it is new to the class.

REVIEW/ASSESSMENT: (15 minutes)

- Students play Tic Tac Toe to review the chapter content. Draw a Tic Tac Toe game on the board (3 x 3 squares) and put students into two teams (X, O). Ask teams the Tic Tac Toe questions but alternate which student you ask. Encourage students to confer with their team members before answering. If they get the answer correct, they can mark an X or O in a square. When one team gets a line of Xs or Os, that team wins.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Go over new vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

Name: _____ Date: _____

Shedding Light on Ions
Lab Report

Research Question:

_____

_____

_____

Hypothesis:

_____

_____

_____

Materials:

_____

_____

_____

Data Table

Sample	Observations

Analyze and Conclude:
Include your data table, investigation table, and bar graph

1. Why did you test both tap water and distilled water before testing the sodium chloride solution?

_____

_____

_____

2. Could you use tap water in your tests instead of distilled water? Explain.

_____

_____

_____

3. Based on your observations, add a column to your data table above to indicate whether each substance produced ions in solution or not.

4. Sodium chloride is an ionic compound. Based on your observations, how do you explain differences in conductivity between dry and dissolved sodium chloride?

_____

_____

_____

5. Based on your observations, decide whether or not you think sucrose (table sugar) is made up of ions. Explain your answer, using evidence from the experiment.

_____

_____

_____

Conclusion:
Write a paragraph summarizing the investigation. In the conclusion, discuss your hypothesis. Was it correct? Explain.

_____

_____

_____

_____

_____

_____

_____

_____

B	I	N	G	O
		Free Space		

Element		Example: aluminum
compound		Example: water
proton		Particle with a positive charge in nucleus
neutron		Particle with a neutral charge in nucleus
Periodic table		System used for organizing elements
subscript		Example: $_2$

Chemical formula	Example: $MgCl^2$
Ionic bonds	Ions join together in a way that balances out the charges on the ions
crystal	Three-dimensional arrangement formed by ions
Ionic compounds	High melting points and good conductors of electricity when dissolved in water
Electron dot diagram	Example: H▪
Noble gas	Has eight valence electrons, like neon

1. What are noble gases such as argon and neon used for?
   (light bulbs)

2. What is an ionic bond?
   (attraction between two oppositely charged ions)

3. What is the overall charge of an ionic compound?
   (it is electrically neutral)

4. What does a subscript in a chemical formula tell you?
   (the ratio of elements in the compound)

5. Why are elements called the building blocks of matter?
   (because all matter is made of one element or a combination of two or more)

6. Is air a compound or mixture?
   (mixture)

7. Tell me one idea from modern atom theory.
   (a number of responses will be ok)

8. Which two types of particles contribute most to an atom's mass?
   (protons and neutrons)

SIOP SCIENCE LESSON PLAN

SUBJECT: Chemical Interactions
UNIT FOCUS: Atoms and Bonding

Lesson # 6 **Length of lesson: 2 days (150 min. total)**

STANDARDS: 1.4.1 State what holds covalently bonded atoms together. **1.4.2** Identify the properties of molecular compounds. **1.4.3** Explain how unequal sharing of electrons occurs and how it affects molecules.

LESSON TOPIC: Covalent Bonds

OBJECTIVES:

Content

- Students will perform an investigation to observe how properties of molecular compounds interact
- Students will observe a demonstration to examine the attraction between molecules
- Students will identify the properties of molecular compounds

Language

- Students will identify and categorize transitional phrases to increase comprehension of a reading passage
- Students will use comparison language to summarize information from a Venn Diagram
- Students will compare and contrast covalent and ionic bonds

KEY VOCABULARY: covalent bond, molecule, double bond, triple bond, molecular compound, polar bond, nonpolar bond, surface tension, in contrast, likewise, similarly, conversely, on the other hand, in comparison, thus, meanwhile, as a result

MATERIALS: Supplies for student investigation (small jar with tight fitting lid, water, vegetable oil, liquid detergent) and for Teacher Demo (glass, water, small sewing needle); Covalent Bonds Notes Outline, Molecular Compounds Concept Map, Fan and pick cards, and Information Gap activity handouts; Venn Diagram, KWL, and Word Strategy Checklist transparencies, *Science Explorer: Chemical Interactions* (pp. 31-35) student edition and teacher edition; if desired, chart paper and markers for test review

PREPARATION:

1) Post the objectives.

2) Make student copies of the Covalent Bonds Notes Outline and Molecular Compound Concept Map. Gather supplies for Discover Activity on page 30 in the text.
3) Make copies of information gap activity chart, one per student pair, and cut apart. Gather supplies for Teacher Demo on page 34 in the teacher edition of the text (glass, water, small sewing needle).
4) Decide on the number of student groups you will have in Practice/Application of Day 2 and prepare Fan and Pick cards by copying the document and then cutting the questions into strips. Make enough for each small group.
5) Make transparency of Venn Diagram. Retrieve Word Strategy Checklist and KWL transparencies.
6) If you choose to do the Chapter Test Review activity, post six pieces of chart paper for the Rotating Review activity and draw quadrants and label as per directions.

- -

Day One

MOTIVATION: **(20 minutes)**

**Read and explain the content and language objectives of this lesson to the students.
Say, "Let's look at our content objectives for today." (Read and discuss content objectives.)
"Now let's look at our language objectives." (Read and discuss language objectives.)

Review/Building Background:

- Have students get into pairs or small groups to do the Discover Activity on page 30 of the text. Walk the students through the steps of the procedure before asking the students to perform the investigation themselves.
- After the students complete the activity, tell them to answer the questions listed in Think it Over on page 30 in their textbooks. Then have the recorder from each group record the group's findings on the board or a transparency. Provide a sentence starter to help students organize their thinking (e.g., "Based on our observations, a good definition for detergent is a _____ that ….." or "Based on our observations, we think the chemical bonds in detergent might…")

PRESENTATION: (35 minutes)

- Tell students today they will learn about **covalent bonds** in molecules. Write the words on the board and ask students to Think-Pair-Share some possible definitions. Have students share out. Confirm or correct as necessary.
- As a whole class, read pages 30-33 in the text and have students take notes using the Covalent Bonds Notes Outline. Students take turns reading using the bump method. One student reads for as long as he or she wishes, and then "bumps" the reading to another student or the teacher. That person "bumps" the reading to another person and the class continues in this manner until the end. Model "Questioning the Author" techniques for the students, stopping at appropriate places to discuss what the author is trying to say and point out transitional phrases in the passage and what they mean (e.g., **meanwhile, on the other hand, thus, in contrast, so, as a result**). Record terms on board by categorizing the phrases (words that show contrast, words that add, words that summarize, etc.).

- Have students complete Word Strategy Checklists in their notebooks for **covalent bond, molecule, double bond,** and **triple bond** using the imagery strategy. Add these words to the Word Wall.

PRACTICE/APPLICATION: (10 minutes)

- Have students complete the Molecular Compounds Concept Map. Go over student maps when all finish. Confirm and correct ideas as necessary.

REVIEW/ASSESSMENT: (10 minutes)

- Do a Snowball activity. Number the students (e.g., 1-2-1-2). Have students take out a piece of paper and write one thing they learned today and one question they have. Have them also write their name on the paper. Instruct the students to crumple the paper into a "snowball." Collect group 1's snowballs in a container, then distribute one to each of the students in group 2. Have the students in group 2 uncrumple the snowball, read it, then find the person who wrote so they can talk about it. Repeat this process with group 2's snowballs.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives). Go over the new vocabulary "Now let's see if we met our language objectives for today." (Read and assess language objectives)."

- -

Day Two

MOTIVATION: (10 minutes)

**Read and explain the content and language objectives of this lesson to the students.
Say, "Let's review our content objectives for today." (Read and discuss content objectives.)
"Now let's review our language objectives." (Read and discuss language objectives.)

Review/Building Background:

- Do the Teacher Demo as outlined on page 34 in teacher edition, teaching the word **surface tension** (record and define on board). Have students do a Word Strategy checklist for this word in their notebooks. Add to Word Wall.

PRESENTATION (30 minutes)

- Tell students today they will learn about bonds, especially **polar** and **nonpolar bonds** in molecules. Read pages 33-35 in the text as class using the bump method. Continue taking notes on the Covalent Bonds Notes Outline. As the students read, pull out key words for the students to do on Word Strategy Checklists later (**polar bond, nonpolar bond).** Then as a class, complete the Venn diagram transparency comparing and contrasting covalent and ionic bonds.
- Using the information in the Venn, have students make comparison and contrast sentences about bonds sentences orally. Teach signal words or phrases you would like the students to use (e.g., **likewise, similarly, conversely, on the other hand, in comparison**). Then partner students and have them write a summary paragraph based on the Venn Diagram. Besides the new signal terms, they could also use some of the transition words identified in the previous day's lesson.

