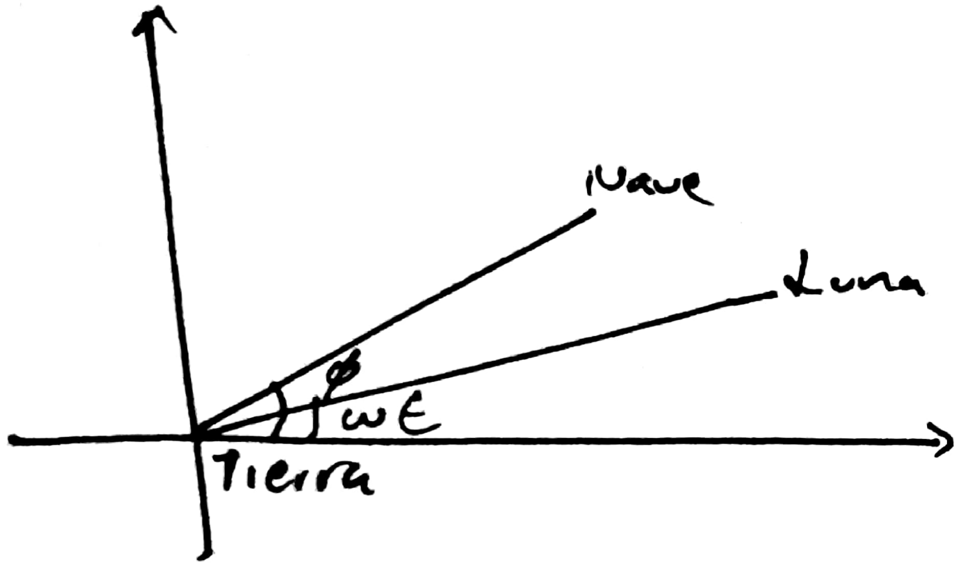
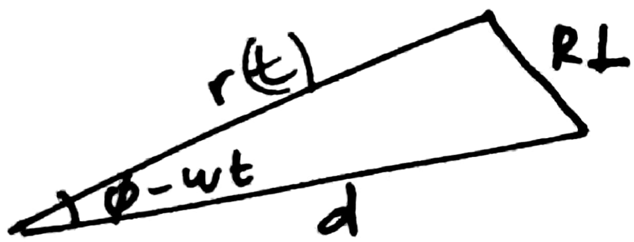
c.)





$$R_L^2 = r^2(t) + d^2 - 2r(t)d\cos(\phi-\omega t)$$

$$R_L(r,\phi,t) = \sqrt{r^2(t)+d^2-2r(t)d\cos(\phi-\omega t)}$$

d.)

$$H = \sum_i^N \dot{x}_i p_i - L \qquad L = K - U$$

$$\dot{x}_i p_i = v(mv) \rightarrow H = 2K - K + U$$

$$= mv^2 \qquad H = K + U$$

$$= 2K \qquad \vec{v} = \dot{r} + r\dot{\phi}$$

Potential E

$$U = -Gm\left(\frac{M_T}{r} + \frac{M_L}{r_L}\right)$$

$$H = K + U$$

$$K = \frac{1}{2}mv^2$$

$$v = \dot{r}^2 + r\dot{\phi}^2$$

$$K = \frac{1}{2}m(\dot{r}^2 + r\dot{\phi}^2)$$

$$\frac{1}{2}m^2\dot{r}^2 = \frac{p_r^2}{2}$$

$$\frac{1}{2}m^2\dot{\phi}^2 r = \frac{p_\phi^2}{2r^2}$$

$$H = \frac{p_r^2}{2m} + \frac{p_\phi^2}{2mr^2} - Gm\left(\frac{M_T}{r} + \frac{M_L}{r_L}\right)$$

e.)

$$\dot{r} = \frac{\partial H}{\partial p_r} \qquad \frac{\partial H}{\partial p_r} = \frac{2p_r}{2m} + 0 + 0 + 0 + 0$$

$$\dot{r} = \frac{\partial H}{\partial p_r} = \frac{p_r}{m}$$

$\frac{P}{\lambda} = \tilde{\lambda}$

$P/\lambda = \tilde{\lambda}$

$(\cdot)$

$$\dot{\phi} = \frac{\partial H}{\partial p_\phi} \qquad \frac{\partial H}{\partial p_\phi} = 0 + \frac{2p_\phi}{2mr^2} + 0 + 0$$

$$\dot{\phi} = \frac{\partial H}{\partial p_\phi} = \frac{\cancel{2}p_\phi}{\cancel{2}mr^2}$$

