

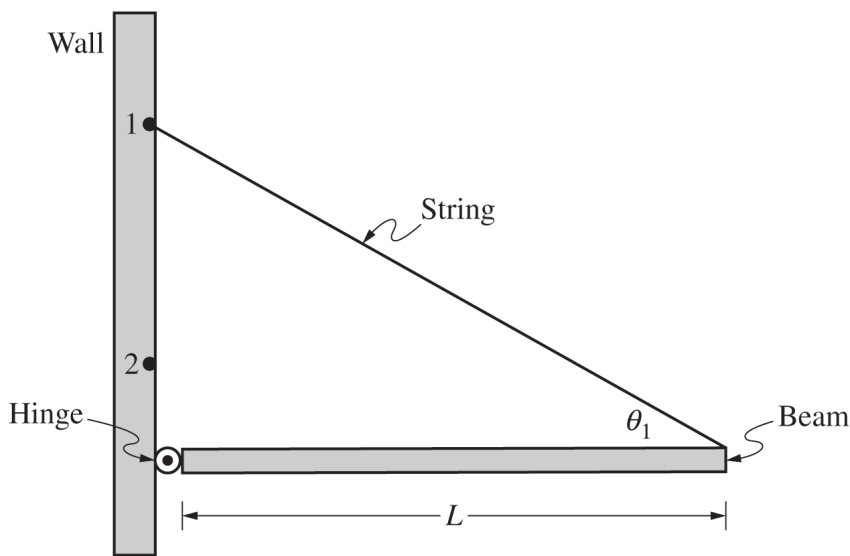


Figure 1

3. (12 points, suggested time 25 minutes)

The left end of a uniform beam of mass M and length L is attached to a wall by a hinge, as shown in Figure 1. One end of a string with negligible mass is attached to the right end of the beam. The other end of the string is attached to the wall above the hinge at Point 1. The beam remains horizontal. The hinge exerts a force on the beam of magnitude F_H , and the angle between the beam and the string is $\theta = \theta_1$.

(b) The string is then attached lower on the wall, at Point 2, and the beam remains horizontal, as shown in Figure 2. The angle between the beam and the string is $\theta = \theta_2$. The dashed line represents the string shown in Figure 1.

The magnitude of the tension in the string shown in Figure 1 is F_{T1} . The magnitude of the tension in the string shown in Figure 2 is F_{T2} . **Indicate** which of the following correctly compares F_{T2} with F_{T1} .

_____ $F_{T2} > F_{T1}$ _____ $F_{T2} < F_{T1}$ _____ $F_{T2} = F_{T1}$

Briefly **justify** your answer, using qualitative reasoning beyond referencing equations.

(c) Starting with Newton’s second law in rotational form, **derive** an expression for the magnitude of the tension in the string. Express your answer in terms of M , θ , and physical constants, as appropriate. Begin your derivation by writing a fundamental physics principle or an equation from the reference book.

GO ON TO THE NEXT PAGE.

(d) Is your derived equation in part (c) consistent with your justification in part (b) ? **Explain** your reasoning.