Midterm Exam No. 03 (Spring 2026)

PHYS 205A-001: UNIVERSITY PHYSICS

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

Date: 2026 Apr 06

(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.**) Determine the kinetic energy of a 2.0 kg object moving with velocity

$$\vec{\mathbf{v}} = (4.0\,\hat{\mathbf{i}} + 3.0\,\hat{\mathbf{j}})\,\mathrm{m/s}. \tag{1}$$

2. (**5 points.**) The Artemis II astronauts are conducting the lunar flyby today, 2026 April 6, while on a 10-day mission around the Moon. What will be the work done by the gravitational force acting on the astronauts during the round trip?

3. (**5 points.**) The gravitational potential energy of an object rolling on a particular terrain is described by the function

$$U(x) = a\,x^2, \qquad a = -1.0\,\frac{\mathrm{J}}{\mathrm{m}^2}. \tag{2}$$

Is the object in stable equilibrium or unstable equilibrium at $x = 0$?

4. (**5 points.**) A railroad car of mass m is moving with a speed of 4.00 m/s. It collides and couples with three other coupled railroad cars, each of the same mass as the single car and moving in the same direction with an initial speed of 2.00 m/s. Determine the speed of the four cars after the 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 $h = 3.0\,\text{m}$ and gains a speed of $4.0\,\text{m/s}$ starting from rest.

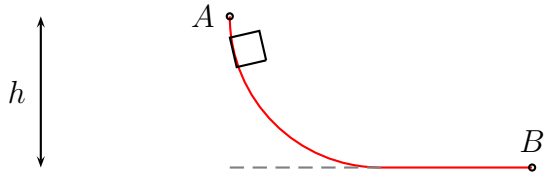

Figure 1: Problem 5.

6. (**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 30.0 cm high after collision. Calculate the speed of the bullet before it hit the block.

7. (**10 points.**) A mass $m_1 = 1.0\,\text{kg}$ moving with speed v_{1i} (elastically) collides with another mass $m_2 = 2.0\,\text{kg}$ initially at rest. After the collision mass m_2 moves with speed $v_{2f} = 3.0\,\text{m/s}$ in the same direction as m_1. Determine the initial speed v_{1i}.