4.15 Loci and Construction: 1-hour Pack

EDEXCEL 1MA1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Write down the locus of points that are exactly 4 cm from a given straight line l.

(Total for Question 1 is 1 mark)

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2 What is the locus of points at a distance less than or equal to 5 cm from point P?

(Total for Question 2 is 1 mark)

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3 Write down the locus of points equidistant from two intersecting straight lines.

(Total for Question 3 is 1 mark)

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4 A and B are two points 14 cm apart. The point P is the same distance from A as it is from B, and P is 24 cm from the midpoint of AB.
Work out the distance AP.

(Total for Question 4 is 3 marks)

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5 A straight path AB is 6 m long. A lamp lights every point that is within 4 m of the path.
Work out the area that is lit. Give your answer correct to 3 significant figures.

(Total for Question 5 is 4 marks)

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6 A goat is tied by a rope of length 2 m to the corner of a rectangular field that is 10 m by 7 m.
The goat stays inside the field.
Work out the area of grass the goat can reach. Give your answer in terms of π.

(Total for Question 6 is 3 marks)

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7 A and B are two points 20 cm apart. The point P is the same distance from A as it is from B, and P is 24 cm from the midpoint of AB.
Work out the distance AP.

(Total for Question 7 is 3 marks)

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8 Describe the locus of points that are equidistant from two fixed points A and B.

(Total for Question 8 is 1 mark)

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9 Mark a point P on a straight line. Using only a ruler and compasses (no protractor), construct an angle of 60 degrees at P.

(Total for Question 9 is 2 marks)

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10 Two mobile phone masts, A and B, are 6 km apart. Using a scale of 1 cm to 1 km, draw the positions of A and B. Then, using a ruler and compasses only, construct the locus of points that are equidistant from both masts.

(Total for Question 10 is 3 marks)

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11 True or false? The locus of points equidistant from a fixed point F and a fixed line d is a parabola that can be constructed exactly using only compass and straightedge. Give a brief reason for your answer.

(Total for Question 11 is 2 marks)

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12 Draw the perpendicular bisector of the line segment joining points A(1, 3) and B(5, 7). Give the equation of the perpendicular bisector in the form $y = mx + c$.

(Total for Question 12 is 2 marks)

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13 Two circles have centres A and B which are 10 cm apart. One circle has radius 6 cm (centre A) and the other has radius 8 cm (centre B). Find the coordinates of their intersection points if AB lies along the x-axis with A at (0, 0) and B at (10, 0).

(Total for Question 13 is 3 marks)

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14 Triangle ABC has side lengths AB = 7 cm, BC = 8 cm and AC = 9 cm. Construct the perpendicular bisectors of two sides to find the circumcentre. Calculate the circumradius (to 3 significant figures).

(Total for Question 14 is 3 marks)

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15 Two points A(-5, 0) and B(5, 0) are 10 cm apart on a coordinate grid (1 unit = 1 cm).

(a) Describe the geometric locus in words and give its equation. **(2)**

(b) Find the coordinates of the points where the circle centre A radius 13 cm meets the locus x = 0. Show your working. **(4)**

(Total for Question 15 is 6 marks)

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16 A school S is at (0, 0), a hospital H is at (12, 0) and a landmark P is at (6, 8).
Find all points that are both equidistant from S and H and exactly 5 units from P. Give coordinates and justify your method. (8 marks)

(Total for Question 16 is 8 marks)

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Mark scheme · 4.15 Loci and Construction: 1-hour Pack

Question 1

two lines parallel to l, each 4 cm from l, cao **B1**

Answer: Two lines parallel to l, each 4 cm from l (one on each side).

Question 2

the circle centre P radius 5 cm including the interior (a filled disc) cao **B1**

Answer: The circle centre P radius 5 cm together with its interior (the disc).

Question 3

the two angle bisectors of the lines (both bisectors) cao **B1**

Answer: The two angle bisectors of the intersecting lines.

Question 4

half of AB is 7 cm so a right-angled triangle with sides 7 and 24 **M1**

$7^2 + 24^2 = 625$ **M1**

25 cm **A1**

Answer: 25 cm

Question 5

rectangle 6 x 8 **M1**

two semicircles $\pi \times 4^2$ **M1**

adds the areas **M1**

98.3 m^2 **A1**

Answer: 98.3 m^2

Question 6

recognises a quarter circle **M1**

$1/4 \times \pi \times 2^2$ **M1**

$1\ \pi\ m^2$ **A1**

Answer: $1\ \pi\ m^2$

Question 7

half of AB is 10 cm so a right-angled triangle with sides 10 and 24 **M1**

$10^2 + 24^2 = 676$ **M1**

26 cm **A1**

Answer: 26 cm

Question 8

the perpendicular bisector of AB **B1**

Answer: the perpendicular bisector of AB

Question 9

arc centred at P crossing the line at a point Q, then a further arc of the same radius centred at Q, crossing the first arc at R **C1**

line PR drawn correctly, with angle QPR measuring 60 degrees within 2 degrees, no protractor marks used **A1**

Answer: Angle QPR = 60 degrees, constructed using the equilateral-triangle compass method.

