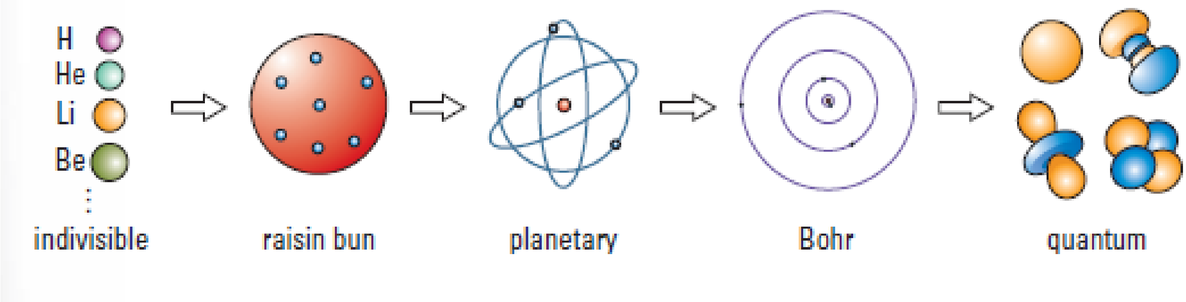
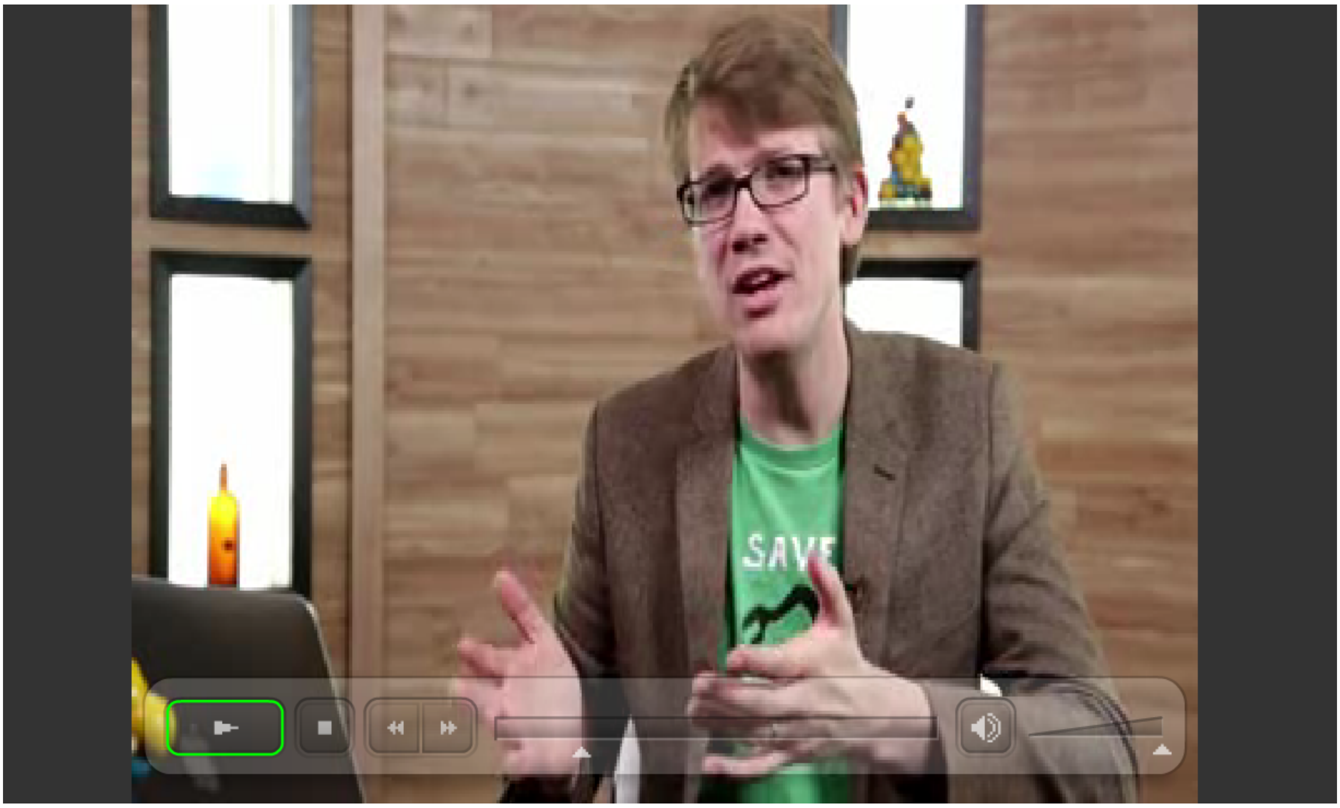
L03 - The Nucleus and Discrete Energy Levels



