Atomic Spectra

- Excited atoms emit light (neon signs, etc.)
- Emission from different elements is different colors.
- Emission of only certain wavelengths
- “Spectral lines”

Continuous Spectrum
Line Spectrum

H₂ Emission

Helium Emission
Energy Levels

• Existence of spectral lines is evidence of “quantized energy levels.”
• For electrons in atoms, only a few selected energies are possible!

Light Sources

• Traditional incandescent lamp emits a continuous spectrum
• LEDs, lasers, some other lamps emit selected wavelengths
• Difference is whether the light is emitted by individual atoms/molecules or by a bulk collection of matter.
Atomic Spectra: Emission

Excited Atom $\rightarrow$ De-excited Atom + Photon

$\Delta E_{(\text{atom})} = E_{(\text{photon})} = h\nu$

Atomic Spectra: Absorption

Atom + Photon $\rightarrow$ Excited Atom

$\Delta E_{(\text{atom})} = E_{(\text{photon})} = h\nu$

Atomic Spectra

- Show energy levels
- Conservation of Energy
  - Relates atom's energy levels to photon energy
- Absorption or Emission
  - Same lines from same element
  - Usually see more lines in emission

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Problem - Energy Levels

- A hypothetical atom has only 4 energy levels.
- Emission spectrum shows 6 lines at wavelengths of 100, 120, 150, 300, 500, and 750 nm.
- Atomic energy levels usually get closer together as energy increases.

Problem - Energy Levels

- Draw an energy level diagram for this atom
- Label the states by energies: \( E_1 < E_2 < E_3 < E_4 \)
- Use arrows to show the 6 transitions, and assign the correct wavelengths
- Try to draw “to scale”

Spectra and Analysis

- Spectra exist for both atoms and molecules
- Wavelengths are a characteristic property of a particular substance.
- Spectra are often used to identify substances, in areas from forensics to astrophysics.