$$
\begin{aligned}
\mathrm{KE} &= \frac{1}{2}M_1 v_1^2 \\
&= \frac{1}{2}M_1 (R_1\omega)^2 \\
&= \frac{1}{2}M_1 {R_1}^2 \omega^2 \\
&= \frac{1}{2}(M_1 {R_1}^2)\omega^2
\end{aligned}
$$

$$
I = MR^2
$$

$$
\mathrm{KE} = \frac{1}{2}I_1\omega^2
$$

$$
\begin{aligned}
\mathrm{KE} &= \frac{1}{2}M_1 v_1^2 + \frac{1}{2}M_2 v_2^2 + \frac{1}{2}M_3 v_3^2 \\
&= \frac{1}{2}(M_1 {R_1}^2)\omega^2 + \frac{1}{2}(M_2 {R_2}^2)\omega^2 + \frac{1}{2}(M_3 {R_3}^2)\omega^2 \\
&= \frac{1}{2}I_1\omega^2 + \frac{1}{2}I_2\omega^2 + \frac{1}{2}I_3\omega^2 \\
&= \frac{1}{2}(I_1 + I_2 + I_3)\omega^2 \\
&= \frac{1}{2}I_{tot}\omega^2
\end{aligned}
$$

$$
\lambda(x) = 3\frac{\mathrm{kg}}{\mathrm{m}} + (3\frac{\mathrm{kg}}{\mathrm{m}})(\frac{x}{10\mathrm{m}})
$$

$$
(\mathrm{KE} - \mathrm{E_{US}}) = \frac{1}{2}\, I\, \omega_{\mathrm{new}}^2
$$

$$\lambda = \frac{M}{L}$$

$$dm = \lambda\, dx$$

$$dI = (\text{mass})(\text{distance from rotation axis})^2 = dm\; x^2$$

$$I = \int dI = \int_{x=0}^{x=L} dm\; x^2 = \int_{x=0}^{x=L} \lambda\, dx\; x^2$$

$$I = \lambda \int_0^L x^2 dx = \lambda \left(\frac{1}{3} L^3\right) = \frac{M}{L}\,\frac{1}{3}\, L^3 = \frac{1}{3}\, M L^2$$

$$I = \int dI = \int_{x=-L/2}^{x=L/2} dm\; x^2 = \int_{x=-L/2}^{x=L/2} \lambda\, dx\; x^2$$

$$I = \lambda \left(\frac{1}{3}\frac{L^3}{8} - \left[-\frac{1}{3}\frac{L^3}{8}\right]\right) = \frac{M}{L}\left(\frac{2}{24}\, L^3\right) = \frac{1}{12}\, M L^2$$

$$\lambda(x) \quad = \quad A \; + \; Bx$$

$$dm \quad = \quad \lambda\, dx \quad = \quad A\, dx \; + \; B\, x dx$$

$$dI \quad = \quad dm\ x^2 \quad = \quad (A\, dx)\, x^2 \; + \; (B\, x dx)\, x^2$$

$$I \quad = \quad \int dI \quad = \quad \int_{x=0}^{x=L} (A\, x^2 dx) \; + \; \int_{x=0}^{x=L} (B\, x^3 dx)$$

$$I \quad = \quad \frac{1}{3}\, AL^3 \; + \; \frac{1}{4}\, BL^4$$