Names _____ Class _____ Date _____.

Relating Electrons and Probability

Background Information:

Early theories of the structure of the atom described the movement of electrons around the nucleus as similar to the movement of the planets around the sun. Today scientists know this is not the case. Electrons do not travel around the nucleus in fixed orbits. Electrons move in an area known as the electron cloud. The electron cloud is a region in which electrons are *likely* to be found. Within the electron cloud, electrons are arranged in energy levels. Energy levels represent the most probable location in which an electron can be found. An energy level should not be confused with a specific path. For electrons do not have a path. In fact, scientists can speak only of the chances, or probability, of finding electrons at various locations – not of their exact positions. In this investigation, you will get a better understanding of probability and how it relates to electrons.

Problem:

How can the movement of electrons outside the nucleus be described?

Materials: *(per pair)*

1 die
ruler
graph paper

Procedure:

1. Select a square near the center of the graph paper and fill it in with a color other than pencil. This square will represent the nucleus. (ALREADY DONE FOR YOU)

2. Roll the die and with each roll, pencil in a square according to the following rules:
   - If a **1, 2 or 3** is rolled, pencil in any square that is between **0 and 3 cm** from the nucleus. This represents the first energy level.
   - If a **4 or 5** is rolled, pencil in any square that is between **3 and 5 cm** from the nucleus. This represents the second energy level.
   - If a **6** is rolled, pencil in any square that is between **5 and 7 cm** from the nucleus. This represents the third energy level.

3. Repeat this procedure of rolling the die and marking the graph for 50 throws. Record your results in the Data Table.

Observations

DATA TABLE	Number of squares penciled in
0–3 cm (first energy level)	
3–5 cm (second energy level)	
5–7 cm (third energy level)	

1. The modern view of the movement of electrons in an atom is based on the concept of probability. What is the definition of probability? _____

_____

_____

_____

2. In which range do you have the most darkened squares on your diagram?

_____

3. Compare your diagram to that of a classmate. Are they identical?

_____

In what ways are they alike? Different? _____

_____

_____

Name _____ Class _____ Date _____

Conclusions

1. Based on your data, in what energy level is an electron most likely to be found?

   _____ Least likely to be found? _____

2. If each square that you penciled in represents a chance of finding an electron in a particular location around the nucleus, where would you look first for an electron?

   Explain your answer. _____

3. Can the exact position of an electron around the nucleus be determined?

   What can be known about electrons? _____

Critical Thinking and Application

1. Mathematically, the probability of an event occurring is equal to the number of favorable outcomes divided by the number of possible outcomes. According to the way you marked your die at the beginning of this investigation, what is the probability of an electron being found in the first energy level? The second? The third?

2. Suppose you had rolled the die 100 times. How do you think your results would have compared with the results you obtained by rolling the die 50 times?

3. Suppose you wanted to determine the probability of a student being found at various locations in your school building at 10 A.M. How might you investigate this problem?

Each energy level in an atom can hold only a certain number of electrons. The first energy level, closest to the nucleus, can hold at most 2 electrons. The second and third energy levels are considered full when they have 8 electrons each. Using this information, fill in the chart below. (Remember, the "s" sub-orbital in the 4th level needs to be filled before the "d" sub-orbital in the 3rd level can start filling!)

Element	Number of electrons	Electron Arrangement								
		1st Level	2nd Level		3rd Level			4th Level		
		s	s	p	s	p	d	s	p	d
Hydrogen	1									
Helium	2									
Carbon	6									
Oxygen	8									
Neon	10									
Sodium	11									
Aluminum	13									
Sulfur	16									
Chlorine	17									
Calcium	20