1. (3 pts.) Simplicio thinks, “Penzias and Wilson probably detected the radiation from lots of dust in the plane of the Milky Way Galaxy. The radiation is not from the Big Bang.” What evidence refutes Simplicio's incorrect statement?
2. (3 pts.) Simplicio thinks, “Penzias and Wilson probably detected the radiation from the evergreen trees nearby. Their radio antenna will receive signals even when not pointed directly at the trees, just as my satellite dish gets a signal even when not pointed directly at the satellite. The radiation is not from the Big Bang.” What evidence refutes Simplicio's incorrect statement?

At the present, the radiation from the big bang has a temperature of 2.7 K, a mass density of 3.56×10^{-32} kg/m^3, and a photon number density of 3.2×10^{7} photons/m^3 . The average mass of a photon is 1.1×10^{-39} kg. The present mass density of matter is 2.0×10^{-27} kg/m^3.

3. Suppose you went back in time to when the universe was 10 seconds old and brought back a sample of the universe in a 1-liter bottle. (A sprinter can run 10 yards in 10 seconds.) At that time, the universe was smaller by a factor of 6.8×10^{-10}. A liter is 0.001 m^3.
    a. (1 pt.) What is the difference between a photon and a proton?
    b. (3 pts.) At earlier times, the mass of a photon was larger, and yet the mass of a proton was unchanged from its present value. Why?
    c. (3 pts.) How many photons are in the bottle?
    d. (3 pts.) What is the mass of each photon?
    e. (3 pts.) Can you pick up the radiation in the bottle?
    f. (3 pts.) Can you pick up the matter in the bottle?
    g. (3 pts.) What is the temperature in the bottle? Compare that to the temperature in the center of the sun (15MK), the temperature on the surface of the sun (5,000K), and the temperature in the room (300K).
    h. (3 pts.) If you opened the bottle and peeked inside, what would you see? Would peeking be harmful to your health?
    i. (3 pts.) The distance to Hoag’s object is now 300Mpc. At the time when you got the sample, how far was the material that eventually became Hoag’s object? Compare that to the distance to the nearest galaxy cluster (10 Mpc), the nearest galaxy (0.7Mpc), the nearest star (1pc), or an AU (1/200,000pc).