November 21, 2006 Name:________________________

Astronomy 102: Review Examination 4

This review exam has five questions, but the real test will only have four questions.

I recommend you use this review exam as a "sample test"; set yourself down somewhere quiet, and try to take it yourself without using any references, and giving yourself only 50 minutes. After that, talk with friends about the test, and ask questions to the course staff about the test.

There are also a set of review problems available, that you should use to help yourself get comfortable with the material. Talk about those with friends.

(Equations and constants potentially useful for the test are on a separate sheet.)

---

1. We can measure the current expansion rate of the Universe by looking at relatively nearby galaxies. If we find a Type Ia supernova (whose peak luminosity we know), we can measure the peak brightness and the redshift.

For a supernova observed at a given redshift, would a dimmer peak brightness indicate a *faster* or *slower* current expansion rate? Explain; use a diagram or picture if it helps you explain. You will not receive any credit on this problem without at least a partially correct explanation.

(**Hint:** we're talking about relatively nearby galaxies and the *current* expansion rate. This question has nothing to do with the deceleration or acceleration of the Universe's expansion.)

2. **(a)** If the expansion rate of the Universe were to stay the same as it is right now, what would people measure the Hubble Time to be five billion years from now?

(b) Given what the expansion rate of the Universe is really doing, will people five billion years from now measure a Hubble Time that is less than, greater than, or equal to your answer from (a)?

3. You find a cluster of galaxies. One of the galaxies in that cluster has the Hydrogen Alpha emission line (rest wavelength 6562.8 Å) observed at 6694.0 Å.

(a) What is the redshift of this galaxy cluster?

(b) What is the distance to this cluster of galaxies in Mpc?

(c) How long ago was the light emitted that we are now observing from this cluster?

(d) A Cepheid Variable star in the galaxy is 1,200 times as luminous as the Sun. How bright would this star be in comparison to Vega?

(e) If a good telescope can detect stars observed to be 10^{11} times dimmer than Vega, would you be able to detect this star?

. . . continued on next page. . .

4. The Cosmological Principle states that “we are nowhere special.”

(a) What does this mean in terms of talking about the Universe as a whole? What are (at least) two pieces of evidence that the Cosmological Principle is a good assumption to make?

(b) If you pick a random spot in the Solar System, that random spot is (by a long margin) most likely to be some piece of empty interplanetary space. Yet, live evolved in a very unique, life-hospitable place: the surface of the Earth. Does this represent a contradiction of the Cosmological Principle? If so, explain. If not, how can you reconcile the contradiction?

5. Our Universe is made up of 70% Dark Energy, 25% Dark Matter, and 5% normal matter.

Suppose that instead our Universe were made up of 5% normal matter and 95% Dark Matter, and that there were *no* Dark Energy.

(a) What would we measure for the change in the rate of expansion (i.e. would it be staying the same, speeding up, or slowing down) in this hypothetical Universe? How does this compare to what we really observe in our real Universe?

(b) Assume that even though there’s a lot more of it, the Dark Matter in this hypothetical Universe is in all the same places as the Dark Matter in our own Universe. How would the rotation curves of spiral galaxies (i.e. a plot of the orbital speed of a star versus its distance from the center) compare to what is observed in our own real Universe?

(c) Continuing our assumption from (b), how would the rotation curve of the Solar System (i.e. a plot of the orbital speed of a planet versus its distance from the Sun) compare to what is observed in our own real Solar System?

. . . this is the last page.