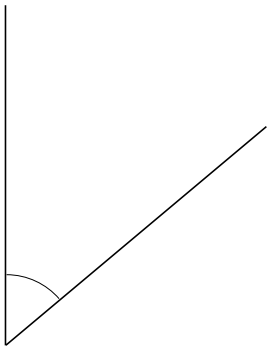
3 Angle Geometry

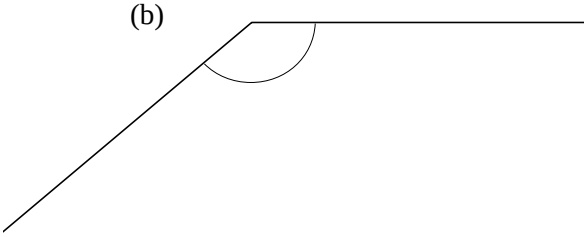
3.1 Measuring Angles

1. Using a protractor, measure the marked angles.

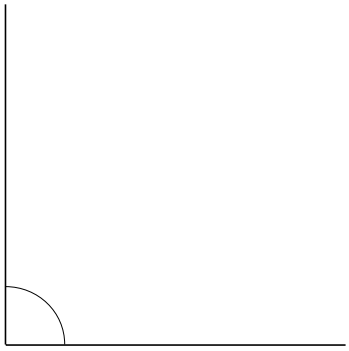
(a)



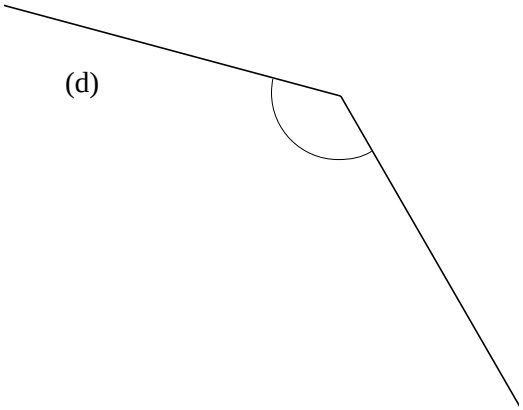
(b)



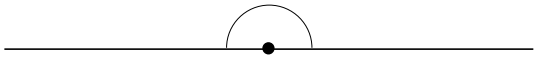
(c)



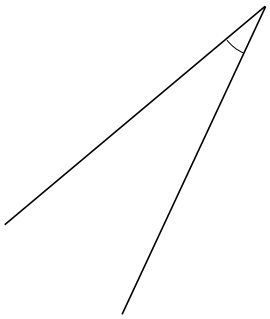
(d)



(e)



(f)

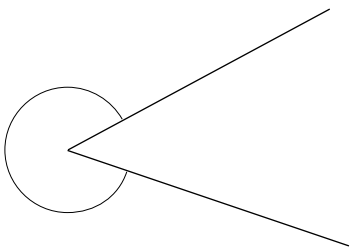


2. Draw angles with the following sizes.

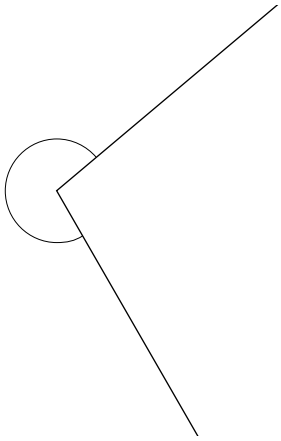
(a)	22°	(b)	75°	(c)	120°	(d)	90°
(e)	153°	(f)	45°	(g)	180°	(h)	62°

3. Measure these angles.

(a)



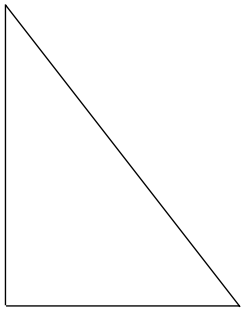
(b)

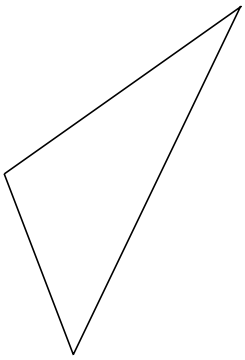


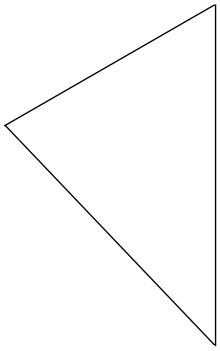
4. Draw angles with the following sizes.

   (a) 195° (b) 330° (c) 262°

5. For each triangle, measure each angle and add up the three angles obtained.

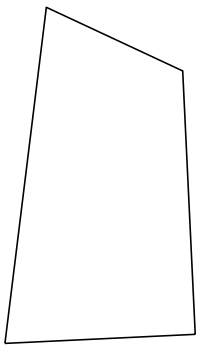
   (a) 

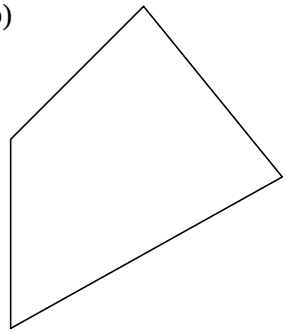
   (b) 

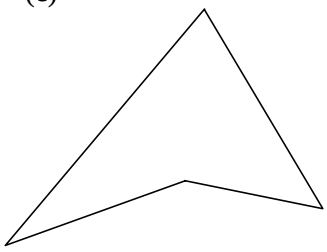
   (c) 

   What do you conclude?

