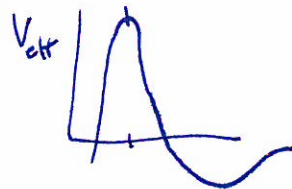


9.11 | expand V_{eff} around unstable max,



$$V_{\text{eff}}(r) = V_{\text{eff}}(r_{\text{max}}) + \underbrace{\frac{1}{2} \left. \frac{d^2 V_{\text{eff}}}{dr^2} \right|_{r_{\text{max}}}}_{\equiv -K^2 > 0} (\delta r)^2 + \dots$$

$$\delta r = r - r_{\text{max}}$$

$$(9.29) \quad \mathcal{E} = \frac{1}{2} \left(\frac{dr}{d\tau} \right)^2 + V_{\text{eff}}(r) \quad \text{becomes}$$

$$\frac{1}{2} \left(\frac{d(\delta r)}{d\tau} \right)^2 - \frac{1}{2} K^2 (\delta r)^2 = 0$$

$$\text{solutions} \quad \delta r \propto \exp(\pm K\tau) \quad \Rightarrow \quad \tau_* = 1/K$$

$$\text{explicitly:} \quad V_{\text{eff}}(r) = -\frac{M}{r} + \frac{l^2}{2r^2} - \frac{Ml^2}{r^3}$$

$$V'_{\text{eff}}(r) = \frac{M}{r^2} - \frac{l^2}{r^3} + \frac{3Ml^2}{r^4}$$

$$V''_{\text{eff}}(r) = -\frac{2M}{r^3} + \frac{3l^2}{r^4} - \frac{12Ml^2}{r^5} = \frac{-2Mr^2 + 3l^2r - 12Ml^2}{r^5}$$

$$\text{finally: plug in } r_{\text{max}} \quad \left(-V''_{\text{eff}}(r_{\text{max}}) \right)^{1/2} = K$$