

4.

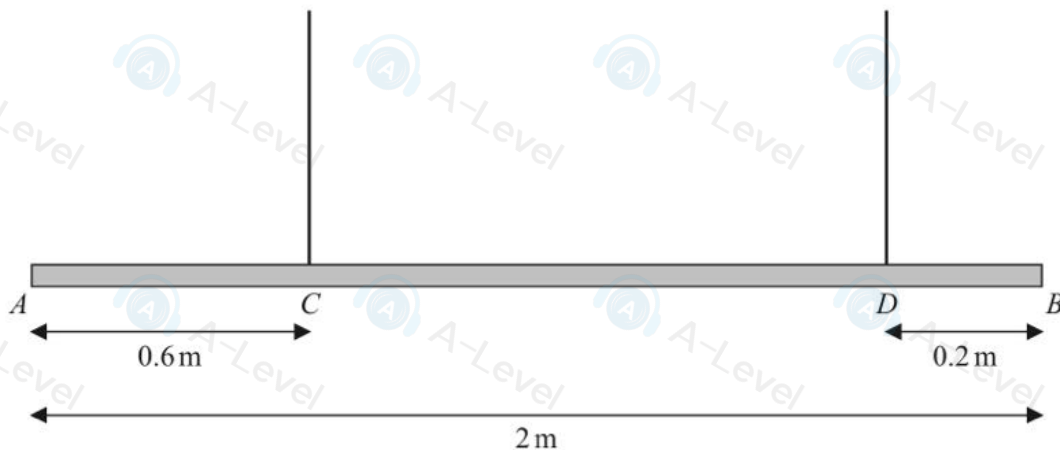


Figure 1

Figure 1 shows a beam AB , of mass m kg and length 2 m, suspended by two light vertical ropes.

The ropes are attached to the points C and D on the beam, where $AC = 0.6$ m and $DB = 0.2$ m

The beam is in equilibrium in a horizontal position.

A particle of mass pm kg is attached to the beam at A and the beam remains in equilibrium in a horizontal position.

The beam is modelled as a uniform rod.

(a) Given that the tension in the rope attached at C is four times the tension in the rope attached at D , use the model to find the exact value of p .

(7)

The particle of mass pm kg at A is removed and replaced by a particle of mass qm kg at A .

The beam remains in equilibrium in a horizontal position but is now on the point of tilting.

(b) Using the model, find the exact value of q

(4)

(c) State how you have used the modelling assumption that the beam is uniform.

(1)



5.

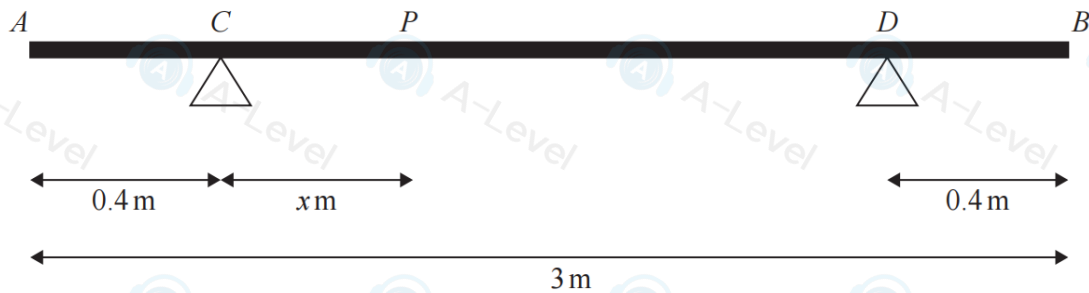


Figure 4

A beam AB has mass 30 kg and length 3 m.

The beam rests on supports at C and D where $AC = 0.4$ m and $DB = 0.4$ m, as shown in Figure 4.

A person of mass 55 kg stands on the beam between C and D .

The person is modelled as a particle at the point P , where $CP = x$ metres and $0 < x < 2.2$

The beam is modelled as a uniform rod resting in equilibrium in a horizontal position.

Using the model,

- (a) show that the magnitude of the reaction at C is $(686 - 245x)$ N. (3)

The magnitude of the reaction at C is **four** times the magnitude of the reaction at D .

Using the model,

- (b) find the value of x (4)

The person steps off the beam and places a package of mass M kg at A .

The package is modelled as a particle at the point A .

The beam is now on the point of tilting about C .

Using the model,

- (c) find the value of M (3)

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1.

