

It's the Law, Periodically – Grade Nine

Ohio Standards Connection:

Physical Sciences

Benchmark A

Describe that matter is made of minute particles called atoms and atoms are comprised of even smaller components. Explain the structure and properties of atoms.

Indicator 4

Explain that when elements are listed in order according to the number of protons (called the atomic number), the repeating patterns of physical and chemical properties identify families of elements. Recognize that the periodic table was formed as a result of the repeating pattern of electron configurations.

Lesson Summary:

Students will observe the chemical reactivity of both a group and a period of elements through a teacher demonstration. The students will then graph various properties and explain the trends in both a group and a period of elements.

Estimated Duration: *Three hours (and additional time for homework for graphing and answering questions outside class)*

Commentary:

This lesson is designed to illustrate and develop student understanding of the Periodic Law. The students will graph and analyze melting point trends for both a group and a period of elements. The teacher will relate the trends to the electron configuration of the valence shell of the atoms of the elements. Either teacher demonstrations or media presentations of chemical reactivity of a family and group of elements will be presented. This lesson allows students to use a mathematical and a visual approach to analyzing and understanding periodic trends.

Pre-Assessment:

- Give the students a periodic table which contains information about various properties of elements.

Instructional Tip:

Some periodic tables are available that include basic information about each element such as melting points, boiling points and densities. The lesson focuses on students being able to recognize the patterns of properties on the periodic table.

- Ask the students to describe a property mentioned on the periodic table.
- Instruct students to graph the atomic number (on the x-axis) versus the value of the chosen property (on the y-axis) for the first 20 elements, hydrogen through calcium.
- Have students describe the trends for both the groups and the periods of the elements.



It's the Law, Periodically – Grade Nine

- Have students include with their graphs a graph title and labeled axes.
- Remind students to include correct descriptions of the trends observed in that property when comparing first a group of elements, then when comparing a period of elements.

Scoring Guidelines:

1. Evaluate students' ability to use the periodic table and identify the properties of elements described in the table.
2. Examine the students' graphs for accuracy in terms of using the information available in the periodic table and using the information logically in their graphs.
3. Evaluate the students' ability to notice and describe trends in the periodic table.

Post-Assessment:

- Give students the sets of elements with corresponding melting points. See Attachment C, *Data Table of Elements and Melting Points, with Directions for Students*. Omit the melting point data for one of the elements in each set.
- Have students consult reference books or Web sites to find the melting points rather than providing them, if appropriate.
- Have students discuss the results as a class.

Scoring Guidelines:

See Attachment A, *Rubric for Post-Assessment*.

Instructional Procedures:

Day One

1. Give the students a periodic table which has the electron configuration printed in each element box.
 - a. Have the students look at the electron configurations of the group 1 elements and ask, "What do the electron configurations of this group of elements have in common?" (*Students should notice that the number of electrons in the outer shell is the same.*)
 - b. Explain to the students that these outer shell electrons are called the valence shell and they primarily determine the chemical and physical behavior of elements.
 - c. Have students complete a chart (See Attachment B, *Valence Chart*) in which they make note of the number of valence electrons in all of the representative groups of elements, groups 1, 2, 13, 14, 15, 16, 17, 18 (also known as groups IA, IIA, IIIA, IVA, VA, VIA, VIIA, VIIIA).
2. Introduce the history of the development of the periodic table. Have students discuss why there were blank spaces left in Mendeleev's version of the periodic table and why he was able to predict the properties of these missing elements.
3. Perform a series of demonstrations using the elements of groups one and two to show the chemical reactivity of families of elements.
 - a. Place small pea-sized samples of each of the elements lithium, potassium and sodium in separate beakers of water.
 - b. Have students make observations about the activity.



It's the Law, Periodically – Grade Nine

- c. Ask students questions such as:
- What evidences of a chemical reaction did you observe?
 - Which element reacted the most vigorously with water?
 - What is the trend for chemical reactivity of the group one elements with water?

Instructional Tip:

Use extreme caution when working with the alkali metals. Use very small pieces in large beakers of water. Cover the beakers with heavy watch glasses immediately after dropping in the pieces of metal. Wear personal protective safety equipment and use a shield between the reaction and the students. Consult science supply-house catalogs for videos or CD-ROMS that may be substituted for these demonstrations.

4. Place pea-sized samples of the elements calcium and magnesium in water. Again, have students make observations.
5. Ask questions such as:
 - What evidences of a chemical reaction did you observe?
 - Which element reacted the most vigorously with water?
 - What is the trend for chemical reactivity of group two elements with water?
6. Show a video or CD-ROM clip of a demonstration in which the elements from groups one and two are placed in diluted (one molar) hydrochloric acid. Have the students make observations about the activity.
7. Ask questions such as:
 - What evidences of a chemical reaction did you observe?
 - Which element reacted the most vigorously with the acid?
 - What is the trend for chemical reactivity of group one elements with hydrochloric acid?
 - With group two elements?
 - Is there a general trend in chemical reactivity for the group one and group two elements? If so, what is it?

