Structure and Function of Matter - Elements and the Compounds they Form

This 5E model for instruction is useful to help students gain an understanding of the concept of elements and compounds. Students will compare and contrast the physical and chemical properties of elements and the compounds they form.	
Student Science Performance	
Grade level: 9-12 Physical Science **Topic: Properties of Elements and Compounds**	**Title:** Elements and the Compounds They Form: The Salt I Used for Lunch Came from What?

Performance Expectations for GSE:

SPS1 Obtain, evaluate, and communicate information from the Periodic Table to explain the relative properties of elements based on patterns of atomic structure.

a. Develop and use models to compare and contrast the structure of atoms, ions and isotopes. (*Clarification statement:* Properties include atomic number, atomic mass and the location and charge of subatomic particles.)
b. Analyze and interpret data to determine trends of the following:
   - Number of valence electrons
   - Types of ions formed by main group elements
   - Location and properties of metals, nonmetals, and metalloids
   - Phases at room temperature
c. Use the Periodic Table as a model to predict the above properties of main group elements.

SPS2 Obtain, evaluate, and communicate information to explain how atoms bond to form stable compounds.

a. Analyze and interpret data to predict properties of ionic and covalent compounds.
b. Develop and use models to predict formulas for stable, binary ionic compounds based on balance of charges.
c. Use the International Union of Pure and Applied Chemistry (IUPAC) nomenclature for translating between chemical names and chemical formulas.

SPS7 Obtain, evaluate, and communicate information to explain transformations and flow of energy within a system.

a. Construct explanations for energy transformations within a system. (*Clarification statement:* Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear.)

Performance Expectations for Instruction:

- Develop and use a model to name ionic and covalent compounds.
- Predict the properties of a compound based on the type of bond either ionic or covalent.
- Understand that elements combine chemically to form compounds that have different physical and chemical properties than the elements.

Additional notes on student supports

Materials:

- Access to internet resources
- Compounds from home such as baking soda, vinegar and "lite" salt
- Plastic chips (several 100 in different colors)
- Poster board (¼ sheet) or chart paper to make element cards (1 per student)

Engaging Learners	***Phenomenon:*** Compounds have properties that are vastly different from the elements that combine to form those compounds. Engage in a discussion with the students about the properties of sodium and chlorine. These are vastly different elements. Sodium is a soft metal that reacts violently with water. Chlorine is a poisonous gas. When they are chemically combined they form table salt. Students can quickly explore the element properties with an internet search or with teacher provided materials. Engage the students in a discussion to encourage them to think of other compounds that might be like salt and made of poisonous elements. Videos of demonstrations of sodium and chlorine can be found online. Show the students table salt and ask them to ask questions about how they think these two poisonous elements became salt. *Teacher Note: Before this lesson students should have studied the properties and trends of the Periodic Table and how elements are arranged in the table. Students should also have an understanding of the basic properties of elements such as valence electrons and how the number of valence electrons relates to the charge of the element and the position of the element in the Periodic Table.* *Additional notes on topic, focus, and phenomenon.*
Exploring	***Obtaining*:** Students will develop questions based on the phenomenon of table salt coming from two hazardous elements. 1. Are there other compounds we eat that come from poisonous elements? 2. How can two elements that are completely inedible form a great tasting food? 3. What is a compound as opposed to a mixture? *Teacher Note: Have students look in their pantry at home and find common food items that are made of simple compounds. Examples are baking soda, vinegar and "lite" salt. Each of these are made of elements that individually do not have the same properties as the compounds they combine to form. The elements may not all be "poisonous" but the concept to get across to the students is that a chemical change has taken place to form the compounds. A physical change would change the size, shape or possibly the physical state of the element. A chemical change results in an entirely new substance. A chemical reaction is necessary to form these new compounds. If the elements are simply mixed together and form a true mixture, they retain their original chemical and physical properties.* In order to begin an exploration of this phenomenon, assign the students an element to research and record the physical and chemical properties of that element. Instruct students to record the information into a format so that the elements can be posted on a classroom wall and the start to the Periodic Table can be reconstructed. *Properties to include:* *Atomic number, atomic mass, number of protons, neutrons and electrons, simple diagram of the atom, melting point, boiling point, phase of matter at room temperature, density, metal, nonmetal or metalloid, reactivity, number of valence electrons and ionic charge of the element.* Arranging the elements back into the Periodic Table format with physical and

chemical properties listed allows for discussion of trends in these properties. (Engaging in this activity will re-enact the process that the original formers of the Periodic Table did when they first designed it. They grouped elements by similarities, often having only a fraction of the understanding of the elements we have today.)

