8 Prior to the alpha-scattering experiment conducted by Rutherford, the plum pudding model of the atom was widely assumed. In this model, the positive charge of the atom was thought to be evenly spread out through the entire volume of the atom, and its electrons vibrating about fixed positions within this sphere of charge.

In the experiment conducted by Rutherford, alpha particles are directed towards a thin gold foil as shown in Fig. 8.1. A detector is used to record the number of alpha particles scattered by the foil. The experiment is performed in a vacuum. The detector can be rotated such that it is able to capture the alpha particles at various scattering angles θ. The variation with the scattering angle θ of the number of alpha particles N striking the detector are shown in Fig. 8.2. The vertical axis in Fig. 8.2 is logarithmic.

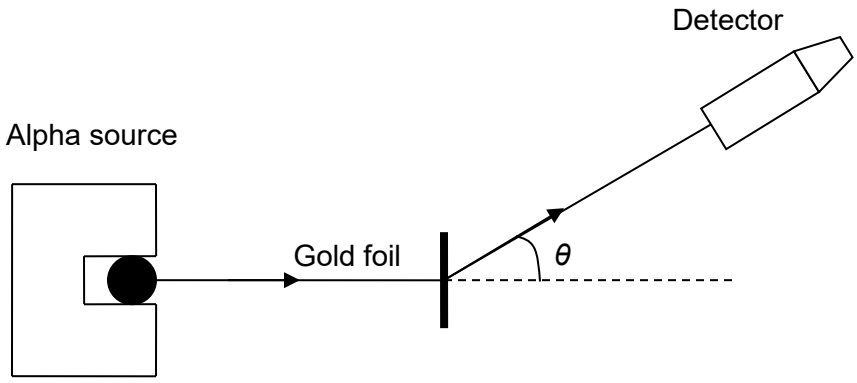

Fig. 8.1

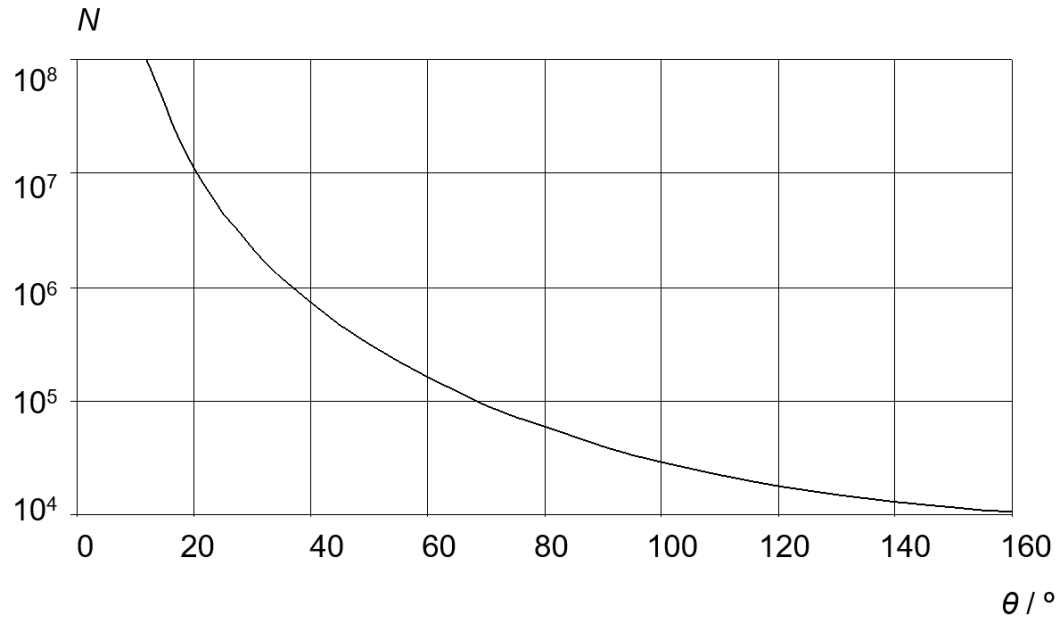

Fig. 8.2

(a) State and explain why

(i) the experiment is not conducted in air, and

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……
…….[2]

(ii) the vertical axis is logarithmic.

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…..

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……
…….[2]

(b) On Fig. 8.2, sketch the results expected if the structure of the atom was indeed that of a plum pudding. [1]

(c) It is thought that the number of alpha particles N striking the detector is directly proportional to $(\sin(\theta/2))^n$ where n is an integer. The variation with θ between 60º to 80º of N is shown in Fig. 8.3.

