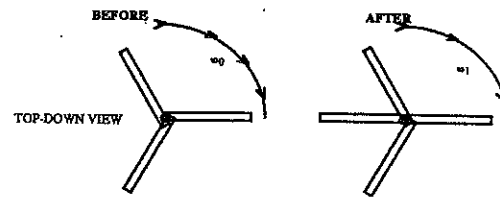
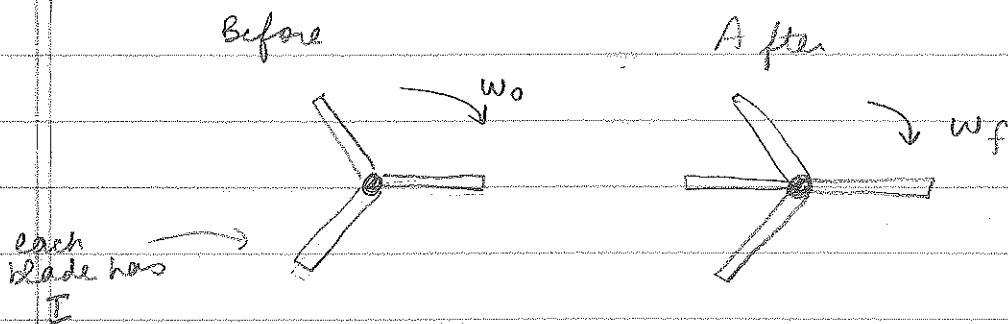


Three identical helicopter blades are mounted on a vertical axle. The axle and blades rotate around the vertical axis with angular speed ω_0 . The axle's rotational inertia with respect to this axis is negligible. A fourth helicopter blade, identical to the other three, is suddenly mounted on the axle, so that all four blades now rotate with the axle. (Assume that the fourth blade does not "unbalance" the axle.)

- What is the angular speed of the helicopter blades after the fourth blade is mounted? Yes, you have enough information.
- What fraction of the initial kinetic energy is lost as a result of the fourth blade's becoming coupled to the axle? Where does this "lost" energy go?



Helicopter blades



- a) Is angular momentum conserved?
Yes - no external torques

$$L_0 = I_{\text{tot}} \omega_0, \quad I_{\text{tot}} = 3I$$

$$L_f = I_{\text{tot}_f} \omega_f, \quad I_{\text{tot}} = 4I$$

$$3I \omega_0 = 4I \omega_f$$

$$\Rightarrow \boxed{\omega_f = \frac{3}{4} \omega_0}$$

- b) Energy is not conserved in an inelastic collision.

$$K_0 = \frac{1}{2} I_0 \omega_0^2, \quad K_f = \frac{1}{2} I_f \omega_f^2$$

$$\text{Fraction lost} = \frac{K_0 - K_f}{K_0} = \frac{\frac{1}{2}(3I)\omega_0^2 - \frac{1}{2}(4I)\left(\frac{3}{4}\omega_0\right)^2}{\frac{1}{2}(3I)\omega_0^2}$$

$$= \frac{3 - 4\left(\frac{9}{16}\right)}{3} = \frac{\frac{12}{4} - \frac{9}{4}}{3} = \frac{\frac{3}{4}}{3}$$

$$\boxed{\text{Fraction lost} = \frac{1}{4}}$$