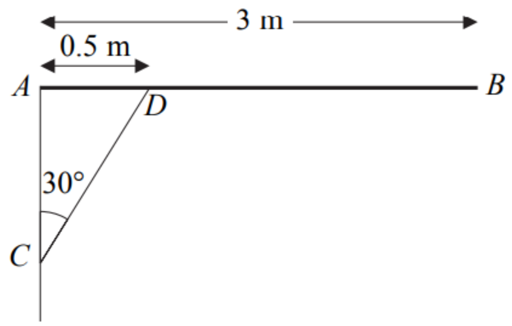
Edexcel June 05

6.

Figure 2



A uniform pole AB, of mass 30 kg and length 3 m, is smoothly hinged to a vertical wall at one end A. The pole is held in equilibrium in a horizontal position by a light rod CD. One end C of the rod is fixed to the wall vertically below A. The other end D is freely jointed to the pole so that $\angle ACD = 30°$ and $AD = 0.5$ m, as shown in Figure 2. Find

(a) the thrust in the rod CD,

(4)

(b) the magnitude of the force exerted by the wall on the pole at A.

(6)

The rod CD is removed and replaced by a longer light rod CM, where M is the mid-point of AB. The rod is freely jointed to the pole at M. The pole AB remains in equilibrium in a horizontal position.

(c) Show that the force exerted by the wall on the pole at A now acts horizontally.

(2)

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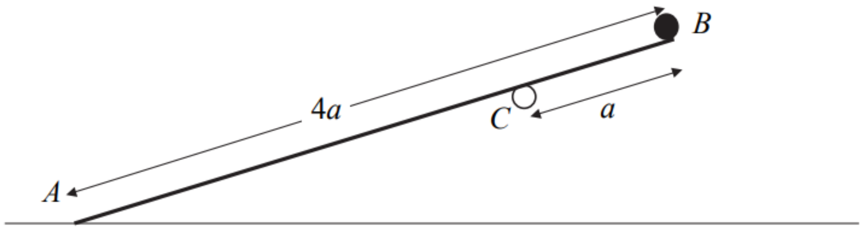
6.

Figure 2



A wooden plank AB has mass $4m$ and length $4a$. The end A of the plank lies on rough horizontal ground. A small stone of mass m is attached to the plank at B. The plank is resting on a small smooth horizontal peg C, where $BC = a$, as shown in Figure 2. The plank is in equilibrium making an angle α with the horizontal, where $\tan\alpha = \frac{3}{4}$. The coefficient of friction between the plank and the ground is μ. The plank is modelled as a uniform rod lying in a vertical plane perpendicular to the peg, and the stone as a particle. Show that

(a) the reaction of the peg on the plank has magnitude $\frac{16}{5}mg$,

(3)

(b) $\mu \geqslant \frac{48}{61}$.

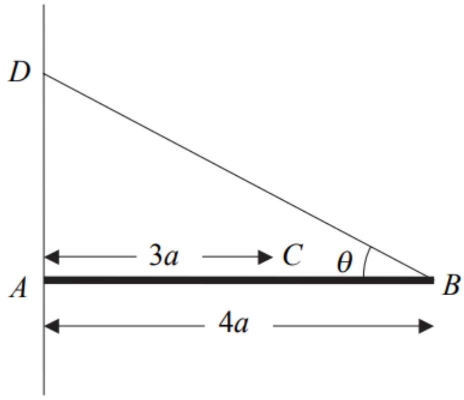
(6)

(c) State how you have used the information that the peg is smooth.

(1)

Edexcel Jan 07

5. **Figure 2**



A horizontal uniform rod AB has mass m and length $4a$. The end A rests against a rough vertical wall. A particle of mass $2m$ is attached to the rod at the point C, where $AC = 3a$. One end of a light inextensible string BD is attached to the rod at B and the other end is attached to the wall at a point D, where D is vertically above A. The rod is in equilibrium in a vertical plane perpendicular to the wall. The string is inclined at an angle θ to the horizontal, where $\tan\theta = \frac{3}{4}$, as shown in Figure 2.

