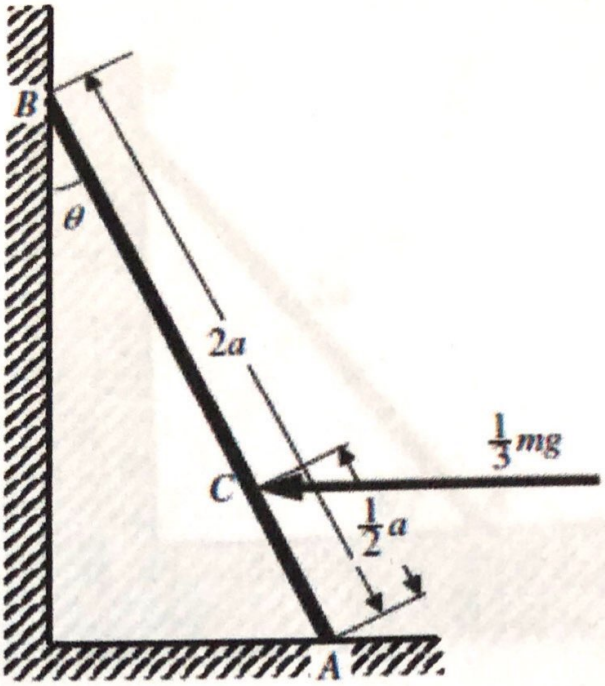
Question 1 (**)



A ladder of length $2a$ and mass m, has one end A on smooth horizontal ground and the other end B against a smooth vertical wall.

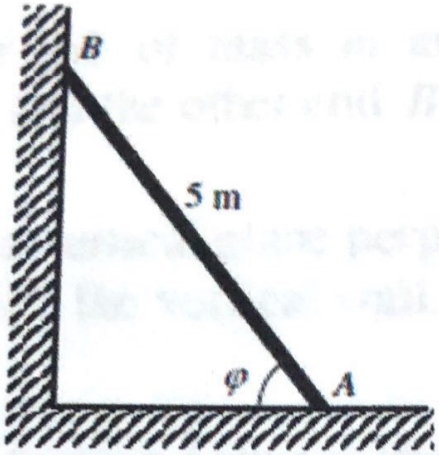
The ladder is kept in equilibrium by a horizontal force of magnitude $\frac{1}{3}mg$ acting at a point C on the ladder, where $AC=\frac{1}{2}a$, as shown in the figure above.

The angle between the ladder and the vertical wall is θ.

By modelling the ladder as a uniform rod find $\tan\theta$

Scanned with CamScanner

Question 2 (+)**



The figure above shows a ladder AB resting in equilibrium with one end A on rough horizontal ground and the other end B against a smooth vertical wall. The ladder is modelled as a uniform rod of length 5 metres and mass 20 kg, and lies in a vertical plane perpendicular to the wall and the ground, inclined at an angle φ to the horizontal.

When a person of mass 60 kg, modelled as a particle, stands at a point C on the ladder, where $AC = 4$ metres the ladder is at the point of slipping.

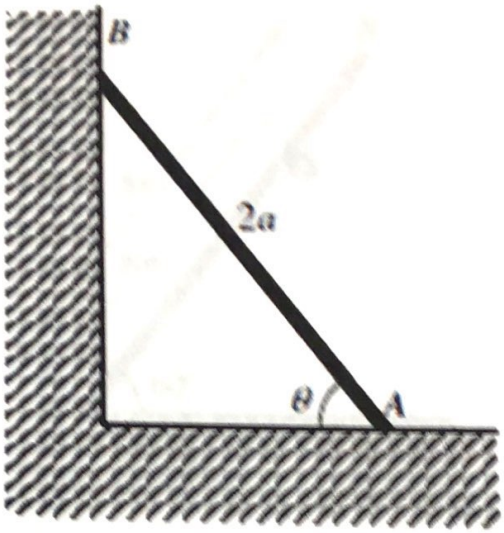
Given that the coefficient of friction between the ladder and the ground is $\frac{1}{4}$, find ...

a) ... the magnitude of the frictional force of the ground on the ladder

b) ... the value of φ, to the nearest degree.

Scanned with CamScanner

Question 3 (**+)



The figure above shows a uniform ladder AB of length $2a$ and of mass m resting with the end A on rough horizontal ground and the end B against a smooth vertical wall. The ladder is inclined at an angle θ to the ground.

When a child of mass $2m$ is standing on the ladder at B, the ladder is about to slip.

Given that the coefficient of friction between the ladder and the ground is $\frac{5}{12}$, find the value of θ.

