

Competency B-11

Solve Problems Involving Angles, Triangles and Geometric Constructions

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Requirements

Learning Tasks

This optional learning guide will be useful to you if you plan to specialize in the Construction, Electrical or Mechanical trades. For example, you will need to understand angles and triangles for site or sheet metal layouts and for building circular stairs. The principles involved in the right angle triangle (or 3:4:5 triangle) are very important in checking for the squareness of your constructions. Carpenters will apply the process of constructing a perpendicular to a line to lay out in full scale the location of a wall. Finding the centre of a circle will be useful if you need to drill a hole in the centre of a given disc.

You will need a protractor, compass and straightedge to complete the learning tasks in this competency.

When you have completed the learning tasks in this competency, you should be able to:

- apply key terms and concepts involving angles,
- use a protractor for angle measurement,
- apply the principles of the 3:4:5 triangle,
- use a compass and straightedge to bisect lines, angles and arcs,
- use a compass and straightedge to construct a perpendicular to a line which passes through either a point on a line or a point not on the line, and
- use a compass and straightedge to find the centre of a circle

on the Self Test on pages 151-152 of this guide.

Competency

WRITTEN: "Solve Mathematical Problems"

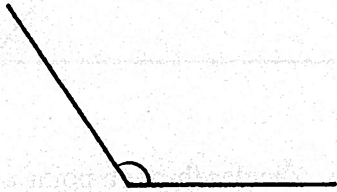
On the Written Competency at the end of Line B you will do problems involving angles, triangles and geometric constructions if you have completed this optional competency.

Pre-Test

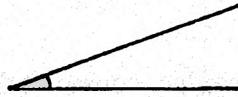
You will need a compass, a protractor and a straightedge for this test.

1. Measure the following angles. (3 marks)

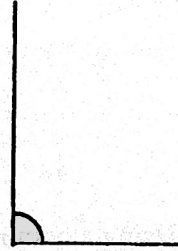
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b.

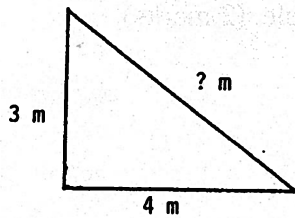


c.

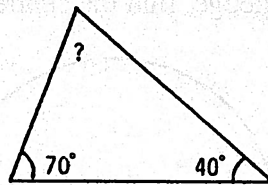


2. Calculate the missing measurements in the diagrams below. (3 marks)

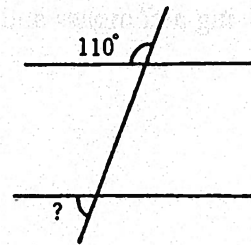
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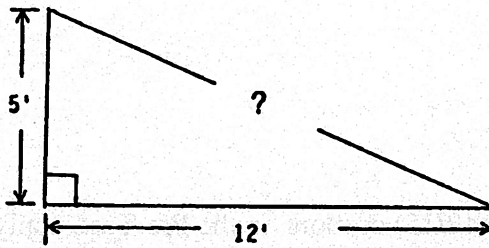
b.



c.



3. Two walls, 5' long and 12' long, meet at a corner that should be 90°. What should the distance be between the two ends of the walls? (1 mark)

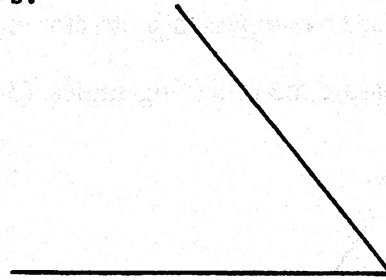


4. Using a compass and a straightedge, bisect the following. (2 marks each)

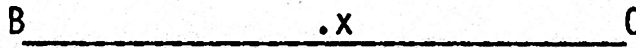
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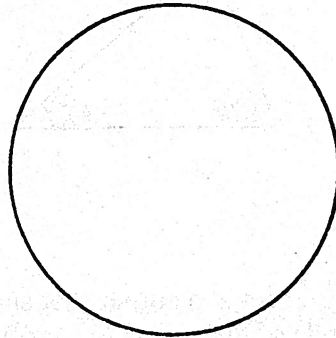
b.



5. Using a compass and straightedge, construct the perpendicular through point x on line BC. (2 marks)



6. Using a compass and straightedge, find the centre of the circle. (2 marks)



Answers are on page 154.