Teacher Note:

1. *An internet search for Periodic Table element projects will give a resource for ideas about how to manage this activity. Use a project format that fits your classroom arrangement and availability of technology.*
   One example is linked here.
2. *There are several websites that list the properties of elements.*
3. *The assessment of the students' performance on this part of the project is based on science content included in the project. The assessment is not based on neatness, number of images included, artistic ability of the student, or number of colors in the finished project.*

An activity to explore how chemical and physical properties follow patterns on the periodic table is Pondering the Periodic Table. In this activity, students are given a variety of cards with properties of an element. Students must arrange cards correctly, including unknowns. Pondering the Periodic Table Answer Key.

Additional notes on topic, focus, and phenomenon.

Evaluating:

Remind students of the table salt phenomena and ask, "Why did sodium and chlorine combine to make table salt?"
Discuss the differences between a mixture and compound. Make sure the students understand that sodium and chlorine have chemically combined to form a compound. The following activity can be used to help students answer these questions:

- Which elements can make compounds together?
- Which elements cannot make compounds together?
- What are the names of the compounds?
- Why do we need 2 hydrogens but only 1 oxygen in water or 1 carbon and 2 oxygen in carbon dioxide?

Arrange the students into seven equal groups. These groups will correspond to the charge (positive or negative) of the elements in the Periodic Table. Discuss again the concept that all elements in group one have one valence electron. This is an unstable state so these elements must fill their outer electron shell with eight electrons or give up the valence electrons so the next energy level can be the full valence shell.

Some of the students will be an element in group one with one valence electron and a charge of positive one. They will each be given one plastic chip or other small item to represent this one valence electron.

The next group represents an element in Group Two and has two plastic chips (a different color than Group one).

A group of students is formed to represent an element in every group in the Periodic table. The students then walk around the room and try to find someone that they can

<table>
<tr><td></td><td>combine with to get a total of eight chips between the two students. Make sure they understand that all the chips or valence electrons for each element must be used to make a total of eight or a multiple of eight. They also must understand the charge of the element they represent. The Group one element would have a charge of positive one and must pair with an element to not only get eight valence electrons but also balance the charge between the two elements.

For example, a group two element with two valence electrons and a charge of positive two could pair with a group six element with 6 valence electrons and a charge of negative two in a ratio of one to one. The total valence electrons is eight and the total charge is zero since the positive two and the negative two balance each other.

The rule for making compounds needs to be that the total valence electrons is a multiple of eight and the total charge is zero.

The first compounds that get made will be the ionic compounds such as group one with group seven. Since these compounds only need one of each element, they are very simple to form. After the students form a number of these compounds, tell them that they can also have more than one of each element to form a compound. For example, two lithiums can pair with one oxygen. As they form compounds the students should record their results in a data table (example shown below).

