

3.

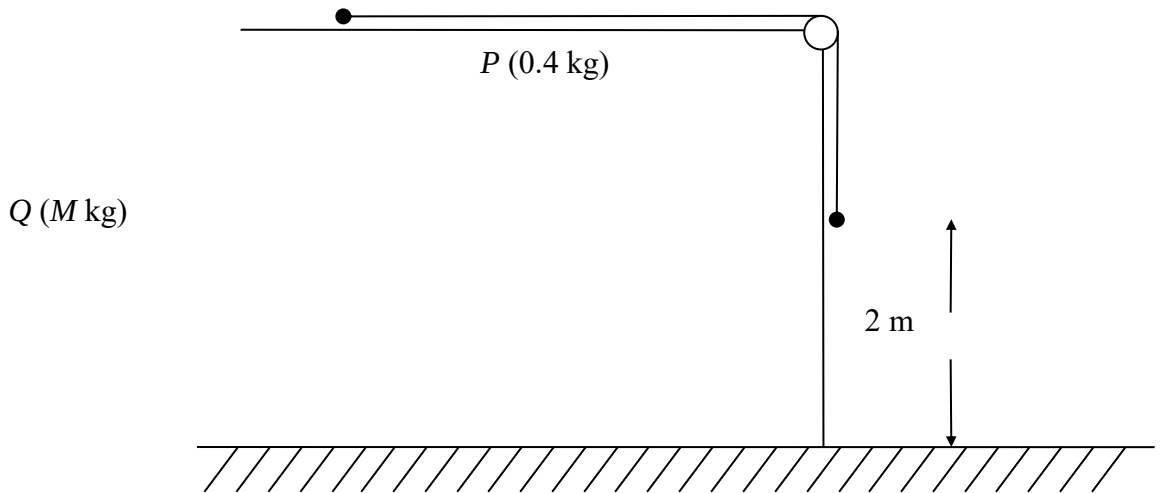


Figure 1

A ball, P , of mass 0.4 kg rests on a rough horizontal table and is attached to one end of a thin rope. The rope passes over a pulley which is fixed at the edge of the table. The other end of the rope is attached to another ball, Q , of mass $M \text{ kg}$ which hangs freely below the pulley, as shown in Figure 1.

The system is released from rest with the rope taut and with Q at a height of 2 m above the ground and Q moves downwards with acceleration 2.5 m s^{-2} . In the subsequent motion P does not reach the pulley before Q reaches the ground.

The balls are modelled as particles, the rope as a light and inextensible string and the pulley as being small and smooth. The total resistance to the motion of P is modelled as having constant magnitude 1.5 N . The acceleration due to gravity is modelled as being 10 m s^{-2} .

Using this model, find, to 2 significant figures,

(a) (i) the tension in the rope,

(ii) the value of M ,

(6)

(b) the time, after release, for Q to hit the ground.

(2)

(c) State one limitation of the model which will affect the accuracy of your answer to part (a).

(1)

(Total 9 marks)