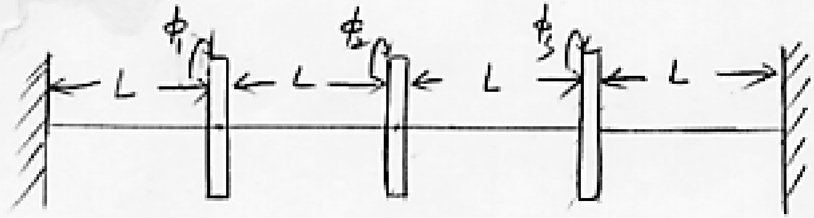

If a rod is twisted by an angle ϕ, then the twist per unit length is $\frac{\phi}{L}$

$\therefore$ Torque $= \frac{k\phi}{L}$ and $V = \frac{1}{2}\frac{k}{L}\phi^2$

The moment of inertia of a disc along the rod through its center is $I = \frac{1}{2}MR^2$

R: radius of the disc.

Since the rods are rigidly fastened the kinetic energy $T = \frac{1}{2}I_1\omega_1^2 + \frac{1}{2}I_2\omega_2^2 + \frac{1}{2}I_3\omega_3^2$

$$= \frac{1}{2}\cdot\frac{1}{2}MR^2(\dot\phi_1^2 + \dot\phi_2^2 + \dot\phi_3^2)$$

The potential energy.

$$V = \frac{k}{2L}[\phi_1^2 + (\phi_1-\phi_2)^2 + (\phi_2-\phi_3)^2 + \phi_3^2]$$

$$= \frac{k}{2L}[2\phi_1^2 + 2\phi_2^2 + 2\phi_3^2 - 2\phi_1\phi_2 - 2\phi_2\phi_3]$$

Let $\phi = \begin{pmatrix}\phi_1\\ \phi_2\\ \phi_3\end{pmatrix}$