If you achieve 80% (12/15) or more on the Pre-Test, apply to write the Written Competency for Line B. If you achieve less than 80%, work through the sections of this guide that apply to your review needs.

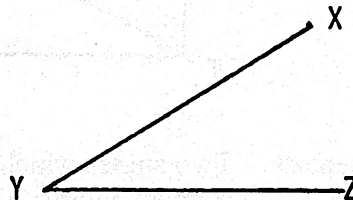
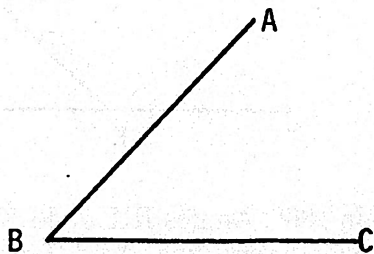
Learning Task 1: Use angles

Key Terms and Concepts

Angle: An angle is produced when a line rotates about a point. One complete rotation is 360° . The symbol " \angle " is often used to stand for "angle".

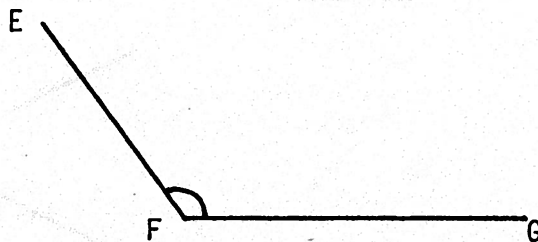
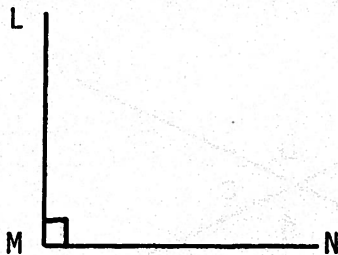
Degree: The common unit of measurement of angles, symbolized by $^\circ$. In the angle formed by one complete rotation (a circle) there are 360 degrees (360°). In a quarter rotation (a right angle) there are 90° .

Vertex: The point about which a line rotates to form an angle. In the angle ABC, B is the vertex. Note that when you name an angle using three letters, the vertex is always the middle letter. You can also name an angle with just the letter with which you have labelled the vertex. Angle ABC can be called angle B.



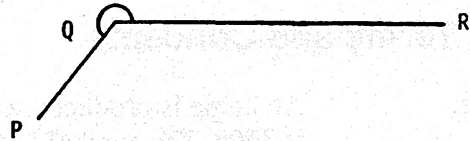
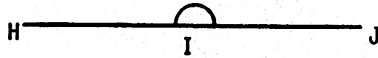
Acute Angle: An angle less than 90° . Angles ABC and XYZ are examples of acute angles.

Right Angle: An angle which contains 90° . Angle LMN is a right angle. Note that right angles are often identified by the square symbol that appears at the vertex M in $\angle LMN$.



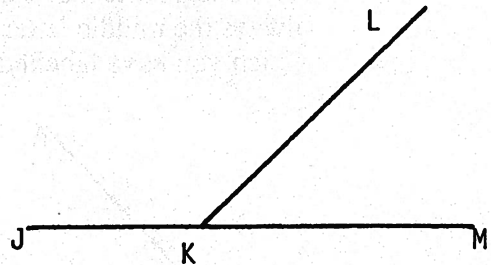
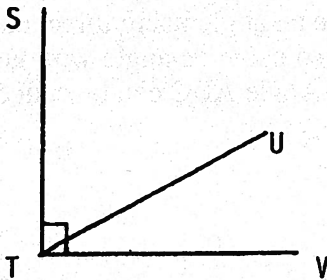
Obtuse Angle: An angle between 90° and 180° . Angle EFG is an obtuse angle. Note that angles are sometimes identified by an arc (part of a circle) at the vertex.

Straight Angle: An angle which contains 180° . Angle HIJ is a straight angle.



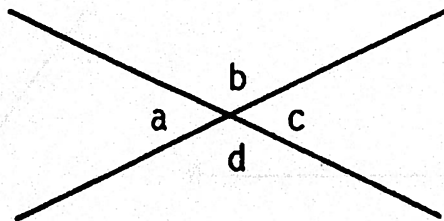
Reflex Angle: An angle between 180° and 360° . Angle PQR is a reflex angle.

Complementary Angles: Two angles which together contain 90° . Angles STU and UTV are complementary angles.



