Physics 271  
Practice Exam 1  
Date: Fall 2017

There are 4 problems. Do all of them. The first two are short answer questions. Write a legible sentence or two for the answer. The last two are require some solving. Show all your work. Cross things out neatly, DO NOT ERASE.

This is a closed textbook exam. You are allowed one sheet of 8.5” × 11” paper with your notes. Write your name on each blue-book you fill.

You need not solve the problems in the order given, but please indicate clearly which one you are solving. Please write neatly, and explain your work. Legibility is a critical factor in determining credit.

1. SHORT ANSWER: You pull a brick of mass $M$ sitting on a flat table using a rope of mass $m$. Friction between the surface of the table and the brick is sufficient so that the brick remains at rest. Compared to the magnitude of the force with which you pull on one end of the rope, is the magnitude of the force that the other end of the rope exerts on the brick larger, smaller, or the same? Explain briefly. See the end of the exam for a figure relevant to this problem.

2. SHORT ANSWER: A mass on a string is swung in a vertical circle. Assume that gravity acts with constant acceleration $g$ downward. What direction is the total force on the mass when it is:
   • at top of the circle, and
   • at the bottom of the circle.

   Explain briefly.

3. A student of mass $M$ stands on a rigid disk at a distance $r$ from the center axis. Assume that the coefficient of friction between the student’s shoes and the disk surface is $\mu$. At time $t = 0$, the disk begins to rotate with a constant angular acceleration rate $\dot{\theta} = \alpha$. Assume that gravity acts with constant acceleration $g$ downward. See the end of the exam for a figure relevant to this problem.

   (a) What is the acceleration vector $\vec{a}$ of the student at $t = 0$, assuming the student does not immediately slip?
(b) What is the maximum value of angular acceleration rate ($\alpha_{\text{max}}$) such that the student does not immediately slip?

(c) Assuming that $\alpha < \alpha_{\text{max}}$, what is the total friction force acting on the student as a function of time (prior to slipping)? Write your answer as a vector in polar coordinates.

(d) Assuming that $\alpha < \alpha_{\text{max}}$, how long after the disk starts rotating will the student slip?

4. Masses $M_1$ and $M_2$ are connected by a massless, inextensible string over a massless, frictionless pulley. The pulley accelerates upward with constant acceleration $A$ due to an external force. Gravity is constant $g$, directed downwards. See the end of the exam for a figure relevant to this problem.

(a) Draw the force diagrams for $M_1$ and $M_2$.

(b) Find the acceleration of $M_1$ and $M_2$ in the inertial $x-y$ reference frame shown in the drawing.
Figure 1: Figure for problem 1
Figure 2: Figure for problem 3
Figure 3: Figure for problem 4