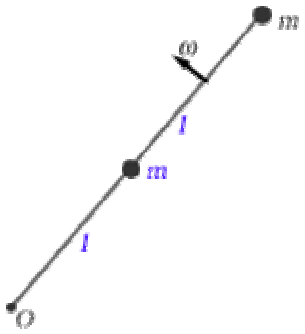
5.

Problem 11.50E (HRW)

Two particles, each with mass m, are fastened to each other, and to a rotation axis at O, by two thin rods, each with length l and mass M as shown in the figure. The combination rotates around the rotation axis with angular velocity ω. *Obtain algebraic expressions for* (a) *the rotational inertia of the combination about O and* (b) *the kinetic energy of rotation about O.*



Solution:

(a)

As mass of each rod is m and their combined length is $2l$, the moment of inertia of the rods with respect to rotation axis at O is $\frac{1}{3}\times 2M\times\left(2l\right)^2=\frac{8}{3}Ml^2$.

The moment of inertia of the two balls about O is $ml^2+m\left(2l\right)^2=5ml^2$.

Therefore, the algebraic expression for the rotational inertia of the combination about O is

$I=\frac{8}{3}Ml^2+5ml^2$.

(b)

And, the kinetic energy of rotation about O is

$$KE_{rot}=\frac{1}{2}\times I\omega^2=\frac{1}{2}\left(\frac{8}{3}M+5m\right)l^2\omega^2.$$