Stay-All-Day Activity (HS) – Organizer Notes

Creating a Periodic Table

Description: Students work as a team to group and rank the elements and look for patterns in the data to create a periodic table like Dmitri Ivanovich Mendeleev did in 1869. They infer data for undiscovered elements and create a 1928 version of the periodic table by analyzing elemental properties. Non-competitive.

Materials:
Each student: 1 student handout copied back to back and stapled.
Each team: 1 set of element cards and group numbers. (Element cards and group numbers are provided in accompanying files. See note about copying and distributing at the bottom of the third page of the element card file.)

NOTE: It is very possible that some students have memorized the location of the elements in the periodic table. Ask them to suspend their memories and to pretend they were Dmitri, the youngest of 13 or so kids who was the apple of his mother's eye. They should use their scientific inquiry skills to develop, not just reproduce, the periodic table.

Part 1: Grouping and Ranking the Elements
Students should figure out to group the elements by oxygen combination ratio and rank the elements in each group in order of ascending atomic weight. The groups should be moved so that a pattern emerges for atomic weight that emerges both vertically (within the group) and horizontally (across the group). Many students will arrange the groups left to right as follows:

1:1, 1:2; 1:3, 2:1, 2:3, 2:5, 2:7

because they think that is in order of increasing ratios. But no pattern emerges in atomic weight in this order. Students should be left alone to create a better arrangement if this occurs.

Once the left to right arrangement is correctly determined (2:1, 1:1, 2:3, 1:2, 2:5, 1:3, 2:7) the atomic weight pattern works well at the top of the table but breaks down at the bottom of the table. Students should discover that gaps exist in their tables and that by moving some elements down, the atomic weight pattern continues. Students should discover the Te-I anomaly: the atomic weight of tellurium is actually higher than the atomic weight of iodine. Mendeleev was certain that the atomic weight of Te was incorrect and encouraged scientists to recalculate the weight. Since his organization worked for the vast majority of elements he had great confidence in his system. It turns out that Te has many naturally occurring isotopes and the most abundant isotope of Te has more neutrons than the only naturally occurring isotope of iodine. Therefore the average atomic mass of Te is higher than the average atomic mass of I. Of course, since the neutron was not discovered until 1932, Mendeleev did not know about isotopes.

Students will infer data from the 4 “holes” in the periodic table (2 holes in group 3, and one each in groups 4 and 7). Once this data is inferred, students receive element cards and compare their inferences with actual data.

Part 2: Some of these things are not like the others…

The next part separates the transition elements from the main group elements, rearranges the columns to preserve the atomic weight pattern, separates the main group elements into a left and right side, and slides the transition elements up into the main table. The result is a periodic table very similar to what students are familiar with.

Elements removed:

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Cu	Zn	Sc	Ti	V	Cr	Mn
Ag	Cd	Y	Zr	Nb	Mo	Tc
Au	Hg	La	Hf	Ta	W	

Rearranged columns:

3B	**4B**	**5B**	**6B**	**7B**	**1B**	**2B**
Sc	Ti	V	Cr	Mn	Cu	Zn
Y	Zr	Nb	Mo	Tc	Ag	Cd
La	Hf	Ta	W		Au	Hg

Final arrangement:

1A	**2A**								**3A**	**4A**	**5A**	**6A**	**7A**
Li	Be								B	C	N	O	F
Na	Mg	**3B**	**4B**	**5B**	**6B**	**7B**	**1B**	**2B**	Al	Si	P	S	Cl
K	Ca	Sc	Ti	V	Cr	Mn	Cu	Zn	Ga	Ge	As	Se	Br
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ag	Cd	In	Sn	Sb	Te	I
Cs	Ba	La	Hf	Ta	W		Au	Hg	Tl	Pb	Bi		

Questions

1. Mendeleev's original group number for 1A and 1B was 1. We split the table because the properties of Cu, Ag, and Au were significantly different from the other elements in Group 1.

2. The group missing from Mendeleev's periodic table was the Noble Gases (group 8A/18). Since these gases do not react very well, they are difficult to detect and were not known in Mendeleev's time.

This activity has been modified from an activity presented at Chem Ed '95 in Norfolk, VA, author unknown.

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Stay-All-Day Activity (HS) – Student Handout

Creating a Periodic Table

Background: The year is 1869 and according to some sources, a chemistry professor wanted a better way to teach his students about the elements; one that allowed the students to go beyond memorization. Dmitri Ivanovich Mendeleev put element names and properties on cards, and sorted, ranked, and made table after table trying to find patterns in the data. Working with about 60 elements (some with incorrect chemical and physical properties!), Mendeleev eventually published a *Periodic System* which was momentous because it left gaps where as of yet undiscovered elements would eventually be placed.

Your Task: Channel Dmitri and create a periodic table using the 49 elements that were known in 1869.

Part 1: Grouping and Ranking the Elements

> **GROUP** – an assemblage of items with a common property
> **RANK** – numerical ordering within the group and between the groups

Explore the small element cards. Each card has the following information for each element: name, symbol, atomic weight, and oxygen combination ratio. The oxygen combination ratio represents the ratio of the element to oxygen when they are chemically bonded in a compound. The last piece of information is a property of the element. Each card has <u>one</u> of the following properties: boiling point of a salt made from that compound, melting point of the element, or electron affinity (the attraction the element has for electrons). Example:

Oxygen (O) <u>atomic weight = 16</u> Oxygen Combination: **1:3** *Property:* *Electron Affinity: 141*

1. Group the cards according to "oxygen combination ratio". This is a characteristic common to all cards and will allow ranking in rows and columns.

2. Rank the cards in each group by atomic weight. This is a characteristic common to all cards and will allow patterns to be seen in rows and columns. For ease of making a table, rank the groups vertically from smallest to greatest atomic weight.

3. Organize the elements into a table. The characteristic used to rank must show a logical pattern down a column and across a row. **Columns may be moved around** but keep groups and ranks intact. You may have to **move a few cards vertically** in a few columns to make horizontal patterns appear. Once you think it is as organized as it will get, have a judge check your findings and initial below.

Congratulations! You have walked in the footsteps of Mendeelev and have created a periodic table!

Judge's initials _____________ Go beyond 1869 by continuing this activity…

4. Do you have any gaps in your table? Complete the information for the missing elements. Estimate the atomic weights based on the patterns that you see. Once your predictions have been made, show them to a judge to receive the missing elements. Then complete the table with the actual name and atomic weight of the element.

	Missing Element A	Missing Element B	Missing Element C	Missing Element D
Oxygen Combination Ratio				
Atomic Weight (estimate)				
Name of Missing Element				
Atomic Weight (actual)				

Part 2: Some of these things are not like the others…

1. Number the columns 1-7 using the numbered cards from the envelope (the numbers without letters next to them).

   Look at the element properties in each column. Remove the 3 element cards that have **property values** that are similar to each other but very different from the rest. The elements that remain should have similar property values, different from the ones that you removed. **NOTE**: The column with the **<u>FEWEST</u>** number of elements (right-most column) has only **<u>2</u>** cards that will be removed.

   Example: 41 35 6 33 23 7 9

   Which 3 numbers are similar to each other? Are the remaining 4 numbers more similar to each other than to the 3 that were removed?

2. Record the element names or symbols of the cards removed and the column (1-7) from which they were taken.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7

3. Slide the remaining cards up so that there are <u>no gaps</u>.

4. <u>Group</u> and <u>rank</u> the removed cards.

5. Arrange the removed cards into a separate <u>sub-table</u> that has a logical pattern like the original table.

6. Using the "B" numbers, label the columns in the <u>sub-table</u> with the number that corresponds to the column from which it came (1-7).

7. Look at your original table. Determine if it can be split vertically (into left and right pieces) such that the <u>sub-table</u> can fit into the <u>original</u> and still maintain rank order throughout the columns and rows.

8. Vertically split the entire table and slide the sub-table into position. Place the "A" numbers on top of the appropriate columns from the <u>original</u> table. Have a judge check your findings and initial below.

Congratulations! You have created a periodic table very close to the table made by Reisenfeld in 1928! The only difference is that you did not have all of the elements known by Reisenfeld in 1928.

Judge's initials ____________________

Questions

1. What was Mendeleev's group number for groups 1A and 1B (part 1)? Why did we split that original group into 2 separate groups?

2. What **group** of **main group elements** on the current periodic table was totally absent from your periodic table? Why do you think that these elements were not known in Mendeleev's time?

Good work, and thanks for Staying-All-Day!