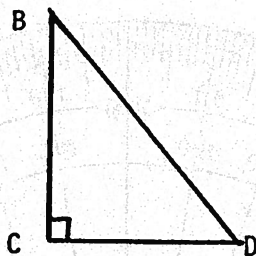
Supplementary Angles: Two angles which together contain 180° . Angles JKL and LKM are supplementary angles. One easy way to remember the difference between complementary angles and supplementary angles is that C comes before S in the alphabet, so C is "smaller" than S, just as the number of degrees in complementary angles is smaller than the number of degrees in supplementary angles.

Opposite Angles: In the two sets of angles formed by the intersection of two straight lines, the two pairs of opposite angles are equal. In the diagram below, $\angle a = \angle c$ and $\angle b = \angle d$.



Triangle: A geometric figure formed by the lines joining three angles. The three angles in a triangle always contain 180° .

Right Triangle: A triangle containing a right angle (90°). Triangle BCD is a right triangle.

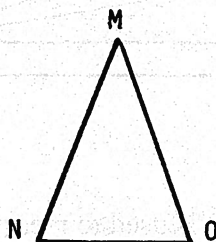
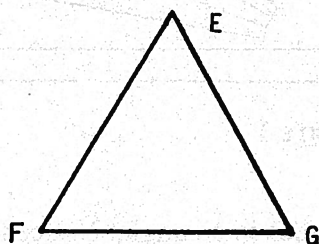


Equilateral Triangle:

A triangle in which three sides are equal and each of the three angles contains 60° . Triangle EFG is an equilateral triangle.

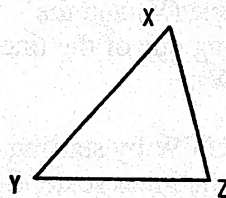
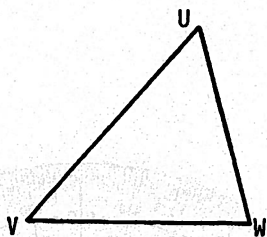
Isosceles Triangle:

A triangle in which two sides are equal and two angles are equal. Triangle MNO is an isosceles triangle.



Similar Triangle:

Two triangles which contain angles of the same size, but have sides of different lengths. Triangles UVW and XYZ are similar triangles.



Using a Protractor

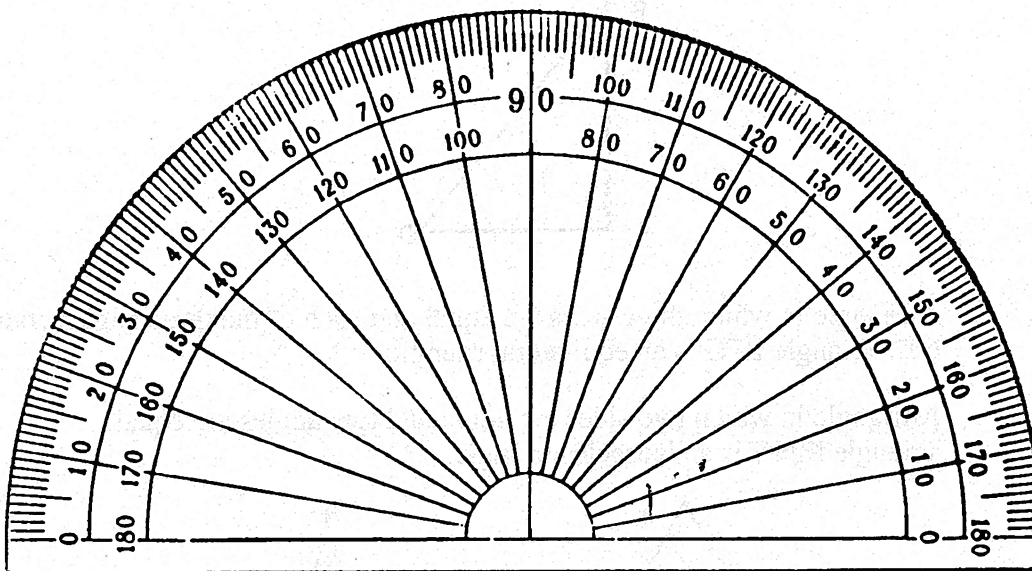
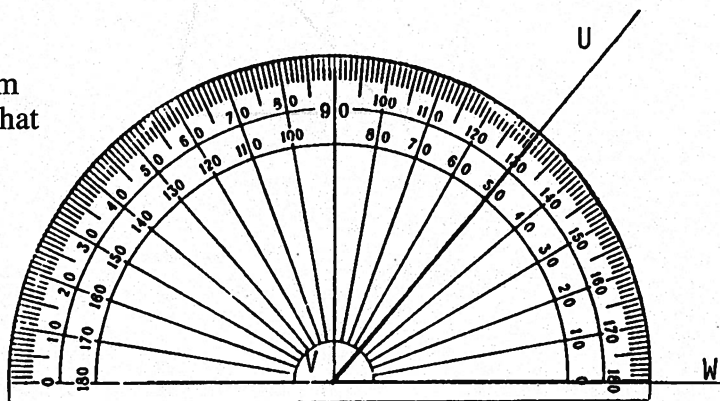


