Midterm Exam No. 03 (Fall 2025)

PHYS 205A-002: UNIVERSITY PHYSICS

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

Date: 2025 Nov 3

(Name) (Signature)

Instructions

1. Seating direction: In alternate rows, B, D, F, . . . , on even-numbered seats.
2. Total time = 50 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.**) The orbit of a planet going around a star is circular. What is the work done by the gravitational force on the planet while the planet moves half a circle around the star.

2. (**5 points.**) Using the potential energy curve shown in Figure 1 determine the direction of the force at $x = 3.0\,\mathrm{m}$.

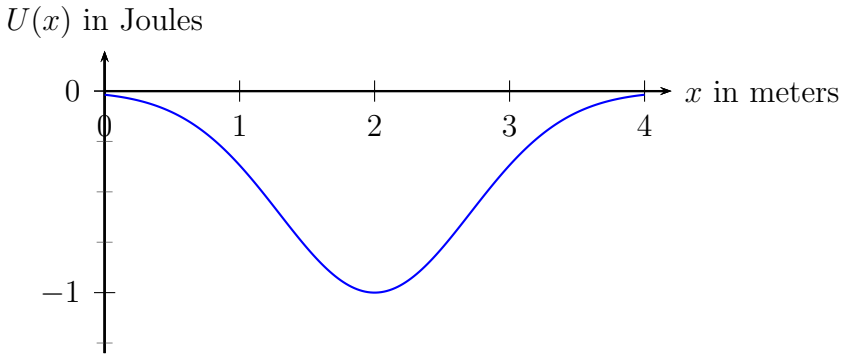

Figure 1: Problem 2.

3. (**5 points.**) What is the ratio of the initial kinetic energy to final kinetic energy in a perfectly inelastic collision involving two particles of equal masses when one of the mass is initially at rest?

4. (**5 points.**) A mass of 100. g moving with a speed 10. m/s (elastically) collides with another identical mass that is at rest. Determine the magnitude and direction of the velocities of the masses after collision.

5. (**10 points.**) A 25 kg mass is projected up a frictionless surface, see Figure 2, from point B. It comes to rest at point A. Determine the height of point A, given the mass is projected with a velocity 14 m/s at point B.

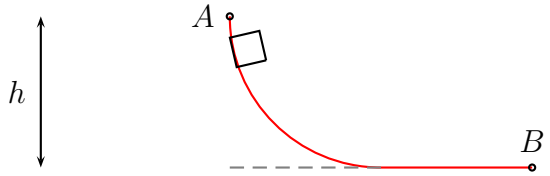

Figure 2: Problem 5.

6. (**10 points.**) The potential energy of a particle moving along the x axis is given by

$$U(x) = ax^2 + bx^4, \qquad a = 8.0\,\frac{\text{J}}{\text{m}^2}, \quad b = -1.0\,\frac{\text{J}}{\text{m}^4}. \tag{1}$$

(a) Determine the points on the x axis where the force on the particle is zero.

(b) What can you conclude about the stability of the particle at the points where the force is zero? That is, is it a stable point or an unstable point?

7. (**10 points.**) A bullet of mass 30.00 g is fired into a wooden block of mass 3.000 kg that hangs like a pendulum. The bullet is embedded in the block (complete inelastic collision). The block (with the bullet embedded in it) goes $h = 30.0$ cm high after collision. Calculate the speed of the bullet before it hit the block.