

# Midterm Exam No. 03 (2022 Fall)

PHYS 205A-002: UNIVERSITY PHYSICS

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

Date: 2022 Nov 7

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(Name)

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(Signature)

## Instructions

- Seating direction: Please be seated on seats with seat numbers divisible by 5.
- Total time = 50 minutes.
- There are 7 questions in this exam.
- Equation sheet is provided separately.
- To be considered for partial credit present your work in detail and organize it clearly.
- A simple calculator (with trigonometric functions) is allowed.
- Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. **(5 points.)** Can the work done by the gravitational force be negative? If no, why not? If yes, illustrate with an example.

2. (5 points.) Figure 1 is a plot of potential energy of an object as a function of position  $x$ . Identify the (equilibrium) points where the force on the particle is zero.

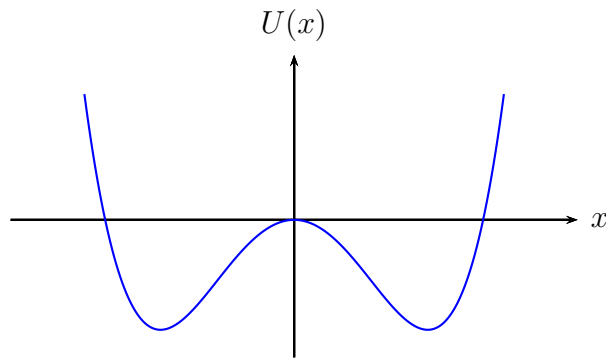


Figure 1: Problem 2

3. (5 points.) Determine the units of momentum in terms of Joule, meter, and second.

4. (5 points.) The object in Figure 2 is constructed by cutting out a disc of diameter  $R$  out of a circular disc of diameter  $2R$ . Assume uniform density of material (shown in blue). Is the center of mass of the object above height  $R$  from the baseline shown, or below height  $R$ ?

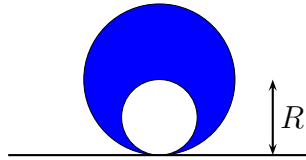


Figure 2: Problem 4.

5. (10 points.) A roller coaster moves on the curve described in Figure 3. Assume frictionless surface. It starts from rest at point  $A$  that is  $40.0\text{ m}$  high. Determine the velocity of the mass at point  $D$  where it is  $10.0\text{ m}$ .

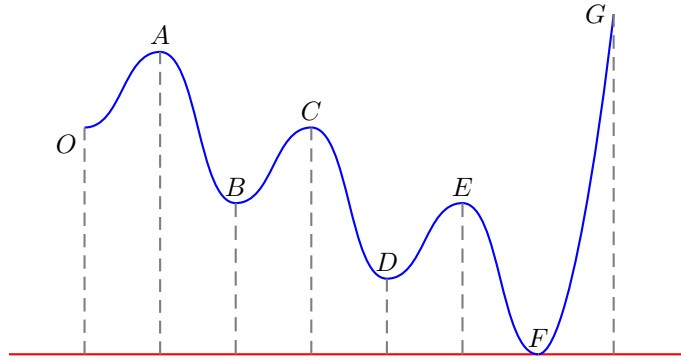


Figure 3: Problem 5.

6. (10 points.) A mass  $m = 20.0\text{ kg}$  slides down a frictionless incline, starting from rest at point  $A$  at height  $h = 1.0\text{ m}$ . After sliding down the incline it moves horizontally on a frictionless surface before coming to rest by compressing a spring of spring constant  $k = 2.0 \times 10^4\text{ N/m}$  by a length  $x$ . See Figure 4. Determine the maximum compression  $x$  in the spring.

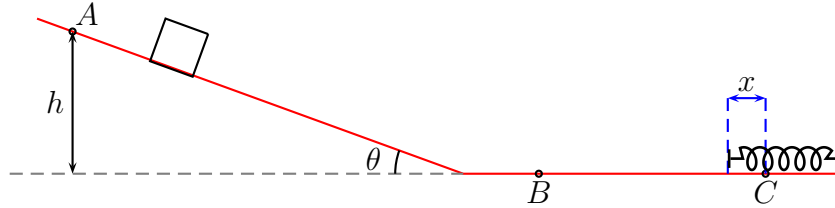


Figure 4: Problem 6.

7. **(10 points.)** A car of mass  $2000.0\text{ kg}$  is moving at speed  $25.0\text{ m/s}$  towards East. A truck three times heavier than the car is moving at the same speed as the car 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?