Organize the Elements

Throughout the guide, teaching tips are in red.

Activity Description & Estimated Class Time

Students work for two 50-minute class periods to organize element cards and look for patterns in the periodic table that hint at principles of its organization. Students perform a task similar to Mendeleev's, except that they work with a different set of elements, some of which were unknown in Mendeleev's day. The exercise is intended to expose students to the names and properties of many of the most familiar elements so that they can begin to see how the elements relate to each other.

Objectives

Students will demonstrate knowledge and understanding of the following ideas and content:

- elements are composed of one kind of matter
- elements have specific measurable properties
- the periodic table is arranged by grouping elements with similar properties

Students demonstrate this knowledge and understanding by developing their own organizational scheme for a set of assorted element cards and by analyzing the current Periodic Table to look for organizational patterns.

Correlations to North Carolina Science Standards

8.P.1.1 Classify matter as elements, compounds, or mixtures based on how the atoms are packed together in arrangements.

8.P.1.2 Explain how the physical properties of elements and their reactivity have been used to produce the current model of the periodic table of elements.

Brief Science Background

In 1869, Dmitri Mendeleev designed a set of cards with descriptions of elements, and sorted them until he arranged the elements known at the time into the first periodic table. He arranged his table according to criteria such as atomic mass, physical properties, and chemical properties. He even left gaps in his table where the pattern suggested that yet undiscovered elements should be. Later, when these elements were discovered, it helped to confirm his system. Mendeleev did this work before atomic theory had been developed and accepted. In fact, his work, was fundamental to understanding atomic structure.

As of 2012, the standard form of the periodic table has 118 confirmed elements arranged by increasing atomic number (the number of protons in an atom of an element). The 7 horizontal rows, or "periods," are based on the number of electrons in the outer shell of the element. The first element in a period has one electron in the outer shell and the last element in a period has a full outer electron shell (the un-reactive noble gases). As you move down the table, the periods are longer due to increased electron shell capacity. The Lanthanides and Actinides are often shown below the table because they would make the last two periods longer than is practical on a chart.

The table is organized in 18 columns, or "groups." Elements in a group have similar numbers of electrons available to engage in chemical reactions. As a result, they show many chemical similarities. Larger groups, or "blocks," group elements with similar characteristics together. These have names such as metalloids, transition metals, halides, or noble gases.

Part 1 — Organize the Elements (50-minutes)

Materials

Materials for groups of 2 or 3 students

- element sorting card set (34 white element cards)

Preparation

Make sure each team has an element card set available. An area with large tables or floor space is helpful for this activity.

Procedure

1. To introduce the activity, tell this brief history of Mendeleev. "In our history of chemistry so far, we saw that people once believed that everything was made of 4 basic things, and that this system proved less useful as chemists discovered more kinds of matter. Eventually, chemists started to think that matter was made of small pieces that fit together in many combinations. By 1869, when Dmitri Mendeleev started his work, scientists had found that some matter could be broken down into pieces that all had the same characteristics. They called these substances elements, and they named them and made symbols for them. Elements could be solids, liquids, or gases, but always made of only one thing. Mendeleev had 63 known elements to work with when he decided that some principle must exist to organize them. To find that principle, he wrote down the properties of the elements on cards and started to work."
2. Tell students that their job is to read their element cards, and like Mendeleev, group similar elements together in ways that make sense.
3. As you circulate among the groups, encourage students to break down larger groups into smaller ones. No hints are necessary as there is no correct answer. Your role is to keep them observing and thinking of new groupings. For example, solids, liquids, and gases is an obvious first grouping. These groups can be broken into sub groups based on other criteria. Depending on time, there are several things to do with students' grouped element sets:
   - Ask students what they notice about the element cards and what characteristics they used to sort.
   - Ask a team to list the elements in one of their groups out loud and challenge the class to come up with the sorting characteristic for that group.
   - Ask teams to move from their table and look at another team's classification scheme to identify characteristics the other team used to group elements.

This is a good breaking point.

Part 2 — What Mendeleev Did (50-minutes)

Materials

Materials for the whole class

- ability to project BLM 1 and 2
- large version of the periodic table (hidden until the end of the activity and supplied by teacher).

Materials for groups of 2 or 3 students

- element sorting card set (34 white element cards)
- newly-discovered element card set (6 yellow cards)
- handout version of BLM 1 (optional)

Preparation

Make sure teams have large tables or open floor space available.