Crash Course - The History of Atomic Chemistry

https://www.youtube.com/watch?v=thnDxFdkzZs



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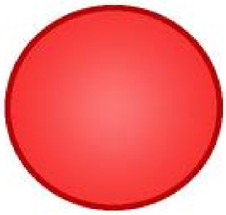
Science 10 - History of the Atomic Model

Dalton Model:

- All matter is made of small, indivisible particles called atoms.
- All atoms of an element are identical in size and mass.
- Atoms of different elements have different properties.

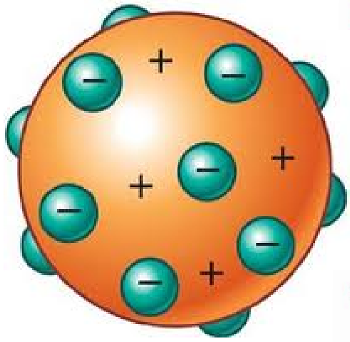


Evidence:

- J.J. Thomson discovered that all elements can produce a beam of negatively charged particles, suggesting that all atoms contained smaller particles that were identical.

J.J. Thomson Model:

- Sphere has a positive charge.
- Embedded in the sphere are negative charges (electrons).

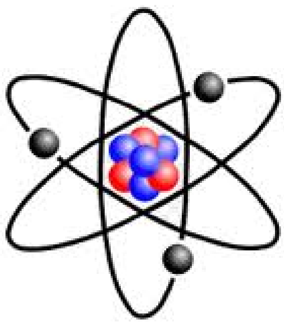


Evidence:

- Rutherford used radioactive substances and aimed the emitted particles at gold foil.
- Most passed through the foil, but 1 in 10,000 were deflected.

Rutherford Model:

- Small positively charged nucleus (1/10,000 the size on the entire atom).
- Most of the atom is empty space.
- Nucleus orbited by electrons (like a planetary model).



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- Neils Bohr discovered that hydrogen atoms made to glow in a tube emitted very distinct colors of light.

Bohr Model:

- Nucleus consists of protons and neutrons.
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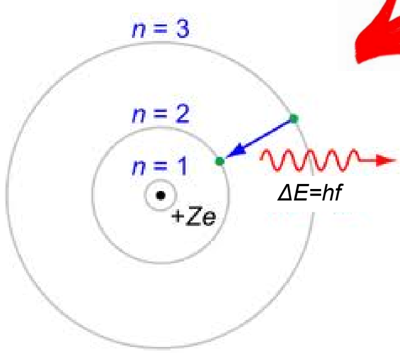
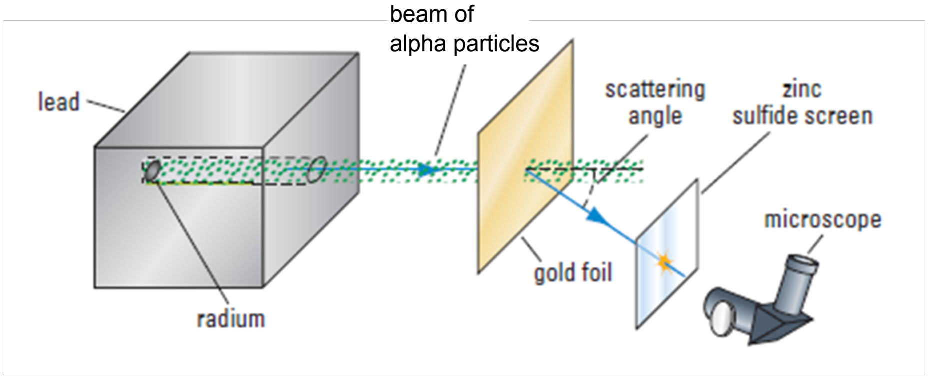


