Activity: The Universe of Elements

FOR THE TEACHER

Summary
In this activity, students are introduced to the periodic table and its elements. Student will discuss that all material in the Universe is composed of elements and that the atom is the smallest particle that still has the physical and chemical properties of any given element. Students will engage in an activity to determine the percent composition of common elements in the universe, and based on their results they will hypothesize the identity of each element based on its relative abundance.

Grade Level
Middle School

Objectives
By the end of this activity, students should be able to
- Identify the chemical compositions of the universe.
- Recognize common elements on the Periodic Table.

Chemistry Topics
This activity supports students’ understanding of
- Periodic Table
- Elements
- Atoms
- Percent Composition

Time
Teacher Preparation: 30-45 minutes
Lesson: 60 minutes

Materials
- Plastic beads in 10 different colors (available at craft stores, or you can purchase a package 1000 beads on Amazon) Quantity of beads will depend on class size and student grouping
- Lap sized dry erase/white board, 1 per group
- Expo markers, 1 per group
- 3-4 Plastic cups per group

Safety
- There are no safety considerations for this activity.
- If you are doing this with elementary aged students, you might remind them of the choking hazard.

Teacher Notes
- Before beginning the lesson, have all beads pre-mixed in different buckets (one for each planet)
- I always group students by handing them cards as they walk in (either numbered or pictures). They then have to find the other students with that picture or number to find their group. This can be a little hectic the first few times. This works best with groups of 3-4.
- I normally scoop beads with a large cup and give students 3-4 small cups to use for sorting beads.
For classroom management purposes, I do not have materials out at student desks when they walk in. One student from each group is the materials manager and has to come get their beads from me once instructions are given. You can easily assign this as the youngest, oldest, nearest birthday, etc. in the group of students.

To create the mix of beads for the universe, I usually use a 1 cup measuring cup or something equivalent and mix the following:
- 50 scoops of clear beads (to represent 90% abundance of hydrogen in Universe)
- 5 scoops of light blue beads (to represent 9% abundance of helium)
- 3 scoops of dark blue beads (to represent 0.08% abundance of oxygen)
- 2 scoops of black beads (to represent 0.03% abundance of carbon)
- 1 scoop of green beads (to represent 0.01% abundance of nitrogen)
- 1 scoop of orange beads (to represent 0.01% abundance of neon)
- 1 scoop of pink, purple, red, and yellow beads in roughly equal amounts (to represent 0.01% abundance of magnesium, silicon, iron, and sulfur together)

I have students use the small dry erase boards to show all of their work when determining the percentages of each bead color present in their sample.

The lightest elements (hydrogen and helium) were created in the Big Bang. These elements combined to form stars. Stars are big balls of hot gas, mostly hydrogen. Stars generate energy by converting hydrogen to a heavier element, helium, through the process of nuclear fusion (two or more lighter atoms are combined to create a heavier atom).

All elements are made of atoms. Each atom is composed of a nucleus (protons and neutrons) and an electron cloud (electrons). The number of protons in the nucleus of an atom determines that element’s identity. The number of electrons and neutrons can change (ions and isotopes), but the number of protons is constant.

As an extension to this activity, you could have students compare the chemical compositions of the universe to the composition of the Earth and of the human body.

FOR THE STUDENT
Lesson
The Universe of Elements

Background
The universe is composed of different elements. Scientists study these elements to determine the origins of the universe and how different celestial bodies (stars, planets, moons, etc.) were formed. The current scientific theory for the origins of the universe is the Big Bang Theory. Scientists created this theory based on the scientific data available to them. Today you will analyze the percentages of elements present in the Bead Universe to determine its chemical composition.

Pre-lab Questions
1. Define the following vocabulary words:
   a. Atom
   b. Element
   c. Molecule
   d. Compound
2. Create a hypothesis that states which element you think will be most prominent in the universe.
   Example: (_____________ is the most prominent element in the universe because _______________).
Objective
Today we will explore the chemical composition of the universe and which elements are most prominent.

Procedure
1. The materials manager should collect one scoop of beads from the teacher.
2. While the materials manager is collecting beads, the other students in the group should write their names on their lab sheets and begin answering the pre-lab questions.
3. Once the materials manager has returned to the group, begin sorting and counting your beads. Each color represents a different element found in the universe.
4. Once you have counted and sorted all of your beads, find the total number of all of your beads.
5. You now need to calculate the percentages of each color of your beads. For example, if you have 50 beads total, and 40 of them are clear, then the percentage of clear beads is 80%.
6. Record all percentages on your answer sheet.
7. In your group, predict which element each color represents.
8. Send your recorder to the front white board to record your percentage results under your group number.
9. As a class, we will determine which bead color represents which element.
10. Record all data and answer all questions on your lab sheet.

Data
In the table below, record the number of each color of bead you had in your sample.

<table>
<thead>
<tr>
<th>Bead Color</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td></td>
</tr>
<tr>
<td>Light Blue</td>
<td></td>
</tr>
<tr>
<td>Dark Blue</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td></td>
</tr>
<tr>
<td>Pink</td>
<td></td>
</tr>
<tr>
<td>Purple</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

Which bead color was most abundant? Which was least abundant?
**Calculations**
Using the total number of beads, and the number of each color, calculate the percentage of each color.

<table>
<thead>
<tr>
<th>Bead Color</th>
<th>Percentage in your group sample</th>
<th>Percentage in class sample</th>
<th>Identify Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Blue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark Blue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pink</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis**
1. Which element is most abundant in the universe? Why do you think it is most abundant?

2. Why did you combine your data with the other groups from the class? Why is this important?

3. Identify each of the following as either an element or a compound:
   a. Carbon Dioxide
   b. Nitrogen
   c. Water (H₂O)
   d. Oxygen
   e. Hydrogen

4. Why do you think scientists study the elements of the universe?

**Conclusion**
After performing this investigation, you should know the most abundant elements in the universe and the composition of stars. Summarize what you have learned below: