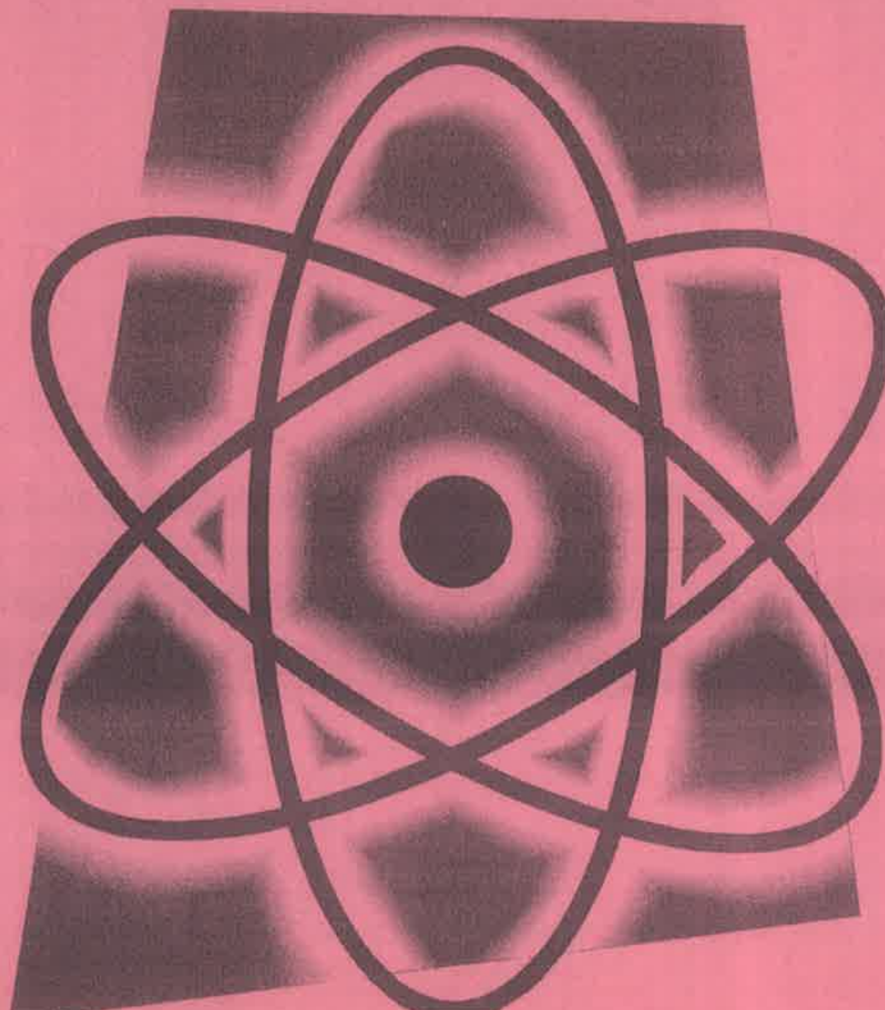
UNIT THREE:



Atomic Theory

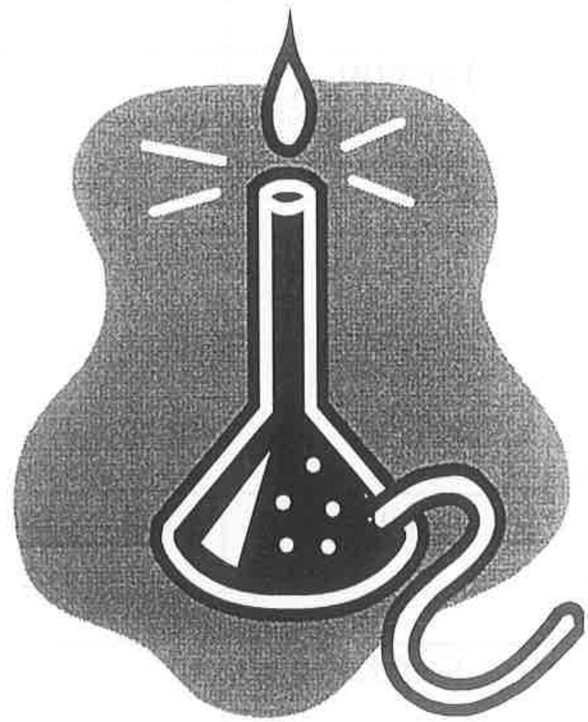
NAME:______________________________ DATE: __________

FLAME TESTS

PURPOSE:

INTRODUCTION:

The normal electron configuration of atoms or ions of an element is known as the "ground state". In this most stable energy state, all electrons are in the lowest energy levels available. When atoms or ions in the ground state are heated to high temperatures or bombarded by charged particles, some electrons may absorb enough energy to allow them to "jump" to higher energy levels. This excited state is not stable and the electrons "fall back" to their normal configurations. As the electrons "fall back" or return to ground state, the energy that was absorbed is emitted, or given off, in the form of visible light. The color of this light can be used as a means to identify the element involved. Such crude analysis is called a flame test.



