Year 1 Chapter 10: Forces and Motions (Pulleys – One Vertical One Horizontal)

Q1.

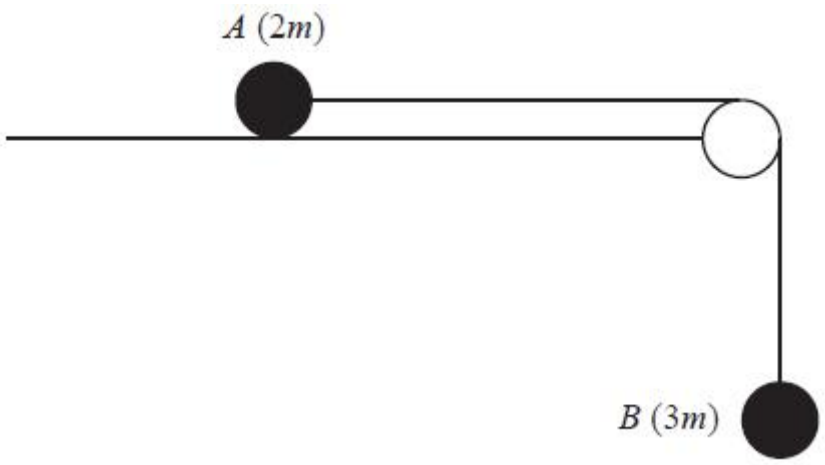

Figure 2

Two particles *A* and *B* have masses 2*m* and 3*m* respectively.

The particles are attached to the ends of a light inextensible string.

Particle *A* is held at rest on a smooth horizontal table.

The string passes over a small smooth pulley which is fixed at the edge of the table.

Particle *B* hangs at rest vertically below the pulley with the string taut, as shown in Figure 2.

Particle *A* is released from rest. Assuming that *A* has not reached the pulley, find

(a) the acceleration of *B*,

(5)

(b) the tension in the string, in terms of m.

(1)

(c) the magnitude and direction of the force exerted on the pulley by the string.

(4)

(Total 10 marks)

Q2.

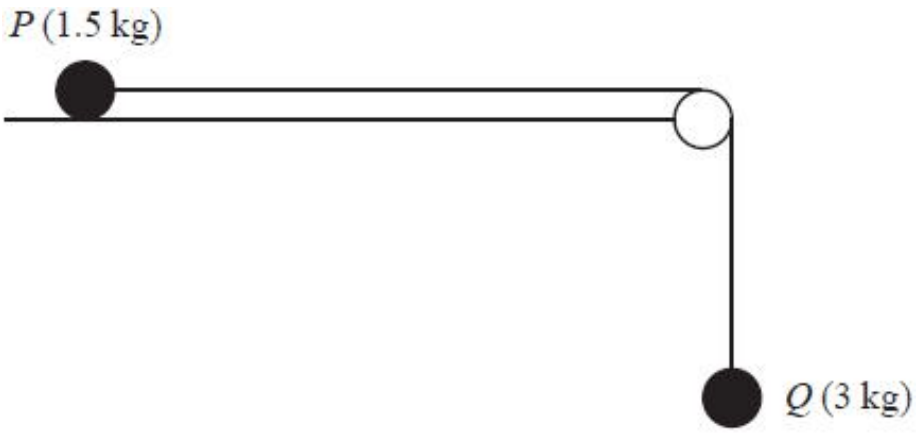

Figure 3

Two particles *P* and *Q* have masses 1.5 kg and 3 kg respectively.

The particles are attached to the ends of a light inextensible string.

Particle *P* is held at rest on a fixed rough horizontal table.

The resistance to the motion of *P* from the rough table is modelled as having constant magnitude $0.3g$ N.

The string is parallel to the table and passes over a small smooth light pulley which is fixed at the edge of the table.

Particle *Q* hangs freely at rest vertically below the pulley, as shown in Figure 3. Particle *P* is released from rest with the string taut and slides along the table.

Assuming that *P* has not reached the pulley, find

(a) the tension in the string during the motion,

(8)

(b) the magnitude and direction of the resultant force exerted on the pulley by the string.

(4)

(Total for question = 12 marks)

Q3.

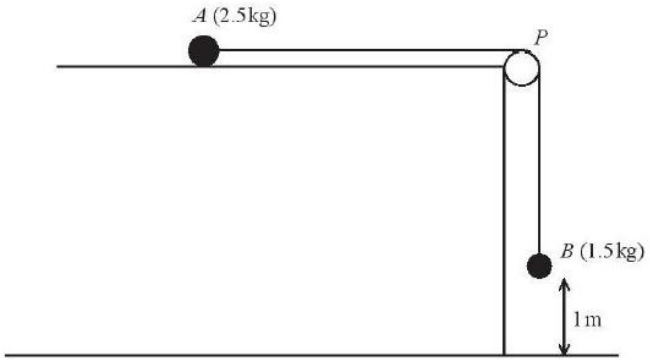

Figure 2

A small ball *A* of mass 2.5 kg is held at rest on a rough horizontal table.

