Atomic Spectra Virtual Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/spectra (two pages, 16 questions). © 2026 Ryan Sajdak. Free to use, share and change under CC BY-NC-SA 4.0 (creativecommons.org/licenses/by-nc-sa/4.0): give credit, do not sell it, share your version the same way.

Objectives

The same two statements are printed at the top of the worksheet, each with a box to tick.

Day	I can	Questions
1	tell which gas is in a tube from the bright lines in its spectrum.	1 to 5, 13, 16
1	explain how an electron dropping to a lower energy level makes light of one color.	6 to 12, 14, 15

Performance expectations: building toward

The lab and worksheet give students evidence for these performance expectations. They are one step on the way, not a full assessment of any one of them.

> **HS-PS1-1 (NYS Chemistry course map)**
> *"Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms."* Worksheet link: electrons sit in fixed energy levels, and more electrons mean more levels and more lines (Parts 3 and 5). DCI PS1.A: *"Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons."*

> **HS-PS4-4 (NYS Chemistry course map)**
> *"Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter."* Worksheet link: the clarification statement's emphasis, *"photons associated with different frequencies of light have different energies,"* is what students measure in Part 3 (energy and wavelength of each drop, including ultraviolet).

> **HS-ESS1-2**
> *"Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe."* Worksheet link: the secondary DCI is the heart of the lab. PS4.B: *"Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities."* ESS1.A: *"The study of stars' light spectra and brightness is used to identify compositional elements of stars."* (Parts 1, 4 and the wrap-up.)

Part by part

Part	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	What students do
1. Light it up Q1 to 5	SEP 3 Planning and carrying out investigations SEP 4 Analyzing and interpreting data	PS4.B characteristic frequencies of light	Patterns	Light four tubes, compare glow color with the lines seen through the glasses, record each spectrum, and explain why lines identify a gas better than glow color.
2. Inside the tube Q6 to 8	SEP 2 Developing and using models, including the limits of a model	PS1.A atomic substructure	Cause and Effect; Systems and System Models	Trace the cause chain: electrons from the power supply hit atoms, atoms are excited, atoms give off photons. Name one way the model is not to scale.

3. One hydrogen atom Q9 to 12	SEP 4 Analyzing and interpreting data SEP 5 Using mathematics and computational thinking	PS4.B photons of different frequencies carry different energies (HS-PS4-4 clarification)	Energy and Matter; Scale, Proportion, and Quantity	Record the color, wavelength and energy of five drops. Multiply wavelength by energy to find the inverse relationship. State the pattern: bigger drop, more energy, shorter wavelength.
4. Mystery tubes Q13	SEP 7 Engaging in argument from evidence	PS4.B identifying an element from its spectrum	Patterns	Identify unknown gases from their lines using the fingerprint chart, then write a claim, evidence and reasoning.
5. More electrons, more colors Q14 to 15	SEP 6 Constructing explanations SEP 2 Developing and using models	PS1.A patterns of outer electron states	Structure and Function	Count the drops in neon's energy level diagram and compare a molecule's bands with an atom's sharp lines (Q14). Then explain why a many-electron atom has many lines and a molecule makes bands (Q15).
Wrap it up Q16	SEP 6 Constructing explanations SEP 8 Obtaining, evaluating, and communicating information	ESS1.A star spectra; PS4.B	Scale, Proportion, and Quantity	Explain how scientists know what stars are made of without going there.

Also in play

- **Explore, then explain, then apply:** each part starts with data questions (Q1 to 4, Q6, Q9 to 11, Q14). A READ FIRST line on the sheet then sends students to the yellow **Learn It** box in the lab, which opens once they have the data, before the questions that use the ideas (Q5, Q7 and 8, Q12, Q15 and 16). Taught there: emission spectrum as a fingerprint (Part 1); energy levels, ground state, excited atoms, photons and what "not to scale" means (Part 2); fixed levels, drop size as photon energy, wavelength and the visible range (Part 3); many electrons making many levels, molecule bands, and the same lines in starlight (Part 5). Part 4 (Q13) has no box of its own; it applies Part 1's fingerprint idea. The slideshow has a matching Learn It slide at each of those points for whole-class teaching.
- **SEP 1 Asking questions:** the page's Feedback button invites students to ask for new gases or features. The Freeze button supports "what is happening right here?" questions during discussion.
- **Connection to the POGIL Bohr model activity:** the One atom view animates the same n = 1 to 6 rings and drops, so students can check worksheet answers against the model.
- **Nature of science:** the model states its own limits (not to scale; only the outer electron jumps in many-electron atoms; the Bohr rings only fit hydrogen), which supports discussion of how models are revised.

Standards text quoted from the New York State P-12 Science Learning Standards, High School (NYSED), and the NYSED Chemistry Course Map, which lists HS-PS1-1 and HS-PS4-4 for the Chemistry course. HS-ESS1-2 is in the Earth and Space Sciences strand.