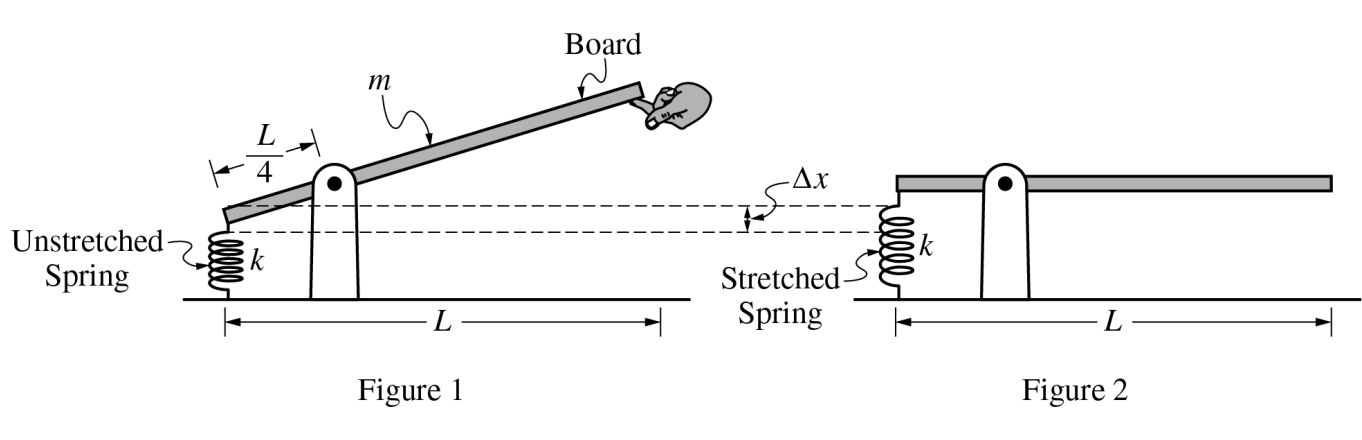




Note: Figures not drawn to scale.

A uniform board of length L and mass m is attached to a pivot $\frac{L}{4}$ from the left end of the board. The left end of the board is attached to an ideal spring of spring constant k that is attached to the ground. The right end of the board is initially held by a student so that the spring is unstretched, as shown in Figure 1. The student slowly lowers and then releases the board. The board remains at rest in the horizontal position, with the spring stretched, as shown in Figure 2. The rotational inertia of the board about the pivot is I .

(a) On the rectangle below, which represents the board, draw and label the forces (not components) that act on the board while the board-spring system is in equilibrium. Each force should be represented by an arrow that starts on, and points away from, the board, and should represent the location at which that force acts.



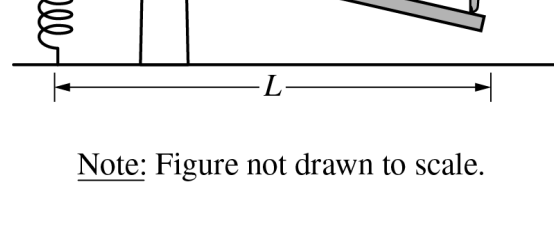
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Continue your response to **QUESTION 3** on this page.

(b) Derive an expression for the distance the spring stretches, Δx , when the board is in equilibrium. Express your answer in terms of k , L , m , and physical constants, as appropriate.

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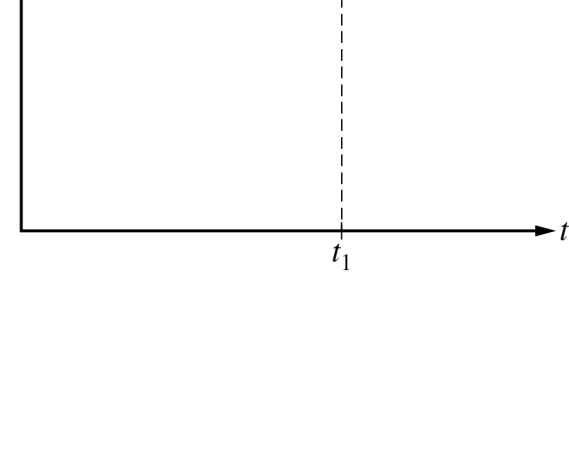
Continue your response to **QUESTION 3** on this page.



Note: Figure not drawn to scale.

(c) A student pushes the board down on the right side, stretching the spring a new distance Δx_2 from the unstretched position. The board is held at a small angle θ_0 with the horizontal, as shown. The student then releases the board from rest.

i. At time $t = 0$, the board is released. At $t = t_1$, the board first crosses the horizontal. Sketch a graph of the magnitude of the angular acceleration α of the board as a function of time t from $t = 0$ to $t = t_1$.



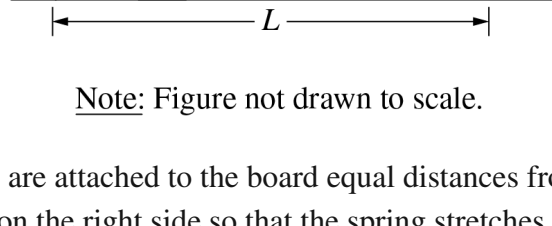
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Continue your response to **QUESTION 3** on this page.

ii. Derive an expression for the angular acceleration α_0 of the board immediately after the board is released. Express your answer in terms of k , L , m , I , Δx_2 , θ_0 , and physical constants, as appropriate.

GO ON TO THE NEXT PAGE.

Continue your response to **QUESTION 3** on this page.



Note: Figure not drawn to scale.

(d) Two blocks of equal mass m are attached to the board equal distances from the pivot point, as shown. The board is again pushed down on the right side so that the spring stretches the same distance Δx_2 as in part (c). The board is then released. How does the new angular acceleration α' when the blocks are attached compare to the angular acceleration α_0 from part (c) ?

☐ $\alpha' > \alpha_0$ ☐ $\alpha' < \alpha_0$ ☐ $\alpha' = \alpha_0$

Justify your answer.

GO ON TO THE NEXT PAGE.

STOP

END OF EXAM