Chapter 11 Problem 28 [†]

Given
$I_{in} = 4.2\ kg \cdot m^2$
$I_{out} = 5.7\ kg \cdot m^2$
$\omega = 3.0\ rev/s$
$m = 2.5\ kg$
$r = 0.76\ m$

Solution
Find the new angular velocity when the skater's arms are brought to the chest.

The initial moment of inertia is the skater with the outstretched arms with two masses at a set distance from the axis of rotation.

$$I_0 = I_{out} + 2(m \cdot r^2) = (5.7\ kg \cdot m^2) + 2(2.5\ kg)(0.76\ m)^2 = 8.59\ kg \cdot m^2$$

The final moment of inertia is just the moment of inertia with the arms in. We are assuming that the masses are brought to the axis of rotation. Using conservation of angular momentum

$$L_0 = L_f$$

$$I_0\omega_0 = I_f\omega_f$$

$$\omega_f = \frac{I_0\omega_0}{I_f} = \frac{I_0\omega_0}{I_{in}} = \frac{(8.59\ kg \cdot m^2)(3.0\ rev/s)}{4.2\ kg \cdot m^2}$$

$$\omega_f = 6.14\ rev/s$$

[†]Problem from Essential University Physics, Wolfson