

Midterm Exam No. 03 (Fall 2024)

PHYS 205A-002: UNIVERSITY PHYSICS

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

Date: 2024 Nov 4

(Name)

(Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows A, C, E,
2. Total time = 50 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.) Give an example of a conservative force.

2. (5 points.) A 20. kg object has a momentum of 40. kg m/s. Determine the kinetic energy of the object.

3. (5 points.) What is the dimension of

$$\frac{K}{U}, \tag{1}$$

where K is kinetic energy and U is gravitational potential energy.

4. **(5 points.)** An object is undergoing uniform circular motion. What is the total work done by the forces on the object while it completes half a circular path.

5. (10 points.) Figure 1 shows a pendulum of length $L = 3.0$ m and mass $m = 5.0$ kg. It starts from rest at angle $\theta = 30.0^\circ$. Determine the velocity of the mass when $\theta = 0$.

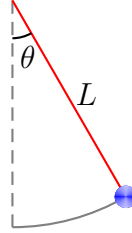


Figure 1: Problem 5.

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

$$U(x) = ax^2 + bx^3, \quad a = 1.0 \frac{\text{J}}{\text{m}^2}, \quad b = 1.0 \frac{\text{J}}{\text{m}^3}. \quad (2)$$

- (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 railroad car of mass m is moving with speed 4.00 m/s . It collides and couples with three other coupled railroad cars, each of the same mass m and moving in the same direction with an initial speed of 2.00 m/s . Determine the ratio of total kinetic energy before collision to total kinetic energy after collision.