Midterm Exam No. 02 (Fall 2024)

PHYS 205A-002: UNIVERSITY PHYSICS

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

Date: 2024 Oct 11

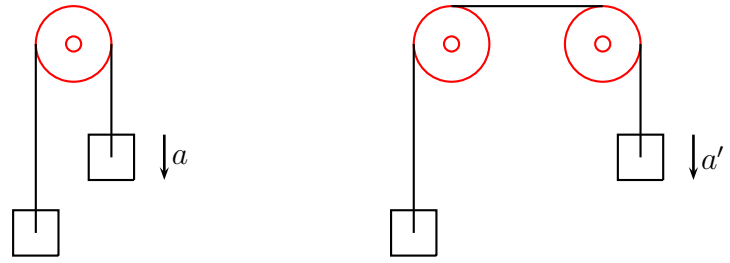
(Name) (Signature)

Instructions

1. Seating direction: on seats with seat-numbers divisible by 4, in alternate rows from the first row.
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.**) What is the direction of acceleration of an object when it is moving in a circle of radius R with uniform speed v.

2. (**5 points.**) The Atwood machine, shown as System 1 in Figure 1, consists of two masses m_1 and m_2 connected by a massless (inextensible) string passing over a massless frictionless pulley. A modified version of the Atwood machine, shown as System 2 in Figure 1, consists of the same two masses m_1 and m_2 connected by a massless (inextensible) string passing over two massless frictionless pulleys. Which of the two systems leads to a larger acceleration? Why?



System 1 **System 2**

Figure 1: Problem 2

3. (**5 points.**) A cup of coffee is on the surface of a table inside an airplane flying at a constant altitude with uniform velocity. The coefficient of static friction between the cup and the table is 0.30 and the coefficient of kinetic friction between the cup and the table is 0.15. Let the plane accelerate forward, maintaining the altitude constant. What is the direction of the force of friction on the cup with respect to the velocity of the airplane?

4. (**5 points.**) A mass m slides down a frictionless track going around a vertical loop as illustrated in Figure 2. Identify all the forces acting on the mass when it is at the highest point in the loop. Describe the forces using a diagram.

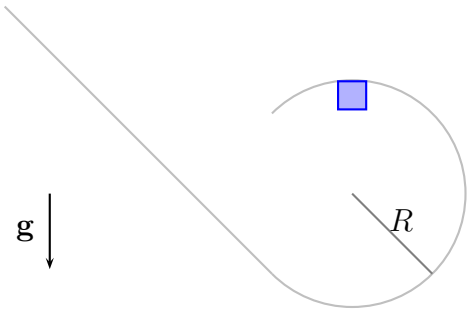


Figure 2: Problem 4.

5. (**10 points.**) A mass $m_2 = 2.0\,\text{kg}$ is connected to another mass $m_1 = 1.0\,\text{kg}$ by a massless (inextensible) string passing over a massless pulley, as described in Figure 3. Surfaces are frictionless. Determine the tension in the string.

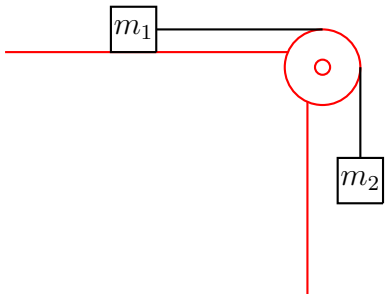


Figure 3: Problem 5

6. (**10 points.**) A 20.0 kg mass slides down an incline with coefficient of static friction $\mu_s = 0.80$ and coefficient of kinetic friction $\mu_k = 0.50$. The incline makes an angle of 30.0° with the horizontal. Find the acceleration of the mass.

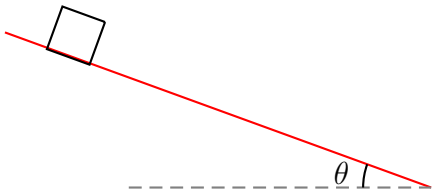


Figure 4: Problem 6.

7. (**10 points.**) A stuntman drives a car over the top of a hill, the cross section of which can be approximated by a circle of radius $R = 150\,\text{m}$. See Figure 5.

   (a) What is the greatest speed at which he can drive without the car leaving the road at the top of the hill?

   (b) What is the normal force acting on the car when it is moving with this greatest speed.

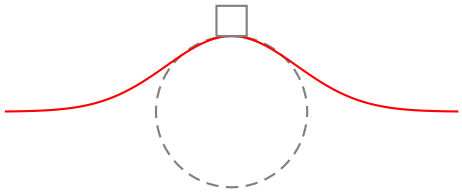


Figure 5: Problem 7