Figure 1

The protractor (Figure 1) is used to measure degrees in an angle. Notice that the protractor has scales, one on the outside and one on the inside. Both of them range from 0° to 180° . You can use either one of them, depending on the direction of angle rotation. Remember that a straight line is always 180° and a circle, or complete rotation, contains 360° .

- Use a protractor to measure angle UVW. Place the centre of the protractor at the vertex of the angle (V) and the straightedge along one of the lines of the angle (along VW).
- Read the angle UVW by starting from UW and, using the inner scale, find that UVW is 50° .



Angles and Parallel Lines

Two straight lines are parallel when they run in exactly the same direction. Floor joists are usually laid out to run parallel, as are studs and rafters.

Figure 2 shows a stud wall with a diagonal brace. Three of the many angles formed are labelled.

Angle A and Angle B are opposite angles, so we know that they are equal. Angle B and Angle C are also equal to each other, as they are formed by the same straight line intersecting parallel lines. Therefore, Angle A and Angle C are equal, as well.

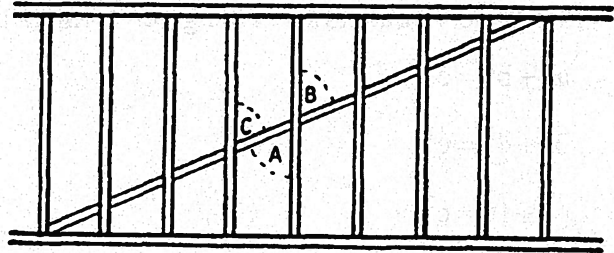


Figure 2

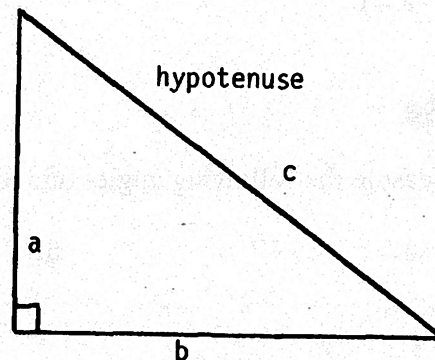
Other Units of Angle Measurement

A complete rotation contains 360° . Each degree contains 60 minutes, and each minute contains 60 seconds. The symbol ' means minutes and the symbol " means seconds. These units are not related to time, even though they use the same names as time units.

Most trade work requires accuracy only to the nearest degree. However, mechanics will require the precision that working with minutes and seconds allows when they place piston rings and work on ignition timing.

The 3:4:5 Triangle

You will recall that a right triangle contains a 90° angle. Sometimes, particularly in the construction trades, a right triangle is called a 3:4:5 triangle. The hypotenuse is the side of a right triangle opposite the right angle. It is always the longest side of the triangle. The base and the altitude (or height) of a right triangle are the names given to the other two sides of a right triangle. These terms are often used interchangeably, since it doesn't matter which is which.



The Pythagorean theorem states that in a right triangle, the square of the hypotenuse equals the sum of the squares of the other two sides, or $h^2 = a^2 + b^2$. This formula is often written $a^2 + b^2 = c^2$. It is used to find the third side of a 3:4:5 triangle when two sides are known.

Example 1: Calculate c in the following right triangle.

- Insert known quantities in the given formula and solve.

