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GCSE MATHEMATICS • GEOMETRY

Loci and Construction

Worksheet

Pearson Edexcel GCSE (1MA1) & International GCSE (4MA1) • No calculator

Free Loci and Construction worksheet for GCSE and iGCSE Maths, with full worked solutions



Tap a section to jump straight to it

By the end of this worksheet you can: construct perpendicular bisectors, angle bisectors and perpendiculars with ruler and compasses • construct triangles and angles of 60° , 30° , 90° and 45° • draw loci and shade regions • use loci on scale drawings • *Higher:* regions with several conditions, loci around shapes and proofs.

Which questions are for me?

FOUNDATION Everyone starts here. These skills appear on both tiers.

HIGHER Higher only: regions with several conditions, loci around shapes, proofs that constructions work, and calculations from loci. Grades 6 to 9.

Every section has both, clearly labelled. Questions get harder as you go, and every skill in Sections A to D is needed in Section E.

Track your progress

Section	B	C	D	E
Foundation marks	23	10	13	15
Higher marks	16	14	17	15
My score				

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A**Worked examples & Your turn**

Read each example carefully. Cover it up, then answer the question beside it using the same method. Use a ruler and compasses, and leave your construction arcs.

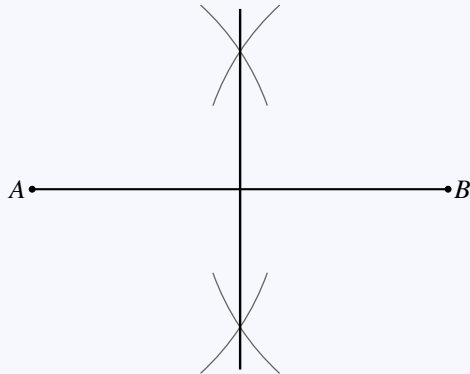
Diagrams in this worksheet are drawn to size: print at 100%.

FOUNDATION

Everyone starts here

Worked example A1

Construct the perpendicular bisector of AB

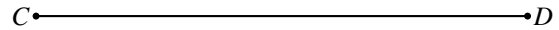


Compasses more than half of AB . Draw arcs from A and from B , above and below. Join the crossings.

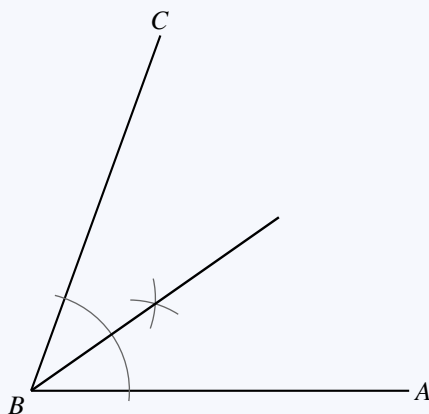
the bisector

Your turn A1

Construct the perpendicular bisector of CD

**Worked example A2**

Construct the bisector of angle ABC

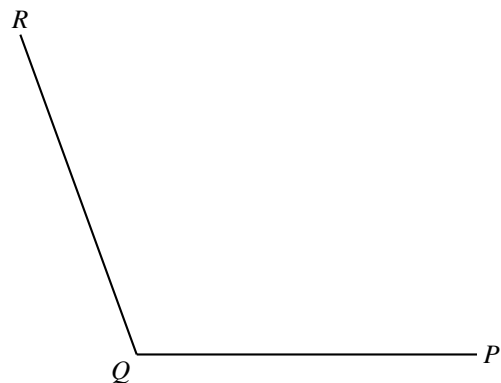


Arc from B cutting both arms. From those two points, equal arcs that cross. Join B to the crossing.

the bisector

Your turn A2

Construct the bisector of angle PQR

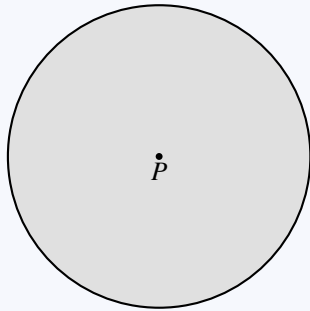


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Worked example A3

Shade the region of points less than 2 cm from P



A circle of radius 2 cm with centre P , and shade inside it.

the shaded disc

Your turn A3

Draw the locus of points exactly 3 cm from Q

Q

HIGHER

Higher only: regions, loci around shapes and scale

Worked example A4: why a construction works

Explain why the construction of an angle bisector really halves the angle.

