Topic: Radioactivity

Teacher Information

Time Allowance
45 min.

Background
Everything in our universe is made up of atoms. There are many different kinds of atoms and these atoms exhibit a wide array of properties. An element is a substance which is made of only one kind of atom.

The difference between elements and how they behave is determined by the number of particles in the nucleus, which is in the center of all atoms. The nucleus contains protons, which are positively charged, and neutrons, which have no charge. Tiny negatively charged electrons orbit the nucleus in very specific paths. The smallest atom is hydrogen, having only 1 proton and 1 electron. Helium is the next lightest atom with 2 protons, 2 neutrons, and 2 electrons.

The larger atoms, such as uranium with 92 protons and 92 neutrons, are so large that they are unstable. The nucleus doesn't seem to be able to hold all of its particles, so eventually it releases 2 protons and 2 neutrons and becomes a new element, thorium, with only 90 protons and 90 neutrons. Because uranium releases particles from its nucleus, we say that it is a radioactive substance. When these particles are released, a great deal of energy is also released in the form of energetic gamma rays.

Materials
blindfolds
stopwatch or other timer
1 meter diameter circle
student page
data collection sheets

Preparation
1. Mark off a 1 meter diameter circle. You can use a circle drawn on a large sheet of paper or place a circle of tape on the floor.
2. Arrange students in pairs.
3. Gather materials.
4. Discuss concept of a radioactive substance.
5. Review the process for computing an average.

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Extensions

- Students make models of various atoms using toothpicks and different colored marshmallows.
- Debate the need for nuclear energy vs. the dangers of nuclear energy.
- Use a periodic table to list other elements which have many protons and neutrons.

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Student Worksheet

Read the following

You will role play a particle in a radioactive nucleus which is unstable and will observe the difficulty of a large nucleus holding itself together.

Materials

blindfolds
stopwatch or other timer
1 meter diameter circle
student page
data collection sheets

Procedures

1. The circle represents a radioactive nucleus. Student partners stand back-to-back inside the circle with arms interlocked.
2. Allow one pair of students to be observers/timers. These students must set the timer and watch until a student steps on or over the line of the circle. The timer is stopped and the amount of time is recorded below.
3. Each "proton" and "neutron" is blindfolded. The circle is packed with the remaining pairs of students. The students should try to move a little without stepping over the circle line.
4. Reset the timer. Time the same "protons" and "neutrons" a second and third time. Write down their times below. Compute the average time and record it on the line.
5. Student pairs return to the circle and begin their random movement again. This time, alternating out one pair to replace the first set of observers/timers. Continue timing each nucleus three times until all "protons" and "neutrons" have been observers/timers.
6. Next, pack the circle with all "protons" and "neutrons". Ask the teacher to record the time it takes for one student to step outside the circle. Write the time below. Reset the timer. Time the entire group a second and third time. Write down their times below. Compute the average time needed for a neutron-proton pair to escape from the nucleus.
7. Compile the data for each group's average and obtain a class average of time needed to release a proton/neutron grouping from the nucleus. Compare the individual group's results to the results of the entire group. What variables can you name that affect the results of your individual group average? Of the entire group average?

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Data Collection Sheet

Group 1 (Write names of “protons” and “neutrons” below)

_____

_____

Trial 1: _____ Trial 2: _____ Trial 3: _____ Average: _____

Group 2 (Write names of “protons” and “neutrons” below)

_____

_____

Trial 1: _____ Trial 2: _____ Trial 3: _____ Average: _____

Group 3 (Write names of “protons” and “neutrons” below)

_____

_____

Trial 1: _____ Trial 2: _____ Trial 3: _____ Average: _____

Group 4 (Write names of “protons” and “neutrons” below)

_____

_____

Trial 1: _____ Trial 2: _____ Trial 3: _____ Average: _____

Entire Group (Write names of “protons” and “neutrons” below)

_____

_____

Trial 1: _____ Trial 2: _____ Trial 3: _____ Average: _____