Compass and straightedge constructions

Junior Cycle · Higher Level

Understand the idea

How to start

A construction uses geometric steps and visible compass arcs to locate points accurately.

1. Read the given lengths and angles before drawing.
2. Keep the compass opening fixed whenever equal distances are needed.
3. Leave the arcs visible and label the completed figure.

Key terms & definitions

Bisect
Divide into two equal parts.

Locus
The set of points satisfying a condition.

Construction arc
A compass mark showing equal distances.

Key ideas

• Use a sharp pencil, compass and straightedge. Leave construction arcs visible so your method can be seen.

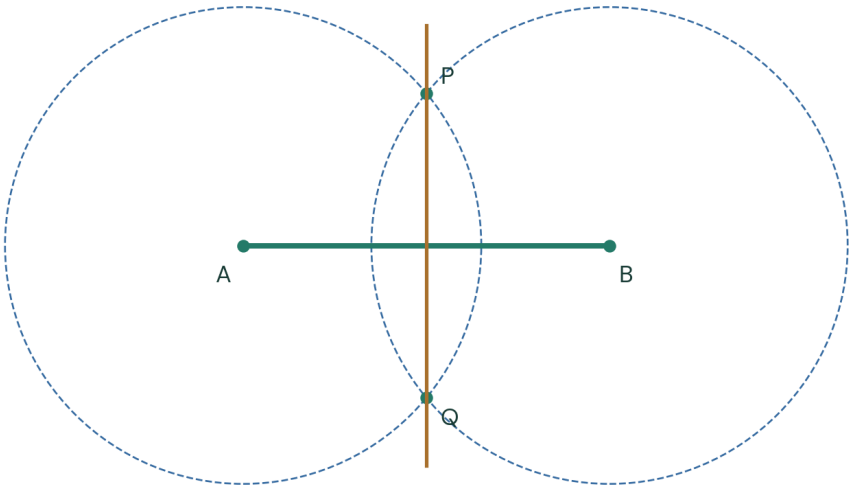
• A perpendicular bisector uses equal-radius arcs from both endpoints; join the arc intersections.

• An angle bisector uses an arc from the vertex, then equal-radius arcs from its two intersections with the arms.

• For a perpendicular from a point to a line, create two points on the line equally distant from the given point; join the given point to the second arc intersection.

• To divide a segment into equal parts, mark equal steps on an auxiliary ray and use parallel lines.

• Construct triangles from sufficient measurements; distinguish SSS, SAS, ASA and RHS. An SSA description can be ambiguous.



Perpendicular bisector: equal-radius arcs from A and B meet at P and Q. Line PQ bisects AB at a right angle.

All 15 construction methods

01 · Bisect an angle

Draw an arc from the vertex crossing both arms. From those two crossing points, draw equal-radius intersecting arcs inside the angle. Join the vertex to their intersection.

02 · Bisect a segment at right angles

From both endpoints draw arcs of the same radius, greater than half the segment, above and below it. Join the two arc intersections.

03 · Perpendicular from a point off a line

Centre an arc at the point and cross the line twice. Use equal-radius arcs from those crossings to locate a second point equidistant from them. Join it to the original point.

04 · Perpendicular at a point on a line

Mark two points on the line equally far from the given point. Draw equal-radius arcs from them to meet off the line. Join their intersection to the given point.

05 · Parallel through a given point

Draw a transversal through the point crossing the original line. Copy the corresponding angle at the point using compass arcs, or use a ruler and set square. Extend the new line.

06 · Divide a segment into two or three equal parts

For halves, use its perpendicular bisector. For thirds, mark three equal compass steps on an auxiliary ray from one end, join the third mark to the far end, then draw parallels through the other marks.

07 · Divide into any chosen number of equal parts

Mark the required number of equal steps on an auxiliary ray. Join the last mark to the far endpoint. Draw lines parallel to this join through the earlier marks; their crossings divide the original segment equally.

08 · Mark a given length on a ray

Place the ruler zero at the ray endpoint, mark the stated distance along the ray and label the new endpoint. A compass can transfer an existing segment.

09 · Draw a given angle

Place the protractor centre at the vertex, align zero with the given ray, mark the required degree value and draw the second ray through the mark. Check which scale starts at zero.

10 · SSS triangle

Draw one side. From its endpoints draw arcs with the other two stated side lengths. Join an arc intersection to both endpoints. Check that the given lengths can form a triangle.

11 · SAS triangle

Draw one known side, construct the stated included angle at the correct endpoint, then mark the second known side along its new arm. Join the remaining vertices.

12 · ASA triangle

Draw the given side between the two known angles. Construct the stated angle at each endpoint, on the same side of the base. Their rays meet at the third vertex.

13 · Right triangle from hypotenuse and one side

Draw the known shorter side AB. Construct a perpendicular at A. Draw an arc centred at B with radius equal to the hypotenuse. Its intersection with the perpendicular is C. Join B to C.

14 · Right triangle from a side and an acute angle

Use the known side as a base. If it is the hypotenuse, construct the given acute angle at one end and its complementary angle at the other. If it is a leg, construct the right angle at its right-angle endpoint and the known or complementary angle at its other endpoint. Join the ray intersection.

15 · Rectangle from side lengths

Draw one side. Construct perpendiculars at both ends on the same side of the base. Mark the second side length on both perpendiculars and join the two new points.

Quick reminder

- Use the stated instruments.
- Equal compass radii create equal distances.
- Leave the construction arcs visible.

Worked examples

Example 01 · Construct an SSS triangle

Construct a triangle ABC with AB $= 6$ cm, AC $= 5$ cm and BC $= 4$ cm.

