Final Exam (2022 Fall)

PHYS 205A-002: UNIVERSITY PHYSICS

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

Date: 2022 Dec 14

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 5.
2. Total time = 120 minutes.
3. There are 4 conceptual questions and 3 problems in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of smart devices, including smart watches, are strictly prohibited. They should stay out of reach during the exam.
8. Restroom breaks are allowed. Under questionable circumstances this might lead up to a Makeup Exam.
9. Academic misconduct will lead to a failing grade in the course.

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

2. (**5 points.**) A weighing scale is designed to measure the normal force acting on the object placed on the scale. A mass m rests on this weighing scale while it is placed on the floor of an elevator. Imagine the scenario when all the cables snap and the elevator falls freely. What does the weighing scale read while the elevator, the scale, and the mass, are all falling freely?

3. (**5 points.**) What is the magnitude and direction of the acceleration of an object when it is moving in a circle of radius R with uniform speed v.

4. (**5 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 does the associated moment of inertia increase or decrease?

5. (**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 passing through m_1, m_0, and m_3. The inertia associated with this rotational motion is quantified by the moment of inertia. Compute the moment of inertia.

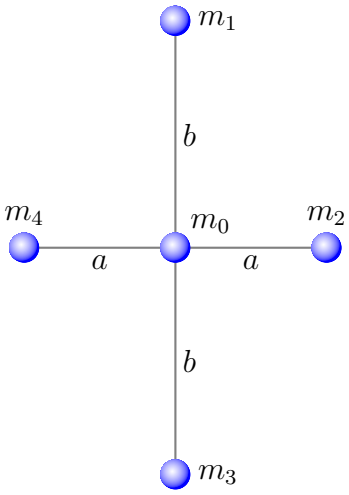

Figure 1: Problem 5.

6. (**10 points.**) A ring, (with $I = MR^2$ when the axis of rotation is along the axis of ring,) rolls perfectly (without sliding or slipping) on an inclined plane. If the ring started from rest at the top, vertical height of 1.20 m, what is the velocity of the ring when it reaches the bottom of the incline?

7. (**10 points.**) Derive the expression for the escape velocity of Earth.