Geometric constructions

Extension material for Level 1 Design and Visual Communication Study Guide

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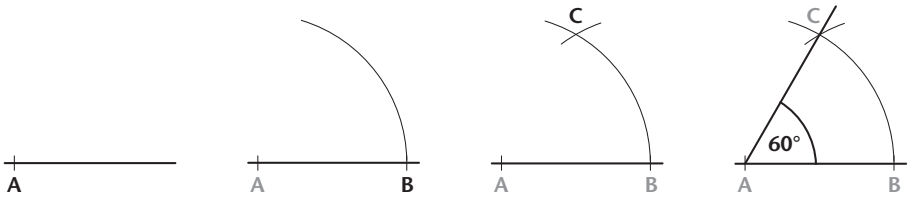
Construction of angles

In Graphics, **construction** means to use **geometric** methods for drawing angles, perpendiculars, parallel lines, etc, rather than using protractors, set-squares, T-squares and circle guides. Geometric methods generally involve the use of compasses.

Constructing a 60-degree angle from a point on a line

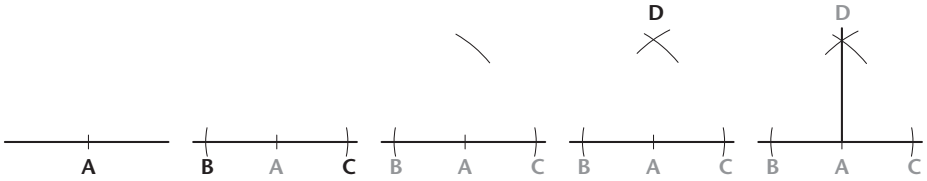
1. Draw a construction line with a point on it – A.
2. With centre A and any radius, draw an arc to cut the line at B.
3. With centre B and the same radius, draw another arc to cut the first arc at C.
4. Join AC. Angle CAB is 60 degrees.



Constructing a 60-degree angle

Constructing a 90-degree angle from a point on a line

1. Draw a construction line with a point on it – A.
2. With centre A and any radius, arcs to cut the line at B and C.
3. With centre B and radius more than half of BC, draw an arc.
4. With centre C and the same radius, draw an arc to cross the first arc at D.
5. Join DA.



Constructing a 90-degree angle

Bisecting an angle

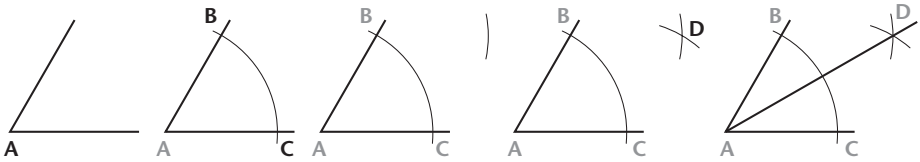
1. Draw the angle at **A**.

2. With centre **A** and any radius, draw an arc to cut the arms of the angle at **B** and **C**.

3. With centre **B** and radius of more than half **BC**, draw an arc.

4. With centre **C** and the same radius, draw an arc to cross this arc at **D**.

5. Join **AD**.



Bisecting an angle

Other angles

Using the technique of bisection, angles of 15°, 7.5°, and 22.5° can be obtained and angles of 52.5°, 37.5° and 82.5° can be 'built up'.

Activity A: Constructing angles

Construct the following angles:

1. 60°	**2.** 30°	**3.** 15°	**4.** 7.5°
5. 22.5°	**6.** 52.5°	**7.** 37.5°	**8.** 82.5°

Drawing a perpendicular from a line

A **perpendicular** line is one at an angle of 90 degrees from another, so the procedure for raising a perpendicular is the same as for constructing a 90-degree angle (see bottom figure in the previous page).

Constructing a perpendicular from a point to a line

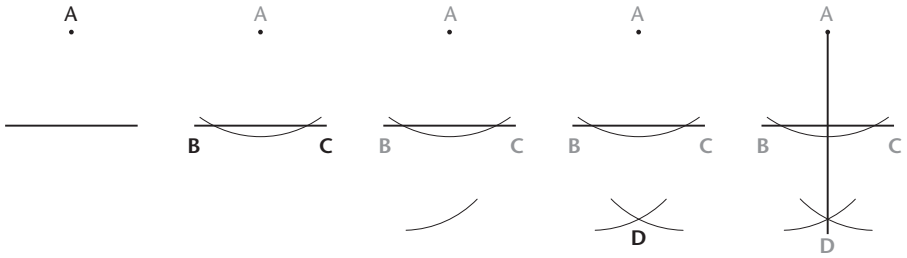
1. Draw the line and the point **A**.

