Constructions and loci

G2 · Geometry and measures · revision notes

Constructions are accurate drawings made with a ruler and compasses, and a locus is the set of points that follow a rule. You construct bisectors, perpendiculars and triangles, and shade regions that satisfy several conditions, leaving all your construction arcs showing.

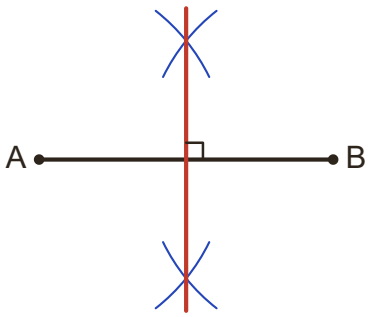
Key facts

- Equidistant from two points → perpendicular bisector
- Equidistant from two lines → angle bisector
- Fixed distance from a point → circle
- Fixed distance from a line segment → two parallel lines with semicircular ends
- Shortest distance from a point to a line → the perpendicular
- 60°: equilateral triangle; 30°: bisect 60°; 45°: bisect 90°

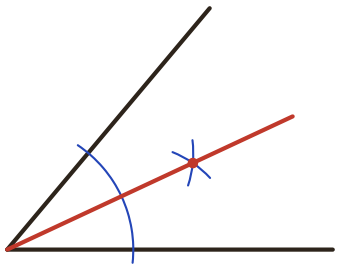
Notes

Standard constructions

- **Perpendicular bisector of AB**: open the compasses to more than half of AB. Draw arcs from A and from B, with the same radius, above and below the line. Join the two points where the arcs cross.
- **Angle bisector**: draw an arc centred on the vertex, crossing both arms. From each crossing point, draw arcs of the same radius that meet. Join the vertex to where they meet.



Perpendicular bisector



Angle bisector

Leave all your construction arcs showing.

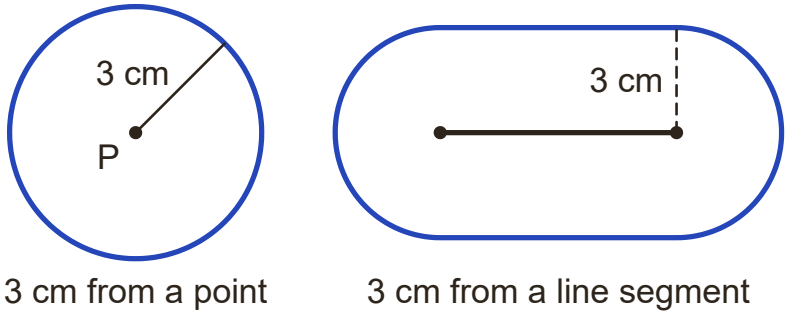
- **Perpendicular from a point P to a line**: draw an arc centred on P that crosses the line twice. From these two points, draw equal arcs that meet on the other side of the line. Join P to where they meet.
- **Perpendicular at a point P on a line**: draw arcs centred on P crossing the line on both sides, then construct the perpendicular bisector of those two points.
- The perpendicular distance from a point to a line is the **shortest distance** from the point to the line.
- An equilateral triangle gives 60°; bisecting it gives 30°. Bisecting a right angle gives 45°.

Constructing triangles

- SSS: draw one side with a ruler. Set the compasses to each of the other two lengths and draw arcs from the ends of that side. Join both ends to where the arcs cross.
- SAS and ASA: use a ruler for the sides and a protractor for the angles.

Loci

- A **locus** is the set of all points that obey a rule.
- A fixed distance from a point: a circle.
- A fixed distance from a line segment: two parallel lines joined by a semicircle at each end.



The locus is drawn in blue.

- Equidistant from two points: the perpendicular bisector. Equidistant from two lines: the angle bisector.
- Closer to A than to B: the side of the perpendicular bisector that contains A. Less than 3 cm from a point: inside a 3 cm circle.
- With several conditions, draw each locus, then shade the region where all of them are true.