(a) Find the tension in the string.

(5)

(b) Show that the horizontal component of the force exerted by the wall on the rod has magnitude $\frac{8}{3}mg$.

(3)

The coefficient of friction between the wall and the rod is μ. Given that the rod is in limiting equilibrium,

(c) find the value of μ.

(4)

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5.

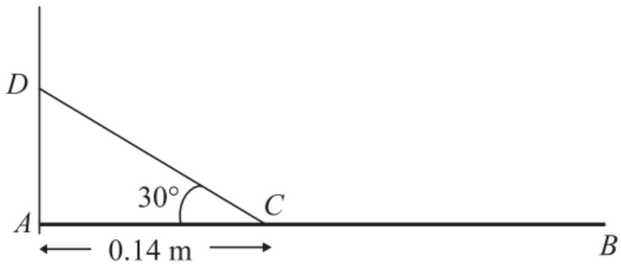

Figure 3

A uniform beam AB of mass 2 kg is freely hinged at one end A to a vertical wall. The beam is held in equilibrium in a horizontal position by a rope which is attached to a point C on the beam, where $AC = 0.14$ m. The rope is attached to the point D on the wall vertically above A, where $\angle ACD = 30°$, as shown in Figure 3. The beam is modelled as a uniform rod and the rope as a light inextensible string. The tension in the rope is 63 N.

Find

(a) the length of AB,

(4)

(b) the magnitude of the resultant reaction of the hinge on the beam at A.

(5)

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5.

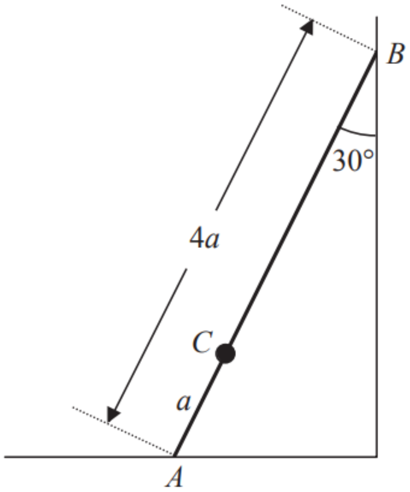

Figure 2

A ladder AB, of mass m and length $4a$, has one end A resting on rough horizontal ground. The other end B rests against a smooth vertical wall. A load of mass $3m$ is fixed on the ladder at the point C, where $AC = a$. The ladder is modelled as a uniform rod in a vertical plane perpendicular to the wall and the load is modelled as a particle. The ladder rests in limiting equilibrium making an angle of 30° with the wall, as shown in Figure 2.

Find the coefficient of friction between the ladder and the ground.

(10)

Edexcel Jan 09

2.

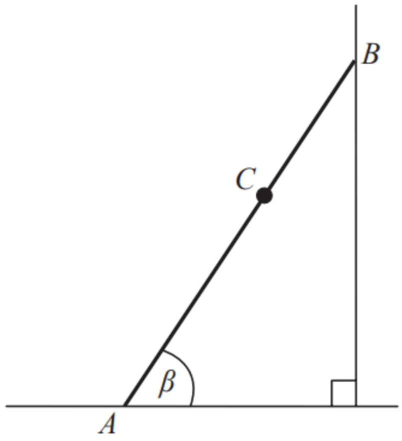

Figure 1

Figure 1 shows a ladder AB, of mass 25 kg and length 4 m, resting in equilibrium with one end A on rough horizontal ground and the other end B against a smooth vertical wall. The ladder is in a vertical plane perpendicular to the wall. The coefficient of friction between the ladder and the ground is $\frac{11}{25}$. The ladder makes an angle β with the ground. When Reece, who has mass 75 kg, stands at the point C on the ladder, where $AC = 2.8$ m, the ladder is on the point of slipping. The ladder is modelled as a uniform rod and Reece is modelled as a particle.

