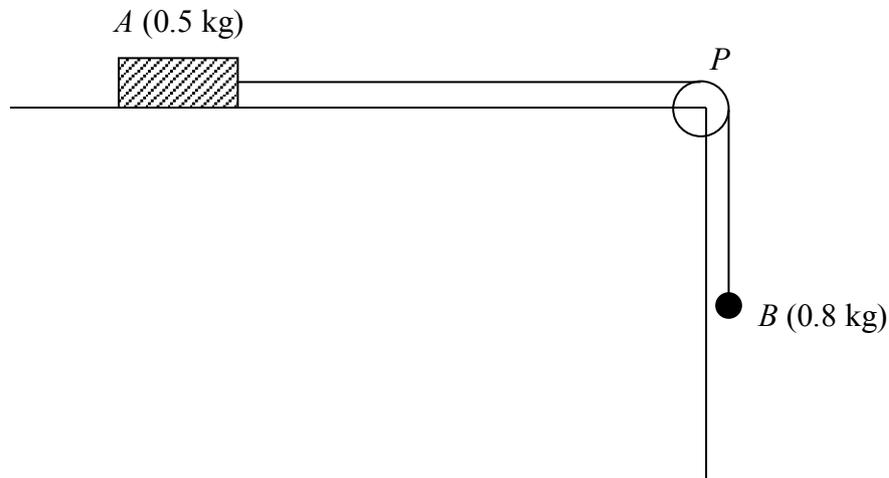

Application of forces: Connected Particles - Edexcel Past Exam Questions

1.

Figure 4

A block of wood A of mass 0.5 kg rests on a rough horizontal table and is attached to one end of a light inextensible string. The string passes over a small smooth pulley P fixed at the edge of the table. The other end of the string is attached to a ball B of mass 0.8 kg which hangs freely below the pulley, as shown in Figure 4. The coefficient of friction between A and the table is μ . The system is released from rest with the string taut. After release, B descends a distance of 0.4 m in 0.5 s . Modelling A and B as particles, calculate

- (a) the acceleration of B , (3)
- (b) the tension in the string, (4)
- (c) the value of μ . (5)
- (d) State how in your calculations you have used the information that the string is inextensible. (1)

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2.

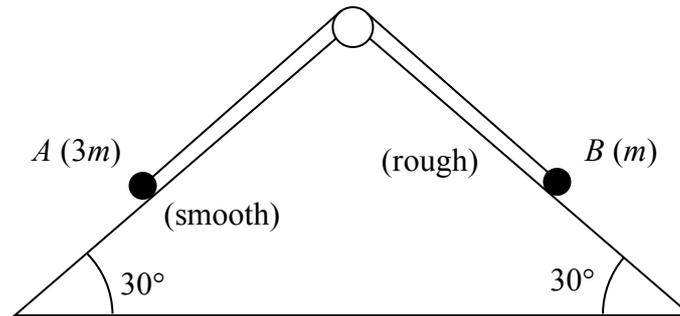


Figure 3

A fixed wedge has two plane faces, each inclined at 30° to the horizontal. Two particles A and B , of mass $3m$ and m respectively, are attached to the ends of a light inextensible string. Each particle moves on one of the plane faces of the wedge. The string passes over a smooth light pulley fixed at the top of the wedge. The face on which A moves is smooth. The face on which B moves is rough. The coefficient of friction between B and this face is μ . Particle A is held at rest with the string taut. The string lies in the same vertical plane as lines of greatest slope on each plane face of the wedge, as shown in Figure 3.

The particles are released from rest and start to move. Particle A moves downwards and particle B moves upwards. The accelerations of A and B each have magnitude $\frac{1}{10}g$.

- (a) By considering the motion of A , find, in terms of m and g , the tension in the string. (3)
- (b) By considering the motion of B , find the value of μ . (8)
- (c) Find the resultant force exerted by the string on the pulley, giving its magnitude and direction. (3)

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3.

