





2. Particle  $P$  has mass  $m$  kg and particle  $Q$  has mass  $3m$  kg. The particles are moving in opposite directions along a smooth horizontal plane when they collide directly. Immediately before the collision  $P$  has speed  $4u \text{ m s}^{-1}$  and  $Q$  has speed  $ku \text{ m s}^{-1}$ , where  $k$  is a constant. As a result of the collision the direction of motion of each particle is reversed and the speed of each particle is halved.

(a) Find the value of  $k$ . (4)

(b) Find, in terms of  $m$  and  $u$ , the magnitude of the impulse exerted on  $P$  by  $Q$ . (3)

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4. A beam  $AB$  has length  $6 \text{ m}$  and weight  $200 \text{ N}$ . The beam rests in a horizontal position on two supports at the points  $C$  and  $D$ , where  $AC = 1 \text{ m}$  and  $DB = 1 \text{ m}$ . Two children, Sophie and Tom, each of weight  $500 \text{ N}$ , stand on the beam with Sophie standing twice as far from the end  $B$  as Tom. The beam remains horizontal and in equilibrium and the magnitude of the reaction at  $D$  is three times the magnitude of the reaction at  $C$ . By modelling the beam as a uniform rod and the two children as particles, find how far Tom is standing from the end  $B$ .

(7)

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**Question 5 continued**

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6. A ball is projected vertically upwards with a speed of  $14.7 \text{ m s}^{-1}$  from a point which is 49 m above horizontal ground. Modelling the ball as a particle moving freely under gravity, find

(a) the greatest height, above the ground, reached by the ball, **(4)**

(b) the speed with which the ball first strikes the ground, **(3)**

(c) the total time from when the ball is projected to when it first strikes the ground. **(3)**

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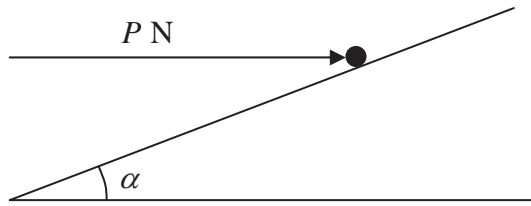
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7.



**Figure 2**

A particle of mass  $0.4\text{ kg}$  is held at rest on a fixed rough plane by a horizontal force of magnitude  $P$  newtons. The force acts in the vertical plane containing the line of greatest slope of the inclined plane which passes through the particle. The plane is inclined to the horizontal at an angle  $\alpha$ , where  $\tan \alpha = \frac{3}{4}$ , as shown in Figure 2.

The coefficient of friction between the particle and the plane is  $\frac{1}{3}$ .

Given that the particle is on the point of sliding up the plane, find

(a) the magnitude of the normal reaction between the particle and the plane, (5)

(b) the value of  $P$ . (5)

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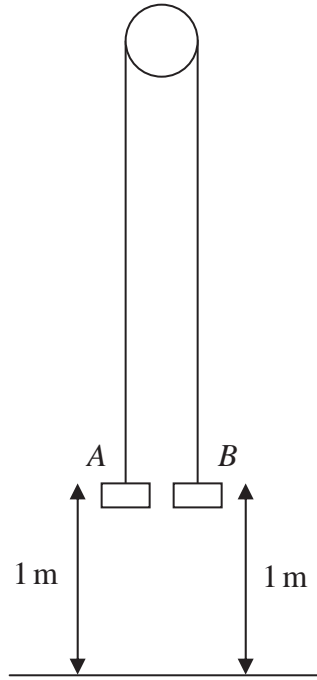
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8.



**Figure 3**

Two particles *A* and *B* have mass 0.4 kg and 0.3 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 above a horizontal floor. Both particles are held, with the string taut, at a height of 1 m above the floor, as shown in Figure 3. The particles are released from rest and in the subsequent motion *B* does not reach the pulley.

- (a) Find the tension in the string immediately after the particles are released. (6)
- (b) Find the acceleration of *A* immediately after the particles are released. (2)

When the particles have been moving for 0.5 s, the string breaks.

- (c) Find the further time that elapses until *B* hits the floor. (9)

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