ASSIGNMENT 3, due date February 24th

Problem I In a single component Universe with flat space and the equation of state parameter w what are

1. the current proper distance $d_P(t_0)$,
2. the luminosity distance d_L, and
3. the angular diameter distance d_A

to the object of fixed luminosity L, fixed size A and the redshift z. Write the distances as functions of z and w.

4. At what redshift will d_A have a maximum value ?
5. What will this maximum value be in the units of cH_0^{-1} ?

Problem II This is similar to one of the problems from the textbook and is related to problem I. Consider again flat Universe with single matter component with the equation of state $P = w\epsilon$. We have a distant object that at the present time is observed with redshift z. Find how observed redshift will change when the same object is observed later, i.e show that

$$\frac{dz}{dt_0} = H_0(1+z) - H_0(1+z)^{3(1+w)/2}$$

Sketch a space-time diagram that illustrates your considerations.

For which values of w the obseved redshift *decreases* with the time of observation t_0 and for which w it is decreases ?

Problem III Considering the energy balance in the Universe with matter, Λ-term and curvature, find the equation for the line in $\Omega_m - \Omega_\Lambda$ plane that separates models that expand forever and the ones that will recollapse in future.