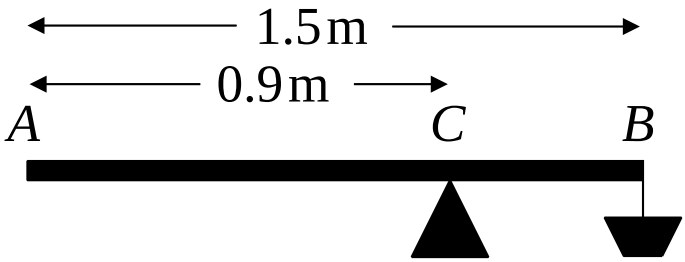
Lesson 6

A-Level Applied Mathematics
Mechanics : Moments : Year 2

6.1 Test

Any solution based entirely on graphical
or numerical methods is not acceptable
Marks Available : 40
Where a numerical value of g is required, assume it is 9.8 m s^{-2}

Question 1



A uniform rod AB has length 1.5 m and mass 8 kg.
A particle of mass m kg is attached to the rod at B.
The rod is supported at the point C, where AC = 0.9 m and the system is in equilibrium with AB horizontal.

(i) Draw a diagram showing all significant lengths and forces acting on the rod.

[2 marks]

(ii) Find the mass, m, in kg of the particle attached at B.

[3 marks]

Question 2

Inspired by an A-Level Examination Question from June 2017, M1, Q3

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.

(i) Draw a diagram showing the significant lengths and forces acting on the rod.

[3 marks]

(ii) By balancing forces vertically determine, in Newtons, the reaction on the rod at A and the reaction on the rod at C clearly stating which is which.

[3 marks]

(iii) By taking moments about A, find the value of x

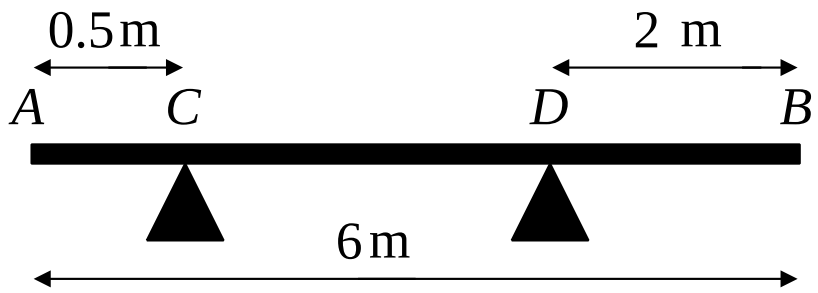
[4 marks]

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

[2 marks]

Question 3

A-Level Question from October 2017, M1, Q2



A metal girder *AB*, of weight 1080 N and length 6 m, rests in equilibrium in a horizontal position on two supports, one at *C* and one at *D*, where *AC* = 0.5 m and *BD* = 2 m, as shown. A boy of weight 400 N stands on the girder at *B* and the girder remains horizontal and in equilibrium.

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

(a) Find,

(i) the magnitude of the reaction on the girder at *C*,

[3 marks]

(ii) the magnitude of the reaction on the girder at D

[3 marks]

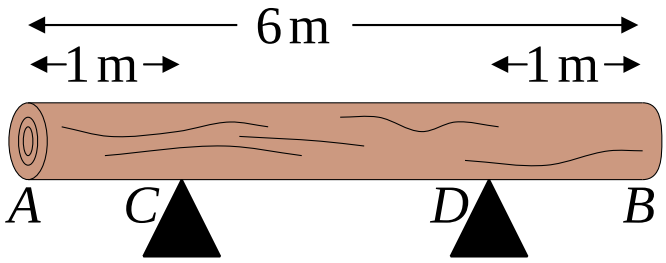
The boy now stands at a point E on the girder, where $AE = x$ metres, and the girder remains in equilibrium. Given that the magnitude of the reaction on the girder at D is now 520 N greater than the magnitude of the reaction on the girder at C,

(b) find the value of x

[5 marks]

Question 4

M1 Exam Question from June 2001, Q5



A large log *AB* is 6 m long. It rests in a horizontal position on two smooth supports *C* and *D*, where *AC* = 1m and *BD* = 1 m, David needs an estimate of the weight of the log, but the log is too heavy to lift off both supports. When David applies a force of magnitude 1500 N vertically upwards to the log at *A*, the log is about to tilt about *D*.

(a) State the value of the reaction on the log at *C* for this case.

[1 mark]

David initially models the log as a uniform log.

(b) Using this model estimate the weight of the log

[3 marks]

The shape of the log convinces David that his initial modelling assumption is too simple. He removes the force at A and applies a force acting vertically upwards at B. He finds that the log is about to tilt about C when this force has magnitude 1000 N. David now models the log as a nonuniform rod, with the distance of the centre of mass of the log from C as x metres.

Using this model find,

(c) a new estimate for the weight of the log

[6 marks]

(d) the value of x

[2 marks]