Students can use the data sheet- DATA SHEET</td></tr>
<tr><td></td><td>Communicating: After a class period of pairing elements and making compounds, have the students discuss any trends they see in the formation of the compounds. Have them look for patterns.
Examples of questions that lead to trends:
Which elements are making compounds together?
Which elements are not making compounds together?
Why do we need only one sodium and one chlorine to make salt?
How do I write the names for these compounds?
Instruct students to write a short paragraph describing the trends or patterns they observe in the data. These short paragraphs will allow the teacher to assess the level of understanding of each student.</td></tr>
<tr><td>Explaining
Finalizing Model</td><td>Obtaining: Students will need to develop answers to the questions raised after the investigations. These answers can come from class discussions, internet searches or from simply analyzing the observations made from the class activity of pairing elements.
Which elements are making compounds together?
Students should understand that when a metal element combines with a nonmetal element an ionic bond is formed. If two nonmetal elements combine, then a covalent bond is formed. Have the students research the properties of these two types of chemical bonds. In addition to the elements involved in these two types of bonds the students should also be able to distinguish between ionic and covalent bonds based on differences in melting point, boiling point and conductivity.</td></tr>
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	2. Which elements are not making compounds together? *Discuss why the elements in group eight were not included in the activity when the students were making compounds. The students should understand that group eight elements have eight valence electrons, so they are stable. These elements have no imbalance of charge to try to balance. Therefore they do not make compounds. Have the students find the name for this group and discuss why this group is called "noble".* 3. Why do we need only one sodium and one chlorine to make salt? *After completing the activity, the goal is to have the students make the connection between valence electrons and charge of the element. As they combine elements they are trying to balance the charge between the two elements. Thus, two positive ones are needed to balance one negative two as in H_2O.* 4. How do I write the names for these compounds? *Using the International Union of Pure and Applied Chemistry nomenclature, have the students write names of all the compounds they made in the activity. This is a simple skill and is easily mastered by most students. The biggest obstacle is that the students must first classify the compound as ionic or covalent and then write the name with the correct format. Many just write all the names in the same format without regard for the type of bond.*
Elaborating- Applying Model to Solve a Problem	***Communicating:*** Now give students two elements and have them determine if they would make an ionic bond or a covalent bond. They will write the chemical formula and the correct name for the compound. There are several ways to assess this skill in students. 1. Compound naming race: Give the students a set of elements and ask them to make as many compounds as possible in a certain amount of time. After time is up, they will give their list to a competing team and each team then grades the other team's list. 2. Give the students some common household items and see if they can write the chemical name and formula. Some examples to use are: Sand SiO_2 Carbon Dioxide CO_2 Windex NH_3 Lite Salt KCl Liquid Paper TiO_2
Evaluation	***Assessment of Student Learning*** ***Communicating:*** At the end of the activities have the students write an explanation of the original phenomena explaining in as much detail as possible how elements' unique properties change when they combine to form compounds. Student's explanations should include the valence electrons and ion charges of Na+ and Cl-, their properties as a metal and non-metal, the type of bond formed, why these elements form this bond, etc. Based on all the investigations, discussions and information students should have the following understandings: ● Compounds have chemical and physical properties that are quite different from the elements that combined to make the compound. ● Compounds are formed when elements chemically combine as a result of a

	chemical reaction. ● Ionic bonds form when metals react with nonmetals. ● Covalent compounds form when two nonmetal elements combine chemically. ● Ionic bonds are strong and require a large amount of energy to break which results in high melting and boiling points for ionic compounds. ● Covalent compounds have lower melting and boiling points than ionic compounds. ● Ionic compounds conduct electricity when dissolved in water. ● Covalent compounds do not conduct electricity when dissolved in water. ● Ionic compounds are mostly solids while covalent can be solids, liquids or gasses.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	● Asking questions and defining problems ● Developing and using patterns ● Constructing explanations ● Engaging in argument from evidence ● Obtaining, evaluating and communicating information
Crosscutting Concepts	● Patterns ● Cause and effect ● Systems and system models ● Energy and matter
Disciplinary Core Ideas	From A Framework for K-12 Science Education: PS1.B: In a chemical process the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change.

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:

1. Provide reading support by reading aloud or doing partner reads
2. Have the teacher model what they are thinking when reading the text
3. Annotate the text with students so that they may refer to it as they work through the lab

Writing:

1. The teacher can provide a sentence starter for the students.
2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic).
3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.

Math:

1. Provide calculators as needed.
2. Provide graph paper as needed.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

Engage:

1. The teacher should consider giving a formative assessment of the periodic table prior to starting the lesson. That way the teacher can remediate, review or enrich prior to making students go beyond the periodic table.
2. The teacher should have clear guidelines in place for discussions. This should help ensure that no student gets too much "floor" time and no student gets too little "floor" time. This should help students feel safe engaging in the discussion as well.
3. The teacher should consider giving other examples besides table salt to help engage students. Another

example is hydrogen peroxide (H_2O_2) which is water and an extra Hydrogen or hydrogen and oxygen gas. Students may describe this either way and it would be a good point of discussion.
4. The teacher should provide some resources that students can use to research and a place to record their research.
5. The teacher should present information on the elements and compounds in multiple ways such as videos, descriptions and images.

