Duke University
Edmund T. Pratt, Jr. School of Engineering

EGR 75 Summer 2010
Test I
Michael R. Gustafson II

Name (please print)_____

In keeping with the Community Standard, I have neither provided nor received any assistance on this test. I understand if it is later determined that I gave or received assistance, I will be brought before the Undergraduate Conduct Board and, if found responsible for academic dishonesty or academic contempt, fail the class. I also understand that I am not allowed to speak to anyone except the instructor about any aspect of this test until the instructor announces it is allowed. I understand if it is later determined that I did speak to another person about the test before the instructor said it was allowed, I will be brought before the Undergraduate Conduct Board and, if found responsible for academic dishonesty or academic contempt, fail the class.

Signature:_____

Instructions

First - please turn **off** any cell phones or other annoyance-producing devices. Vibrate mode is not enough - your device needs to be in a mode where it will make no sounds during the course of the test, including the vibrate buzz or those acknowledging receipt of a text or voicemail.

Please be sure to put each problem on its own page or pages - do *not* write answers to more than one problem on any piece of paper and do not use the back of a problem for work on a *different* problem. You will be turning in each of the problems independently. This cover page should be stapled to the front of Problem 1.

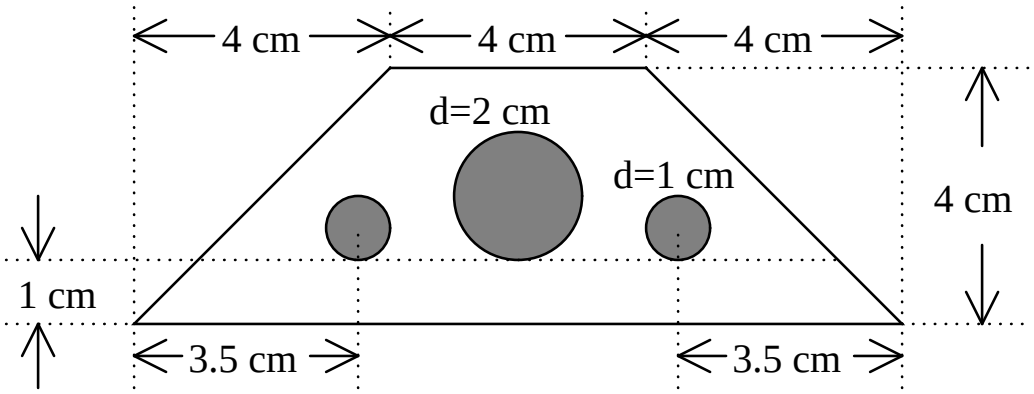
Make sure that your name *and* NET ID are *clearly* written at the top of *every* page, just in case problem parts come loose in the shuffle. Make sure that the work you are submitting for an answer is clearly marked as such. Finally, when turning in the test, individually staple all the work for each problem and place each problem's work in the appropriate folder.

Note that there may be people taking the test after you, so you are not allowed to talk about the test - even to people outside of this class - until I send along the OK. This includes talking about the specific problem types, how long it took you, how hard you thought it was - really anything. Please maintain the integrity of this test.

Name (please print):
Community Standard (print ACPUB ID):

Problem I: [15 pts.] Centroid

Given the following connector plate:



Clearly demonstrate the process by which you could locate the centroid of the plate below. You may assume that the material has uniform density. Once you have found the location of the centroid, draw a * at approximately that location on the drawing. Note that the plate has left-right symmetry and that the bottoms of the three circles are aligned.

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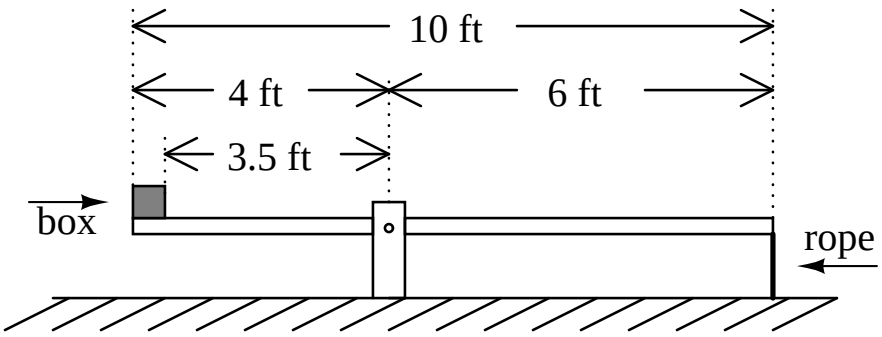
Problem II: [30 pts.] Sand+box≠sandbox

A 10 ft long, 1 ft wide asymmetric see-saw is made by mounting a straight piece of wood using a pin connection 4 ft from the left end. An empty (cubical) box that is 0.5 ft on a side is placed on the left end of the platform. A rope is tied to the right end of the platform such that when fully extended, the platform is perfectly horizontal. The setup is pictured below:



- If the weight of the platform is 20 lb and the weight of the empty box is negligible, what volume of sand would need to be poured in the box so that the rope on the right side is fully extended but is supporting almost zero tension? You may assume that the sand is evenly distributed in the box and that the specific weight of the sand is 100 lb/ft^3.
- If the appropriate amount of sand is placed in the box to balance the platform, calculate the reaction at the mounting pin.

Now imagine that the box is completely filled with sand.

