



ANSWER BOOK

Rutherford scattering and the nuclear atom

Nuclear physics · Year 13

AQA 3.8.1.1, 3.8.1.2 · CIE 11.1 · OCR A 6.4.1, 6.4.3

10 questions · 30 marks

NAVY EDITION

SECTION A · Warm-up

- A1** Most alpha particles passed straight through the thin gold foil with little or no deflection; a small fraction were deflected through large angles, and a very few were deflected back through more than 90° . [2]
- A2** The atom is mostly empty space (most particles pass through); its positive charge and nearly all its mass are concentrated in a tiny, dense central nucleus (which deflects the few close-approaching particles). [2]
- A3** Alpha is stopped by a sheet of paper (or a few cm of air); beta by a few mm of aluminium; gamma is only reduced, needing several cm of lead. [2]

SECTION B · Standard

- B1** Stopped by paper: alpha. Stopped by aluminium (but not paper): beta. Only reduced by lead: gamma. [3]
- B2** $I \propto 1/r^2$, so $I = 800 \times (1.0/2.0)^2 = 200$ units. [3]
- B3** $I = 1600 \times (0.50/2.0)^2 = 1600 \times (1/16) = 100$ counts per second. [4]
- B4** The atom is mostly empty space, with the nucleus occupying only a tiny fraction of its volume. Most alpha particles pass far from any nucleus, so they feel little electrostatic repulsion and continue almost undeflected. [3]

SECTION C · Stretch

- C1** Corrected count at 0.10 m = $520 - 20 = 500$ counts per second. At 0.20 m, corrected = $500 \times (0.10/0.20)^2 = 125$ counts per second. Adding background gives a measured 145 counts per second. [4]
- C2** A large deflection occurs when an alpha particle passes very close to a nucleus, where the concentrated positive charge exerts a strong electrostatic repulsion. The particles heading almost directly at a nucleus (nearly head-on) approach closest and are deflected the most, some bouncing straight back. [3]
- C3** Alpha is the most strongly ionising but least penetrating (stopped by paper). Beta is moderately ionising and moderately penetrating (stopped by aluminium). Gamma is the least ionising but the most penetrating (only reduced by thick lead). [3]