Exploring:

1. The teacher may need to remind students that they need to ask questions that require more than a yes or no answer.
2. The teacher may then need to help students narrow down the questions that they are going to research and help students focus on questions that have depth and relate to the standards.
3. Explicitly link the way that students are approaching this activity to how the original designers of the periodic table would have approached the elements.
4. The teacher may need to provide resources for students to use for research of the elements.
5. The teacher should consider giving students a template to put the element in to get all the correct information.
6. The teacher should explicitly state the most important parts of the element that students should focus on multiple times to help students identify it. Consider writing it on the board or putting it on an instruction sheet to give to the students.
7. Show students an example of a mixture (mix plastic pieces and metal pieces then show students how a magnet can separate the parts of the mixture) and then show them salt. Have students compare the two. The goal is for students to see that a mixture can be separated but that it is much harder to separate a compound like salt.
8. The teacher should use flexible and intentional group of students to assign student groups.
9. This activity has students acting out how the electrons work in an element and how the electrons assist in bonding to make a compound. The teacher should consider adding drawing and explaining how the electrons work.
10. The teacher should be sure to explicitly explain the directions and be prepared to repeat directions as needed.
11. The teacher should provide the data sheet to the students.
12. The teacher should have specific guidelines for discussions.
13. The teacher should consider giving students the questions in advance of the discussion so that the students can formulate answers. This should alleviate the anxiety that discussion create in some students that have difficulty forming answers on the spot.
14. The teacher should provide multiple formats for the students to express their knowledge. These formats could include writing, drawing, acting it out or verbally explaining.

Explaining:

1. The teacher should provide resources that students can use to find answers to the questions.
2. The teacher should consider providing the questions as guidance.
3. The teacher should carefully review the answers and provide feedback to avoid misconceptions.

Elaborating:

1. The teacher should conduct a formative assessment. This will guide the teacher in re-teaching, reviewing or enriching. 2. The teacher should be careful when conducting a race because this may leave out some students that need additional time processing information and then providing answers. 3. The teacher should consider discussing with guidelines established in advance.
Evaluating: 1. The teacher should provide multiple formats for the students to express their knowledge. These formats could include writing, drawing, designing a play or verbally explaining. 2. The students should share their ideas with some classmates and then revise their explanation as needed. 3. The teacher should provide constructive feedback on the students' explanation.

Pondering the Periodic Table

Problem:

Use your knowledge of the periodic table to determine the identity of each of the eleven unknown elements in this activity.

- The unknown elements are from the following groups in the periodic table. Each group listed below contains at least one unknown.

  1 2 11 13 14 17 18

- None of the known elements serve as one of the eleven unknown elements.
- Two radioactive elements are used during this experiment.
- You may not use your textbook or other reference materials. You have been provided with enough information to determine each of the unknown elements.

Materials:

Set of element cards
Blank answer sheet
Scissors (optional)

Procedure:

1. Inspect the properties of the known elements.
2. Arrange the cards of the known elements in a crude representation of the periodic table. You may cut out the cars and physically arrange them on your desk or table if you would like.
3. Once the known elements are in place, inspect the properties of the unknowns to see where their properties would best "fit" the trends of the elements of each group.
4. In your data table, assign the proper element name to each of the unknowns. Record the symbol for each of the "unknowns" in your data table.

Conclusion:

1) Summarize your group's reasoning for assignment of each unknown.
2) Explain in a few sentences exactly how you predicted the identity of the unknowns.
3) Use your knowledge to predict the properties that Unknown #3 SHOULD have.

Li		Cl_2	
Physical State	solid	Physical State	gas
Density	0.534 g/cm^3	Density	0.00321 g/cm^3
Hardness	soft, claylike	Hardness	none
Conductivity	good	Conductivity	very poor
Solubility (H_2O)	reacts with water	Solubility (H_2O)	slight
Melting Point	180ºC	Melting Point	-101ºC
Color	silver	Color	greenish yellow

Ag		He	
Physical State	solid	Physical State	gas
Density	10.50 g/cm^3	Density	0.00018 g/cm^3
Hardness	somewhat soft	Hardness	none
Conductivity	excellent	Conductivity	very poor
Solubility (H_2O)	none	Solubility (H_2O)	none
Melting Point	961ºC	Melting Point	-272ºC
Color	silver	Color	colorless

