Final Exam (2022 Spring)

PHYS 205A-001: UNIVERSITY PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Date: 2022 May 5

(Name) (Signature)

Instructions

- Seating direction: Please be seated on seats with seat numbers divisible by 2.
- Total time = 50 minutes.
- There are 7 questions in this exam.
- Equation sheet is provided separately.
- To be considered for partial credit present your work in detail and organize it clearly.
- A simple calculator (with trigonometric functions) is allowed.
- Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**5 points.**) When you throw a ball up in the air what is the instantaneous acceleration of the ball when it reaches the highest point?

2. (**5 points.**) A particle is undergoing uniform circular motion. That is, it is moving along a circular path with uniform speed. What can you conclude about the magnitude and direction of the acceleration of the particle?

3. (**5 points.**) What is the difference between gravitational field and gravitational force?

4. (**10 points.**) Your mass is 75 kg. How much will you weigh on a bathroom scale (designed to measure the normal force in Newtons) inside an elevator that is slowing down at $2.0\,\mathrm{m/s^2}$ while moving down?

5. (**10 points.**) A motorcycle accelerates uniformly from rest and reaches an angular speed of 75.0 rad/s in 8.00 s. The radius of each tire is 0.300 m. What is the magnitude of the linear acceleration of each tire? Assume perfect rolling (without sliding or slipping).

6. (**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 1. This configuration is rotated about an axis represented by a line passing through m_3, m_0, and m_1. The inertia associated with this rotational motion is quantified by the moment of inertia. Compute the moment of inertia.

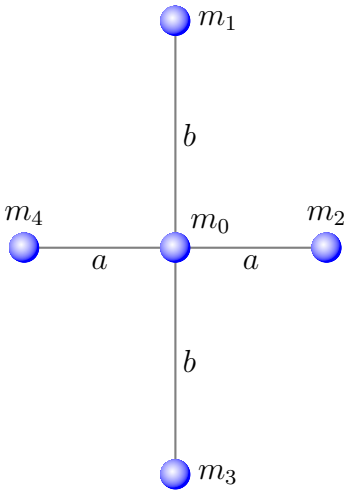

Figure 1: Problem 6.

7. (**10 points.**) An object in the shape of 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 the surface shown in Figure 2. 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 $h_E = 20.0\,\text{m}$.

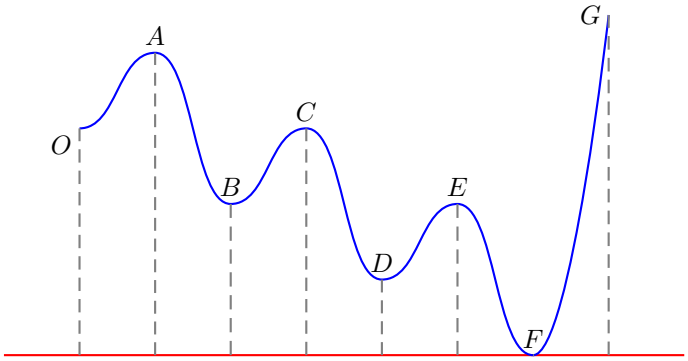

Figure 2: Problem 7.