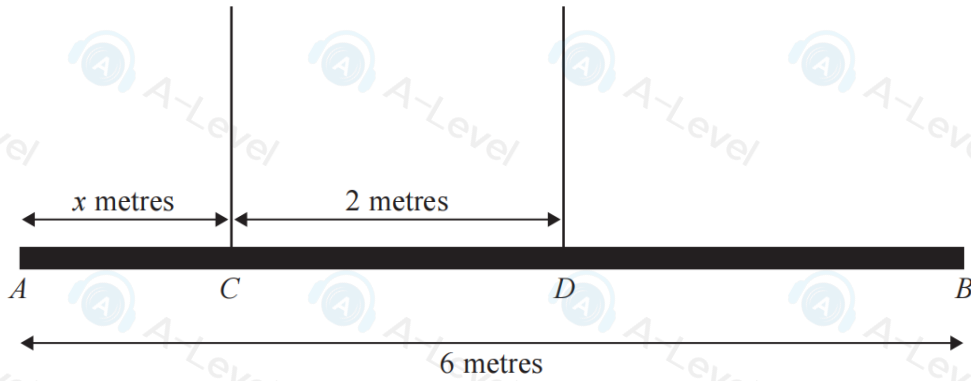


Figure 1

Figure 1 shows a beam AB with weight 24 N and length 6 m .

The beam is suspended by two light vertical ropes. The ropes are attached to the points C and D on the beam where $AC = x$ metres and $CD = 2\text{ m}$.

The tension in the rope attached to the beam at C is double the tension in the rope attached to the beam at D .

The beam is modelled as a uniform rod, resting horizontally in equilibrium.

Find

- (i) the tension in the rope attached to the beam at D .
- (ii) the value of x .

(5)



7.

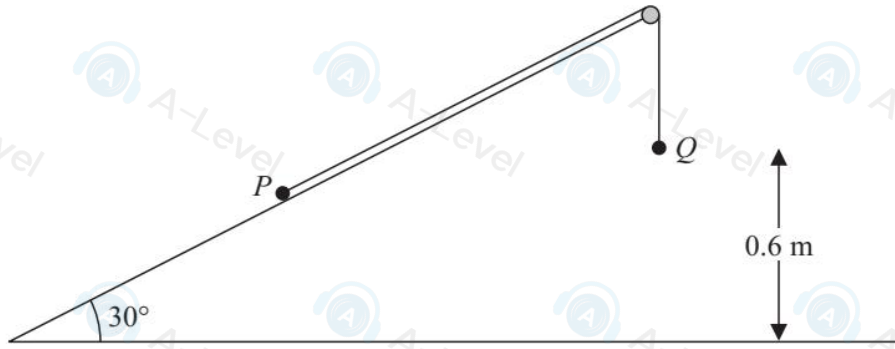


Figure 3

Two particles P and Q , of mass 2 kg and 3 kg respectively, are connected by a light inextensible string. Initially P is held at rest on a fixed smooth plane inclined at 30° to the horizontal. The string passes over a small smooth fixed pulley at the top of the plane. The particle Q hangs freely below the pulley and 0.6 m above the ground, as shown in Figure 3. The part of the string from P to the pulley is parallel to a line of greatest slope of the plane. The system is released from rest with the string taut.

For the motion before Q hits the ground,

- (a) (i) show that the acceleration of Q is $\frac{2g}{5}$,
- (ii) find the tension in the string. (8)

On hitting the ground Q is immediately brought to rest by the impact.

- (b) Find the speed of P at the instant when Q hits the ground. (2)

In its subsequent motion P does not reach the pulley.

- (c) Find the total distance moved up the plane by P before it comes to instantaneous rest. (4)
- (d) Find the length of time between Q hitting the ground and P first coming to instantaneous rest. (2)



2.

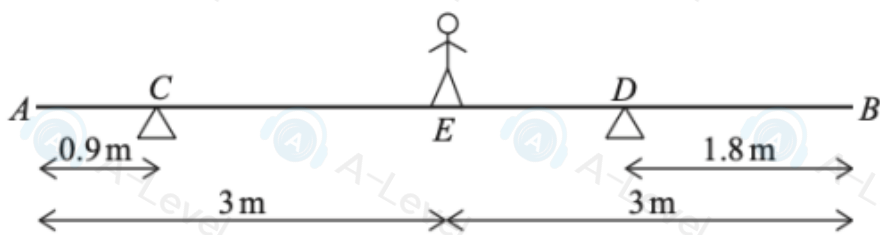


Figure 1

A non-uniform beam AB has length 6 m and mass 50 kg. The beam rests horizontally on two supports at C and D , where $AC = 0.9$ m and $DB = 1.8$ m.

A child of mass 25 kg stands on the beam at E , where $AE = EB = 3$ m, as shown in Figure 1.

The beam is in equilibrium.

The magnitude of the normal reaction between the beam and the support at C is R_C newtons.

The magnitude of the normal reaction between the beam and the support at D is R_D newtons.

The beam is modelled as a rod and the child is modelled as a particle.

The centre of mass of the beam is between C and D and is a distance x metres from D .

Given that $2R_D = 3R_C$

(a) show that $x = 1.38$

(6)

The child remains at E and a block of mass M kg is placed on the beam at B .

The block is modelled as a particle.

Given that the beam is on the point of tilting,

(b) find the value of M .

(3)