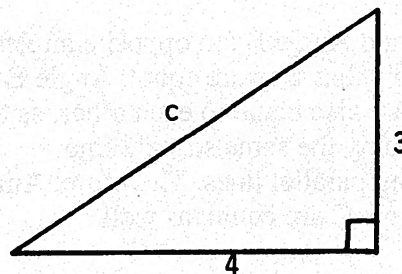
$$a^2 + b^2 = c^2$$

$$3^2 + 4^2 = c^2$$

$$9 + 16 = c^2$$

$$\sqrt{c^2} = \sqrt{25}$$

$$c = 5$$



Example 2: Calculate a in the following right triangle.

- Insert known quantities in the given formula and solve.

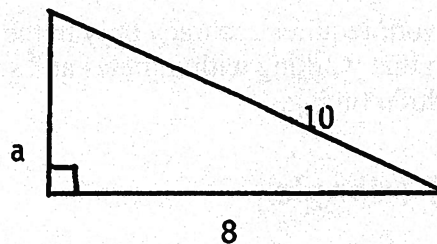
$$a^2 + b^2 = c^2$$

$$a^2 + 64 = 100$$

$$a^2 = 36$$

$$\sqrt{a^2} = \sqrt{36}$$

$$a = 6$$



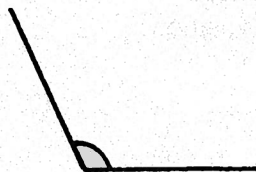
Exercise

1. Measure the following angles and identify what type of angle each is.

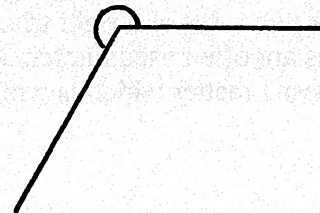
a.



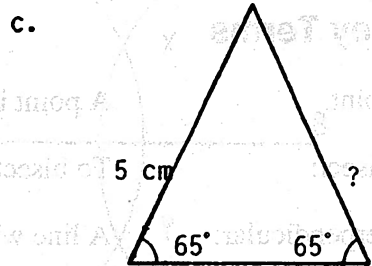
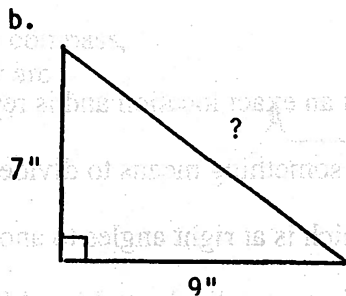
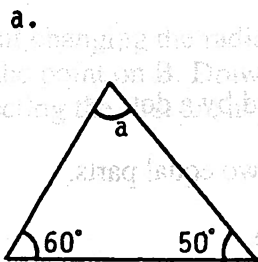
b.



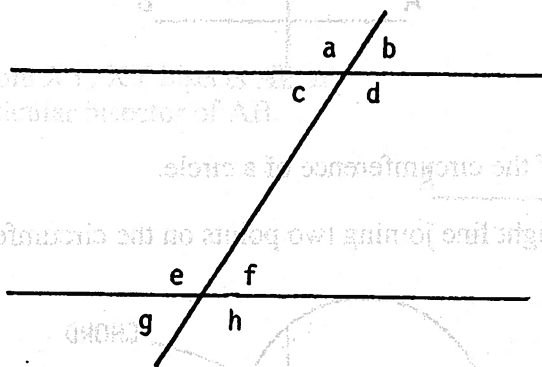
c.



2. Calculate the missing measurements in the following triangles.



3. Name two pairs of equal angles from the following diagram.

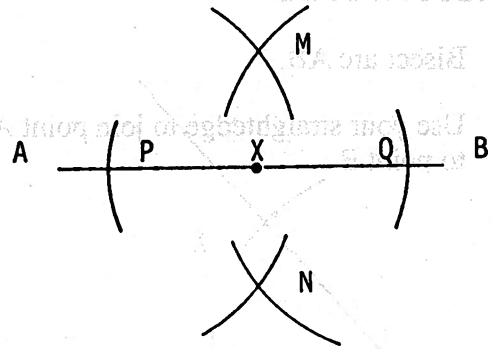


4. Guidelines for installing ceiling tiles are checked for squareness. A measurement of 6' is marked off on one wall and a measurement of 8' is marked off on the adjacent wall. If the guidelines are square, what should be the measurement of the line which joins the two marks?

