Review Questions

1. Describe some differences between quasars and normal galaxies.

2. Describe the arguments supporting the idea that quasars are at the distances indicated by their redshifts.

3. In what ways are active galaxies like quasars but different from normal galaxies?

4. Why could the concentration of matter at the center of an active galaxy like M87 not be made of stars?

5. Describe the process by which the action of a black hole can explain the energy radiated by quasars.

6. Describe the observations that convinced astronomers that M87 is an active galaxy.

7. Why do astronomers believe that quasars represent an early stage in the evolution of galaxies?

8. What is the typical structure we observe in a quasar at radio frequencies?

9. What evidence do we have that the luminous central region of a quasar is small and compact?

10. Suppose you observe a star-like object in the sky. How can you determine whether it is actually a star or a quasar?

11. Why don't any of the methods for establishing distances to galaxies, described in the chapter on Galaxies, (other than Hubble's law itself), work for quasars?

12. A friend of yours who has watched many *Star Trek* episodes and movies says, "I thought that black holes pulled everything into them. Why then do astronomers think that black holes can explain the great *outpouring* of energy from quasars?" How would you respond?

13. Could the Milky Way ever become an active galaxy? Is it likely to ever be as luminous as a quasar?

14. Why are quasars generally so much more luminous (why do they put out so much more energy) than active galaxies?

15. Show that no matter how big a redshift (z) we measure, v/c will never be greater than 1. (In other words, no galaxy we observe can be moving away faster than the speed of light.)

16. If a quasar has a redshift of 3.3, at what fraction of the speed of light is it moving away from us?

17. The quasar that appears the brightest in our sky, 3C 273, is located at a distance of 2.4 billion light-years. The Sun would have to be viewed from a distance of 1300 light-years to have the same apparent magnitude as 3C 273. Using the inverse square law for light, estimate the luminosity of 3C 273 in solar units.