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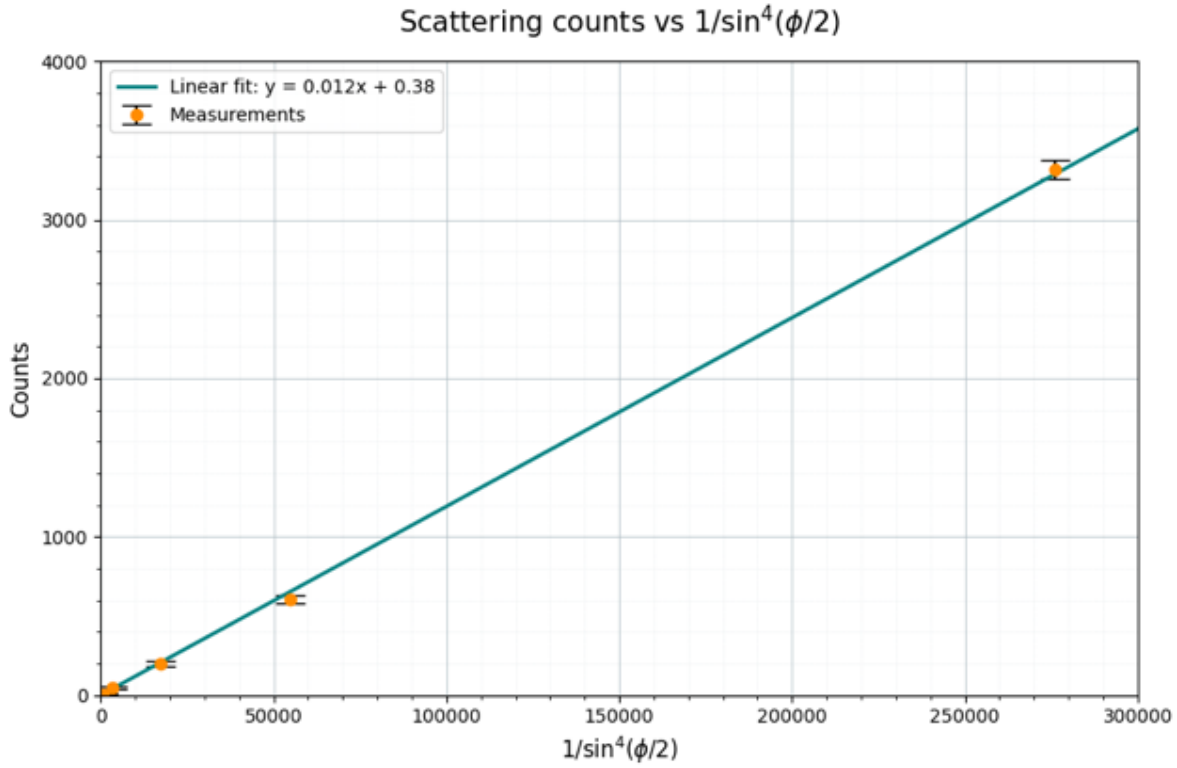
Investigating the atom

Explanations sheet

From tables 1 and 2 of the Activity 2: Resource card 2 we can draw the following conclusions:

