Landau-Lifschitz p.11 - Problem 3 (a)

$$x = a\cos(\gamma t) + l\sin\phi$$
$$y = a\sin(\gamma t) - l\cos\phi$$

$$\dot{x} = -a\gamma\sin(\gamma t) + l\dot{\phi}\cos\phi$$
$$\dot{y} = a\gamma\cos(\gamma t) + l\dot{\phi}\sin\phi$$

$$\dot{x}^2 = a^2\gamma^2\sin^2(\gamma t) - 2al\gamma\dot{\phi}\sin(\gamma t)\cos\phi + l^2\dot{\phi}^2\cos^2\phi$$
$$\dot{y}^2 = a^2\gamma^2\cos^2(\gamma t) + 2al\gamma\dot{\phi}\cos(\gamma t)\sin\phi + l^2\dot{\phi}^2\sin^2\phi$$

$$-2\sin(\gamma t)\cos\phi = -\sin(\gamma t - \phi) - \cos(\gamma t + \phi)$$
$$+2\sin\phi\cos(\gamma t) = \sin(\phi - \gamma t) + \cos(\phi + \gamma t)$$
$$= 2\sin(\phi - \gamma t)$$

$$T = \frac{1}{2}m(\dot{x}^2 + \dot{y}^2) = \frac{1}{2}ml^2\dot{\phi}^2 + mal\gamma\dot{\phi}\sin(\phi - \gamma t)$$

$$\frac{d}{dt}\cos(\phi - \gamma t) = -\dot{\phi}\sin(\phi - \gamma t) + \gamma\sin(\phi - \gamma t)$$

omitted: $\dot{\phi}\sin(\phi - \gamma t) \to \gamma\sin(\phi - \gamma t)$

$$U = -mgl\cos\phi$$ omitting $mg\,a\sin(\gamma t)$. Does not contribute to Lagrangl equation.

$$L = T - U = \frac{1}{2}ml^2\dot{\phi}^2 + mal\gamma^2\sin(\phi - \gamma t) + mgl\cos(\phi)$$