2 Short Questions

1. (7 points) Assuming that the present density of baryonic matter is $\rho_{b0} = 4.17 \times 10^{-28}$ kg m^{-3}, what was the density of baryonic matter at the time of Big Bang nucelosynthesis (when T $\sim 10^{10}$ K)? Assume the present temperature, T_0 to be 2.7 K.

2. (7 points) On the night of January 21st, 2019, there was a total lunar eclipse during a supermoon. At the time, the moon was close to perigee, at a distance of 351837 km from the earth, which was 1.4721×10^8 km from the sun. The gamma (γ) of a lunar eclipse refers to the closest distance between the center of the moon and the center of the shadow, expressed as a fraction of the earth's radius. For this eclipse, $\gamma = 0.3684$. Given this information, find the closest estimate for the duration of totality of the eclipse.

3. (7 points) You are in the northern hemisphere and are observing rise of star A with declination $\delta = -8^o$, and at the same time a star B with declination $\delta = +16^o$ is setting. What will happen first: next setting of the star A or rising of the star B?

4. (7 points) Consider a star with mass M and radius R. The star's density varies as a function of radius r according to the equation $\rho(r) = \rho_{center}(1 - \sqrt{r/R})$, where ρ_{center} is the density at the center of the star. Derive an expression for dP/dr in terms of G, M, R, and r, where P is the pressure at a given radius r