$$\dot{p}_r = -\frac{\partial H}{\partial r}$$

$$\frac{\partial H}{\partial r} = 0 - \frac{2p_\phi^2}{2mr^3} + \frac{Gmm_T}{r^2} + \frac{r + d\cos(\phi - \omega t)\, Gmm_L}{(r^2 + d^2 - 2rd\cos(\phi - \omega t))^{3/2}}$$

$$\frac{\partial}{\partial r}\left(-\frac{1}{\sqrt{r^2 + d^2 - 2rd\cos(\phi - \omega t)}}\right) = \frac{r + d\cos(\phi - \omega t)}{(r^2 + d^2 - 2rd\cos(\phi - \omega t))^{3/2}}$$

$$-\frac{\partial H}{\partial r} = \frac{p_\phi^2}{mr^3} - \frac{Gmm_T}{r^2} - \frac{Gmm_L}{r_L(r,\phi,\phi)^3}[r - d\cos(\phi - \omega t)]$$

$$\dot{p}_\phi = -\frac{\partial H}{\partial \phi}$$

$$\frac{\partial H}{\partial \phi} = 0 + 0 + 0 + Gmm_L \frac{\partial}{\partial \phi}\left(-\frac{1}{\sqrt{r^2 + d^2 - 2rd\cos(\phi - \omega t)}}\right.$$

$$\frac{\partial}{\partial \phi} = \frac{dr\sin(\phi - \omega t)}{(r^2 + d^2 - 2rd\cos(\phi - \omega t))^{3/2}}$$

$$-\frac{\partial H}{\partial \phi} = -\frac{Gmm_L}{r_L(r,\phi,t)^3}\, dr\sin(\phi - \omega t)$$

f.)

$\tilde{r} = r/d$

$\dot{\tilde{r}} = \frac{\dot{r}}{d}$

$\tilde{P}_r = \frac{P_r}{md} \rightarrow P_r = md\dot{r}$

$md\dot{\tilde{r}} = md\tilde{P}_r$

$\underline{\dot{\tilde{r}} = \tilde{P}_r}$

$\tilde{P}_\phi = P_\phi/md^2 \qquad P_\phi = mr^2\dot{\phi}$

$\frac{1}{\tilde{r}^2} = \frac{d^2}{r^2}$

$\tilde{P}_\phi = \frac{\cancel{m}r^2\dot{\phi}}{\cancel{m}d^2}$

$\dot{\phi} = \frac{d^2}{r^2}\tilde{P}_\phi$

$\dot{\phi} = \tilde{r}^2\tilde{P}_\phi$

g.) $\tilde{P}_r^{\,0} = \frac{\dot{r}}{d} \qquad \frac{1}{d}\frac{dr}{dt}$

$$\tilde{P}_r^{\,0} = \frac{1}{d}\frac{d}{dt}\left(\sqrt{x^2+y^2}\right)$$

$$= \frac{x\dot{x}+y\dot{y}}{rd}$$

$$\tilde{P}_r^{\,0} = \bar{V}_0 \cos(\theta)\cos(\phi) + \bar{v}_0 \operatorname{sen}\theta \operatorname{sen}\phi$$

$$\tilde{P}_r = \bar{v}_0 \cos(\theta-\phi)$$

$$\tilde{P}_\phi^{\,0} = \frac{mr^2\dot{\phi}}{md^2} \qquad \phi = \arctan\left(\frac{y}{x}\right)$$

$$\dot{\phi} = \frac{d}{dt}\left(\arctan\left(\frac{y}{x}\right)\right)$$

$$r^2\dot{\phi} = \frac{1}{1+\left(\frac{y}{x}\right)^2}\frac{d}{dt}\left(\frac{y}{x}\right) = \left(\frac{\dot{y}x-\dot{x}y}{x^2+y^2}\right)\bar{r}^2$$

$$x^2+y^2 = r^2$$

$$\frac{\bar{r}^2}{r^2}(\dot{y}x-\dot{x}y) = r^2\dot{\phi}$$

$$(\dot{y}x-\dot{x}y) = \bar{V}_0 \operatorname{sen}(\theta)\cos\phi - \bar{V}_0\cos(\theta)\operatorname{sen}\phi$$

$$\frac{\bar{r}^2}{r} = \bar{V}_0 \operatorname{sen}(\theta-\phi)$$

$$\frac{\bar{r}^2}{r} = \frac{r}{\partial} = \bar{r}$$

$$\tilde{p}_{\phi}^{0} = \overline{v_0}\, v_0 \sin(\theta - \phi)$$