Distributed on Friday, December 3, due in class 1:25 pm on Friday, December 10

Guidelines:
1. Please show all your work. Please take the time to write your solutions neatly and clearly
2. You can use your text, notes and computer – but you may not consult with anyone while taking this exam nor you cannot use the web to search for solutions.
3. If you have a question about any of these problems: send email to me (aszczepa@indiana.edu). The response will be sent to the entire class, together with the original question, but I will NOT specify who asked the question.

Thank you, Adam Szczepaniak

Name (please print): ______________________________________________

Problem 1 (10 points)

A simple pendulum (a point-like mass, suspended on a massless thread) has length L=1m. What should be the length of a thin rod, oscillating around one of its ends if it is to have the same period of oscillations as this simple pendulum?

![Simple pendulum and oscillating rod diagrams]

Problem 2 (10 points)

How many 20g ice cubes, whose initial temperature is -10\(^\circ\)C, must be added to 1 liter of hot tea, whose initial temperature is 90\(^\circ\)C, for the final mixture to have a temperature of 10\(^\circ\)C. Assume that all the ice is melted, that the tea can be treated as water and that the system is isolated.
Problem 3 (10 points)

Balls A, B, C have masses \( m_A = 1 \text{kg} \) and \( m_B = 5 \text{kg} \), \( m_C = 2 \text{kg} \) respectively. Ball A moving with speed \( v_A = 1 \text{m/s} \) hits ball C which is initially at rest. After that ball C hits ball B, which is also initially at rest. All collisions are elastic and central (i.e. one dimensional). What is the speed of ball B after being hit by ball C?

Problem 4 (10 points)

A caterpillar of mass \( m \) is accelerating down a bar of mass \( M \), as shown. What should be the acceleration of the caterpillar for the bar to remains at rest. Assume there is no friction between the bar and supporting elements. (But clearly there must be friction between the caterpillar and the bar). The bar is inclined at an angle \( \alpha \) with respect to the horizontal direction.
Problem 5 (10 points)

A siren emitting a sound of frequency 1000 Hz moves away from you towards the face of a cliff at a speed of 10 m/s. Take the speed of sound in air to be 330 m/s.

a. What is the frequency of the sound you hear directly from the siren?
b. What is the frequency of the sound you hear reflected off the cliff?
c. What is the beat frequency between the two sounds?