UC Berkeley
Astronomy Department

Astro C10 – QUIZ #1

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Name: _____

Discussion Section: _____

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This quiz contains 4 questions and will be graded out of 50 points. The questions include material from the first three homeworks of the course, with an emphasis on content we have discussed in section. I suggest that you start by looking over all the questions to see which questions you feel most comfortable answering first, then circling back to the challenging questions at the end. **To receive full credit, you must show your work, include units, and circle your final answers.** Good luck!

Distribution of Points

Question	Points	Score
1	16	
2	24	
3	9	
4	1	
Total:	50	

Useful Constants and Equations

Constants

The Speed of Light $= c$

Wavelength $= \lambda$

Frequency $= f$

Energy $= E$

Temperature $= T$

Luminosity $= L$

$h \approx 6 \times 10^{-34}$ J s

$1\text{m} = 10^9$ nm $= 10^{-3}$ km

$\sigma \approx 6 \times 10^{-8}$ watt/m^{2}K^4

$c = 3 \times 10^8$ m/s $= 3 \times 10^5$ km/s

Equations

[Wavelength vs Frequency] $c = \lambda f$

[Energy vs Frequency] $E = hf = \dfrac{hc}{\lambda}$

[Color vs Temperature] $\lambda_{peak} \cdot T \approx 3.0 \times 10^6$ nm K

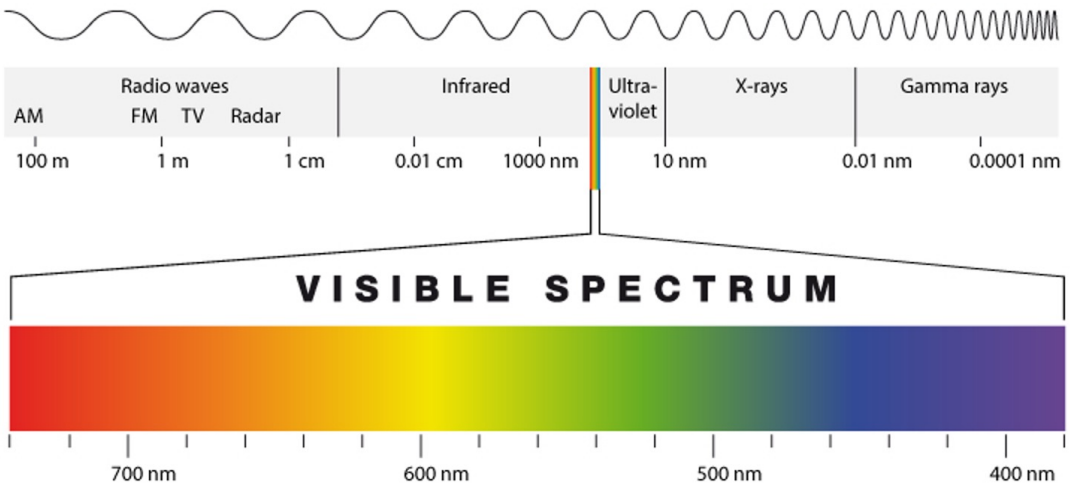
[Luminosity vs Temperature] $L = A\sigma T^4$

[Doppler Shift] $\dfrac{v}{c} = \dfrac{\Delta\lambda}{\lambda_0} = \dfrac{\lambda - \lambda_0}{\lambda_0}$

[Telescope Power] Power $= \dfrac{D_1^2}{D_2^2}$

[Resolution] Resolution $\simeq \dfrac{\lambda}{D}$

Electromagnetic Spectrum



1. **Explorer Lyra and her crew are traveling through the Andromeda sector aboard the science vessel Aurora. They're on the hunt for a rare fuel source: tritium, a heavier isotope of hydrogen that powers their fusion drives. The crew uses spectrographs to scan nebulae for tritium's signature emission lines, which are known to occur at wavelengths of 500 nm and 600 nm. Spotting these characteristic lines tells them whether a cloud of gas is rich in tritium and worth harvesting.**

   (a) (4 points) Which emission line comes from more energetic photon? Which one has a higher frequency? No need for calculation, just explain in words why that is the case through mathematical relationships (like proportional or inversely proportional etc.).

   (b) (8 points) The science vessel Aurora is scanning a gas cloud for tritium, whose known emission lines are at **500 nm** and **600 nm (at rest)**. The ship is moving toward the cloud at a velocity **1/100th of the speed of light**. The spectrograph detects two emission lines at **550 nm and 660 nm (while moving)**. Is the cloud the correct cloud to collect tritium?

   (c) (2 points) If we are now moving **toward** from the cloud in search of more coffee, what will happen to these lines? Why is this? No need for math, just explain in words.

   (d) (2 points) If Aurora is moving at velocity v, how fast is the light that formed from the emission lines moving as they reach the starship Voyager?

2. **You've booked a vacation trip to the exoplanet Kepler-16b, which orbits a striking pair of suns. The two stars are named Aurelia and Borealis. While both stars emit the same total luminosity, Borealis has a radius four times smaller than Aurelia.**

   (a) (4 points) (4) Which star is hotter, Aurelia or Borealis? Without doing the calculations, why is that?

   (b) (8 points) By what factor is one star hotter than the other? Make sure to show your work.

   (c) (8 points) If the thermal radiation of Borealis peaks at a wavelength of 400 nm, at what wavelength does the thermal radiation of Aurelia peak? Which star would then appear redder, and which would appear bluer?

   (d) (4 points) Draw a rough estimate of the spectra of these two stars below using your previous answers. Assume Aurelia has a brightness of 4 units at the peak. Make sure to label the x-axis position of your peaks, as well as which star is which!

3. **You bring a friend to a groundbased observatory that houses three telescopes, each tuned to a different part of the spectrum: one designed for X-rays, one for radio waves, and one for visible light.**

   (a) (2 points) While peering through the optical telescope, your friend notices a star positioned near Saturn in the eyepiece. They observe that the star appears to twinkle, whereas Saturn does not, and ask you to explain the reason.

   (b) (6 points) Assume that all three telescopes have the same angular resolution. Rank the telescopes in increasing order of how big they would have to be, and explain your reasoning.

   (c) (1 point) What is unrealistic about this scenario in this question?

4. **Bring your own question!**

   (a) (1 point) Bring your own question! Sometimes the question you studied for didn't make it to the exam, write down an exam question you studied and write your answer. (Remember to answer your own question correctly of course!)