Cu		Na	
Physical State	solid	Physical State	solid
Density	8.96 g/cm^3	Density	0.971 g/cm^3
Hardness	somewhat soft	Hardness	soft, claylike
Conductivity	excellent	Conductivity	good
Solubility (H_2O)	none	Solubility (H_2O)	reacts rapidly
Melting Point	1803ºC	Melting Point	98ºC
Color		Color	silver

C		Ca	
Physical State	solid	Physical State	solid
Density	2.10 g/cm^3	Density	1.57 g/cm^3
Hardness	soft, yet brittle	Hardness	medium
Conductivity	good	Conductivity	good
Solubility (H_2O)	negligible	Solubility (H_2O)	reacts
Melting Point	3550ºC	Melting Point	845ºC
Color	black	Color	silvery white

Unknown #8		Unknown #9	
Physical State	solid	Physical State	solid
Density	1.74 g/cm^3	Density	11.85 g/cm^3
Hardness	medium	Hardness	very soft
Conductivity	good	Conductivity	medium
Solubility (H_2O)	reacts slowly	Solubility (H_2O)	none
Melting Point	651ºC	Melting Point	303ºC
Color	silvery white	Color	silvery white

Be		**Sn**	
Physical State	solid	Physical State	solid
Density	1.85 g/cm^3	Density	7.31 g/cm^3
Hardness	brittle	Hardness	somewhat soft
Conductivity	excellent	Conductivity	good
Solubility (H_2O)	none	Solubility (H_2O)	none
Melting Point	1287ºC	Melting Point	232ºC
Color	gray	Color	silver
Ne		**Br_2**	
Physical State	gas	Physical State	liquid
Density	0.00090 g/cm^3	Density	3.12 g/cm^3
Hardness	none	Hardness	none
Conductivity	very poor	Conductivity	very poor
Solubility (H_2O)	none	Solubility (H_2O)	negligible
Melting Point	-249ºC	Melting Point	-7.2ºC
Color	colorless	Color	reddish brown

K		**Ba**	
Physical State	solid	Physical State	solid
Density	0.86 g/cm^3	Density	3.6 g/cm^3
Hardness	soft, claylike	Hardness	soft
Conductivity	good	Conductivity	good
Solubility (H_2O)	reacts rapidly	Solubility (H_2O)	reacts strongly
Melting Point	63ºC	Melting Point	710ºC
Color	silver	Color	silvery white

Xe		**In**	
Physical State	gas	Physical State	solid
Density	0.00585 g/cm^3	Density	7.31 g/cm^3
Hardness	none	Hardness	very soft
Conductivity	very poor	Conductivity	medium
Solubility (H_2O)	none	Solubility (H_2O)	none
Melting Point	-119.9ºC	Melting Point	157ºC
Color	colorless	Color	silvery white

I_2		**Pb**	
Physical State	solid	Physical State	solid
Density	4.93 g/cm^3	Density	11.35 g/cm^3
Hardness	soft	Hardness	somewhat soft
Conductivity	very poor	Conductivity	poor
Solubility (H_2O)	negligible	Solubility (H_2O)	none
Melting Point	113.5ºC	Melting Point	327.5ºC
Color	bluish-black	Color	gray

Ar		**Ga**	
Physical State	gas	Physical State	solid
Density	0.00178 g/cm^3	Density	5.904 g/cm^3
Hardness	none	Hardness	soft
Conductivity	very poor	Conductivity	medium
Solubility (H_2O)	none	Solubility (H_2O)	none
Melting Point	-189.2ºC	Melting Point	30ºC
Color	colorless	Color	silvery

Cs	
Physical State	solid
Density	1.87 g/cm^3
Hardness	soft
Conductivity	good
Solubility (H_2O)	reacts violently
Melting Point	29ºC
Color	silvery white

Unknown #1	
Physical State	solid
Density	2.33 g/cm^3
Hardness	brittle
Conductivity	intermediate
Solubility (H_2O)	none
Melting Point	1410ºC
Color	gray

Unknown #2	
Physical State	gas
Density	0.00170 g/cm^3
Hardness	none
Conductivity	very poor
Solubility (H_2O)	slight
Melting Point	-219.6ºC
Color	pale yellow

Unknown #3

No DATA for this Element included

Unknown #4	
Physical State	gas
Density	0.00374 g/cm^3
Hardness	none
Conductivity	very poor
Solubility (H_2O)	none
Melting Point	-156.6ºC
Color	colorless

