Homework No. 14 (Spring 2024)

PHYS 205A-001: UNIVERSITY PHYSICS

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

Due date: Monday, 2024 Apr 29, 12:00 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.
- 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.**) A solid sphere, (with $I = \frac{2}{5}MR^2$ when the axis of rotation passes through the center of sphere,) rolls perfectly (without sliding or slipping) on a horizontal surface. The total kinetic energy of the sphere is the sum of the translational kinetic energy and rotational kinetic energy. What percentage of the total kinetic energy of the sphere is in the form of translational kinetic energy.

   [**Solution**]

2. (**10 points.**) 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 an inclined plane. If the sphere started from rest at the top, from a vertical height of 1.00 m, what is the velocity of the sphere when it reaches the bottom of the incline?

   [**Solution**, 2023S FE P06, 2022F FE P06, 2022S FE P07]

3. (**10 points.**) A solid sphere of radius $a = 0.20\,\text{m}$, (with moment of inertia $I = \frac{2}{5}Ma^2$ when the axis of rotation passes through the center of sphere,) rolls perfectly (without sliding and slipping) on a surface in the shape of a circle of radius $R = 2.0\,\text{m}$ shown in Figure 1. For what minimum velocity v_i at the bottom of the circle will the sphere be able to go all around?

   [**Solution**, 2017F FE P07, 2015F FE P08]

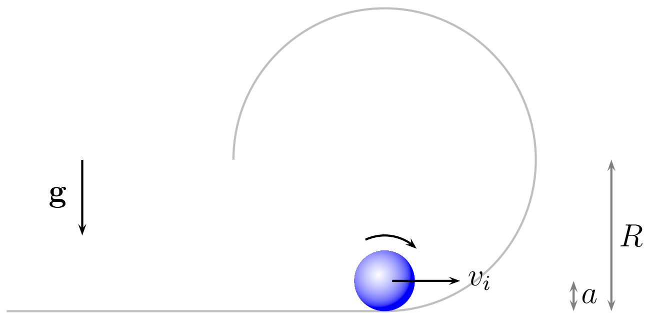

Figure 1: Problem 3.

4. (**10 points.**) A circular platform in the shape of a disc of radius $R = 2.0\,\mathrm{m}$ and mass $M = 75\,\mathrm{kg}$ is free to rotate about an axis passing through the center of the disc, with the axis perpendicular to the disc, ($I = \frac{1}{2}MR^2$.) A boy weighing $50.0\,\mathrm{kg}$ moves inward from the outer edge of the disc to the center of the disc. What is the anglular speed of the disc when the boy reaches the center, if the angular speed was $5.0\,\mathrm{rad/s}$ when the boy was at the outer edge.

   [**Solution**, 2018S FE P09, 2017F FE P08, 2016F FE P08]

5. (**10 points.**) An ice skater is spinning with both arms and a leg outstretched. Then, she pulls her arms and leg inward. As a result of this maneuver, her angular velocity ω increases by a factor of 2.0. What is the corresponding change in the moment of inertia.

   [**Solution**, 2022F FE P04]