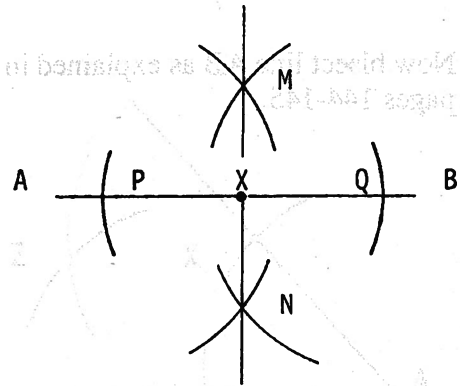
Answers

- 62° , acute
 - 115° , obtuse
 - 240° , reflex
- 70° ($60^\circ + 50^\circ + a = 180^\circ$)
 - 11.4 " ($a^2 + b^2 = c^2$; $49 + 81 = 130$; $\sqrt{130} = 11.4$)
 - 5 cm (Since the triangle is isosceles, the two sides are equal.)
- Any of the following: $\angle a = \angle d = \angle e = \angle h$; $\angle b = \angle c = \angle f = \angle g$
- 10 ' ($a^2 + b^2 = c^2$; $36 + 64 = 100$; $\sqrt{100} = 10$)

- Increase the radius of the compass. Place the point of the compass on each of P and Q in turn. Draw larger arcs above and below the line with this new radius. These arcs should intersect at two points, M above the line and N below the line.



- Using a straightedge, join MN. MN will pass through X and is perpendicular to AB.



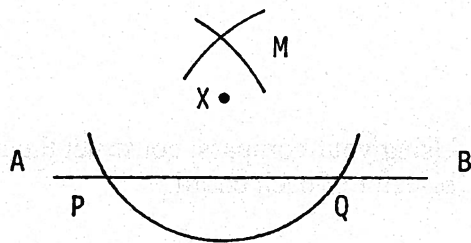
Practice constructing perpendiculars through two or three given points on a line. If you have any difficulties, consult your instructor.

Construct a Perpendicular Through a Given Point Not on a Line

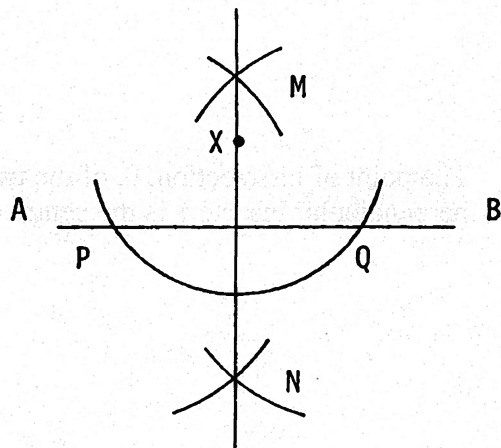
- Construct the perpendicular to line AB passing through point X.
- Place the point of the compass on X. Draw an arc that cuts AB, or its extension, at two points, P and Q. Increase the radius of the compass.



- Place the point of the compass on each of P and Q in turn and draw arcs above and below the line. These arcs should intersect at two points, M above AB and N below AB.



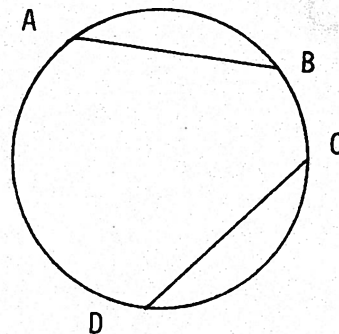
- Using a straightedge, join MN. MN will pass through X and is perpendicular to AB.



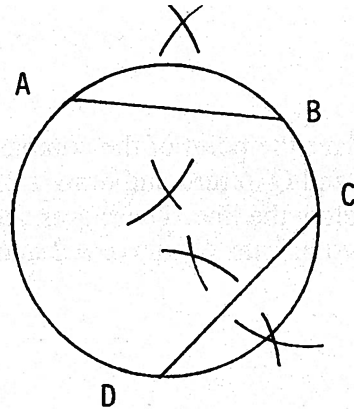
Practice constructing a perpendicular through two or three given points not on a line. If you have any difficulties, consult your instructor.

Find the Centre of a Circle

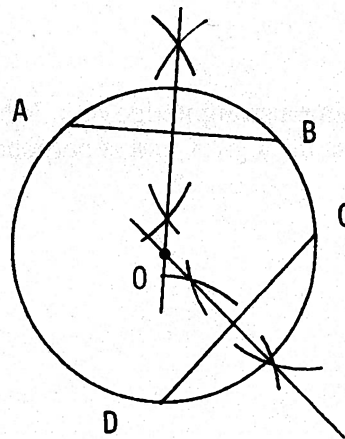
- Find the centre of the given circle.
- Draw two chords of the circle, AB and CD.



