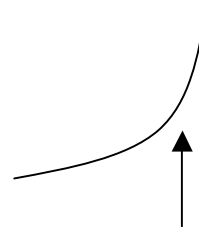
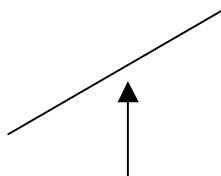
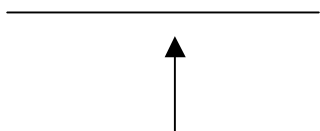


Chem10: Lab: Atomic Target Practice

1. Tomorrow's activity is a simulation of Rutherford's scattering experiments. Read the entire procedure and compare the components used in this simulation (the marbles, the board, the unseen object, and the traced path of the marbles) to Rutherford's original experiments. What role is played by each component?
2. It is important to trace the apparent path of each marble roll, even when the marble rolls straight through without striking the unknown target. What general information about the target can be inferred based on where the marble rolls in one end and out the other?
3. The key skills in this activity, as in Rutherford's experiments, are the ability to make careful observations and to draw reasonable hypotheses. Assume that the marble strikes the following sides of a possible target. Sketch the path the marble might be expected to take in each case. **The arrows indicate the initial paths of the marbles.**



Introduction

Rutherford described the surprising results of his gold foil or scattering experiment this way:

“It was about as credible as if you had fired a 15-inch shell at a piece of tissue paper and it came back and hit you.”

Rutherford’s experiment has been described as a “black box” experiment. The pattern of the scattered alpha particles helped Rutherford to solve the “black box,” the structure of the atom.

Purpose

The purpose of this activity is to discover by indirect means the size and shape of an unknown object, which is hidden underneath the middle of a large piece of cardboard. The board is raised about 2 cm, leaving just enough space to roll or shoot a marble at the object. By observing and tracing the paths the marble takes when entering the box and after striking the unknown target from a variety of angles, it should be possible to estimate the general size and shape of the unknown target.

Materials

“Black box,” a 17” x 17” cardboard cover with a hidden, unknown object underneath

2 – Marbles

Pencil

2 – 8½ x 11” sheets of white paper

Tape

Procedure

1. Tape two pieces of standard size white paper together to form an 11” square sheet
2. Center the paper on top of a black box and tape it down to keep it in place. If there is a code letter for the black box, write the code on the sheet of white paper. ***Do not look underneath the “black box”!***
3. Roll a marble with a moderate amount of force under one side of the black box. Observe where the marble enters and exits the black box. Trace the approximate straight paths of the marble on the white paper. The lines should intersect at the edge of the block. ***Do not trace the lines through the center of the black box. This is not a possible path for the marble.*** For example, if the marble rolls straight through, draw a straight line from one end of the sheet to the other. ***Note: Do not press too hard on the paper and black box when drawing the lines!***
4. Working from all four sides of the black box, continue to roll the marble under the board, making observations and tracing the entry and rebound path for each marble roll. Roll the marble *at least* 20 times from each side of the box. Vary the angles at which the marble is rolled into the box.
5. After sketching the apparent path of the marble from all sides and angles, the general size and shape of the unknown target should emerge “in the negative” from the area where there are no lines (where the marble does not penetrate).

Name _____ Period _____ Date _____

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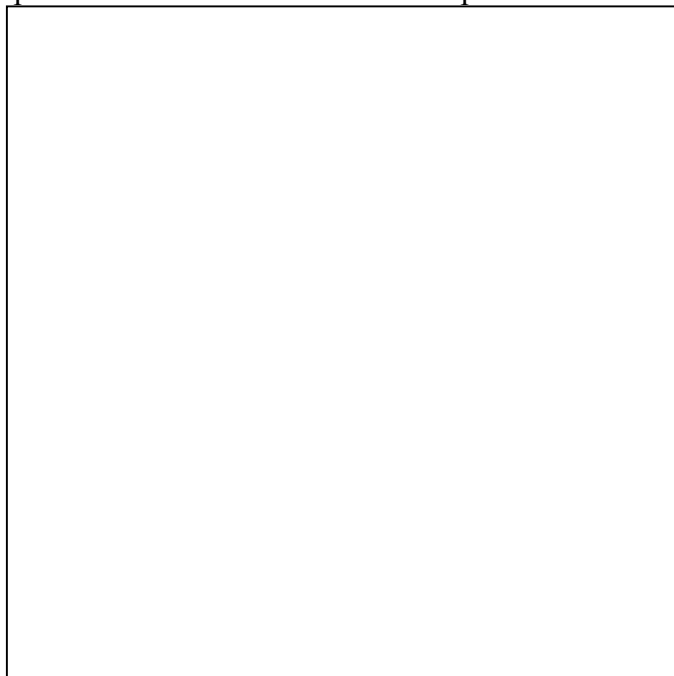
6. Form a working hypothesis concerning the structure of the unknown target. Based on this hypothesis, repeat as many “targeted” marble rolls as necessary to either confirm or revise the structure.
7. Check your final results with your teacher. Do not look inside the black box until the teacher verifies your results.
8. If time permits, switch black boxes with another group of students and conduct a second investigation.

Name _____ Period _____ Date _____

Chem10: Lab: Atomic Target Practice

Post-Lab Questions

1. Draw the general size and shape of the target to approximate scale in the square below. What characteristics of the target were easiest to determine? What characteristics of the target's shape were difficult to determine? Explain.



Shape # _____

2. The speed of the marble rolls was an uncontrolled variable in this activity. How would the outcome of the scattering test have been different if the marble speed had been faster or slower?
3. Compare the overall size of the target with the size of the marble used to probe its structure. How would the outcome of the scattering test have been different if different size marbles had been used? Explain?
4. In what ways did this activity simulate Rutherford's efforts to determine the structure of the atom? In what ways was it different? Be specific – consider the size, speed, and charge of both the particles and the target.

This activity is adapted from *Flinn Chemtopic Labs*, Volume 3, Atomic and Electron Structure; Cesa, I., Ed; Flinn Scientific: Batavia, IL, 2003