Quiz 9: Quantum Physics I

You are studying the composition of a cloud of intergalactic gas millions of light years away. If only you knew the energy levels of the constituents of the gas, you could match them against those of elements and molecules here on Earth. Fortunately, nature has provided you with a few clues.

One region of the gas is being heated by nearby young stars and produces emission lines at 500 nm, 660 nm, and 2062 nm. Another region of the gas is much cooler (its constituents are mostly in their ground states), but is backlit by a bright star. It exhibits absorption lines at 500 nm and 660 nm.

1. Draw the gas’s emission spectrum, labeling each line with its wavelength.

2. Draw the gas’s absorption spectrum, labeling each line with its wavelength.

3. Draw the simplest energy level diagram consistent with these observations. Give each level a label ($E_1$, $E_2$, ...), and compute the energy difference between each pair of adjacent levels.
4. For each of the following, identify which energy transition (e.g. $E_4 \rightarrow E_2$) is responsible for the line:

- 500 nm emission
- 500 nm absorption
- 660 nm emission
- 660 nm absorption
- 2062 nm emission

5. (optional) If you were a TA, how would you run a physics section?