Boğaziçi University

Introductory Phys Labs

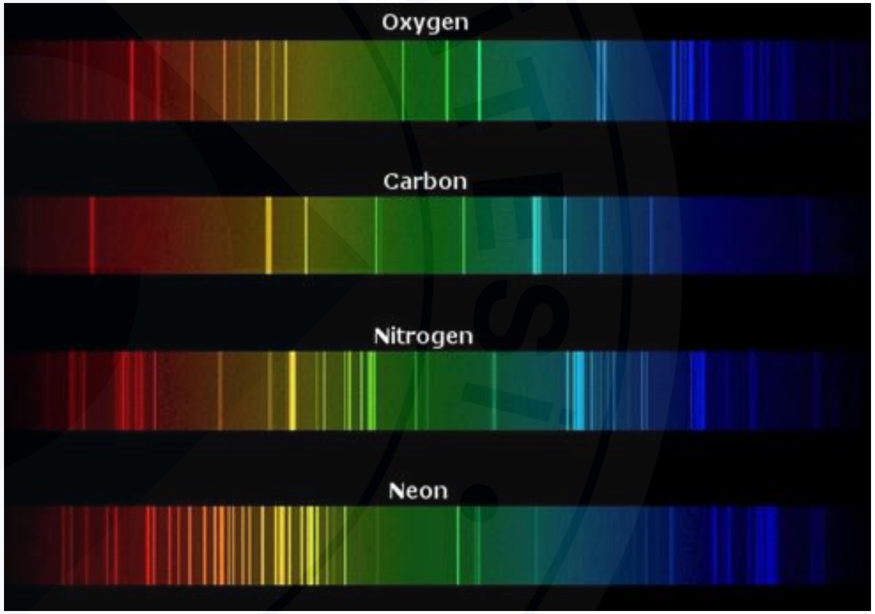
THE BALMER LINES OF HYDROGEN AND RYDBERG CONSTANT

PHYL 202

THEORY

Emission in an Atom

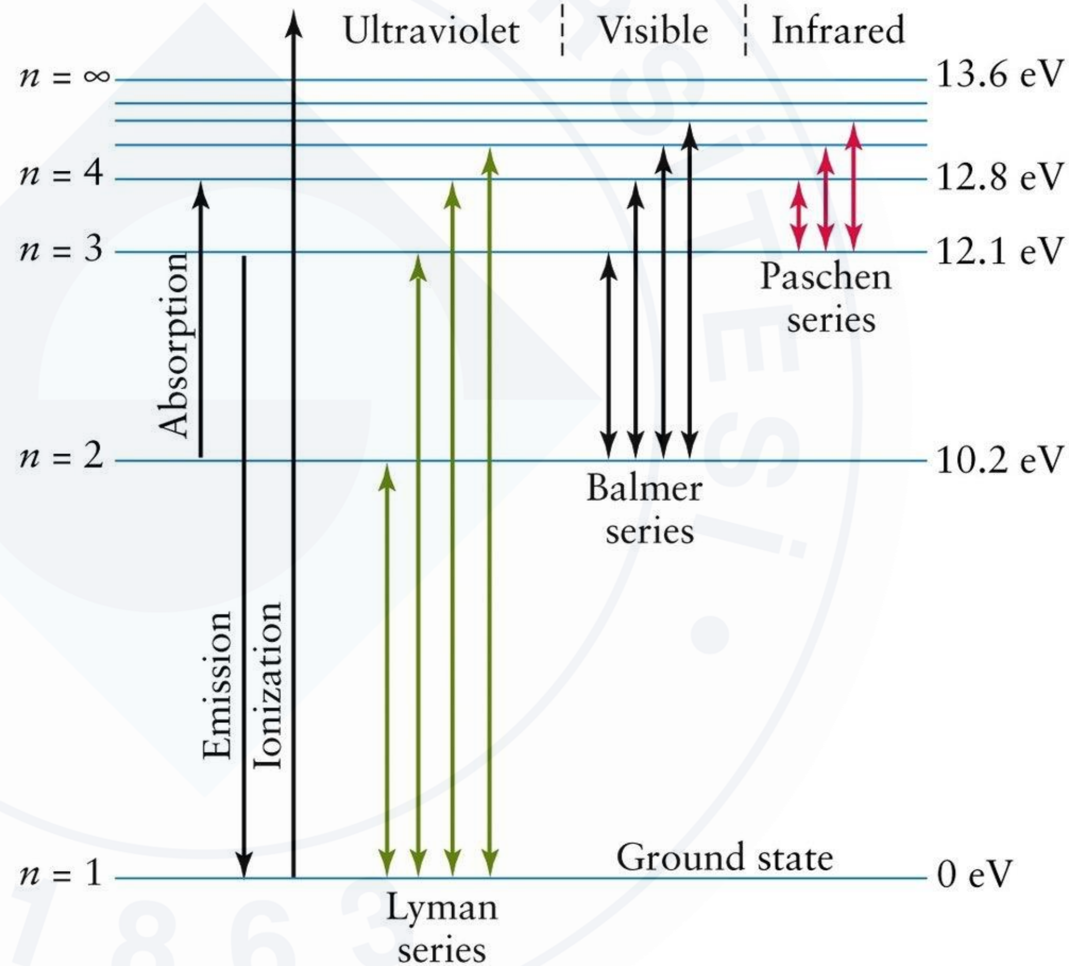
If an atom is given energy through heating or applying voltage, some of its electrons become excited to higher states. After the excitation, the atom gives its excess energy via emitting a photon. The energy of the photon equals to the energy difference of initial and final states of the electron. Since the energy levels unique, each atom has a distinct emission spectra.