From J.J. Thomson to Rutherford

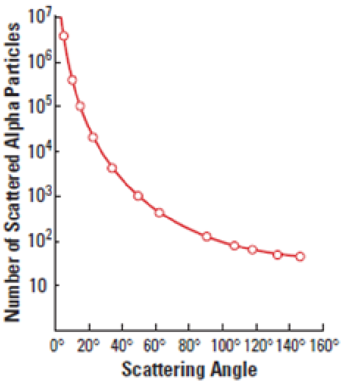
Important Idea: Rutherford's Scattering Experiment

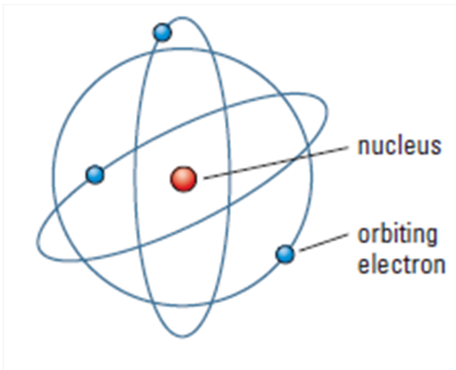
From J.J. Thomson to Rutherford

Important Idea:



J. J. Thomson *versus* Rutherford Models





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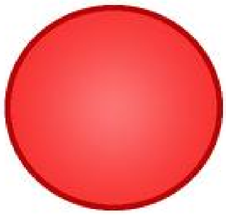

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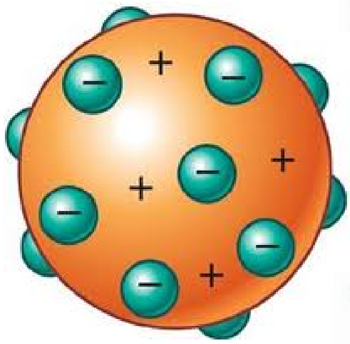

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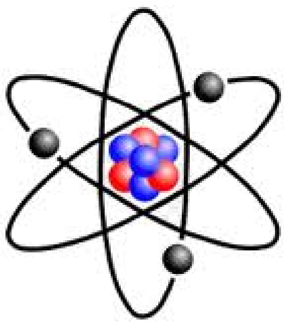

