Periodically at War

An inquiry-based game to teach periodic trends in chemistry

Background Information

Atomic radius, electronegativity, and ionization energy are three main properties of elements that are studied when discussing periodic trends in chemistry. This inquiry-based activity has students discover the different patterns that can be found in the periodic table through playing a variation of the familiar card game, "war". The questions that follow the game ask students to connect the patterns they observed to what they know and have learned about atomic structure.

Student Prior Knowledge

Prior to this activity, students should have completed a unit on atomic structure and have a basic understanding of the structure of an atom (protons, neutrons, electrons).

Logistics

Time: One 60 minute period (can be modified to fit shorter or longer class periods)

Suggested Grade Level: This lesson is designed for an introductory high school chemistry class, typically grades 10-11.

Materials: *(per group of four students)*

- Periodic Table War Cards*
- Periodic Table
- Element Reference Table (suggested: Table S from the New York State Reference Tables for Physical Setting/Chemistry)

***** *Indicates advanced preparation*

Advanced Preparation:

- Make and cut out Periodic Table War Cards for each group of 4. For each round, pick 4 elements that are either in the same group or the same period. Use student pages 4-6 as a guide for choosing your cards.
- If students do not have copies of the periodic table or element reference table, print out enough copies for each group.

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Standards:

- **Next Generation Science Standards (NGSS) HS-PS1-1:** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
- **Common Core State Standards ELA/Literacy RST.9-10.7:** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words

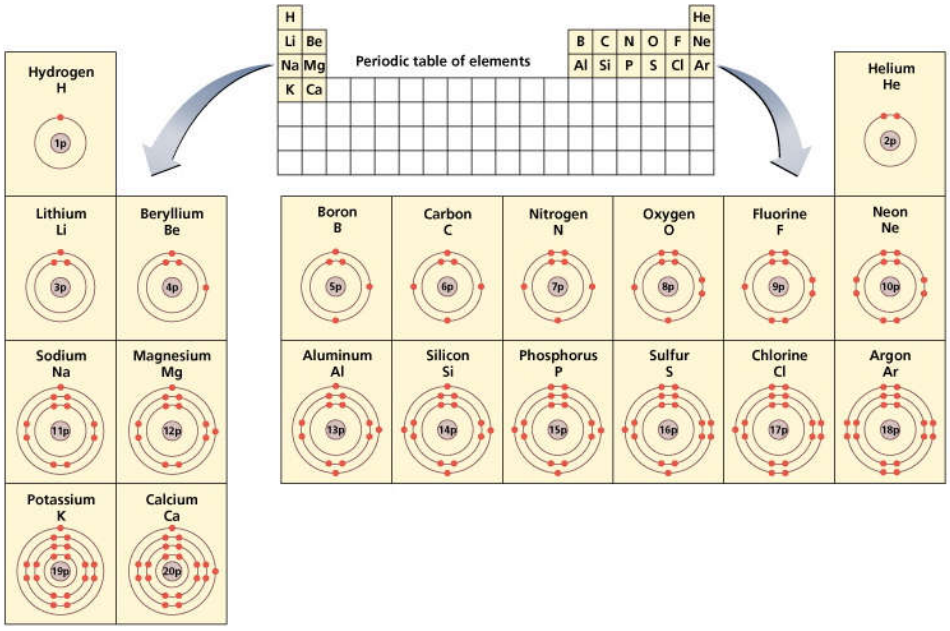
Objectives:

- To deduce the periodic trends for atomic radius, ionization energy, and electronegativity
- To connect the observed periodic trends to atomic structure

Suggested Approach

This lesson assumes students have completed a unit on atomic structure. It is suggested to do this activity after students have been introduced to the basic organization of the periodic table (groups and periods, family names).

Begin by showing students the following graphic and ask these questions:



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- Find and label the noble gases on the periodic table. What is special about the noble gases?
- Pick <u>one group (column)</u> of elements to examine.
  - What do elements in the same group have in common?
  - What changes about the *structure of the atom* as you go down the group (top to bottom)?
- Pick <u>one period (row)</u> of elements to examine.
  - What do elements in the same period have in common?
  - What changes about the *structure of the atom* as you go across the period (left to right)?

These questions have students look for how atomic structure (specifically, number of protons and electrons) change as you go across and go down a periodic table. You may refer students back to these when they answer the post-game questions.

Next, give students a very brief definition of the three element properties that they will be exploring in the lesson: atomic radius, electronegativity, and ionization energy.

- **Atomic Radius:** A measure of the <u>size</u> of an atom
- **<u>Electronegativity:</u>** A measure of an atom's ability to <u>gain</u> or <u>attract electrons</u>
- **<u>Ionization Energy:</u>** The amount of <u>energy</u> required to <u>remove an electron</u> from the outermost shell of an atom

Note that students are only being given basic definitions and not the trends themselves. The inquiry component of this activity has students determine the trends.

Next, familiarize students with the reference table they will be using during the game. Have students look up the atomic radius, electronegativity, and ionization energy for magnesium and calcium. Once students find these and identify the element that has the larger value, briefly explain the meaning of the numbers based on the definitions:

- A calcium atom is larger than a magnesium atom.
- Magnesium can attract an electron more easily than calcium
- It is harder (requires more energy) to remove an electron from an atom of magnesium than calcium

Students now have all the background knowledge they need to play the game. Students will play 6 rounds of the game in groups of 4. Students will be dealt one card per round that has a specific element on it. For each round, students find the value for a specific property (radius, electronegativity, or ionization energy) for their element. Students compare their values with their group, and whoever has the highest value wins.

Remind students to make sure they are looking up the value for the specified property for each round!

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You may direct students to the questions done at the beginning of the lesson to help them with the "why" component. They may not be able to completely figure out why after the game, and that's okay! You can go into more detail and debrief in a later lesson. The purpose is to get students to use what they know and observed to think about why the patterns exist.

Debriefing the Activity

The post-game questions have students analyze their results from every round. As they go through the questions, students will realize that they were comparing elements in the same group or in the same period for each round. There are two main components to the questions for each round:

- For each round, students use their results to determine how radius, electronegativity, and ionization energy changes as they go down a group or across a period.
- Students are asked to use what they know about atomic structure to come up with why they think they observed these patterns.

Extension

This can be done as a stand-alone introduction to the periodic trends. If desired, it can be followed with an inquiry-based lab in which students use the results of this game to predict the reactivity of certain elements.

Appendix

New York State Regents Chemistry Reference Tables:
http://www.p12.nysed.gov/assessment/reftable/chemistry-rt/chemrt-2011.pdf