1. What are the RA and DEC of Perseus constellation? At what time do you expect it to transit at Kharagpur on 23 January? Does the Sun ever visit this constellation? How high in the sky from the horizon, will this constellation appear?
2. Sketch the Orion constellation, and indicate the location of the Orion nebua. What is the Orion nebula?
3. Explain briefly why Earth's rotation axis precesses. What is the rate of precession?
4. Verify that

$$u^{-1} = r = \frac{a(1-e^2)}{1 + e\,\cos\phi}$$

with $a = -2GM/E$ and $e = [1+2J^2E^2/G^2M^2]^{1/2}$ is acually a solution to the equation

$$E = \frac{1}{2}\left[J^2\left(\frac{du}{d\phi}\right)^2 + J^2u^2\right] - GMu$$

which governs the trajectory under the gravitational attraction of a massive object.
5. Show that

$$P^2 = \frac{4\pi^2}{GM}a^3$$

for a general elliptic orbit.
6. Assuming that the Earth has a rotational period of 24 hrs around its own axis and revolution period of 365.25 days around the Sun, what is the length of a Solar day? After what period do distant stars come back to the same position on the sky?
7. Given Comet Halley has period 75 yrs, determine the semimajor axis of its orbit?
8. Consider an orbit around the Sun with $e = 0.3$. What is the ratio of the speeds at apogee and perigee?
9. At what height from center of Earth do we have geostationary satellite orbits?
10. For a central force motion in a gravitational potential α/r, show that $\vec{A} = \vec{v} \times \vec{L} + \alpha\vec{r}/r$ is conserved.
11. Consider a Comet whose orbit is observed to have perihelion of 0.1 A.U. and the speed at perihelion is observed to be 133 km/s. Determine the eccentricity, semimajor axis and period of the Comet's orbit.
12. It is believed that the entire Solar System (Sun and planets) formed from the same gas cloud. Given this, what could be the reason that the Sun is predominantly Hydrogen and Helium, whereas we do not find these in Earth's atmosphere?
13. What are the differences between a planet and a dwarf planet? What are the masses and orbital parameters of the currently known dwarf planets? In which part of the Solar System are they located?
14. The two stars in a spectroscopic binary have masses $2.5\,M_\odot$ and $0.5\,M_\odot$ respectively, and the orbit is circular with an inclination angle of $i = 90°$ to the observer's line of sight. The separation between the two stars is 0.4 AU. (a.) What is the distance between the larger star and the center of mass. (b.) What is the period of the binary orbit? (c.) What is the ratio of the speeds of the two stars? (d.) What is the maximum change in the observed wavelength $\Delta\lambda$ of a spectral line emitted at wavelength $\lambda = 5000\,A$ from the more massive star?
15. A binary stellar system with two stars of mass $1\,M_\odot$ are in a cicular orbit with separation 1 AU between the stars. How close can the binary system approach a blackhole of mass $10^6\,M_\odot$ before the tidal force due to the blackhole exceeds the gravitational force between the two stars.
16. How far from Earth's center is the center of mass of the Earth-Moon system?
17. Does a spherical object experience a torque due to tidal forces. Under what conditions can the tidal forces produce a torque?