Each of two identical light elastic strings has natural length 0.25 m and modulus of elasticity 4 N. A particle $P$ of mass 0.6 kg is attached to one end of each of the strings. The other ends of the strings are attached to fixed points $A$ and $B$ which are 0.8 m apart on a smooth horizontal table. The particle is held at rest on the table, at a point 0.3 m from $AB$ for which $AP = BP$ (see diagram).

(i) Find the tension in the strings. [2]

(ii) The particle is released. Find its initial acceleration. [3]

One end of a light inextensible string of length 0.16 m is attached to a fixed point $A$ which is above a smooth horizontal table. A particle $P$ of mass 0.4 kg is attached to the other end of the string. $P$ moves on the table in a horizontal circle, with the string taut and making an angle of 30° with the downward vertical through $A$ (see diagram). $P$ moves with constant speed 0.6 m s$^{-1}$. Find

(i) the tension in the string, [3]

(ii) the force exerted by the table on $P$. [3]
A uniform beam $AB$ has length 2 m and mass 10 kg. The beam is hinged at $A$ to a fixed point on a vertical wall, and is held in a fixed position by a light inextensible string of length 2.4 m. One end of the string is attached to the beam at a point 0.7 m from $A$. The other end of the string is attached to the wall at a point vertically above the hinge. The string is at right angles to $AB$. The beam carries a load of weight 300 N at $B$ (see diagram).

(i) Find the tension in the string. [4]

The components of the force exerted by the hinge on the beam are $X$ N horizontally away from the wall and $Y$ N vertically downwards.

(ii) Find the values of $X$ and $Y$. [3]

A particle of mass 0.4 kg is released from rest and falls vertically. A resisting force of magnitude $0.08v$ N acts upwards on the particle during its descent, where $v \text{ m s}^{-1}$ is the velocity of the particle at time $t \text{ s}$ after its release.

(i) Show that the acceleration of the particle is $(10 - 0.2v)$ m s$^{-2}$. [2]

(ii) Find the velocity of the particle when $t = 15$. [5]
Each of two light elastic strings, \( S_1 \) and \( S_2 \), has modulus of elasticity 16 N. The string \( S_1 \) has natural length 0.4 m and the string \( S_2 \) has natural length 0.5 m. One end of \( S_1 \) is attached to a fixed point \( A \) of a smooth horizontal table and the other end is attached to a particle \( P \) of mass 0.5 kg. One end of \( S_2 \) is attached to a fixed point \( B \) of the table and the other end is attached to \( P \). The distance \( AB \) is 1.5 m. The particle \( P \) is held at \( A \) and then released from rest.

(i) Find the speed of \( P \) at the instant that \( S_2 \) becomes slack. [4]

(ii) Find the greatest distance of \( P \) from \( A \) in the subsequent motion. [3]

A particle is projected from a point \( O \) at an angle of 35° above the horizontal. At time \( T \)’s later the particle passes through a point \( A \) whose horizontal and vertically upward displacements from \( O \) are 8 m and 3 m respectively.

(i) By using the equation of the particle’s trajectory, or otherwise, find (in either order) the speed of projection of the particle from \( O \) and the value of \( T \). [5]

(ii) Find the angle between the direction of motion of the particle at \( A \) and the horizontal. [4]
Fig. 1 shows the cross-section of a uniform solid. The cross-section has the shape and dimensions shown. The centre of mass $C$ of the solid lies in the plane of this cross-section. The distance of $C$ from $DE$ is $y$ cm.

(i) Find the value of $y$. [3]

The solid is placed on a rough plane. The coefficient of friction between the solid and the plane is $\mu$. The plane is tilted so that $EF$ lies along a line of greatest slope.

(ii)

The solid is placed so that $F$ is higher up the plane than $E$ (see Fig. 2). When the angle of inclination is sufficiently great the solid starts to topple (without sliding). Show that $\mu > \frac{1}{2}$. [3]

(iii)

The solid is now placed so that $E$ is higher up the plane than $F$ (see Fig. 3). When the angle of inclination is sufficiently great the solid starts to slide (without toppling). Show that $\mu < \frac{5}{6}$. [3]