PRACTICE/APPLICATION: (20 minutes)

- First do an Information Gap activity. Pair students: one student is Student A, the other is Student B. Distribute the appropriate chart. Tell students that each has information that his or her partner does not have. Explain that students will ask each other questions to complete their charts. Pre-teach some sample questions like "Which compound type do you have? What is its boiling point? Does it have a strong or weak force?" Model this process for the class with a student with strong content and verbal skills.
- Next, have students get into groups of four and do a Fan and Pick activity to review the chapter. One student will fan the questions (spread them out), another student will pick and read the question. A third student will answer and the fourth student will rephrase or summarize what the third student said. The first student will praise the third student and ask one follow-up or clarifying question. Then the group starts the whole process again with the second student picking a new card and the rest of the roles rotating accordingly.

REVIEW/ASSESSMENT: (10 minutes)

- Revisit the KWL from Lesson 1 for the last time. Read the entries in the K and W columns. Have partners discuss what else they have learned. Then have students share out and record responses in the L column.
- Review the objectives. Say, "Let's see if we met our content objectives for today." (Read and assess content objectives above). Go over new vocabulary. "Now let's see if we met our language objectives for today." (Read and assess language objectives above)."

- -

CHAPTER TEST REVIEW: (20 minutes)

- Do a Rotating Review to review chapter content. Post six pieces of chart paper around the room. Label each with one of the following terms: ionic bonds, covalent bonds, periodic table, molecular compound, ionic compound, and chemical reaction. Divide the chart paper into four quadrants. Label the quadrants as follows: Definition, Ideas or Examples, Questions, Slogan.
- Divide students into six groups and explain the task. In the first box, they record a definition of the word. The second box is for ideas or examples of the term. The third box is for questions students have about it. In the fourth box, students write a slogan to help other students remember what that term is about.
- Have each group start at a different poster and start writing in one quadrant. They do not need to finish writing in the box, but tell them not to fill out more than one quadrant. After 2-3 minutes, tell the students to move clockwise to the next poster. Have them continue in the quadrant the other group started and then begin filling in a new quadrant. Continue in this manner. Once all quadrant have some information, groups can add to any quadrant. When groups return to their original poster, they choose a presenter to tell the class what is on the poster. Correct, elaborate and confirm ideas as necessary. Have students respond to questions if they can.

Covalent Bonds Notes Outline

Directions: Read pages 31-35 in text and take notes on the outline below.

I. How Covalent Bonds Form

We know that ionic bonds usually form when a metal combines with a nonmetal, but covalent bonds form between _____

A. Electron Sharing
   1. Some elements such as _____ are not very reactive. But other nonmetals, like _____ can bond to other nonmetals by _____.
   2. These types of elements can _____ _____.
   3. The force that holds these atoms together is _____ _____ _____
   4. A _____is a group of atoms joined by covalent bonds. It has a _____charge.

B. How Many Bonds?
   1. All elements except _____ can take up to eight valence electrons.
   2. Oxygen has six valence electrons so it can form _____ covalent bonds.

C. Double Bonds and Triple Bonds
   1. Double bonds occur when _____ _____
      Example: _____
   2. Triple bonds occur when _____ _____
      Example: _____

II. Molecular Compounds

This type of compound is made up of _____ with atoms that have _____. These compounds have the following characteristics:

A. Low Melting Points and Boiling Points
   Example: _____ _____

B. _____

Example: _____
_____

III. Unequal Sharing of Electrons
Atoms of some elements pull shared electrons more _____ than atoms of other elements. These bonded atoms have _____. The charges of these atoms are _____ than ions.

A. Polar Bonds and Nonpolar Bonds
1. The unequal sharing of electrons makes the atom with the _____ have a small negative charge and the atom with the _____ a small positive charge. When electrons are shared unequally, this is called a _____.
2. When two atoms pull equally on the electrons, neither _____. When covalent bonds share electrons equally, this is called a _____.
   Example: _____

B. Polar Bonds in Molecules
1. A molecule can contain polar bonds but still be nonpolar, because _____
   Example: _____
2. Other molecules that have polar covalent bonds are polar because _____
   Example: _____

C. _____
We know that _____ and _____ don't mix. This is because of _____. The molecules in the oil are _____ and these molecules have little _____ for polar water molecules. The water molecules are _____ than to molecules of oil. So, _____ _____.

