

ASTRONOMY 143: The History of the Universe  
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## PRACTICE MINI-EXAM

Potentially useful numbers:

1 astronomical unit (AU) = 150,000,000 kilometers =  $1.5 \times 10^{11}$  meters

1 parsec (pc) = 206,000 AU =  $3.1 \times 10^{13}$  kilometers =  $3.1 \times 10^{16}$  meters

1 megaparsec (Mpc) = 1,000,000 parsecs

1 year = 32,000,000 seconds

Diameter of Earth = 12,800 kilometers

Mass of Earth =  $6 \times 10^{24}$  kilograms

Diameter of Sun =  $109 \times$  diameter of Earth = 1,400,000 kilometers

Mass of Sun =  $330,000 \times$  mass of Earth =  $2 \times 10^{30}$  kilograms

Speed of light = 300,000 km/sec

Hubble constant =  $H_0 = 71$  km/sec/Mpc

Hubble time =  $1/H_0 = 1.4 \times 10^{10}$  years

Hubble distance =  $c/H_0 = 4300$  Mpc

Critical density =  $10^{-26}$  kg/m<sup>3</sup>

Note: The actual final exam will have 15 short-answer problems (3 points each), 3 mathematical problems (10 points each), and 1 essay question (25 points). This mini-exam contains 8 short-answer problems and 2 mathematical problems.

### Short-Answer Problems

- 1) Which has the greater energy: a photon of infrared light or a photon of ultraviolet light?
  
- 2) Which is longer: a sidereal day or a solar day?
  
- 3) Arrange the following objects in order of increasing mass: brown dwarf, Jupiter, Sun, Earth.
  
- 4) Two stars have the same luminosity. One star has a parallax of 0.1 arcseconds. The other has a parallax of 0.5 arcseconds. Which star has the greater flux?
  
- 5) If the density of the universe were greater than the critical density, would the universe be negatively curved, positively curved, or flat?
  
- 6) A newly formed zircon crystal contains 1000 uranium-238 atoms. How many uranium-238 atoms will be left after two half-lives?
  
- 7) Which contributes most to the average density of the universe: dark energy, dark matter, or ordinary matter?
  
- 8) How long after the Big Bang did the first galaxies form?

### Mathematical Problems

- 9) The star named “Gliese 710” is at a distance  $d = 15$  parsecs from the Sun.
- What is the distance from the Sun to Gliese 710, measured in kilometers?
  - From the Doppler shift of Gliese 710, it is known to be coming closer to the Sun, with a radial velocity  $v = -24$  km/sec. If Gliese 710 is moving *straight* toward the Sun, how many years will it be until they collide?

- 10) Ordinary matter provides 4% of the critical density of the universe.
- a) What is the average density of ordinary matter in the universe, given in units of kilograms per cubic meter?
  - b) Suppose that the ordinary matter consisted entirely of regulation bowling balls, each with a mass  $M_{\text{bb}} = 7 \text{ kg}$ . How many bowling balls, on average, would there be in one cubic astronomical unit (AU) of space?