Both arc points are the same distance from B ; the crossing is the same distance from each. Three pairs of equal sides.

congruent (SSS), so equal angles

Your turn A4

Explain why every point on the perpendicular bisector of AB is the same distance from A and B

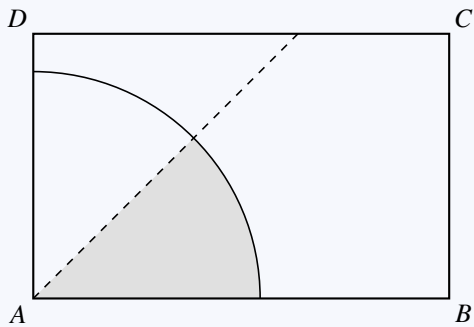


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Worked example A5: two conditions

Shade the points inside $ABCD$ that are less than 3 cm from A and nearer AB than AD

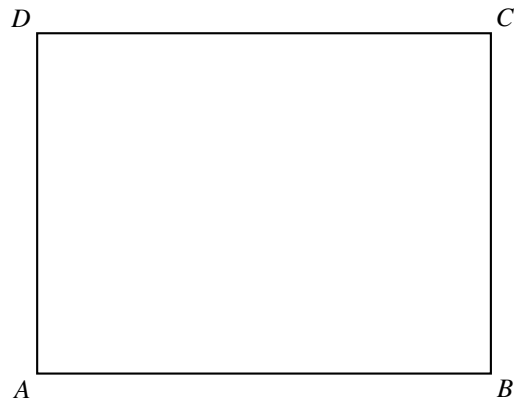


Arc of radius 3 cm about A. Bisect angle A: nearer AB is below the bisector.

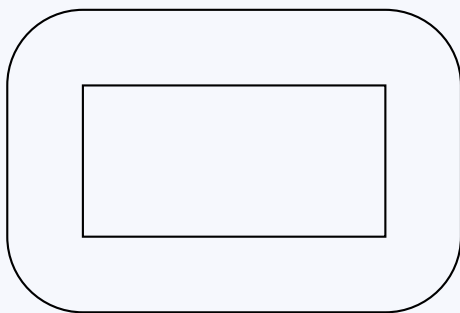
the shaded region

Your turn A5

Shade the points inside $ABCD$ that are less than 4 cm from D and more than 2 cm from AB

**Worked example A6: a locus round a shape**

Draw the locus of points 1 cm outside the rectangle.

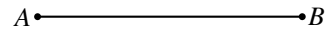


Lines 1 cm from each side, joined by quarter circles of radius 1 cm at the corners.

a rounded rectangle

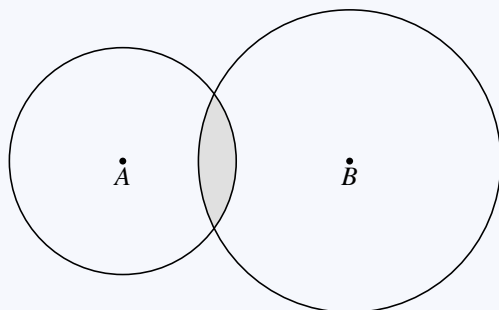
Your turn A6

Shade the points less than 1.5 cm from the line segment AB



Worked example A7: a scale drawing

Masts A and B are 6 km apart (1 cm to 2 km). A reaches 3 km and B reaches 4 km. Shade where both signals reach.



Circles of radius $3 \div 2 = 1.5$ cm about A and $4 \div 2 = 2$ cm about B . Shade the overlap.

the overlap

Your turn A7

Ships A and B are 30 km apart (1 cm to 10 km). Draw the positions that are the same distance from A and B , and within 25 km of A