2. With centre **A**, draw an arc of sufficient radius to cut the line in two places, **B** and **C**.

3. With centre **B**, and radius more than half **BC**, draw an arc.

4. With centre **C**, and the same radius, draw an arc to cross at **D**.

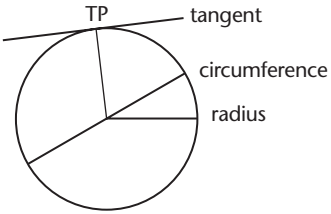
5. Join **AD**.



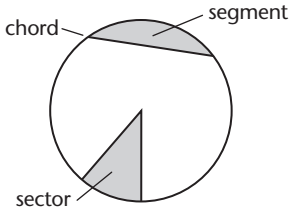
Constructing a perpendicular from a point to a line

Circle Geometry

- **Circumference** – the perimeter of the circle.
- **Diameter** – the width of the circle through the centre point.
- **Radius** – the distance between the centre and the circumference.
- **Tangent** – a line which touches the circle at only one point. The tangent is perpendicular to the radius at this point. The point where the tangent touches is called the **TP** (tangent point).
- **Arc** – part of the circumference.
- **Chord** – a straight line from one part of the circumference to another.
- **Segment** – the area bounded by a chord and an arc.
- **Sector** – the area bounded by two radii and an arc.



Circumference, diameter, radius, tangent



Arc, chord, sector and segment

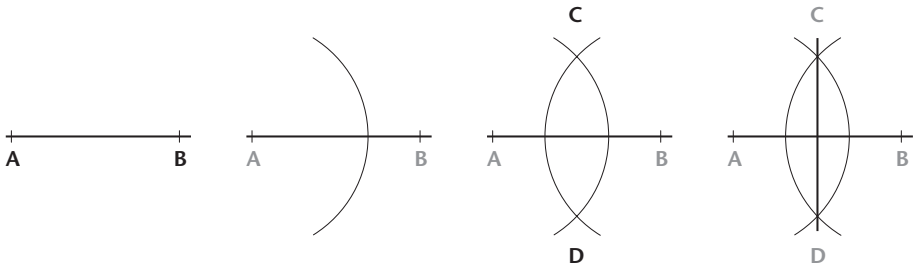
Bisecting a line

1. Draw the line and two points, **A** and **B**.

2. With centre **A** and radius more than half of **AB**, draw an arc.

3. With centre **B** and the same radius, draw another arc to cross at **C** and **D**.

4. Draw the line **CD**.



Bisecting a line

Finding the centre of an arc

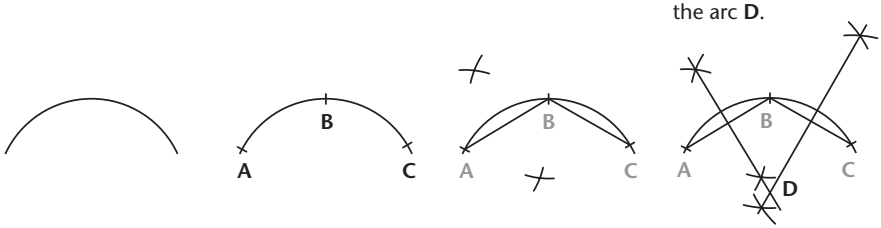
1. Draw the arc.

2. Put three widely-spaced points on the arc; **A**, **B** and **C**.

3. Join the points.

4. Bisect **AB** and **BC**.

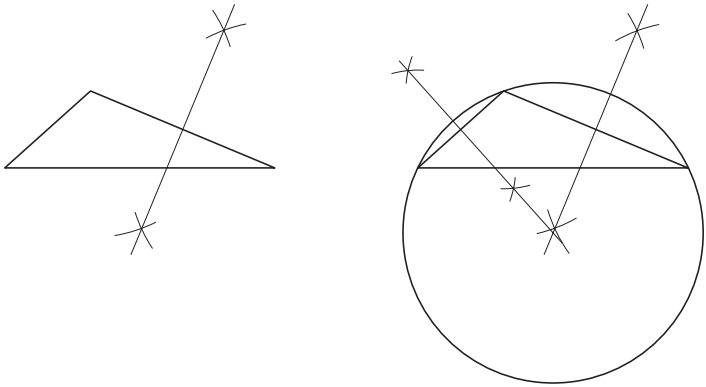
5. Project perpendiculars from the midpoints of **AB** and **BC**. Where they meet is the centre of the arc **D**.



