

S369 AP Physics Emission Spectra Lab

Background:

Purified gasses held at low pressure can be excited to light emission either by intense heating or by applying a high voltage. Since the individual atoms of the gas are relatively far apart, they do not interact with each other so any observed light is the result of emissions from individual atoms. Thus, the emission spectra observed is a characteristic of that particular gas and upon analysis, will reveal details about that atom's electron structure.

For the hydrogen atom, the energy levels of the orbits are determined by the

relationship: $E_n = \frac{-13.6 \text{ eV}}{n^2}$ where n represents the orbital level (ground state = 1). The equation can be extended to other singly ionized (one electron remaining...) atoms with an approximation: $E_n = \left(Z^2\right) \frac{-13.6 \text{ eV}}{n^2}$ where Z is the number of protons in the nucleus.

According to Bohr the energy of the emitted radiation (photons) must be the same amount as the quantized energy-level transitions possible within the atom. Since the energy of a photon is related to wavelength by $E=hc/\lambda$, the following relationship can be made to determine the wavelength of light emitted for any possible energy transition:

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

Where R is Rydberg's Constant $1.097 \times 10^7 \text{ m}^{-1}$

The lab:

In this lab you will observe the visible emission spectra for some gas which is assumed to fit the model above. Using diffraction principles, accurately measure quantities that will enable you to calculate the wavelengths of the photons. You should then produce a spread-sheet that will display and/or calculate the following values:

Gas

Color	d (m/line)	X (m)	L (m)	(nm)	Photon Energy (eV)	Initial Level	Final Level	Energy Of Trans. (eV)	% Difference
Obs.	Obs.	Obs.	Obs.	Calc.	Calc.	Input	Input	Calc.	Calc.

Obs. are cells with data you record.

Calc. are cells that the spreadsheet calculates.

Input are cells that you put integer energy levels into.

Note that the % Difference is the difference between the Photon Energy and your Transition energy expressed as a percentage of the Transition Energy.