※ 考生請注意：本試題可使用計算機

1, Jenga is a game with players taking turns removing a block from a tower and balance it on top, resulting in a taller and increasingly unstable structure as the game progresses. The key to wining in Jenga is the ability to locate center of gravity of the remaining structure with and without a specific block. Consider the Jenga as in Figure 1. The dimension of each block is h in height, l in length, and w in width. $l = 3w$. The overall height of the structure if H.

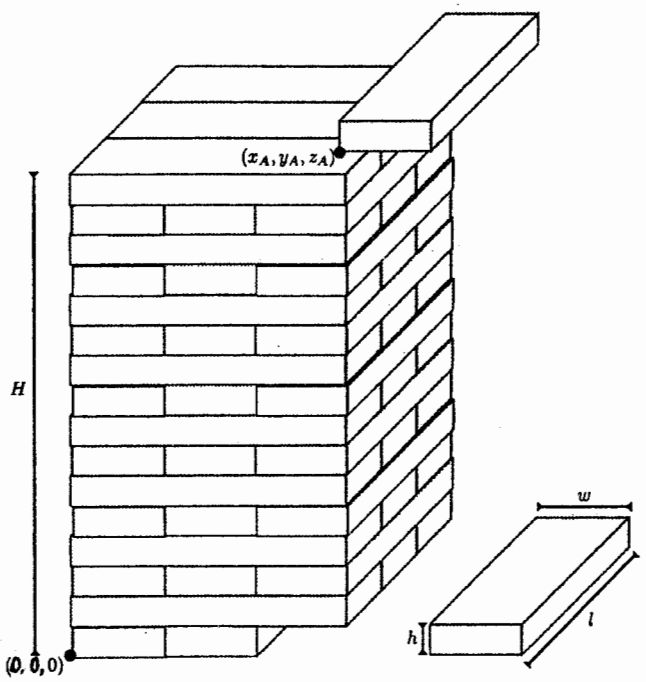

Figure 1: Schematic of Problem 1

(a) (5%) If you are required to remove one block from the bottom and put it on the top, what is the marginal location of (x_A, y_A, z_A) to ensure the block remains on the top without falling ?

(b) (15%) With the increase of layers, hence the increase of H, the structure will be unstable with the removal of the bottom block. What is the maximal H to maintain the stability of the structure? Assuming rigid body right before collapsing.

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2, (20%)A chopstick with uniform cross-section having a length L is placed in the smooth hemispherical bowl having a radius r. Determine the angle of inclination θ for equilibrium.

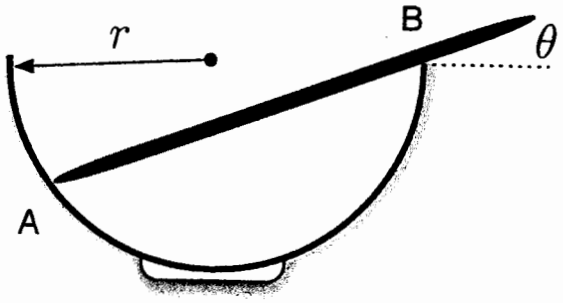


Figure 2: Schematic of Problem 2

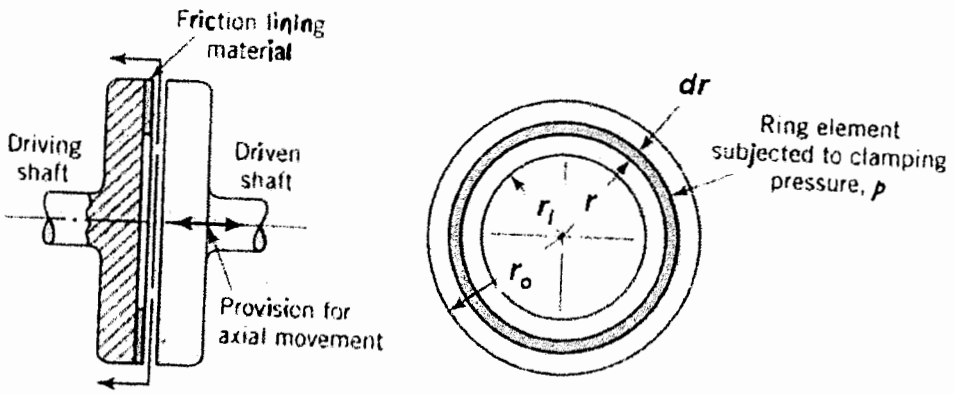
3. Please translate (a) into **Chinese** and answer (b), (c), and (d) according to (a)'s definition.

(a) (7%) A "break-in" or used disk clutch can be assumed that wear rate over the lining is uniform. Wear rate is proportional to the pressure times sliding velocity. On the clutch face, the velocity is proportional to radius; hence, rate of wear is proportional to the product of pressure and radius.

(b) (4%) The maximum pressure at interface of a used disk clutch as shown is p_{max}. Please answer the pressures at inner circle (radius r_i) and outer circle (radius r_o).

(c) (8%) The coefficient of friction at interface is f. Determine the torque of this used clutch described by f, p_{max}, r_i, and r_o

(d) (6%) Show the maximum torque occurs for a used disk clutch at $r_i = \sqrt{\frac{1}{3}} r_o$ when the outer radius is given.



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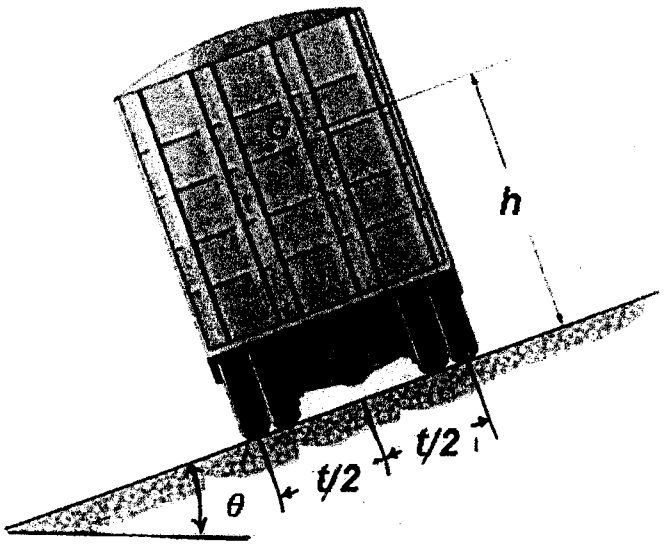
4.

(a) (9%) Please describe *Stable Equilibrium*, *Neutral Equilibrium*, and *Unstable Equilibrium* in **English**

(b) (8%) The truck as shown has a mass of m and a mass center at G. Determine the steepest grade θ along which it can park without overturning.

(c) (8%) If $h=t$, find the steepest grade θ and investigate the stability in this position.



5, (10%) 請將下列中文翻譯成英文：
求解平衡問題的第一步是需先繪製剛體的自由體圖，三維空間可用卡式座標系向量求解平衡，若物體在平衡狀態下之外力數目恰等於平衡方程式個數，則爲靜定系統；若未知外力數目超過平衡方程式，則爲靜不定系統。