Answer on Question #56961-Physics-Mechanics-Relativity

A circular disk of mass 0.3 kg and radius 31 cm, initially not rotating, slips down a thin spindle onto a turntable (disk) of mass 1.9 kg and the same radius, rotating freely at 4.5 rad/s.

a) Find the new angular velocity of the combination;

b) The change in the kinetic energy?

c) If the motor is switched on after the disk has landed, what is the constant torque needed to regain the original speed in 3.3 s?

Solution

$$I_{turntable} = \frac{1}{2} \cdot 1.9 \cdot \ 0.31^2 = \ 0.091295 \ kgm^2$$

$$I_{disc} = \frac{1}{2} \cdot 0.3 \cdot \ 0.31^2 = 0.014415 \ kgm^2$$

$$I_{Total} \ = \ 0.10571 \ kgm^2$$

Original angular momentum is

$$(L) = \ 0.091295 \cdot 4.5 = \ 0.4108275 \frac{kgm^2}{s}.$$

Conservation of angular momentum says this must be the same as the final angular momentum as there is no external torques on the system.

$$0.4108275 = \ \ 0.10571 \cdot w$$

Final angular speed

$$w \ = 3.9 \frac{rad}{s}.$$

b) The change in the kinetic energy is

$$\Delta K = \frac{1}{2}\left(I_f w_f^2 - I_i w_i^2\right) = \frac{1}{2}(0.10571 \cdot 3.9^2 \ - 0.091295 \cdot 4.5^2) = -0.12 \ J.$$

c)

$$T = I\alpha = 0.10571 \cdot \frac{4.5 - 3.9}{3.3} = 0.019 \ Nm.$$

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