

Write your name here	
Surname	Other names
Pearson Edexcel GCE	Centre Number Candidate Number
A level Mathematics Practice Paper Mechanics – Moments	
You must have: Mathematical Formulae and Statistical Tables (Pink)	Total Marks

Instructions

- Use black ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer all the questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – there may be more space than you need.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet ‘Mathematical Formulae and Statistical Tables’ is provided.
- There are 14 questions in this question paper. The total mark for this paper is 150.
- The marks for each question are shown in brackets – use this as a guide as to how much time to spend on each question.
- Calculators must not be used for questions marked with a * sign.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

1. A steel girder AB , of mass 200 kg and length 12 m, rests horizontally in equilibrium on two smooth supports at C and at D , where $AC = 2$ m and $DB = 2$ m. A man of mass 80 kg stands on the girder at the point P , where $AP = 4$ m, as shown in Figure 1.

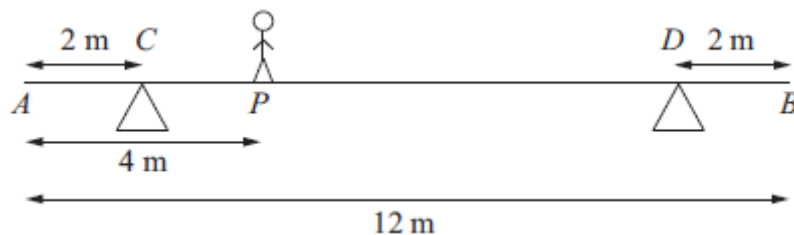


Figure 1

The man is modelled as a particle and the girder is modelled as a uniform rod.

- (a) Find the magnitude of the reaction on the girder at the support at C .

(3)

The support at D is now moved to the point X on the girder, where $XB = x$ metres. The man remains on the girder at P , as shown in Figure 2.

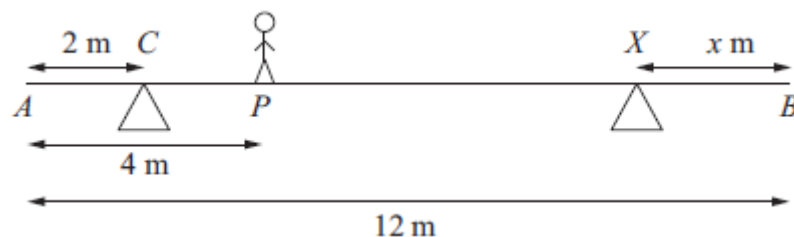


Figure 2

Given that the magnitudes of the reactions at the two supports are now equal and that the girder again rests horizontally in equilibrium, find

- (b) the magnitude of the reaction at the support at X ,

(2)

- (c) the value of x .

(4)

(Total 9 marks)

2. A plank AB has length 6 m and mass 30 kg. The point C is on the plank with $CB = 2$ m.

The plank rests in equilibrium in a horizontal position on supports at A and C . Two people, each of mass 75 kg, stand on the plank. One person stands at the point P of the plank, where $AP = x$ metres, and the other person stands at the point Q of the plank, where $AQ = 2x$ metres.

The plank remains horizontal and in equilibrium with the magnitude of the reaction at C five times the magnitude of the reaction at A . The plank is modelled as a uniform rod and each person is modelled as a particle.

- (a) Find the value of x .

(7)

- (b) State two ways in which you have used the assumptions made in modelling the plank as a uniform rod.

(2)

(Total 9 marks)

3.

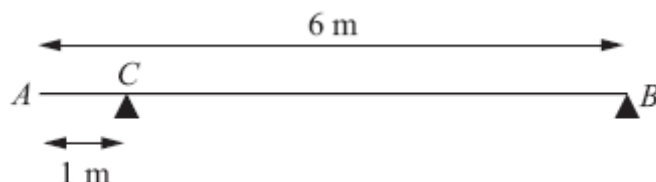


Figure 3

A uniform beam AB has mass 20 kg and length 6 m. The beam rests in equilibrium in a horizontal position on two smooth supports. One support is at C , where $AC = 1$ m, and the other is at the end B , as shown in Figure 3. The beam is modelled as a rod.