Finding the centre of an arc

Drawing the circumscribed circle around a triangle

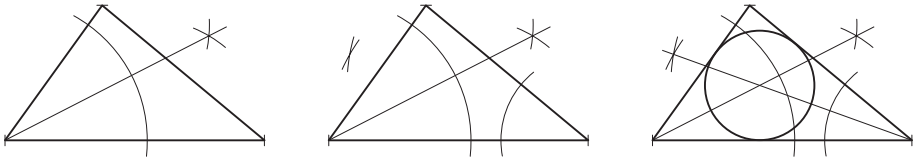
To draw the centre of a circle touching all three corners of a triangle, bisect two of the sides – where the perpendiculars from these points meet is the centre of the circle.



Circumscribed circle around a triangle

Drawing the inscribed circle inside a triangle

Bisect two of the angles of the triangle, and where the bisectors meet is the centre of the inscribed circle.



Inscribing a circle inside a triangle

Dividing a line into any number of equal parts

The following example shows how to divide a line into three equal parts.

1. Draw the line **AB**.

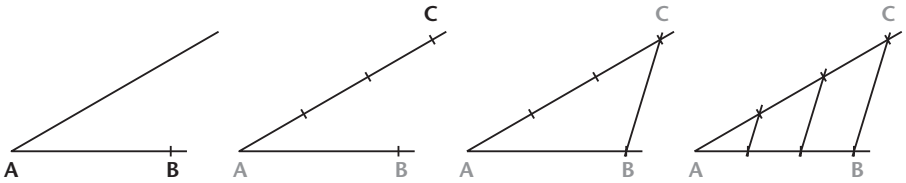
2. Draw a line at any angle from **A**.

3. With the compass, 'step out' three equal steps, approximately the size of the part expected, to **C**.

4. Join **CB**.

5. Draw lines parallel to **CB** at each step to cross the original line **AB**.

6. The line **AB** has now been divided into three equal parts without having been measured.



The same procedure is followed no matter how many parts are desired.

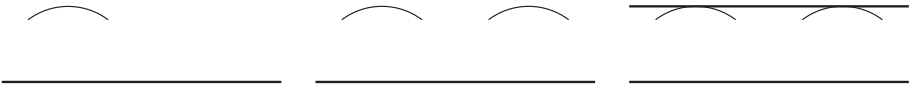
Dividing a line into equal parts

Constructing a parallel line 10 mm from a given line

1. Set the compass to 10 mm and draw an arc from near one end of the line.

2. Repeat near the other end of the line.

3. Join the tops of the arcs.



Constructing parallel lines

Rounds and fillets

Rounds and **fillets** are the rounded corners of an object.

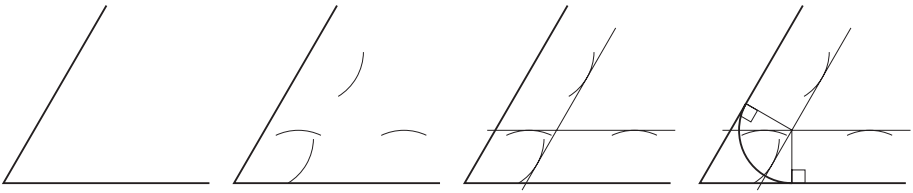
To draw a curve of given radius 10 mm within an angle:

1. Draw the angle.

2. Construct parallel lines 10 mm away from each arm of the angle.

3. Where the parallel lines intersect is the centre of the curve.

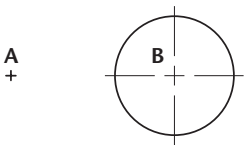
4. Draw the arc.