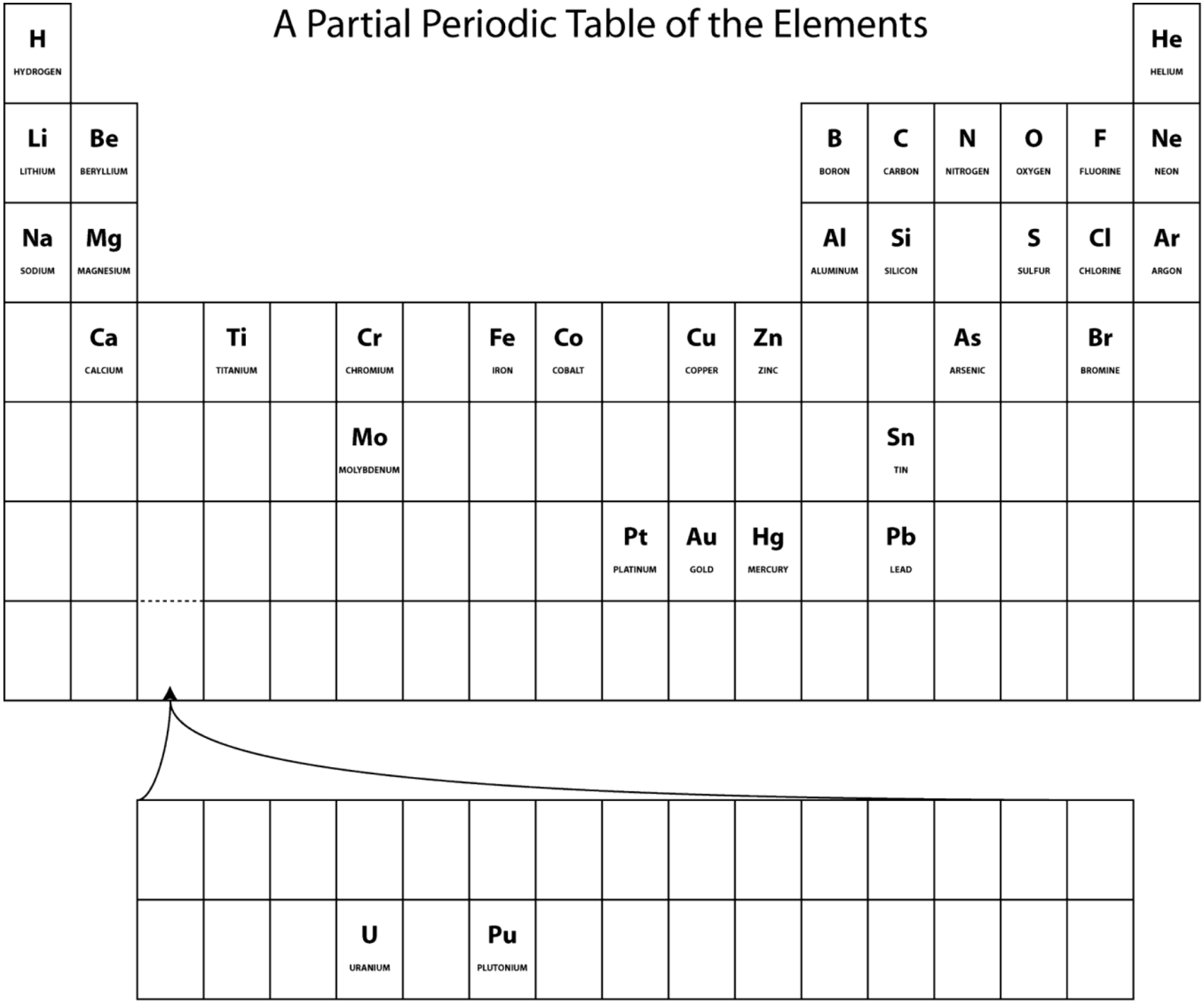
Procedure

1. Project BLM1 and ask teams to arrange their cards in this order. **A paper copy of BLM 1 can be helpful for this.**
2. After students arrange their element cards, explain that this is the scheme, still used today, that Mendeleev developed. Challenge them to look at the arrangement and find criteria that Mendeleev used to set it up. Push them to find as many patterns as they can.
3. Tell students that part of Mendeleev's genius was to intentionally leave spaces in the table for elements that he hypothesized would be discovered. The gaps actually helped scientists look for and find these elements. Pass out the yellow cards and tell students that these new elements were just discovered. Ask them to put the new elements where they belong in the table.
4. Project BLM 2 and ask students what clues they used to place the new elements.

Wrap-Up

1. Reveal a larger version of the periodic table and talk with the students about what the numbers and symbols mean. This is a good time to describe the idea of an atom and fit it into the periodic table. Mention that in many ways, this table helped to shape atomic theory.
2. The most important points are:
   - In chemical reactions, electrons are the active parts of atoms.
   - Reactions tend to make stable arrangements of electrons by filling shells as much as possible.
   - Discuss the ideas of rows and groups with the class, giving examples of how the reactivity of different elements relates to the atomic theory.