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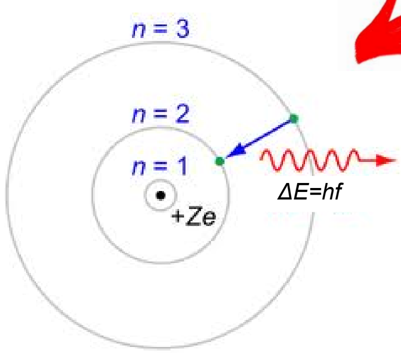
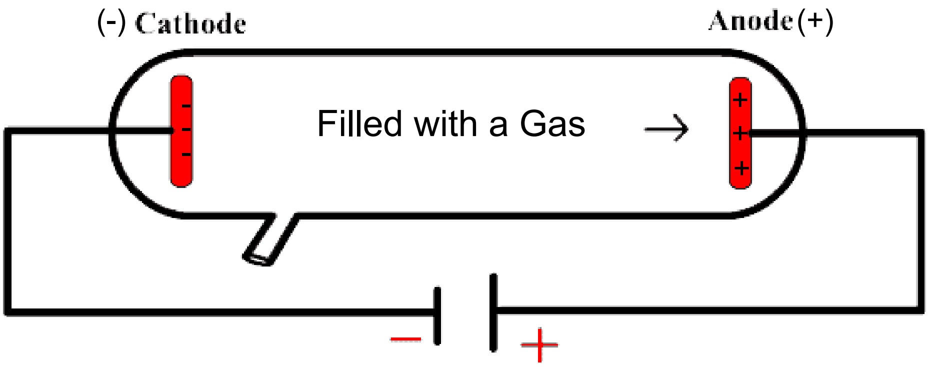
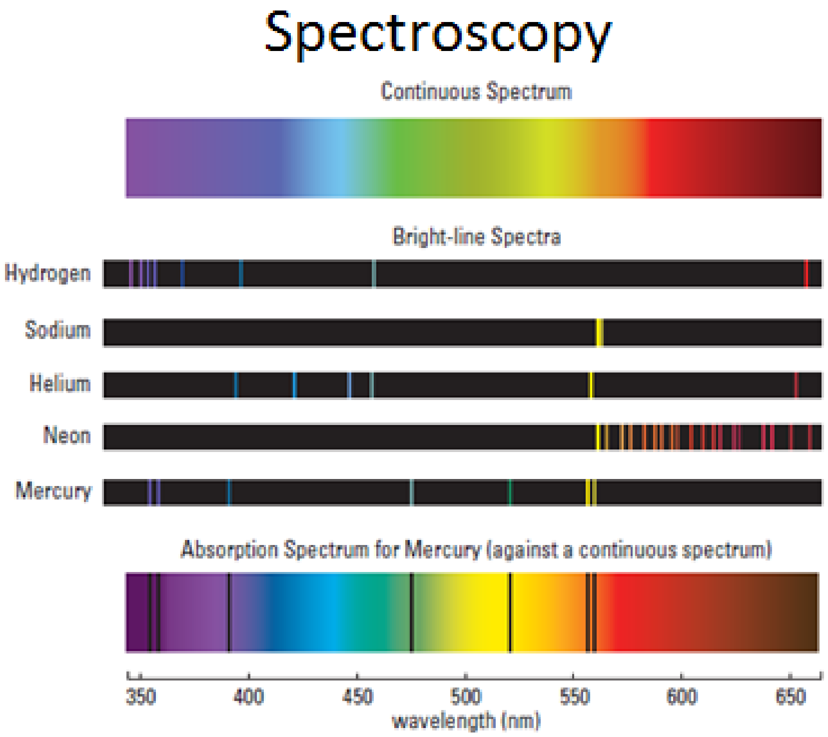


From Rutherford to Bohr

Important Idea: Emission and Absorption Line Spectrum





Emission Frequencies when the gas is excited per the diagram above.

Spectroscopy

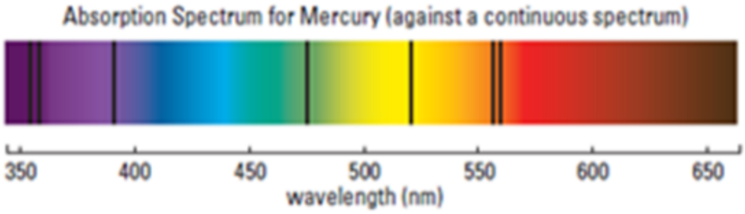
Spectroscopy - The study of the light emitted and absorbed by different materials

Continuous spectrum - Hot, dense material emits the entire rainbow

Emission line spectrum - A hot gas will emit an emission line spectrum

Emission Frequencies when the gas is excited per the diagram above.

Absorption line spectrum - A white light shone through a gas has dark lines at the same spots it would have emitted.