Unknown #5	
Physical State	solid
Density	19.3 g/cm^3
Hardness	soft
Conductivity	excellent
Solubility (H_2O)	none
Melting Point	1064ºC
Color	gold

Unknown #6	
Physical State	solid
Density	2.54 g/cm^3
Hardness	somewhat soft
Conductivity	good
Solubility (H_2O)	reacts rapidly
Melting Point	769ºC
Color	silvery white

Unknown #7	
Physical State	solid
Density	5.32 g/cm^3
Hardness	fairly brittle
Conductivity	fair to poor
Solubility (H_2O)	none
Melting Point	937ºC
Color	gray

H_2	
Physical State	gas
Density	0.0708 g/cm^3
Hardness	none
Conductivity	none
Solubility (H_2O)	slight
Melting Point	-259 ºC
Color	colorless

B	
Physical State	solid
Density	2.34 g/cm^3
Hardness	brittle
Conductivity	semi-conductor
Solubility (H_2O)	none
Melting Point	2300ºC
Color	shiny, black

Unknown # 10		**At_2**	
Physical State	solid	Physical State	solid
Density	2.70 g/cm^3	Density	---- g/cm^3
Hardness	soft	Hardness	brittle
Conductivity	excellent	Conductivity	fair; semi-conductor
Solubility (H_2O)	none	Solubility (H_2O)	none
Melting Point	2467ºC	Melting Point	302ºC
Color	silvery white	Color	unstable, radioactive

Unknown #11	
Physical State	gas
Density	0.00973g/cm^3
Hardness	none
Conductivity	very poor
Solubility (H_2O)	none
Melting Point	-71.1ºC
Color	colorless; radioactive

General Properties Predicted for Element #3:

Physical State -
Density -
Hardness -
Conductivity -
Solubility (H_2O) -
Melting Point -

Pondering the Periodic Table Data

	1	2	11	13	14	17	18
1							
2							
3							
4							
5							
6							

Return to Instructional Segment

Pondering the Periodic Table—Answer Key

		1	2	11	13	14	17	18
1		H_2	---	---	---	---	---	He
2		Li	Be	---	B	C	*#2*	Ne
3		Na	*#8*	---	*#10*	*#1*	Cl_2	Ar
4		K	Ca	Cu	Ga	*#7*	Br_2	*#4*
5		*#3*	*#6*	Ag	In	Sn	I_2	Xe
6		Cs	Ba	*#5*	*#9*	Pb	At_2	*#11*

Physical State	solid
Density	~1.2 g/cm^3
Hardness	soft
Conductivity	good
Solubility (H_2O)	reacts rapidly/violently
Melting Point	~50°C
Color	silvery

Return to Instructional Segment

Structure and Function of Matter Data Log

Student Names:____

Element 1	# of Valence Electrons Element 1	Charge of Element 1	Element 2	# of Valence Electrons Element 2	Charge of Element 2	Total Valence Electrons	Total Charge of Both Elements	How Many Atoms of Element 1 Do I Need?	How Many Atoms of Element 2 Do I Need?	Formula for Compound	Name for Compound
Li	2	+1	O	6	-2	8	-1	2	1	L_2O	Lithium Oxide

Return to Instructional Segment

Structure & Function of Matter: Topic, Focus, and Phenomenon Teacher Notes

GSE: **SPS1a,b,c; SPS2a,b,c; SPS7a**

Anchoring Phenomenon:

Elements have different properties than the compounds they combine to form.

Topic	Focus	Lesson Phenomenon	GSE/Notes/Language
Structure of Atoms and Elements	● Brief review of the basic structure of atoms and subatomic particles ● Elements are not always the same; they can form ions and isotopes. ● Elements are defined by their atomic number (number of protons) and their properties are determined by the location and charge of their subatomic particles.	Historical and current models of the atom. ● There have been many models of the atom over time. ● Using the historical models as a guide, students can trace the discovery of the subatomic particles as a method for explaining our current understanding. ● They can then design and make models showing the strengths and weaknesses of the historical and current understanding of the atom. The following resources may be used- Thomson's Model Rutherford Model Bohr Model Electronic Cloud Model	SPS1a. Develop and use models to compare and contrast the structure of atoms, ions and isotopes. (Clarification statement: Properties include atomic number, atomic mass and the location and charge of subatomic particles.) Notes- ● Models can include 3D and 2D (drawing or writing) representations of atoms, ions and isotopes. ● Connecting this topic to all other topics in this unit will deepen understanding.
Trends in the Periodic Table	● The periodic table groups elements into regions, columns and rows based on several properties. ● Place emphasis on understanding the importance of the trends	Historical development of the periodic table. ● Many scientists spent their lives working on the periodic table. This process took more than 100 years.	SPS1b. Analyze and interpret data to determine trends of the following: ● number of valence electrons ● types of ions formed by main group elements

