

## Final Exam (Fall 2024)

### PHYS 205A-002: UNIVERSITY PHYSICS

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

Date: 2024 Dec 13

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(Name)

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### Instructions

1. Seating direction: On even-numbered seats in alternate rows A, C, E, . . . .
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.) A projectile is launched with an initial velocity of magnitude  $v_0 = 25 \text{ m/s}$  at an angle  $\theta_0 = 30^\circ$  above the horizontal. What is the magnitude and direction of the velocity of the projectile when it is at the highest point  $B$  in Figure 1?

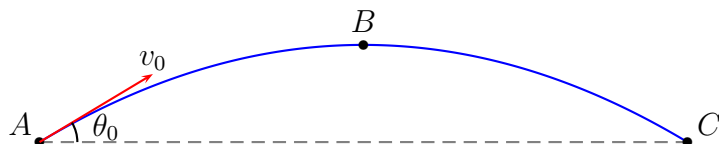


Figure 1: Problem 1.

2. (5 points.) What is the dimension (or units) for coefficient of static friction.

3. (5 points.) A 25.0 kg mass slides down a frictionless incline that makes an angle of  $\theta = 30.0^\circ$  with the horizontal. Assume that the mass starts from rest. The mass slides  $d = 10.0$  m along the incline. Determine the work done by the normal force.

4. (**5 points.**) A solid sphere, (with  $I = \frac{2}{5}MR^2$  when the axis of rotation passes through the center of sphere,) and 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 a horizontal surface. Which one of them experiences a larger rotational inertia?

5. (10 points.) A student slides a mass off the top of a horizontal table. The height of the table is 1.30 m. The mass slides off the table with a horizontal velocity of 3.50 m/s. How far from the base of the table does the mass strike the floor?

6. **(10 points.)** A motorcycle accelerates uniformly from rest and reaches a linear speed of  $24.0 \text{ m/s}$  in a time of  $8.00 \text{ s}$ . The radius of each tire is  $0.300 \text{ m}$ . What is the magnitude of the angular acceleration of each tire?

7. (10 points.) Determine the expression for the gravitational field at point marked  $\times$  in Figure 2, along the bisector of the line segment connecting two identical stars, masses  $m_1 = m_2 = m$ , that are separated by distance  $2a$  and a vertical distance  $a$  from the origin.

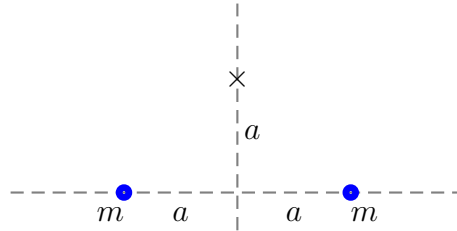


Figure 2: Problem 7