- Calculate the tension in the rope if the system is at equilibrium.
- Calculate the reaction at the mounting pin in this situation.
- Determine where the full box would need to be placed in order to again perfectly balance the platform (i.e. where to place the full box so that there is almost zero tension in the rope). Be sure to clearly indicate where the box goes - for example, by drawing a diagram and indicating the extreme edges of the box relative to an edge or the pivot.

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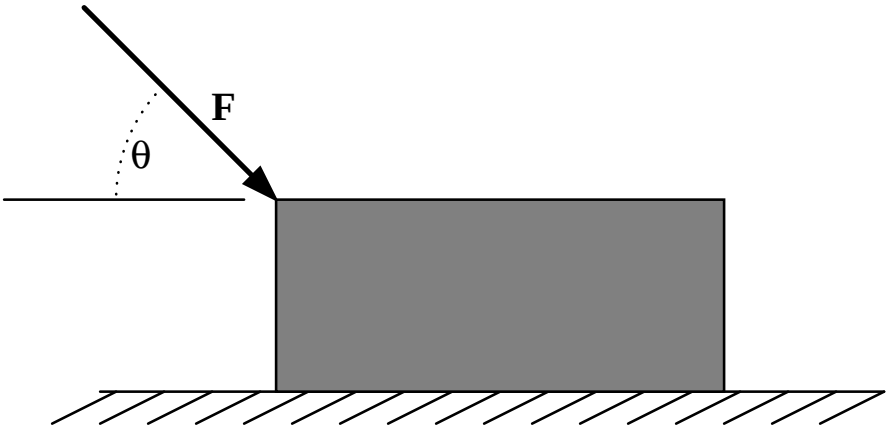
Problem III: [25 pts.] Pushy, pushy

This problem is adapted from Problem 4-62 on p. 201 of Hibbeler. A person wants to move a dresser that weighs 90 lb. The interface between the interface between the dresser and the floor has a coefficient of static friction of μ_{s1}=0.25. The person plans to push on the top left corner of the dresser with a force **F** at an angle θ as shown here:



- If $\theta = 0°$, find the magnitude of **F** required to just start to move the dresser.
- If $\theta = 0°$ and the person pushing on the dresser weighs 150 lb, first draw a free-body diagram of the person pushing on the dresser and then calculate the minimum required coefficient of static friction between the person's shoes and the floor.
- Clearly, there is an angle after which no finite amount of force would be sufficient to move the dresser (think 90° as an extreme example). Determine the maximum possible angle for which a finite amount of force would just be able to move the dresser given the weight of the dresser and the coefficient of static friction between the dresser and the floor.

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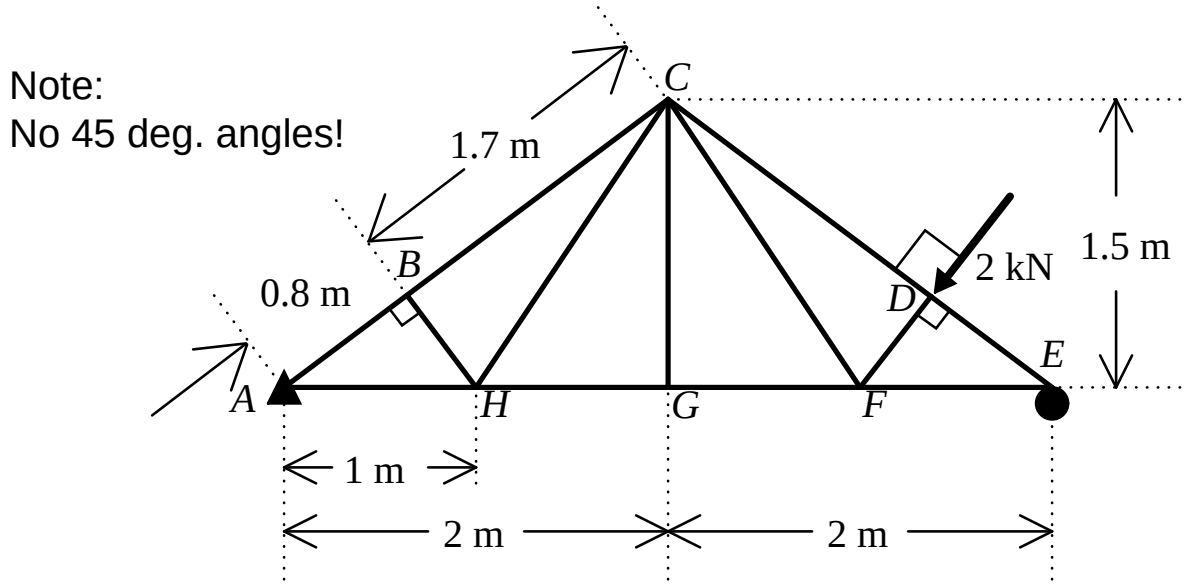
Problem IV: [30 pts.] "A transitional passage connecting two subjects or movements."[1]

This problem is adapted from Problem 5-33 on p. 231 of Hibbeler. Given the following bridge, which is supported by a pin connection at A and a roller connection at E:



and assuming that there is a 2 kN force directed perpendicular to CDE at node D,

- Determine the reactions from the pin at A and the roller at E.
- Determine and list all the zero-force members.
- Determine the force in members CD, CF, and FG and indicate if the members are in tension or compression.

[1] **bridge** def. 5b, The Free Dictionary