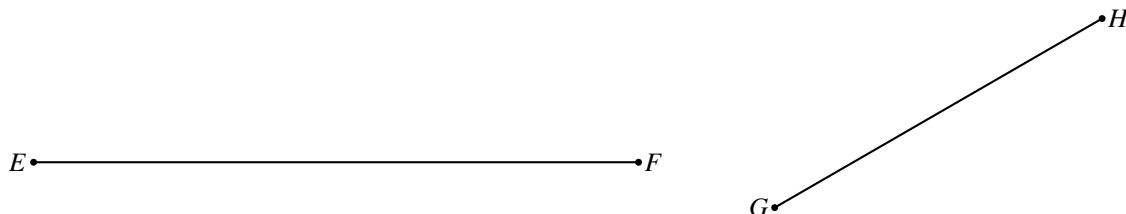


B**Fluency**

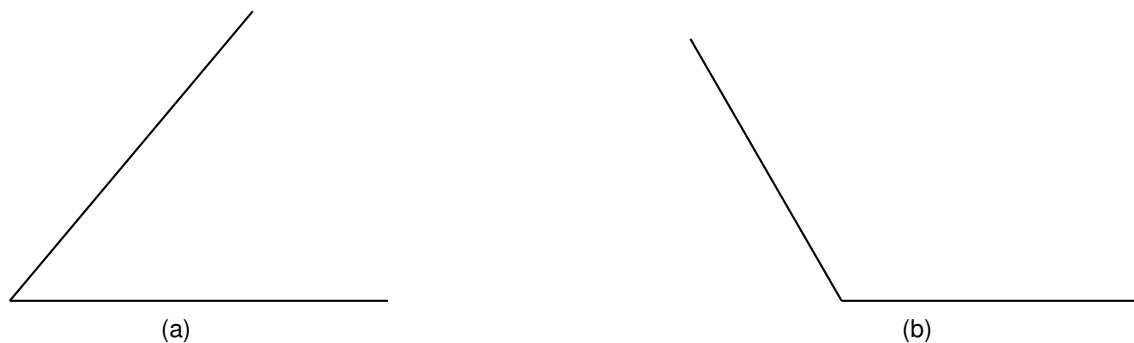
Each question is a designed sequence. From one part to the next, ask yourself: what changed, and what did it do to the answer? Leave all construction arcs.

FOUNDATION*Everyone starts here*

- B1** Construct the perpendicular bisector of EF and of GH

**[4 marks]**

- B2** Construct the bisector of each angle, and measure each half.

**[4 marks]**

- B3** (a) Construct a triangle with sides 6 cm, 7 cm and 8 cm. Measure its largest angle.
(b) Construct a triangle with sides 7 cm and 5 cm and an angle of 50° between them. Measure the third side.

[4 marks]

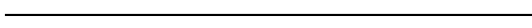
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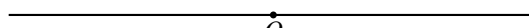
FOUNDATION

continued: perpendiculars and loci

- B4** (a) Construct the perpendicular from P to the line, and measure the distance from P to the line.
(b) Construct the perpendicular to the line at Q

 P 

(a)



(b)

[4 marks]

- B5** Describe each locus.

(a) Points 4 cm from a point O (b) Points the same distance from A and B

(c) Points the same distance from two lines that cross

[3 marks]

- B6** (a) Draw the locus of points exactly 2.5 cm from P (b) Draw the locus of points the same distance from P and Q

(c) Draw the locus of points 4 cm from Q (d) Shade the points nearer P than Q and less than 4 cm from Q

 P Q

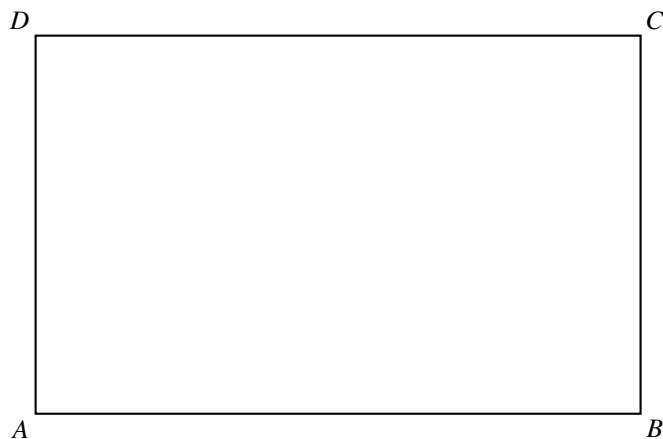
[4 marks]



HIGHER*Higher tier only*

- B7** Inside rectangle $ABCD$: (a) draw the points the same distance from AB and AD (b) draw the points 4 cm from C

(c) shade the points nearer AB than AD and less than 4 cm from C



[4 marks]

- B8** A and B are points. P is 5 cm from A and 5 cm from B . How many positions are there for P , and how far apart are they, when

(a) $AB = 8$ cm (b) $AB = 6$ cm (c) $AB = 10$ cm (d) $AB = 12$ cm

[4 marks]

- B9** The rectangle is 3 cm by 2 cm.

(a) Draw the locus of points 1 cm outside the rectangle.

(b) Work out the area inside the locus.

(c) Work out the length of the locus.

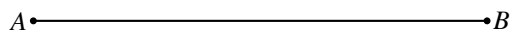
Give (b) and (c) to 1 decimal place.