Covalent Bonds Notes Outline

Directions: Read pages 31-35 in text and take notes on the outline below.

I. How Covalent Bonds Form

We know that ionic bonds usually form when a metal combines with a nonmetal, but covalent bonds form between *atoms of nonmetals*.

A. Electron Sharing
   1. Some elements such as *noble gases* are not very reactive. But other nonmetals, like *hydrogen* can bond to other nonmetal by *sharing electrons*.
   2. These types of elements can *bond with atoms of the same element .*
   3. The force that holds these atoms together is *the attraction of each atom's nucleus for the shared pair of electrons.*

B. How Many Bonds?
   1. All elements except *hydrogen* can take up to eight valence electrons.
   2. Oxygen has six valence electrons so it can form *two* covalent bonds.

C. Double Bonds and Triple Bonds
   1. Double bonds occur when *two atoms that share two pairs of electrons*
      Example: *carbon dioxide*
   2. Triple bonds occur when *atoms that share three pairs of electrons*
      Example: *nitrogen*

II. Molecular Compounds

This type of compound is made up of *molecules* with atoms that *have covalent bonds*. These compounds have the following characteristics:

A. Low Melting Points and Boiling Points
   Example: *less heat must be added to molecular solids to separate the molecules and change the solid to a liquid.*

B. *Poor Conductivity*
   Example: *no charges, particles are available to move in a molecular compound, water doesn't conduct electricity*

III. Unequal Sharing of Electrons

Atoms of some elements pull shared electrons more *strongly* than atoms of other elements. These bonded atoms have *a slight electrical charge*. The charges of these atoms are *weaker* than ions.

A. Polar Bonds and Nonpolar Bonds
   1. The unequal sharing of electrons makes the atoms with the *stronger pull* have a small negative charge and the atom with the weaker pull a small positive charge. When electrons are shared unequally this is called a *polar bond*.
   2. When two atoms pull equally on the electrons, neither *is charged.* When covalent bonds share electrons equally this is called a *nonpolar bond*.
      Example: *fluorine bonded to fluorine is nonpolar but hydrogen fluoride is polar*

B. Polar Bonds in Molecules
   1. A molecule can contain polar bonds but still be nonpolar.
      Example: *carbon dioxide*
   2. Other molecules that have polar covalent bonds are polar.
      Example: *water molecule*

C. *Attractions Between Molecules*
   We know that *oil* and *water* don't mix. This is because of *differences in attractions between their molecules*. The molecules in the oil are *nonpolar* and these molecules have little *attraction* for polar water molecules. The water molecules are *attracted more strongly to each* than to molecules of oil. So, *water stays with water and oil stays with oil*.

Word	Definition

Strategy Checklist: Check the box of the strategy you will use to remember the word.

☐ Imagery (draw a picture)

☐ Spider Map (body is the word, details and examples are the legs)

☐ Synonym and antonym (same/opposite)

☐ Context (use the word in an original sentence)

In the box show how you are using this strategy.

Student A:

Compound Type	Characteristics			
	Boiling Point	**Melting Point**	**Force**	**Electricity**
	low		Yes, but weak	Doesn't conduct electricity
Ionic	high	high		

- -

Student B:

Compound Type	Characteristics			
	Boiling Point	**Melting Point**	**Force**	**Electricity**
Molecular	low	low		
			Yes, strong	Does conduct electricity

Compound Type	Characteristics			
	Boiling Point	**Melting Point**	**Force**	**Electricity**
Molecular	low	low	Yes, but weak	Doesn't conduct electricity
Ionic	high	high	Yes, strong	Does conduct electricity

1. Both carbon dioxide molecules and water molecules have polar bonds. Explain why carbon dioxide is a nonpolar molecule while water is a polar molecule.

2. Compare and contrast the properties of ionic and molecular compounds.

3. How do some atoms in covalent bonds become slightly negative or slightly positive? What type of covalent bond does each of these atoms form?

4. What is a double bond? Explain how a carbon dioxide molecule has a stable set of eight valence electrons for each atom.

- -

1. Both carbon dioxide molecules and water molecules have polar bonds. Explain why carbon dioxide is a nonpolar molecule while water is a polar molecule.

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