Name: _____ Date: _____

ASTR 130, Fall 2016, Homework on Chapter 22

1. The early universe was characterized by a much lower metal content than the present universe. What difference did that make to the process of star formation?
   A) The first generation of stars had lower metallicity than the present generation, but in each era the formation of large stars and small stars was equally likely.
   B) It is easier to make a gas and dust cloud collapse when the metal content is low. Thus, even small stars could be formed in the early universe but large stars were a rarity.
   C) It is harder to make a gas and dust cloud collapse when the metal content is low. Thus, even small stars could be formed in the early universe but large stars were a rarity.
   D) It is harder to make a gas and dust cloud collapse when the metal content is low. Thus, large stars were more likely to be formed in the early universe but small stars were a rarity.

2. How do we know that matter in the early universe was extremely smooth (i.e., not really lumpy)?
   A) because the cosmic background radiation is almost completely isotropic
   B) because at the present time galaxies are spread almost completely uniformly through the universe
   C) because quasars are spread almost completely uniformly around the sky
   D) because the expansion of the universe is almost completely isotropic

3. What significant event occurred 380,000 years after the start of the Big Bang?
   A) The production of helium ceased.
   B) All of the galaxies we see today formed.
   C) Quarks became confined in nuclei.
   D) Electrons and nuclei combined to form neutral atoms.

4. Opposite sides of the universe have the same temperature, yet according to the standard Big Bang Theory these points are too far apart for light to have traveled from one side to the other in the age of the universe; i.e., they cannot have exchanged heat to even out their temperature. Why, then, do they have the same temperature?
   A) Light (and heat) could travel much faster in the early universe, allowing them to exchange heat while the universe was young.
   B) The expansion of the universe has always been the same everywhere; therefore all parts of the universe have the same temperature regardless of whether they have ever exchanged heat or not.
   C) pure coincidence
   D) They were originally close together and evened out their temperature, then a rapid inflation of the universe carried them far apart.

5. In cosmology, what is the "inflationary epoch"?
   A) the period of universal expansion from the Big Bang to the present
   B) a period when the cost of living rose faster than astronomers' salaries
   C) the first 300,000 years of the life of the universe, when matter and radiation interacted vigorously
   D) a short period of extremely rapid expansion when the universe was very young

6. It has been shown that above 100 GeV in energy, intermediate vector bosons behave like photons. What is the significance of this in the early universe?
   A) Light (the cosmic microwave background radiation) was emitted by the weak interaction.
   B) Above this energy matter behaved like radiation: the radiation-dominated era of the early universe.
   C) The weak and electromagnetic interactions were unified.
   D) The strong force separated from the electromagnetic force.

7. Particle-antiparticle pairs are coming into existence all the time in the space around (and inside!) us. According to Heisenberg's uncertainty principle,
   A) the more massive the particles, the shorter the time that they can exist.
   B) the more massive the particles, the less precisely we know their position.
   C) the more massive the particles, the longer the time that they can exist.
   D) the more massive the particles, the more precisely we know their position.

8. The physical force that controls the structure of the nucleus and binds together protons and neutrons is the
   A) gravitational force.
   B) electromagnetic force.
   C) strong nuclear force.
   D) weak nuclear force.

9. In modern quantum physics, Heisenberg's uncertainty principle states that
   A) the more precisely you know a particle's velocity, the more certain you are of its position in space.
   B) the more precisely you know a particle's mass, the less certain you are of its size.
   C) the more precisely you know a particle's position, the more certain you are of its speed and motion.
   D) the more precisely you know a particle's position, the less certain you are of its speed and motion.

10. In high-energy physics, when two gamma-ray photons meet, they can
   A) produce a huge number of low-energy photons.
   B) disappear completely, leaving nothing behind.
   C) disappear, creating two negative electrons.
   D) disappear, creating a particle-antiparticle pair.