Chapter 11 Problem 72

$I_0 = 1.8\ kg\,m^2$ $I_f = 0.5\ kg\cdot m^2$

$\omega_0 = 0.5\ \frac{rev}{s}$

$v_0 = 9.0\ m/s$ $\theta_0 = 45^\circ$

How many revolutions are executed while in the air.

First find the time in the air

$v_{0y} = v_0 \cdot \sin\theta_0 = (9.0\ m/s)\sin(45^\circ) = 6.36\ m/s$

Use the kinematic equation in the vertical direction to find the time in the air.

$$y = y_0 + v_{0y}\cdot t - \frac{1}{2}gt^2$$

Skater begins and ends at $y = 0$ & $y_0 = 0$

$$\therefore\ 0 = 0 + v_{0y}t - \tfrac{1}{2}gt^2$$

$$\tfrac{1}{2}gt^2 = v_{0y}t$$

$$t = \frac{2v_{0y}}{g} = \frac{2(6.36\ m/s)}{(9.80\ m/s^2)} = \underline{1.30\ s}$$

Now find the rotation rate in the air in revolution per second.

$$I_0\omega_0 = I_f\cdot\omega_f$$

$$\omega_f = \frac{I_0\omega_0}{I_f} = \frac{(1.8\ kg\,m^2)(0.5\ \frac{rev}{s})}{(0.5\ kg\,m^2)}$$

$$\underline{\omega_f = 1.8\ rev/s}$$

Now $\omega_f = \frac{\theta}{t} \rightarrow \theta = \omega_f\cdot t = \left(1.8\ \frac{rev}{s}\right)(1.30\ s)$

$$\boxed{\theta = 2.34\ rev}$$

skater can make 2 whole revolutions but comes up short of 2 ½ revolutions