

# **A Level Physics A**

**H556/02** Exploring physics

## **Question Set 20**

- 1(a) The structure of atoms was deduced in the early 1900s by Rutherford and his co-workers from the scattering of alpha-particles by a very thin sheet of gold.

Rutherford assumed that the scattering of the alpha-particles was due to electrostatic forces. Fig. 23 shows a detector used to record the number  $N$  of alpha-particles scattered through an angle  $\theta$ .

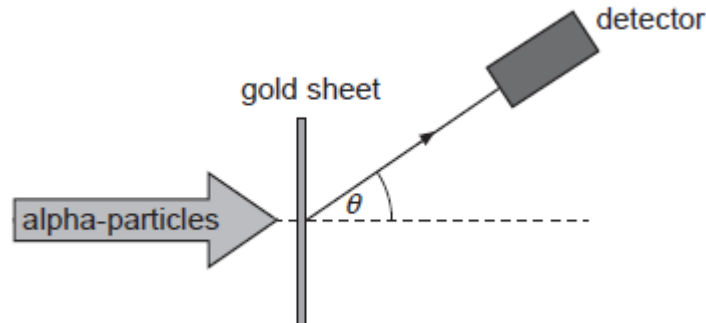


Fig. 23

At  $\theta = 0^\circ$ ,  $N$  was too large to be measured. The table below summarises some of the collected data.

$\theta / ^\circ$	$\lg(N)$
150	1.5
75	2.3
60	2.7
30	3.9
15	5.1
0	$N$ too large

- (i) Show that the number of alpha-particles scattered through  $15^\circ$  is about 4000 times more than those scattered through  $150^\circ$ .

$$\begin{aligned} \theta = 15^\circ &\Rightarrow \lg N = 5.1 \Rightarrow N = 10^{5.1} \\ \theta = 150^\circ &\Rightarrow \lg N = 1.5 \Rightarrow N = 10^{1.5} \end{aligned} \quad \frac{10^{5.1}}{10^{1.5}} = 3981 \approx 4000 \quad [1]$$

- (ii) Use the evidence from the table to explain the structure of the atom.

- Most alpha particles went straight through, so atom is mostly empty space
- Some alpha particles were scattered, so there must be a nucleus in the centre.
- Alpha particles are positive, suggesting the nucleus is also positive because of repulsion

[3]

(b) A proton with kinetic energy 0.52 MeV is travelling directly towards a stationary nucleus of cobalt-59 ( $^{59}_{27}\text{Co}$ ) in a head-on collision.

(i) Explain what happens to the electric potential energy of the proton-nucleus system.

KE is transferred to potential so it increases.

[1]

(ii) Calculate the **minimum** distance  $R$  between the proton and cobalt nucleus.

KE is transferred to electric potential energy:  $E = \frac{Qq}{4\pi\epsilon_0 R}$

Q of cobalt =  $27 \times 1.6 \times 10^{-19}$

q of proton =  $1.6 \times 10^{-19}$

$$0.52 \times 1 \times 10^6 \times 1.6 \times 10^{-19} = \frac{27 \times (1.6 \times 10^{-19})^2}{4\pi \times 8.85 \times 10^{-12} \times R}$$

$$R = 7.5 \times 10^{-14} \text{ m}$$

$$R = \dots\dots\dots 7.5 \times 10^{-14} \dots\dots\dots \text{ m [3]}$$

**Total Marks for Question Set 20: 8**

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