

DISCOVERING THE STRUCTURE OF THE ATOM

Performance Standard 12 C/11A/13A.I

Students will apply the processes of scientific inquiry to investigate atomic and nuclear structure of matter by examining historical atomic theories accordingly:

- *Knowledge:* Understand the prevailing theories of the structure of the atom prior to and including Rutherford's scattering experiment.
- *Application:* Using simulated data from the scattering experiment, select and perform data analysis to determine whether the experiment supports or refutes the prevailing theory of the structure of the atom or necessitates an alternative hypothesis or model.
- *Communication:* Summarize the progression of the changing models of the atom incorporating the analysis of the scattering experiment data and succeeding conclusions which resulted.

Procedures

1. ***In order to know and apply concepts that describe properties of matter and energy and the interactions between them (12C), and the concepts, principles and processes of scientific inquiry 11A and the accepted practices of science (13),*** students should experience sufficient learning opportunities to develop the following:
 - Replicate formulation and reformulation of hypothesis about structure of the atom. referencing pertinent reliable prior research and experimental data.
 - Identify Rutherford's studies which demonstrate how scientific conclusions are open to modification as new data are collected.
 - Interpret and represent analysis of results to produce findings that support or refute historical hypothesis.
 - Analyze observations and data to provide evidence that supports or refutes the (historic) prevailing atomic models.
 - Produce findings by projecting trends of simulated data.
 - Construct a visual model to illustrate experimental results.
 - Reflect on comparable findings for consolidation or refinement of procedures in subsequent investigations.

Note to teacher: This activity relates to knowledge associated with standard 12C, while addressing the performance descriptors for stage I within standard 11A. Applying the accepted practices of science as suggested in standard 13A is foundational.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. This activity can follow a discussion of Democritus' theory of the structure of matter, Dalton's Atomic Theory and the discoveries of the electron and proton. It should precede any discussion of Rutherford's Scattering Experiment. Distribute the instruction/task description for "Discovering the Structure of the Atom". Discuss the procedures to be followed.
4. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
 - *Knowledge:* The prevailing theory of the structure of the atom, the Scattering Experimental procedure and the historical setting of the experiment are correctly described.
 - *Application:* Data was manipulated in an appropriate manner as an analysis to provide evidence to test the prevailing hypothesis and refute the prevailing theory. (example: Percentage of alpha particles deflected at different angles; graph of number or percentage of alpha particles deflected versus the angle of deflection.)
 - *Communication:* Data analysis is displayed with correct labels and units. Summary is written clearly, coherently, and including enough background material to describe the impact the discovery had on the scientific community and the future development of the atomic theory.

Examples of Student Work not available

Time Requirements

- One class period

Resources

- Student instruction/task sheet
- Science Rubric

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STUDENT INSTRUCTION/TASK DESCRIPTION

Problem:

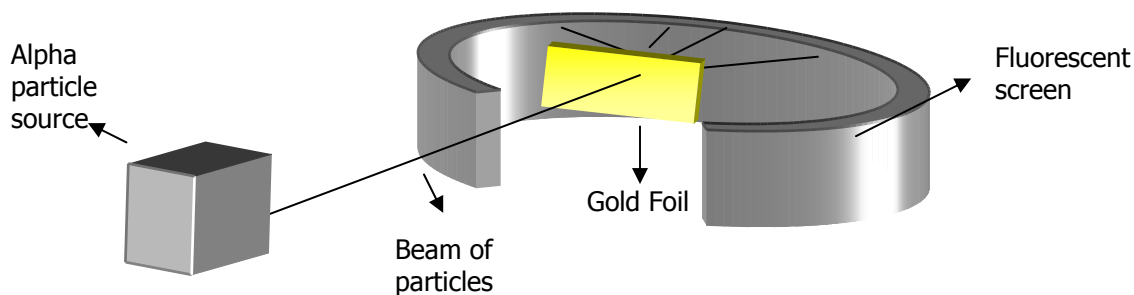
An early and prevailing theory about the structure of the atom was that electrons and protons were scattered widely and uniformly throughout the atom. Select a method to analyze the simulated 1911 experimental data in order to provide evidence to confirm or refute the theory of the structure of the atom. Propose a description of the structure of the atom that the data analysis would support. Research the historical setting of the experiment and describe the developments of atomic theory that followed as a result of this experiment.

SCATTERING EXPERIMENT (1911)

1911 Experimental Procedure:

The experiment used alpha particles: relatively large helium nuclei that have a double positive charge. In the experiment, as illustrated below, the researchers directed a beam of alpha particles at a very thin sheet of gold foil. The gold foil was surrounded by a fluorescent screen that glowed if struck by alpha particles.

DIAGRAM OF 1911 EXPERIMENTAL SET-UP



Data:

Table 1: The Number of Alpha Particles Deflected at Different Angles by the Atoms in the Gold Foil

ANGLE OF DEFLECTION (Degrees)	NUMBER OF DEFLECTIONS
5	50256243
10	314567
15	75476
30	4883
45	896
60	298
75	132
>105	124

Concluding Summary:

Describe the theory that was tested by the data and data analysis. Summarize the procedure used in the experiment. Describe how the data analysis confirms or refutes that theory. Propose a description of the structure of the atom that is supported by the data analysis. Describe the historical setting of the experiment and how the theories of the structure of the atom developed following this experiment. Explain how scientists and their scientific conclusions respond as new data are collected.