Worksheet 24
Module 10.4 Kinetic Energy of Rotation
Module 10.5 Calculating the Rotational Inertia
Problems 33, 37, 39, 40

----- Problem 1 -----  Determine the rotational inertia of a uniform solid disc of mass $M$ and radius $R$ spinning around its center.

----- Problem 2 -----  A uniform thin rod of mass $M$ and length $L$ spins around a central axis that is perpendicular to its length.

- What is the rotational inertia of this rod about this axis?
- If this rod has a mass of 48 g and length of 27 cm and it rotates with a period of 0.90 s, what is the rod’s rotational kinetic energy?

----- Problem 3 -----  A thin uniform rod of length $L$ and mass $M$ is mounted non-centrally to an axle. Placing the $x$ axis along the rod with the axle along the $z$ axis, the rod extends from $x = -a$ to $x = +b$ where $a + b = L$.

- By altering the limits of integration in our previous analysis of the thin rod, find the rotational inertia $I$ of the rod about this non-central axle?
- Derive an alternate form for the result by application of the parallel-axis theorem.

Answers
1. $I_{\text{disc}} = (1/2) M R^2$
2. $I_{\text{rod}} = (1/12) M L^2$ (about center of rod), $K = 0.007106$ J
3. $I_{\text{rod}} = M(b^3 + a^3)/(3 L) = (1/12) M L^2 + M[(b - a)/2]^2$
   Note: it’s tricky to show, but these are equivalent!
   The first form comes from doing the integral.
   The second form comes from applying the parallel-axis theorem.