

STEP II, 2014, Q11 MS

Question 11:

A diagram shows that the coordinates of P are $(x + (L - x) \sin \alpha, -(L - x) \cos \alpha)$

Therefore, by differentiating the y -coordinate of P shows that the vertical acceleration of P is $\ddot{x} \cos \alpha$ and applying Newton's Second Law gives

$$T \cos \alpha - kmg = km\ddot{x} \cos \alpha$$

A similar method for the horizontal motion of P and R gives the two equations

$$T \sin \alpha = -km(1 - \sin \alpha)\ddot{x}$$

$$T - T \sin \alpha = -m\ddot{x}$$

For part (ii), eliminating T from the last two equations gives the required relationship. A sketch of the graph of $y = \frac{x}{(1-x)^2}$ will then show that for any value of k there is a possible value between 0 and 1 for $\sin \alpha$.

In part (iii), elimination of T from the two equations formed by considering the motion of P gives the required result.



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