Leave blank

2.

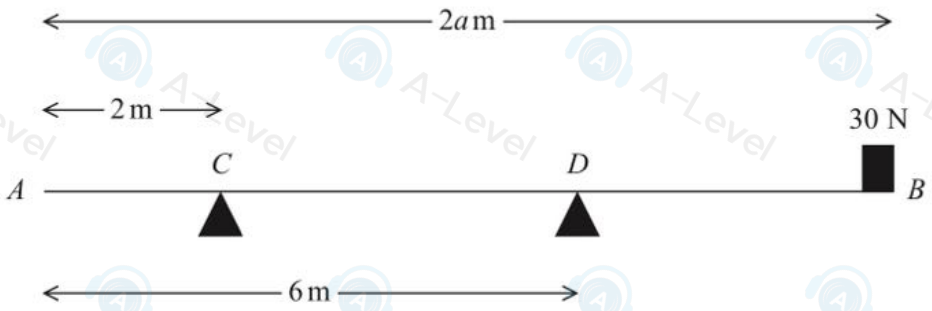

Figure 2

A wooden beam AB has weight 140 N and length $2a$ metres. The beam rests horizontally in equilibrium on two supports at C and D, where $AC = 2$ m and $AD = 6$ m. A block of weight 30 N is placed on the beam at B and the beam remains horizontal and in equilibrium, as shown in Figure 2. The reaction on the beam at D has magnitude 120 N. The block is modelled as a particle and the beam is modelled as a uniform rod.

(a) Find the value of a.

(4)

The support at D is now moved to a point E on the beam and the beam remains horizontal and in equilibrium with the block at B. The magnitude of the reaction on the beam at C is now equal to the magnitude of the reaction on the beam at E.

(b) Find the distance AE.

(5)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Leave blank

6. A uniform rod AC, of weight W and length $3l$, rests horizontally on two supports, one at A and one at B, where $AB = 2l$. A particle of weight $2W$ is placed on the rod at a distance x from A. The rod remains horizontal and in equilibrium.

(a) Find the greatest possible value of x.

(5)

The magnitude of the reaction of the support at A is R. Due to a weakness in the support at A, the greatest possible value of R is $2W$,

(b) find the least possible value of x.

(5)

4.

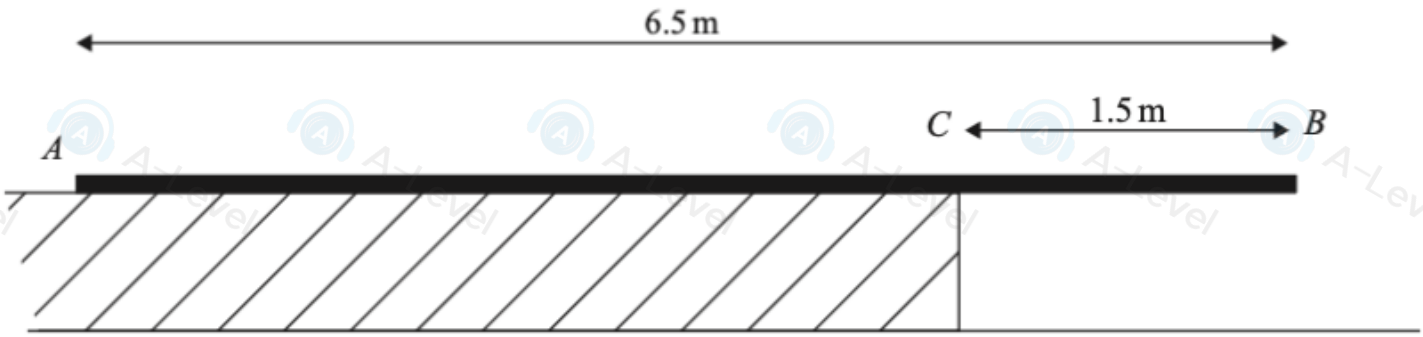

Figure 2

A non-uniform rod AB has length 6.5 m and mass 1.2 kg. The centre of mass of the rod is 3 m from A. The rod rests on a horizontal step and overhangs the end of the step C by 1.5 m, as shown in Figure 2.

The rod is perpendicular to the edge of the step.

A particle of mass 4 kg is placed on the rod at B and another particle, whose mass is M kg, is placed on the rod at D, where $AD = 0.5$ m.

The rod remains in equilibrium in a horizontal position.

(a) Find the smallest possible value of M.

(3)

The particle at B **and** the particle at D are now **removed**.

A new particle is placed on the rod at the point E, where $EB = 0.9$ m.

The rod remains in equilibrium in a horizontal position but is on the point of tilting about C.

(b) Find the magnitude of the force acting on the rod at C.

(3)

Leave blank

3.

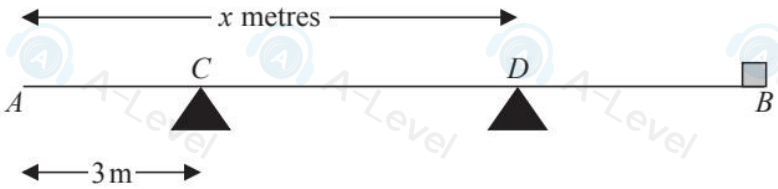

Figure 1

A plank AB has length 8 m and mass 12 kg. The plank rests on two supports. One support is at C, where $AC = 3$ m and the other support is at D, where $AD = x$ metres. A block of mass 3 kg is placed on the plank at B, as shown in Figure 1. The plank rests in equilibrium in a horizontal position. The magnitude of the force exerted on the plank by the support at D is twice the magnitude of the force exerted on the plank by the support at C. The plank is modelled as a uniform rod and the block is modelled as a particle.

