Background information

Title: Discovering the Nucleus (Rutherford's Gold Foil Experiment)
Brief Description: At this STEAM-AR project students get introduced to Rutherford's investigation about the structure of the atom.
Keywords: Rutherford, atomic model, nucleus, proton, electron, gold foil, science, physics
Target audience: Students of high school
Age range: 13-14 years old
Context: The places that this AR STEAM activity involves are: school, science museum, independently on the web, combination of the above, etc.
Time required: 2 teaching hours (approximately 90 minutes)
Technological tools required: Android device with AR MetAclass app downloaded and Playing with Protons authoring tool downloaded to a PC.
Author(s)'s background: The main function of the person who prepared this AR STEAM activity is science teacher and scientist
Connection with the curriculum: Physics grade 8 of High school
Learning objectives:

1. Understanding Rutherford's Experiment: Students should grasp the purpose, methodology, and significance of Rutherford's gold foil experiment in challenging the existing atomic model and revealing the structure of the atom.
2. Make observations: Through the simulation activity, students should learn to make observations, and draw conclusions.
3. Critical Thinking and Hypothesis Formation: Encourage students to think critically about why certain alpha particles were deflected and others passed through, leading them to formulate hypotheses about the atom's structure.
4. Conceptualizing the Atomic Nucleus: Students should understand the concept of the atomic nucleus as a dense, positively charged center of an atom, which was a groundbreaking discovery from Rutherford's experiment.
5. Stimulating Interest in Science: Engage students' curiosity and interest in the field of physics by showcasing the exciting and transformative nature of scientific exploration and discovery.

These objectives aim to provide students with a comprehensive understanding of Rutherford's investigation and its significance in shaping our understanding of the atom's structure and the subsequent development of atomic theory.

TEMPLATE:

1. Setting the scene

Objective: To understand Rutherford's model of the atom and the discovery of the atomic nucleus through a simple game.

As trigger, let students for 20 minutes to play the game:
https://phet.colorado.edu/sims/html/rutherford-scattering/latest/rutherford-scattering_en.html

2. Look around

Ask students for their observations.
Engage the students in critical thinking by asking questions like:

- Why did most alpha particles pass through the gold foil without any deflection?
- Why did a few alpha particles experience significant deflection or even bounce back?
- What does this tell us about the structure of the atom?

✓ As the "alpha particles" are flicked towards the foil, students should observe how they interact with the nucleus of gold atoms.
✓ Most of the alpha particles should pass through the foil with little or no deflection, but some may be deflected at different angles, and a few may bounce back.
✓ Discuss the observations and ask the students why they think this is happening.

Explanation:

- In Rutherford's original experiment, alpha particles had been used to probe the structure of the atom. Most of the alpha particles passed through the foil undeflected because the atom is mostly empty space. The few deflections and backward scattering occurred because the alpha particles were encountering the small, dense, positively charged nucleus at the center of the atom.
- This experiment helps students understand that the atom is not a solid structure as was previously believed. Instead, it is mostly empty space, with a tiny, positively charged nucleus at its center. This model revolutionized our understanding of the atomic structure and paved the way for modern atomic theory.

