Statics and Dynamics in 2d Without Friction (From OCR 4728)

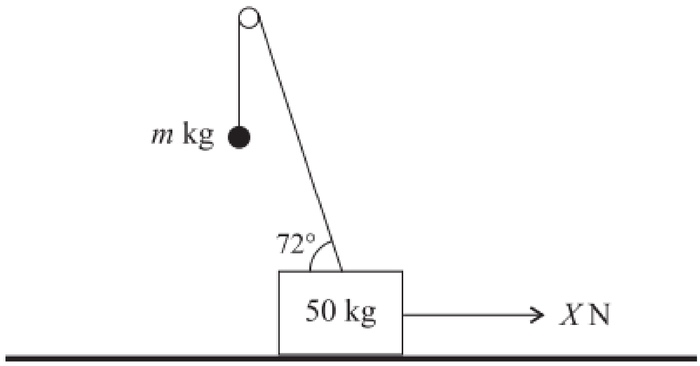
Q1, (Jun 2005, Q4)

A particle moves downwards on a smooth plane inclined at an angle α to the horizontal. The particle passes through the point P with speed $u\,\text{m s}^{-1}$. The particle travels 2 m during the first 0.8 s after passing through P, then a further 6 m in the next 1.2 s. Find

(i) the value of u and the acceleration of the particle, [7]

(ii) the value of α in degrees. [2]

Q2, (Jun 2007, Q3)



A block of mass 50 kg is in equilibrium on smooth horizontal ground with one end of a light wire attached to its upper surface. The other end of the wire is attached to an object of mass m kg. The wire passes over a small smooth pulley, and the object hangs vertically below the pulley. The part of the wire between the block and the pulley makes an angle of 72° with the horizontal. A horizontal force of magnitude X N acts on the block in the vertical plane containing the wire (see diagram).

The tension in the wire is T N and the contact force exerted by the ground on the block is R N.

(i) By resolving forces on the block vertically, find a relationship between T and R. [2]

It is given that the block is on the point of lifting off the ground.

(ii) Show that $T = 515$, correct to 3 significant figures, and hence find the value of m. [4]

(iii) By resolving forces on the block horizontally, write down a relationship between T and X, and hence find the value of X. [2]

Q3, (Jun 2010, Q6)

A block B of mass 0.85 kg lies on a smooth slope inclined at 30° to the horizontal. B is attached to one end of a light inextensible string which is parallel to the slope. At the top of the slope, the string passes over a smooth pulley. The other end of the string hangs vertically and is attached to a particle P of mass 0.55 kg. The string is taut at the instant when P is projected vertically downwards.

(i) Calculate

(a) the acceleration of B and the tension in the string, **[5]**

(b) the magnitude of the force exerted by the string on the pulley. **[2]**

The initial speed of P is $1.3\,\text{m s}^{-1}$ and after moving 1.5 m P reaches the ground, where it remains at rest. B continues to move up the slope and does not reach the pulley.

(ii) Calculate the total distance B moves up the slope before coming instantaneously to rest. **[6]**

Q4, (Jan 2006, Q6)

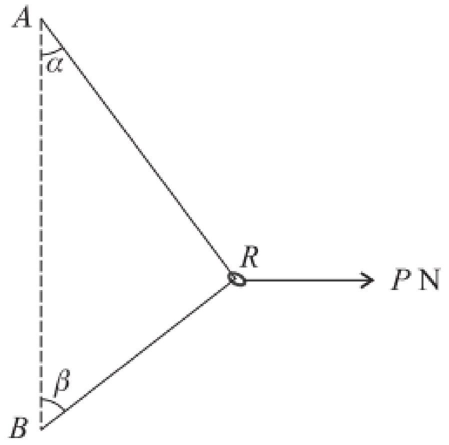


Fig. 1

A smooth ring R of weight W N is threaded on a light inextensible string. The ends of the string are attached to fixed points A and B, where A is vertically above B. A horizontal force of magnitude P N acts on R. The system is in equilibrium with the string taut; AR makes an angle α with the downward vertical and BR makes an angle β with the upward vertical (see Fig. 1).