- (a) Find the magnitudes of the reactions on the beam at B and at C .

(5)

A boy of mass 30 kg stands on the beam at the point D . The beam remains in equilibrium. The magnitudes of the reactions on the beam at B and at C are now equal. The boy is modelled as a particle.

- (b) Find the distance AD .

(5)

(Total 10 marks)

4.

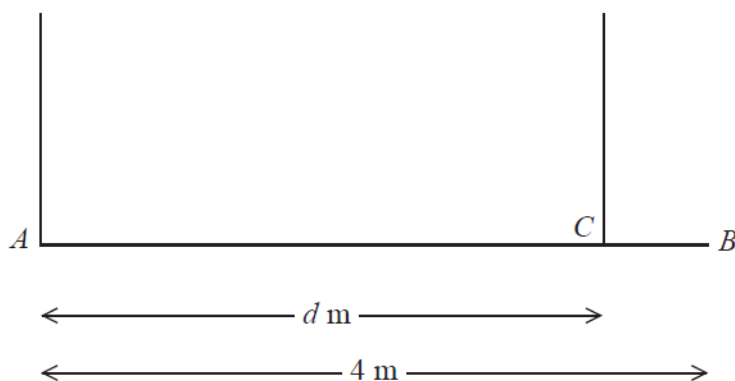


Figure 4

A beam AB has weight W newtons and length 4 m . The beam is held in equilibrium in a horizontal position by two vertical ropes attached to the beam. One rope is attached to A and the other rope is attached to the point C on the beam, where $AC = d$ metres, as shown in Figure 4. The beam is modelled as a uniform rod and the ropes as light inextensible strings. The tension in the rope attached at C is double the tension in the rope attached at A .

(a) Find the value of d .

(6)

A small load of weight kW newtons is attached to the beam at B . The beam remains in equilibrium in a horizontal position. The load is modelled as a particle. The tension in the rope attached at C is now four times the tension in the rope attached at A .

(b) Find the value of k .

(6)

(Total 12 marks)

5.

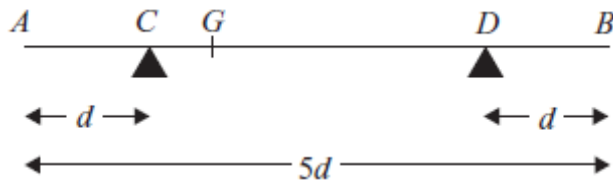


Figure 5

A non-uniform rod AB , of mass m and length $5d$, rests horizontally in equilibrium on two supports at C and D , where $AC = DB = d$, as shown in Figure 5. The centre of mass of the rod is at the point G . A particle of mass $\frac{5}{2}m$ is placed on the rod at B and the rod is on the point of tipping about D .

- (a) Show that $GD = \frac{5}{2}d$. (4)

The particle is moved from B to the mid-point of the rod and the rod remains in equilibrium.

- (b) Find the magnitude of the normal reaction between the support at D and the rod. (5)
- (Total 9 marks)
-

6. A plank PQR , of length 8 m and mass 20 kg, is in equilibrium in a horizontal position on two supports at P and Q , where $PQ = 6$ m.

A child of mass 40 kg stands on the plank at a distance of 2 m from P and a block of mass M kg is placed on the plank at the end R . The plank remains horizontal and in equilibrium. The force exerted on the plank by the support at P is equal to the force exerted on the plank by the support at Q .

By modelling the plank as a uniform rod, and the child and the block as particles,

- (a) (i) find the magnitude of the force exerted on the plank by the support at P ,
 (ii) find the value of M . (10)

- (b) State how, in your calculations, you have used the fact that the child and the block can be modelled as particles. (1)

(Total 11 marks)

7.

