

Structure of the atom · supported focus

International Baccalaureate · IB Diploma · Physics · HL

Scope and prerequisites

Supported HL focus. First assessment 2025; full Physics guide acquired (84 PDF pages). Remaining guide, assessment and practical requirements retain their recorded holds.

Prerequisites: read the stated quantities and units, use arithmetic and the model conditions below. Each lesson develops its own method before independent transfer.

These are original or explicitly fictional teaching examples, not actual measurements or completed assessed learner investigations.

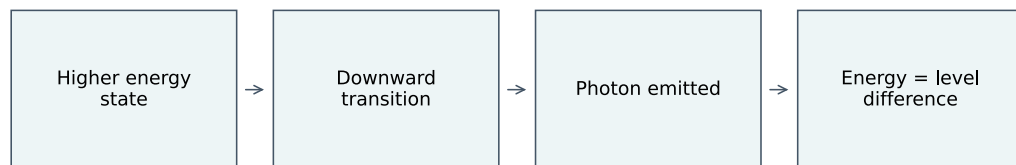
Atomic models and line spectra

■ What would explain this observation?

- An excited gas produces separate coloured lines rather than every wavelength. The pattern is evidence for discrete atomic energy differences.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Atoms have a small positive nucleus and electrons. Emission and absorption spectra arise from transitions between discrete **energy levels**. A photon energy equals the level difference and obeys $E = hf$.
- **emission spectrum** : Wavelength pattern of radiation emitted by a source; energy level : An allowed energy state in a model.



■ Choose evidence that can test it

- An emitted photon corresponds to a transition to a lower energy level. Absorption requires a compatible energy difference. Rutherford scattering supported a small dense nucleus, but that experiment alone did not establish the complete quantum model.
- Read a labelled energy-level diagram before calculating. Keep joules and electronvolts distinct and use the given constants. Compare attributed spectra at a common wavelength scale and avoid looking at unsafe light sources.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: energy levels are -6.0 and -2.0 eV. A downward transition releases 4.0 eV $= 6.4 \times 10^{-19}$ J using $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$. With $h = 6.4 \times 10^{-34} \text{ J s}$ for this rounded exercise, frequency is $1.0 \times 10^{15} \text{ Hz}$.

Example:

Levels are -7.0 and -2.0 eV. Find the energy emitted in the downward transition. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- Negative bound-state energies are relative to a chosen zero; they do not mean a negative photon energy is emitted. A larger downward energy difference gives higher frequency.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A negative bound-state energy means an emitted photon has negative energy. This claim is false: Negative bound-state energies are relative to a chosen zero; they do not mean a negative photon energy is emitted. A larger downward energy difference gives higher frequency.

Key:

Atomic models and line spectra: An emitted photon corresponds to a transition to a lower energy level. Absorption requires a compatible energy difference. Rutherford scattering supported a small dense nucleus, but that experiment alone did not establish the complete quantum model.