Figure 4

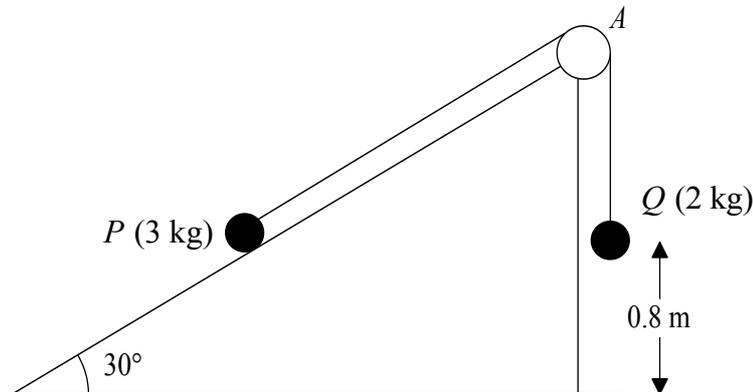


Figure 4 shows two particles P and Q , of mass 3 kg and 2 kg respectively, connected by a light inextensible string. Initially P is held at rest on a smooth fixed plane inclined at 30° to the horizontal. The string passes over a small smooth light pulley A fixed at the top of the plane. The part of the string from P to A is parallel to a line of greatest slope of the plane. The particle Q hangs freely below A . The system is released from rest with the string taut.

- (a) Write down an equation of motion for P and an equation of motion for Q . (4)
- (b) Hence show that the acceleration of Q is 0.98 m s^{-2} . (2)
- (c) Find the tension in the string. (2)
- (d) State where in your calculations you have used the information that the string is inextensible. (1)

On release, Q is at a height of 0.8 m above the ground. When Q reaches the ground, it is brought to rest immediately by the impact with the ground and does not rebound. The initial distance of P from A is such that in the subsequent motion P does not reach A . Find

- (e) the speed of Q as it reaches the ground, (2)
- (f) the time between the instant when Q reaches the ground and then instant when the string becomes taut again. (5)

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4.

Figure 3



Two particles A and B , of mass m and $2m$ respectively, are attached to the ends of a light inextensible string. The particle A lies on a rough 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 coefficient of friction between A and the table is μ . The particles are released from rest with the string taut. Immediately after release, the magnitude of the acceleration of A and B is $\frac{4}{9}g$. By writing down separate equations of motion for A and B ,

(a) find the tension in the string immediately after the particles begin to move, (3)

(b) show that $\mu = \frac{2}{3}$. (5)

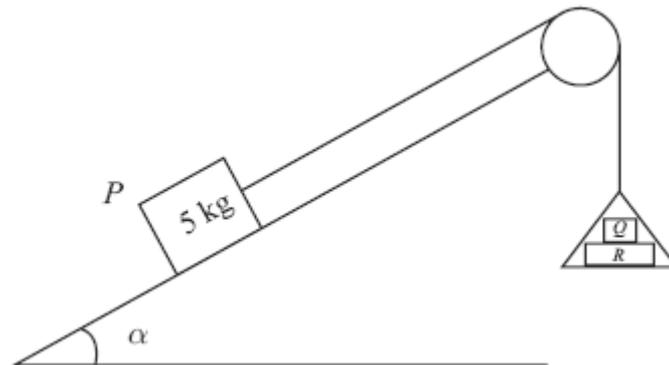
When B has fallen a distance h , it hits the ground and does not rebound. Particle A is then a distance $\frac{1}{3}h$ from P .

(c) Find the speed of A as it reaches P . (6)

(d) State how you have used the information that the string is light. (1)

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5.

