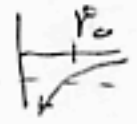
For the case $E < 0$, write $r_0^2 = \frac{\sigma}{E} \Rightarrow$ Draft 58 cont.

$E = \frac{\sigma}{r_0^2}$ and




$$\frac{m}{2}(\dot{r}^2) + \frac{\sigma}{r^2} = E \Rightarrow \frac{m}{2}(\dot{r}^2) = -\sigma\left(\frac{1}{r^2} - \frac{1}{r_0^2}\right) \Rightarrow$$

$$\dot{r}^2 = \left(-\frac{2\sigma}{m}\right)\left(\frac{1}{r^2} - \frac{1}{r_0^2}\right) \Rightarrow \dot{r} = -\left(\frac{-2\sigma}{m}\right)^{1/2}\left[\frac{1}{r^2} - \frac{1}{r_0^2}\right]^{1/2}$$

$$\Rightarrow t - t_0 = -\left(\frac{m}{-2\sigma}\right)^{1/2} \int_{r_0}^{r} \frac{dr'}{\left[\frac{1}{r'^2} - \frac{1}{r_0^2}\right]^{1/2}} \Rightarrow$$

$$t - t_0 = -\left(\frac{m}{-2\sigma}\right)^{1/2} \int_{r_0}^{r} \frac{r'\,dr'}{\left[1 - r'^2/r_0^2\right]^{1/2}} \Rightarrow$$

$$t - t_0 = \left(\frac{m}{-2\sigma}\right)^{1/2} r_0 \int_{r_0}^{r} \frac{r'\,dr'}{\left[r_0^2 - r'^2\right]^{1/2}} \Rightarrow$$

$$t - t_0 = -\left(\frac{m}{-2\sigma}\right)^{1/2} r_0 \,(-1)\left[r_0^2 - r'^2\right]^{1/2}\Big|_{r_0}^{r} \Rightarrow$$

$$t - t_0 = \left(\frac{m}{-2\sigma}\right)^{1/2}\left[r_0^2 - r^2\right] \Rightarrow$$

$$r^2 = r_0^2 - \left(\frac{-2\sigma}{m}\right)^{1/2}(t - t_0) \Rightarrow$$

$$\boxed{r = \left[r_0^2 - \left(\frac{-2\sigma}{m}\right)^{1/2}(t - t_0)\right]^{1/2}}$$