Rods, Wire Frameworks and Wires of Different Densities

Specification: AQA 7367: ME1, ME2 · Edexcel 9FM0: FM2 Centres of mass of plane figures (frameworks, circular arcs)

INDEPENDENT

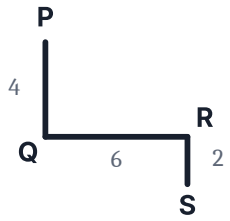
You do

A · One wire Lengths in place of masses: ΣLx ÷ ΣL.

1 A uniform wire is bent at B into AB = 3 m and BC = 9 m, at right angles. Find the distances of the centre of mass from BC and from BA.

2 A framework OAB is made from uniform wire, with O at the origin, A at $(16, 0)$ and B at $(0, 12)$. Find its centre of mass.

3 A uniform wire PQRS is bent into three straight pieces: P $(0, 4)$, Q $(0, 0)$, R $(6, 0)$ and S $(6, -2)$. Find its centre of mass.

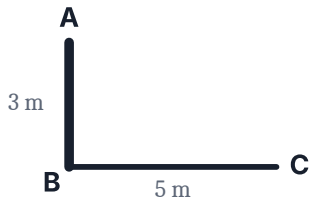


4 A uniform wire forms three sides of a rectangle: OA = 10 cm along the x-axis from the origin O, AB = 4 cm and BC = 10 cm, with C at $(0, 4)$. Side OC is missing. Find the centre of mass.

B · Different densities and particles Masses first: m = λL.

5 Two uniform rods are joined end to end in a straight line ABC. AB has length 2 m and mass 3 kg; BC has length 4 m and mass 1 kg. Find the distance of the centre of mass from A.

6 Rods AB and BC are joined at right angles at B. AB has length 3 m and mass 2 kg m^{-1}; BC has length 5 m and mass 1 kg m^{-1}. Find the distances of the centre of mass from BC and from BA.



7 A square framework OABC has side 2 m, with O at the origin, A on the positive x-axis and C on the positive y-axis. Side OA has mass 4 kg m^{-1}; the other three sides have mass 1 kg m^{-1}. Find the centre of mass.

8 A uniform wire of mass 1 kg m^{-1} is bent at B into AB = 4 m and BC = 6 m, at right angles. A particle of mass 2 kg is attached at C. Find the distances of the centre of mass from BC and from BA.

C · Reasoning No calculator. Explain in words.

9 A square framework is made from uniform wire, with one diagonal added. Explain why its centre of mass is at the centre of the square.

10 True or false? "A triangular framework of uniform wire and a uniform triangular lamina with the same corners $(0, 0)$, $(6, 0)$, $(0, 8)$ have the same centre of mass." Show your working.

11 A semicircular arc of wire and a semicircular lamina have the same radius r. The lamina's centre of mass is $4r/3\pi$ from the centre. Which centre of mass is further from the centre? Explain.

D · Unknowns and show that Write $(\Sigma m)\bar{x} = \Sigma mx$, or $\Sigma L\ \bar{x} = \Sigma Lx$, then solve.

12 A uniform wire is bent at B into AB = a and BC = $2a$, at right angles. Show that its centre of mass is $2a/3$ from BA and $a/6$ from BC.

13 A uniform wire is bent at B into AB = 4 cm and BC = L cm, at right angles. The centre of mass is 0.5 cm from BC. Find L.

14 Rods AB and BC are joined at right angles at B. AB has length 3 m and mass 2 kg m^{-1}. BC has length 6 m and mass λ kg m^{-1}. The centre of mass is 2 m from BA. Find λ.

15 A uniform wire forms a semicircular arc of radius r and the diameter joining its ends. Show that the centre of mass is $2r/(\pi + 2)$ from the diameter.

E · Exam-style question Show your method: marks are for working.

16 A uniform wire ABCD forms three sides of a rectangle: AB = 20 cm, BC = 15 cm, CD = 20 cm. G is its centre of mass.

(a) Explain why G is 7.5 cm from AB. [1 mark]

(b) Show that G is $140/11$ cm from AD. [3 marks]

(c) The wire has mass 0.02 kg per cm. A particle of mass M kg at D moves G to 10 cm from AD. Find M. [2 marks]

(d) Find the new distance of G from AB. [2 marks]

