Homework No. 13 (Fall 2024)

PHYS 205A-002: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale

Due date: Wednesday, 2024 Nov 20, 2:00 PM, on D2L

Instructions

- You are encouraged to use any of the resources to complete this homework. However, the extent to which you depend on resources while doing this homework is a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Links to solutions are provided. Further, links to few variations of the problem are provided that serve as practice problems.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and right number of significant digits.
- Additional problems, with hyperlinks to exams, are available in Lecture Notes.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments). You can replace your PDF file, only the last file is graded.

Problems

1. (**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.

   [**Solution**]

2. (**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.

   [**Solution**]

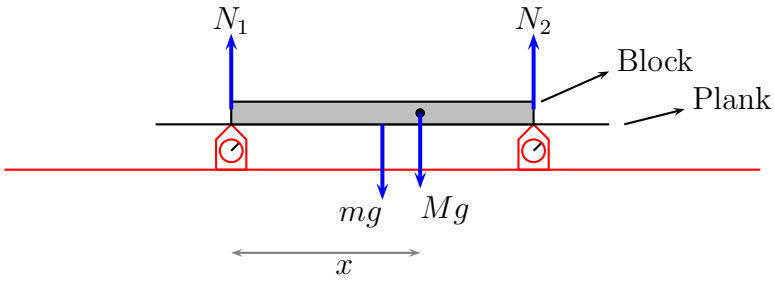

Figure 1: Problem 1.

3. (**10 points.**) Five balls of masses $m_1 = 1.0\,\text{kg}$, $m_2 = 2.0\,\text{kg}$, $m_3 = 3.0\,\text{kg}$, $m_4 = 4.0\,\text{kg}$, and $m_0 = 5.0\,\text{kg}$, are connected by massless rods of length $a = 10.0\,\text{cm}$ and $b = 15.0\,\text{cm}$, 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.

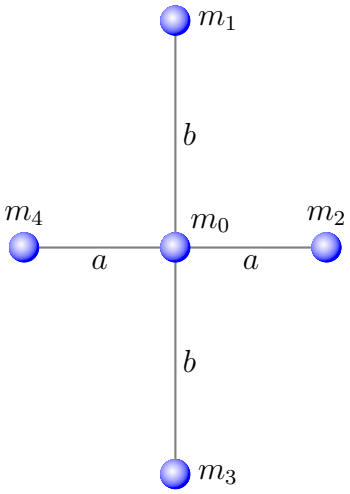

Figure 2: Problem 3.

[**Solution**]

4. (**10 points.**) An object in the shape of a spherical shell, (with $I = \frac{2}{3}MR^2$ when the axis of rotation passes through the center of sphere,) rolls perfectly (without sliding or slipping) on the surface of an incline that makes an angle 30° with the horizontal. What is the acceleration of the shell?

[**Solution**]

5. (**10 points.**) A uniform solid sylinder ($I = \frac{1}{2}MR^2$) of radius 10.0 cm and mass 1.00 kg is free to rotate about its symmetry axis. The cylinder acts like a pulley. A string wound

around the cylinder is connected to a block of mass $m = 0.50\,\text{kg}$, which falls under gravity. See Figure 3. What is the acceleration of the mass m?

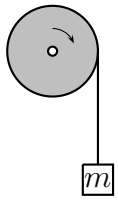

Figure 3: Problem 5.

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