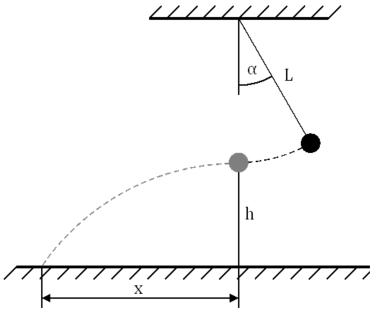
Exercises in Introductory Physics I

Exercise Sheet 7
due to 04.12.23, 11:59 AM

Energy and Momentum Conservation

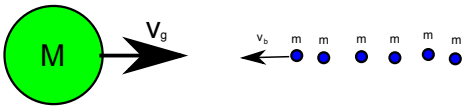
1. A pendulum with a length L starts at a time $t = 0$ with a velocity $v = 0$, displaced by an angle α. At the lowest point it hits another mass which sits on a pole, and an elastic collision happens.



   a) How much time passes from the beginning of the movement unto the collision? (1P)

   b) What are the speeds of the pendulum and the mass on the pole before and after the collision? (2P)

2. Imagine a battle of green monsters vs. blue monsters. The green monsters shoot one huge green rubber ball (mass $M = 400\,\text{kg}$, velocity $v_g = 40\,\text{km/h}$) at the blue monsters. The blue monsters counter by shooting little blue bullets ($m = 10\,\text{g}$) with high velocity ($v_b = 400\,\text{km/h}$) at the green ball. The bullets pierce through the green ball and lose half of their initial velocity during this process. How many shots with the blue bullets are needed to stop the green monsters' ball? How much energy is deposited into the green ball? (2P)



3. A projectile with a mass M and a velocity $v(t = 0) = 0$ explodes into two pieces(masses m_1 and m_2). The energy gain from the explosion is E. What is the ideal mass distribution so that for one of the pieces:

   (a) The kinetic energy is maximised. (1P)

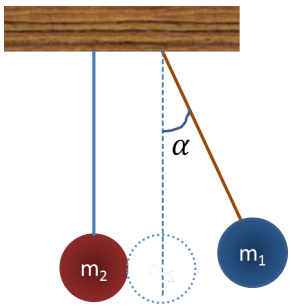
   (b) The velocity is maximised. (1P)

   (c) The momentum is maximised. (1P)

4. A pendulum, a string with the attached ball of mass m_1, is released from an initial angle α. It collides elastically with a second pendulum (see figure below), which is found in its equilibrium state. The second pendulum is identical to the first one, but has a different mass m_2.

   a) Find the angles to which both pendula will deviate after the collision. (1P)

   b) Find the collision frequency (number of collisions per unit time). (1P)



Center of Mass

1. From a rectangle, having a side length a, a triangular region of height h is cut off as shown in the figure below. When the thus obtained object is placed on a sharp needle at the point P, it remains in equilibrium given any initial orientation. Find the height h of the triangle. (2P)