

# Homework No. 09B (Fall 2021)

## PHYS 203A: COLLEGE PHYSICS

*Department of Physics, Southern Illinois University–Carbondale*

Due date: Thursday, 2021 Nov 18, 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).
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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 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  $h_A = 40.0$  m. Determine the velocity of the object at point  $E$ , where the vertical height is  $h_E = 20.0$  m.
  4. **(10 points.)** A circular platform in the shape of a disc of radius  $R = 2.0$  m and mass  $M = 75$  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 kg moves inward from the outer edge of the disc to the center of the disc. What is the angular speed of the disc when the boy reaches the center, if the angular speed was 5.0 rad/s when the boy was at the outer edge.
  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  $\omega$  increases by a factor of 2.0. What is the corresponding change in the moment of inertia.

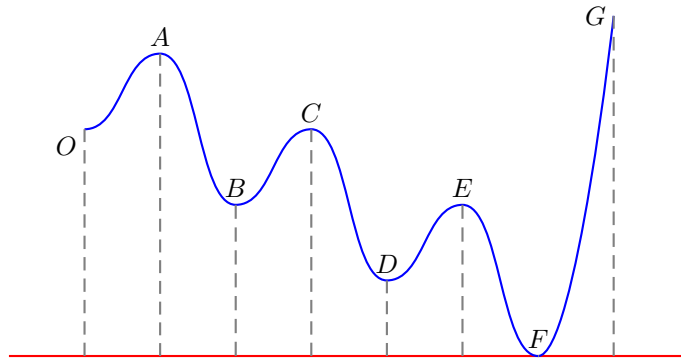


Figure 1: Probel 3.

6. **(10 points.)** Earth's orbit around the Sun is an ellipse. At the aphelion the distance between Earth and Sun is  $152.10 \times 10^6$  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  $147.10 \times 10^6$  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.