Examination #3 - Review Questions:

What causes stars during formation (the pre-main sequence stage) to heat up enough for nuclear reactions to begin? Why do the nuclear processes require high temperatures anyway?

About what fraction of a star's mass of hydrogen gets converted to helium or heavier elements during its lifetime? Why is only this "core fraction" involved? What fraction of that hydrogen is converted to energy?

Stars are believed to form by the contraction of interstellar dust and gas clouds. What observational evidence supports this belief? (Where would you look for newborn stars - or those in the process?)

In what respects are the nuclear process powering upper and lower main sequence stars different? In what respects are they the same? From which of these two process does the Sun derive its energy? Why?

What effect does interstellar dust have upon a star's spectrum, color, and the determination of its distance? How can we tell if a star is suffering such effects? How does this affect our view of the Milky Way galaxy? (Remember Herschel's star-counting?)

How do we know that there is interstellar gas as well as dust? What is its effect on starlight? Can we observe the cold neutral hydrogen component? How?

Why would we expect white dwarf stars to be much more common than either neutron stars or black holes among stellar corpses? Why do we see so few of any of these?

Draw a Hertzsprung-Russell diagram and label its axes. Indicate where you would find (a) stars converting hydrogen to helium, (b) stars which have yet to begin hydrogen "burning", (c) stars which have recently exhausted their core hydrogen, (d) stars which have exhausted all nuclear energy sources, (e) the Sun.

What is believed to be the process which leads to the explosion of ordinary novae and some types of supernovae? What (different process) causes supernova explosions in massive single stars? How do you get supernovae from white dwarfs? (A hint is contained in the questions.)

What processes give rise to the so-called planetary nebulae? What do they look like, and what makes them glow? What kinds of stars are involved in this process? (Also, what does a supernova remnant look like?)

What principally determines whether a star winds up as a white dwarf, neutron star, or black hole? Why?

How does a star's mass affect its evolution and its location in the Hertzsprung-Russell diagram? What do observations tell us about the mass range for stars and the relative numbers of stars of various masses?

Explain how one determines the age of a star cluster from its Hertzsprung-Russell diagram. What other factors might indicate age differences? How do typical galactic and globular clusters differ in this respect? In what other respects (e.g., location) do they differ?

Make a sketch of our Galaxy providing face-on and edge-on views and some indication of size. What kind of a galaxy is it? Label major features and indicate where you would most likely to find (a) the Sun, (b) a globular cluster, (c) interstellar gas, (d) interstellar dust, (e) a main-sequence O-star and (f) the oldest stars.

How do the major components of our galaxy differ in regard to their locations? their motions? their ages? their chemical (elemental) compositions?

How do we use the rotation of the galaxy to map out the distribution of neutral hydrogen? Upon what optical phenomenon does this technique depend? (How do we tell <u>where</u> the emission is coming from?)

Radio astronomy has provided a particularly powerful tool for understanding the internal structure of our own galaxy, particularly the disk. Why is this? (See previous question!)

Explain how one determines the distance to a globular cluster. Then explain how these distances are used to locate the galactic center and determine our distance from it. About what is that distance?

The distances of the “spiral nebulae” were once controversial. What evidence suggested that they were other galaxies or “island universes” like the Milky Way? What suggested otherwise? What observations showed conclusively that they were extragalactic objects? (The last is the most important part.)

How does one determine the mass of a galaxy? (There are several possible ways). How do these determinations give rise to the belief that some galaxies (including our own) contain “dark” matter?

Much of the matter in our galaxy does seem to be “dark.” Evidence for dark matter is also found in clusters of galaxies. What is the evidence in for its presence in clusters? In what forms might this dark matter occur?

Describe as many methods as you can think of for determining distances to other galaxies. What assumptions and observations are needed to apply them? What are the limitations of these methods?

According to the Hubble classification, what are the basic types of galaxies? How do these types differ in appearance and the motions and properties of the stars, gas, and dust of which they are composed?

Among peculiar galaxies, the quasars are apparently the most energetic. On what basis do we believe that these are the most luminous of objects? What process is believed to account for their energy output?

Hubble discovered a relationship between observed radial velocity and distance for other galaxies. Describe this relation and how he obtained it. What is the significance of the “Hubble Law” insofar as the history of our universe is concerned?

That all galaxies seem to be moving away from us does NOT mean that we are in any sort of a “special” place or are particularly repulsive. The particular form of the Hubble expansion law indicates that no place in the universe is particularly “special”. Explain. (Hint: What does “linear” mean?)

Cosmologists are very interested in determining the present-day density of matter in the universe. (Hence the great concern over “dark matter”). Why do they care? More politely, what does the density of matter have to do with the history and future of the universe?

How can one use observations of distant galaxies to determine how much the Hubble expansion has been slowing down. Why do we expect it to be slowing down anyway? Is it? (See next question.)

The “cosmological constant” represents a pressure-like term which can cause accelerating expansion. Recent observations suggest that such an effect might actually be present. What observations?

What characteristics of <u>clusters</u> of galaxies provide some means of determining their distances? their masses? What assumptions about cluster galaxies are necessary for these determinations?

The “Big Bang” theory makes certain rather specific predictions about what we should see when we examine our universe. What are some of these predictions, and what is the status of their observational verification?

The only elements produced in significant amounts by the cosmological “Big Bang” are hydrogen, helium, and a bit of lithium. Why? If so, where did the heavier elements come from? What about the very heaviest elements, those whose atoms are more massive than iron?

What is the origin of the 3°K cosmic background radiation? Why is it so “cold”? At what wavelengths is it brightest?

What, approximately, is believed to be the current age of our universe? How does this compare to the age of the oldest stars in our Galaxy? The Earth? The span of human history? Give rough numbers for each.