3. A package P of mass 2 kg is held at rest on a horizontal table.
One end of a thin rope is attached to P.
The rope passes over a pulley that is fixed at the edge of the table.
The other end of the rope is attached to a package Q of mass 3 kg that hangs freely below the pulley.

Package P is 1.2 m from the pulley.
Package Q is 0.4 m above a horizontal floor and the rope is taut, as shown in Figure 2 on page 7.

Package P is released from rest and Q moves downwards.

In an initial model of the motion of P and Q

- the table is modelled as being smooth
- the packages are modelled as particles
- air resistance is modelled as being negligible
- the pulley is modelled as being small and smooth
- the rope is modelled as being light and inextensible

Using this model,

(a) write down an equation of motion for Q as it moves downwards,

(2)

(b) find the acceleration of Q as it moves downwards,

(3)

(c) find the speed of Q at the instant when Q hits the floor.

(2)

Given that K seconds **after** Q hits the floor, P hits the pulley

(d) use the model to find the value of K.

(2)

In a refinement of the model, there is a **resistance** which acts against the motion of P.

This refined model is now used to find the acceleration of Q as it moves downwards.

(e) State, **with a reason**, whether this **new** acceleration will be greater than, equal to, or less than, the acceleration found in part (b).

(1)

(f) Suggest one **further** refinement that could be made to the model, apart from including air resistance, that would make the model more realistic.

(1)

Question 3 continued

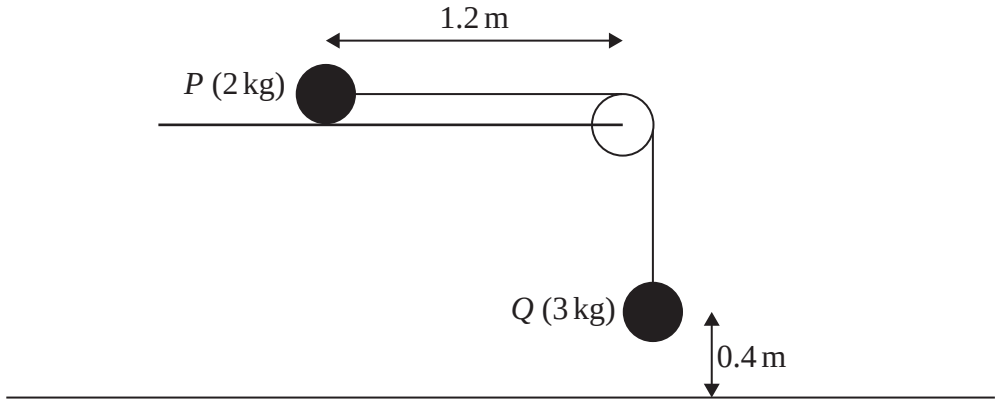

Figure 2