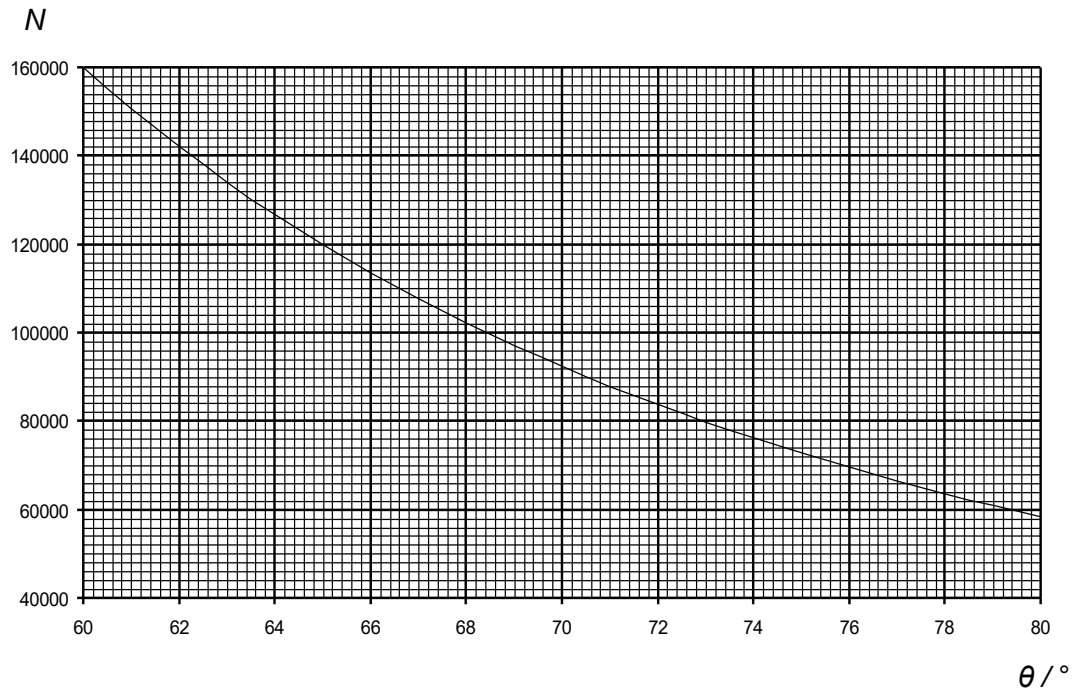

Fig. 8.3

Some corresponding values of lg (sin (θ/2)) and lg N are plotted on the graph of Fig. 8.4.

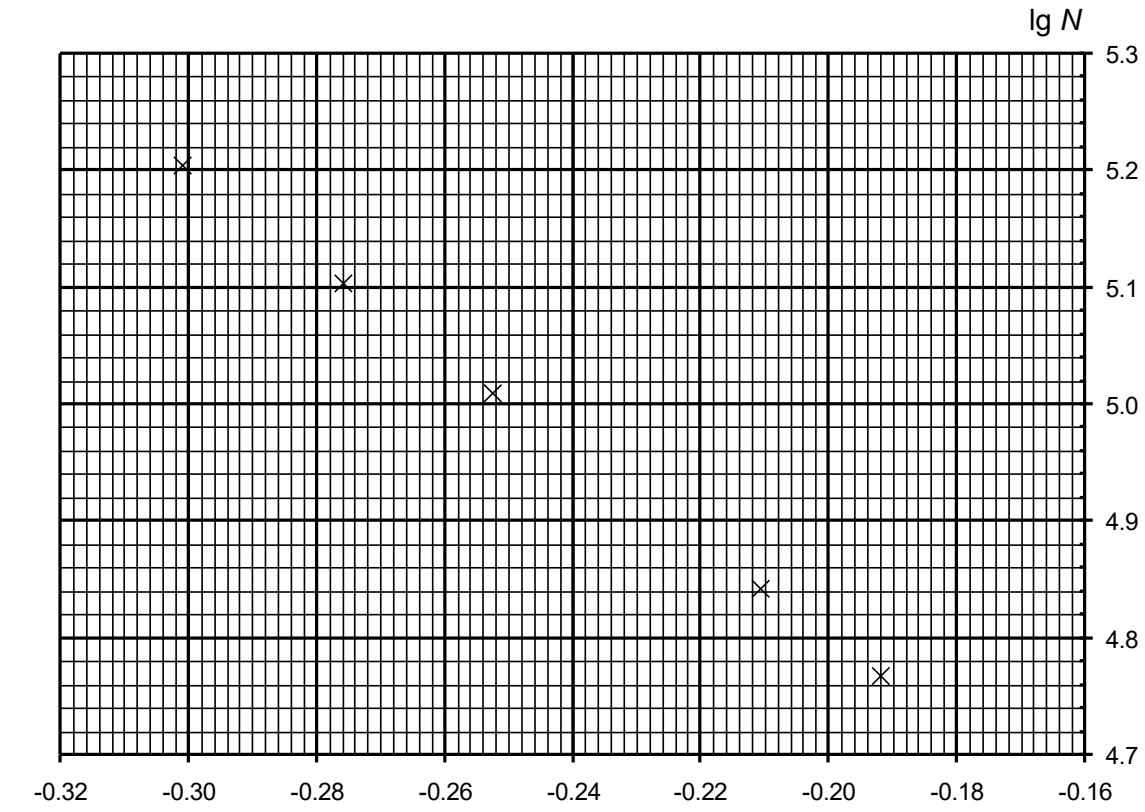

Fig. 8.4

(i) On Fig. 8.4,

1. plot the point corresponding to $\theta = 72^{o}$, and

2. draw the best-fit line for all plotted points. [2]