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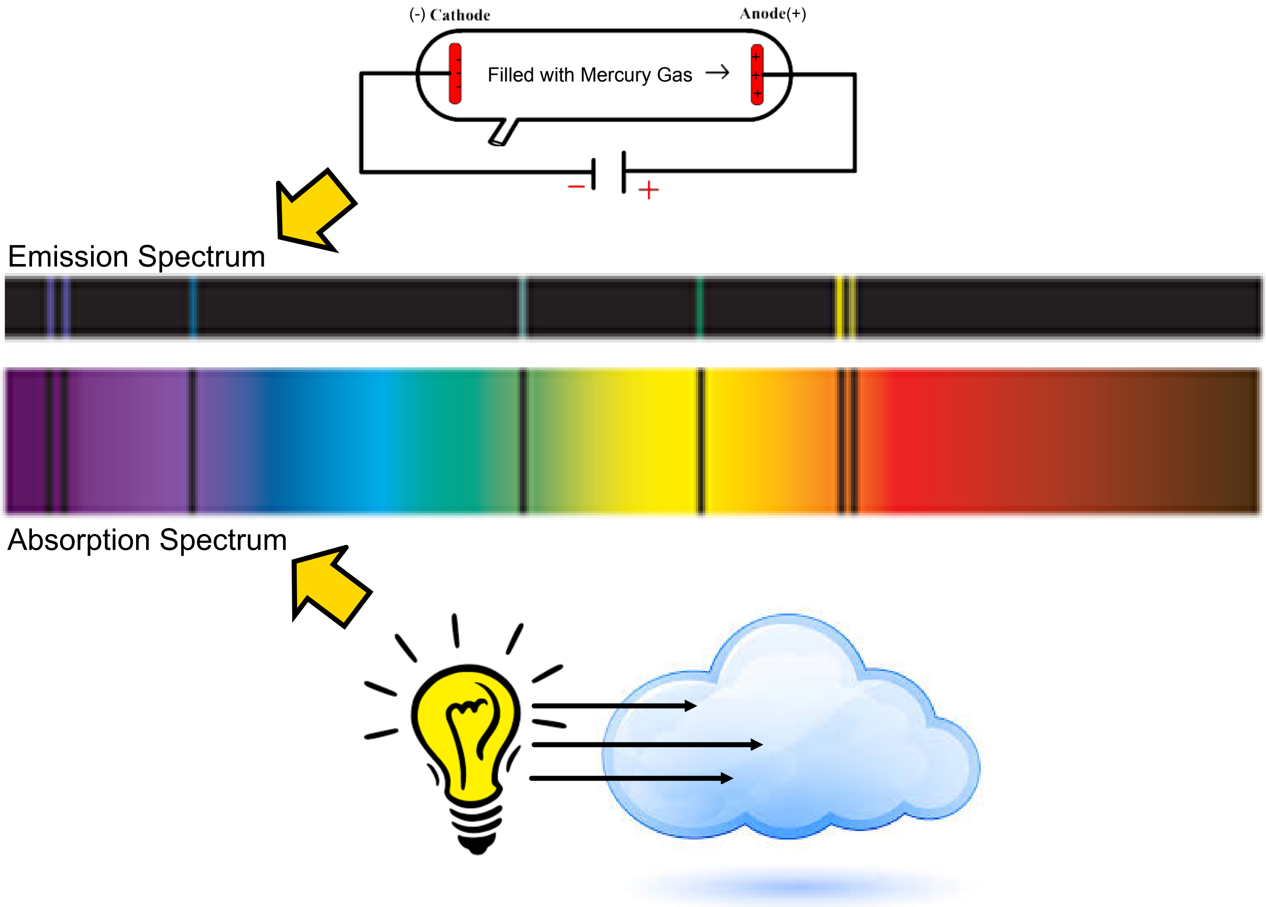
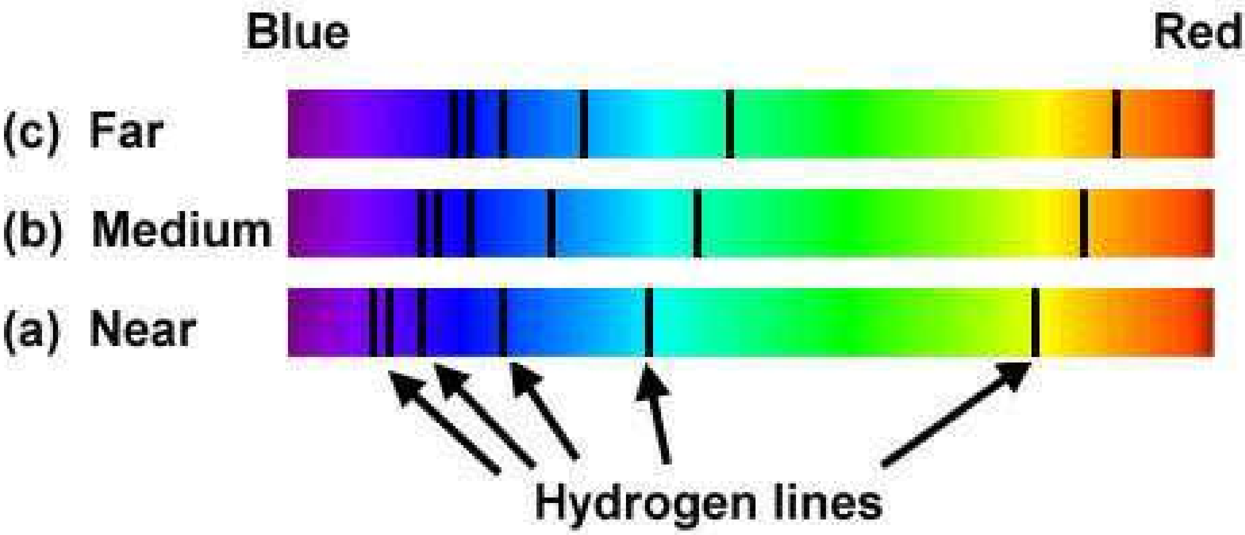
Emission and Absorption Spectrums for Mercury