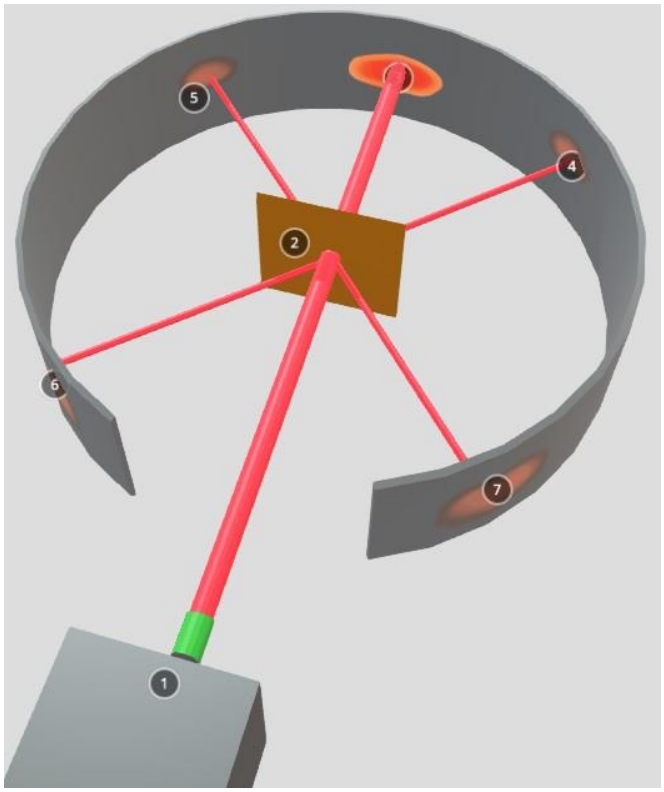
3. Creation AR project – Part 1

To create your AR project, at first download:

1. An image of Rutherford's experiment, and
2. A 3D model of the experiment

Find them above:

1.



Picture 1: Picture which will be used as a marker to the AR project

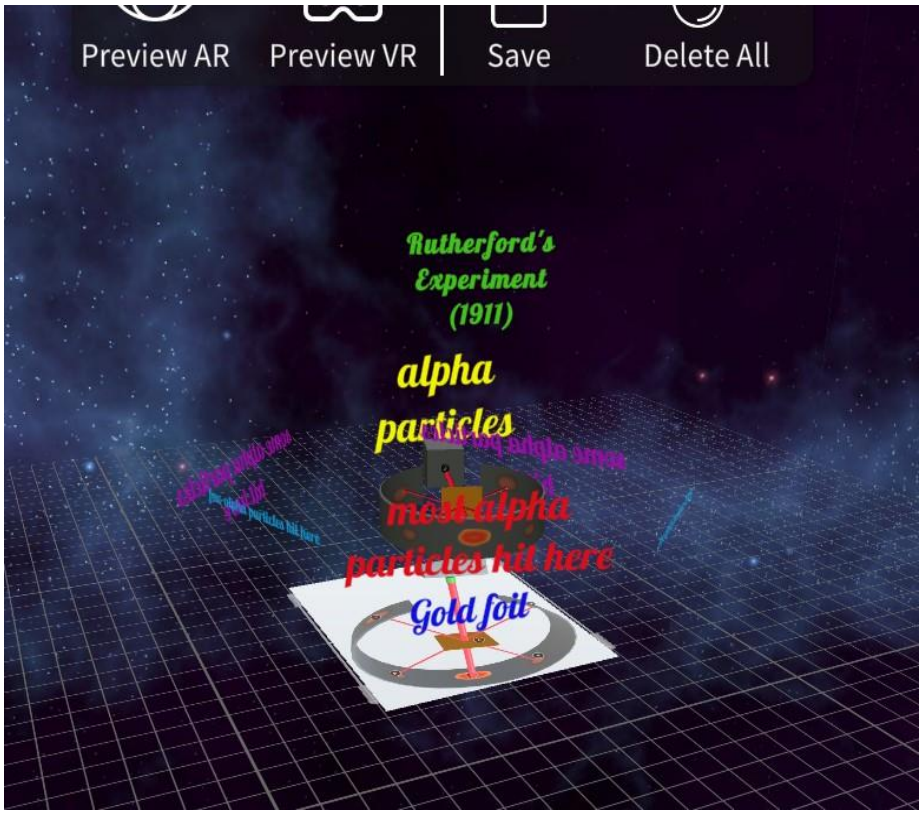
2. https://sketchfab.com/3d-models/rutherfords-scattering-experiment-1d83e005cc974ef9a6a3b88029611abe

