Clues Inside Atoms

Use experimental evidence to trace changes in atomic theory.

CHE.2 "Students will demonstrate an understanding of the atomic structure and the historical developments leading to modern atomic theory. Investigate the historical progression leading to the modern atomic theory, including, but not limited to..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline experimental observations and circle conclusions about atomic structure or electron energy levels, then draw arrows connecting at least two observations to the conclusions they support.

What the Evidence Revealed

1. In 1803, John Dalton proposed that each element consists of its own kind of atom. He treated atoms as indivisible, a useful model for explaining why compounds form in fixed ratios. Later, J. J. Thomson sent electricity through a nearly empty glass tube. The beam bent toward a positive plate, showing that it contained negatively charged particles, later called electrons. Because electrons could be removed from atoms, atoms could not be indivisible. Robert Millikan then tracked charged oil drops in an electric field. By balancing electric and gravitational forces, he measured the electron's charge; combined with Thomson's charge-to-mass measurement, this gave scientists the electron's mass.

2. Ernest Rutherford's team aimed alpha particles at thin gold foil. Most passed through, but a few bounced back or turned sharply. If positive charge filled an atom evenly, such sharp turns would be very unlikely. Rutherford concluded that most of an atom is empty space and that a tiny, dense, positively charged nucleus holds much of its mass. Yet this nuclear model did not explain why an excited gas gives off only certain colors of light. Niels Bohr proposed that electrons occupy specific energy levels. When an electron drops to a lower level, it emits a photon with an energy equal to the difference between the levels.

3. A spectroscope splits light into a spectrum. In a lab, an excited gas may show bright lines against a dark background, called an emission spectrum. Each line marks a photon released during an electron energy change. When continuous light passes through cooler gas, atoms absorb photons at energies that lift electrons to higher levels. The resulting spectrum has dark lines at those wavelengths. Astronomers compare patterns of dark lines in starlight with laboratory spectra to identify elements in a star's outer layers. A match is evidence, not a direct photograph of atoms; motion and temperature can change a spectrum's appearance.

2 ANSWER WITH EVIDENCE

Use the passage

1. How did Thomson's beam result challenge Dalton's idea that atoms are indivisible?

2. Why do the gold foil results support a tiny, dense nucleus rather than positive charge spread evenly through the atom?

3. What did Millikan measure, and how did Thomson's result help scientists use it?

4. Why can dark lines in starlight help identify elements, even though an excited gas in a lab shows bright lines?

3 YOUR TURN

Your own words

A student says, “Most alpha particles crossed the gold foil, so atoms must be solid all the way through. A gas shows only a few bright lines, so its electrons can have any energy.” In three or four sentences, correct both claims using evidence and explain how the bright lines arise.

ANSWER KEY

Clues Inside Atoms

PART 1 · READ AND MARK

Underline experimental observations and circle conclusions about atomic structure or electron energy levels, then draw arrows connecting at least two observations to the conclusions they support. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How did Thomson's beam result challenge Dalton's idea that atoms are indivisible?	**The beam contained electrons that could be removed from atoms, showing that atoms have smaller parts.**
2	Why do the gold foil results support a tiny, dense nucleus rather than positive charge spread evenly through the atom?	**Most alpha particles passed through, indicating mostly empty space. The few sharp turns indicate a small, dense region of positive charge.**
3	What did Millikan measure, and how did Thomson's result help scientists use it?	**Millikan measured the electron's charge. Scientists combined it with Thomson's charge-to-mass measurement to calculate the electron's mass.**
4	Why can dark lines in starlight help identify elements, even though an excited gas in a lab shows bright lines?	**Electrons in an element absorb and emit photons at energies linked to its energy levels. Astronomers compare the star's dark-line pattern with laboratory patterns to identify elements.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Because most alpha particles crossed the foil, atoms contain mostly empty space, not solid material throughout. The few particles that turned sharply indicate a small, dense, positively charged nucleus. A gas shows only certain bright lines because electrons drop between specific energy levels and release photons with energies equal to those gaps.

Accept descriptions of bright lines as photons emitted when electrons move to lower energy levels. Students should use both foil observations to support their correction of the solid-atom claim.