2. $r(\theta) = A(1-\cos\theta)$, $t(\theta) = B(\theta - \sin\theta)$

$A = \frac{GM}{2|E|}$, $A^3 = GMB^2$.

is a soln. to

$$\frac{1}{2}\dot{r}^2 - \frac{GM}{r} = E.$$

$$\Rightarrow \frac{1}{2}\left(\frac{dr}{d\theta}\frac{d\theta}{dt}\right)^2 - \frac{GM}{A(1-\cos\theta)}$$

$$= \frac{1}{2}\left(\frac{A\sin\theta}{B(1-\cos\theta)}\right)^2 - \frac{A^2}{B^2(1-\cos\theta)}$$

$$= \frac{1}{2}\frac{A^2\sin^2\theta}{B^2(1-\cos\theta)^2} - \frac{A^2}{B^2(1-\cos\theta)}.$$

$$= \frac{A^2}{B^2}\left(\frac{1}{2}\frac{(1-\cos^2\theta)}{(1-\cos\theta)^2} - \frac{1}{1-\cos\theta}\right)$$

$$= \frac{A^2}{B^2}\left(\frac{1}{2}\frac{(1-\cos\theta)(1+\cos\theta)}{(1-\cos\theta)^2} - \frac{1}{1-\cos\theta}\right)$$

$$= \frac{A^2}{2B^2}\left(\frac{(1+\cos\theta)-2}{1-\cos\theta}\right)$$

$$= \frac{-A^2}{2B^2} = -\frac{GM}{2A} = -|E|.$$

As $E<0$, $-|E| = E$, and we have verified that $r(\theta)$ and $t(\theta)$ are a soln. to the diff. eqn.

3. $k_{eq} = a_{eq} H_{eq} = a_{eq} \sqrt{H_0^2 \left(\frac{\Omega_{m,0}}{a_{eq}^3} + \frac{\Omega_{r,0}}{a_{eq}^2} \right)}$

Al $a_{eq} \cdot \frac{\Omega_{m,0}}{a_{eq}^3} = \frac{\Omega_{r,0}}{a_{eq}^2}$.

Tmw. $k_{eq} = a_{eq} \sqrt{H_0^2 \left(\frac{2\Omega_{m,0}}{a_{eq}^3} \right)}$

$= H_0 \sqrt{\frac{2\Omega_{m,0}}{a_{eq}}}$