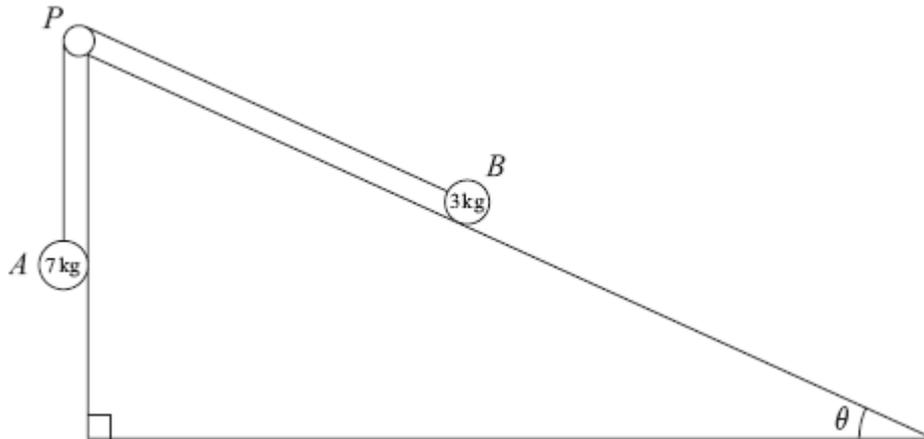


One end of a light inextensible string is attached to a block P of mass 5 kg . The block P is held at rest on a smooth fixed plane which is inclined to the horizontal at an angle α , where $\sin \alpha = \frac{3}{5}$. The string lies along a line of greatest slope of the plane and passes over a smooth light pulley which is fixed at the top of the plane. The other end of the string is attached to a light scale pan which carries two blocks Q and R , with block Q on top of block R , as shown in Figure 3. The mass of block Q is 5 kg and the mass of block R is 10 kg . The scale pan hangs at rest and the system is released from rest. By modelling the blocks as particles, ignoring air resistance and assuming the motion is uninterrupted, find

- (a) (i) the acceleration of the scale pan, (8)
 (ii) the tension in the string, (8)
- (b) the magnitude of the force exerted on block Q by block R , (3)
- (c) the magnitude of the force exerted on the pulley by the string. (5)

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6.


Figure 4

Two particles A and B , of mass 7 kg and 3 kg respectively, are attached to the ends of a light inextensible string. Initially B is held at rest on a rough fixed plane inclined at angle θ to the horizontal, where $\tan \theta = \frac{5}{12}$. The part of the string from B to P is parallel to a line of greatest slope of the plane. The string passes over a small smooth pulley, P , fixed at the top of the plane. The particle A hangs freely below P , as shown in Figure 4. The coefficient of friction between B and the plane is $\frac{2}{3}$. The particles are released from rest with the string taut and B moves up the plane.

(a) Find the magnitude of the acceleration of B immediately after release. (10)

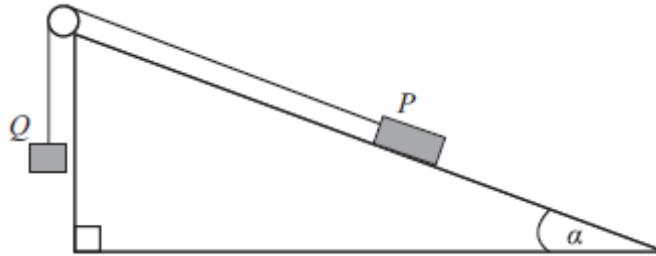
(b) Find the speed of B when it has moved 1 m up the plane. (2)

When B has moved 1 m up the plane the string breaks. Given that in the subsequent motion B does not reach P ,

(c) find the time between the instants when the string breaks and when B comes to instantaneous rest. (4)

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7.



Two particles P and Q have masses 0.3 kg and m kg respectively. The particles are attached to the ends of a light inextensible string. The string passes over a small smooth pulley which is fixed at the top of a fixed rough plane. The plane is inclined to the horizontal at an angle α , where $\tan \alpha = \frac{3}{4}$. The coefficient of friction between P and the plane is $\frac{1}{2}$.

The string lies in a vertical plane through a line of greatest slope of the inclined plane. The particle P is held at rest on the inclined plane and the particle Q hangs freely below the pulley with the string taut, as shown in Figure 2.

The system is released from rest and Q accelerates vertically downwards at 1.4 m s^{-2} .

Find

- (a) the magnitude of the normal reaction of the inclined plane on P , (2)
- (b) the value of m . (8)

When the particles have been moving for 0.5 s, the string breaks. Assuming that P does not reach the pulley,

- (c) find the further time that elapses until P comes to instantaneous rest. (6)

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