PHY 211 Homework 13

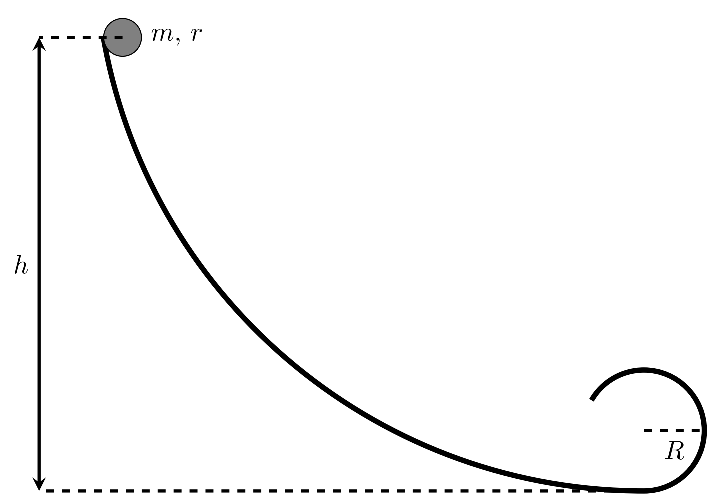
Due April 22, 2020

Problem 1. A thin hoop with a mass m and a radius r is rolling without slipping along the ground, when it encounters a slope upwards. Its initial translational velocity is v_0.

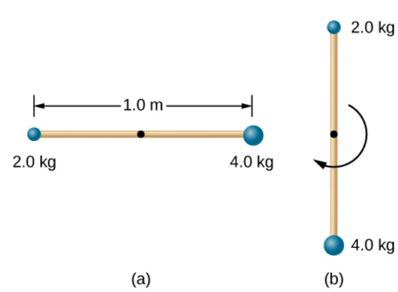
(a) To what height will the hoop roll up the slope before changing direction?

(b) Would a solid ball with the same velocity roll up higher, lower, or the same distance?

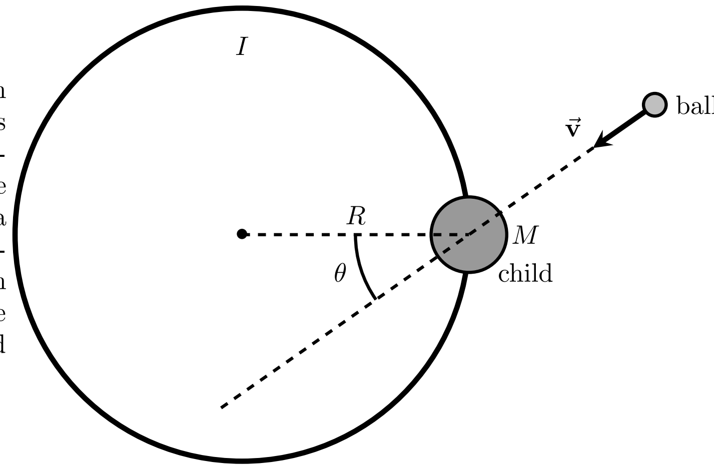
Problem 2. A uniform ball of radius r and mass m rolls without slipping down the track shown below. The radius of the loop is R. The ball is released from rest at a height h above the bottom of the track. You can ignore the radius of the ball when dealing with its height above the bottom of the track. How high must h be to ensure that the ball makes it around the loop?



Problem 3. A stick of length 1.0 m and mass 6.0 kg is free to rotate about a horizontal axis through the center. Small bodies of masses 4.0 and 2.0 kg are attached to its two ends (see the figure). The stick is released from the horizontal position. What is the angular velocity of the stick when it swings through the vertical?



Problem 4. A child of mass $M = 25\,\text{kg}$ stands on the edge of a stationary merry-go-round of radius $R = 5\,\text{meter}$. The moment of inertia of the merry-go-round about its rotation axis is $I = 150\,\text{kg}\,\text{m}^2$. The child catches a ball of mass $m = 3\,\text{kg}$ thrown by a friend. Just before the ball is caught, it has a velocity of magnitude $v = 12\,\text{m/s}$, at angle $\theta = 35°$ with respect to a line pointing towards the center of the merry-go-round, as shown. What is the angular speed of the merry-go-round just after the ball is caught?



Problem 5. An Earth satellite has its apogee (farthest point away, labelled A) at $h_A = 2500\,\text{km}$ above the surface of Earth and perigee (closest point labelled P) at $h_P = 500\,\text{km}$ above the surface of Earth. The radius of Earth is 6370 km. At apogee its speed is $v_A = 6260\,\text{m/s}$. What is its speed at perigee?
Note: you can't use $U_{grav} = mgh$ for general gravitation; it only works near the surface of the Earth. If you want to solve this problem with energy, you will have to look up how to treat the potential correctly.