Only metals, with their loosely held electrons, are excited in the flame of a Bunsen burner. Thus, flame tests are useful in the identification of metallic ions. Many metallic ions exhibit characteristic colors when vaporized in a flame. If the light emitted is passed through a prism or a spectroscope, it will separate into its characteristic spectrum. Each metallic element gives off its own bright light spectrum which is as unique as fingerprints are to man. In this experiment, characteristic colors of several different metallic ions will be observed and an unidentified ion will be identified by means of a flame test.

SAFETY:

MATERIALS:

PROCEDURE:

1. Wear your goggles and tie long hair back. Roll up long sleeves or lose sleeves.
2. Carefully light your Bunsen burner.
3. Take the solutions and remove the wooden splint in the solution with a test tube tong.
4. Place the wooden splint in the flame of the Bunsen burner
5. Record the color of the flame in your chart for each of the known solutions.
6. Use this information to identify the unknown substance.

DATA:

METAL	METAL ION	OBSERVATIONS
SODIUM		
POTASSIUM		
LITHIUM		
CALCIUM		
STRONTIUM		
BARIUM		
COPPER		
UNKNOWN		

QUESTIONS:

1. What inaccuracies may be involved in using flame test for identification purposes?

2. What pair of ions produced similar colors in the flame tests?

3. Explain how the colors observed in the flame test are produced.

4. Define the following terms:
   a. Quantum
   b. Ground State
   c. Excited State

5. How many protons, neutrons and electrons do <u>each</u> of the metallic ions have?

NAME: DATE:

QUANTUM MECHANICAL MODEL OF THE ATOM

PURPOSE:

1. To determine the distribution of dart hits about a bulls-eye.
2. To obtain and interpret probability information.
3. To compare the results of the dart experiment to the quantum theory prediction of the electron density around an atomic nucleus.

INTRODUCTION:

Movement can be considered to occur either as particles, like billiard balls, or in waves, as water or sound. When scientists study the motion of small particles, like electrons (which, for this lab, are considered to be particles), they find that these particles do not seem to behave like more the familiar larger solid, such as billiard balls or baseballs.

With the larger particles, given an initial speed and direction, one can predict its speed and path – otherwise catching a fly ball would be impossible. For this, we use the laws of classical mechanics developed by Isaac Newton. However, this is not possible with electrons and other small particles: the way that we determine the speed and direction of electrons is affected by the measurement, itself. To deal with these and other properties of electrons, the branch of science called quantum mechanics was developed. One of the fundamental principles of quantum mechanics is that we can only know the probable location of an electron in an atom.

If you flip a coin once, you can't accurately predict whether it will fall head up or tail up. However, if you flip a coin one hundred times, chances are that 50% of the time the coin will land with the head up. Similarly, quantum nechanics tells us the probable location over time of an electron around an atom.

The activity of this lab is to model how one obtains and interprets data on electron positions. In this activity, we will drop pencils and use the landing mark on the paper to model the location of an electron over time (Figure 1). The target consists of ten concentric rings one cm wide. If we drop darts on to such a target, we find that not all of the darts hit the bulls-eye. There will be a scatter of hits over the target, with more hits near the bulls-eye than far from it (if you are a good dart dropper, that is).

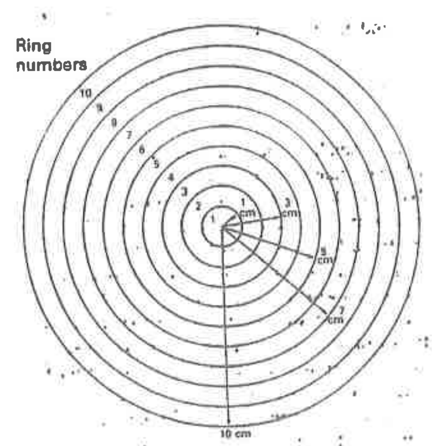
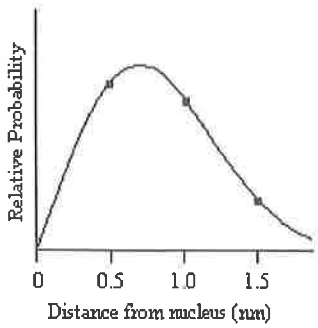


Figure 1. Pencil Marks Representing Electron Locations.

From the pattern of hits, one can determine the probability that a dart will hit any given ring; we will call this the hit probability. The hit probability essentially tells us the likelihood that a dart will hit at any given distance from the bulls-eye. We can also find a related quantity called the hit density: the probability that a dart will hit within a particular unit area located on a given ring on the target.

HIT DENSITY = THE HIT PROBABILITY AT THAT DISTANCE / AREA OF THE RING AT THAT DISTANCE.

