Homework #16

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1 Problem 1

Two disks are mounted (like a merry-go-round) on low-friction bearings on the same axle and can be brought together so that they couple and rotate as one unit. The first disk, with rotational inertia 3.30 $\text{kg} * \text{m}^2$ about its central axis, is set spinning counterclockwise at 450 rev/min. The second disk, with rotational inertia 6.60 $\text{kg} * \text{m}^2$ about its central axis, is set spinning counterclockwise at 900 rev/min. They then couple together. (a) What is their angular speed after coupling? If instead the second disk is set spinning clockwise at 900 rev/min, what are their (b) angular speed and (c) direction of rotation after they couple together?

1.1 Solution

1.1.1 Section (a)

We have a concept called conservation of angular momentum.

$$
\begin{aligned}
L_i &= L_f && (1)\\
L_f &= l_1 + l_2 = I_1\omega_1 + I_2\omega_2 && (2)\\
\omega_f &= \frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2} = \frac{3.3 * 450 + 6.6 * 900}{3.3 + 6.6} && (3)\\
&= \frac{1485 + 5940}{9.9} = \boxed{750\text{rev/min}} && (4)
\end{aligned}
$$

1.1.2 Section (b)

We just need to change a positive to a negative.

$$
\begin{aligned}
\omega_f &= \frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2} = \frac{3.3 * 450 - 6.6 * 900}{3.3 + 6.6} && (5)\\
&= \frac{1485 - 5940}{9.9} = \boxed{-450\text{rev/min}} && (6)
\end{aligned}
$$

1.1.3 Section (c)

Since the magnitude is negative and negative angular velocity corresponds to clockwise motion, the angular motion is $\boxed{\textit{clockwise}}$.

2 Problem 2

The Sun's mass is 2.0×10^{30} kg, its radius is 7.0×10^{5} km, and it has a rotational period of approximately 28 days. If the Sun should collapse into a white dwarf of radius 3.5×10^{3} km, what would its period be if no mass were ejected and a sphere of uniform density can model the Sun both before and after?

2.1 Solution