Midterm Exam No. 02 (2021 Spring)

PHYS 205A-001: UNIVERSITY PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Date: 2021 Mar 12

Honor Pledge: I affirm that I will not give or receive any consultation during this examination.

__________________ (Name) __________________ (Signature)

Instructions

- There are 8 questions in this exam.
- To be considered for partial credit present your work in detail and organize it clearly.
- This is a timed exam, from 12:00 PM to 12:50 PM on Friday 2021 Mar 12. This time includes the time required for downloading the exam and uploading the solutions.
- Please submit a single PDF file on D2L. Note that D2L will not allow submissions after 12:50 PM.
- In case of technical issues contact me by email at the earliest. Accommodations will be made after fairness to other students is taken into consideration.
- This is an open book and open resource examination, and use of Internet is allowed. However, consultation is prohibited.

0. (**0 points.**) Write the Honor Pledge on your answer sheet. You do not have to attach the cover sheet with your submission.

Conceptual questions

1. (**5 points.**) A weighing scale is designed to measure the normal force acting on the object placed on the scale. A mass m rests on this weighing scale while it is placed on the floor of an elevator. Imagine the scenario when all the cables snap and the elevator falls freely. What does the weighing scale read while the elevator, the scale, and the mass, are all falling freely?

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?

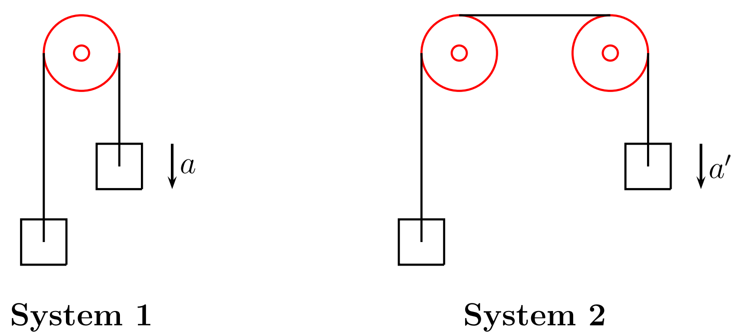

Figure 1: Problem 2

3. (**5 points.**) A mass m rests on the surface of Earth. Earth exerts the force of gravity $m\mathbf{g}$ on the mass. The surface of Earth exerts the normal force $\mathbf{N}$ on the mass. Are the forces $m\mathbf{g}$ and $\mathbf{N}$ acting on the mass m action reaction pairs? Explain.

4. (**5 points.**) A 10.0 kg mass rests on an incline that makes 30° with respect to the horizontal. Determine the magnitude of the force of static friction acting on the mass if the coefficient of static friction between the mass and incline is 0.80.

Problems

5. (**10 points.**) Mass of a planet is 100 times larger than that of Earth, while the radius of the planet is ten times larger than that of Earth. Determine the acceleration due to gravity on the surface of this planet.

6. (**10 points.**) A 75 kg student is skateboarding down a ramp that is 6.0 m long and inclined at $\theta = 30°$ with respect to the horizontal. The student starts from rest at the top of the ramp. Neglect friction. See Figure 2.

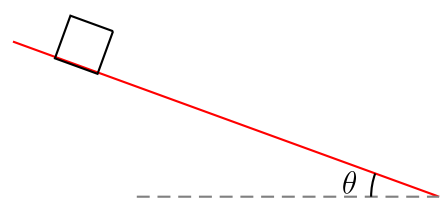

Figure 2: Problem 6.

   (a) Determine the normal force acting on the student.

   (b) Determine the acceleration of the student.

   (c) Determine the time taken by the student to reach the bottom of the ramp.

7. (**10 points.**) Determine the magnitude of the centripetal acceleration at Austin, Texas, (latitude 30° N) due to rotation of Earth about its axis. Illustrate the direction of this centripetal acceleration unambiguously. (Radius of Earth is 6.4×10^6 m.)

8. (**10 points.**) A 20.0 kg block of mass rests on the floor of a bus. The coefficient of static friction between the floor and the mass is 0.50 and the coefficient of kinetic friction is 0.40. What is the maximum acceleration the bus can have if the block is to not slide on the floor.