6. For each quadrilateral, measure all the interior angles and find the sum.

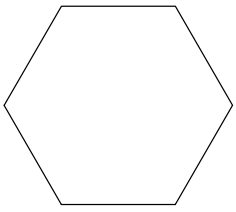
   (a) 

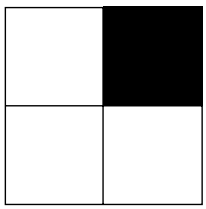
   (b) 

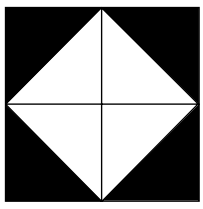
   (c) 

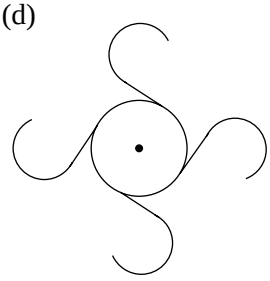
3.2 Line and Rotational Symmetry

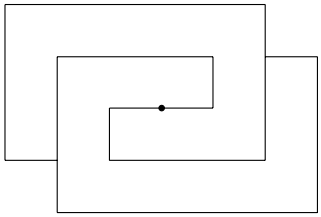
1. Copy each shape below, mark all lines of symmetry and state the order of rotational symmetry.

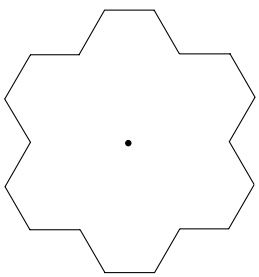
   (a) 

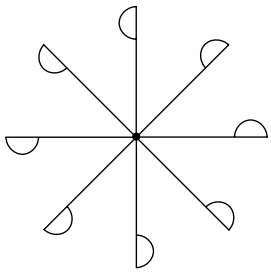
   (b) 

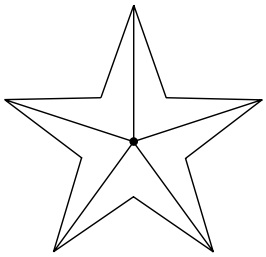
   (c) 

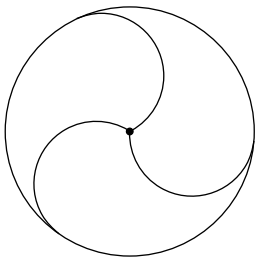
   (d) 

   (e) 

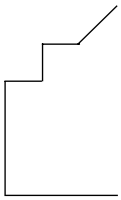
   (f) 

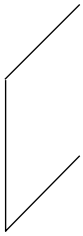
(g) 

(h) 

(i) 

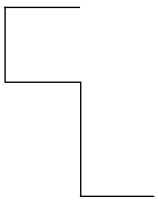
2. Copy and complete each shape below so that they have line symmetry but no rotational symmetry. Mark your lines of symmetry.

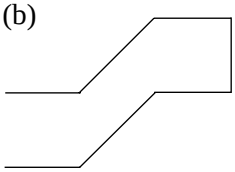
(a) 

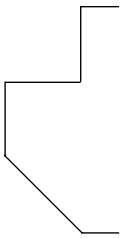
(b) 

(c) 

3. Copy and complete each shape below so that they have rotational symmetry but no line symmetry. In each case state the order of rotational symmetry.

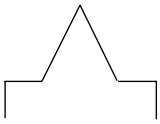
(a) 

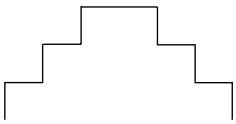
(b) 

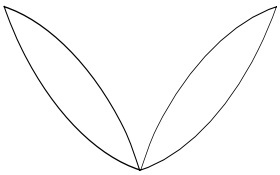
(c) 

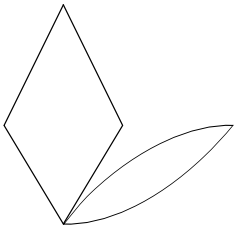
(d) 

4. Copy and complete each of the following shapes, so that they have both rotational and line symmetry. In each case draw the lines of symmetry and state the order of the rotational symmetry.

