Merry-Go-Round Example

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- A merry go round of mass M and radius R rotates freely about a frictionless vertical axle. A student with mass m walks from the rim of the disk to the center. If the angular speed of the system is w when the student is at the rim, what is the angular speed when the student is halfway to the center (R/2)?

Initial moment of inertia I_i

$$I_i = I_{mi} + I_{si}$$

$$= \tfrac{1}{2}MR^2 + mR^2$$

$\tfrac{1}{2}MR^2$: rotating disk; mR^2: point mass

$$I_f = I_{mf} + I_{sf}$$

$$= \tfrac{1}{2}MR^2 + mr^2$$

Angular momentum is conserved

$$I_i \omega_i = I_f \omega_f$$

$$\left(\tfrac{1}{2}MR^2 + mR^2\right)\omega_i = \left(\tfrac{1}{2}MR^2 + mr^2\right)\omega_f$$

$$\omega_f = \frac{\left(\tfrac{1}{2}MR^2 + mR^2\right)\omega_i}{\left(\tfrac{1}{2}MR^2 + m(R/2)^2\right)}$$