[4 marks]



- B10** Using ruler and compasses only, construct at A an angle of (a) 60° (b) 30° (c) 90° (d) 45°



[4 marks]



C**Reasoning**

Show your working and explain your thinking. A correct answer without a reason does not score full marks.

FOUNDATION

Everyone starts here

- C1** Tom sets his compasses to 2 cm to bisect a line 6 cm long. His arcs do not cross. Explain why. [2 marks]
- C2** Sam says the points the same distance from A and B form a circle. Explain why Sam is wrong. [2 marks]
- C3** Explain why the locus of points 3 cm from a line segment has two straight sides and two semicircular ends. [3 marks]
- C4** When bisecting an angle, why must the compasses stay the same width for the two crossing arcs? [3 marks]



HIGHER*Higher tier only*

- C5** Prove that any point on the perpendicular bisector of AB is the same distance from A as from B [3 marks]
- C6** Explain why the perpendicular bisectors of the three sides of a triangle meet at one point, and what is special about that point. [3 marks]
- C7** Kai says the locus of points 2 cm outside a square is a bigger square. Explain Kai's mistake. [3 marks]
- C8** Two parallel lines are 6 cm apart. P is a point on one of them.
- (a) Describe the locus of points the same distance from both lines.
- (b) Find the points on that locus that are 4 cm from P , and work out the exact distance between them. [5 marks]



D**Problem solving**

You decide the method. Read the whole question first, and show every step.

FOUNDATION

Everyone starts here

- D1** Towns A and B are 10 km apart (1 cm to 2 km). A mast must be within 6 km of both towns. Shade the region where the mast can go.

 $\dot{A}$ $\dot{B}$

[3 marks]

- D2** Lighthouses A and B are 8 km apart (1 cm to 1 km). A boat is the same distance from both, and 5 km from A

Mark the possible positions, and find how far apart they are.

 $\dot{A}$ $\dot{B}$

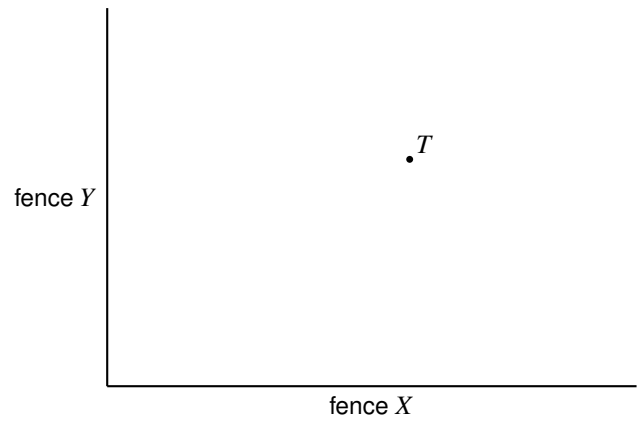
[4 marks]



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- D3** Two fences meet at a right angle (1 cm to 1 m). Treasure is more than 3 m from the tree T and nearer fence X than fence Y . Shade the region where the treasure could be.



[3 marks]

- D4** Using ruler and compasses only, construct a square with sides of 5 cm.

[3 marks]



HIGHER*Higher tier only*

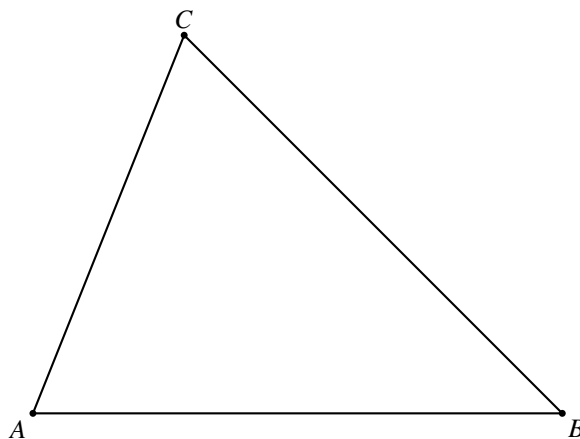
- D5** A goat is tied to the corner of a shed with a rope 4 m long. The shed is 3 m by 2 m, and the goat cannot go inside it.

Work out the area the goat can reach, to 1 decimal place.

[4 marks]

- D6** Villages A , B and C are shown (1 cm to 1 km). A phone mast must be the same distance from all three.

Construct its position, and work out that distance to 1 decimal place.



