



4.15F Loci and Construction: Foundation Tier Practice

EDEXCEL Edexcel 1MA1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / ____

Answer ALL questions. Show all your working.

- 1** On a scale drawing 1 cm represents 2 m. A tree is represented by a point T. Draw the locus of points that are exactly 4 m from T. Describe the locus and state its radius on the drawing.

(Total for Question 1 is 1 mark)

- 2** Priya stands at point P. Shade the locus of points that are within 3 m of P on a garden plan where 1 cm represents 1 m. Describe the locus.

(Total for Question 2 is 1 mark)

- 3** Work out the distance from a point to a line. A road is represented by a straight line L on a map. A house H is 5 cm from L on the map. The scale is 1 cm = 10 m. Calculate the shortest real distance from the house to the road in metres.

(Total for Question 3 is 2 marks)

- 4** A point A is at (0, 0) and point B is at (6, 0) on a grid. Work out and construct the perpendicular bisector of AB. Give the equation of the line of the perpendicular bisector and state one point on it.

(Total for Question 4 is 4 marks)

- 5** On a drawing, two shops S1 and S2 are 8 cm apart. Draw and describe the locus of points that are equidistant from S1 and S2.

(Total for Question 5 is 2 marks)

- 6** A library L and a park P are points on a plan. You are to find the places that are 5 m from L and closer to P than to L. The scale is 1 cm = 1 m.

Part (a) Draw the locus of points 5 m from L.

Part (b) Describe the region that is closer to P than to L.

Part (c) On your drawing shade the region that satisfies both conditions.

(a) Draw the locus 5 m from L on the plan (1 cm = 1 m). (1)

(b) Describe the region closer to P than to L. (2)

(c) Shade the part of the circle from part (a) that lies on the P side of the perpendicular bisector. (2)

(Total for Question 6 is 5 marks)

- 7** Constructing an angle bisector. At point A, angle BAC = 60 degrees. Using ruler and compass only, describe the construction sequence to bisect angle BAC and give the size of each resulting angle. No measurement with a protractor is allowed.

(Total for Question 7 is 6 marks)

- 8** Two towers T1 and T2 are 20 m apart. A point X must be placed so that it is 10 m from T1 and within 8 m of T2. On a scale plan 1 cm = 2 m:

Part (a) Find the radius for the locus 10 m from T1 on the plan.

Part (b) Find the radius for the locus within 8 m of T2 on the plan.

Part (c) State what the feasible region for X is on the plan.

(a) Radius for locus 10 m from T1 on the plan. (1)

(b) Radius for locus within 8 m of T2 on the plan. (1)

(c) Describe the feasible region for X on the plan. (2)

(Total for Question 8 is 4 marks)

- 9** A museum M and a cafe C are 12 m apart. A location P must be at least 6 m from M and at least 6 m from C. On a plan 1 cm = 2 m:

Part (a) What is the smallest distance between the two loci (the two circles of radius 6 m) on the plan? Show working.

Part (b) Explain whether there are any points that satisfy both requirements.

(a) Find the distance between the two circle centres on the plan and compute the distance between their circumferences (smallest distance between the two circles). (4)

(b) Explain whether there are any points that are at least 6 m from both M and C. (4)

(Total for Question 9 is 8 marks)

10 A builder needs to place a lamppost L so that it is 15 m from a corner A of a rectangular playground and also lies on the perpendicular bisector of the diagonal from A to the opposite corner C. The playground is 24 m by 10 m with A at one corner and C at the opposite corner. On a scale 1 cm = 2 m:

Part (a) Work out the position(s) of L relative to A in metres (distance and direction along the perpendicular bisector).

Part (b) On the plan give the coordinates of L using A as origin (0, 0) with the rectangle sides along the axes. Show working and final coordinates in metres.

- (a) Find possible point(s) L that are 15 m from A and lie on the perpendicular bisector of AC. (4)

- (b) Find the coordinates of L in metres using A as (0,0). (3)

(Total for Question 10 is 7 marks)

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Question 1

- **B1** circle centre T, radius 2 cm (since 4 m $\rightarrow$ 2 cm on drawing) cao
- **Answer: A circle centre T, radius 2 cm.**

Question 2

- **B1** filled disc (circle and interior) centre P radius 3 cm on the plan cao
- **Answer: The disc (circle and interior) centre P, radius 3 cm.**

Question 3

- **M1** scale conversion 5 cm * 10 m/cm or equivalent method
- **A1** 50 m cao
- **Answer: 50 m**

Question 4

- **M1** midpoint of AB found as (3, 0) or correct method to find midpoint
- **M1** perpendicular slope identified as undefined? or vertical/horizontal reasoning: AB is horizontal so perpendicular bisector is vertical through x=3
- **A1** equation $x = 3$ cao
- **A1** a point on it, e.g. (3, 2) or (3, 0) cao
- **Answer: Equation $x = 3$. One point on it: (3, 0) (midpoint) or (3, 2).**

Question 5

- **M1** identify perpendicular bisector of segment S1S2 as the locus
- **A1** description: the perpendicular bisector of S1S2, a line at right angles through the midpoint, cao
- **Answer: The perpendicular bisector of S1S2: the straight line at right angles through the midpoint.**