How to answer each type of question

M = method mark, A = answer mark, B = a mark on its own.

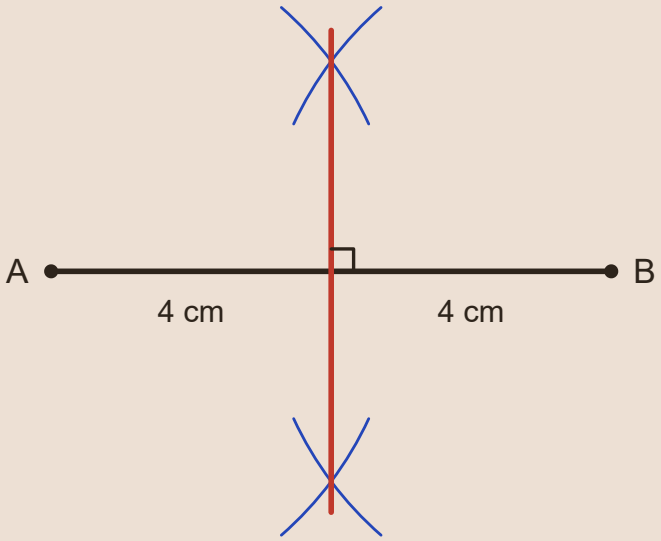
Use ruler and compasses only to construct a bisector

2 marks | Grade 4

1. Set the compasses to more than half the length of the line (or any suitable radius for an angle).
2. Draw both pairs of arcs without changing the compass width.
3. Draw the bisector through the crossing points, leaving all arcs visible.

Example. Draw a line AB 8 cm long.
Use ruler and compasses only to construct the perpendicular bisector of AB. You must show all your construction lines.

Model answer.



Arcs of the same radius (more than 4 cm), centred on A and on B, crossing above and below AB (M1)

A straight line through both crossing points, meeting AB at right angles 4 cm from A, with the arcs left showing (A1)

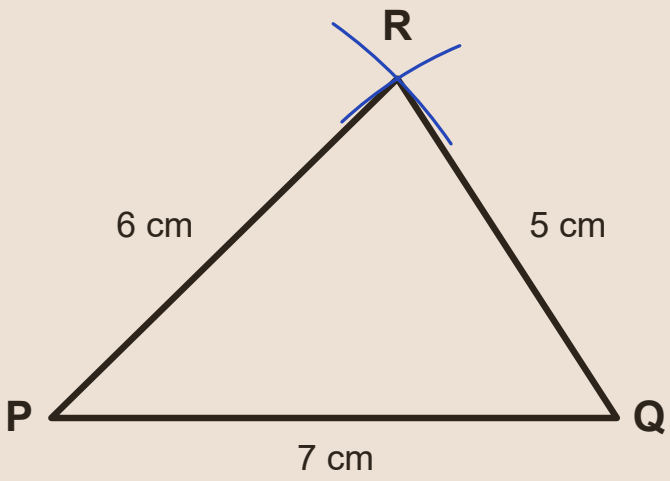
Construct a triangle

2 marks | Grade 3

1. Draw the longest side first with a ruler.
2. Draw an arc from each end with the compasses set to the other two lengths.
3. Join each end to the point where the arcs cross.

Example. Use ruler and compasses to construct triangle PQR with PQ = 7 cm, QR = 5 cm and PR = 6 cm. You must show all your construction lines.

Model answer.