(a) 

(b) 

(c) 

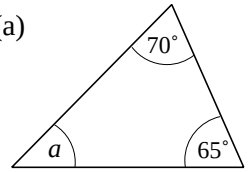
(d) 

5. Draw a shape with exactly 5 lines of symmetry.

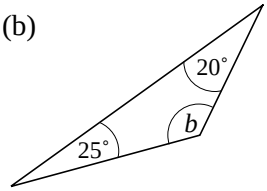
3.3 Angle Geometry

1. Calculate the size of the angles marked with a letter in each diagram. *None to scale*

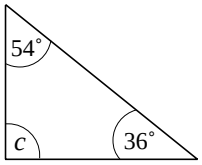
(a)



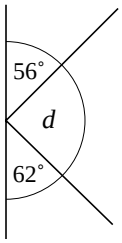
(b)



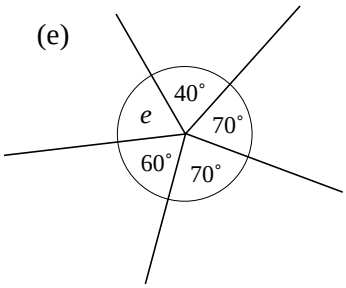
(c)



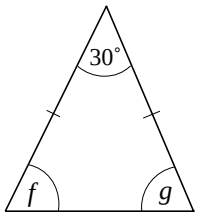
(d)



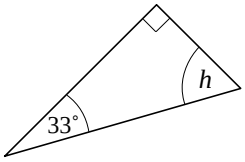
(e)



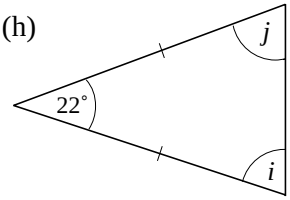
(f)



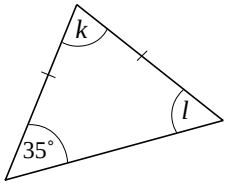
(g)



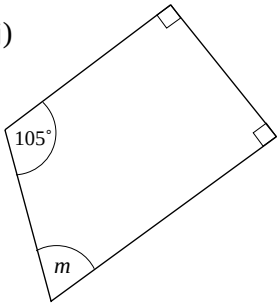
(h)



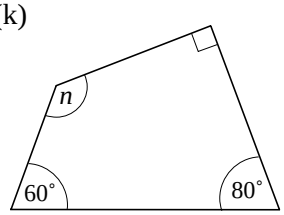
(i)



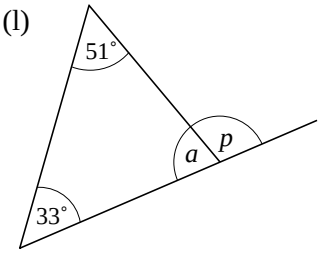
(j)



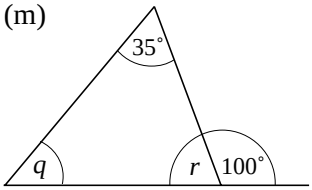
(k)



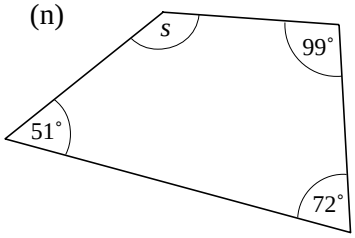
(l)



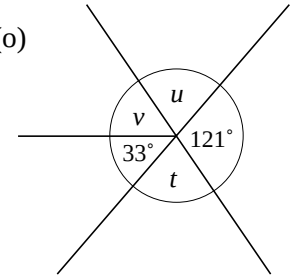
(m)



(n)

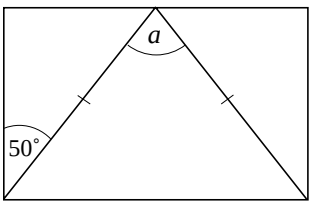


(o)

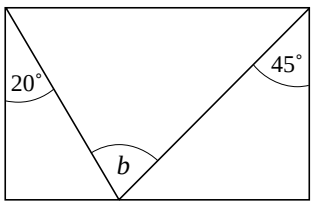


2. Find the angles marked with a letter in each rectangle below.

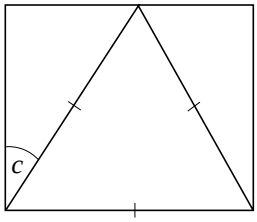
(a)



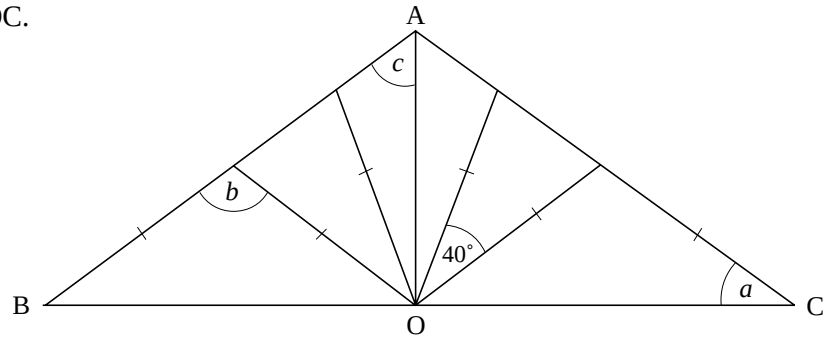
(b)



(c)



3. The framework of a symmetrical roof is illustrated below. OA is perpendicular to BOC.

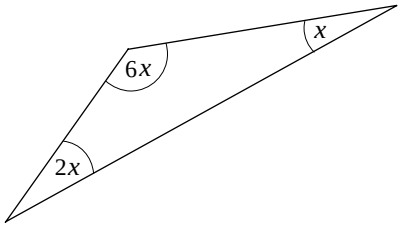


Find the size of the angles marked *a*, *b* and *c*.

