

1. Particle P has mass 3 kg and particle Q has mass $m \text{ kg}$. The particles are moving in opposite directions along a smooth horizontal plane when they collide directly. Immediately before the collision, the speed of P is 4 m s^{-1} and the speed of Q is 3 m s^{-1} . In the collision the direction of motion of P is unchanged and the direction of motion of Q is reversed. Immediately after the collision, the speed of P is 1 m s^{-1} and the speed of Q is 1.5 m s^{-1} .

(a) Find the magnitude of the impulse exerted on P in the collision. **(3)**

(b) Find the value of m . **(3)**



3.

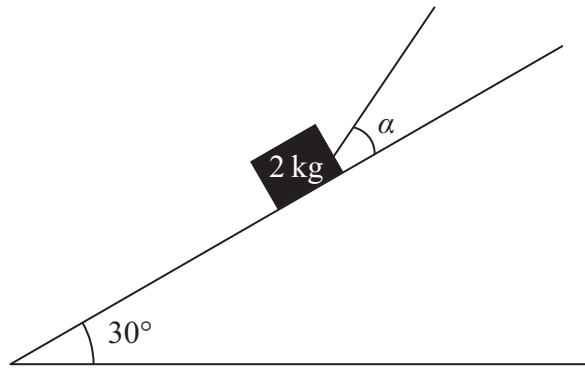


Figure 1

A box of mass 2 kg is held in equilibrium on a fixed rough inclined plane by a rope. The rope lies in a vertical plane containing a line of greatest slope of the inclined plane. The rope is inclined to the plane at an angle α , where $\tan \alpha = \frac{3}{4}$, and the plane is at an angle of 30° to the horizontal, as shown in Figure 1. The coefficient of friction between the box and the inclined plane is $\frac{1}{3}$ and the box is on the point of slipping up the plane. By modelling the box as a particle and the rope as a light inextensible string, find the tension in the rope.

(8)



Question 4 continued

A series of horizontal lines for writing.



Question 4 continued

Ruled lines for writing.

Q4

(Total 9 marks)



5. A car is travelling along a straight horizontal road. The car takes 120 s to travel between two sets of traffic lights which are 2145 m apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for 30 s until its speed is 22 m s^{-1} . The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

(a) Sketch, in the space below, a speed-time graph for the motion of the car between the two sets of traffic lights. (2)

(b) Find the value of T . (3)

A motorcycle leaves the first set of traffic lights 10 s after the car has left the first set of traffic lights. The motorcycle moves from rest with constant acceleration, $a \text{ m s}^{-2}$, and passes the car at the point A which is 990 m from the first set of traffic lights. When the motorcycle passes the car, the car is moving with speed 22 m s^{-1} .

(c) Find the time it takes for the motorcycle to move from the first set of traffic lights to the point A . (4)

(d) Find the value of a . (2)



Question 5 continued

Handwritten response area consisting of 30 horizontal lines.

Q5

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(Total 11 marks)



6. A beam AB has length 15 m. The beam rests horizontally in equilibrium on two smooth supports at the points P and Q , where $AP = 2$ m and $QB = 3$ m. When a child of mass 50 kg stands on the beam at A , the beam remains in equilibrium and is on the point of tilting about P . When the same child of mass 50 kg stands on the beam at B , the beam remains in equilibrium and is on the point of tilting about Q . The child is modelled as a particle and the beam is modelled as a non-uniform rod.

- (a) (i) Find the mass of the beam.
 - (ii) Find the distance of the centre of mass of the beam from A .
- (8)**

When the child stands at the point X on the beam, it remains horizontal and in equilibrium. Given that the reactions at the two supports are equal in magnitude,

- (b) find AX .
- (6)**



Question 6 continued

[Lined area for writing answer]

(Total 14 marks)

Q6



7. [In this question, the horizontal unit vectors \mathbf{i} and \mathbf{j} are directed due east and due north respectively.]

The velocity, \mathbf{v} m s $^{-1}$, of a particle P at time t seconds is given by

$$\mathbf{v} = (1 - 2t)\mathbf{i} + (3t - 3)\mathbf{j}$$

(a) Find the speed of P when $t = 0$ (3)

(b) Find the bearing on which P is moving when $t = 2$ (2)

(c) Find the value of t when P is moving

- (i) parallel to \mathbf{j} ,
- (ii) parallel to $(-\mathbf{i} - 3\mathbf{j})$. (6)



Question 7 continued

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8.

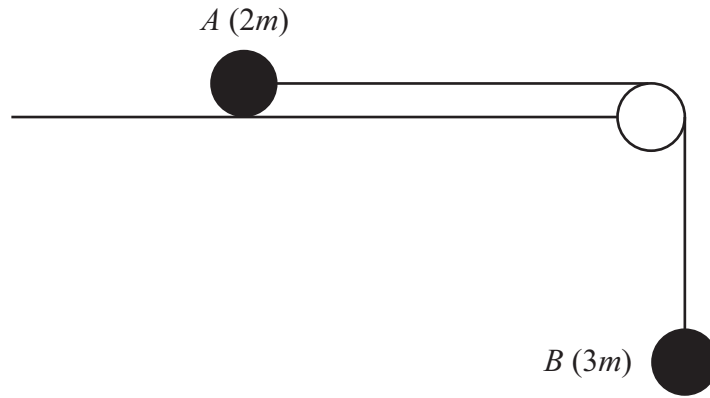


Figure 2

Two particles A and B have masses $2m$ and $3m$ 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, **(1)**

- (c) the magnitude and direction of the force exerted on the pulley by the string. **(4)**



