

STEP III, 2008 Q10

- 10 A long string consists of n short light strings joined together, each of natural length ℓ and modulus of elasticity λ . It hangs vertically at rest, suspended from one end. Each of the short strings has a particle of mass m attached to its lower end. The short strings are numbered 1 to n , the n th short string being at the top. By considering the tension in the r th short string, determine the length of the long string. Find also the elastic energy stored in the long string.

A uniform heavy rope of mass M and natural length L_0 has modulus of elasticity λ . The rope hangs vertically at rest, suspended from one end. Show that the length, L , of the rope is given by

$$L = L_0 \left(1 + \frac{Mg}{2\lambda} \right),$$

and find an expression in terms of L , L_0 and λ for the elastic energy stored in the rope.



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