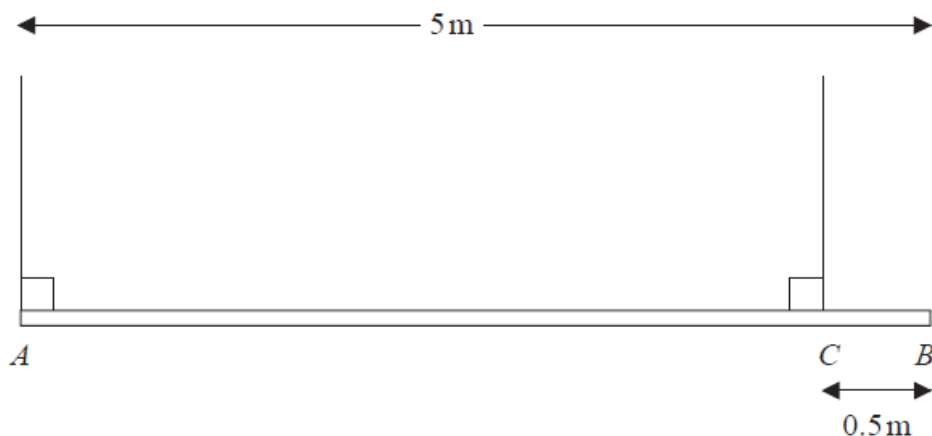


Figure 6

A beam AB has length 5 m and mass 25 kg. The beam is suspended in equilibrium in a horizontal position by two vertical ropes. One rope is attached to the beam at A and the other rope is attached to the point C on the beam where $CB = 0.5$ m, as shown in Figure 6. A particle P of mass 60 kg is attached to the beam at B and the beam remains in equilibrium in a horizontal position. The beam is modelled as a uniform rod and the ropes are modelled as light strings.

(a) Find

- (i) the tension in the rope attached to the beam at A ,
- (ii) the tension in the rope attached to the beam at C .

(6)

Particle P is removed and replaced by a particle Q of mass M kg at B . Given that the beam remains in equilibrium in a horizontal position,

(b) find

- (i) the greatest possible value of M ,
- (ii) the greatest possible tension in the rope attached to the beam at C .

(6)

(Total 12 marks)

8. A non-uniform plank AB has length 6 m and mass 30 kg. The plank rests in equilibrium in a horizontal position on supports at the points S and T of the plank where $AS = 0.5$ m and $TB = 2$ m.

When a block of mass M kg is placed on the plank at A , the plank remains horizontal and in equilibrium and the plank is on the point of tilting about S .

When the block is moved to B , the plank remains horizontal and in equilibrium and the plank is on the point of tilting about T .

The distance of the centre of mass of the plank from A is d metres. The block is modelled as a particle and the plank is modelled as a non-uniform rod. Find

(i) the value of d ,

(ii) the value of M .

(Total 7 marks)

9.

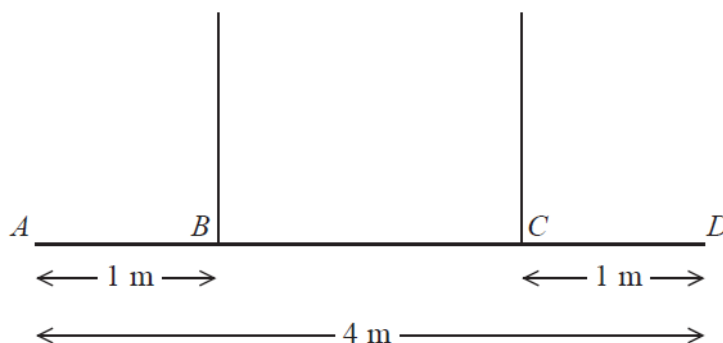


Figure 7

A non-uniform beam AD has weight W newtons and length 4 m. It is held in equilibrium in a horizontal position by two vertical ropes attached to the beam. The ropes are attached to two points B and C on the beam, where $AB = 1$ m and $CD = 1$ m, as shown in Figure 7. The tension in the rope attached to C is double the tension in the rope attached to B . The beam is modelled as a rod and the ropes are modelled as light inextensible strings.

- (a) Find the distance of the centre of mass of the beam from A . (6)

A small load of weight kW newtons is attached to the beam at D . The beam remains in equilibrium in a horizontal position. The load is modelled as a particle.

Find

- (b) an expression for the tension in the rope attached to B , giving your answer in terms of k and W , (3)

- (c) the set of possible values of k for which both ropes remain taut. (2)

(Total 11 marks)

10.

