1 A distant galaxy has a redshift $z = (\lambda_{observed} - \lambda_{emitted})/\lambda_{emitted}$ of .2. According to Hubble's law, how far away was the galaxy when the light was emitted if the Hubble constant is 72 (km/s)/Mpc?

2 A Cepheid variable star is observed with an apparent magnitude of 22 (see `http://outreach.atnf.csiro.au/education/senior/astrophysics/photometry_magnitude.html#magnapparent` for the notion of the magnitute of a star) and a period of 28 days. Using data from `http://hyperphysics.phy-astr.gsu.edu/hbase/astro/cepheid.html`, determine the distance to this star.

3 Check by a direct calculation of the Christoffel symbols that the radial null rays in a FRW metric are geodesics, when suitably parameterised.

4 Verify that for FRW models with $\rho + 3p \geq 0$ and with non-positive cosmological constant the scale factor R is a concave function of t (i.e. $\frac{d^2R}{dt^2} \leq 0$). Assuming that $R(t) \approx ct^\alpha$ as $t \to 0$, deduce from this that $1/H(t) \geq t$ for $t > 0$.

5 (For self-study) Check, or derive the $k \neq 0$ solutions of the Friedman equation in a non-empty matter-dominated universe with $\Lambda = 0$:

$$k = 1: \quad R = C(1 - \cos\eta)\,, \quad t = C(\eta - \sin\eta)\,, \tag{1}$$

$$k = -1: \quad R = C(\cosh\eta - 1)\,, \quad t = C(-\eta + \sinh\eta)\,. \tag{2}$$

6 (For self-study) Suppose that the spatial volume of a closed, matter dominated, FRW universe with spherical space sections and vanishing cosmological constant is 10^{12}Mpc^3 at the moment of maximum expansion. What is the duration of this universe from big bang to big crunch in years?