Final Exam (Spring 2025)

PHYS 205A-001: UNIVERSITY PHYSICS

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

Date: 2025 May 7

(Name) (Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows, B, D, F, ...
2. Total time = 120 minutes.
3. There are 4 conceptual questions and 3 problems in this exam.
4. Equation sheet is provided separately.
5. 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. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) A ball is dropped from rest from a height of 10.0 m above the ground. Neglect air resistance. Determine the velocity of the ball right before it reaches the ground.

2. (**5 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 moving upward at constant speed?

3. (**5 points.**) Given the expression

$$P = \kappa J, \tag{1}$$

where P has the dimension of momentum and J that of impulse. What is the dimension of κ?

4. (**5 points.**) A uniform disc rolls perfectly (without slipping or sliding) on a surface. What is the total work done by the frictional force. Include the contributions of both linear and rotational motion.

5. (**10 points.**) A car of mass $m_1 = 2.0 \times 10^3\,\text{kg}$ is moving at speed $v_{1i} = 35.0\,\text{m/s}$ towards East. A truck of mass $m_2 = 3.0\,m_1\,\text{kg}$ is moving at speed $v_{2i} = 25\,\text{m/s}$ towards North. They collide at an intersection and get entangled. (complete inelastic collision). What is the magnitude and direction of the final velocity of the entangled automobiles?

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 passing trough the masses m_1 and m_3. The inertia associated with this rotational motion is quantified by the moment of inertia. Compute the moment of inertia.

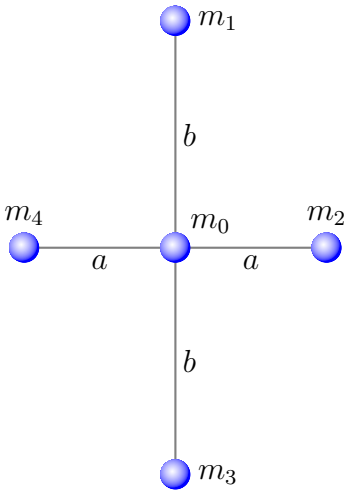

Figure 1: Problem 6.

7. (**10 points.**) Three identical stars, each of mass m, are positioned at the corners of a square of edge length L. Find the gravitational potential at the vacant corner of the square due to the three stars.