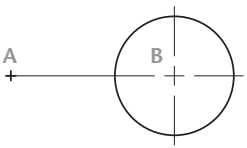
Constructing centres of rounds and fillets

Construction for a tangent to a circle from a point

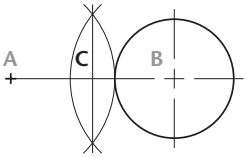
1. Draw the circle with centre **B** and the point **A**.



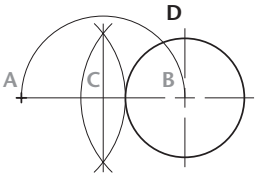
2. Join **AB**.



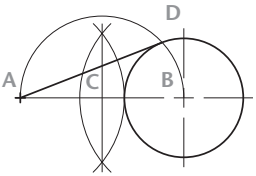
3. Bisect **AB** to get **C**.



4. With centre **C** and radius **CA**, draw a semicircle crossing the circle at **D**.

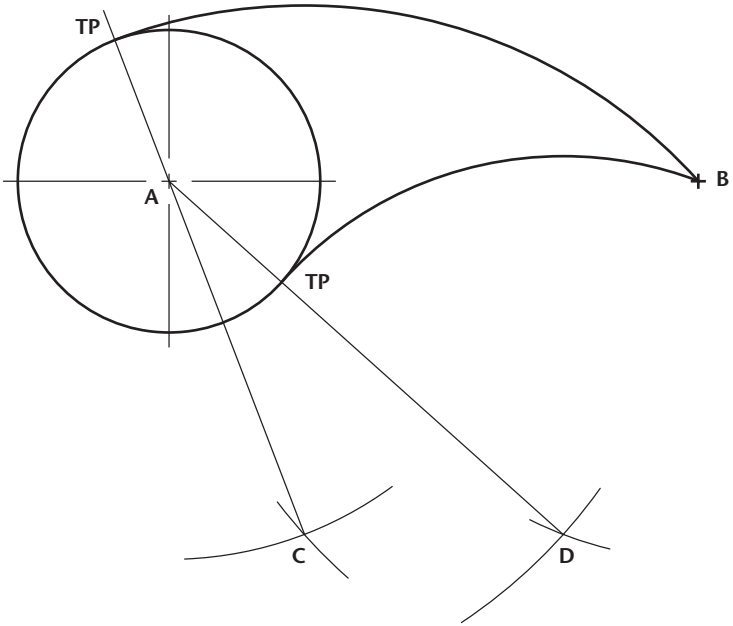


5. Join **AD**.



Constructing a tangent to a circle from a point

Frequently, it is necessary to draw figures consisting of arcs and tangents. Fig. 6.15 is a simple example of arcs and tangent construction.



Arcs and tangent construction

The circle, centre **A**, has a radius of 20 mm. The upper curve has a radius of 70 mm and the lower curve has a radius of 50 mm. **A** and **B** are 70 mm apart.

Only well-defined points can be used, so the arcs are constructed from the centre of the circle (i.e. from **A**) and from the point **B**.

To obtain the upper curve:

- With centre **A** and radius 70–20 mm (i.e. 50 mm), draw an arc.
- With centre **B** and radius 70 mm, draw an arc to cut the first arc at **C**.
- Join **CA** and project to the circumference and extend through the circle to locate the tangent point, **TP** (where the 70 mm curve will meet the 20 mm circle).
- With centre **C** and radius 70 mm, draw an arc from **TP** to **B**.

To obtain the lower curve

Only clearly defined points can be used to draw arcs from. The centre of the circle, **A**, is such a point. The centre of the lower curve is more than 50 mm away from **A**. It is 50 mm to the circumference of the circle and another 20 mm to **A** itself. So, with centre **A** and radius 50 + 20 mm (the radius of the circle, centre **A**, needs to be added to 50 mm), draw an arc.

- With centre **B** and radius 50 mm, draw an arc to cut the first arc at **D**.
- Join **DA** to locate the tangent point.
- Draw the arc of 50 mm from **D** to complete the figure, being careful to stop at the **TP** to avoid a 'tail'.

Activity B: Geometric construction

1. Sketch some angles of any size and bisect them using your compass.
2. Sketch some arcs and find the centres by geometric means. Check with your compass to see how accurate you were.
3. Draw a line of any length and divide it geometrically into three parts. Check with a ruler to see how accurate you were.
4. Can you think of a different way to geometrically divide a line into four parts?