Scanned with CamScanner

Question 4 (***)

A uniform ladder AB of mass m and length $2a$ has one of its end A on rough horizontal ground and the other end B against a smooth vertical wall.

The ladder lies in a vertical plane perpendicular to the wall and the ground, and makes an angle of 30° with the vertical wall.

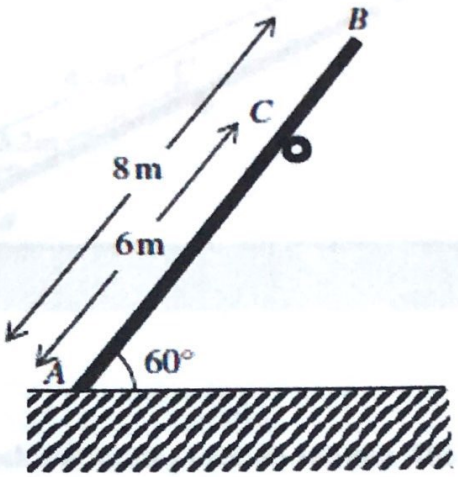
The coefficient of friction between the ladder and the ground is $\frac{1}{3}$.

The greatest distance from A that a man of mass $4m$ can walk up this ladder is ka, where k is a positive constant.

By modelling the man as a particle and the ladder as a uniform rod, determine the value of k.

Scanned with CamScanner

Question 5 (***)



The figure above shows a uniform rod AB of length 8 metres and of mass 15kg. The rod is resting in equilibrium with the end A on rough horizontal ground and the point C, where $AC = 6$ metres, on a smooth peg. The rod is inclined at $60°$ to the ground.

a) Determine in any order ...

i. ... the reaction on the rod at the peg.

ii. ... the normal reaction on the rod at the ground.

iii. ... the friction acting on the rod.

The coefficient of friction between the rod and the ground is denoted by μ.

b) Find the range of the possible values of μ.

Scanned with CamScanner

Question 6 (***)

A non uniform ladder of weight 180 N and length 6 metres, rests with its end A on smooth horizontal ground and its end B against a rough vertical wall. The coefficient of friction between the ladder and the wall is $\frac{1}{4}$.

The centre of mass of the ladder is 1.5 metres from A.

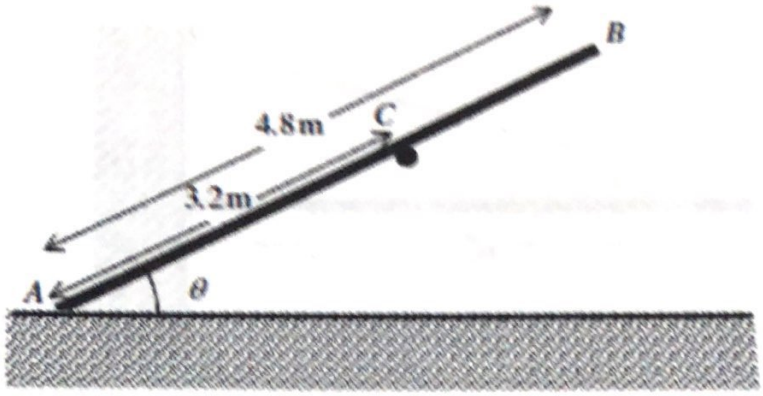
The ladder lies in a vertical plane perpendicular to the wall and the ground, and is inclined at an angle θ to the horizontal, where $\tan\theta = 2$.

A man can just prevent the ladder from sliding down the wall by pushing the bottom of the ladder with a horizontal force F.

By modelling the ladder as a non uniform rod determine the value of F.

Scanned with CamScanner

Question 7 (***)



The figure above shows a plank AB resting on a smooth peg. The plank is modelled a uniform rod of weight W N and of length 4.8 metres, resting on the peg at the point C, where AC is 3.2 metres.

The end A of the plank rests in limiting equilibrium on rough ground, where the coefficient of friction between the plank and the ground is $\frac{9}{13}$.

The plank is inclined at angle θ to the horizontal, where $\tan\theta = \frac{3}{4}$. The points A, B and C lie in a vertical plane which is perpendicular to the ground.

