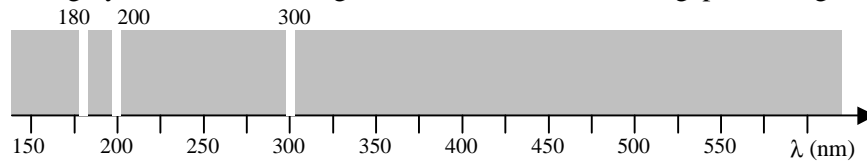


5. Consider two gases of  $N$  non-interacting atoms.

I. Consider the first gas. It is at its lowest possible temperature.

- a. A uniform light (i.e. equally intense in all frequencies) shines upon the gas. The following spectrum is observed (where grey indicates where light is measured, and white a gap in the light spectrum):

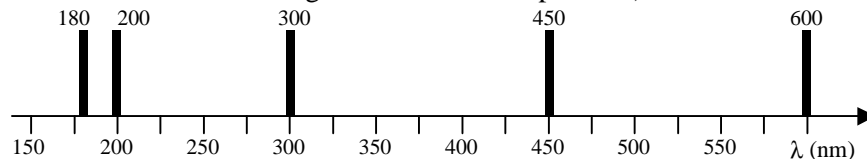


What is the highest energy line? What is it measuring the energy of? Explain.

- b. Describe the structure of the energy levels of the atom that produces such a spectrum. Explain.
- c. Suppose that the spectrum lines shown in part *a* are all the lines that exist in the range from 150 nm to 600 nm. Consider that the range of the spectrum were increased to show all lines from 0 nm to 1000 nm. Where, if anywhere, would you expect to find additional spectral lines? If none are found, state so explicitly. Explain.

II. Consider the second gas at its lowest possible temperature.

- a. When a current is run through this gas of atoms, a spectrum with the following spectral lines is observed (dark lines indicate where light is found in the spectrum):



Could you conclude that the gas shown here is the same as the one in *I.a*? Explain how you know.

- b. Consider that the spectrum region considered is expanded to reach from 0 nm to 1000 nm. Would you expect to find additional lines in the figure in part *II.a*? If so, where? If not, state so explicitly. Explain how you know.