Emission in Hydrogen Atom

Emission spectra of Hydrogen atom have special names depending on the final state of the electron. For n = 1, it is called Lyman series.

Balmer series, n = 2, is a special case, since the photons are in the visible range of the spectrum.



THE BALMER LINES OF HYDROGEN

Balmer Series:

Four lines from Balmer series falls to visible range in the spectrum. As seen in the figure, red, blue/green and two violet lines are the emission spectra of ni = 3, 4, 5, 6 to nf = 2.

The formula for wavelength is

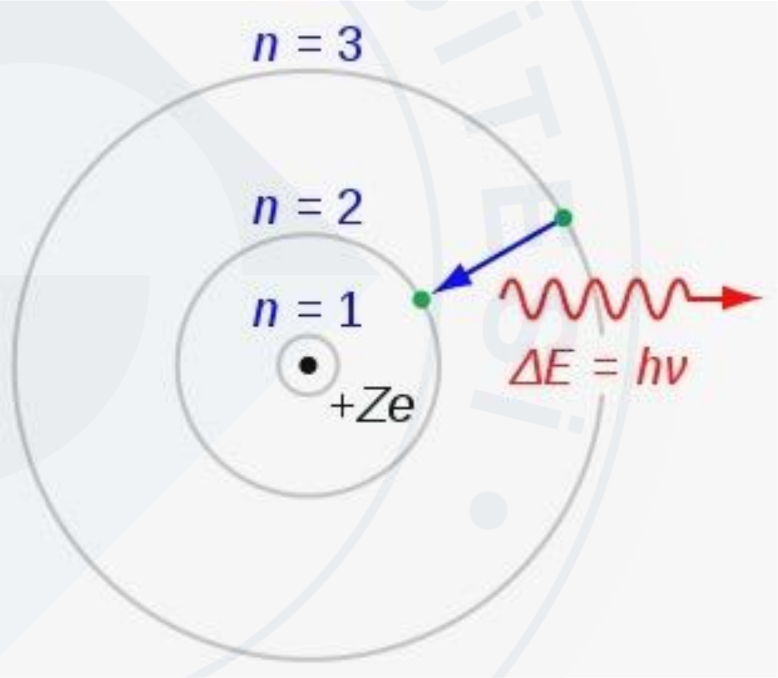
$$\frac{1}{\lambda} = R.(\frac{1}{n_f^2} - \frac{1}{n_i^2})$$

R is the Rydberg constant.

Bohr Atom Model:

The Bohr model is a relatively primitive model of the hydrogen atom, compared to the valence shell atom model.

The Rydberg formula, which was known empirically before Bohr's formula, is seen in Bohr's theory as describing the energies of transitions or quantum jumps between orbital energy levels.



Rydberg Constant

The aim of this experiment is to find Rydberg constant experimentally.

Theoretical formula for the constant is

$$R = \frac{m.e^4}{8.\epsilon_0^2.h^3.c}$$

where

- m is the mass of electron,
- e is the charge of electron,
- h is the Planck constant,
- c is the speed of light and
- ϵ is vacuum permittivity.

EXPERIMENT

Hydrogen Spectrum Lines

- Read the angles for red, green(blue) and violet light from both left and right side of the spectrometer.
- Take the average of left and right angle values for each.
- Use the angles and diffraction grating constant found at Part-1 to calculate the wavelengths for red, green(blue) and violet lights.

CALCULATIONS:

Description / Symbol		Calculation (show each step)	Result
Diffraction Grating Constant d	=	....	....
Wavelength for the Red Line λ_{red}	=	....	....
Wavelength for the Green Line λ_{green}	=	....	....
Wavelength for the Violet Line λ_{violet}	=	....	....

Write the appropriate initial and final states for red, green and violet light. Then calculate Rydberg constant using wavelengths and states. Calculate the average Rydberg constant.

For Red Spectrum Line

Initial state n_{i} = ...

Final state n_{f} = ...

Rydberg constant R_{red} = ...

Calculate the theoretical Rydberg constant from the formula

$$R = \frac{m.e^4}{8.\epsilon_0^2.h^3.c}$$

The values of m, e, h, c and ϵ can be found from Appendix A.

Then using experimental and theoretical values, calculate the percentage error of the experiment.

Finally, show the dimensional analysis of Rydberg constant.