Clues Inside Atoms

Trace how experimental evidence changed atomic models.

CHE.2.1 "Investigate the historical progression leading to the modern atomic theory, including, but not limited to, work done by Dalton, Rutherford's gold foil experiment, Thomson's cathode ray experiment, Millikan's oil drop experiment..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB READ AND MARK: Underline one observation or measurement for each named scientist, then circle the conclusion it supported. Number the scientists in the order their work appears to trace how the atomic model changed.

How Do You Study What You Cannot See?

1. Imagine trying to map a room by watching what comes out of it. Early scientists faced a similar problem with atoms: they could not see them directly, so they used chemical changes as clues. In the early 1800s, John Dalton studied how elements combine. He found that compounds form in fixed mass ratios and that the same two elements can form compounds in different simple mass ratios. Dalton proposed that matter consists of tiny atoms that combine in whole-number ratios. His atoms were solid and indivisible. The ratio evidence made his model useful, but later experiments showed that an atom has smaller parts.

2. In the late 1800s, J. J. Thomson sent a cathode ray through a tube with little gas inside. An electric field bent the ray toward a positive plate, evidence that the ray contained negatively charged particles. Thomson concluded that these electrons were parts of atoms, so Dalton's indivisible atom could not be right. He pictured electrons embedded in a spread-out positive charge. In 1909, Robert Millikan measured the electric charge on tiny oil drops held between charged plates. Their charges came in multiples of one small value, revealing the magnitude of an electron's charge. Together, these results established electrons as measurable parts of atoms.

3. A different clue came from Ernest Rutherford's team. In 1909, they fired positively charged alpha particles at thin gold foil. Most passed through, but a few scattered at large angles. Rutherford concluded that an atom is mostly empty space with a small, dense, positively charged nucleus, contradicting Thomson's spread-out positive charge. In 1913, Niels Bohr examined hydrogen's bright-line spectrum: hydrogen emits only certain colors, not every color. Bohr proposed that hydrogen's electron occupies certain energy levels and releases light when it moves to a lower level. His model explained hydrogen's lines but did not fully explain atoms with many electrons.

2 ANSWER WITH EVIDENCE

Use the passage

1. How did Thomson's cathode ray result challenge Dalton's picture of an atom?

2. What did Millikan's oil drop measurements add to the evidence about electrons?

3. How did the gold foil results lead Rutherford to change Thomson's model?

4. What feature of hydrogen's light led Bohr to propose energy levels, and what could his model not fully explain?

3 YOUR TURN

Your own words

YOUR TURN: A classmate says scientists changed atomic models just because they preferred new pictures. Write a five-sentence museum label that challenges this claim using evidence from at least three named investigations. Include one earlier idea that remained useful and one limitation of a model.

ANSWER KEY

Clues Inside Atoms

HIGH SCHOOL · CHE.2.1

PART 1 · READ AND MARK

READ AND MARK: Underline one observation or measurement for each named scientist, then circle the conclusion it supported. Number the scientists in the order their work appears to trace how the atomic model changed. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How did Thomson's cathode ray result challenge Dalton's picture of an atom?	**The ray bent toward a positive plate, showing that it contained negatively charged electrons. If electrons are parts of atoms, atoms are not indivisible as Dalton proposed.**
2	What did Millikan's oil drop measurements add to the evidence about electrons?	**The drops' charges came in multiples of one small value, revealing the magnitude of an electron's charge.**
3	How did the gold foil results lead Rutherford to change Thomson's model?	**Most alpha particles passed through the foil, suggesting mostly empty space. A few scattered at large angles, supporting a small, dense, positively charged nucleus rather than spread-out positive charge.**
4	What feature of hydrogen's light led Bohr to propose energy levels, and what could his model not fully explain?	**Hydrogen emitted only certain colors, which Bohr explained using set electron energy levels. His model did not fully explain atoms with many electrons.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Dalton used fixed mass ratios in compounds to argue that atoms combine in whole-number ratios. Thomson's bent cathode ray showed that atoms contain negatively charged electrons, overturning Dalton's idea that atoms are indivisible. Even so, Dalton's idea that atoms combine in whole-number ratios remained useful. Rutherford's gold foil results replaced Thomson's spread-out positive charge with a small, dense nucleus in a mostly empty atom. Bohr used hydrogen's bright lines to propose set electron energy levels, although his model did not fully explain atoms with many electrons.

For the YOUR TURN museum label, accept any accurate five-sentence account that links evidence to changes in atomic models across at least three named investigations. It must identify an earlier idea that remained useful and a model limitation.