(i) By considering the vertical components of the forces acting on R, show that $\alpha < \beta$. [3]

(ii)

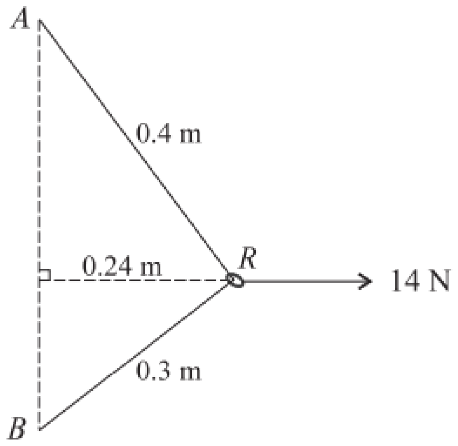


Fig. 2

It is given that when $P = 14$, $AR = 0.4$ m, $BR = 0.3$ m and the distance of R from the vertical line AB is 0.24 m (see Fig. 2). Find

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

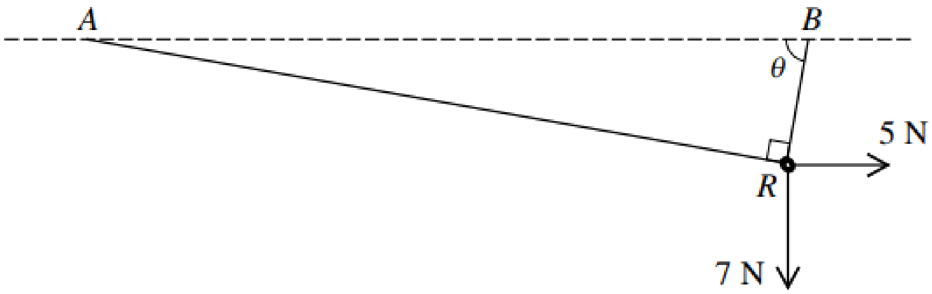
(b) the value of W. [3]

(iii) For the case when $P = 0$,

(a) describe the position of R, [1]

(b) state the tension in the string. [1]

Q5, (Jun 2011, Q6)



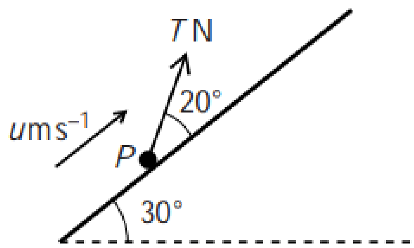
A small smooth ring R of weight 7 N is threaded on a light inextensible string. The ends of the string are attached to fixed points A and B at the same horizontal level. A horizontal force of magnitude 5 N is applied to R. The string is taut. In the equilibrium position the angle ARB is a right angle, and the portion of the string attached to B makes an angle θ with the horizontal (see diagram).

(i) Explain why the tension T N is the same in each part of the string. **[1]**

(ii) By resolving horizontally and vertically for the forces acting on R, form two simultaneous equations in $T\cos\theta$ and $T\sin\theta$. **[4]**

(iii) Hence find T and θ. **[6]**

Q6, (Jan 2013, Q3)



A particle P of mass 0.25 kg moves upwards with constant speed $u\,\text{m s}^{-1}$ along a line of greatest slope on a smooth plane inclined at 30° to the horizontal. The pulling force acting on P has magnitude T N and acts at an angle of 20° to the line of greatest slope (see diagram). Calculate

(i) the value of T, **[3]**

(ii) the magnitude of the contact force exerted on P by the plane. **[3]**

The pulling force T N acting on P is suddenly removed, and P comes to instantaneous rest 0.4 s later.

(iii) Calculate u. **[4]**

Q7, (Jun 2016, Q1)

A particle P is projected down a line of greatest slope on a smooth inclined plane. P has velocity $5\,\text{m s}^{-1}$ at the instant when it has been in motion for 1.6 s and travelled a distance of 6.4 m. Calculate

(i) the initial speed and the acceleration of P, **[5]**

(ii) the inclination of the plane to the vertical. **[3]**