(ii) Determine the gradient of the line drawn in **c(i)2.**

gradient = ... [2]

(iii) Hence, deduce a value for n. Show your working clearly.

n = ... [2]

(d) The experiment is repeated using target foils made of 3 other different elements - tungsten W, iridium Ir and platinum Pt. The results for the angles between 65º to 74º are shown in Fig. 8.5 together with that of gold Au.

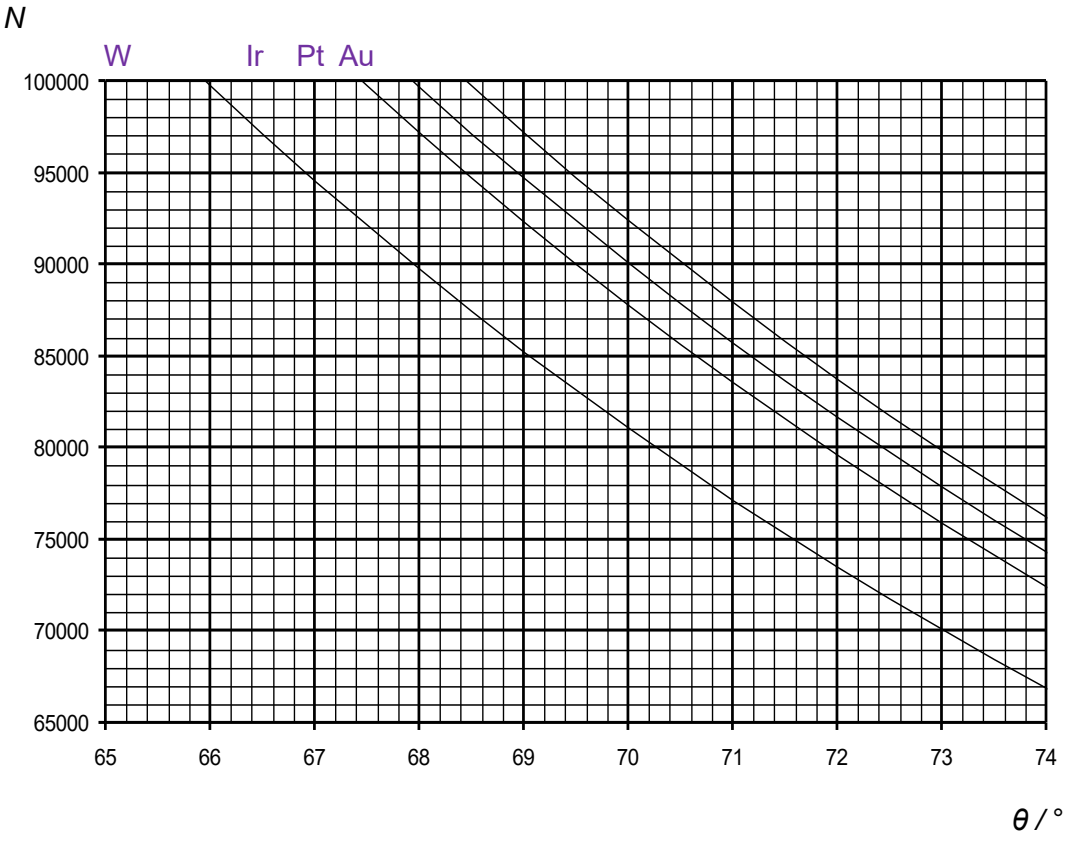

Fig. 8.5

Without drawing a further graph, show that, at θ = 70º, the value of N is directly proportional to Z^2, where Z is the proton number of the target foil.

The proton number of W, Ir, Pt and Au are 74, 77, 78 and 79 respectively. [3]

(e) The overall relationship between N, Z and θ may be expressed as

$$N = kZ^2(\sin(\theta/2))^n$$

where k is a constant.

Suggest two physical quantities that determine the value of k.

1. ..……..…………………………………………………………………………………
……..

…...……..…………………………………………………………………………………...

2. ..……...………………………………………………………………………………
….

..……..…………………………………………………………………………………...[2]

(f) The experiment is repeated with a foil made from a heavier isotope of gold.

State and explain how the results in Fig. 8.2 would be different.

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……...………………………………………………………………………………
………….[2]

END OF PAPER