A Partial Periodic Table of the Elements



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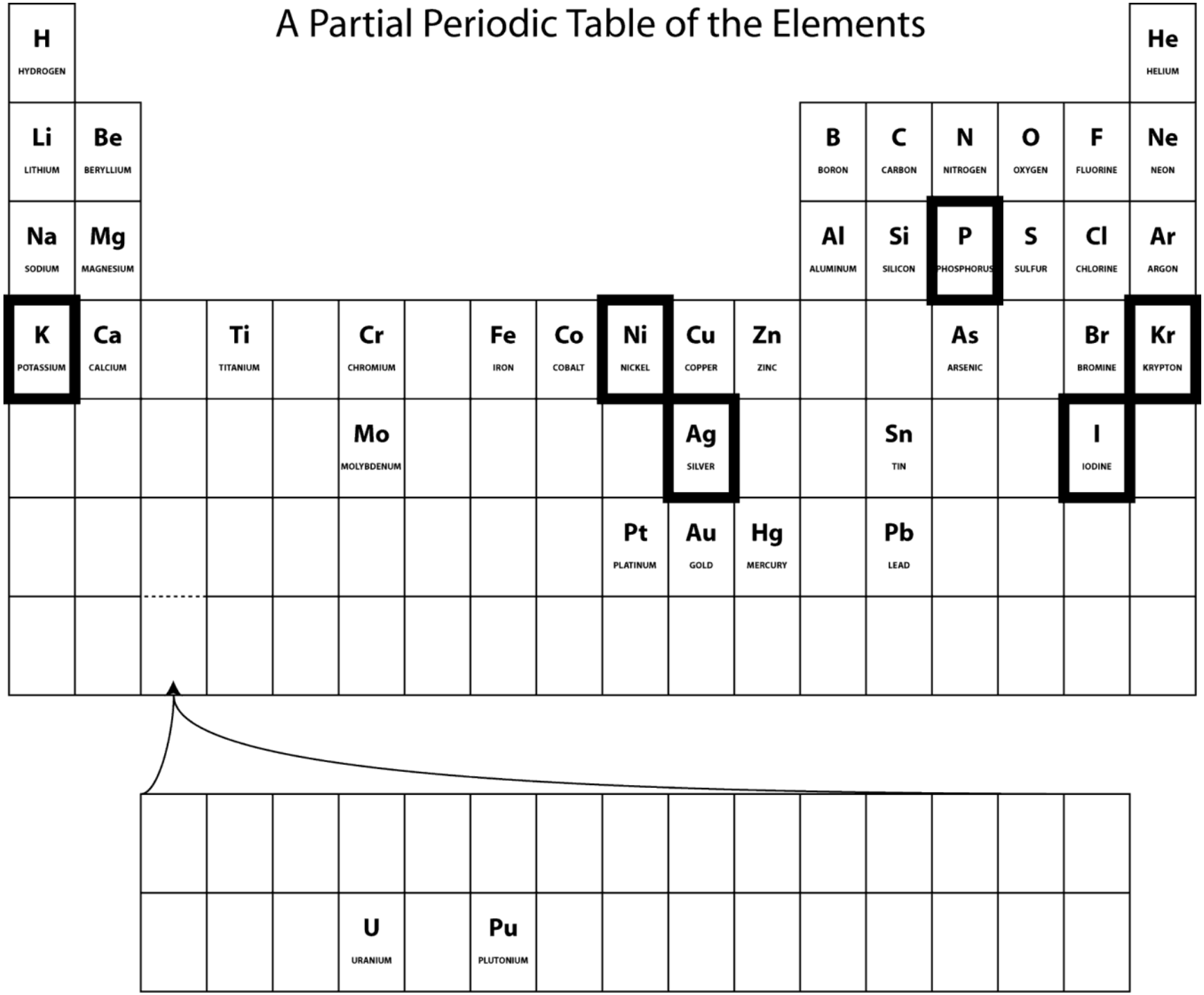

Appendix

Common Student Preconceptions About This Topic

Children have difficulty distinguishing between elements, compounds, atoms, and molecules for reasons having to do with basic language. For example, elements are described as “pure” substances, meaning, “made of only one thing.” For many children, the term “pure” means “without harmful contents,” or “clean, bright, and as-it-should-be.” In addition, children have difficulty with the idea of “substance.” For example, some middle school children see ice and water as different substances. In general, most children’s characterization of matter is at a macroscopic level, not a microscopic one. They tend to view chemical combination as a kind of mixing, with only a hazy idea of internal microscopic chemical bonds. For example, many think that burning is like evaporation, only faster because of the heat. Although they know that oxygen is necessary for combustion, they have little sense that it interacts with the material that is burning.