AST 301
Test #3
Friday Dec. 5 Name:_____

1.a) Give me a description of a white dwarf.
A star about the size of the Earth, but the mass of the Sun. Fusion has stopped and it is cooling off. It is supported by electron degeneracy (or quantum) pressure.
b) Describe how white dwarfs form.
A red giant expels its envelope leaving the core, which is then a white dwarf.
1.a) Describe (or draw a picture of) a massive star just before a supernova explosion occurs.
The star has an iron core surrounded by shells of lighter elements.
b) What happens in that massive star that causes the supernova?
When iron fuses to make heavier elements, energy isn't released. Instead energy is absorbed, causing the core to lose pressure and collapse and form a neutron star. Then the star's envelope falls onto the core and bounces, and is thrown out into space violently.

2. Describe what makes the light we see from pulsars pulse. That is, say why they alternately get brighter and fainter.
Pulsars are like lighthouses. They shine light out of their magnetic poles and when they rotate, the light beam flash past us.
2. Describe what makes the light we see from Cepheid variable stars vary. That is, say why they alternately get brighter and fainter.
Unlike pulsars, Cepheid variables actually pulse, in that they alternately grow and shrink.

3.a) I have found two Cepheid variable stars with the same period, but one of them is at a distance of 100 pc and the other is at 200 pc. Which one appears brighter, and how many times brighter?
If they have the same period they have the same luminosity. The star at 200 pc is twice as distant, so it is 4 times fainter. (Brightness varies as 1/distance squared.)
b) If instead one of the Cepheid variables (with the same period) appeared 100 times brighter than the other, which is more distant, and how many times more distant?
The fainter star would have to be 10 times farther to be 100 times fainter.
3.a) I have found two Cepheid variable stars with the same period, but one of them is at a distance of 100 pc and the other is at 1000 pc. Which one appears brighter, and how many times brighter?
The closer one appears 100 times brighter. (Brightness varies as 1/distance squared.)
b) If instead one of the Cepheid variables (with the same period) appeared 4 times brighter than the other, which is more distant, and how many times more distant?
The fainter on must be the more distant. To be 4 times fainter, it must be twice as far away.

4.a) What observation led us to think that there is dark matter inside of galaxies?
We measure the masses of galaxies from the orbital speeds of their stars (or the rotation curves). The orbits of the stars indicate that there is more mass in galaxies than we see.
b) What observations led us to think that dark energy (or vacuum energy) exists?

The line on the Hubble diagram isn't straight. This means that the expansion of the Universe has been accelerating. We think that what we call dark energy causes the acceleration.

4.a) What does Hubble's law say? (Give a statement of Hubble's law, not the explanation.)

Distant galaxies move away from us (or have redshifts) and the more distant galaxies move away from us faster, with speed being proportional to distance.

b) How do astronomers explain Hubble's law? That is, what do we think is the reason that galaxies obey Hubble's law?

The galaxies that started out moving away from us faster in the big bang have gotten farther away during the age of the Universe. Or the wavelengths of the light have been stretched by the expansion of the Universe, and the longer the light had to travel to get to us the more its wavelengths have been stretched.

5.a) Astronomers have concluded that planets as massive as Jupiter orbit other stars in orbits as small as Mercury's. How could they have concluded this when they couldn't actually see the light from a planet that close to a star?

They infer the presence of planets from how they pull on the stars they orbit around and cause the stars to have Doppler shifts as a result. The period of the orbits are found from the period of variation of the Doppler shifts. You can then get the sizes of the orbits from the periods, using Kepler's 3rd law.

b) Why did it surprise astronomers to find massive planets in such small orbits around stars?

The massive planets in our solar system are much farther from the Sun. And our theory of the formation of the solar system predicts that massive planets should form far from the Sun.

6.a) A white rock orbiting 1 AU from the Sun would be colder than a black rock 1 AU from the Sun. Why is this? Use the idea of thermal equilibrium in your answer.

A rock is heated by the sunlight it absorbs. White objects don't absorb as much light as black objects do. So white objects don't have to be as hot to emit the same amount of energy or power as they absorb.

b) The Earth's atmosphere causes the surface of the Earth to be warmer (on average) than it would be if the Earth had no atmosphere. How does the Earth's atmosphere cause this?

Molecules in the Earth's atmosphere absorb infrared radiation emitted by the surface. This heats the atmosphere, which then emits infrared radiation which goes back to the surface, heating it more.

b) Often when it is clear out it is both warmer during the day and colder at night than it is when it is cloudy. I can understand why it is warmer when the Sun is out, but why does it cool off more at night on a clear night?

The Earth cools off by radiating infrared radiation into space. On cloudy nights, the clouds absorb some of that radiation and send it back to the Earth, keeping it warm.