Lines of Light

Use two spectra to trace electron energy changes.

CHE.2.3 "Investigate absorption and emission spectra to interpret explanations of electrons at discrete energy levels using tools such as online simulations, spectrometers, prisms, flame tests, and discharge tubes..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the electron movements that cause bright and dark lines, then circle the table wavelengths that pair a bright tube line with a dark starlight line.

Hydrogen in the Lab and the Stars

1. At a lab bench, a student views a hydrogen discharge tube through a spectrometer. Electricity excites its atoms. Instead of a smooth rainbow, the student sees thin bright lines at selected wavelengths. Each line forms when an electron drops to a lower allowed energy level and releases a photon. A larger drop produces a shorter-wavelength photon.

2. The student studies light from a star. Hot inner layers emit many wavelengths. As this light passes through cooler outer gas, atoms can absorb photons with the right energy to lift electrons to higher allowed levels. Missing wavelengths appear as dark lines. Several kinds of atoms may be present in that gas.

3. A spectrometer separates starlight by wavelength, just as it separates light from the tube. The table records several positions in both spectra. Bright and dark lines at the same wavelength suggest a shared energy gap in the same kind of atom. Compare several lines before naming an element, since other atoms could cause an extra dark line.

SELECTED WAVELENGTHS IN TWO SPECTRA

Wavelength (nm)	Hydrogen tube	Starlight
434	Bright line	Dark line
486	Bright line	Dark line
550	No bright line	Dark line
656	Bright line	Dark line

2 ANSWER WITH EVIDENCE

Use the passage

1. Which three dark lines in the starlight match bright lines from the hydrogen tube? What do the matches suggest?

2. Why do these data not support calling the 550 nm dark line a hydrogen line?

3. Which matched line, 434 nm or 656 nm, corresponds to a larger electron energy change? Explain.

4. At 486 nm, how does the electron's movement differ between the bright tube line and the dark starlight line?

3 YOUR TURN

Your own words

A mystery gas tube has bright lines at 470 nm and 620 nm. Describe how you would use a spectrometer and light passing through cooler mystery gas to look for absorption lines, then predict where the dark lines might appear and explain what a match would show about electron energy levels.

Lines of Light

PART 1 · READ AND MARK

Underline the electron movements that cause bright and dark lines, then circle the table wavelengths that pair a bright tube line with a dark starlight line. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which three dark lines in the starlight match bright lines from the hydrogen tube? What do the matches suggest?	**The lines at 434, 486, and 656 nm match. Together, they suggest hydrogen is present in the star's outer gas.**
2	Why do these data not support calling the 550 nm dark line a hydrogen line?	**The hydrogen tube has no bright line at 550 nm. Another atom in the star's outer gas could cause the dark line.**
3	Which matched line, 434 nm or 656 nm, corresponds to a larger electron energy change? Explain.	**The 434 nm line corresponds to the larger energy change because its shorter wavelength means a higher-energy photon.**
4	At 486 nm, how does the electron's movement differ between the bright tube line and the dark starlight line?	**In the tube, an electron drops to a lower level and emits light. In the outer gas of the star, an electron absorbs light and rises to a higher level.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would shine a light with many wavelengths through cooler mystery gas and view the result with a spectrometer. I would look for dark lines at 470 nm and 620 nm, the wavelengths of the tube's bright lines. If those dark lines appear, electrons in the cooler gas absorbed photons that lifted them to higher allowed levels. In the tube, electrons dropped between those levels and emitted photons with the same energies.

Accept answers that use the three matching wavelengths as evidence for hydrogen without treating the 550 nm line as hydrogen. For Your Turn, dark lines are a prediction, not a guarantee, since absorption requires electrons in the appropriate lower levels.