

4.2 The development of the model of the atom

Name: _____ Class: _____ Date: _____

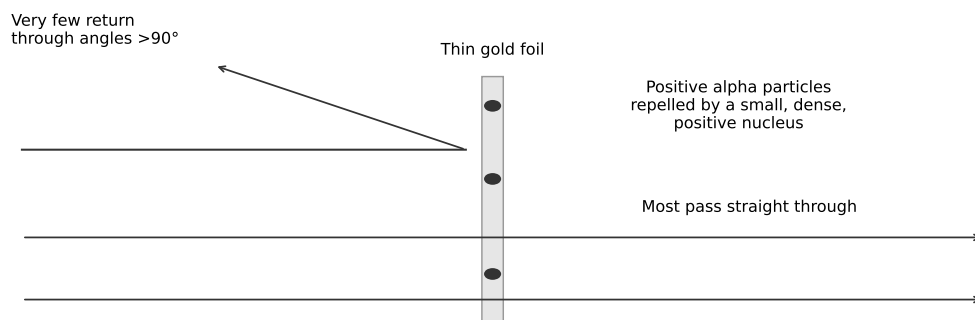
Total: 15 marks

KEY WORDS nucleus

Objective

Tell the story of the atomic model in order, and explain why the alpha scattering evidence forced the change from the plum pudding model. Original questions for spec statement 4.4.1.3.

1 Key knowledge and worked examples



Paths are schematic. Their drawn numbers do not represent the measured proportions.

The observations only make sense with a nuclear model.

Stage	Model	Evidence that caused it
before 1897	tiny spheres, indivisible	none better available
after electron found	plum pudding: ball of positive charge, electrons embedded	electrons exist but atom is neutral
after scattering	nuclear model: mass and positive charge at the centre	alpha scattering results
Bohr	electrons orbit at specific distances	his calculations matched observations
later	nucleus = whole-number positive units → protons	further experiments
Chadwick (~20 years on)	neutrons in the nucleus	his experimental evidence

Why the scattering changed the model (three marks):

1. If the pudding model were right, alpha particles would pass through with only small deflections – the charge is spread out.
2. Most did pass straight through (atoms are mostly empty space), but **a few bounced back through large angles**.
3. A large deflection needs a concentrated repulsion: the mass and positive charge must sit in a **tiny, dense, positively charged nucleus**.

You do not need the experimental details behind Bohr or Chadwick – only what each contributed.

2 Practice

2.1 Put in order: plum pudding model, nuclear model, tiny indivisible spheres, Bohr orbits, neutrons. [1]

2.2 State two features of the plum pudding model. [2]

2.3 State what Bohr added to the nuclear model. [1]

3 Exam-style questions

3.1 Describe the difference between the plum pudding model and the nuclear model of the atom. [2]

3.2 In the alpha scattering experiment, most alpha particles passed straight through the gold foil.

(a) What does this observation show about the structure of the atoms? [1]

(b) A few alpha particles were deflected through angles greater than 90° . Explain what this observation shows. [3]

(c) Explain why these observations led to the plum pudding model being replaced. [2]

3.3 “The change from the plum pudding model to the nuclear model shows how science works.” Explain this statement using the idea of evidence and models. [3]

Solutions

2.1 Tiny indivisible spheres → plum pudding model → nuclear model → Bohr orbits → neutrons.

2.2 A ball of positive charge; with negative electrons embedded in it.

2.3 Electrons orbit the nucleus at specific distances (fixed energy levels).

3.1 Plum pudding: positive charge spread through the whole atom with electrons embedded. Nuclear model: nearly all the mass and positive charge concentrated in a tiny central nucleus, with electrons around it.

3.2 (a) The atom is mostly empty space. (b) The alpha particle meets a concentrated region of positive charge and mass; repelling/deflecting it through a large angle requires the charge and mass to be in a tiny nucleus; much smaller than the atom. (c) The plum pudding model predicted small deflections only, because its charge is spread out; the large-angle observations contradict it, so the model had to be replaced by one matching the evidence – the nuclear model.

3.3 Scientific models are explanations that must fit all the experimental evidence; when new evidence (the scattering results) contradicts a model, the model is changed or replaced rather than the evidence ignored; this self-correction – test, compare, revise – is exactly how science develops reliable knowledge.