

One or more correct

1. Normal spiral galaxies and barred spiral galaxies differ in the following:
 - A. Ratio of luminosity of bulge to disk
 - B. Linear size of the bulge
 - C. Presence of a bar through the bulge
 - D. Number of spiral arms
2. The classes a, b, c of spiral galaxies differ in the following aspects:
 - a. Ratio of luminosity of bulge to disk
 - b. Linear extent of the bulge
 - c. How tightly the spiral arms are wound
 - d. Smoothness of the light distribution of the disk
3. Which of the following statements is true?
 - a) Pop I stars have low metallicity and move in circular orbits in the disk
 - b) Pop II stars have low metallicity and move in elliptical orbits oriented randomly
 - c) Pop I stars are old stars with high metallicity
 - d) Pop II stars are younger and move in circular orbits in the disk
4. The orbits of stars orbiting close to the central supermassive black hole of the Milky Way galaxy are in general
 - a) Cycloids
 - b) Closed ellipses
 - c) Precessing ellipses
 - d) Catenaries
5. Consider two spiral galaxies, say A and B. Their luminosity profiles follow the exponential law with radial profiles given by: $I(r) = I_0 \exp(-r/h)$. Central surface brightness I_0 of galaxy A is twice that of B. The scale length h of galaxy B is twice that of A. The brightness of which galaxy is more at $r = 2h_B$.
6. The average mass of a galaxy in a group of galaxies is found to be 2×10^{10} solar masses. There are fifty galaxies and the linear extent of the system is determined as 1 Mpc. The velocity dispersion of the galaxies is determined as 50 km/s. Is the group bound?
7. Luminosity of a particular AGN is observed to be 10^{12} times the solar luminosity. The luminosity from accretion on to a black hole accreting at the rate \dot{M} is $\eta \dot{M} c^2$, with $\eta = 0.1$. Obtain an estimate for the mass accretion rate of the black hole in the AGN in units of solar masses per year.
8. The Schwarzschild radius of a black hole is 10 cm. Determine its mass.
9. A gas cloud is observed in a circular orbit around the center of a galaxy at 10 kpc from its center. Its orbital speed is determined as 220 km/s. The mass in stars and gas clouds within 10 kpc is determined as 5×10^{10} solar masses. Obtain a rough estimate of the mass of dark matter within 10 kpc in the galaxy.
10. The unresolved sodium D line of 5893 Angstrom is seen to be shifted by 20 Angstrom in the spectrum of a galaxy. Determine the speed of its recession from the observer.