7. An engineer is designing a carousel for an amusement park. The ride will be 15 m in diameter and when filled with riders will weigh 25,000 kg, all balanced and rotating about a central axis.

   a. Calculate this carousel's moment of inertia. Assume the ride behaves like a solid cylinder.

   $r = d/2 = 15/2 = 7.5$

   $I = 1/2 mr^2$

   $= (.5)(25{,}000)(7.5)^2$

   $= 7.0 \times 10^5 \ kg \cdot m^2$

   b. The carousel may also be designed with 12 uniformly spaced rods fixed like the spokes of a wheel around a center of rotation. Assuming the outward weight and dimensions are the same, is the moment of inertia for this rod design greater than or less than the design used in part a?

   $m_{rod} = \frac{25{,}000 \ kg}{12} = 2083 \ kg$

   $I_{rod} = 1/3 ml^2 = 1/3(2083 \ kg)(7.5 m)^2 = 3.91 \times 10^6 \ kg \cdot m^2$

   $I_{total} = 12 I_{rod} = (12)(3.91 \times 10^6) = 4.69 \times 10^5 \ kg \cdot m^2$

   c. For an entertaining attraction, the carousel should not move the riders at the outer edge of the carousel in part a faster than 3.0 m/s. Calculate the maximum angular velocity of the carousel.

   $\omega = v/r$

   $= \frac{3.0 \ m/s}{7.5 \ m}$

   $= 0.40 \ rad/s$

   d. For maximum enjoyment, the carousel in part a should reach its maximum angular velocity within 3.0×10^1 s of starting from rest. Calculate the minimum angular acceleration that would accomplish this velocity.

   $\alpha = \frac{\Delta\omega}{t}$

   $= \frac{.40 \ rad/s}{3.0 \times 10^1 \ s} = 0.013 \ rad/s^2$

   e. Calculate the net torque necessary for this carousel so a motor can be purchased. Use the design in part a for your calculations.

   Net torque calculated from angular acceleration

   $\alpha = \frac{\tau_{Net}}{I}$

   $\tau_{Net} = \alpha I$

   $= (0.013 \ rad/s^2)(7.0 \times 10^5 \ kg \cdot m^2)$

   $= 9.1 \times 10^3 \ N \cdot m$