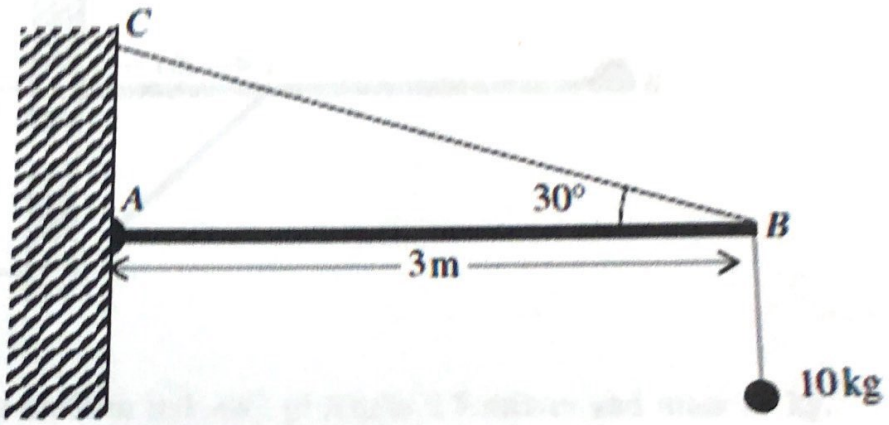
Given that the magnitude of the normal reaction of the ground at A is 65 N, find in any order ...

a) ... the value of W.

b) ... the magnitude of the force between the plank and the peg.

Scanned with CamScanner

Question 8 (***)



The figure above shows a uniform rod AB of length 3 metres and of mass 20 kg smoothly hinged at the point A, which lies on a vertical wall. A particle of mass 10 kg is suspended from the end B of the rod. The rod is kept in a horizontal position by a light inextensible string BC, where C lies on the same wall vertically above A.

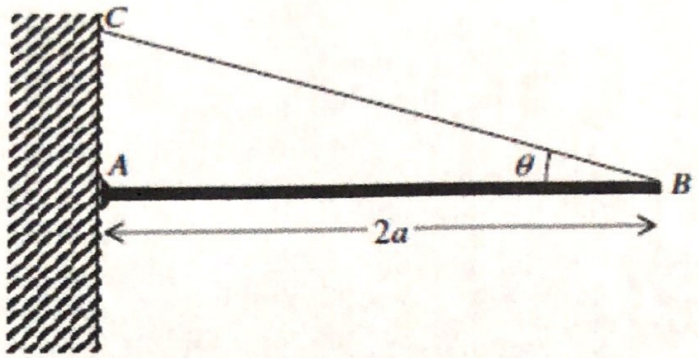
The plane ABC is perpendicular to the wall and the angle ABC is $30°$.

a) Determine the tension in the string.

b) Show that the reaction at the hinge has magnitude is ?

Scanned with CamScanner

Question 9 (*+)**



The figure above shows a uniform rod AB of length $2a$ and of mass m smoothly hinged at the point A, which lies on a vertical wall.

The rod is kept in a horizontal position by a light inextensible string BC, where C lies on the same wall vertically above A.

The plane ABC is perpendicular to the wall and the angle ABC is denoted by θ.

a) Given that $\tan\theta = \frac{1}{2}$, find

the tension in the string

b) state which

$>$

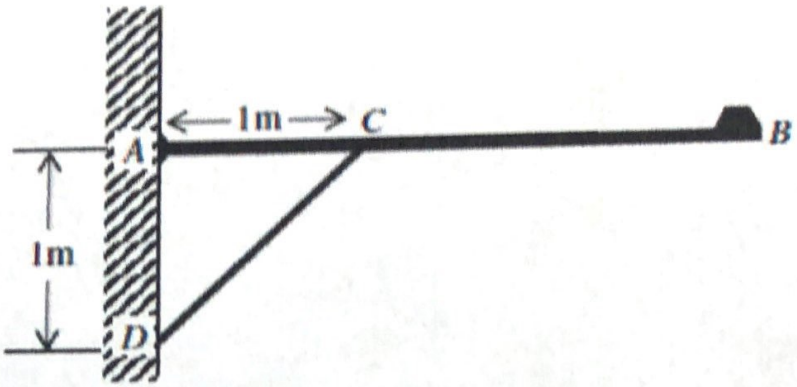
$=$

$<$

is the magnitude of the reaction at the hinge magnitude as the tension in the string.

Scanned with CamScanner

Question 10 (***+)



The figure above shows a uniform rod AB, of length 2.5 metres and mass 10 kg, with one of its ends A smoothly hinged vertical wall.

The rod is kept in equilibrium in a horizontal position by a light rigid strut DC, where D lies on the same wall vertically below A and C lies on the rod such that $|AC| = |AD| = 1$ metre.

A particle of mass 5 kg is placed at B. The plane ACD is perpendicular to the wall.

a) Calculate the force exerted by the strut on the rod.

b) Determine the magnitude and direction of the force exerted by the hinge on the rod AB.

Scanned with CamScanner