Goldstein

1.14. We use generalized coordinates θ, ϕ, where

θ parameterizes the coordinate of COM on the radius-a circle.

ϕ parameterizes the rotation of the Rod.

$$T_{COM} = \frac{1}{2}(2m)(a\dot{\theta})^2$$

$$= ma^2\dot{\theta}^2$$

$$T_{rod} = (2)\left(\frac{1}{2}\right)(m)\left(\frac{l}{2}\dot{\phi}\right)^2$$

$$= \frac{ml^2}{4}\dot{\phi}^2$$

$$\boxed{T = ma^2\dot{\theta}^2 + \frac{ml^2}{4}\dot{\phi}^2}$$

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