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

(3)

(b) Find, to the nearest degree, the value of β.

(6)

(c) State how you have used the modelling assumption that Reece is a particle.

(1)

Edexcel Jun 09

4.

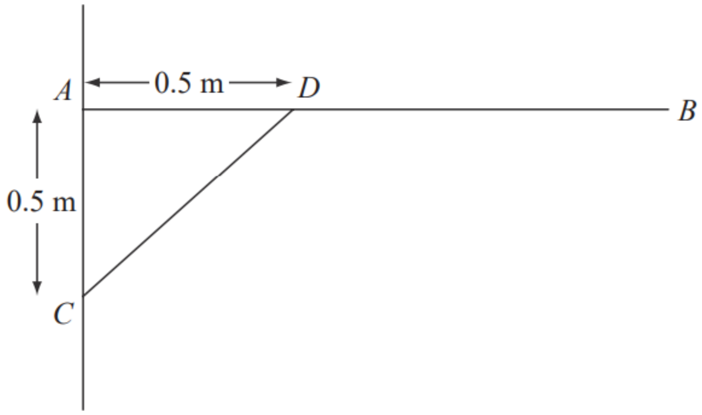

Figure 1

A uniform rod AB, of length 1.5 m and mass 3 kg, is smoothly hinged to a vertical wall at A. The rod is held in equilibrium in a horizontal position by a light strut CD as shown in Figure 1. The rod and the strut lie in the same vertical plane, which is perpendicular to the wall. The end C of the strut is freely jointed to the wall at a point 0.5 m vertically below A. The end D is freely joined to the rod so that AD is 0.5 m.

(a) Find the thrust in CD.

(4)

(b) Find the magnitude and direction of the force exerted on the rod AB at A.

(7)

Edexcel Jan 10

6.

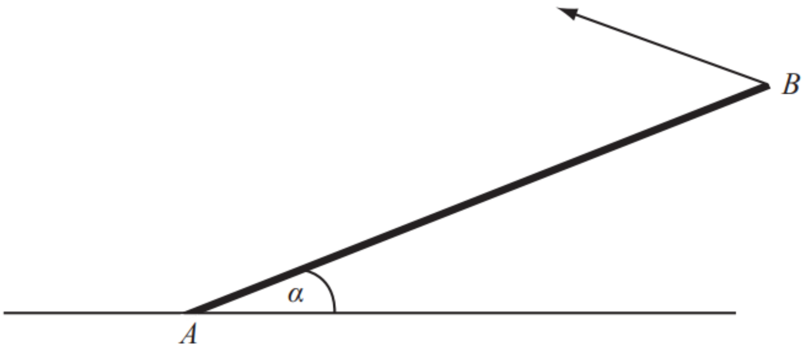

Figure 2

A uniform rod AB, of mass 20 kg and length 4 m, rests with one end A on rough horizontal ground. The rod is held in limiting equilibrium at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$, by a force acting at B, as shown in Figure 2. The line of action of this force lies in the vertical plane which contains the rod. The coefficient of friction between the ground and the rod is 0.5. Find the magnitude of the normal reaction of the ground on the rod at A.

(7)

Edexcel Jun 10

6.

