ISP 205
Review Answers, Week 3

This is not required homework. It will not be graded. Answers will be supplied next week (in this case, on **Monday afternoon**, so that you can see the answers before taking the exam).

These questions are intended to help you think about the more important points from my lectures. The exams will ask you about these points, as well as about additional details. But note that the exams will be multiple choice questions.

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1. When I describe light to you as a wave:

    a. What kind of wave is it? *An Electromagnetic wave… the electric force and the magnetic force interact with each in empty space, creating a wave that can travel forever.*

    b. What does it mean when I say that the wave "moves" at the speed of light? *The strength of the electrical (and magnetic) field varies up and down in a repeating (sine-wave) fashion as you travel along the wave in space. That whole pattern then slides along through space, at the speed of light.*

    c. If lightwave #1 has a two times bigger wavelength than lightwave #2, is the frequency of lightwave #1 larger or smaller than the frequency of lightwave #2? By how many times? *Lightwave #1 has 2× smaller frequency than #2. Frequency is inversely proportional to wavelength.*

2. In the particle description of light, how would the energies of photons #1 and #2 compare? *Photon #1 would have 2× less energy than photon #2. The photon energy is directly proportional to the frequency of the lightwave, and hence inversely proportional to the wavelength.*

3. Arrange the following "types" of light into their order of increasing wavelength:
gamma-rays, x-rays ,ultra-violet, visible, infra-red,,microwaves, radio

4. Why do atoms absorb and emit light only at some wavelengths, but not at other wavelengths? *The electrons associated with the atomic nuclei can change their energy level by absorbing or emitting individual photons. But because of the way that the atom works internally, the electrons are only able to posses certain specific energies. So they can only absorb or emit photons that carry the exact amounts of energy required to move the electrons from one allowed energy level to another.*

5. How can we determine the chemical composition of a distant star or gas cloud? *Different chemical elements have different sets of allowed energy levels for their electrons. That means that each different chemical element can absorb or emit light at its own (different) set of possible wavelengths. By measuring the wavelengths of the emission or absorption*

lines created when the atoms interact with light, we can tell which chemical element is involved..

6. As a source of thermal radiation gets hotter,

    a. How does the average energy of the photons that it emits change? *Gets larger.*

    b. How does that affect the average wavelength of the photons? *Gets smaller.*

    c. Does that cause the color of the thermal emitter to appear bluer, redder, or stay the same? *Gets bluer.*

    d. How does the total amount of energy emitted per unit surface area change? *It increases very rapidly, in proportion to temperature to the fourth power (T^4).*

7. What property of a distant star can be measured just be just looking at the color of the star as it shines up in the sky? *The temperature of the surface of the star.*

8. How can light be used to measure the line-of-sight velocity of a distant star? *The Doppler effect is used… this is the "train whistle" effect. When the train is coming towards you its whistle seems to have a higher pitch, but when the train is moving away from you its whistle takes on a lower pitch. That is because the frequency at which we hear a sound depends on the motion of the object emitting the sound. The same thing happens with the frequency of light. We use absorption or emission lines from the distant star or gas cloud in place of the pure (single-frequency) tone of the train whistle.*

9. What are two key reasons for launching telescopes into space? *(1) To be able to observe at wavelengths that are absorbed by the Earth's atmosphere. (2) To avoid the smearing out of images that is caused by turbulent air bubbles in the Earth's atmosphere (where each air bubble acts like a little distorting lens that bobs all around).*

10. What are two general reasons for making telescopes larger? *(1) To collect more light in the same amount of time (meaning you can see fainter objects). (2) To form sharper images so that you can see smaller details.*