Absorption Spectrum and Cosmic Red Shift



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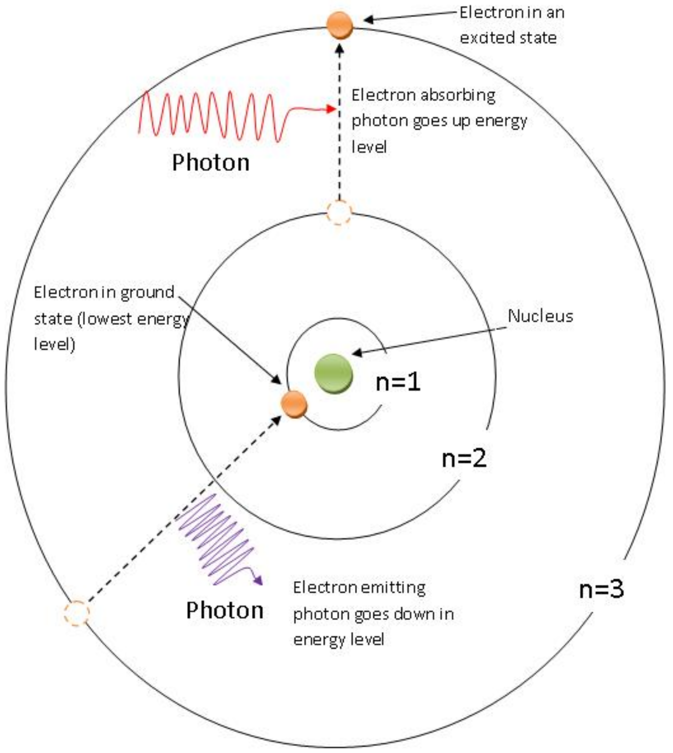
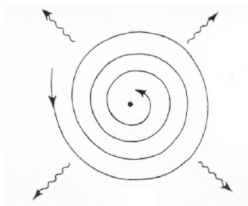
Bohr's Model



Bohr's Model:
- Electrons can only exist a certain orbits.
- When an electron jumps up an orbit it needs to absorb a photon.
- When an electron jumps down an orbit it releases a photon.
- The Energy it receives from the photon must equal the amount of energy needed to jump to the next orbit.
- The energy it emits must equal the energy it loses as it falls to the orbit.

