

SIMULATOR: Development of the Periodic Table

Purpose

The purpose of this activity is to use information given about the elements known at the time of Dmitri Mendeleev in 1869 to develop a crude version of the modern periodic table.

Background

Dmitri Ivanovich Mendeleev, a Russian scientist, was able to organize the elements into a system based upon first grouping the known elements by similar properties and then ranking by increasing atomic weight. In the first part of this activity you will use ordinary playing cards to familiarize yourself with the idea of *grouping versus ranking*.

In the second part of this activity, you will become a scientist in the year 1869. The known elements are written out on cards with properties of each element. The goal is to group the cards by oxygen combination properties and then rank the cards by increasing atomic weight. The final steps will be to expand the table into the periodic table.

Materials

Card set #1

Card set #3

Card set #2

Simulator cards

Part 1.

Note: Aces will be considered a low card (value = 1).

A. Simple Grouping and Rank Order

1. Use card set #1.
2. Group the cards by suit.
3. Rank each set of cards with the group. Stack them on top of each other within the group by having the low card on top and the high value card on bottom of the stack.
4. Expand the ranked groups into a 3-column, 4-row table, maintaining the ranked order within the groups and between the groups.
5. Fill in the data table below with your results.

HEARTS	SPADES	DIAMONDS

B. Sequential Grouping

1. Use card set #2.
2. Values: Ace = 1, Jack = 11, Queen = 12.
3. Group the cards.
4. Rank within each group as before, placing the low card on top of the group and the highest value card on the bottom of the pile.
5. Order the piles of the cards and then expand into a table as before.
6. Record your results in the table below.

HEARTS	SPADES	DIAMONDS

Questions

1. What card is missing? Be specific as to the suit and the value of the card. _____
2. If there were one more card in the sequence,
 - a. What suit would the card be in? _____
 - b. What would the value of the card be? _____

C. Non-Sequential Grouping:

1. Use card set #3.
2. Repeat the procedure of grouping and ranking the cards.
3. Expand into a table and record results below.

HEARTS	SPADES	DIAMONDS

Questions

1. If there were another card in the sequence, what suit would it belong to? _____
2. If the jack has a value of 11 and the king has a value of 13, what would be the value of the next card in the sequence? _____
3. The elements known to Dmitri Mendeleev were ranked by increasing atomic weight. Today, the modern periodic table is ranked by increasing _____ .

PART II. Periodic Table Simulation

Mendeleev was able to organize the known chemical elements by a system similar to what you did in part 1 of this activity. He grouped the elements according to the chemical property of oxygen combination ratio, chlorine combination ratio, and by valence numbers. He then ranked the elements according to increasing atomic weight. Mendeleev left holes or gaps in his periodic table for elements not yet discovered. Mendeleev was then able to predict properties of these yet-to-be discovered elements.

A. Simulator

1. Use the simulator card set.
2. Group the elemental cards by oxygen combination. There should be seven groups.
3. Rank within each group by increasing atomic weight, placing the lowest weight on top of the pile and the heaviest atomic weight on the bottom of the pile.
4. Place the seven piles in a row with the lowest atomic weight on the left and the highest on the right.
5. Expand the cards into a table. Leave gaps for missing elements.
6. Record results of your crude periodic table in the data table below. Include the symbol of the element and the atomic weight.
7. Label the top of each column with the oxygen combination ratio.

OXYGEN COMBINATION RATIO

Questions

1. What problem did you encounter with tellurium and iodine? (Did you notice a problem? Look at your table.)
2. Now you are going to predict the properties of 4 elements left as blanks in your periodic table above.
 - a. The first element to predict was called "eka-boron" by Mendeleev because it was located below boron and aluminum in the table. There were 2 blanks in this column. Predict the characteristics of the first blank in this column. Predict the oxygen combination ratio of this element. Predict the atomic weight of this element.
OXYGEN COMBINATION: _____ ATOMIC WEIGHT: _____
 - b. The next element to predict was called "eka-aluminum." This element is below "eka-boron."
Predict the oxygen combination ratio and atomic weight of this element.
OXYGEN COMBINATION: _____ ATOMIC WEIGHT: _____
 - c. The next element to predict is the element below silicon. Mendeleev called this element "eka-silicon." Find this blank and predict the oxygen combination and atomic weight of this missing element.
OXYGEN COMBINATION: _____ ATOMIC WEIGHT: _____

- d. Element #43 Technetium, was predicted by a friend of Mendeleev. Predict the oxygen combination ratio and atomic weight of this element.

OXYGEN COMBINATION: _____ ATOMIC WEIGHT: _____

3. The instructor will now give you the cards that are missing. Place them into your table and fill in the blank spots on your data table.
4. Fill in the correct names of the elements named by Mendeleev.
 - a. "eka-boron" _____
 - b. "eka-aluminum" _____
 - c. "eka-silicon" _____

B. Separation of the Transition Metals

1. From the table just constructed, you will remove cards from each group that "don't belong."
2. Look at the transition properties of the elements in the first column.
3. You are not to remove the first card in each column.
4. Remove 3 cards from the first column of elements. Place them to the side in a column. You will use them to construct a second "sub-table."
5. Repeat with each column, removing 3 cards that do not fit the transition properties. In the last column, remove only 2 cards.
6. Compress the original table.
7. Organize the "sub-table."
8. Look at the original table. You need to split the table and place the sub-table in a place that makes sense. Keep the sub-table as one unit.
9. Fill in the data table with your final table. Leave blanks where there are no cards.

Questions

1. Take out your periodic tables. Compare the crude periodic table you just constructed with the one used in class.
 - a. How many groups are in the Modern Periodic Table? _____
 - b. How many groups are in your crude periodic table above? _____
 - c. Group 0 (old designation), called group 18 (new designation) has a special name. What is the name of this group? _____
 - d. Group 0 (old designation), called group 18 (new designation) is not part of your crude periodic table. Suggest a reason why Mendeleev did not include this group in his periodic table.
 - e. Group VIII (old designation) or groups 8, 9, 10 (new designation) are not part of Mendeleev's periodic table. These elements were known to Mendeleev, but he chose not to place them in his periodic table.

Johann Wolfgang Dobereiner (1829), noticed that iron (atomic weight 55.8), cobalt (atomic weight 58.9), and nickel (atomic weight 58.7) were all magnetic. He also noticed that there were similar properties to osmium (atomic weight 190.2), iridium (atomic weight 192.2) and platinum (atomic weight 195.1). Dobereiner called these groupings "triads." The triad elements were placed in groups of their own. They were added to the periodic table after Henry Moseley discovered the atomic numbers of the elements.

2. Going back to your original table in Part A of the simulator, find lithium and copper.
 - a. What column were they in originally?

 - b. Look on your modern periodic table. What group (old designation) is lithium in? _____

 - c. Look at your modern periodic table. What group is copper in? _____

 - d. Look at your modern periodic table. There are A groups of elements and B groups of elements. Now look at your crude periodic table.
Is the following true or false: _____
The A groups of elements are the elements left in the original grouping of elements and the B groups of elements are those elements pulled out into a sub-group. The number of the group matches the column the elements were in on the original table.

3. Groups VIII and 0 were not part of the crude periodic table developed by Mendeleev. They are not given a grouping of A or B.