Review sheet, Quiz 1, ASTR 503, Spring 2018

Quiz rules:

1. You may use one "cheat sheet", **handwritten, not photocopied or computer-generated**, front and back OK. Attach or fax in a copy when you turn in your test. No other books or notes.
2. You may use a scientific calculator (logs and antilogs (10 to the x); sines and cosines, square roots). No constants or formulas in the memory!
3. Sign the pledge – no cooperative work during the quiz, obviously.

Constants you should memorize:
Speed of light (3 E5 km/s); 1 AU = 1.5 E8 km ; 1.6 km ≅ 1 mile; 1 radian ≅ 57.3 deg
Calculate or memorize the distance for 1 AU, 1 LY, 1 Pc
Constants you should have on your cheat sheet:
Charge of one electron: 1.6 E-19 J; h = 6.62 E-34 (J-s); σ = 5.67 E-8 W/(m^2-K^4)

QUIZ 1 COVERS TOPICS AND TERMS: #1-14; 24-28; plus Angles and math 1-14; 31-44

Be able to calculate:
1. Total luminosity of the Sun given the light energy flux at Earth (≅1.4 kW/m^2).
   L = (1.4) (4 pi) AU^2 (W) (be sure to make units come out correctly!)
2. The ratio of brightnesses of two stars, given each one's apparent magnitude
   (2.5) log (b1 / b2) = m2 – m1 (Note: the brighter star has **smaller** magnitude)
   (Note, you can determine the ratios of LUMINOSITIES of stars by using the absolute magnitudes M instead of apparent magnitudes m)
3. This distance of a star (or galaxy!) given its apparent magnitude m and absolute magnitude M
   distance modulus μ = m – M = 5 (log (D /10 pc) = 5 log (D/1 pc) - 5
4. The distance to an object D given its parallax α and baseline d, or vice versa.
   Tan (α) = d / D. For small angles, tan (α) ~ sin (α) ~ α , if α is measured in RADIANS. (note: this is the same formula for the angular size of an object (α) if its actual size is d and distance D.) **Remember, the definition of parsec is that 1 AU / 1 Pc = angle of 1 arc sec.**
5. The wavelength of light (or sound!) given its frequency or vice versa
   λ = c / f f = frequency λ = wavelength (m / oscillation)
   1 Hz = 1 osc/sec and c is the speed of light or sound, as appropriate.
6. The line-of-sight speed from the Doppler shift and vice versa. (non-relativistic)
   -$\Delta\lambda$ / λ = Δf/f = v/c where c is the speed of sound or the speed of light, depending on whether you are talking about a sound wave or a light wave, and the denominator is the ORIGINAL wavelength or frequency. Higher frequency and lower wavelength if approaching. (this formula is not valid if the speed gets near the speed of sound or light, respectively… need to use the relativistic version then:
   z = $\Delta\lambda$ / λo = -1 + SQRT ((1 + v/c)/(1 - v/c)). This formula reduces to z = v/c for small v's**.**)
7. The amount of energy (per sec) emitted by a black body per square meter of its surface is $J = \sigma T^4$, where σ is the Stephan-Boltzmann constant = 5.67 E-8 W/(m^2-K^4) and T is the temperature in Kelvins (0K = absolute zero = -273C)
8. The expansion velocity of a distant galaxy given its distance D, or vice versa.
   V (km/s) = H D Where H, Hubble constant, is approximately **71** km/s / MPc
   (note - this value keeps getting refined, most recently estimated from the IMAP mission at 68 km/s / MPc) Use either 71 or 68 in calculations.)

9. The energy of a photon, given its frequency
   $E = h\,f = (h\,\omega)/2\pi$ where h = Planck's constant = 6.62 E-34 (J-s)
   (ω is the frequency in radians per second).

Be able to explain:

1. The difference between a continuous spectrum and an emission line spectrum. Which one is associated with a black body? Which with a thin gas? What is the name of the spectrum you observe when the light from a black body passes through a thin gas? Which kind of spectrum tells you the temperature? Which the composition? Which most accurately gives the line-of-sight speed?
2. Calculate the distance given the distance modulus, and vice versa.
3. Why if the galaxy has been expanding at the same rate since the Big Bang, then 1/H gives the age of the Universe, but if it is slowing down, then 1/H is longer than the age of the Universe, and if it's speeding up, then 1/H is shorter than the age of the Universe.
4. Why the farthest things we can see can be no farther than about c/H .
5. How knowing the rotation speed of a galaxy as a function of distance gives us the total mass inside, and that for most galaxies, the mass you get that way is nearly a factor of ten larger than you would estimate by counting stars: dark matter.
6. How you calculate the distance of distant galaxies.
   (parallax is the only accurate measurement, and it only works to a thousand pc or so). After that you use brighter and brighter "standard candles" and use how bright they appear to calculate how far away they must be. Each brighter and brighter "standard candle" requires more assumptions (Cepheid variables have brightness related to their frequency; all type 1 supernovae are about the same luminosity; the brightest galaxy in a group is a standard brightness, etc). This makes the calculations of very distant objects VERY difficult to do, since the errors accumulate and we have to assume that the galaxies shortly after the Big Bang were similar in brightness to galaxies now, which may not be a great assumption, but it's the best we can do. That's why H is uncertain.
7. That if the universe had a higher density, it would slow down, and fall back in on itself. The best estimates are that in fact the density is NOT that high, and in fact the universe appears to be even accelerating its expansion now. This is "dark energy" (different from dark matter) that gives a pressure that seems to increase as the volume of the Universe expands.
8. The difference between ecliptic and zodiac
9. Which celestial coordinate is most like a longitude? Which like a latitude? What is the definition of zero declination? Zero Right Ascension?
   Why both Right Ascension and declination of a star change VERY slowly as the earth's spin axis precesses (26,000 years). Why the North Star won't be at the North Celestial Pole 3000 years from now. Why this is "the Dawning of the Age of Aquarius".
10. Estimate the Sidereal Time for noon, dusk, dawn or midnight for any month of the year.
11. Why the sidereal day is 4 minutes shorter than the solar day. Which one is the Earth's true spin period?
12. Know the definitions of Altitude and Azimuth.
13. That the star directly over your head right now has a declination equal to your **latitude** and has a Right Ascension equal to the current **sidereal time**.
14. What is the difference between luminosity and brightness? Which is related to the apparent magnitude? Which is related to the Absolute magnitude?