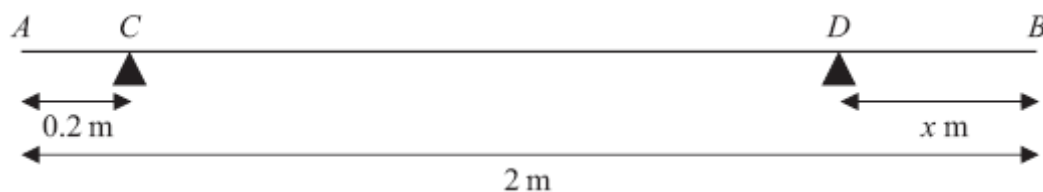


Figure 8

A uniform rod AB has length 2 m and mass 50 kg . The rod is in equilibrium in a horizontal position, resting on two smooth supports at C and D , where $AC = 0.2$ metres and $DB = x$ metres, as shown in Figure 8. Given that the magnitude of the reaction on the rod at D is twice the magnitude of the reaction on the rod at C ,

(a) find the value of x .

(6)

The support at D is now moved to the point E on the rod, where $EB = 0.4$ metres. A particle of mass $m\text{ kg}$ is placed on the rod at B , and the rod remains in equilibrium in a horizontal position. Given that the magnitude of the reaction on the rod at E is four times the magnitude of the reaction on the rod at C ,

(b) find the value of m .

(7)

(Total 13 marks)

11. A beam AB has length 15 m . The beam rests horizontally in equilibrium on two smooth supports at the points P and Q , where $AP = 2\text{ m}$ and $QB = 3\text{ m}$. When a child of mass 50 kg stands on the beam at A , the beam remains in equilibrium and is on the point of tilting about P . When the same child of mass 50 kg stands on the beam at B , the beam remains in equilibrium and is on the point of tilting about Q . The child is modelled as a particle and the beam is modelled as a non-uniform rod.

(a) (i) Find the mass of the beam.

(ii) Find the distance of the centre of mass of the beam from A .

(8)

When the child stands at the point X on the beam, it remains horizontal and in equilibrium. Given that the reactions at the two supports are equal in magnitude,

(b) find AX .

(6)

(Total 14 marks)

12.

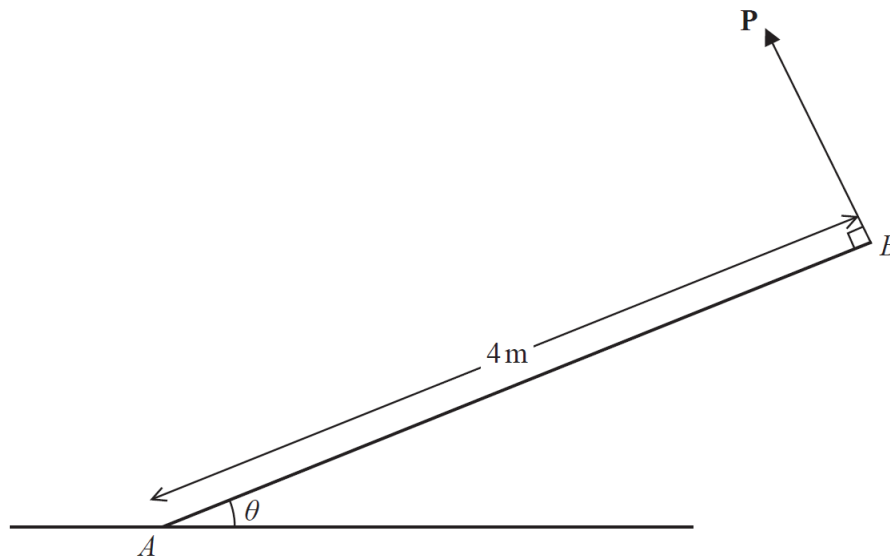


Figure 9

A non-uniform rod AB , of mass 5 kg and length 4 m, rests with one end A on rough horizontal ground. The centre of mass of the rod is d metres from A . The rod is held in limiting equilibrium at an angle θ to the horizontal by a force $\mathbf{P}$, which acts in a direction perpendicular to the rod at B , as shown in Figure 9. The line of action of $\mathbf{P}$ lies in the same vertical plane as the rod.

(a) Find, in terms of d , g and θ ,

(i) the magnitude of the vertical component of the force exerted on the rod by the ground,

(ii) the magnitude of the friction force acting on the rod at A .

(8)

Given that $\tan \theta = \frac{5}{12}$ and that the coefficient of friction between the rod and the ground is $\frac{1}{2}$,

(b) find the value of d .

(4)

(Total 12 marks)

13.

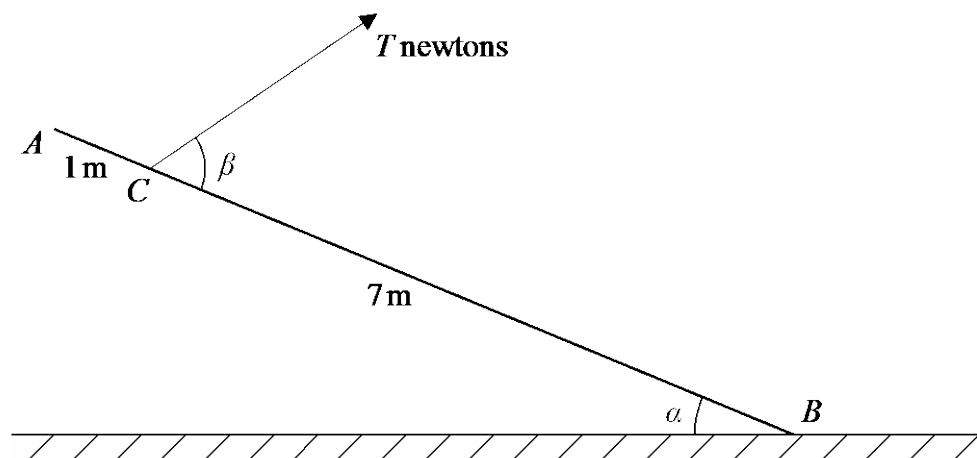


Figure 10

A uniform rod AB , of mass 5 kg and length 8 m, has its end B resting 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 rope attached to the rod at C . The distance $AC = 1$ m. The rope is in the same vertical plane as the rod. The angle between the rope and the rod is β and the tension in the rope is T newtons, as shown in Figure 10. The coefficient of friction between the rod and the ground is $\frac{2}{3}$. The vertical component of the force exerted on the rod at B by the ground is R newtons.

(a) Find the value of R .

(6)

(b) Find the size of angle β .

(5)

(Total 11 marks)

14.

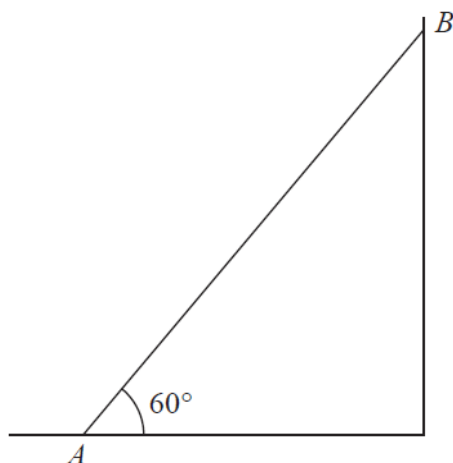


Figure 11

A non-uniform rod, AB , of mass m and length $2l$, rests in equilibrium with one end A on a rough horizontal floor and the other end B against a rough vertical wall. The rod is in a vertical plane perpendicular to the wall and makes an angle of 60° with the floor as shown in Figure 11. The coefficient of friction between the rod and the floor is $\frac{1}{4}$ and the coefficient of friction between the rod and the wall is $\frac{2}{3}$. The rod is on the point of slipping at both ends.

- (a) Find the magnitude of the vertical component of the force exerted on the rod by the floor. (5)

The centre of mass of the rod is at G .

- (b) Find the distance AG . (5)

(Total 10 marks)

TOTAL FOR PAPER: 150 MARKS