

ELECTRONS IN ATOMS

From fireworks to stars, the color of light emitted by matter is useful in determining what elements it contains. Energy absorbed and emitted by hydrogen and other atoms plays a key role in the understanding of atomic structure of atoms. Trace materials, such as evidence from a crime scene; lead in paint; or mercury in drinking water, can be identified by heating or burning the materials and examining the color(s) of light emitted.

Model 1: Data Table of Properties of Light

Speed (m/s)	Energy ($\times 10^{-21}$ J)	Wavelength (nm)	Color
3.00×10^8	269-318	625-740	Red
3.00×10^8	318-337	590-625	Orange
3.00×10^8	337-352	565-590	Yellow
3.00×10^8	352-382	520-565	Green
3.00×10^8	382-452	440-520	Blue
3.00×10^8	452-523	380-440	Violet

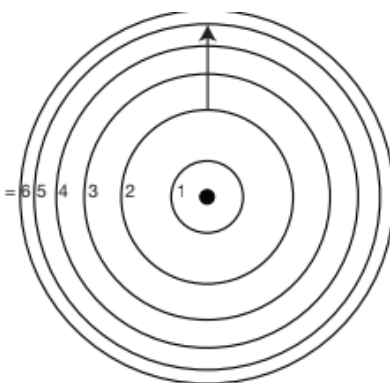
Consider the information in Model 1.

1. If a photon given off by an element has a wavelength of 500, what color would it be?
2. Do all colors of light travel at the same speed? If so, what is it?
3. Do all colors of light have the same wavelength? If not, which colors have the longest wavelength and the shortest wavelength, respectively?
4. Do all colors of light have the same energy? If not, which colors have the highest energy and the least energy, respectively?

5. Write a sentence that describes the relationship between wavelength and energy of light.

Model 2: Bohr Model of a Hydrogen Atom

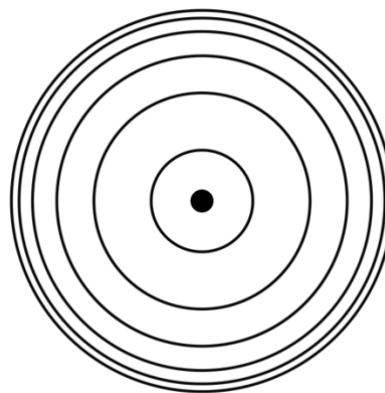
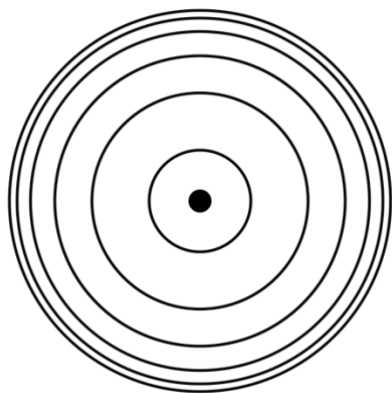
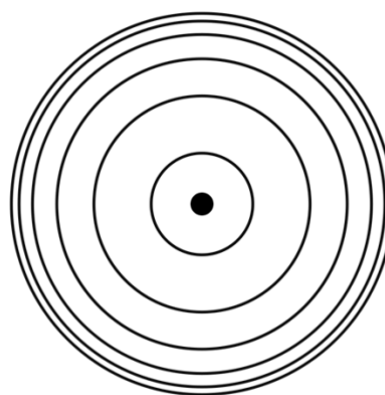
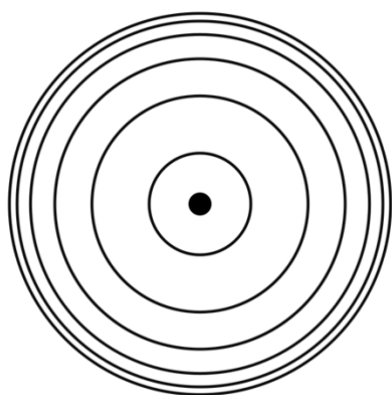
Bohr modified Rutherford's Nuclear model to explain how light interacted with the electrons in an atom to specific colors emitted. His model includes electrons orbiting the nucleus at specific energy levels. When electrons absorb energy from various sources (electricity, heat, etc.) they move from lower energy levels (ground state) to higher energy levels (excited state). Energy is released as electrons return to their lower energy levels.



1. What subatomic particle(s) are in the nucleus or outside the nucleus of the atom?
2. What do the circles in the diagram represent?
3. The arrow represents a transition of an electron. Where is the electron initially? Where is the electron after?
4. Does the electron absorb or release energy during this transition? Explain your reasoning.

Model 3: Visible Light Emitted by the Element Hydrogen

Transition	Wavelength (nm)	Color
3 to 2	626	
4 to 2	486	
5 to 2	494	
6 to 2	410	



1. In the above Bohr model diagrams:

- Number the energy levels in each diagram.
- Draw arrows to represent each transition in the chart. Use a different diagram for each transition.
- Using Model 1, determine the color emitted and add it to both the chart and next to the diagram for that transition.

2. Name a limitation of Models 2 and 3. How do the models differ from the real world?

Extension Question

The hydrogen spectral lines in Model 3 are only the wavelengths of light that are in the visible range and therefore “seen” by the naked eye. However, many other wavelengths can be detected with special equipment. Propose a hydrogen electron transition that involves light with a wavelength in the ultraviolet (UV) range (10–400 nm).