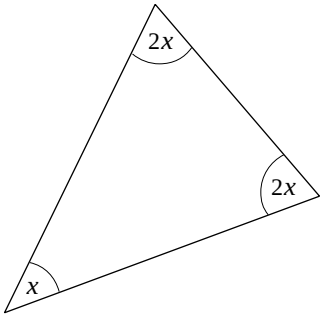
4. Write down an equation that is satisfied in each of the following diagrams.

In each case, solve the equation for *x*.

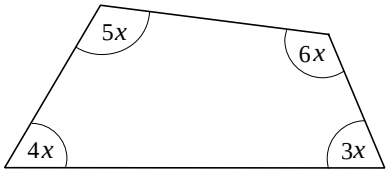
(a)



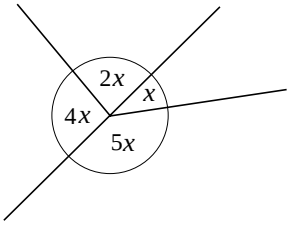
(b)



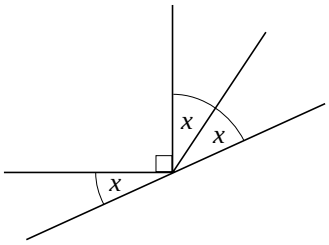
(c)



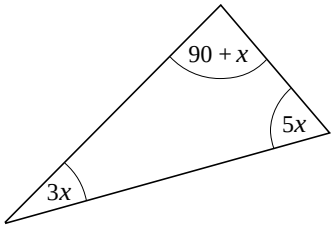
(d)



(e)



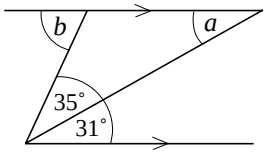
(f)



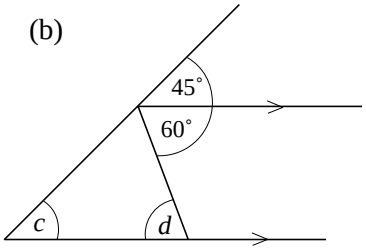
3.4 Angles with Parallel and Intersecting Lines

1. Calculate the unknown angles in the following diagrams.

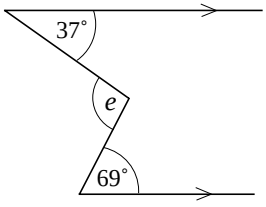
(a)



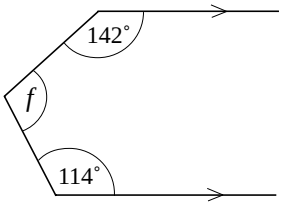
(b)



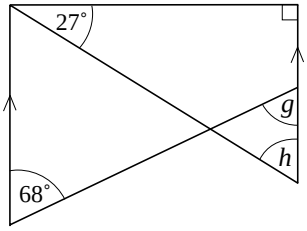
(c)



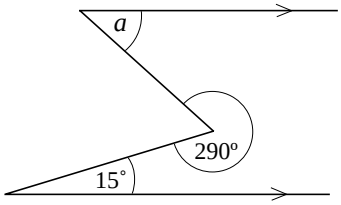
(d)



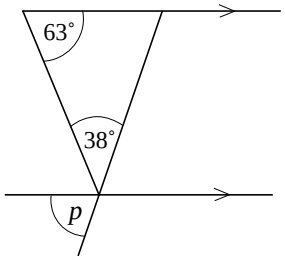
(e)



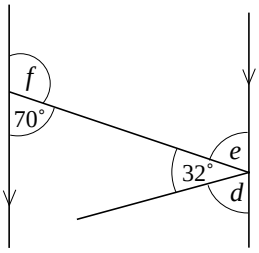
(f)



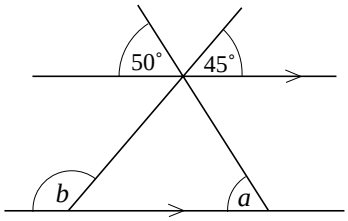
(g)



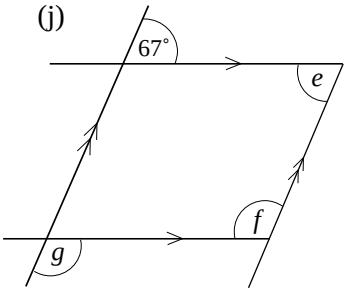
(h)



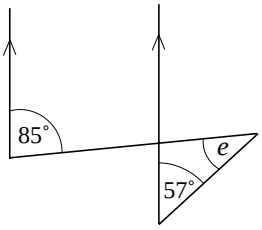
(i)



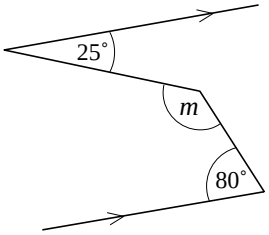
(j)



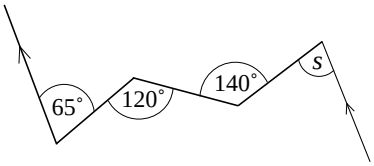
(k)