[4 marks]

- D7** $ABCD$ is a garden 8 m by 6 m (1 cm to 1 m). A tree must be more than 2 m from AB , nearer D than B , and less than 5 m from A .

Shade the region where the tree can go.



[4 marks]

- D8** A plank 4 m long leans against a wall. Its top slides down the wall and its foot slides along the floor. Prove that the midpoint of the plank always stays 2 m from the corner, and describe the locus of the midpoint.

[5 marks]



E**Exam practice**

Exam-style questions. Use a ruler and compasses, and leave your construction arcs. Aim for about one minute per mark.

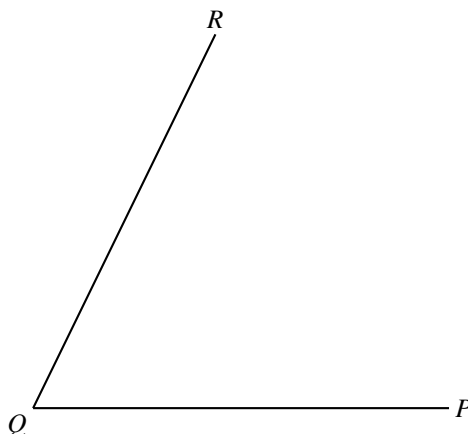
FOUNDATION*Foundation and Higher crossover*

- E1** Use ruler and compasses to construct the perpendicular bisector of AB



(Total for Question E1 is 2 marks)

- E2** Use ruler and compasses to construct the bisector of angle PQR



(Total for Question E2 is 2 marks)

- E3** Use ruler and compasses to construct a triangle with sides 6 cm, 8 cm and 9 cm.

(Total for Question E3 is 2 marks)



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- E4** Shade the region of points less than 3 cm from A and nearer A than B

$\dot{A}$

$\dot{B}$

(Total for Question E4 is 3 marks)

- E5** (a) Use ruler and compasses to construct the perpendicular from P to the line.

$\dot{P}$

(2)

- (b) Measure the distance from P to the line.

.....

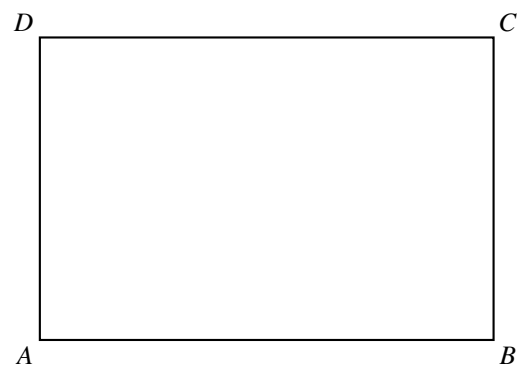
(1)

(Total for Question E5 is 3 marks)

- E6** $ABCD$ is a garden 6 m by 4 m (1 cm to 1 m). A sprinkler at the centre waters everything within 2 m of it.

Shade the watered region. Which walls does the water reach?

.....



(Total for Question E6 is 3 marks)



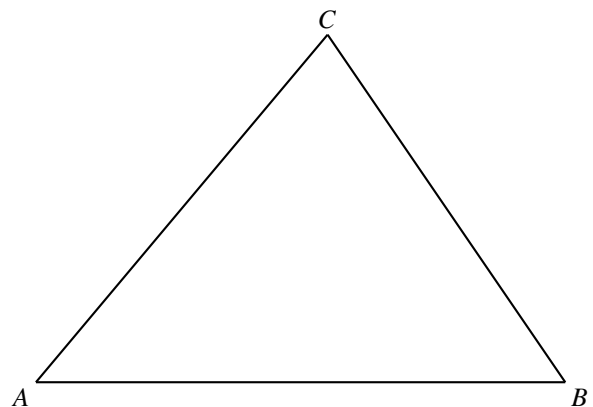
HIGHER*Higher tier only*

- E7** Draw the locus of points 1 cm outside the rectangle.



(Total for Question E7 is 3 marks)

- E8** Shade the points inside triangle ABC that are nearer AB than AC and less than 4 cm from A



(Total for Question E8 is 3 marks)

- E9** Use congruent triangles to prove that the construction of the perpendicular from a point to a line gives a line at right angles to it.

(Total for Question E9 is 4 marks)



E10 A and B are 10 cm apart. P and Q are the two points that are 13 cm from A and 13 cm from B

(a) Work out the distance PQ

.....

(2)

(b) Explain why $APBQ$ is a rhombus, and work out its area.

.....

(3)

(Total for Question E10 is 5 marks)

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