

Midterm Exam No. 02 (2018 Spring)

PHYS 205A-001: University Physics

Date: 2018 Mar 19

(Name)

(Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
2. Total time = 50 minutes.
3. There are 7 questions in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**10 points.**) A car travels due east with a speed of 40.0 km/h. Raindrops are falling at a constant speed vertically with respect to the Earth. The traces of the rain on the side windows of the car make an angle of 76.0° with the vertical.
- (a) Find the speed of the rain with respect to the Earth.
 - (b) Find the speed of the rain with respect to the car.

2. **(10 points.)** Your mass is 75 kg. How much will you weigh on a weighing scale (designed to measure the normal force in Newtons) inside an elevator that is slowing down at 2.0 m/s^2 while moving upward?

3. (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 1. Assume frictionless surfaces.

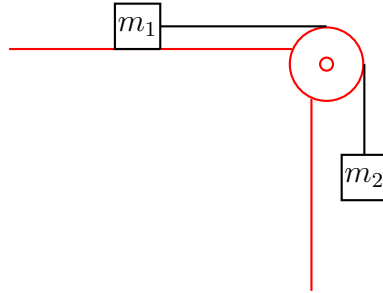
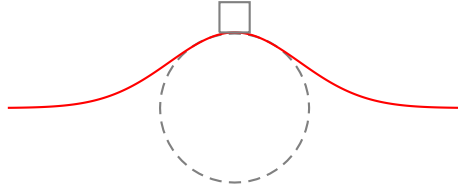


Figure 1: Problem 3.

- List the forces acting on mass m_1 .
- List the forces acting on mass m_2 .
- Determine the acceleration of mass m_2 .

4. (10 points.) A 25.0 kg block is initially at rest on a horizontal surface. A horizontal force of 75.0 N is required to set the block in motion, after which a horizontal force of 50.0 N is required to keep the block moving with constant speed.
- (a) There are how many forces acting on the block while the horizontal force is acting? List them.
 - (b) Find the coefficient of static friction between the block and the surface.
 - (c) Find the coefficient of kinetic friction between the block and the surface.

5. (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 $R = 150$ m. What is the greatest speed at which he can drive without the car leaving the road at the top of the hill?



6. (10 points.) A mass falling under gravity experiences a drag force that is linearly proportional to velocity and acts in the direction opposite to the direction of velocity. The equation of motion of the mass is

$$m \frac{dv}{dt} = mg - bv. \quad (1)$$

Find the expression for the terminal velocity of the mass in terms of the variables m , g , and b .

7. (**10 points.**) A cup of coffee is on a table in an airplane flying at a constant altitude and a constant velocity. The coefficient of static friction between the cup and the table is 0.40 and the coefficient of kinetic friction between the cup and the table is 0.20. Suddenly, the plane accelerates forward, its altitude remaining constant.
- (a) List all the forces acting on the cup while the plane is accelerating forward.
 - (b) What is the direction of the friction force with respect to the velocity of the airplane?
 - (c) What is the maximum acceleration that the plane can have without the cup sliding backward on the table?