1. What are the most massive galaxies in the universe?  
   a. normal spirals,  
   b. barred spirals,  
   c. giant ellipticals  
   d. dwarf ellipticals,  
   e. irregulars  
   c. Giant Ellipticals

3. Which of the following statements about the motion of galaxies is correct?  
   a. All galaxies are moving apart.  
   b. Superclusters of galaxies are all moving apart.  
   c. Superclusters of galaxies are all moving toward each other.  
   d. The Milky Way Galaxy is at the center of the universe.  
   e. All clusters of galaxies in each supercluster are moving toward each other.  
   b. Superclusters are all moving apart

5. In spiral galaxies, what spectral classes of stars are found only in spiral arms?  
   Classes O and B are found only in spiral arms. Stars are being formed in the spiral arms, so all classes are made. The Class O and B stars explode as supernovae before they can drift out of the spiral arms, so they aren’t found anywhere else.

7. In which Hubble types of galaxies are new stars most commonly forming? Describe the observational evidence that supports your answer.  
   New stars are forming in Spirals and Barred Spirals, specifically in the spiral arms. The arms look blue, which indicates the presence of high-mass main-sequence stars. These stars have short lifetimes of only a few million years, so their presence indicates that new stars are still being formed today.

15. Why do astronomers believe that considerable quantities of dark matter must exist in clusters of galaxies?  
   The observable mass is not great enough to gravitationally bind the galaxies, given the speeds with which they move. And they have around long enough that they must be gravitationally bound.

19. What is a standard candle? Why are standard candles important to astronomers trying to measure the Hubble constant?  
   A standard candle is an object whose luminosity is known. The term originates from literally “standard candles” in the 1800s in illumination technology. If an object’s luminosity is known, then its distance can be calculated from its apparent brightness. To be useful, it must be bright enough to be seen from large distances. The two types of standard candles we have discussed in the course are Cepheid variables and Type Ia supernovae. Others include RR Lyrae variables and the Tully-Fisher relationship.

21. Suppose a spectrum of a distant galaxy showed that its redshift corresponds to a speed of 22,000 km/s. How far away is the galaxy in Mpc?  
   Astronomer’s Toolbox 16-1. \( v = \frac{d}{H_0} \), so  
   \[ d = \frac{v}{H_0} = \frac{22,000 \text{ km/s}}{71 \text{ km/s/Mpc}} = 310 \text{ Mpc}. \]  
   To convert Mpc to light-years, multiply by 3.26 million:  
   \[ d = 310 \text{ Mpc} \times (3.26 \times 10^6 \text{ LY/Mpc}) = 1.01 \times 10^9 \text{ LY}. \] This is one billion light years.