Torque and Angular Momentum

1. A heavy wheel shaped as a uniform disk with $M = 100\,kg$ and $R = 80\,cm$ is rapidly spinning. A pair of brakes is applied, after which the wheel stops in 1 min, making $N = 1200$ revolutions in the process.

   (a) find ω_0

   (b) find α

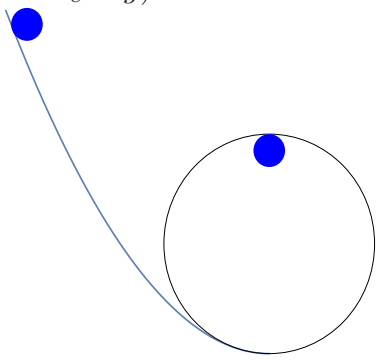
   (c) Find the torque τ from the brake pads.

   (d) find the initial angular momentum $\mathcal{L}$; check if $\Delta\mathcal{L}/\Delta t = \tau$?

   (e) find the initial kinetic energy K of the spinning wheel

2. A force $\vec{F} = \hat{i} + 2\hat{j}$ is applied to a point $\vec{r} = 2\hat{i} + \hat{j}$. Find the vector-torque about the origin.

3. (*) (Loop-the-loop). A small ball ($I = (2/5))mr^2$) is released from height H and goes into a loop with $R = 1\,m$ as shown in the figure. For which H will it make the loop? (Hint: for minimal H, at the top of the loop the ball is "weightless", i.e. $a_c = g$).



4. A figure skater goes into a spin, keeping her arms up and close to her body, illustrating conservation of angular momentum. In a classroom demonstration of the above effect, a student is standing on a rotating platform, which is spinning with 2 rev/s . The student is holding two heavy dumbbells, 5 kg each, originally tightly pressed to his/her body at a negligible distance from the axis of rotation. The student then extends the arms horizontally, bringing each dumbbell 80 cm from the axis of rotation. Assume the student (without dumbbells) and the platform have a combined rotational inertia of $I = 8\,kg \cdot m^2$ and (unlike the case of the figure skater) neglect the rotational inertia of extended arms.

   (a) find the original ω

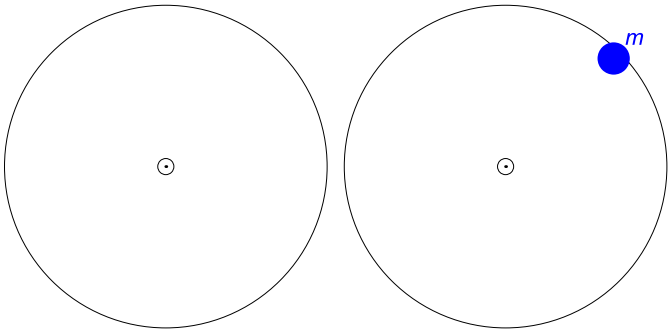
   (b) find the angular momentum $\mathcal{L}$

   (c) find the final I' (note: there are *two* arms)

   (d) find the final Ω

   (e) find the change in kinetic energy

5. A merry-go-round on a playground has rotational inertia $I = 50\,kg \cdot m^2$ and is spinning at $\omega = 2\,rad/s$. An $m = 30\,kg$ kid hops on the platform, $1\,m$ away from the axis of rotation, with no initial velocity.



   (a) find the new rotational inertia I'

   (b) Find the new angular velocity ω'.

6. An $M = 2\,kg$ disk with $R = 1\,m$ is freely spinning with $\omega = 4\,rad/s$. A ring with $m = 0.5\,kg$, $r = 80\,cm$ is dropped onto the center of the dsk and sticks to it. Find the new Ω (in rad/s).