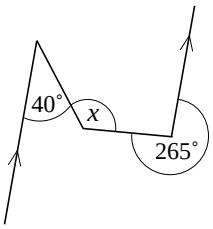
(l)



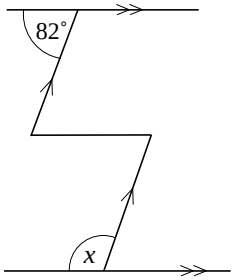
(m)



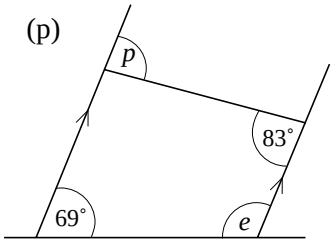
(n)



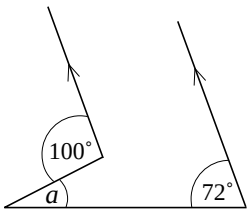
(o)



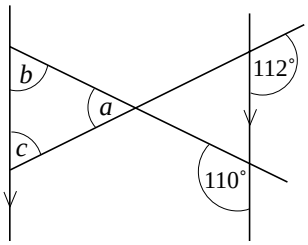
(p)



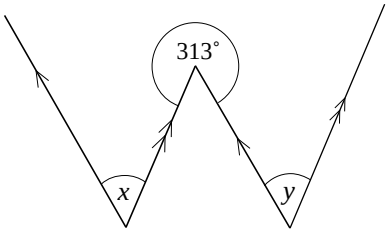
(q)



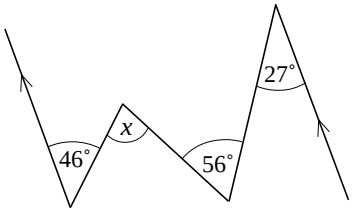
(r)



(s)

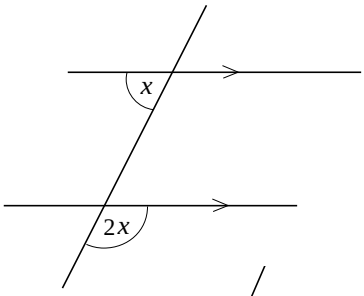


(t)

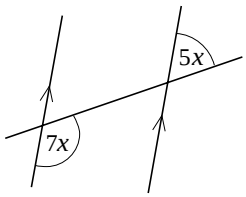


2. For each diagram, find an equation in x, and hence solve for x.

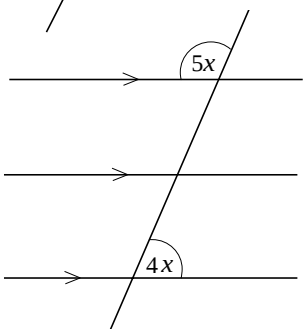
(a)



(b)

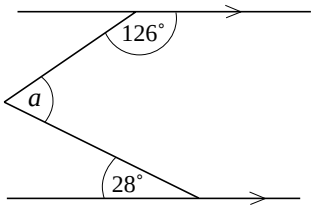


(c)

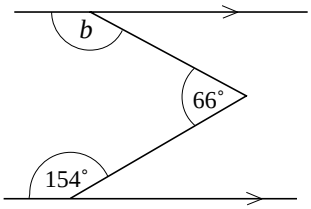


3. Find the values of the unknown angles in each of the following.

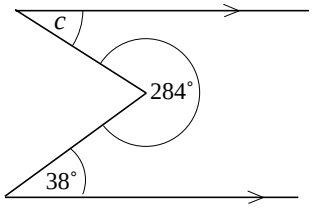
(a)



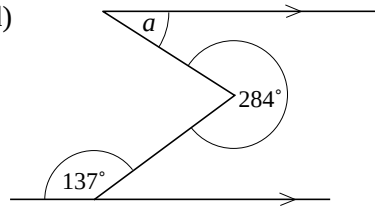
(b)



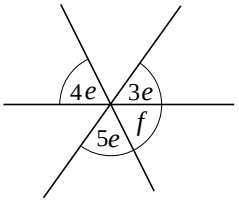
(c)



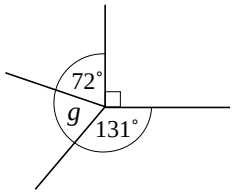
(d)



(e)



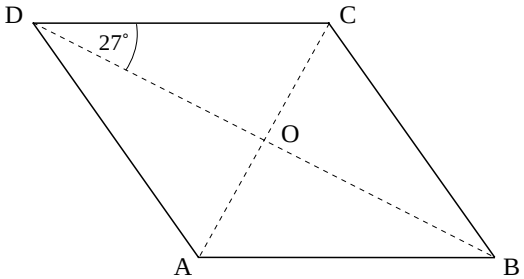
(f)



4. ABCD is a rhombus.

Angle BDC = 27°
The diagonals AC and BD cross at O.

Calculate the size of the angle ADC.

