Physics 7A, Spring 2018, Sections 2 and 3, Instructor: Professor Adrian Lee
Midterm Examination, Tuesday, February 20, 2018

Please do work in your blue/greenbooks. Show your reasoning carefully so that we can be sure that you derived the answer rather than guessing it or relying on memory; in addition, this enables us to give partial credit. You may use one double-sided 3.5 x 5 index cards of notes. Test duration is 110 minutes. Simple calculators allowed.

1 Qualitative Questions [15 pts. total].

Answers should be a short paragraph only, perhaps with a drawing, and very little, if any, math.

a) A mass m is suspended by a string from the ceiling. A second string is attached to the bottom of the mass and pulled. If the bottom string is pulled slowly (slow build up of force and hardly moving) which string breaks first? And if the string is pulled quickly (high velocity and high force), which string breaks? Give brief explanations of your reasoning. [5 pts.]

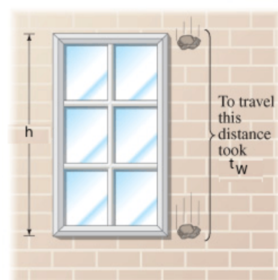
b) Give a simple explanation for why the static coefficient is usually higher than the kinetic coefficient of friction. [5 pts.]

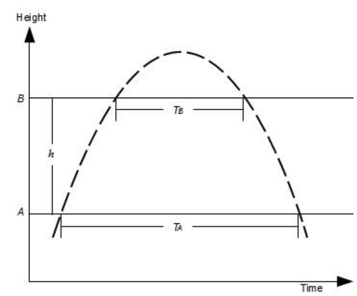
c) Does the force of friction always point in opposite direction of motion? If yes, explain why. If no, please give an example. [5 pts.]

2 Trajectory Problems [25 pts. total]

a) A falling stone takes time t_W to travel past a window of height h (see figure). From what height above window did the stone fall? (note: there is at least one way to do this problem without excessively long algebra) [10 pts.]

b) The acceleration of gravity can be measured by sending a mass upward and measuring the time that it takes to pass two given points in both directions (up then down). The time it takes for the mass to pass the lower point A twice is T_A, and the time for the upper point B is T_B. Find an expression for the gravitational acceleration g in terms of $h = y(B) - y(A)$, T_A, and T_B. To be clear, the time here is the time difference from when the mass passes a given point on the way up until it falls to the same height again (see figure at far right). [15 pts.]



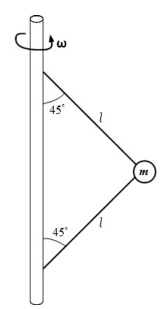


3 Rotating Mass [25 pts. total]

A mass is connected to a vertical revolving axle by two strings of length l, each making an angle of 45° with the axle, as shown. Both the axle and mass are revolving with angular velocity ω. Gravity is directed downward. The tension in the upper string is T_{upper} and the tension in the lower string is T_{lower}

a) Draw a clear free body diagram for the mass m. Please include real forces only. [10 pts.]

b) Find the tensions in the upper and lower strings, T_{upper} and T_{lower}. [15 pts.]



4 Masses on inclined plane with pulley [25 pts. total]

A box of mass m_A rests on a surface inclined at an angle θ to the horizontal. It is connected by a massless cord, which passes over a massless and frictionless pulley, to a second box of mass m_B, which hangs freely as shown in the figure.

a) If the coefficient of static friction is μ_s, determine what range of values for mass m_B will keep the system at rest. [15 pts.]

b) If the coefficient of kinetic friction is μ_k, and m_B is heavy enough that it moves downward, determine the acceleration of the system. [10 pts.]