	in the periodic table, not just their existence. • Elements are organized into several main group- metals, nonmetals and metalloids. These are defined by specific properties.	• In the end, Mendeleev's original predictions about the properties of the elements and their placement on the table was correct, despite the fact that he was not even aware of the subatomic particles. • Mendeleev (and others) used elemental composition (mass, boiling point, melting point and others) to place elements in a patterned order on the table. Students can use this information, and our current knowledge of the elements, to model this work. (Large element cards with molecular mass, melting and boiling points, conductivity, bonding, etc. will help students with this work. Research will facilitate this project.)	• location and properties of metals, nonmetals, and metalloids • phases at room temperature SPS1c. Use the Periodic Table as a model to predict the above properties of main group elements.
Compounds-properties	• Elements have specific properties (melting point, boiling point, etc.) that are unchanging in the pure form. • When elements combine to form compounds, the compounds they make have very different properties. • Based on the types of bonds that form, compounds have specific properties.	*Properties of elements vs. compounds.* • The properties of elemental sodium (Na^+) and chlorine (Cl^-) are very different than that of the familiar table salt ($NaCl$) that they combine to form.	SPS2a. Analyze and interpret data to predict properties of ionic and covalent compounds. (Clarification statement: Properties are limited to types of bonds formed, elemental composition, melting point, boiling point, and conductivity.)
Compounds-bonding	• The properties of the elements (number of electrons in outer shell,	*Properties of compounds determined by bond types.*	SPS2b. Develop and use models to predict formulas for stable, binary ionic

	type of element- metal, nonmetal, etc.) determine the types of bonds they form. • Bonding occurs when electrons are transferred (ionic) or shared (covalent). • Bonds form due to the charges of the elements that interact. • Chemical reactions are due to the change in electron configuration.	The Na+ and Cl- phenomena can be used here as a stable, binary ionic compound with balanced charges.	compounds based on balance of charges.
Compounds- naming	• Students will read chemical names and translate them to a chemical formula. • Charges of ions needed to understand the naming should reference back to the ions and isotopes lessons earlier in this instructional segment. • Students should understand the purpose of naming and the role of the IUPAC.	*Naming systems need and development.* • As humans, our minds naturally seek patterns and stable explanations for the natural world. Scientists required a patterned, consistent system with which to name and describe chemical compounds. • Lavoisier and de Morveau's writing and works can introduce the need for the creation of this system.	SPS2c- Use the International Union of Pure and Applied Chemistry (IUPAC) nomenclature for translating between chemical names and chemical formulas. (Clarification statement: Limited to binary covalent and binary ionic, containing main group elements, compounds but excludes polyatomic ions.)
Energy in atoms, elements and compounds	Through the formation of and breaking of bonds, energy is either used or released. These interactions are used in everyday life to power our world.	*Chemical energy in cars and rockets.* The chemical energy used to launch a rocket involves forming bonds between hydrogen and oxygen (typically).	SPS7a. Construct explanations for energy transformations within a system. (Clarification statement: Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear.) Teacher note- The different types of energy will be introduced throughout the year, in this instructional segment, the focus is on chemical energy and how it is transformed to do work.
Anchoring Phenomenon:			

Elements have different properties than the compounds they combine to form.

Students will explain the phenomenon using the following concepts:

- Elements are based on the number of protons in an atom.
- All elemental substances display consistent properties (melting point, boiling point, metal, nonmetal, gas, rare-earth, etc.)
- When elements combine to form compounds, the compounds have properties that are different (typically dramatically so) than the individual elements that form them.
- The differences in the properties of compounds can also include bonding types (compounds with single bonds have different properties than similar compounds with double or triple bonds).
- Bonding types (covalent, ionic) are dependent on the atomic properties of the elements.

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