

STEP II, 2002, Q11

- 11 A rigid straight beam AB has length l and weight W . Its weight per unit length at a distance x from B is $\alpha Wl^{-1}(x/l)^{\alpha-1}$, where α is a positive constant. Show that the centre of mass of the beam is at a distance $\alpha l/(\alpha + 1)$ from B .

The beam is placed with the end A on a rough horizontal floor and the end B resting against a rough vertical wall. The beam is in a vertical plane at right angles to the plane of the wall and makes an angle of θ with the floor. The coefficient of friction between the floor and the beam is μ and the coefficient of friction between the wall and the beam is also μ . Show that, if the equilibrium is limiting at both A and B , then

$$\tan \theta = \frac{1 - \alpha\mu^2}{(1 + \alpha)\mu}.$$

Given that $\alpha = 3/2$ and given also that the beam slides for any $\theta < \pi/4$ find the greatest possible value of μ .



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