The ball is attached to one end of a string. The string passes over a pulley *P* which is fixed at the edge of the table.

The other end of the string is attached to a small ball *B* of mass 1.5 kg hanging freely, vertically below *P* and with *B* at a height of 1 *m* above the horizontal floor.

The system is released from rest, with the string taut, as shown in Figure 2.

The resistance to the motion of *A* from the rough table is modelled as having constant magnitude 12.7 N. Ball *B* reaches the floor before ball *A* reaches the pulley.

The balls are modelled as particles, the string is modelled as being light and inextensible and the pulley is modelled as being small and smooth.

(a) (i) Write down an equation of motion for *A*.

(ii) Write down an equation of motion for *B*.

(4)

(b) Hence find the acceleration of *B*.

(2)

(c) Using the model, find the time it takes, from release, for *B* to reach the floor.

(2)

It was found that it actually took 2.3 seconds for ball *B* to reach the floor.

(d) Using this information

(i) comment on the appropriateness of using the model to find the time it takes ball *B* to reach the floor, justifying your answer.

(ii) suggest one improvement that could be made in the model.

(2)

(Total for question = 10 marks)

Q4. No resistance to P and hits the pulley

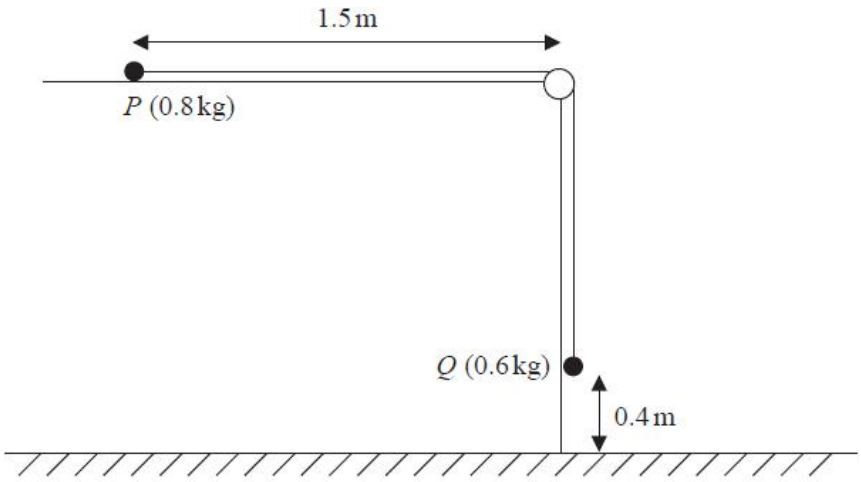

Figure 1

A small ball, *P*, of mass 0.8 kg, is held at rest on a smooth horizontal table and is attached to one end of a thin rope.

The rope passes over a pulley that is fixed at the edge of the table.

The other end of the rope is attached to another small ball, *Q*, of mass 0.6 kg, that hangs freely below the pulley.

Ball *P* is released from rest, with the rope taut, with *P* at a distance of 1.5 m from the pulley and with *Q* at a height of 0.4 m above the horizontal floor, as shown in Figure 1.

Ball *Q* descends, hits the floor and does not rebound.

The balls are modelled as particles, the rope as a light and inextensible string and the pulley as small and smooth.

Using this model,

(a) show that the acceleration of *Q*, as it falls, is 4.2 m s^{-2}

(5)

(b) find the time taken by *P* to hit the pulley from the instant when *P* is released.

(4)

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

(1)

(Total for question = 10 marks)

Q5. No resistance to A and hits the Pulley

Figure 3

Two particles *A* and *B*, of mass *m* and 2*m* respectively, are attached to the ends of a light inextensible string.

The particle *A* lies on a smooth horizontal table.

The string passes over a small smooth pulley *P* fixed on the edge of the table.

The particle *B* hangs freely below the pulley, as shown in Figure 3.

The particles are released from rest with the string taut. Immediately after release, the magnitude of the acceleration of *A* and *B* is 2*g*/3. By writing down separate equations of motion for *A* and *B*,

(a) find, in terms of m, the tension in the string immediately after the particles begin to move,

(3)

When *B* has fallen a distance 8 *metres*, it hits the ground and does not rebound. Particle *A* is then a distance $\frac{8}{3}$ *metres* from *P*.

(b) Given that Find the time it takes *A* to reach *P* after *B* hist the ground.

(5)

(c) State how you have used the information that the string is light.

(1)

(Total 9 marks)