Oxford Cambridge and RSA

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 *θ*.

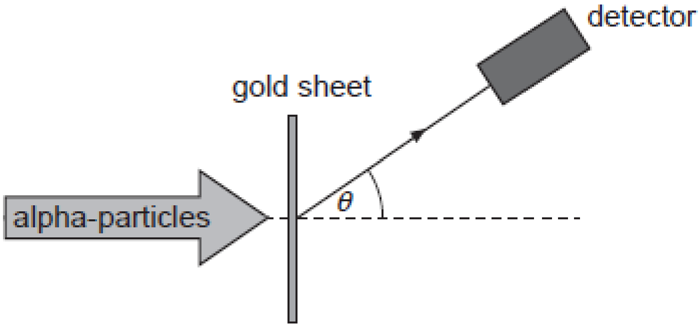

Fig. 23

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

θ / °	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° is about 4000 times more than those scattered through 150°.

$\theta = 15° \Rightarrow \log N = 5.1 \Rightarrow N = 10^{5.1}$

$\theta = 150° \Rightarrow \log N = 1.5 \Rightarrow N = 10^{1.5}$

$\frac{10^{5.1}}{10^{1.5}} = 3981 \approx 4000$

[1]

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

[3]

- 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

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

(i) Explain what happens to the electric potential energy of the proton-nucleus system. **[1]**

KE is transferred to potential so it increases.

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

KE is transferred to electric potential energy: $E = \frac{Qq}{4\pi\varepsilon_0 R}$

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

q of proton = 1.6×10^{-19}

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

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

R = ... 7.5×10^{-14} .... m **[3]**

Total Marks for Question Set 20: 8

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