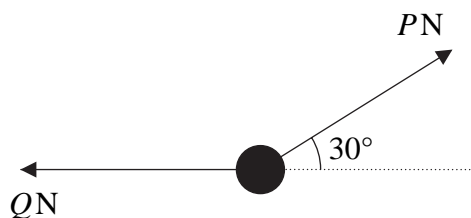


1.

Figure 1



A particle of weight 24 N is held in equilibrium by two light inextensible strings. One string is horizontal. The other string is inclined at an angle of 30° to the horizontal, as shown in Figure 1. The tension in the horizontal string is Q newtons and the tension in the other string is P newtons. Find

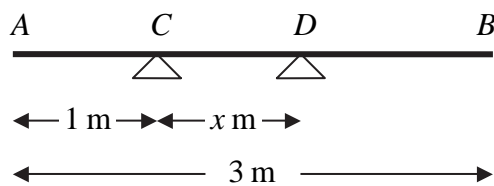
(a) the value of P , **(3)**

(b) the value of Q . **(3)**



2.

Figure 2



A uniform plank AB has weight 120 N and length 3 m . The plank rests horizontally in equilibrium on two smooth supports C and D , where $AC = 1\text{ m}$ and $CD = x\text{ m}$, as shown in Figure 2. The reaction of the support on the plank at D has magnitude 80 N . Modelling the plank as a rod,

- (a) show that $x = 0.75$ (3)

A rock is now placed at B and the plank is on the point of tilting about D . Modelling the rock as a particle, find

- (b) the weight of the rock, (4)
- (c) the magnitude of the reaction of the support on the plank at D . (2)
- (d) State how you have used the model of the rock as a particle. (1)



4. A particle P of mass 0.3 kg is moving with speed $u \text{ m s}^{-1}$ in a straight line on a smooth horizontal table. The particle P collides directly with a particle Q of mass 0.6 kg, which is at rest on the table. Immediately after the particles collide, P has speed 2 m s^{-1} and Q has speed 5 m s^{-1} . The direction of motion of P is reversed by the collision. Find

(a) the value of u , (4)

(b) the magnitude of the impulse exerted by P on Q . (2)

Immediately after the collision, a constant force of magnitude R newtons is applied to Q in the direction directly opposite to the direction of motion of Q . As a result Q is brought to rest in 1.5 s.

(c) Find the value of R . (4)

5. A ball is projected vertically upwards with speed 21 m s^{-1} from a point A , which is 1.5 m above the ground. After projection, the ball moves freely under gravity until it reaches the ground. Modelling the ball as a particle, find

(a) the greatest height above A reached by the ball, **(3)**

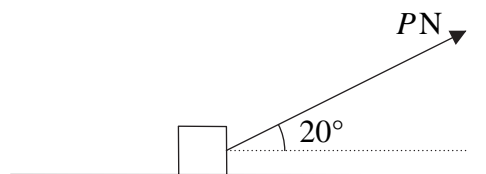
(b) the speed of the ball as it reaches the ground, **(3)**

(c) the time between the instant when the ball is projected from A and the instant when the ball reaches the ground. **(4)**



6.

Figure 3



A box of mass 30 kg is being pulled along rough horizontal ground at a constant speed using a rope. The rope makes an angle of 20° with the ground, as shown in Figure 3. The coefficient of friction between the box and the ground is 0.4. The box is modelled as a particle and the rope as a light, inextensible string. The tension in the rope is P newtons.

(a) Find the value of P . (8)

The tension in the rope is now increased to 150 N.

(b) Find the acceleration of the box. (6)



Question 6 continued

Lined area for writing the answer to Question 6.

Q6

(Total 14 marks)

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7.

Figure 4

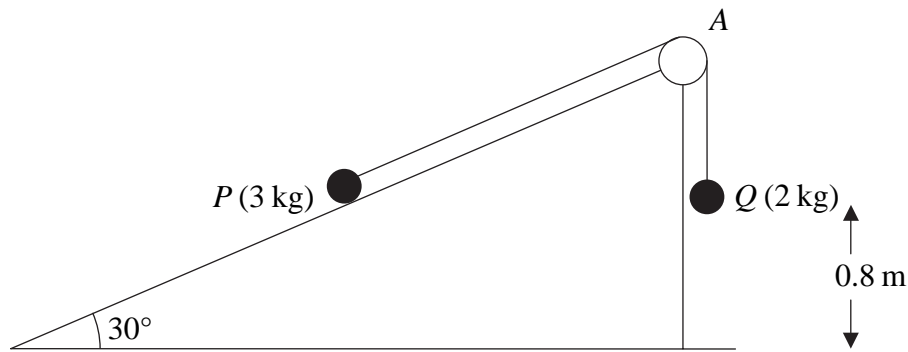


Figure 4 shows two particles P and Q , of mass 3 kg and 2 kg respectively, connected by a light inextensible string. Initially P is held at rest on a fixed smooth plane inclined at 30° to the horizontal. The string passes over a small smooth light pulley A fixed at the top of the plane. The part of the 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 the instant when the string becomes taut again. (5)