Instructional Tip:

It is dangerous to perform these demonstrations yourself; however, the reaction of magnesium and hydrochloric acid can be demonstrated if proper safety procedures are followed (wear goggles, apron and possibly gloves and use a safety shield).

Day Two

8. Give students a table of atomic radii for the group one (IA or alkali metal) elements to study a physical property of a family of elements. See the table below.
9. Have students construct a graph of atomic number (x-axis) versus atomic radius (y-axis), using the atomic radii table as a reference,



It's the Law, Periodically – Grade Nine

<u>Element</u>	<u>Atomic Number</u>	<u>Atomic Radius (Angstroms)</u>
Cesium	55	2.67
Francium	87	2.7
Lithium	3	1.55
Potassium	19	2.35
Sodium	11	1.90

Instructional Tip:

As a variation, have some students make a bar graph and have other students make a line graph with the data. Ask them which one is more appropriate for these data and why.

10. Ask students to explain what trends are noticed on the graph curve and, in general, where these elements are located on the periodic table. Also, have students explain whether these elements make up a period or a group, what the relationship is between these elements and their electron configurations, and how a missing value might be predicted. Have students comment on how accurate such a prediction might be.

Day Three

11. Give students a table of atomic radii values for the period 2 (group IIA or the alkaline Earth) elements and have them construct a graph of the atomic number (x-axis) versus atomic radius (y-axis).

<u>Element</u>	<u>Atomic Number</u>	<u>Atomic Radii (Angstroms)</u>
Beryllium	4	1.12
Boron	5	0.98
Carbon	6	0.91
Fluorine	9	0.57
Lithium	3	1.53
Neon	10	0.51
Nitrogen	7	0.92
Oxygen	8	0.65

12. Ask students to discuss any trend that the curve of the graph shows, where these elements are located on the periodic table, and whether these elements make up a group or a period of elements. Ask the students to explain what the relationship is between these elements and their electron configurations and how a missing value might be predicted. Have students comment on how accurate such a prediction might be.
13. Give students the post-assessment.

Differentiated Instructional Support:

Instruction is differentiated according to learner needs, to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator(s).

- Provide a completed graph of a particular periodic trend for those students who have



It's the Law, Periodically – Grade Nine

difficulty graphing. In some cases, a bar graph makes it easier to visualize the trend.

- Have students observe graphs of various trends on Web sites or printed material.
- Provide lab kits (commercially available through educational science supply companies) in which straws are used to construct graphs. The various lengths of the straws arranged in group or period order allow the students to visualize the graph.
- Explain why the properties of elements change in a group or across the table in a period.

Extensions:

- Have students graph other trends in the periodic table, such as electronegativity.
- Have students research the properties of the halogen (group 17 or group VIIA) and noble gas (inert gas, group 18, group VIIIA) families.
- Provide a visual demonstration in which 0.1 molar solutions of the nitrate compounds of the group two (IIA or alkaline earth) elements are reacted with 0.1 molar solutions of ammonium hydroxide, potassium chromate, ammonium carbonate, ammonium sulfate and ammonium oxalate. Have students make note of those group two compounds which were soluble in most of the above solutions and relate this to the position of the group two elements in the periodic table
- Challenge students to use their knowledge to answer the following questions: How is the activity of metals related to their abilities to corrode? Why are metal medical implants made of titanium? Why do articles made of silver need more polishing than articles made of gold? Why is copper the major choice for use in electrical wiring?

Homework Options and Home Connections:

Have students look for names of elements in various products found at home and report which elements are most commonly found.

Interdisciplinary Connections:

Mathematics:

Throughout this lesson students are able to see patterns and trends within the periodic table when information from the table is put into graphical form. Using different kinds of graphs helps different students see the patterns and trends more clearly than when using just one type of graph.

Materials and Resources:

The inclusion of a specific resource in any lesson formulated by the Ohio Department of Education should not be interpreted as an endorsement of that particular resource, or any of its contents, by the Ohio Department of Education. The Ohio Department of Education does not endorse any particular resource. The Web addresses listed are for a given site's main page, therefore, it may be necessary to search within that site to find the specific information required for a given lesson. Please note that information published on the Internet changes over time, therefore the links provided may no longer contain the specific information related to a given lesson. Teachers are advised to preview all sites before using them with students.



It's the Law, Periodically – Grade Nine

For the teacher: Samples of lithium, sodium, potassium, calcium, magnesium, distilled water, 1.0 molar hydrochloric acid, glass beakers, heavy watch glasses, test tubes, safety equipment (goggles, lab apron, gloves and shield).