- Using your compass, construct the perpendicular bisector of each chord.



- The point of intersection, O, of the two perpendicular bisectors is the centre of the circle.



Using your compass, draw two or three circles of varying sizes and practice locating the centres. If you have any difficulty, contact your instructor.



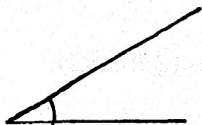
Now do the Self Test, and check your answers with the Answer Sheet on page 154.

Self Test

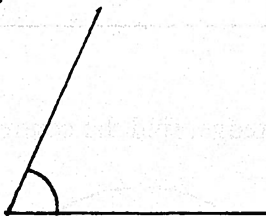
You will need a compass, protractor and straightedge for this test.

1. Measure the following angles. (3 marks)

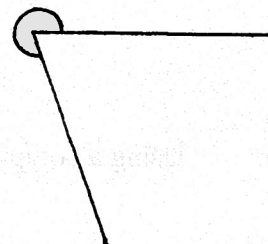
a.



b.

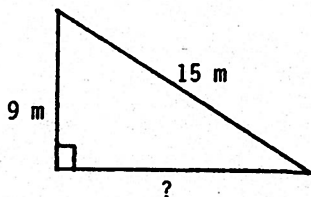


c.

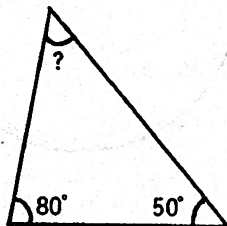


2. Calculate the missing measurements in the following figures. (3 marks)

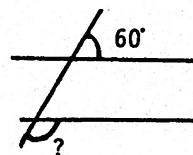
a.



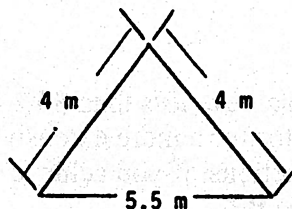
b.



c.

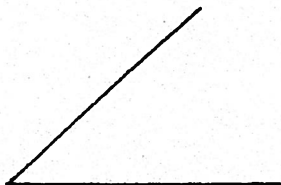


3. In checking some forms, a foreman finds that the diagonal distance between the ends of two 4 m walls is 5.5 m. Are the walls at right angles? (1 mark)



4. Using a compass and a straightedge, bisect the following. (2 marks each)

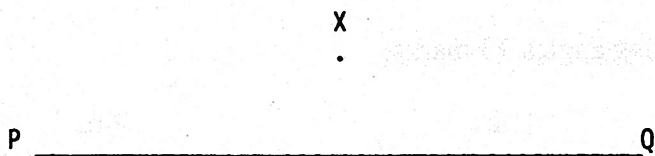
a.



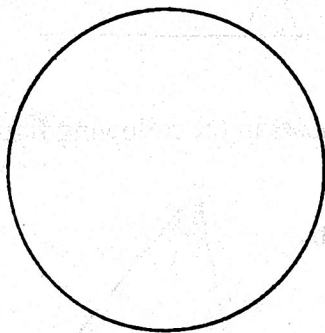
b.



5. Using a compass and straightedge, construct the perpendicular to line PQ which passes through point X. (2 marks)



6. Using a compass and straightedge, find the centre of this circle. (2 marks)



Answers are on page 154.



If you achieve less than 80% (12/15) on the Self Test, you should contact your instructor for a more extensive review of angles, triangles and geometric constructions. If you achieve 80% or more, apply to write the Written Competency for Line B.

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1962-1963

Answer Sheet

Pre-test — pages 135–136

1. a. 125° (p. 140)
b. 20° (p. 140)
c. 90° (p. 140)

2. a. 5 m (pp. 141-142)
b. 70° (p. 139)
c. 70° (p. 138, p. 141)

3. 13' (pp. 139 - 140)

4. a. page 144
b. page 146

5. page 147

6. page 149

Self Test — pages 151–152

1. a. 30°
b. 65°
c. 290°

2. a. 12 m
b. 50°
c. 120°

3. no

4. a. page 146
b. page 147

5. page 148

6. page 149