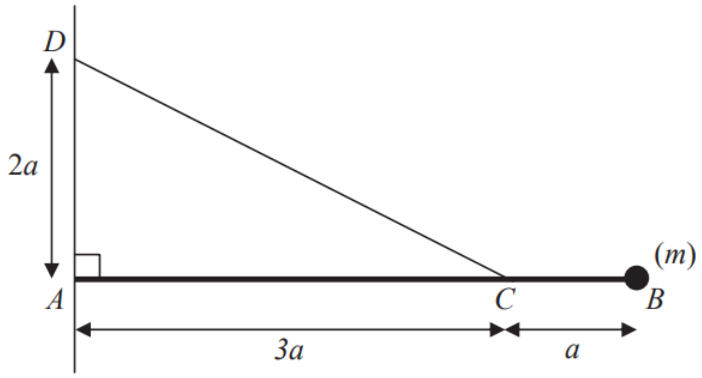

Figure 2

Figure 2 shows a uniform rod AB of mass m and length $4a$. The end A of the rod is freely hinged to a point on a vertical wall. A particle of mass m is attached to the rod at B. One end of a light inextensible string is attached to the rod at C, where $AC = 3a$. The other end of the string is attached to the wall at D, where $AD = 2a$ and D is vertically above A. The rod rests horizontally in equilibrium in a vertical plane perpendicular to the wall and the tension in the string is T.

(a) Show that $T = mg\sqrt{13}$.

(5)

The particle of mass m at B is removed from the rod and replaced by a particle of mass M which is attached to the rod at B. The string breaks if the tension exceeds $2mg\sqrt{13}$. Given that the string does not break,

(b) show that $M \leqslant \frac{5}{2}m$.

(3)

Edexcel Jan 11

7.

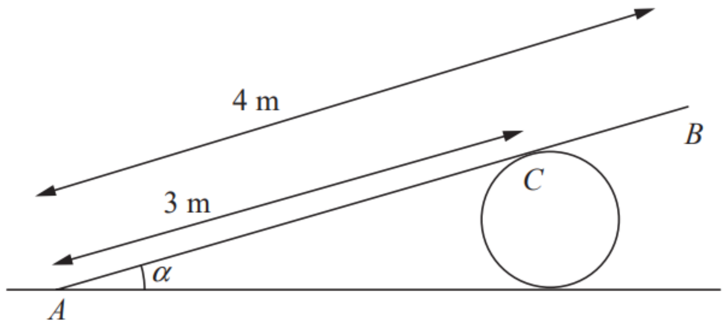

Figure 4

A uniform plank AB, of weight 100 N and length 4 m, rests in equilibrium with the end A on rough horizontal ground. The plank rests on a smooth cylindrical drum. The drum is fixed to the ground and cannot move. The point of contact between the plank and the drum is C, where $AC = 3$ m, as shown in Figure 4. The plank is resting in a vertical plane which is perpendicular to the axis of the drum, at an angle α to the horizontal, where $\sin \alpha = \frac{1}{3}$. The coefficient of friction between the plank and the ground is μ. Modelling the plank as a rod, find the least possible value of μ.

(10)

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7.

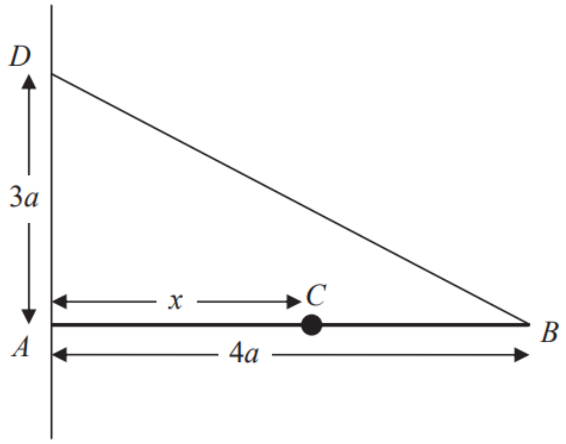

Figure 3

A uniform rod AB, of mass $3m$ and length $4a$, is held in a horizontal position with the end A against a rough vertical wall. One end of a light inextensible string BD is attached to the rod at B and the other end of the string is attached to the wall at the point D vertically above A, where $AD = 3a$. A particle of mass $3m$ is attached to the rod at C, where $AC = x$. The rod is in equilibrium in a vertical plane perpendicular to the wall as shown in Figure 3. The tension in the string is $\frac{25}{4}mg$.

Show that

(a) $x = 3a$,

(5)

(b) the horizontal component of the force exerted by the wall on the rod has magnitude $5mg$.

(3)

The coefficient of friction between the wall and the rod is μ. Given that the rod is about to slip,

(c) find the value of μ.

