1. Can you name a situation in which a non-ionized hydrogen atom CANNOT absorb a photon of visible light?

If a hydrogen atom is in the ground state, then the minimum amount of energy needed to get it up to the next level corresponds to a Lyman alpha photon, which is in the ultraviolet. Since visible light has *less* than the *minimum* amount of energy needed to excite the atom, then the atom cannot absorb a visible photon when it is in the ground state.

Another situation is when the atom is in the first excited state, but the photon does not have the same wavelength as one of the Balmer series lines. In other words, if the photon's wavelength was longer than Bβ but shorter than Bα, it would not be absorbed. However, this is *only* true if the atom is in the first excited state (see note below).

Note: if the atom is in the second excited state or higher then it will be ionized if it absorbs a visible light photon, but it *will* absorb the photon. The question asked when it CANNOT absorb a photon.

"MU" means you misunderstood the question (see note above)
"US" means unspecified situation—you said there was a situation in which it could happen, but did not specify what it was (i.e. that it must be in the ground state)
"NR" means "not reasonable". Your argument or your assumptions were not reasonable or didn't make sense
"NF" means not fully argued. You got part way there but didn't finish it off.

2. If the main sequence were level on the H-R diagram, what would be the relative sizes of O stars and M stars?

If the main sequence were level, it would mean that all stars had the same luminosity, regardless of temperature. However, by the Stefan-Boltzmann law, O stars, which are hotter, have a higher luminosity *per unit area* than M stars, which are cooler. If O stars have a higher luminosity per unit area, but the same TOTAL luminosity, then they must have less area. Therefore, O stars would be smaller than M stars if the main sequence were level.

3. Why does it hurt more to jump off a tall building than off of a low stool?

As you fall under the influence of gravity, you gain 9.8m/s (32 ft/s) of velocity for every second that you fall. Falling from a higher place (e.g. a tall building) means falling for a longer time. If you accelerate for a longer period of time, you will have a greater velocity when you finally hit the ground.

You got a bonus point (or two) if you correctly explained *why* having a higher impact velocity hurts you more. Here's why:

The faster you are going, the more force it takes to bring you to a sudden stop when you hit the ground. The greater the stopping force, the more it's going to hurt.

If you got an "FT" on your paper, it means that you seem to have the basic concept down, but you're Fuzzy on your Terminology (e.g. speed, force, velocity, acceleration).

4. Name some problems which result when you use a lens at the front of your telescope.

The major problem with using a telescope with a lens in the front (called a refracting telescope) is that light going through glass bends differently depending on the wavelength. Blue light bends more than yellow light, which bends more than red light. Thus, when the light passes through the lens, different wavelengths will focus at different points. This can be somewhat (but not completely) corrected for with an achromatic lens, but it is not possible to bring *all* of the colors into focus at the same place.

Chromatic aberration (as the above is called) was the most important problem to include in your answer. A "CA" (usually followed by a ? mark) on your paper, means that you didn't even mention it, and therefore did not get many points.

If "problems" (or the just the 's' in "problems") is underlined in the question, it means that you only talked about one type of problem. As long as it was CA, you got most of the points, but you needed at least one other problem to get full credit. These include:

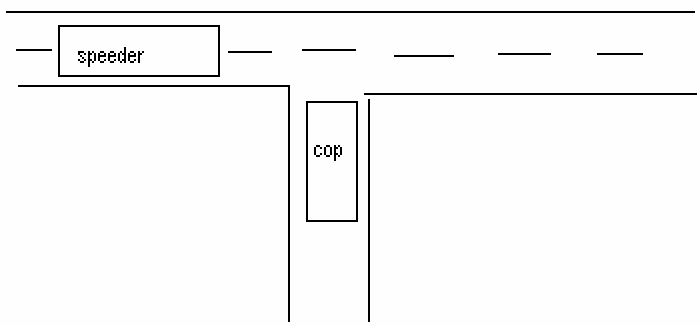
- Since light passes through the lens, it must be supported around its edges, whereas a mirror can be supported from behind.
- For a telescope to be astronomically useful, the lens would have to be so big that it would sag under its own weight.
- A lens must be made of a very pure material with no imperfections on its surface *or* inside it.
- Also, *both* sides of a lens must be ground precisely (or 4 surfaces in the case of an achromatic lens).
- For all of the above reasons, refracting telescopes are therefore exceedingly expensive.
- Also, when light enters a material such as glass, only part of it gets transmitted through the material while some of it reflects (think of looking out a window on a dark night).
- Finally, mirrors can be made in segments and are easier to repair.

5. How do you know that main-sequence O stars are denser than main-sequence M stars?

Density is defined as mass/volume. The mass of main-sequence stars is given by the Mass-Luminosity relation $L \alpha M^{3.5}$. Since O stars are the most luminous main-sequence stars, they are the most massive ones.

The sizes (and volumes) of main sequence stars are all about the same. We know this because the greater luminosity of O stars compared to M stars is consistent with their greater temperature (Stephan-Boltzman Law) and no greater area. Thus the greater mass of O stars and their same volume gives them a greater density

6. If you are a police officer using the Doppler Effect to catch speeders, should you choose to park on a side street because you would be less easy to spot?



The Doppler effect measures radial velocity. That is, the target must be moving toward or away from the police car. In the drawing above, when the car crosses the side street it is moving sideways, and no matter how fast he is traveling, the Doppler shift will be zero.

An “AQ” on either of the last two means ANSWER THE QUESTION.