Centre of Mass of a System of Particles

Specification: AQA 7367: ME1 · Edexcel 9FM0: FM2 Centres of mass of plane figures (particles)

INDEPENDENT **You do**

A · Particles on a line Origin, Σm, Σmx, divide.

1 Particles of mass 2 kg and 6 kg are at $x = 0$ and $x = 4$. Find $\bar{x}$.

2 Particles of mass 3, 2 and 5 kg are attached to a light rod AB of length 4 m, at 1 m, 2.5 m and 4 m from A. Find the distance of the centre of mass from A.



3 Particles of mass 1, 4 and 5 kg lie on the x-axis at $x = -3$, $x = 2$ and $x = 1$. Find $\bar{x}$.



4 A uniform rod AB of length 2 m has mass 3 kg. Particles of mass 2 kg and 5 kg are attached at A and B. Find the distance of the centre of mass from A.

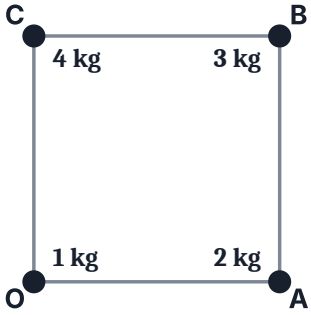
B · Particles in a plane x and y separately: use a table.

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

6 Particles of mass 4, 1 and 3 kg are at $(-1, 3)$, $(6, -2)$ and $(2, 0)$. Find their centre of mass.

7 Particles of mass 2, 3 and 5 kg have position vectors $3\mathbf{i} + \mathbf{j}$, $-\mathbf{i} + 4\mathbf{j}$ and $2\mathbf{i} - 2\mathbf{j}$ metres. Find the position vector of their centre of mass.

8 A light square lamina OABC has side 2 m, with O at the origin, A on the positive x-axis and C on the positive y-axis. Particles of mass 1, 2, 3 and 4 kg are at O, A, B and C. Find the centre of mass.



C · Reasoning No calculator. Explain in words as well as numbers.

9 Three particles, each of mass m, are at $(0, 0)$, $(6, 0)$ and $(0, 3)$. Show that their centre of mass is the mean of their coordinates, and find it.

10 Particles of mass 2 kg at A and 3 kg at B are joined by a light rod of length 5 m. Explain why G lies on AB, nearer to B, and find AG.

11 Every mass in a system of particles is doubled. What happens to the centre of mass? Explain.

D · Unknown masses and positions Write $(\Sigma m)\bar{x} = \Sigma mx$, then solve.

12 Particles of mass 3 kg, 2 kg and m kg are at $x = 0$, $x = 5$ and $x = 10$. Their centre of mass is at $x = 6$. Find m.

13 Particles of mass 2, 4 and 2 kg are at $(0, 0)$, $(a, 3)$ and $(6, b)$. Their centre of mass is $(3, 2)$. Find a and b.

14 Particles of mass m, $2m$ and $3m$ are at $(0, 0)$, $(3a, 0)$ and $(a, 2a)$. Show that their centre of mass is at $(1.5a, a)$.

15 A light rod AB has length 4 m. Particles of mass 2 kg at A, 3 kg at B and 5 kg at C, on AB, have their centre of mass at the midpoint of AB. Find AC.

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

16 A light rectangular lamina OABC has O at the origin, OA = 60 cm along the positive x-axis and OC = 40 cm along the positive y-axis. Particles of mass 3, 2, 4 and 1 kg are at O, A, B and C.

(a) Find the centre of mass. [4 marks]

(b) A particle of mass k kg is added at the midpoint of OC. The centre of mass is now on the line $x = 30$. Find k. [2 marks]

(c) Show that $\bar{y}$ does not change. Explain why. [2 marks]