(5)

Jan 12

5.

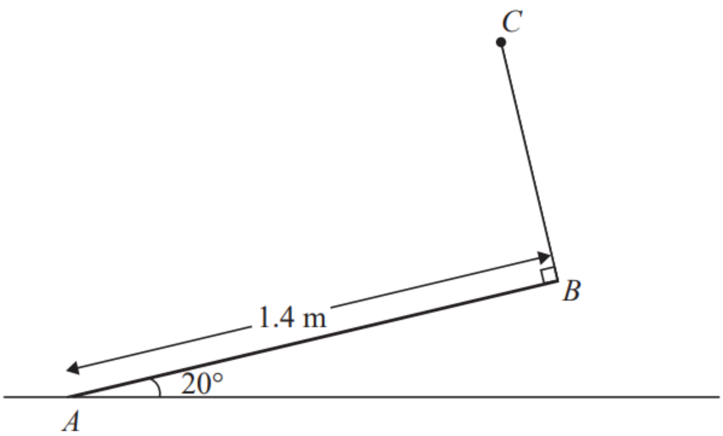

Figure 2

A uniform rod AB has mass 4 kg and length 1.4 m. The end A is resting on rough horizontal ground. A light string BC has one end attached to B and the other end attached to a fixed point C. The string is perpendicular to the rod and lies in the same vertical plane as the rod. The rod is in equilibrium, inclined at 20° to the ground, as shown in Figure 2.

(a) Find the tension in the string.

(4)

Given that the rod is about to slip,

(b) find the coefficient of friction between the rod and the ground.

(7)

Edexcel Jun 12

3.

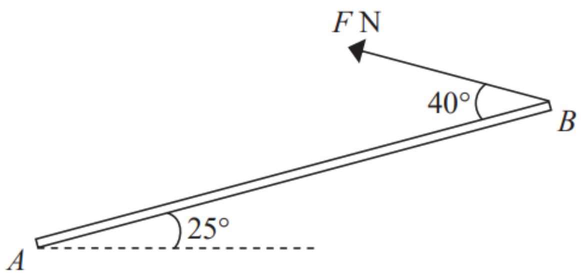

Figure 1

A uniform rod *AB*, of mass 5 kg and length 4 m, has its end *A* smoothly hinged at a fixed point. The rod is held in equilibrium at an angle of 25° above the horizontal by a force of magnitude *F* newtons applied to its end *B*. The force acts in the vertical plane containing the rod and in a direction which makes an angle of 40° with the rod, as shown in Figure 1.

(a) Find the value of *F*.

(4)

(b) Find the magnitude and direction of the vertical component of the force acting on the rod at *A*.

(4)

Edexcel Jan 13

1. Two uniform rods AB and BC are rigidly joined at B so that $\angle ABC = 90°$. Rod AB has length 0.5 m and mass 2 kg. Rod BC has length 2 m and mass 3 kg. The centre of mass of the framework of the two rods is at G.

(a) Find the distance of G from BC.

(2)

The distance of G from AB is 0.6 m.
The framework is suspended from A and hangs freely in equilibrium.

(b) Find the angle between AB and the downward vertical at A.

(3)

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3.

