Rigid Body PPQ's (Early Years)

June 01 Q3

(1)

A uniform ladder AB, of mass m and length $2a$, has one end A on rough horizontal ground. The coefficient of friction between the ladder and the ground is 0.5. The other end B of the ladder rests against a smooth vertical wall. The ladder rests in equilibrium in a vertical plane perpendicular to the wall, and makes an angle of 30° with the wall. A man of mass $5m$ stands on the ladder which remains in equilibrium. The ladder is modelled as a uniform rod and the man as a particle. The greatest possible distance of the man from A is ka.

Find the value of k.

(9)

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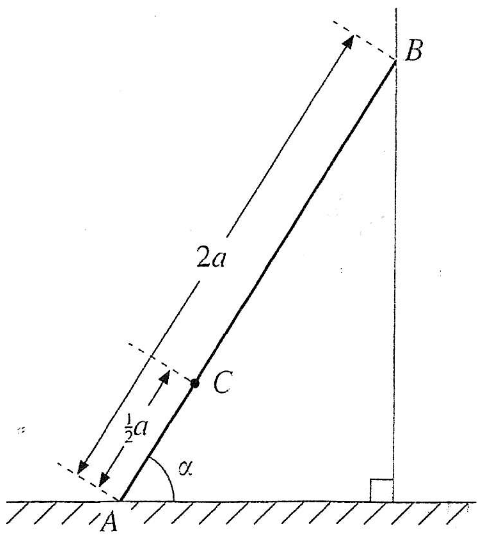
(2)

Jan 03 Q3

Figure 1



A uniform ladder AB, of mass m and length $2a$, has one end A on rough horizontal ground. The other end B rests against a smooth vertical wall. The ladder is in a vertical plane perpendicular to the wall. The ladder makes an angle α with the horizontal, where $\tan \alpha = \frac{4}{3}$. A child of mass $2m$ stands on the ladder at C where $AC = \frac{1}{2}a$, as shown in Fig. 1. The ladder and the child are in equilibrium.

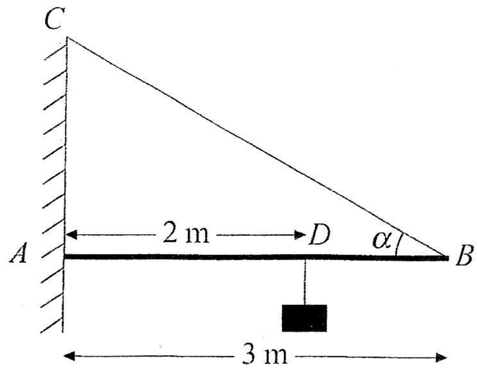
By modelling the ladder as a rod and the child as a particle, calculate the least possible value of the coefficient of friction between the ladder and the ground.

(9)

(3)

June 03 Q4

Figure 2



A uniform steel girder AB, of mass 40 kg and length 3 m, is freely hinged at A to a vertical wall. The girder is supported in a horizontal position by a steel cable attached to the girder at B. The other end of the cable is attached to the point C vertically above A on the wall, with $\angle ABC = \alpha$, where $\tan \alpha = \frac{3}{4}$. A load of mass 60 kg is suspended by another cable from the girder at the point D, where $AD = 2$ m, as shown in Fig. 2. The girder remains horizontal and in equilibrium. The girder is modelled as a rod, and the cables as light inextensible strings.

(a) Show that the tension in the cable BC is 980 N.

(5)

(b) Find the magnitude of the reaction on the girder at A.

(6)

(c) Explain how you have used the modelling assumption that the cable at D is light.

(1)

(4)

JAN 02 Q5

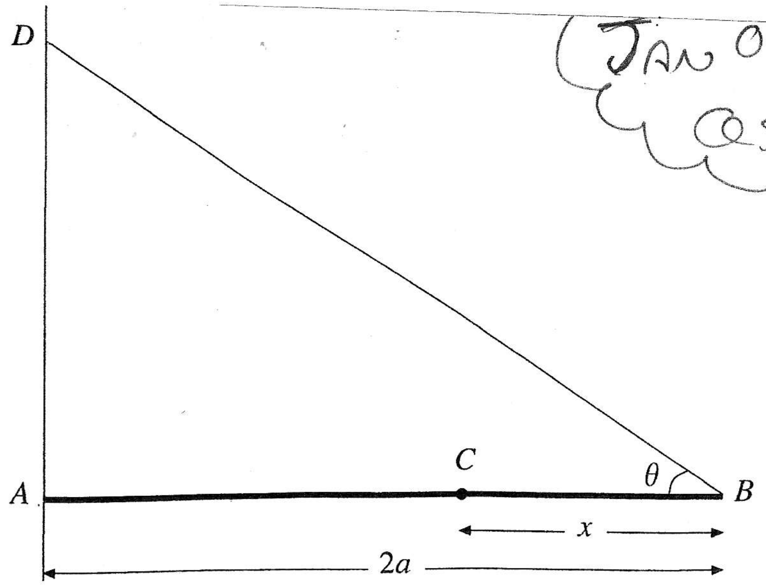


Figure 2 shows a horizontal uniform pole AB, of weight W and length $2a$. The end A of the pole rests against a rough vertical wall. One end of a light inextensible string BD is attached to the pole at B and the other end is attached to the wall at D. A particle of weight $2W$ is attached to the pole at C, where $BC = x$. The pole is in equilibrium in a vertical plane perpendicular to the wall. The string BD is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{3}{5}$. The pole is modelled as a uniform rod.

(a) Show that the tension in BD is $\dfrac{5(5a - 2x)}{6a}W$.

(5)

The vertical component of the force exerted by the wall on the pole is $\frac{7}{6}W$. Find

(b) x in terms of a,

(3)

(c) the horizontal component, in terms of W, of the force exerted by the wall on the pole.

(4)

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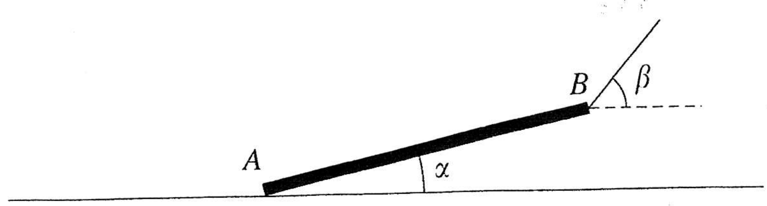
(5)

JUNE 02 Q7



A straight log AB has weight W and length $2a$. A cable is attached to one end B of the log. The cable lifts the end B off the ground. The end A remains in contact with the ground, which is rough and horizontal. The log is in limiting equilibrium. The log makes an angle α to the horizontal, where $\tan\alpha = \frac{5}{12}$. The cable makes an angle β to the horizontal, as shown in Fig. 3. The coefficient of friction between the log and the ground is 0.6. The log is modelled as a uniform rod and the cable as light.

(a) Show that the normal reaction on the log at A is $\frac{2}{5}W$.

(6)

(b) Find the value of β.

(6)

The tension in the cable is kW.

(2)

(c) Find the value of k.

NUMERICAL ANSWERS

(1) $K = 1.88$ *READ question very carefully regarding given angle*
(I didn't!!)

(2) $\mu = \frac{1}{4}$

(3) (a) 980N (given)

(b) $R_A = 876.5N$

(4) (b) $x = \frac{2a}{3}$

(c) $R_x = \frac{22W}{9}$

(5) (b) 68.2°

(c) $k = 0.65$