

1. [4] *Why is the  $H\alpha$  absorption line of hydrogen in the Sun relatively weak, even though the Sun is more than 90% hydrogen?*

The sun's atmosphere is not hot enough to allow that kind of absorption. In order for a hydrogen atom to absorb the red H-alpha light, the atom must already be in the first excited state. Since the Sun's atmosphere is a relatively cool at around 5800K very few hydrogen atoms are in an excited state.

2. [4] *How can the Doppler effect cause broadening of a spectral line?*

Whenever the atoms emitting the light are in motion along our line of sight, a Doppler effect will occur. If the group of emitting atoms have both motion in both directions, then some emission will be red-shifted and some blue-shifted, resulting the broadening of the emission. That type of motion can occur from the thermal motion of a gas of atoms or from a star's rotation or even turbulence in a gas of atoms. This can occur even if the source as a whole has relative motion with respect to us, like a star moving away from us. The motion of the whole star causes an overall red-shift, but the sum of the individual motions causes line broadening.

3. [12] *Spectra quest: A mini-project.*

Example data:

Source	Observation	Classification
candle flame	continuous spectra lots of red not much blue	continuous spectrum
espresso sign	emission lines on a fainter continuous background, lots of red	neon
fluorescent light	continuous with brighter emission lines	mercury (fluorescent light)
street light	continuous with brighter emission lines	sodium