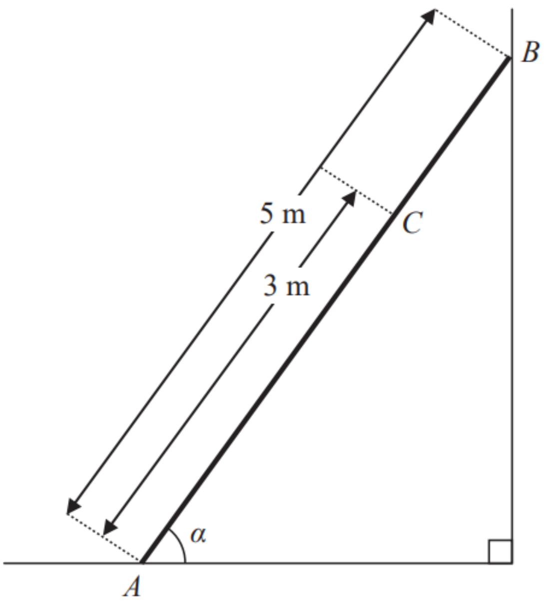

Figure 1

A ladder, of length 5 m and mass 18 kg, has one end A resting on rough horizontal ground and its other end B resting against a smooth vertical wall. The ladder lies in a vertical plane perpendicular to the wall and makes an angle α with the horizontal ground, where $\tan \alpha = \frac{4}{3}$, as shown in Figure 1. The coefficient of friction between the ladder and the ground is μ. A woman of mass 60 kg stands on the ladder at the point C, where $AC = 3$ m. The ladder is on the point of slipping. The ladder is modelled as a uniform rod and the woman as a particle.

Find the value of μ.

(9)

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4. A rough circular cylinder of radius $4a$ is fixed to a rough horizontal plane with its axis horizontal. A uniform rod AB, of weight W and length $6a\sqrt{3}$, rests with its lower end A on the plane and a point C of the rod against the cylinder. The vertical plane through the rod is perpendicular to the axis of the cylinder. The rod is inclined at 60° to the horizontal, as shown in Figure 1.

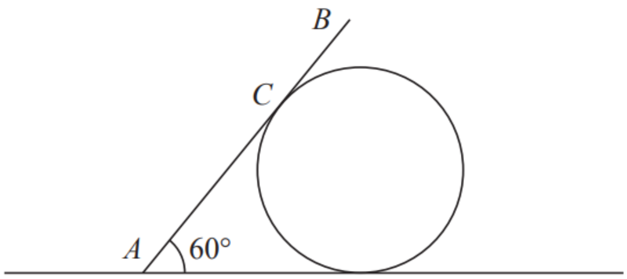

Figure 1

(a) Show that $AC = 4a\sqrt{3}$

(2)

The coefficient of friction between the rod and the cylinder is $\frac{\sqrt{3}}{3}$ and the coefficient of friction between the rod and the plane is μ. Given that friction is limiting at both A and C,

(b) find the value of μ.

(9)

Edexcel Jun 13

5.

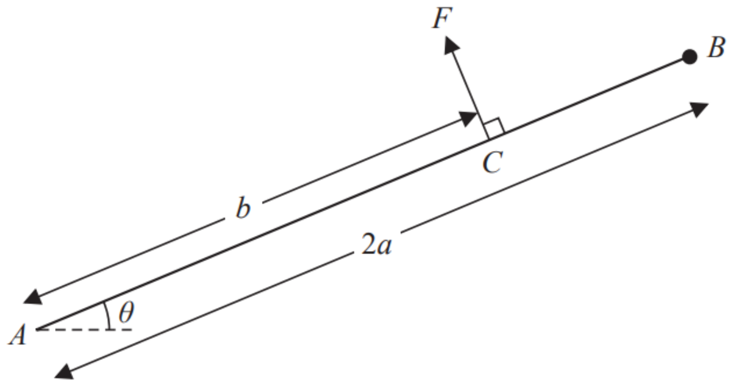

Figure 3

A uniform rod AB, of mass m and length $2a$, is freely hinged to a fixed point A. A particle of mass m is attached to the rod at B. The rod is held in equilibrium at an angle θ to the horizontal by a force of magnitude F acting at the point C on the rod, where $AC = b$, as shown in Figure 3. The force at C acts at right angles to AB and in the vertical plane containing AB.

(a) Show that $F = \dfrac{3amg\cos\theta}{b}$.

(4)

(b) Find, in terms of a, b, g, m and θ,

(i) the horizontal component of the force acting on the rod at A,

(ii) the vertical component of the force acting on the rod at A.

(5)

Given that the force acting on the rod at A acts along the rod,

(c) find the value of $\dfrac{a}{b}$.

(4)