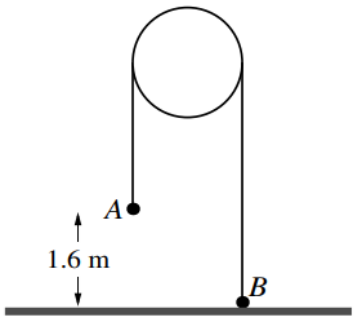
Newton's Laws of Motion 2

Q1.



Particles A and B, of masses 0.35 kg and 0.15 kg respectively, are attached to the ends of a light inextensible string which passes over a fixed smooth pulley. The system is at rest with B held on the horizontal floor, the string taut and its straight parts vertical. A is at a height of 1.6 m above the floor (see diagram). B is released and the system begins to move; B does not reach the pulley. Find

(i) the acceleration of the particles and the tension in the string before A reaches the floor, [4]

(ii) the greatest height above the floor reached by B. [3]

Q2.

Two particles A and B, of masses 0.8 kg and 0.2 kg respectively, are connected by a light inextensible string. Particle A is placed on a horizontal surface. The string passes over a small smooth pulley P fixed at the edge of the surface, and B hangs freely. The horizontal section of the string, AP, is of length 2.5 m. The particles are released from rest with both sections of the string taut.

(i) Given that the surface is smooth, find the time taken for A to reach the pulley. [5]

(ii) Given instead that the surface is rough and the coefficient of friction between A and the surface is 0.1, find the speed of A immediately before it reaches the pulley. [5]

Q3.

Two particles of masses 1.3 kg and 0.7 kg are connected by a light inextensible string that passes over a fixed smooth pulley. The particles are held at the same vertical height with the string taut. The distance of each particle above a horizontal plane is 2 m, and the distance of each particle below the pulley is 4 m. The particles are released from rest.

(i) Find

(a) the tension in the string before the particle of mass 1.3 kg reaches the plane,

(b) the time taken for the particle of mass 1.3 kg to reach the plane.

[6]

(ii) Find the greatest height of the particle of mass 0.7 kg above the plane. [4]

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Q4.

Two particles P and Q, of masses 0.6 kg and 0.4 kg respectively, are connected by a light inextensible string. The string passes over a small smooth light pulley fixed at the edge of a smooth horizontal table. Initially P is held at rest on the table and Q hangs vertically (see diagram). P is then released. Find the tension in the string and the acceleration of Q. [4]

Q5.

A particle of mass 0.1 kg is released from rest on a rough plane inclined at 20° to the horizontal. It is given that, 5 seconds after release, the particle has a speed of $2\,\text{m s}^{-1}$.

(i) Find the acceleration of the particle and hence show that the magnitude of the frictional force acting on the particle is 0.302 N, correct to 3 significant figures. [3]

(ii) Find the coefficient of friction between the particle and the plane. [2]

Q6.

Particles P and Q, of masses 7 kg and 3 kg respectively, are attached to the two ends of a light inextensible string. The string passes over two small smooth pulleys attached to the two ends of a horizontal table. The two particles hang vertically below the two pulleys. The two particles are both initially at rest, 0.5 m below the level of the table, and 0.4 m above the horizontal floor (see diagram).

(i) Find the acceleration of the particles and the speed of P immediately before it reaches the floor. [4]

(ii) Determine whether Q comes to instantaneous rest before it reaches the pulley directly above it. [2]

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Q7.

A box of mass 50 kg is at rest on a plane inclined at 10° to the horizontal.

(i) Find an inequality for the coefficient of friction between the box and the plane. [2]

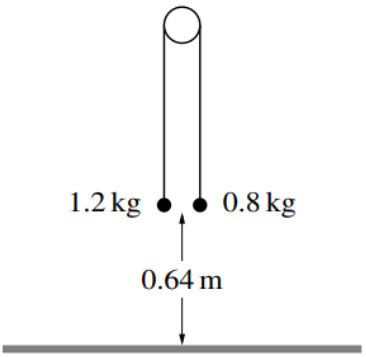
In fact the coefficient of friction between the box and the plane is 0.19.

(ii) A girl pushes the box with a force of 50 N, acting down a line of greatest slope of the plane, for a distance of 5 m. She then stops pushing. Use an energy method to find the speed of the box when it has travelled a further 5 m. [5]

The box then comes to a plane inclined at 20° below the horizontal. The box moves down a line of greatest slope of this plane. The coefficient of friction is still 0.19 and the girl is not pushing the box.

(iii) Find the acceleration of the box. [2]

Q8.



Two particles of masses 1.2 kg and 0.8 kg are connected by a light inextensible string that passes over a fixed smooth pulley. The particles hang vertically. The system is released from rest with both particles 0.64 m above the floor (see diagram). In the subsequent motion the 0.8 kg particle does not reach the pulley.

(i) Show that the acceleration of the particles is $2\ \text{m s}^{-2}$ and find the tension in the string. [4]

(ii) Find the total distance travelled by the 0.8 kg particle during the first second after the particles are released. [8]
