

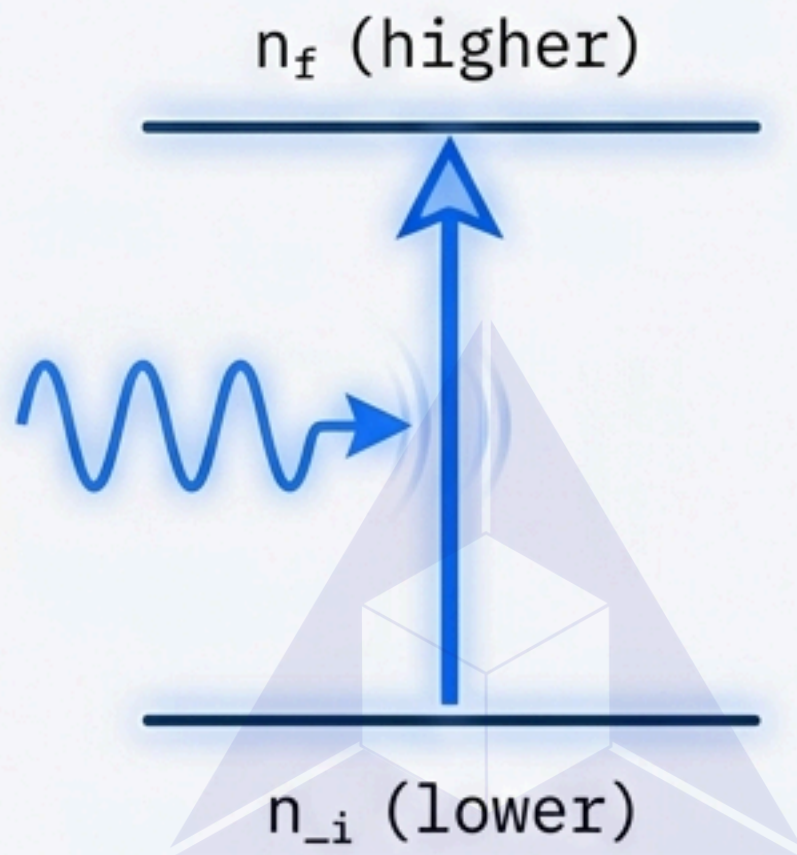
Hydrogen Line Spectrum

The Quantum Math of Electron Transitions

JEE Class 11 Chemistry | Section 2.4.1

Absorption vs. Emission

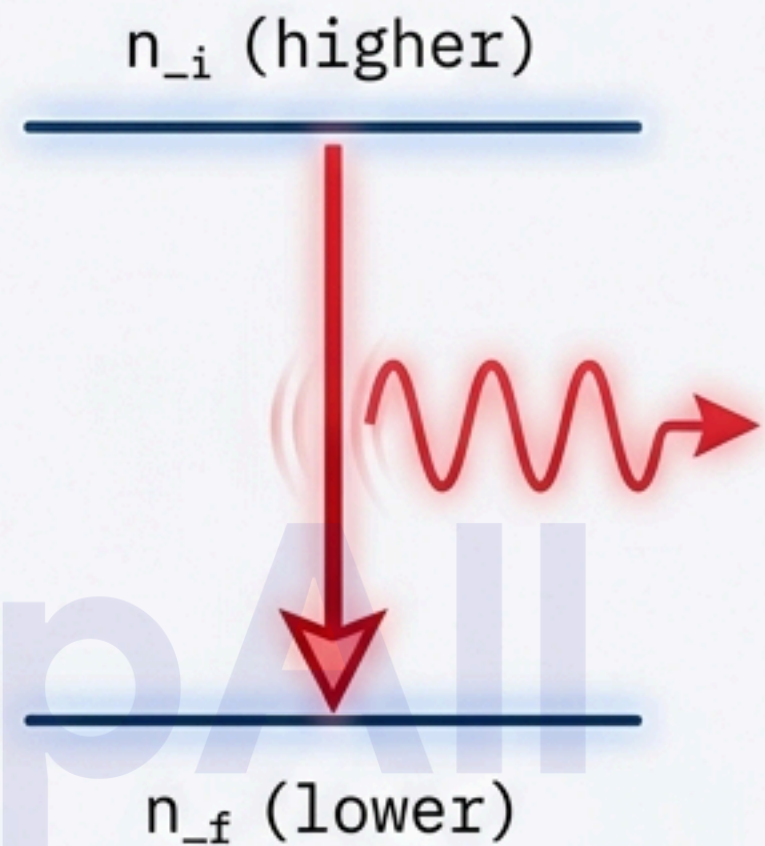
Absorption



Upward Transition:

Electron moves from lower (n_i) to higher (n_f) orbit.
Energy is absorbed.

