

Midterm Exam No. 03 (Spring 2025)

PHYS 205A-001: UNIVERSITY PHYSICS

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

Date: 2025 Apr 7

(Name)

(Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows, B, D, F,
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 velocity of a 20. kg object is $\vec{v}_i = (4.0\hat{\mathbf{i}} + 3.0\hat{\mathbf{j}})$ m/s. Compute the kinetic energy of the object.

2. (**5 points.**) You climb up a stair at the North entrance of a building, walk around in the corridors, climb down a stair at the South entrance of the building, and return back to where you started. What is the work done by the gravitational force acting on you during the round trip?

3. **(5 points.)** The potential energy of a particle moving along the x axis is described by $U(x)$. What physical quantity is associated to the negative derivative of the potential energy with respect to x ,

$$-\frac{\partial U}{\partial x}. \quad (1)$$

4. **(5 points.)** A mass m_1 moving with a speed 10.m/s (elastically) collides with another identical mass $m_2 = m_1$ initially at rest. Determine the magnitude and direction of the final velocities of the masses after collision.

5. (10 points.) A 25 kg mass slides down a surface, see Figure 1. Determine the work done by the force of friction while it falls a vertical height of $h = 3.0$ m and gains a speed of 4.0 m/s starting from rest.

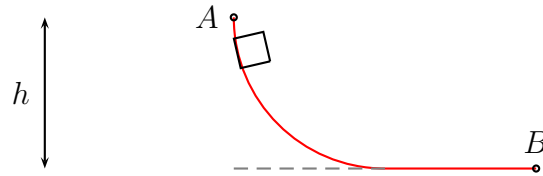


Figure 1: Problem 5.

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

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

- (a) Determine the points on the x axis where the potential energy is zero.
- (b) Determine the points on the x axis where the force on the particle is zero.
- (c) 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 car of mass 2000.0 kg is moving at speed $30.\text{ m/s}$ towards East. A truck of mass 6000.0 kg is moving at speed $20.\text{ m/s}$ towards South. 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?