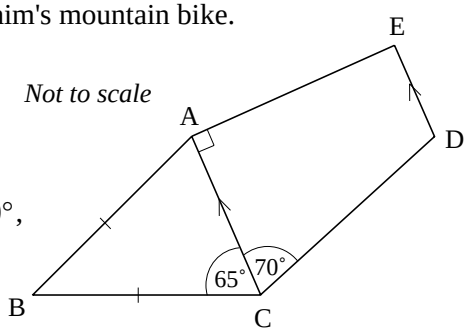


5. The pentagon ABCDE is the frame for Ibrahim's mountain bike.

ABC is an isosceles triangle in which AB = BC and angle BCA = 65°.

In the quadrilateral ACDE angle ACD = 70°, angle CAE = 90° and AC is parallel to ED.

Not to scale



(a) (i) Calculate the size of angle ABC.

(ii) What facts about the angles of a triangle did you use in your calculation?

(b) Calculate the size of the angle CDE.

(MEG)

3.5 Angle Symmetry in Polygons

1. Find the sum of the interior angles of

(a) a quadrilateral (b) a pentagon.

2. Find the size of each interior angle of

(a) a regular hexagon (b) a regular nonagon.

3. Find the number of sides of a polygon if the sum of its interior angles is

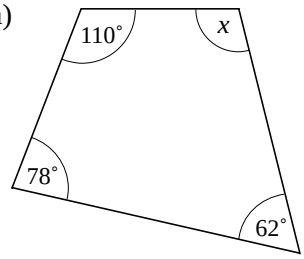
(a) 1800° (b) 1080°.

4. Each interior angle of a regular polygon is 140°. Find the number of sides of the polygon.

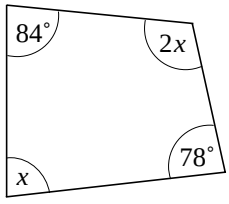
5. Each interior angle of a regular n-gon is 168°. What is the value of n?

6. Find the value of x in each of the following diagrams.

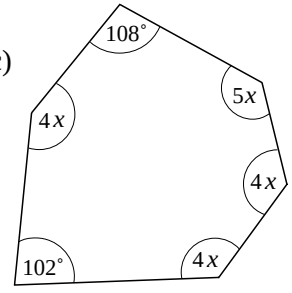
(a)



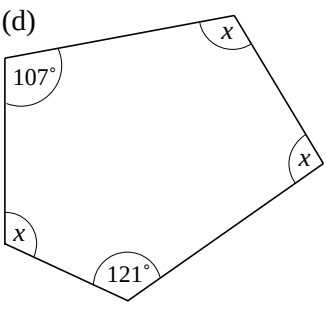
(b)



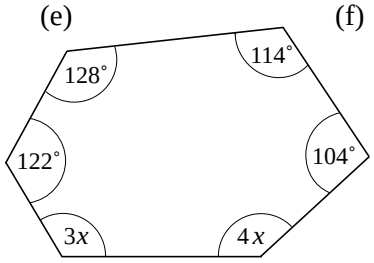
(c)



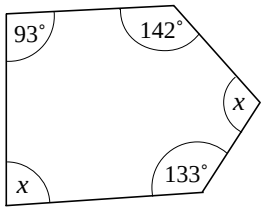
(d)



(e)



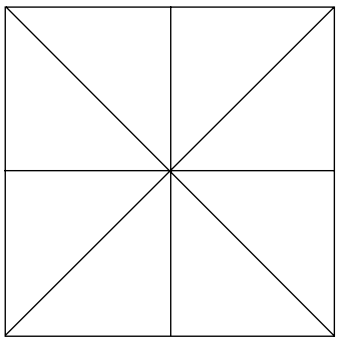
(f)

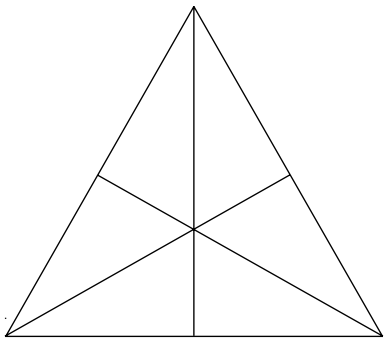


7. The angles of a quadrilaterial are $3x$, $4x$, $5x$ and $6x$.

(a) Find x. (b) What are the angles in degrees?

8.





(a) For each diagram above, show three different ways of shading parts of the shapes so that they have line symmetry but no rotational symmetry.

(b) Shade sections of one shape so that it has rotational symmetry of order 2 but no lines of symmetry. Is it possible to do this for both shapes?

(c) Repeat (b) for rotational symmetry of order 3.

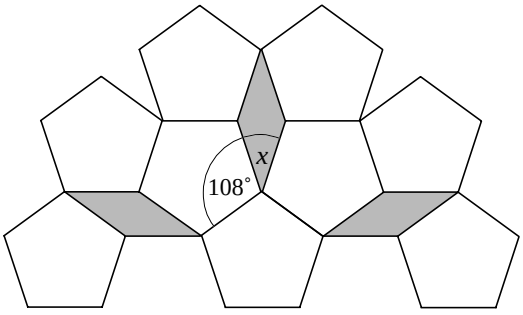
(d) Repeat (b) for rotational symmetry of order 4.

9. (a) A regular polygon has an interior angle of $175°$.
How many sides does it have?

