Unit Review

Specification: AQA 7367: ME1, ME2 · Edexcel 9FM0: FM2 Centres of mass of plane figures, Further centres of mass

HOMEWORK Consolidation

1 Particles of mass 1 kg, 4 kg, 3 kg and 2 kg are at the points $(2, 5)$, $(3, -1)$, $(-2, 2)$ and $(5, 4)$. Find the coordinates of their centre of mass.

AQA 7367 ME1 · Edexcel FM2 (particles)

2 A uniform rod AB of length 4 m and mass 6 kg has particles of mass 2 kg at A and 4 kg at B.

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

(b) A further particle of mass 3 kg is attached to the rod so that the centre of mass moves to the midpoint of AB. How far from A is it attached?

AQA 7367 ME1, ME2 · Edexcel FM2 (uniform rod with particles)

3 A wire ABC is bent at B into a right angle, with AB = 5 cm and BC = 8 cm. The piece AB has twice the mass per unit length of the piece BC. Take B as the origin, BC along the x-axis and BA along the y-axis.

(a) Find the centre of mass of the wire.

(b) The wire is freely suspended from A. Find the angle between AB and the vertical.

AQA 7367 ME2 · Edexcel FM2 (frameworks, different densities)

4 A uniform lamina is a sector OAB of a circle with centre O, radius 12 cm and angle AOB = $60°$.

(a) Find the distance of its centre of mass from O.

(b) The triangle OAB is cut away, leaving the segment between the chord AB and the arc. Find the distance of the centre of mass of the segment from O.

AQA 7367 ME2 · Edexcel FM2 (composite laminas, standard results)

5 A uniform rectangular lamina occupies $0 \le x \le 12$, $0 \le y \le 4$. It is folded along the line $x = 8$, so that the part $8 \le x \le 12$ lies flat on top of the part $4 \le x \le 8$. Find $\bar{x}$ for the folded lamina.

AQA 7367 ME2 · Edexcel FM2 (composite laminas: folding)

6 A uniform triangular lamina has vertices $O(0, 0)$, $A(9, 0)$ and $B(0, 6)$. It is freely suspended from A. Find the angle between AO and the vertical.

AQA 7367 ME2 (freely suspended) · Edexcel FM2 (plane figures: hanging)

7 A cylindrical hole of radius 2 cm and depth 3 cm is drilled into the plane face of a uniform solid hemisphere of radius 6 cm, along its axis. Find the distance of the centre of mass of the remaining solid from the plane face.

AQA 7367 ME2 (composite bodies) · Edexcel FM2 (Further centres of mass: solids)

8 A toy is a uniform solid hemisphere of radius 2 cm with a uniform solid cone of base radius 2 cm and height 4 cm on its plane face, centre O.

(a) Find the distance of the centre of mass from O.

(b) The toy rests with its curved surface on a horizontal floor. Does it return upright when tilted? Explain.

(c) The toy is freely suspended from a point A on the rim of the plane face. Find the angle between its axis and the vertical.

AQA 7367 ME2 · Edexcel FM2 (solids: resting on a curved surface, hanging)

9 A uniform wire of mass 3 kg is bent into a semicircular arc AB with centre O and radius 5 cm. A particle of mass 1 kg is attached at B. The arc is freely suspended from A. Find the angle between the diameter AB and the vertical.

AQA 7367 ME2 (freely suspended) · Edexcel FM2 (plane figures: hanging)

10 A container, open at the top, is made of thin uniform sheet metal: a hemispherical bowl of radius 3 cm joined at its rim to the curved surface of a cylinder of radius 3 cm and height 6 cm. Find the distance of the centre of mass from the lowest point of the bowl.

AQA 7367 ME2 (shells) · Edexcel FM2 (Further centres of mass: shells)

11 *AQA-style*. A framework is made of uniform wire in the shape of a triangle OAB, where $O(0, 0)$, $A(12, 0)$ and $B(12, 5)$.

(a) Show that the centre of mass of the framework is at $(7, 1.5)$. [3 marks]

(b) The framework is freely suspended from O. Find the angle between OA and the vertical. [2 marks]

(c) A particle of the same mass as the framework is attached at A and it is again freely suspended from O. Find the new angle between OA and the vertical. [2 marks]

AQA 7367 ME2 · Edexcel FM2 (frameworks, different densities) · AQA-style

12 *Edexcel-style*. A uniform lamina is a sector OAB of a circle with centre O and radius $3a$, and angle AOB = $\frac{2\pi}{3}$.

(a) Show that the centre of mass of the lamina is at a distance $\frac{3\sqrt{3}a}{\pi}$ from O. [3 marks]

(b) The lamina is freely suspended from A. Find the angle between AO and the vertical. [3 marks]

AQA 7367 ME2 (freely suspended) · Edexcel FM2 (plane figures: hanging) · Edexcel-style