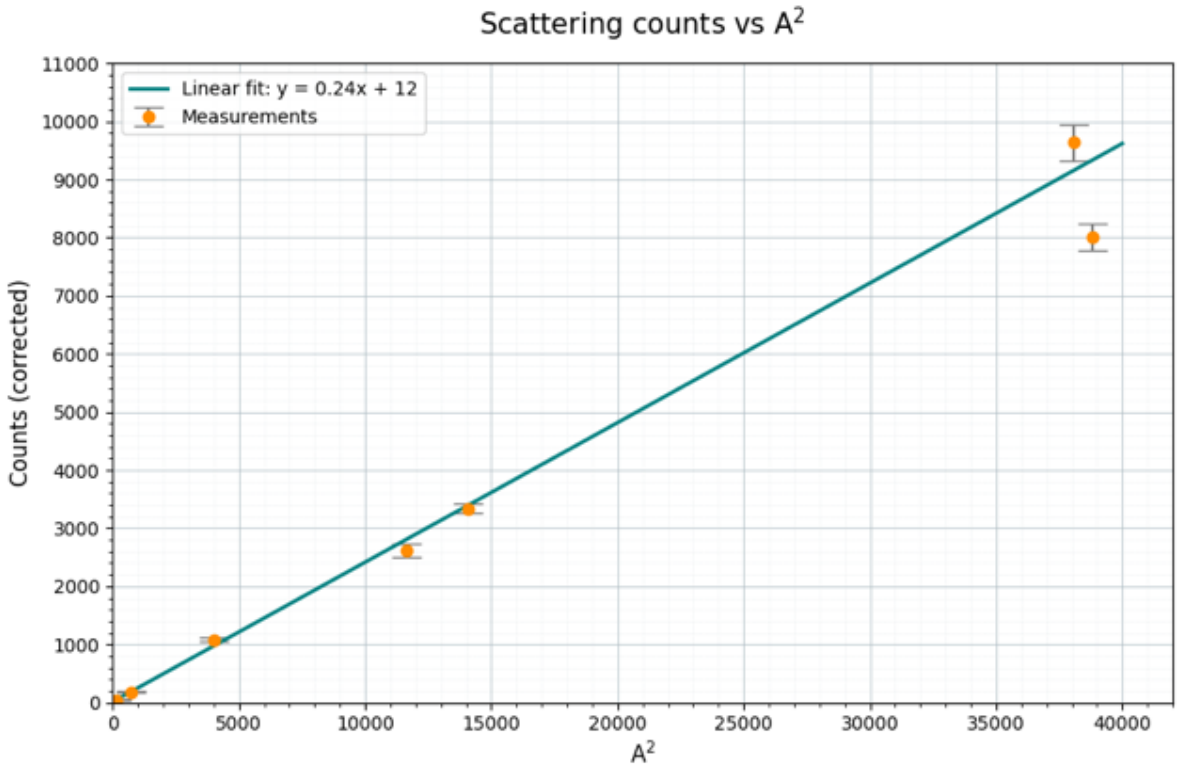
1) Using the data of table 1 we can plot counts against $1/\sin^4(\phi/2)$, where ϕ is the angle at which the alpha particle exits the foil. Observe that the data is compatible with a straight-line curve, i.e., the counting is linearly proportional to $1/\sin^4(\phi/2)$. This compatibility can be verified qualitatively by visually assessing the fit of a line to the data. The compatibility obtained tells us that within the uncertainty of the experiment, the data is well described by the model calculated by E. Rutherford in his article. This indicates then that the hypothesis of an atom with all the positive charge concentrated in a sphere at the centre is favoured by the measurements done by Geiger and Marsden. The graph looks like:



Plot of the particle counts against $1/\sin^4(\phi/2)$ from the data in table 1.
Image courtesy of the authors; designed using DeepSeek.

2) Using the data of table 2, we can plot the corrected counts against atomic weight squared (A^2). The data is well described again by a straight line, and checking the angular coefficient of this line allows us to address the conclusion B of Geiger and Marsden. The coefficient can be obtained either by plotting the data on a millimetre paper and drawing the straight line with a ruler, or on the computer with a graphics application. We found it very useful to do everything by hand with the groups. The graph looks as follows.

Using Rutherford's calculations from Resource card 2, we can see that, according to his hypothesis, the result of the counting (represented by σ in his formula) as proportional to Z^2. In the graph, the counting is plotted against A^2. The angular coefficient of the fit is 0.24. Therefore, for Rutherford's proposed model to be consistent with the data, it is necessary that $Z^2 = 0.24A^2$, or $Z = 0.49A$. This is why the article concludes that the mass number is twice the electric charge.



Plot of the corrected particle counts against the atomic weight squared (A^2) from the data in table 2.
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