(b) A second regular polygon has an interior angle which is $1°$ smaller.
How many sides does it have?

(c) Is it possible for a regular polygon to have an interior angle of $173°$?

10. (a) The diagram shows part of a tiling pattern of regular pentagons and another shape.

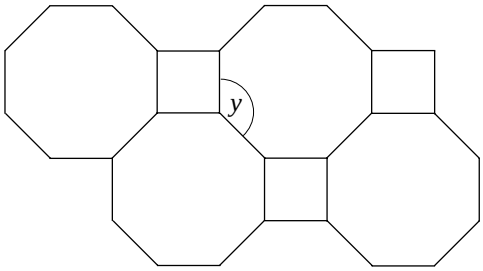


(i) Which of the following correctly describes the shaded shape:
square, rhombus, trapezium, rectangle, parallelogram, kite?

(ii) Calculate the size of the angle marked x.

(iii) A regular pentagon has rotational symmetry. What is the order of rotational symmetry of a regular pentagon?

(b) Another tiling pattern is formed using regular octagons and squares, as shown.



Calculate the size of the angle marked y.

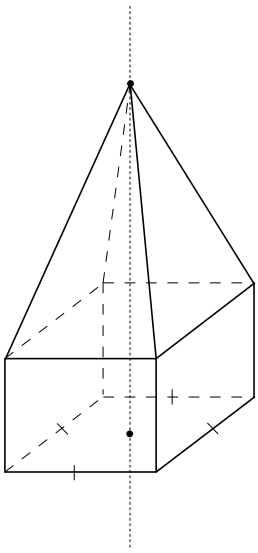
(c) Draw a tiling pattern using regular hexagons only. You must draw at least five hexagons.

(SEG)

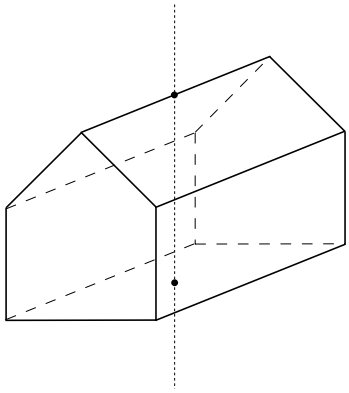
3.6 Symmetry Properties of 3D Shapes

1. The following solids have rotational symmetry.
For each of them, state the order of rotational symmetry about the given axis.

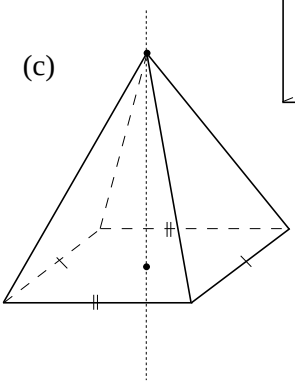
(a)



(b)

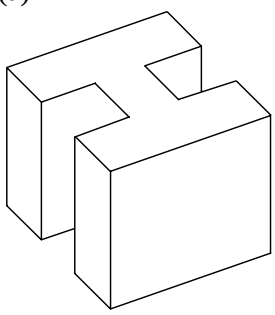


(c)

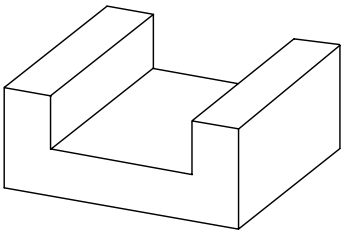


2. For each of the following prisms, copy each diagram and draw an axis so that the order of rotational symmetry about that axis is 2.

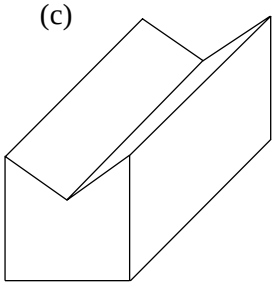
(a)



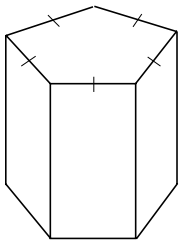
(b)



(c)



3. In the given prism, the cross-section is in the shape of a regular pentagon. Draw

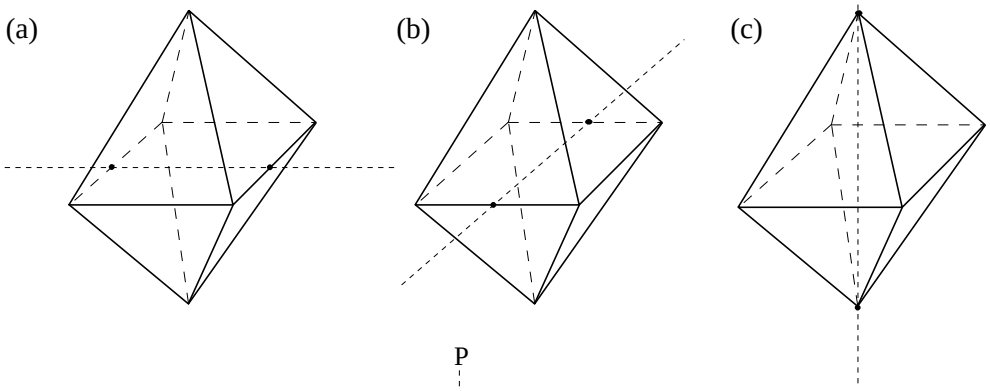


(a) an axis ST so that the order of rotational symmetry about ST is 2;