Rutherford Model and Maxwell's Theory
- Continuous acceleration should emit continuous EMR, and thereby be continuously losing energy.



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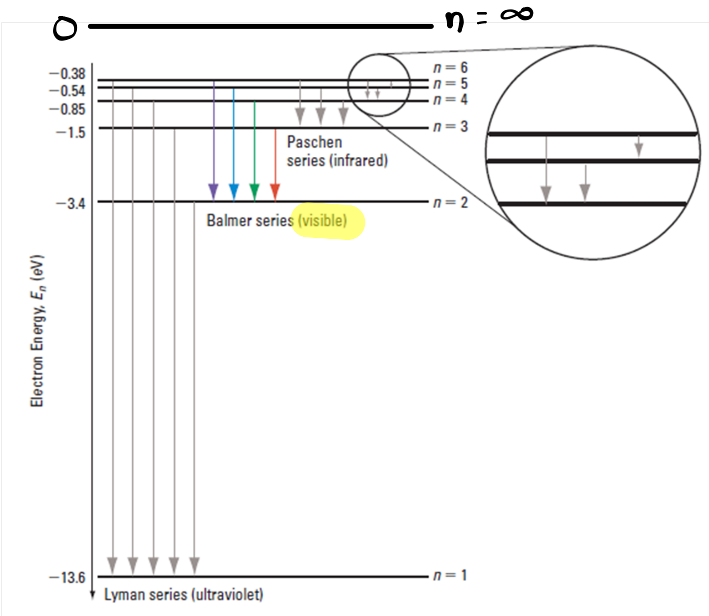
Hydrogen Atom



Q1: If an electron goes from the n=2 to the n=1 orbit, what wavelength photon does it emit?

$\Delta E = (13.6) - (3.4)$

$= 10.2\,eV$

$E = \frac{hc}{\lambda} \qquad 10.2 = \frac{(4.14\times10^{-15})(c)}{\lambda}$

$\boxed{\lambda = 1.22\times10^{-7}\,m}$

Q2: If an electron goes from the n=2 to the n=4 orbit, what wavelength photon does it absorb?

$\Delta E = (3.4) - (0.85) = 2.55\,eV$

$E = \frac{hc}{\lambda} \qquad 2.55 = \frac{(4.14\times10^{-15})(c)}{\lambda}$

$\lambda = 4.87\times10^{-7}\,m$

$\boxed{\approx 487\,nm}$

Key Words:
- Ground state - lowest energy state
- Ionized - electron is ripped off (sometimes 0 eV)
- Excited state - anything inbetween Ground State and Ionization State

Q3: During the aurora, an electron in the oxygen atoms drops from a 4.17 eV orbit to a 1.96 eV orbit. Calculate the wavelength ofthe light given off and determine the colour of the aurora.

$\Delta E = ?$

$E = \frac{hc}{\lambda}$

$2.21\,eV = \frac{(4.14\times10^{-15})(3\times10^{8})}{\lambda}$

$\lambda = 5.62\times10^{-7}\,m$

$\approx 562\,nm$

Q4: Electrons also fall from a 1.96 eV state and a 1.90 eV state to the ground state (0 eV). Calculate the wavelength and colour oflight given off in each of these cases.

$\Delta E = \frac{hc}{\lambda}$

$1.96 = \frac{(4.14\times10^{-15})(3.0\times10^{8})}{\lambda}$

$\lambda = 6.34\times10^{-7}\,m$

$1.90 = \frac{(4.14\times10^{-15})(3\times10^{8})}{\lambda}$

$\lambda = 6.54\times10^{-7}\,m$