Question 6

- (a) **M1** circle centre L radius 5 cm shown
- (a) **Answer: Circle centre L radius 5 cm (on the plan).**
- (b) **M1** identify perpendicular bisector of PL divides plane into two regions
- (b) **A1** state region: the side of the perpendicular bisector containing P is points closer to P than to L cao
- (b) **Answer: Points on the side of the perpendicular bisector of PL that contains P are closer to P than to L.**
- (c) **M1** correct region shaded: part of circle (or arc) on P side of perpendicular bisector
- (c) **A1** clear indication of region (shaded area or labelled) cao
- (c) **Answer: The arc or sector of the circle of radius 5 m around L that lies on the P side of the perpendicular bisector is shaded.**

Question 7

- **M1** draw an arc from A cutting both arms AB and AC at two points
- **M1** draw equal arcs from those two points to intersect at a point inside the angle
- **M1** draw line from A through the intersection point (the bisector)
- **M1** each step described clearly and in the correct order
- **A1** state each resulting angle is 30 degrees cao
- **A1** final statement that bisector divides 60 degrees into two equal 30 degree angles cao
- **Answer: Construction: from A draw an arc cutting AB and AC at two points; from each of those points draw equal-radius arcs that meet; draw line from A to their intersection. Each resulting angle is 30 degrees.**

Question 8

- (a) **B1** 5 cm (since 10 m at scale 1 cm = 2 m gives $10/2 = 5$ cm) cao
- (a) **Answer: 5 cm**
- (b) **B1** 4 cm (since $8 \text{ m} / 2 \text{ m per cm} = 4 \text{ cm}$) cao
- (b) **Answer: 4 cm**
- (c) **M1** identify intersection of circle radius 5 cm around T1 with disc radius 4 cm around T2
- (c) **A1** state feasible region: points on the circle centred at T1 radius 5 cm that also lie within the circle centred at T2 radius 4 cm cao
- (c) **Answer: Points on the circle centre T1 radius 5 cm that lie inside (or on) the circle centre T2 radius 4 cm; i.e. the parts of the T1 circle inside the T2 disc.**

Question 9

- (a) **M1** convert centre distance: $12 \text{ m} / 2 = 6 \text{ cm}$
- (a) **M1** radius on plan for each circle: $6 \text{ m} / 2 = 3 \text{ cm}$
- (a) **M1** compute gap: centre distance 6 cm - 3 cm - 3 cm = 0 cm
- (a) **A1** state smallest distance = 0 cm (circles touch) cao
- (a) **Answer: Smallest distance = 0 cm; the circles touch.**
- (b) **M1** recognise that circles touching means there is exactly one point at distance exactly 6 m from both
- (b) **M1** state that points at least 6 m from both are points on or outside both circles
- (b) **M1** conclude: there is exactly one point that is exactly 6 m from both (the touch point), and infinitely many points outside both if centres sufficiently far; but here only the single common point satisfies exactly equal 6 m to both
- (b) **A1** clear conclusion: there is one point (the touch point) that is 6 m from both; no point is strictly more than 6 m from both while on both circles, but outside both there are points further from both - accept reasoning that the only common point on both loci is the touching point cao
- (b) **Answer: The two circles touch, so there is exactly one point that is 6 m from both M and C (the point of contact). There are points further than 6 m from both, but only one point lies on both circles.**

Question 10

- (a) **M1** find coordinates of C: (24, 10) and midpoint of AC as (12, 5)
- (a) **M1** perpendicular bisector goes through (12, 5); direction vector perpendicular to AC: AC vector (24, 10) so perpendicular direction (-10, 24) or (10, -24)
- (a) **M1** distance from A to midpoint is $\sqrt{12^2 + 5^2} = \sqrt{144 + 25} = \sqrt{169} = 13 \text{ m}$, so use right triangle to find points at distance 15 from A on the perpendicular bisector
- (a) **A1** state there are two possible points symmetric about the midpoint; give their distances along the bisector from the midpoint or coordinates cao
- (a) **Answer: There are two possible positions for L symmetric about the midpoint of AC, because the perpendicular bisector intersects the circle centre A radius 15 m twice (since 15 m is greater than AM = 13 m).**
- (b) **M1** set up equation: point on perpendicular bisector has form $(12, 5) + t(-10, 24)/\sqrt{10^2 + 24^2}$ or using perpendicular direction and solve distance to A = 15
- (b) **M1** compute unit perpendicular vector length $\sqrt{100 + 576} = \sqrt{676} = 26$ so unit vector is $(-10/26, 24/26) = (-5/13, 12/13)$ and solve $(12 + t(-5/13))^2 + (5 + t(12/13))^2 = 15^2$
- (b) **A1** solutions $t = \pm 2\sqrt{14}$ giving coordinates $L1 = (12 - 10\sqrt{14}/13, 5 + 24\sqrt{14}/13)$ and $L2 = (12 + 10\sqrt{14}/13, 5 - 24\sqrt{14}/13)$, with decimal forms approx (9.1218, 11.9077) and (14.8782, -1.9077) metres cao
- (b) **Answer: $L1 = (12 - 10\sqrt{14}/13, 5 + 24\sqrt{14}/13)$ approx (9.1218 m, 11.9077 m); $L2 = (12 + 10\sqrt{14}/13, 5 - 24\sqrt{14}/13)$ approx (14.8782 m, -1.9077 m).**