For the students: Periodic tables, graph paper.

Vocabulary:

- group
- period
- family
- valence shell
- electron configuration
- periodicity
- Periodic Law
- atomic number
- density
- melting point
- boiling point
- periodic table
- chemical reactivity

Technology Connections:

- Use the Internet to find examples of periodic trends.
- Use the Internet to access interactive periodic tables
- Use graphing calculators or computers to graph the periodic trends.
- Use CD-ROMS or videotape collections of chemical reactivity of families of elements.

Research Connections:

Marzano, R. et al. *Classroom Instruction that Works: Research-Based Strategies for Increasing Student Achievement*. Alexandria, Va.: Association for Supervision and Curriculum Development, 2001.

Identifying similarities and differences enhances students' understanding of and ability to use knowledge. This process includes comparing, classifying, creating metaphors and creating analogies and may involve the following:

- Presenting students with explicit guidance in identifying similarities and differences;
- Asking students to independently identify similarities and differences;
- Representing similarities and differences in graphic or symbolic form.

Summarizing and note-taking are two of the most powerful skills to help students identify and understand the most important aspects of what they are learning.



It's the Law, Periodically – Grade Nine

Reinforcing effort and providing recognition addresses students' attitudes and beliefs about themselves as learners. They have positive effects on student learning.

Homework and practice provide students with opportunities to deepen their understanding and skills related to content that has been presented to them.

Nonlinguistic representations help students think about and recall knowledge. This includes the following:

- Creating graphic representations (organizers);
- Making physical models;
- Generating mental pictures;
- Drawing pictures and pictographs;
- Engaging in kinesthetic activity.

Cooperative learning has a powerful effect on student learning. This type of grouping includes the following elements:

- Positive interdependence;
- Face-to-face promotive interaction;
- Individual and group accountability;
- Interpersonal and small group skills;
- Group processing.

General Tips:

- Give students opportunities to ask questions and discuss ideas with other students in their groups or in the class.
- Offer guiding questions throughout the lesson so that students are encouraged to think at high levels.
- Practice extreme caution when using the recommended chemicals for demonstrations in class. To ensure proper procedure and safety measures, review each chemical substance's properties by re-reading its Materials Safety Data Sheet (MSDS) before doing the demonstrations.
- Observing and explaining the change in properties of elements as we go down the table within a group or across the table within a period gives the students the opportunity to investigate the shielding effect, distance between nucleus and valence shell, and numbers of protons and electrons present in an atom of a specific element.

Attachments:

Attachment A, *Rubric for Post-Assessment*

Attachment B, *Valence Chart*

Attachment C, *Data Table of Elements and Melting Points, with Directions for Students*



It's the Law, Periodically – Grade Nine

Attachment A Rubric for Post-Assessment

- Level 4** Graphs and trends are constructed and explained accurately. Periodic and group trends are identified and accurately explained. Information and explanations are presented in a logical manner with valid, detailed and consistent conclusions.
- Level 3** Graphs and trends are constructed and explained with few errors. Periodic and group trends are identified. Information and explanations are presented in a logical manner with valid and consistent conclusions.
- Level 2** Graphs and trends are constructed and explained with some inaccuracies or are simplified. Periodic and group trends are implied. Information and explanations have some clarity and some conclusions are invalid and inconsistent.
- Level 1** Graphs and trends are constructed and explained with major inaccuracies or are overly simplified. Periodic and group trends are unclear or inaccurate. Information and explanations have no relationship and conclusions are unclear or unrelated to the data.

It's the Law, Periodically – Grade Nine

Attachment B Valence Chart

Group Number	# of Valence Electrons
1 (IA)	
2 (IIA)	
13 (IIIA)	
14 (IVA)	
15 (VA)	
16 (VIA)	
17 (VII A)	
18 (VIIIA)	



It's the Law, Periodically – Grade Nine

Attachment C Data Table of Elements and Melting Points, with Directions for Students

Data Set 1:

<u>ELEMENT</u>	<u>MELTING POINT (Kelvin)</u>
Lithium	453.7
Sodium	371.0
Potassium	336.9
Rubidium	312.63
Cesium	301.54
Francium	300

Data Set 2:

<u>ELEMENT</u>	<u>MELTING POINT (Kelvin)</u>
Lithium	453.7
Beryllium	1560
Boron	2365
Carbon	3825
Nitrogen	63.15
Oxygen	54.8
Fluorine	53.55
Neon	24.55

Directions for Students:

- Graph each set of data separately.
- Explain each graph in terms of the observed trends.
- Predict the missing melting points.
- Explain how the predictions were made.
- For each set of data, explain the relationship between the elements and their electron configurations.
- Discuss why the periodic table might be valuable to scientists.