4.

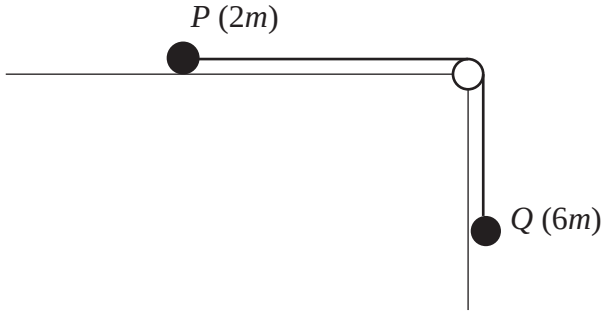

Figure 1

Two balls, P and Q, have masses $2m$ and $6m$ respectively.

The balls are attached to the ends of a rope that passes over a pulley.
The pulley is fixed at the edge of a horizontal table.

Ball P is held at rest on the table, with the rope taut and Q hanging vertically below the pulley, as shown in Figure 1.

The system is released from rest and the balls move.

In a model of the motion

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

In the motion

- Q moves downwards with an acceleration of magnitude $\frac{7g}{16}$
- the total resistance to the motion of P has magnitude kmg, where k is a constant
- the tension in the rope either side of the pulley is T

Using the model,

(a) write down an equation of motion for P, giving your answer in terms of T, k, m and g,

(2)

(b) find the value of k.

(4)

In reality, the pulley would **not** be smooth.

(c) State how this would affect the tension in the rope.

(1)

The model is refined so that the pulley is modelled as **not** being smooth.

(d) Suggest **one** further refinement of the model, apart from including air resistance, that would make the model more realistic.

(1)