4. Creation AR project – Part 2

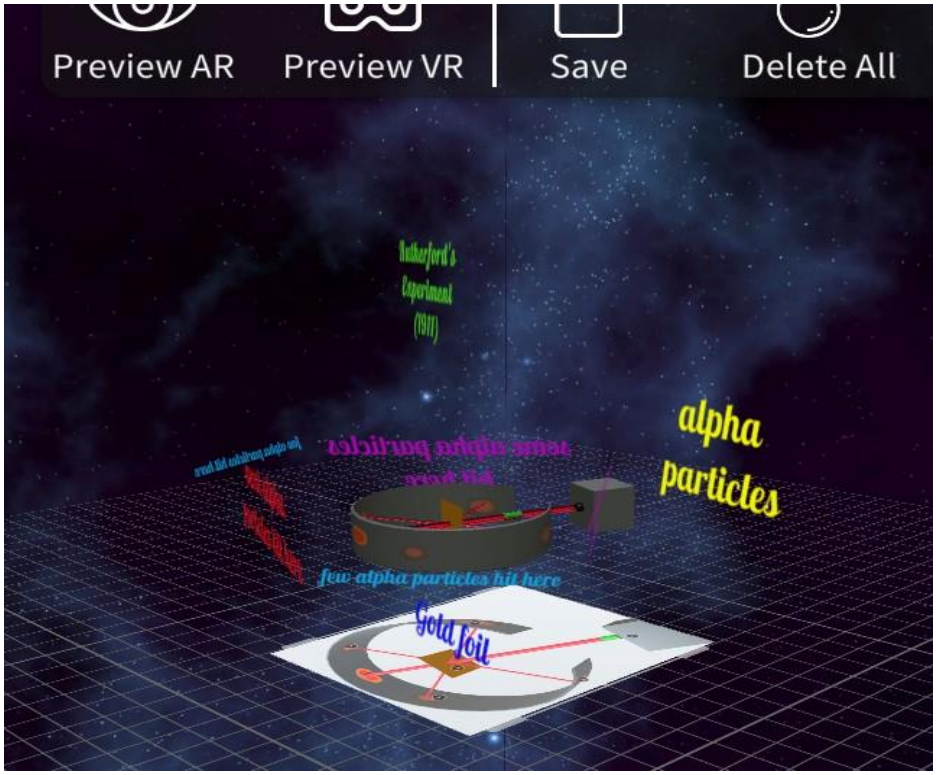
A. Open the "Playing with Protons AR" platform.
B. Load a marker for your project.
C. Load the 3D model.
D. For each spot that alpha particles may hit write a text as above:

   1. Alpha particles
   2. Gold foil
   3. Most alpha particles hit here.
   4. Some alpha particles hit here.
   5. Some alpha particles hit here.
   6. Few alpha particles hit here.

7. Few alpha particles hit here.



Picture 2: A perspective of the AR project



Picture 3: Image of the AR project with the texts

Then, save the AR project and import it to your files.

5. Creation of the QR code

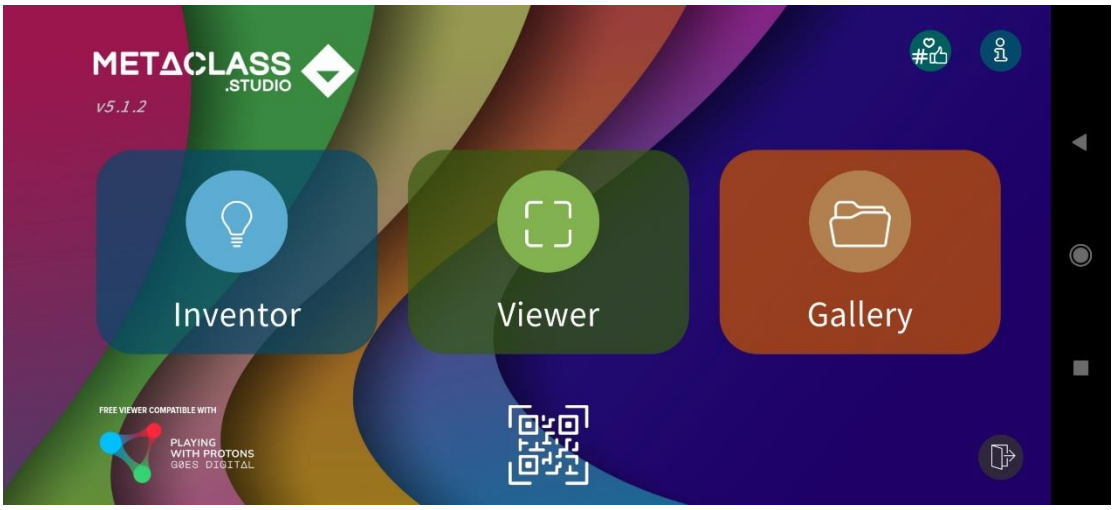
After you complete your AR project, download it as a QR code.
The proceeding is the following:

1. At first, upload your project on a Drive with public access.
2. Then, copy the link.
3. Go to the https://www.qr-code-generator.com/
4. Paste the link and make the QR code.