For example, if 16 out of 100 darts hit in ring number 3, we can say that the probability that the next dart will hit that ring is 16/100, or 0.16. This is the hit probability for that ring. Because the area of that ring is 16 cm^2, the hit density would equal 0.16/16, or 0.01. This means that if we placed a square 1 cm on an edge anywhere on ring number 3, the odds are that 1 dart out of the next 100 would hit somewhere on that square. You could also say that the hit density at any given radial distance is the probability that a dart will strike a particular unit area at that distance from the bulls-eye. What are the hit probability and the hit density as we move from the bulls-eye out to the more distant rings?



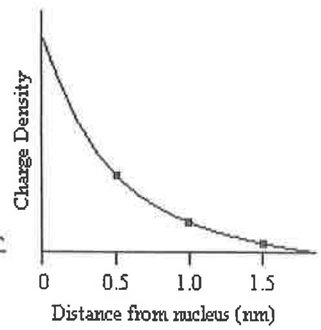


Figure 2. Graphs showing electron probability and electron charge density for a 1-s electron of a hydrogen atom.

What do these figures mean?

PROCEDURE:

1. Place the target on the floor. Stand up straight and extend your arm straight out so that it is directly above the target. Drop the pencil (do not throw) to the target below in such a way as to try to hit the bulls-eye. The second student should retrieve the pencil and mark the position of the hit with a small x. Repeat this procedure 99 times for a total of 100 drops. You may want to trade places frequently with your partner. Don't count pencil marks outside the largest circle.
2. Count the number of hits in each concentric ring and record in the data table. Divide the number of hits for each ring by its area to determine the hits per cm^2

DATA & RESULTS:

CONCENTRIC RING NUMBER	AVERAGE DISTANCE OF RING FROM BULLS-EYE (CM)	AREA OF CONCENTRIC RING (CM^2)	NUMBER OF HITS IN RING	NUMBER OF HITS PER UNIT AREA ($HITS/CM^2$)
1	0.5	3.1		
2	1.5	9.4		
3	2.5	16		
4	3.5	22		
5	4.5	28		
6	5.5	35		
7	6.5	41		
8	7.5	47		
9	8.5	59		
10	9.5	60		

CALCULATIONS AND QUESTIONS:

1. Make a graph plotting the number of hits in the ring *versus* average distance of the ring from the center of the bulls-eye
   a. For each ring, plot the number of hits in the ring on the y-axis against the average distance of the ring from the center on the x-axis. Beginning at the 0,0 point, draw a smooth curve ("best-fit" line) through the plotted points.
   b. Compare this curve to the electron probability curve in Figure 2A. State in words what the graph in Figure 2A tells us about the electron.

Name:___________________________ Date: __________

THE ATOMIC MASS OF BEANIUM

INTRODUCTION:

Imagine a new element has been discovered, and has been given the name 'beanium'. Students at local high schools have been given the job of determining the number of isotopes of this new element, the mass of each isotope, the abundance of each isotope, and the atomic weight of the new element. Fortunately, beanium atoms are very large, so you will be able to sort and weigh them easily.

PURPOSE: To determine the abundance of each isotope and determine the average mass of the element.

SAFETY:

Make a list of all safety procedures related to this lab.

MATERIALS:

Sample of beanium
Balance

PROCEDURE:

1. Determine the number of isotopes of beanium based upon appearance (size, color, etc.). Draw a picture of each isotope in your data table.
2. Count the total number of atoms of each isotope and fill in the data table.
3. Determine the total number of atoms in the data table.
4. Using a balance, measure the total mass of all the atoms of each isotope of beanium.
5. Measure the mass of all of the beanium atoms at once.
6. Count the total number of beanium atoms.

DATA TABLE:

ISOTOPE	DRAWING	# OF ATOMS	ABUNDANCE	TOTAL MASS (G)	MASS OF ISOTOPE (G)	PRODUCT (G)
1						
2						
3						

TOTAL # OF ATOMS: _____ ATOMIC MASS OF BEANIUM:_____

MASS OF ALL THE BEANIUM ATOMS	# OF ALL THE BEANIUM ATOMS	AVERAGE MASS OF BEANIUM

CALCULATIONS:

1. Determine the abundance of each isotope. (# of atoms of each isotope/ total # of atoms)
2. Determine the mass of one atom of the isotopes. (total mass of isotope/ # of atoms of each isotope)
3. Determine the product of each isotope. (Abundance of isotope x mass of each isotope)
4. Find the average mass of beanium. (mass of all beanium atoms / number of all beanium atoms)

QUESTIONS:

Copy and complete the following questions in your lab notebook.

1. How does the atomic mass of beanium compare to average mass of beanium? Why?
2. Why isn't the atomic mass of most of the elements on the Periodic Table an integer?
3. If the heaviest isotope was more abundant, and the other two isotopes were less abundant, what would happen to the atomic weight of beanium? Why?
4. How is the average mass of an element calculated? Which method is more accurate?