Physics 303

Newtonian Cosmology

1. Our cosmological model for the motion of a 'test' galaxy gives rise to the following expression

$$\dot{R}^2 = \left(\frac{R_S}{R} - k\right) c^2$$

where R is the distance from our galaxy to the test galaxy, $R_S = 2GM/c^2$ is a constant, and c is the speed of light. For the case $k = -1$ show that R and t are related by the following equation

$$\sqrt{(R_S + R)R} - R_S \ln\left(\sqrt{R} + \sqrt{R_S + R}\right) = ct + C_2$$

where C_2 is a constant of the integration.

2. The initial conditions we are applying to our universe are that $R = 0$ when $t = 0$. What is the time $t(R)$ for these initial conditions?

3. For the case $k = +1$ show that R and t are related by the following equation

$$-\sqrt{(R_S - R)R} + R_S \arctan\left(\sqrt{\frac{R}{R_S - R}}\right) = ct + C_3$$

where C_3 is a constant of the integration.

4. The initial conditions we are applying to our universe are that $R = 0$ when $t = 0$. What is the time $t(R)$ for the $k = +1$ universe under these initial conditions?