

NAME: _____

- 1) The *Planck time* corresponds to how many seconds?
- 2) Approximately how long after the Big Bang were the first protons and neutrons formed?
- 3) Approximately how long after the Big Bang were the first helium nuclei formed?
- 4) Approximately how long after the Big Bang were the first atoms formed, clearing the “fog” so to speak?
- 5) In the context of cosmology, a *filament* refers to a long collection of...
a) quarks b) hydrogen atoms c) stars d) galaxies
- 6) What is the best estimate for the current age of the Universe? _____
- 7) The first generation of stars, or “megasuns”, were made entirely of _____ and _____ (enter the two elements).
- 8) The book states that the *redshift* of light from galaxies is due to the *Doppler effect*. However, as discussed in class, this redshift is actually a *cosmologically redshift*. Write a single sentence below that describes what the cosmological redshift is. (Note: The best answer will be of the form “The cosmological redshift is...[something]...which is caused by...[something].”)
- 9) Why is the Big Bang theory not able to analyze what the Universe would have been like when it was younger than the Planck time? That is, what would have been happening right after the Big Bang that we don't yet know how to analyze?

(OVER →)

10) The mass of an electron is 9×10^{-31} kg. How much energy would be needed to create an *electron–antielectron* pair? (Note that an *antielectron* has the same mass as an electron. Please show your calculation as well as your answer below.)

11) If the energy you calculated in the previous question is entirely contained in a single photon, what would be the *frequency* of the corresponding light wave? (Again, show your calculation.)

12) On the axes below draw a plot of imaginary data illustrating Hubble’s law, labeling both axes.

