Sample Exam type questions
to be addressed in Discussion Sections

Equations that may or may not be useful:

$$F = ma; E = mc^2; T = T_o(1 + z); D = v/H_0; F = L/(4\pi D^2)$$

1. In terms of this thing we called the equation of state (P/ρ) what is the difference between the general Dark Energy version and Einstein's original version: (a) $P/\rho < mc^2$, $P/\rho = mc^2$; (b) $P/\rho > mc^2$, $P/\rho = mc^2$, (c) $P/\rho < 0$, $P/\rho = -1$; (d) $P/\rho > 0$, $P/\rho = 1$

2. What is a White Dwarf Star?

3. To make a SN Ia (called type Ia), we first need what: a _____ in a _____ system

4. The concept that makes all SNe Ia have the a maximum brightness that can be calibrated the (multiple choice) (a) the Hubble limit; (b) the speed limit of light; (c) the Chandrasekhar limit; (d) the Abusamium limit.

5. The above corresponds to the maximum _____ a White _____ can have before it explodes and this equals: (a) 10.4 $M_\odot$; (b) 3.4 $M_\odot$; (c) 1.4 $M_\odot$; (d) 0.14 $M_\odot$.

6. Given a fixed [suppose we measure it accurately] age of the Universe, how would we expect the expansion rate (which we then go measure afterward) to depend on the current value of the total mass density (Ω_{m0}) of the universe?

7. Conversely, given a fixed [we now measure this very accurately, but leave the age flexible] expansion rate of the Universe, how would we expect the scale factor of the Universe to vary with Ω_{m0}? i.e. would the scale factor be larger or smaller for a smaller Ω_{m0}? Explain by drawing the relationship between the scale factor R(t) of the Universe and time.

8. Relate the above two questions to the expected apparent brightness versus distance for SNe Ia and explain why it seems we need Dark Energy.

9. What does time dilation have to do with our observations of SNe Ia and why do the results give us confidence in our model of the expanding universe and that all SNe Ia are the same regardless of distance?

10. What is the difference between the models of Type I and Type II SNe?

11. Extra Credit: In the movie *Contact*, Dr. Arrowyay's (Jody Foster's) boy friend was worried she would return from her trip to Vega and find that he and everyone else on Earth had aged much more than she did. Why?