Find the value of x.

(7)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Leave blank

4.

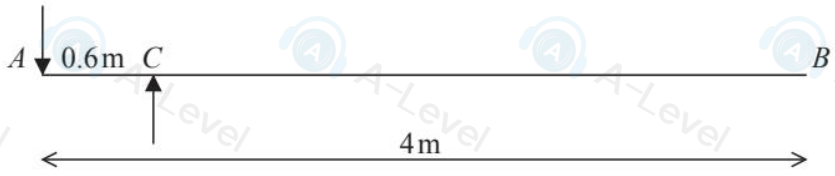

Figure 1

A diving board AB consists of a wooden plank of length 4m and mass 30kg. The plank is held at rest in a horizontal position by two supports at the points A and C, where $AC = 0.6$ m, as shown in Figure 1. The force on the plank at A acts vertically downwards and the force on the plank at C acts vertically upwards.

A diver of mass 50 kg is standing on the board at the end B. The diver is modelled as a particle and the plank is modelled as a uniform rod. The plank is in equilibrium.

(a) Find

(i) the magnitude of the force acting on the plank at A,

(ii) the magnitude of the force acting on the plank at C.

(6)

The support at A will break if subjected to a force whose magnitude is greater than 5000 N.

(b) Find, in kg, the greatest integer mass of a diver who can stand on the board at B without breaking the support at A.

(3)

(c) Explain how you have used the fact that the diver is modelled as a particle.

(1)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

1.

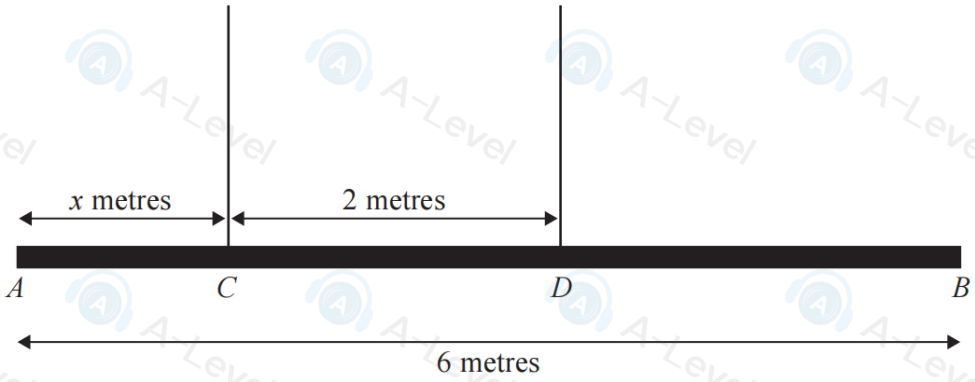

Figure 1

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 $CD = 2$ 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)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Leave blank

2.

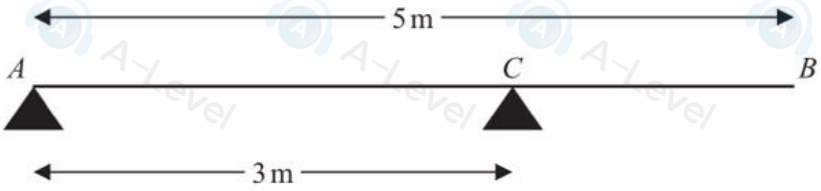

Figure 1

A non-uniform plank AB has weight 60 N and length 5 m. The plank rests horizontally in equilibrium on two smooth supports at A and C, where $AC = 3$ m, as shown in Figure 1. A parcel of weight 12 N is placed on the plank at B and the plank remains horizontal and in equilibrium. The magnitude of the reaction of the support at A on the plank is half the magnitude of the reaction of the support at C on the plank.

By modelling the plank as a non-uniform rod and the parcel as a particle,

(a) find the distance of the centre of mass of the plank from A.

(6)

(b) State briefly how you have used the modelling assumption

(i) that the parcel is a particle,

(ii) that the plank is a rod.

(2)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

4.

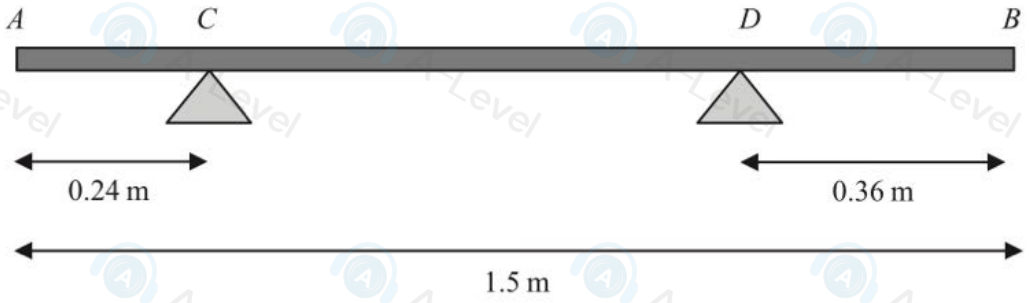

Figure 1

A branch AB, of length 1.5 m, rests horizontally in equilibrium on two supports.

The two supports are at the points C and D, where $AC = 0.24\,\text{m}$ and $DB = 0.36\,\text{m}$, as shown in Figure 1.

When a force of 150 N is applied vertically upwards at B, the branch is on the point of tilting about C.

When a force of 225 N is applied vertically downwards at B, the branch is on the point of tilting about D.

The branch is modelled as a non-uniform rod AB of weight W newtons.

The distance from the point C to the centre of mass of the rod is x metres.

Use the model to find

(i) the value of W

(ii) the value of x

(8)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA