Emission Spectra

Essential Question

How can light identify an element?

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Ground State and Excited State

- Ground state: lowest energy level
- Excited state: a higher level
- Energy in: heat or electricity

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Falling Back Down Releases Light

- Electron drops to a lower level
- It gives off a photon of light
- Photon energy = energy gap

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Only Certain Energies

- Levels are fixed (quantized)
- Only certain drops can happen
- So only certain colors appear

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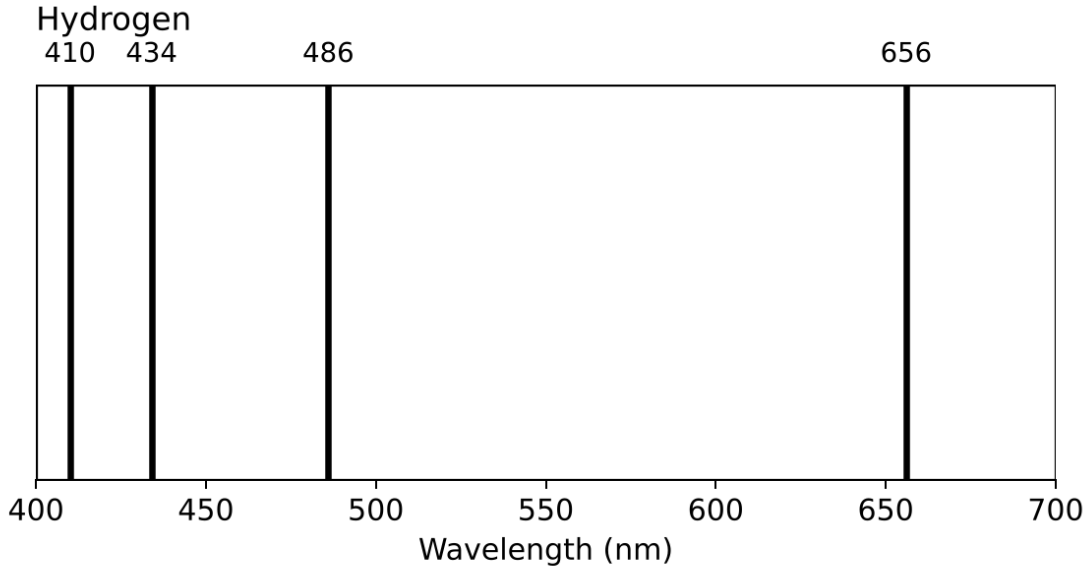
Continuous vs Line Spectrum

- Continuous spectrum: every color, no gaps
- Line spectrum: only bright lines
- White light → continuous; a glowing gas → lines

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Hydrogen's Emission Spectrum

- Four visible lines: 410, 434, 486, 656 nm
- Each line comes from one specific drop
- 656 nm (red): the smallest drop, 3 → 2



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Each Element Has a Fingerprint

- Different energy levels = different lines
- No two elements share a pattern
- Match every line to identify a gas

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Flame Tests

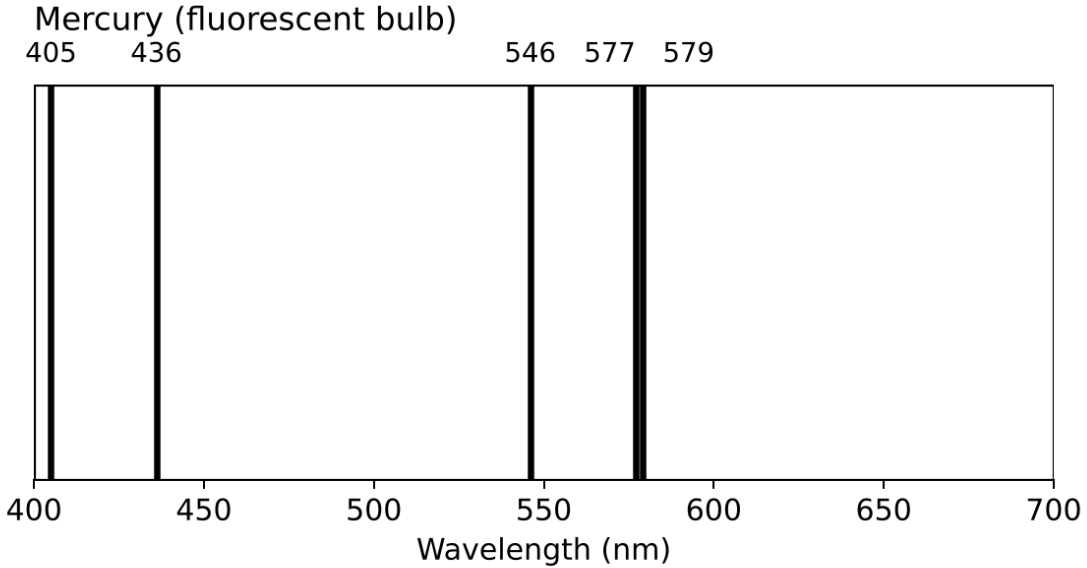
- Heat excites the electrons
- Each metal gives its own color
- Used in fireworks

Ion	Flame color
Li^+	crimson red
Na^+	yellow orange
K^+	lilac
Ca^{2+}	orange red
Sr^{2+}	red
Cu^{2+}	blue green

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Spectroscopes and Discharge Tubes

- Discharge tube: electricity excites a gas
- Spectroscope: spreads light by wavelength
- Fluorescent bulb: mercury lines



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Absorption and Spectroscopy

- Light is electromagnetic radiation
- Spectroscopy: studying light to identify a sample
- Atoms absorb the same wavelengths they emit
- Absorption → dark lines in starlight

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Light Equations Refresher

- $c = \lambda\nu$
- $E = h\nu$
- Shorter λ → higher ν → more energy

Symbol	Meaning	Value or unit
c	speed of light	2.998×10^{8} m/s
λ	wavelength	m
ν	frequency	s^{-1}
E	energy of one photon	J
h	Planck's constant	6.626×10^{-34} J·s

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Converting nm to m

- Equations need λ in meters
- Then fix to scientific notation
- $434\ \text{nm} = 434 \times 10^{-9}\ \text{m} = 4.34 \times 10^{-7}\ \text{m}$

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Example: Frequency of a Line

Hydrogen gives off red light with a wavelength of 656 nm. What is the frequency of this light?

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Example: Energy of a Photon

Hydrogen also gives off light with a wavelength of 486 nm. What is the energy of one photon of this light?

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Example: Which Drop Has More Energy?

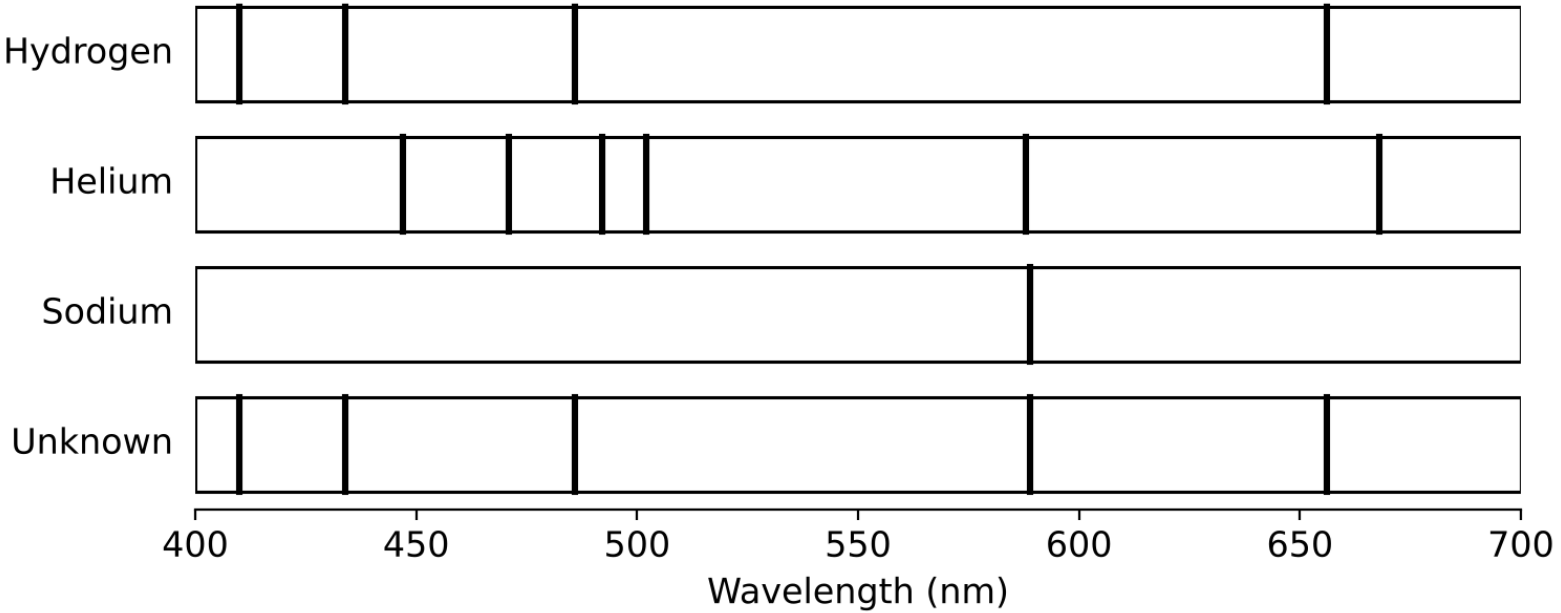
Which drop gives off a photon with more energy, n = 3 → 2 or n = 5 → 2?

What color line does each drop make?

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Example: Identify the Gas

Which element or elements are in the unknown gas?



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Emission Spectra

Big Ideas

- Electrons give off light when they drop
- Fixed levels mean only certain colors
- Each element has its own line pattern
- A spectroscope spreads a discharge tube's light into lines
- Use $c = \lambda\nu$ and $E = h\nu$ for ν and E

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