Horizons and Inflation

a) Find the deviation from flatness, $1-\Omega(z)$, at $z_{rec}=10^3$ and $z_{ns}=10^{10}$ if $\Omega_m=0.1$, $\Omega_r=4\times10^{-5}$. Find the deviation if $\Omega_{tot}=\Omega_\Lambda=0.1$.

b) The particle horizon is the physical size of the universe in causal contact,

$$r_h(t)=a(t)\,r(t)=a(t)\int_0^t dt'/a(t').$$

Calculate the particle horizon size at z_{eq} and at z_{dec}. Calculate the comoving wavelengths and masses ($M=(\pi/6)\rho\lambda^3$) those correspond to today. Calculate the angle those horizons subtend today, $\theta_h=r_h(z)/r_a(z)$, using the angular distance for an Einstein-de Sitter universe, $r_a(z)=2H_0^{-1}[(1+z)^{-1}-(1+z)^{-3/2}]$.

c) The following plot is a handy way of understanding the concept of scales leaving and entering the Hubble volume. Why is comoving wavelength a horizontal line? What is the general cosmological interpretation of $(aH)^{-1}$? This is often informally referred to as the horizon (it is the event horizon scale for the deSitter spacetime of inflation). Identify the times at which a perturbation of comoving wavelength λ leaves/enters this "horizon". Identify the time intervals during which inflation takes place and explain what property of the curve shows this.