PQ drawn 7 cm long, with an arc of radius 6 cm centred on P and an arc of radius 5 cm centred on Q (M1)

R at the point where the arcs cross, joined to P and Q, all sides accurate to within 2 mm (A1)

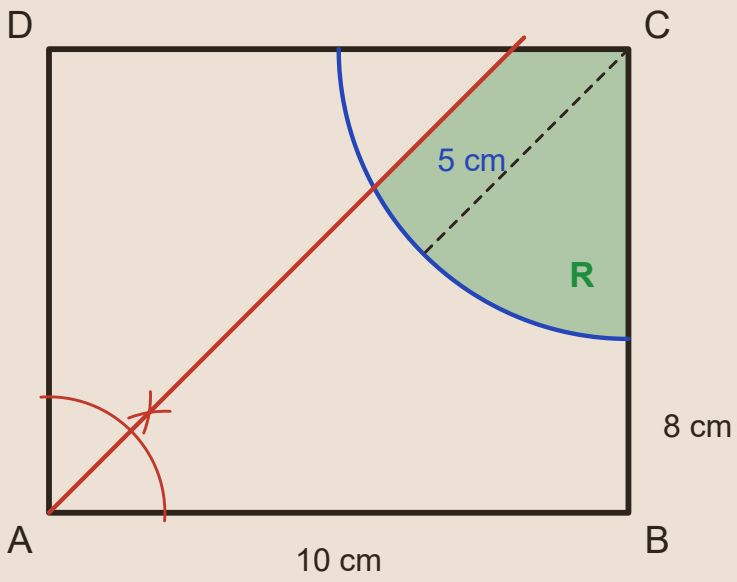
Loci: show the region by shading

3 marks | Grade 5

1. Turn each condition into a locus: a circle, a perpendicular bisector or an angle bisector.
2. Construct each locus accurately on the diagram (using the scale).
3. Shade only the region where every condition is true, and label it.

Example. A rectangular garden ABCD has AB = 10 m and BC = 8 m. A scale drawing uses 1 cm to represent 1 m. A tree is to be planted closer to AB than to AD, and less than 5 m from C.
On a scale drawing, show by shading the region where the tree can be planted.

Model answer.



Rectangle drawn 10 cm by 8 cm; bisector of angle DAB constructed with compasses (M1)

Arc of radius 5 cm centred on C (M1)

Region shaded inside the garden, inside the arc and on the AB side of the angle bisector (the bisector cuts off the part of the arc nearer AD) (A1)

Don’t lose marks

- Rubbing out construction arcs; without them the construction scores no marks.
- Using a protractor when the question says 'ruler and compasses only'.
- Setting the compasses to less than half the line, so the arcs do not cross.
- Drawing a full circle when the locus is limited by a boundary such as a wall or the edge of a garden.
- Shading the wrong side of a bisector.

More tips

Memory tricks

- Keep the compass width the same for each pair of arcs.
- Check a perpendicular bisector afterwards: it should cut the line exactly in half at 90°.
- 'Closer to' means a bisector; 'within' or 'less than' a distance from a point means inside a circle; 'at least' means outside it.
- Test one point in your shaded region against every condition before you finish.

Exam technique

- 'Use ruler and compasses' means every construction arc must be visible in your answer.
- Use a sharp pencil and compasses that do not slip; accurate work is only allowed an error of about 2 mm or 2°.
- Read each condition carefully: 'less than', 'at least', 'closer to' and 'equidistant from' mean different regions.
- Label the required region (e.g. with R) as well as shading it.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Construct triangles from given sides and angles**
Use a ruler and protractor for SAS and ASA, and a ruler and compasses for SSS.

Grade 4 — **Construct the perpendicular bisector of a line**
Draw arcs of equal radius from each end, then join the two points where they cross.

Grade 4 — **Construct the bisector of an angle**
Draw an arc from the vertex, then equal arcs from where it crosses the arms, and join to the vertex.

Grade 5 — **Construct perpendiculars from and at a point**
Construct the perpendicular from a point to a line, or at a point on a line, with compasses.

Grade 5 — **Draw loci and shade the required region**
Combine loci such as 'within 3 cm of A' and 'closer to B than to C', then shade where all are true.

Grade 5 — **Solve loci problems on scale drawings**
e.g. show where a tree can be planted in a garden, using a scale drawing and constructions.

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