

Homework No. 09A (Fall 2021)

PHYS 203A: COLLEGE PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Due date: Tuesday, 2021 Nov 9, 12.30pm, on D2L

Instructions

- Describe your thought process in detail and organize it clearly. Make sure your answer has the correct units and the right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (Assessments → Assignments).

1. **(10 points.)** Two children hang by their hands from the same tree branch. The branch is straight, and grows out from the tree trunk at an angle of 30.0° above the horizontal. One child, with a mass of 45.0 kg , is hanging 1.50 m along the branch from the tree trunk. The other child, with a mass of 35.0 kg , is hanging 2.00 m from the tree trunk. What is the magnitude of the total torque exerted on the branch by the children? Assume that the axis is located where the branch joins the tree trunk and is perpendicular to the plane formed by the branch and the trunk.
2. **(10 points.)** The center of mass of an elongated block of mass M , with non-uniform mass distribution inside it, may be determined by an arrangement shown in Figure 1 below. The block is placed on a plank of mass $m = 0$ that rests on two scales separated by a distance equal to the length $L = 2.00\text{ m}$ of the block. The scales that measure the normal forces read $N_2 = 450.0\text{ N}$ and $N_1 = 350.0\text{ N}$. Determine the distance x of the center of mass of the block from one end.

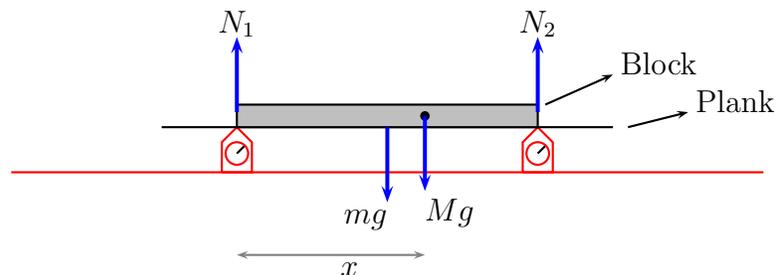


Figure 1: Problem 2.

3. (10 points.) Workers have loaded a delivery truck in such a way that its center of mass is only slightly forward of the rear axle. The mass of the truck and its contents is 7500 kg. Find the magnitude of the normal force exerted by the ground on the front wheels of the truck.
4. (10 points.) Five balls of masses $m_1 = 1.0$ kg, $m_2 = 2.0$ kg, $m_3 = 3.0$ kg, $m_4 = 4.0$ kg, and $m_0 = 5.0$ kg, are connected by massless rods of length $a = 10.0$ cm and $b = 15.0$ cm, as shown in Figure 2. This configuration is rotated about an axis coming out of the plane containing the five masses and passing through the mass m_3 . The inertia associated with this rotational motion is quantified by the moment of inertia. Compute the moment of inertia.

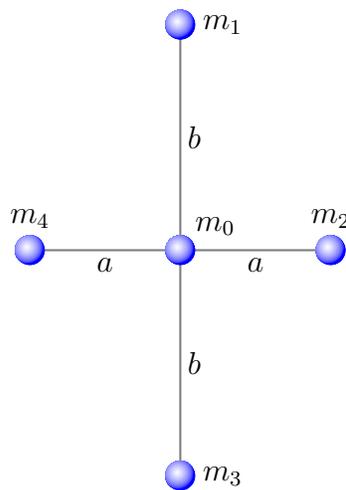


Figure 2: Problem 4.

5. (10 points.) The Atwood machine in Figure 3 consists of two masses $m_1 = 10.0$ kg and $m_2 = 20.0$ kg connected by a massless (inextensible) string passing over a pulley of mass $M = 5.0$ kg in the shape of a uniform disc of radius R such that it has moment of inertia $I = MR^2/2$. Determine the magnitude of the resultant acceleration of mass m_1 . (Recall that in an earlier analysis we had assumed massless pulley.)

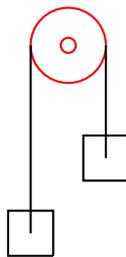


Figure 3: Atwood machine.