Physics Laboratory: Rutherford Scattering

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4th Hour (Tuesday A.M.)

Objective:

The objective of this laboratory was to replicate the Rutherford scattering experiment using 3-MeV protons on a C^{12} target in the tandem Van de Graff accelerator at W.M.U. The Rutherford equation was expected to fail at the angle where the proton collided with the C^{12} nucleus.

Changes to the Procedure:

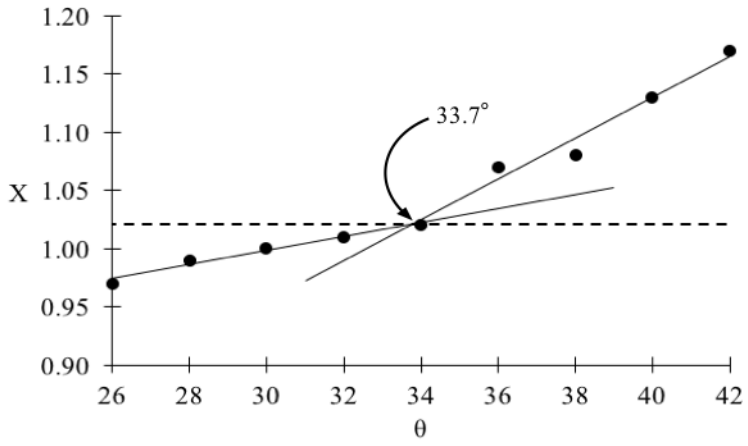
None.

Results:

A table of corrected data comparing X vs. θ is given below.

θ	**X**	N_{Actual}	$N_{Theoretical}$
26	0.97	160834	165943
28	0.99	122891	124054
30	**1.00**	94695	94695
32	1.01	74638	73614
34	1.02	59042	58153
36	1.07	49663	46600
38	1.08	40999	37822
40	1.13	34962	31053
42	1.17	30050	25763

The measured angle at which the Rutherford equation failed was at 33.7º, as shown below, yielding a measured nucleus of a C^{12} atom of 13.95 fermis (with the size of a proton of about 1.16 f).



Conclusions:

The measurements looked quite accurate, but throughout the experiment, a slightly different number of particles were captured at the same angle of 30º, hence there was some

experimental error involved. Ultimately, for the number of particles detected at the 30º angle, the experimental error was calculated to be approximately ±717.20 from the mean N_{Actual} at 30º.

Answers to Questions:

a) Running the detector for a given number of incident protons was necessary because we are trying to compare the number of incident protons at a particular angle, relative to the constant number of protons that were recorded at an angle of 30º, hence we wouldn't run the detector for a given time period, but instead compare just the number of protons that were detected at that particular angle and those at 30º.

b) While we didn't end up counting the recoiled nuclei since they were a part of the first of the three peaks observed for the particles detected during the experiment, the Rutherford experiment does make an important assumption that the target particle is so massive that it does not recoil during the experiment, hence it is quite critical for the experiment for us to know that the target nucleus is not infinitely massive and, in fact, recoils during the collision. The recoil could be taken into account by just counting the second visibly tall peak in the graph of scattering of particles at any angle, and not the first peak, which generally comprises of all the recoiled nuclei that recoiled and were detected.

c) X would be significantly less than 1.00 if there was a hole or tear in the target since most of the protons would pass straight through the hole and not be scattered at an angle from the nucleus. We could check for this *during* the experiment as we vary the angle of incidence and detection, by checking for the number of incident protons at the 30º angle every once in a while, and seeing if it is approximately equal to the other recorded number of incident protons at 30º.