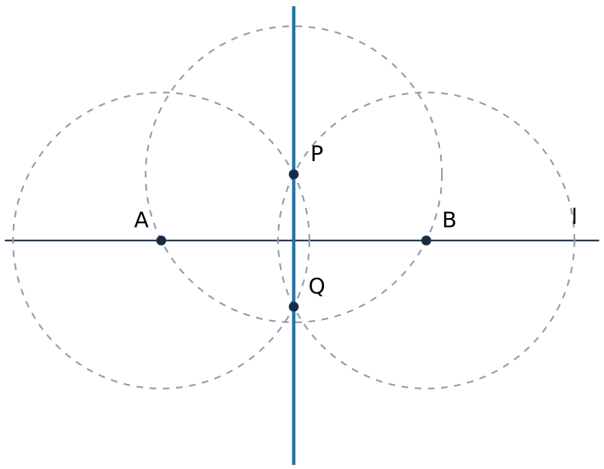
Why this method?

Identify the distances or angles that must be equal. Use the construction marks to show why the final line or point is correct.

Draw AB of length 6 cm.	**Step 1** Draw the base
Draw an arc centred at A with radius 5 cm.	**Step 2** Use the distance from A
Draw an arc centred at B with radius 4 cm. Name an intersection C.	**Step 3** Use the distance from B
Join A to C and B to C. Leave the arcs visible; either mirrored intersection gives a congruent triangle.	**Step 4** Complete and check

Example 02 · Constructions 3 and 7

Construction 3 : in a coordinate model, l is $y = 0, A = (-6, 0), B = (6, 0),$ and $P = (0, 3)$. A circle centred at P passes through A and B. Equal-radius circles centred at A and B, each with radius AP, meet at P and again at Q. Choose the final line through P perpendicular to l, with its equal-distance reason.



Keep equal-radius construction arcs visible.

Construction 3 solution. Not to scale; dashed lines are construction lines.

Why this method?

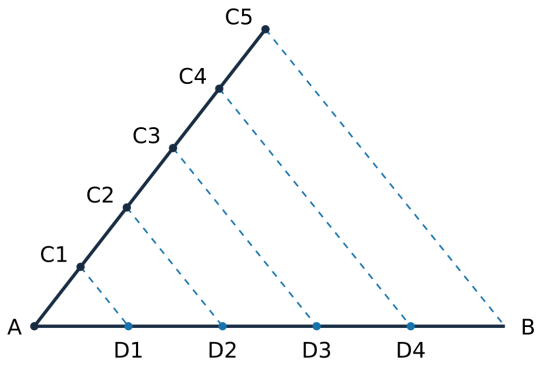
Identify the distances or angles that must be equal. Use the construction marks to show why the final line or point is correct.

PA = PB $= \sqrt{45}$.	**Step 1** Mark two points equidistant from P on l
Their other intersection is $Q = (0, -3)$. Thus QA = QB as well as PA = PB.	**Step 2** Keep the same radius for circles centred at A and B
Draw PQ. It passes through P and is perpendicular to l; retain the construction arcs.	**Step 3** Draw the final line through the two equidistant points

Think about it: Which equal lengths or parallel lines make the construction exact, rather than an estimate?

Example 03 · Constructions 3 and 7 — another example

Construction 7 : divide segment AB into 5 equal parts without measuring AB. On an auxiliary ray from A, mark $C1$ to $C5$ with equal compass steps. Join $C5$ to B. Through $C3$, draw a parallel meeting AB at $D3$. What fraction of AB is AD3?



Equal compass steps on the ray; parallel connectors.

Construction 7 solution. Not to scale; dashed lines are construction lines.

Why this method?

Identify the distances or angles that must be equal. Use the construction marks to show why the final line or point is correct.

There are 5 equal steps from A to $C5$.	**Step 1** Count equal intervals, not just interior marks
$C3D3$ is parallel to $C5B$.	**Step 2** Join the last ray mark to B and copy parallels
AD3/AB = AC3/AC5 = $\frac{3}{5}$.	**Step 3** Use the equal intercepts

Common mistake

Erasing the compass arcs after finishing a construction. The arcs show how the required point or line was found. Leave the useful construction marks visible; do not replace the method with a measured guess.

Exam technique

Check measurements afterwards, but use the prescribed construction method rather than measuring every angle.

Try it yourself

Work on paper before checking the answers at the end. These questions are for self-checking, not submitted homework.

Question 1

Construction 3 : in a coordinate model, l is $y = 0, A = (-3, 0), B = (3, 0),$ and $P = (0, 3)$. A circle centred at P passes through A and B. Equal-radius circles centred at A and B, each with radius AP, meet at P and again at Q. Choose the final line through P perpendicular to l, with its equal-distance reason.

A. Change the second compass radius and join the new intersection to P: unequal radii still guarantee a perpendicular bisector.

B. Join P to A: any radius of the circle centred at P is perpendicular to l.

C. Join A to B: AB is perpendicular to l because A and B lie on l.

D. Join P to Q: both P and Q are equidistant from A and B, so PQ is the perpendicular bisector of AB.

Watch an explanation

Corbettmaths — Constructions: perpendicular bisector

Corbettmaths — Constructions: angle bisector

Corbettmaths — Constructions: triangles SSS

Corbettmaths — Constructions: perpendicular to point

Open the website chapter to load the embedded players. Use the rates and rules in your question for financial examples.

Self-check answers

Question 1

Join P to Q: both P and Q are equidistant from A and B, so PQ is the perpendicular bisector of AB.

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