

Modeling the Location of an Electron in an Atom

Background Information

In the atomic models of the early twentieth century, electrons were said to move around the nucleus along specific paths, much as the planets move around the sun. However, experimental evidence has indicated that the precise position of an electron in an atom cannot be known or predicted. Scientists can speak only of the probability of finding electrons at various locations, not of their exact positions.

Probability is a measure of how often a certain event will occur out of a total number of events. For example, there are two ways a coin can land—with its head facing up or its tail facing up. Each side has a 50 percent (or one out of two) probability of landing face up for any toss.

An **electron cloud** provides a visual model for the probable behavior of an electron in an atom. The electron cloud shows the likelihood that an electron will be found in a given part of the atom around the nucleus. If the electron is not likely to be found at a particular position, the cloud appears less dense. If the electron is more likely to be found at a particular position, the cloud has a denser appearance, as shown in Figure 1.

In this investigation, you will use probability to describe the location of an electron in an atom.

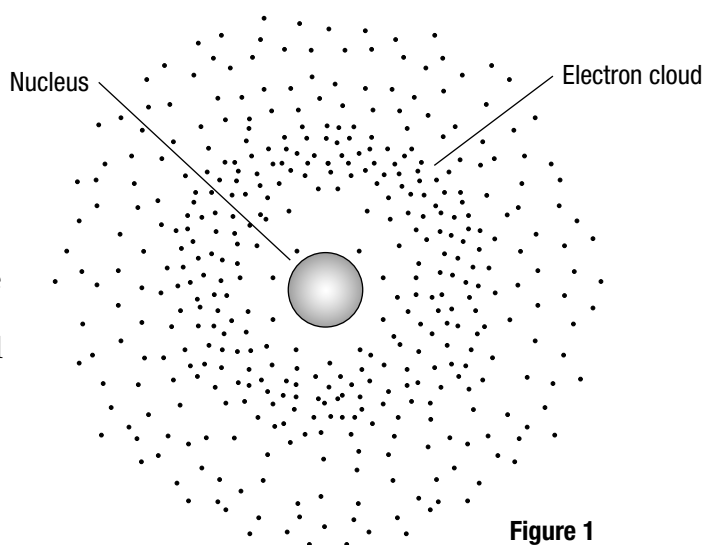


Figure 1

Problem

How can the location of an electron in an atom be described?

Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

- 1. Applying Concepts** Scientists use probability to predict the behavior of electrons in an atom. What is probability?

2. **Applying Concepts** According to the way you will mark your die at the beginning of this investigation, what is the probability of the electron being found in the zone closest to the “nucleus” (0–4 cm)? In the second closest zone (4–6 cm)? In the third closest zone (6–8 cm)?

3. **Predicting** Describe the results you expect to observe.

4. **Inferring** What can you infer about the probable locations of an electron in an atom from the above prediction?

5. **Comparing and Contrasting** Do you expect your results to be identical to those of other students, or similar to those of other students, or completely different from those of other students? Explain your answer.

Materials *(per group)*

game die
masking tape
graph paper
pencil
red pencil
metric ruler

Procedure

1. Cover all six sides of the die with masking tape. Mark one of the sides with one dot, four of the sides with two dots each, and the remaining side with three dots.
2. Select a square near the center of the graph paper and use a red pencil to color it red. This red square will represent the nucleus of a hydrogen atom with one electron.

3. Toss the die. Use a regular pencil to color in a square according to the following rules:

If the number 1 appears face up on the die, color in any square that is between 0 cm and 4 cm from the “nucleus.”

If the number 2 appears face up on the die, color in any square that is between 4 cm and 6 cm from the “nucleus.”

If the number 3 appears face up on the die, color in any square that is between 6 cm and 8 cm from the “nucleus.”

4. Repeat Step 3, tossing the die and marking the graph for a total of 50 tosses. Record your results in the data table.

Observations

DATA TABLE

Distance from “Nucleus”	Number of Colored-in Squares
0–4 cm	
4–6 cm	
6–8 cm	

Analysis and Conclusions

1. **Observing** In which zone are most of the colored-in squares on your diagram?

2. **Using Models** What does each colored-in square on your diagram represent?

3. **Inferring** Based on your data, where would you be most likely to find an electron? Explain your answer.

- 4. Comparing and Contrasting** Compare your diagram to a classmate's. Are they identical? In what ways are they alike or different?

- 5. Drawing Conclusions** Can the exact position of an electron in an atom be determined? What can you know about an electron's location?

- 6. Predicting** Suppose you had tossed the die 100 times. How do you think your results would have compared with the results you obtained by tossing the die 50 times?

Go Further

Redesign the procedure in this investigation to model the behavior of the two electrons in a helium atom. Can the electrons be in the same location at the same time? Can they be in the same location at different times? Describe the modified procedure and the results you might expect.