Final Exam (2023 Fall)

PHYS 205A-002: UNIVERSITY PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Date: 2023 Dec 15

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
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 present 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, is 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 vertically up in the air the instantaneous velocity of the ball is zero when it reaches the highest point. What is the instantaneous acceleration of the ball when the ball reaches the highest point? Neglect air resistance.

2. (**5 points.**) Two masses $m_1 = 10.0\,\text{kg}$ and $m_2 = 20.0\,\text{kg}$ are stacked together on a frictionless plane. A force $\mathbf{F}$ is exerted on m_2. See Figure 1. Identify all the forces acting on mass m_1.

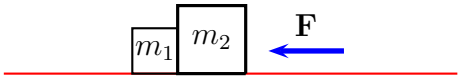

Figure 1: Problem 2.

3. (**5 points.**) The velocity of a 25 kg object changes from $\vec{\mathbf{v}}_i = (4.0\,\hat{\mathbf{i}} + 3.0\,\hat{\mathbf{j}})\,\mathrm{m/s}$ to $\vec{\mathbf{v}}_f = (6.0\,\hat{\mathbf{i}} + 8.0\,\hat{\mathbf{j}})\,\mathrm{m/s}$ while it traverses along a path. What is the total work done by all the forces acting on the object during this change in velocity.

4. (**5 points.**) What can you deduce about the total torque acting on an object if it's angular momentum is not changing in time. In particular, report the value of the total torque.

5. (**10 points.**) A mass slides down a ramp that is 6.0 m long and inclined at $\theta = 30°$ with respect to the horizontal. The initial speed of the mass at the top of the ramp is 3.0 m/s. Neglect friction. See Figure 2. Determine the acceleration of the mass.

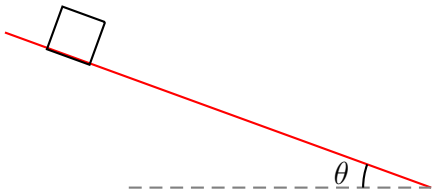

Figure 2: Problem 5.

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 3. This configuration is rotated about an axis passing through masses 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.

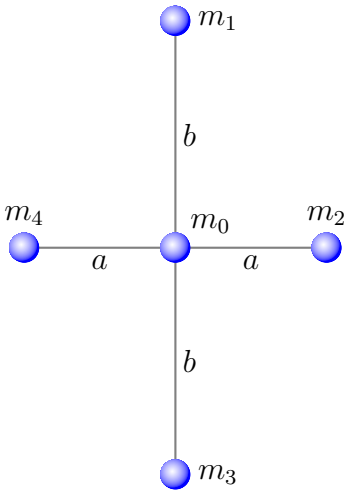

Figure 3: Problem 6.

7. (**10 points.**) Two identical stars, each of mass m, are positioned at the corners, sharing the same edge, of a square of edge length L. See Figure 4. Find the magnitude and direction of the gravitational field at the center of the square marked $\times$.

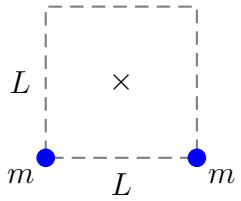

Figure 4: Problem 7