Atoms Under Review

Use evidence to compare five models of the atom.

PHS.2 "Students will demonstrate an understanding of both modern and historical theories of atomic structure. Research and develop models (e.g., 3-D models, online simulations…"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle the names of the five atomic models and number them in historical order, then underline observations that led scientists to change their models.

How Do You Picture an Atom?

1. Imagine building an atom from clues too small to see directly. In the early 1800s, John Dalton used the fixed mass ratios in chemical compounds to argue that each element consists of atoms with characteristic masses. He pictured atoms as solid, indivisible spheres. Later, J. J. Thomson found that a beam inside a glass tube bent toward a positive electric plate. The beam contained negatively charged electrons, so atoms could not be indivisible. Thomson proposed electrons embedded in a spread-out positive charge. His model could explain an atom's overall neutral charge, but it did not identify a tiny, dense center.

2. Rutherford's team sent positively charged alpha particles through thin gold foil. Most passed straight through, but a few bounced back or turned sharply. Rutherford concluded that an atom is mostly empty space around a small, dense, positively charged nucleus. This result challenged Thomson's spread-out positive charge. Later, Niels Bohr proposed that electrons in hydrogen occupy only certain allowed energy levels. When an electron drops to a lower level, it releases light of a particular color. Hydrogen's separate lines of color, rather than a continuous rainbow, supported the idea of distinct energy levels. Bohr's model kept Rutherford's nucleus but changed the picture of electrons.

3. Electron diffraction patterns show that electrons behave like waves as well as particles. Modern atomic theory uses orbitals, regions describing where an electron is likely to be found, rather than fixed tracks. Calculations based on this theory predict spectra for many-electron atoms more accurately than Bohr's simple orbits. To compare models, build a ball-and-stick or digital hydrogen atom, then ask which claims match line spectra and diffraction. A circular track can represent an allowed energy but wrongly suggest a known route. A shaded cloud represents location probability but cannot pinpoint an electron at one moment.

2 ANSWER WITH EVIDENCE

Use the passage

1. How did Thomson's evidence change Dalton's picture of an atom?

2. Which gold-foil observation challenged Thomson's model, and what did Rutherford's model add?

3. How did Bohr's model build on Rutherford's model to account for hydrogen's separate lines of color?

4. What evidence supports replacing Bohr's fixed electron tracks with modern orbitals?

3 YOUR TURN

Your own words

In two panels, sketch your own Bohr and modern models of a hydrogen-1 atom. Label the nucleus and electron representation in each, then write one sentence under each sketch explaining what that picture shows and what it cannot show.

ANSWER KEY

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HIGH SCHOOL · PHS.2

PART 1 · READ AND MARK

Circle the names of the five atomic models and number them in historical order, then underline observations that led scientists to change their models. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How did Thomson's evidence change Dalton's picture of an atom?	**The beam's negatively charged electrons showed that atoms contain smaller parts, unlike Dalton's indivisible spheres.**
2	Which gold-foil observation challenged Thomson's model, and what did Rutherford's model add?	**A few alpha particles bounced back or turned sharply. Rutherford added a small, dense, positively charged nucleus.**
3	How did Bohr's model build on Rutherford's model to account for hydrogen's separate lines of color?	**Bohr kept Rutherford's nucleus but placed electrons at allowed energy levels. Drops between levels release light of particular colors.**
4	What evidence supports replacing Bohr's fixed electron tracks with modern orbitals?	**Electron diffraction shows wave behavior, and modern calculations predict many-electron spectra more accurately than Bohr's simple orbits.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Bohr panel sketch: A central dot labeled “nucleus: one proton” has one surrounding circle labeled “electron at an allowed energy.”
Sentence: This circle shows an allowed energy, but it suggests a fixed electron track that modern theory does not support.
Modern panel sketch: A central dot labeled “nucleus: one proton” sits inside a shaded region labeled “electron probability.”
Sentence: This cloud shows where the electron is likely to be found, but it cannot give its exact position at one moment.

Accept sketches that clearly distinguish a fixed Bohr orbit from a modern probability region around a one-proton nucleus. Each written sentence should identify both a useful feature and a limitation of its own model.