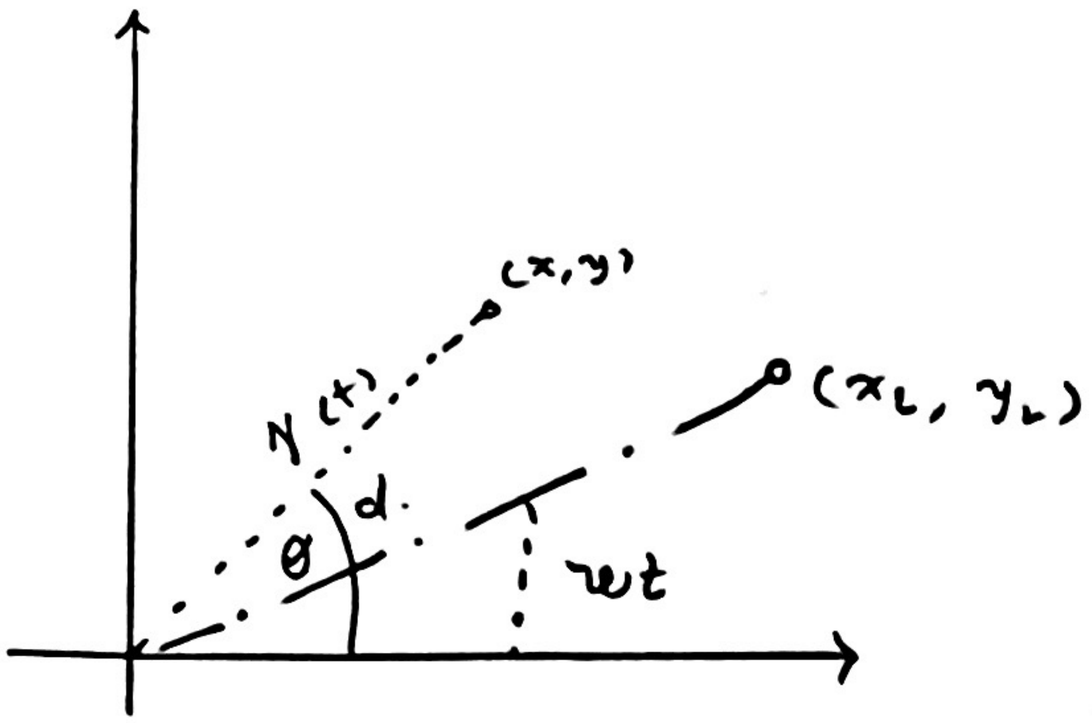
4c)



$$x_L = d\cos(\omega t)$$
$$y_L = d\sin(\omega t)$$
$$x = r_{(t)}\cos\theta$$
$$y = r_{(t)}\sin\theta$$

$$\alpha = (x_L - x)^2 = d^2\cos^2\omega t - 2d r_{(t)}\sin\theta\cos\omega t + r^2_{(t)}\sin^2\theta$$

$$\beta = (y_L - y)^2 = d^2\sin^2\omega t - 2d r_{(t)}\sin\omega t\cos\theta + r^2_{(t)}\sin^2\theta$$

$$d_{nL} = \sqrt{\alpha + \beta} = \sqrt{d^2 + r^2_{(t)} - 2d r_{(t)}(\sin\omega t\cos\theta + \cos(\omega t)\sin\theta)}$$

$$d_{nL} = \sqrt{d^2 + r^2_{(t)} - 2d r_{(t)}\cos(\theta - \omega t)}$$

4d)

$$H = T + V$$

$$V = V_{nT} + V_{nL}$$

$$T = \frac{1}{2}mV_x^2 + \frac{1}{2}mV_y^2$$

$$T = \frac{1}{2}m\dot{r}^2 + \frac{1}{2}m(r\dot{\theta})^2$$

$$V_{nT} = -\frac{GM_T m_n}{r}$$

$$V_{nL} = -G\frac{M_T m_L}{r_{nL(t,r,\theta)}}$$

$$p_r = \frac{\partial \mathcal{L}}{\partial \dot{r}} = m\dot{r}$$

$$p_\theta = \frac{\partial \mathcal{L}}{\partial \dot{\theta}} = mr^2\dot{\theta}$$

$$H = \frac{p_r^2}{2m} + \frac{p_\theta^2}{2mr^2} - \frac{GM_T m_n}{r} - \frac{GM_L m_n}{r_{nL}(t,r,\theta)}$$

4e)

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

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

$$\dot{p}_r = \frac{\partial H}{\partial r} = -\frac{2p_\theta^2}{2mr^3} - \frac{GM_T m_n}{r^2} - G\frac{M_L m_n}{r_{nL}(r,\theta,t)^2}\left[\dot{r}_{nL}(t,r,\theta)_r\right]$$

$$\dot{p}_\theta = -\frac{GM_L m_n}{r_{nL}(t,\theta,r)^2} \cdot \dot{r}(r,\theta,t)_\theta$$