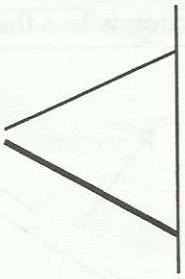
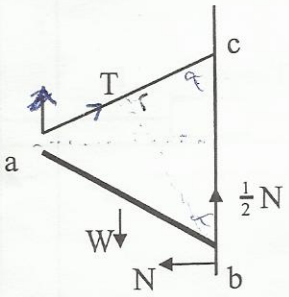
1999

7 (b) A uniform rod [ab] of length d rests with one end b against a rough vertical wall. The other end a is tied to a point c by a light string [ac] of length d. If the coefficient of friction between the rod and the wall is $\frac{1}{2}$, find the least angle that the rod can make with the wall.





5

Resolve forces:

horizontally: $T \sin\alpha = N$ .....(i) 5

vertically: $T \cos\alpha + \frac{1}{2}N = W$ .....(ii) 5

Take moments about b:

$$W \cdot \tfrac{1}{2} d \sin\alpha = T\,|bc| \sin\alpha \quad 5$$

$$\tfrac{1}{2} W\, d \sin\alpha = T\, 2d \cos\alpha \sin\alpha$$

$$\frac{W}{4} = T\cos\alpha$$

Substitute into equation (ii)

$$\frac{W}{4} + \frac{1}{2}.T\sin\alpha = W$$

$$\frac{W}{4} + \frac{1}{2}.\frac{W}{4\cos\alpha}.\sin\alpha = W$$

$$\Rightarrow \quad \tan\alpha = 6 \quad 5$$

$$\alpha = 80.54° \text{ or } 80° 32'$$