② $V(r)$, ohranjene količine: $p_\varphi =$

$$L = \frac{1}{2}m(\dot{r}^2 + r^2\dot{\varphi}^2) - V(r)$$

1. $p_\varphi = \frac{\partial L}{\partial \dot{\varphi}} = \text{konst} = mr^2\dot{\varphi}$

2. $H = \frac{1}{2}m\dot{r}^2 + \underbrace{\frac{p_\varphi^2}{2mr^2} + V(r)}_{V_{ef}}$

Krožna orbita: $\left.\frac{\partial V_{ef}}{\partial r}\right|_{r_0} = 0$ pogoj

~~Obhodni~~ ~~čas~~.

$$-\left.\frac{p_\varphi^2}{mr^3}\right|_{r_0} + \left.\frac{\partial V}{\partial r}\right|_{r_0} = 0$$

Obhodni čas: $\frac{m^2 r_0^4 \dot{\varphi}^2}{\cancel{m}\, \cancel{r_0^3}} = \frac{\partial V}{\partial r} \Rightarrow p_\varphi \dot{\varphi} = \sqrt{\frac{1}{r}\frac{\partial V}{\partial r}}$

$$T = \frac{2\pi}{\dot{\varphi}} = 2\pi\left(\frac{1}{r}\frac{\partial V}{\partial r}\right)^{-1/2}$$

Odmiki iz krožne orbite: $r_0 \to r_0 + \varepsilon$; $|\varepsilon| \ll r_0$

$$H = \frac{1}{2}m\dot{\varepsilon}^2 + V_{ef}(r_0+\varepsilon) \approx \frac{1}{2}m\dot{\varepsilon}^2 + V_{ef}(r_0) + \left.\frac{\partial V_{ef}}{\partial r}\right|_{r_0}\varepsilon + \left.\frac{\partial^2 V_{ef}}{\partial r^2}\right|_{r_0}\varepsilon^2$$

Krožna orbita $\leftarrow$ 0

$$H - V_{ef}(r_0) = \frac{1}{2}m\dot{\varepsilon}^2 + \left.\frac{1}{2}\frac{\partial^2 V_{ef}}{\partial r^2}\right|_{r_0}\varepsilon^2$$

Stabilna, ko $\left.\frac{\partial^2 V_{ef}}{\partial r^2}\right|_{r_0} > 0$, ko:

Harmonski oscilator: $H - V_{ef}(r_0) = \frac{1}{2}m\dot{\varepsilon}^2 + \frac{1}{2}m\omega^2\varepsilon^2$

$$\omega^2 = \left.\frac{1}{m}\frac{\partial^2 V_{ef}}{\partial r^2}\right|_{r_0}$$

Rešitev: $\varepsilon(t) = A\cos(\omega t + \varphi)$

$$H - V_{ef}(r_0) = \frac{1}{2}m\omega^2 A^2 \sin^2(\omega t + \varphi) + \frac{1}{2}m\omega^2 A^2 \cos^2(\omega t + \varphi)$$

$$\Rightarrow A = \sqrt{\frac{2(H - V_{ef}(r_0))}{\omega^2 m}}$$