Emission



Downward Transition:

Electron drops from higher (n_i) to lower (n_f) orbit.
Energy is emitted.

Transition Logic: Moving from a higher orbit to a lower orbit **emits energy** in the exact form of a photon

Quantifying the Energy Difference

$$\Delta E = E_f - E_i$$

Energy of the
Final Orbit

Energy of the
Initial Orbit

$$\Delta E = 2.18 \times 10^{-18} \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right) \text{ J}$$

Absorption

If $n_f > n_i$

→ ΔE is Positive (+)

→ Absorption

Emission

If $n_i > n_f$

→ ΔE is Negative (-)

→ Emission



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



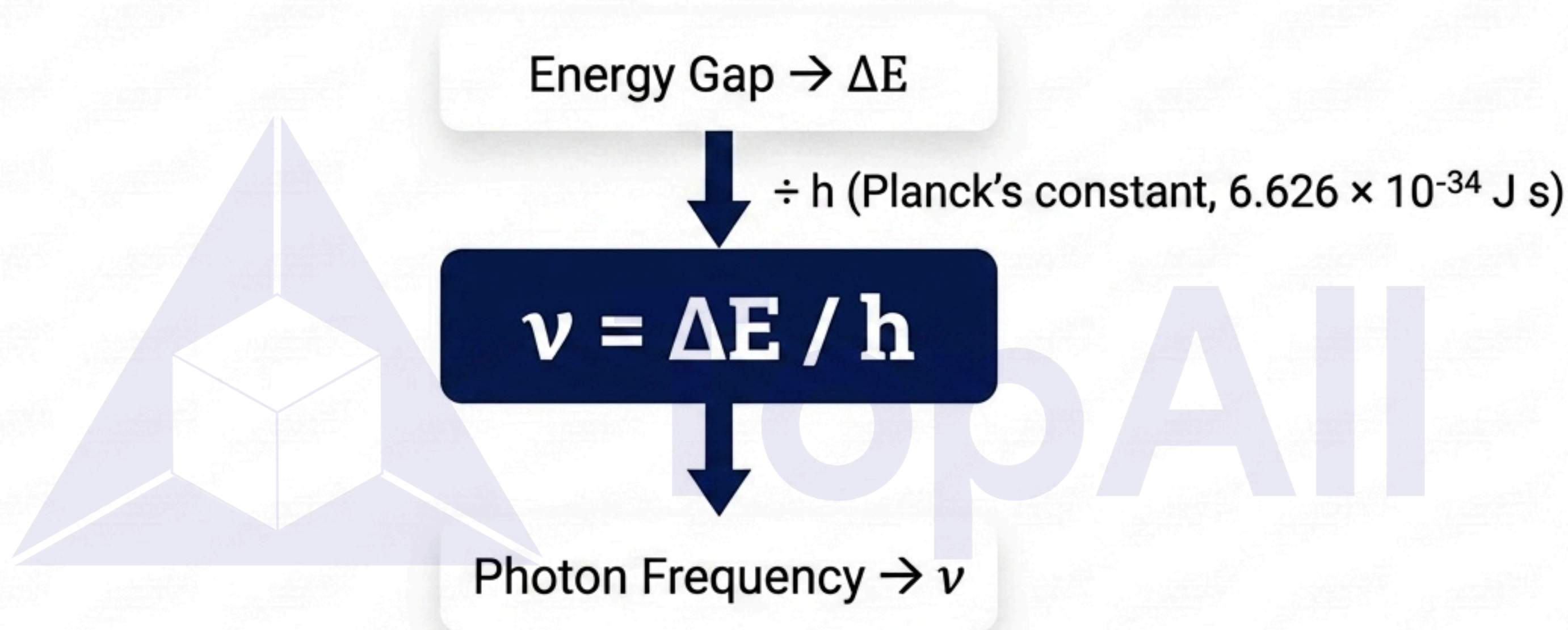
At prep.topall.app

Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



The Photon Link: Frequency



$$\nu = 3.29 \times 10^{15} \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right) \text{ Hz}$$

Combining Bohr's model with Planck's theory allows us to calculate the exact frequency of light emitted.

The Wavenumber Relation

Wavenumber ($\bar{\nu}$) is the number of wavelengths per unit length (m^{-1})—the standard unit for spectroscopy.

