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 $\omega$. 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 
\[
\frac{1}{3} \times 2M \times (2l)^2 = \frac{8}{3} Ml^2.
\]
The moment of inertia of the two balls about \( O \) is 
\[
ml^2 + m(2l)^2 = 5ml^2.
\]
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
\[
KE_{rot} = \frac{1}{2} \times I \omega^2 = \frac{1}{2} \left( \frac{8}{3} M + 5m \right) l^2 \omega^2.
\]