

Due on Monday September 22 by 24.00.

1. **Redshift.** Derive the relation between the scale factor and redshift using conformal time.
2. **Einstein–de Sitter model.** Consider the case $a \propto t^{2/3}$ and $K = 0$. (This corresponds to a spatially flat universe filled with non-relativistic matter.)
 - a) Calculate the age-redshift relationship $t(z)$ and the angular diameter distance $D_A(z)$. (Express the age and distance in units of the Hubble time H_0^{-1} .)
 - b) What is the particle horizon today in units of H_0^{-1} ? (Defined as the proper distance to $z = \infty$.)
 - c) What is the age of the universe (in years) today and at $z = 1090$ if $H_0 = 70$ km/s/Mpc?
 - d) What is the angular diameter distance (in Mpc) to redshift $z = 1090$ if $H_0 = 70$ km/s/Mpc?
 - e) The function $D_A(z)$ has a maximum. At which redshift is it?
3. **Continuity equation.** Derive the continuity equation

$$\dot{\rho} = -3(\rho + p)\frac{\dot{a}}{a}$$

from the Friedmann equations. What does this equation say about conservation of energy?