Picture 4: QR code of the AR project

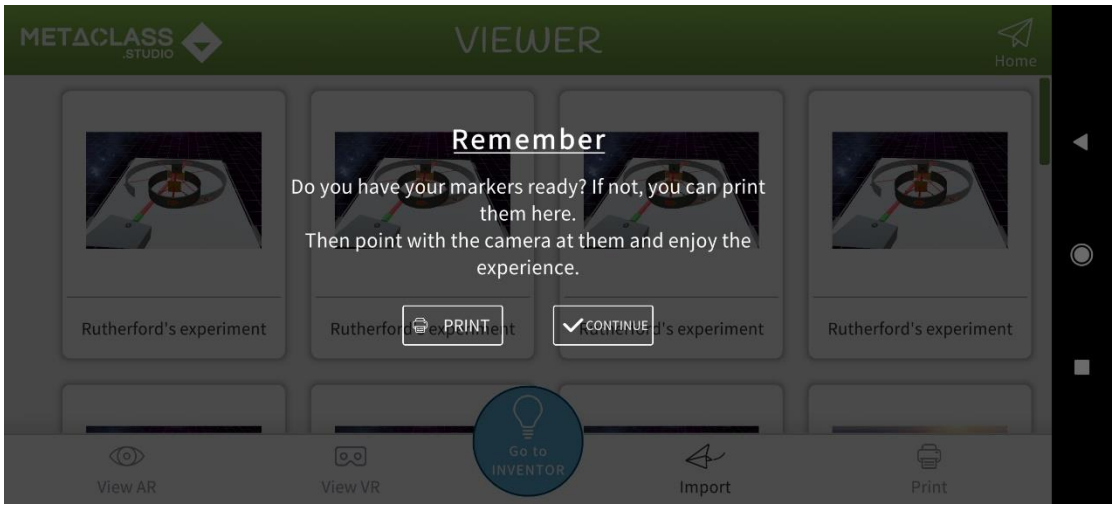
6. Scan with the App

1. Go to metAclass app

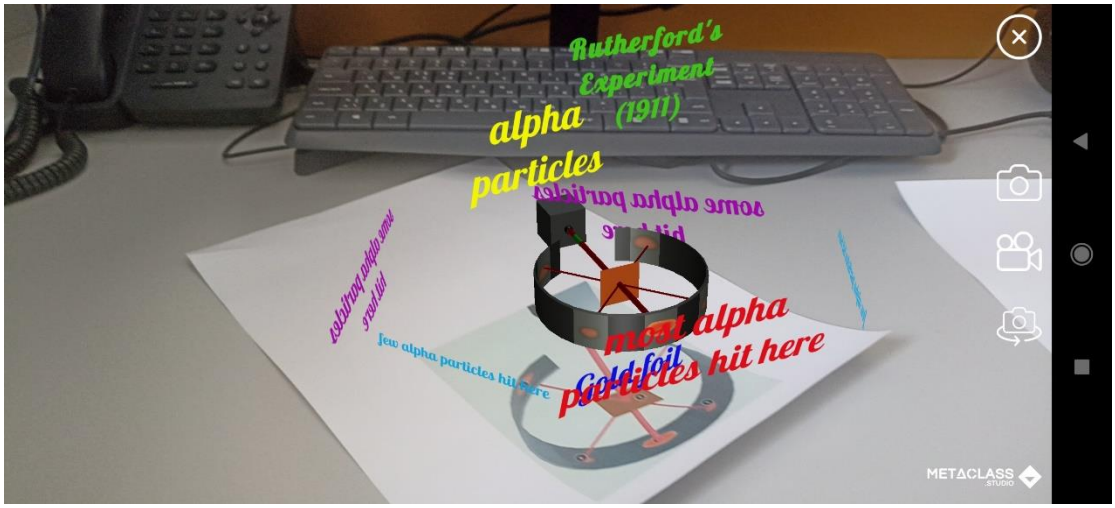


2. Scan the project.

3. Import it



4. View the AR project of the experiment.



7. Communication and discussion

Important Points to Discuss:

Emphasize the importance of experimentation and observation in science.
Discuss how Rutherford's experiment led to the development of the nuclear model of the atom.
Mention the contributions of other scientists, such as Thomson and Bohr, to our understanding of atomic structure.