Homework No. 09B (Fall 2020)

PHYS 203A: COLLEGE PHYSICS

Department of Physics, Southern Illinois University–Carbondale
Due date: Tuesday, 2020 Nov 17, 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).

Questions

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. What fraction of the total kinetic energy of the sphere is in the form of rotational kinetic energy.

2. (**10 points.**) A solid cylinder, (with $I = \frac{1}{2}MR^2$ when the axis of rotation is along the axis of cylinder,) rolls perfectly (without sliding or slipping) on an inclined plane. If the cylinder started from rest at the top, vertical height of $1.20\,\text{m}$, what is the velocity of the cylinder when it reaches the bottom of the incline?

3. (**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 shown in Figure 1. It starts from rest at point A where the vertical height is $h_A = 40.0\,\text{m}$. Determine the velocity of the object at point E, where the vertical height is $h_E = 20.0\,\text{m}$.

4. (**10 points.**) A rod of length $L = 1.0\,\text{m}$, (with $I = \frac{1}{3}ML^2$ when the axis of rotation is perpendicular to the rod and passing through one end of the rod,) is free to rotate in a vertical plane. The axis of rotation is frictionless. For what minimum velocity v_i of the tip of the rod in Figure 2 will the rod be able to go all around.

5. (**10 points.**) A circular platform in the shape of a disc of radius $R = 2.0\,\text{m}$ and mass $M = 75\,\text{kg}$ 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 $50.0\,\text{kg}$ 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 $5.0\,\text{rad/s}$ when the boy was at the outer edge.
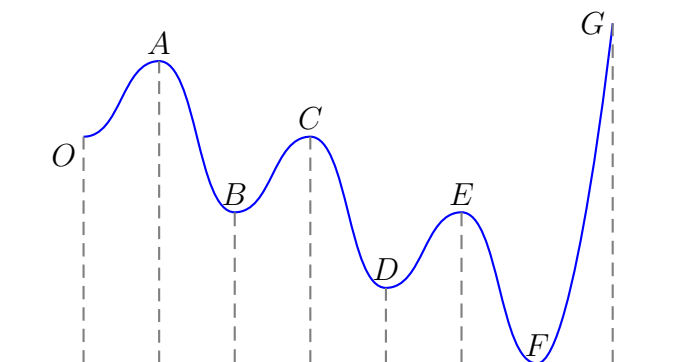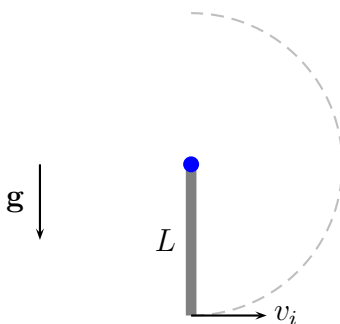
Figure 1: Problem 3.

Figure 2: Problem 4.

6. (**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.

7. (**10 points.**) Earth's orbit around the Sun is an ellipse. At the aphelion the distance between Earth and Sun is 152.10×10^6 km and Earth's speed is 29.29 km/s. What will be Earth's speed at the perihelion when the distance between Earth and Sun is only 147.10×10^6 km. Hint: Angular momentum of Earth-Sun system is conserved. In orbital mechanics of spaceships this concept is used for gaining speed and is known as gravitational slingshot.