Question 10

A and B plotted correctly, 6 cm apart, to the given scale **B1**

two pairs of intersecting arcs of equal radius (greater than 3 cm), centred on A and on B **C1**

correct perpendicular bisector line drawn through the intersections, extending beyond the line AB **A1**

Answer: The perpendicular bisector of AB, crossing AB at its midpoint (3 km from each mast).

Question 11

false, because the parabola is a quadratic locus and cannot be constructed exactly with a finite sequence of compass-and-straightedge steps (oe) **B1**

give reason: construction of a full parabola requires plotting many points or higher-order methods, not a single compass-and-straightedge procedure oe **B1**

Answer: False. The parabola is a continuous quadratic locus and cannot be constructed exactly by a finite straightedge-and-compass procedure; it is usually drawn by plotting many points.

Question 12

midpoint of AB found as (3, 5) or equivalent **M1**

equation y = -x + 8 cao **A1**

Answer: y = -x + 8 (equivalently y = -1x + 8). Working: midpoint ((1+5)/2, (3+7)/2) = (3,5). Slope AB = (7-3)/(5-1) = 1 so perpendicular slope = -1. Line: y - 5 = -1(x - 3) gives y = -x + 8. Recompute: midpoint (3,5), perpendicular slope -1, substitute gives y = -x + 8.

Question 13

use formula $x = (r1^2 - r2^2 + d^2)/(2d)$ or set up equations and subtract to find x **M1**

substitute r1 = 6, r2 = 8, d = 10 to get x = (36 - 64 + 100)/20 = 72/20 = 3.6 **M1**

$y = \pm\sqrt{6^2 - 3.6^2} = \pm 4.8$ so intersections (3.6, 4.8) and (3.6, -4.8) cao **A1**

Answer: Intersection points: (3.6, 4.8) and (3.6, -4.8). (Checks: $3.6^2 + 4.8^2 = 12.96 + 23.04 = 36 = 6^2$.)

Question 14

use Heron to find area: s = 12, area = $\sqrt{12(12-7)(12-8)(12-9)} = \sqrt{720}$ **M1**

use circumradius formula R = abc/(4*area) with a=8, b=9, c=7 **M1**

$R = 7*8*9/(4*\sqrt{720})$ approx 4.70 cm awrt **A1**

Answer: Circumradius R approx 4.70 cm (to 3 s.f.). Computation: s = 12, area = $\sqrt{720}$ approx 26.8328, R = 504/(4*26.8328) approx 4.698 -> 4.70.

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Question 15

(a) identify locus as the perpendicular bisector of AB (the set of points equidistant from A and B) **M1**

(a) state equation x = 0 (since AB is horizontal with midpoint (0,0)) cao **A1**

(a) Answer: The locus is the perpendicular bisector of AB: the straight line through the midpoint (0,0) at right angles to AB. Since AB lies along the x-axis, the perpendicular bisector is the y-axis, equation x = 0.

(b) set up equation of circle centre A(-5,0) radius 13: $(x+5)^2 + y^2 = 169$ **M1**

(b) substitute x = 0: $25 + y^2 = 169$, so $y^2 = 144$ **M1**

(b) y = 12 or y = -12 **A1**

(b) final coordinates (0, 12) and (0, -12) cao **A1**

(b) Answer: (0, 12) and (0, -12).

Question 16

identify locus equidistant from S and H is the perpendicular bisector of SH; since S(0,0) and H(12,0), bisector is x = 6 **M1**

parametrise points on bisector as (6, y) **M1**

apply distance condition to P(6,8): distance = |y - 8| = 5, set up equation |y - 8| = 5 **M1**

solve |y - 8| = 5 to get y = 13 or y = 3 **M1**

state candidate points (6, 13) and (6, 3) **M1**

check each point lies on perpendicular bisector and so is equidistant from S and H (show distance to S equals distance to H for one point) **M1**

both points satisfy the condition; give coordinates (6, 13) and (6, 3) cao **A1**

give brief construction statement: on the map draw perpendicular bisector of SH and mark points on it at distance 5 from P (using compass) cao **A1**

Answer: Points are (6, 13) and (6, 3). Reason: equidistant locus is x = 6; distance to P(6,8) is |y - 8| = 5 so y = 13 or 3; both points lie on x = 6.

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