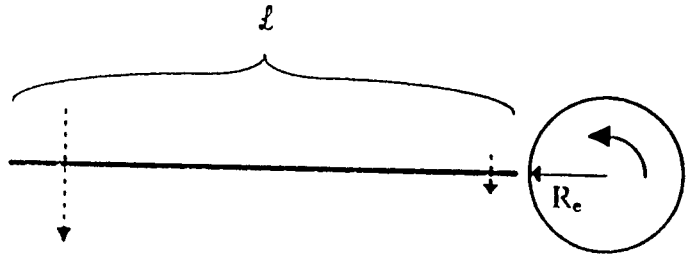
CM7all95A

A government space program decides to save money by having their astronauts climb into space using a long rope. A diagram of their proposed system (viewed from above the north pole) is shown below. An un-stretchable rope of length ℓ extends radially outward from a point on the equator, rotating along with the earth. The rope has a mass per unit length $\lambda = 1$ kg/m, and is long enough that centripetal acceleration keeps it straight and stationary (i.e. always extending radially above the same point on earth). The rope is unsupported, and its bottom end dangles freely just above the ground, a distance $R_e = 6.4 \times 10^6$ m from the center of the earth. You may assume that the earth is a perfect sphere, and you should ignore any stability problems that you feel this configuration may have. Answers should be in MKS units.



By considering the dynamics of a small element of the rope, answer the following questions:

a) At what distance from the bottom end of the rope is the tension in the rope maximum?

b) What is the maximum tension the rope must be able to withstand (assuming no-one tries to climb it)?

c) What is the length of the rope ℓ?