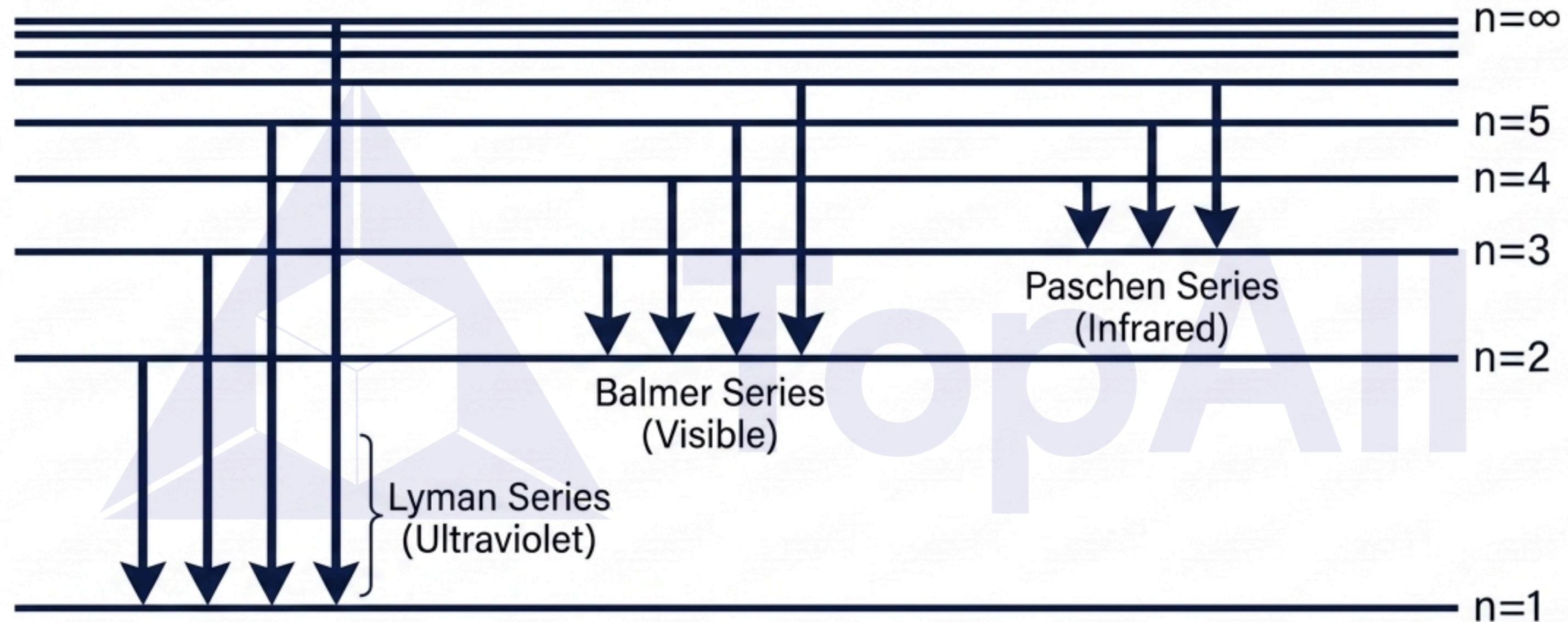
$$\bar{\nu} = 1.09677 \times 10^7 \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right) \text{m}^{-1}$$

Initial and final principal quantum numbers (must be integers)

Rydberg Constant for Hydrogen (R_H)

This single empirical equation accurately predicts the position of every spectral line in the Hydrogen atom.

Origin of the Spectral Lines



A large sample of hydrogen contains billions of atoms undergoing simultaneous, random transitions—creating a complete spectrum of distinct lines.

⚠ EXAM TRAP

The 'Negative Photon' Error



When calculating an emission transition, ΔE will be mathematically negative (since $E_f < E_i$). Students wrongly plug this negative ΔE directly into $\nu = \Delta E / h$.



A physical photon cannot have negative energy or negative frequency. The negative sign on ΔE only indicates that the atom lost energy.



Always use the magnitude (absolute value) of the atomic energy change to calculate the photon's properties.

$$E_{\text{photon}} = |\Delta E|$$

Key Takeaway

A spectral line is the exact optical signature of an electron transitioning between two quantized energy states.

- ✓ Downward jump = Emission (Produces a bright line).
- ✓ Upward jump = Absorption (Produces a dark line).
- ✓ The Rydberg math perfectly matches the physical observable spectrum.



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis