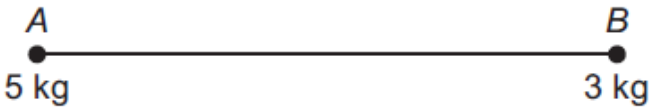
AQA – Centres of mass and moments – A2 Further Mathematics Mechanics

1. June/2020/Paper_3/No.1

A rigid rod, AB, has mass 2 kg and length 4 metres.

Two particles of masses 5 kg and 3 kg are fixed to A and B respectively to create a composite body, as shown in the diagram.



Find the distance of the centre of mass of the composite body from B.

Circle your answer.

[1 mark]

1.5 metres 1.6 metres 2.4 metres 2.5 metres

2. June/2020/Paper_3/No.8

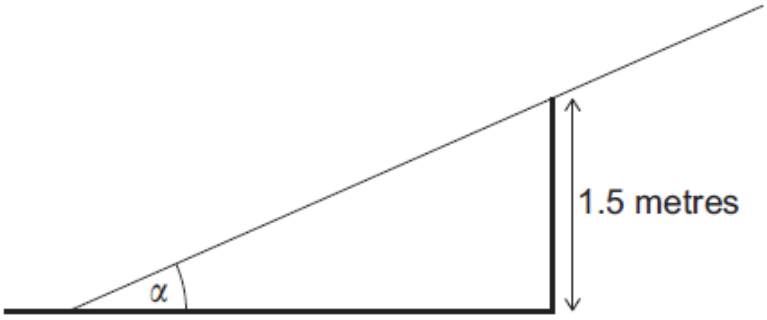
A ladder has length 4 metres and mass 20 kg

The ladder rests in equilibrium with one end on a horizontal surface and the ladder resting on the top of a vertical wall.

In this position the ladder is on the point of slipping.

The top of the wall is 1.5 metres above the horizontal surface.

The angle between the ladder and the horizontal surface is α, as shown in the diagram.



The coefficient of friction between the ladder and the wall is 0.5

The coefficient of friction between the ladder and the ground is also 0.5

Show that

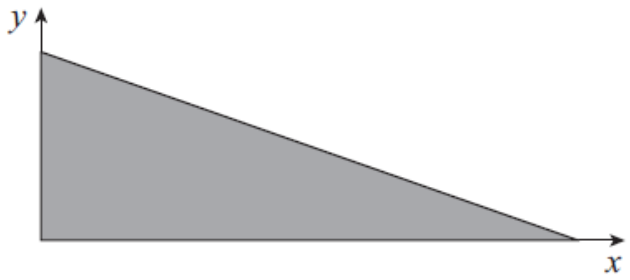
$$\cos\alpha \sin^2\alpha = \frac{3}{10}$$

stating clearly any assumptions you make.

[8 marks]

3. June/2019/Paper_3/No.5

The triangular region shown below is rotated through 360° around the x-axis, to form a solid cone.



The coordinates of the vertices of the triangle are (0, 0), (8, 0) and (0, 4).

All units are in centimetres.

(a) State an assumption that you should make about the cone in order to find the position of its centre of mass.

[1 mark]

(b) Using integration, prove that the centre of mass of the cone is 2 cm from its plane face.

[5 marks]

(c) The cone is placed with its plane face on a rough board. One end of the board is lifted so that the angle between the board and the horizontal is gradually increased. Eventually the cone topples without sliding.

(c) (i) Find the angle between the board and the horizontal when the cone topples, giving your answer to the nearest degree.

[2 marks]

(c) (ii) Find the range of possible values for the coefficient of friction between the cone and the board.

[3 marks]