5.

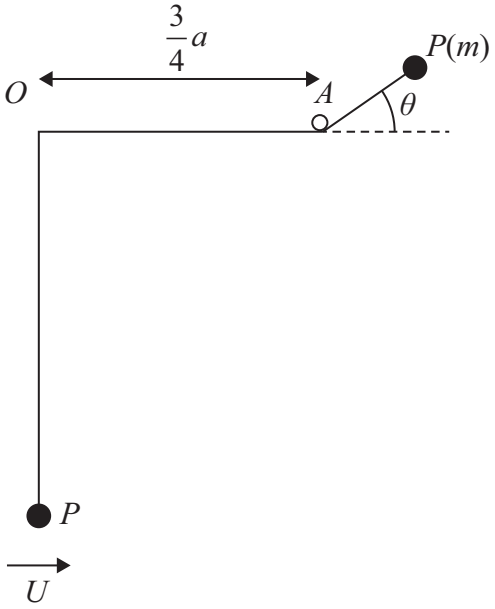


Figure 5

One end of a light inextensible string of length a is attached to a fixed point O. The other end is attached to a particle P of mass m. The particle is held at rest with the string taut and vertical.

The particle is then projected horizontally with speed U, where $U > \sqrt{2ag}$.

When the string is horizontal, it comes into contact with a small smooth peg.

The peg is fixed at the point A on the same horizontal level as O, with $OA = \frac{3}{4}a$.

After the string makes contact with A, the particle P initially moves in a vertical circle centre A.

When the string is taut and AP makes an angle θ with the horizontal, as shown in Figure 5, the speed of P is V and the tension in the string is T.

(a) Show that $V^2 = U^2 - \frac{ag}{2}(4 + \sin\theta)$

(4)

(b) Find T in terms of m, g, U, a and θ

(4)

Given that $U = \sqrt{\frac{19ag}{8}}$

(c) find, in terms of a, the height of P above the level of A when the string goes slack.

(2)

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Question 5 continued

(Total for Question 5 is 10 marks)