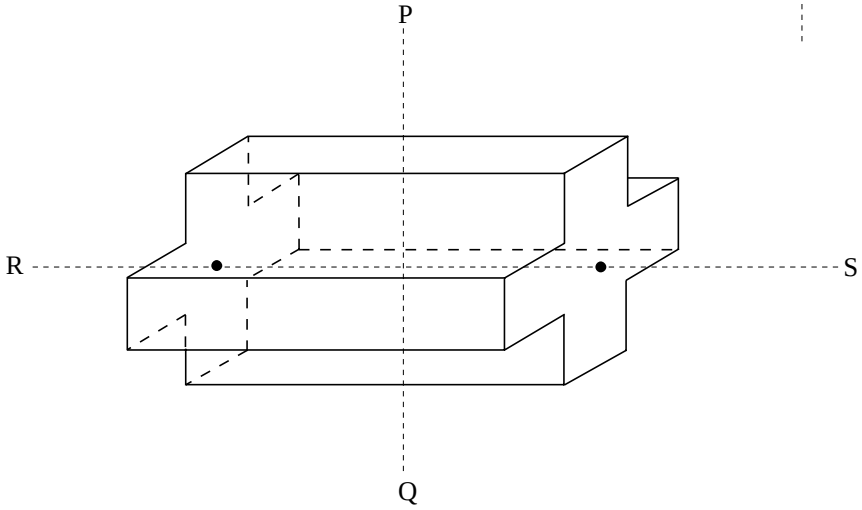
(b) an axis XY so that the order of rotational symmetry about XY is 5.

4. State the order of rotational symmetry about each of the axes shown. All the 12 edges of the solid are equal in length.

(a) (b) (c)



5.



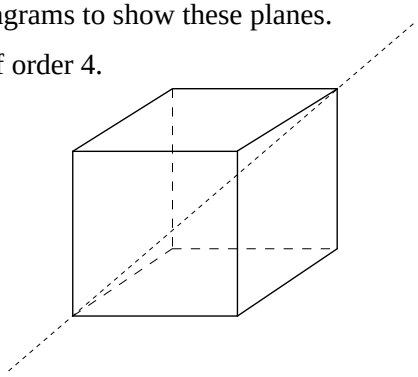
For the solid above, find the order of its rotational symmetry about

(a) PQ (b) RS.

6. (a) A cube has 9 planes of symmetry. Draw diagrams to show these planes.

(b) A cube has 3 axes of rotational symmetry of order 4. Draw diagrams to show these axes.

(c) The diagram of a cube opposite shows one axis of rotational symmetry of order 3. There are 3 other axes with the same order. Draw diagrams to show these axes.

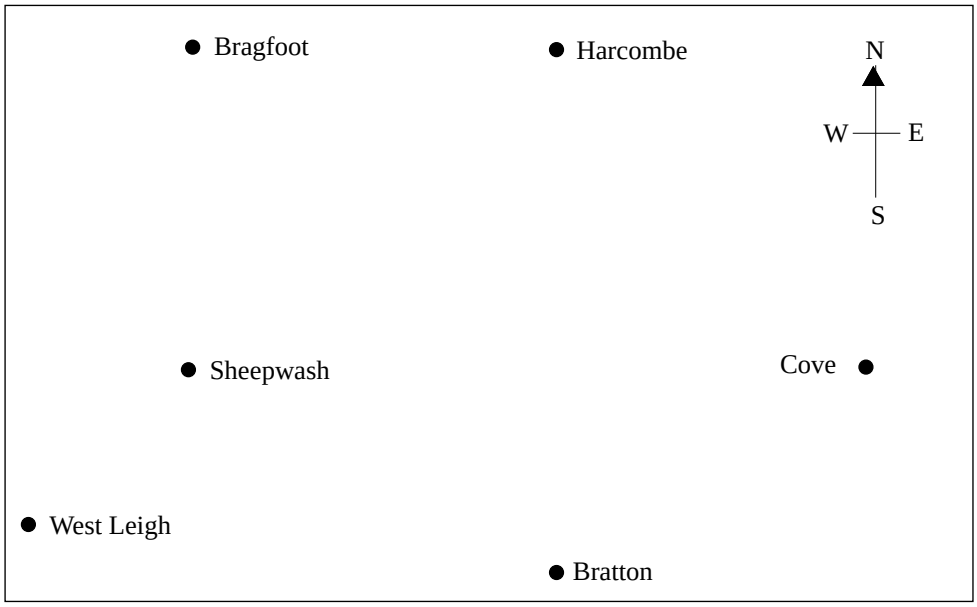


(d) There are 6 axes with symmetry of order 2. Draw diagrams to show these axes.

7. Draw a solid that has one axis of symmetry and rotational symmetry of order 5 about the axis.

3.7 Compass Bearings

1. The map below shows the positions of some villages.



Scale: 2 miles to 1 cm

(a) Which village is due north of *Sheepwash*?

(b) Which village is due west of *Cove*?

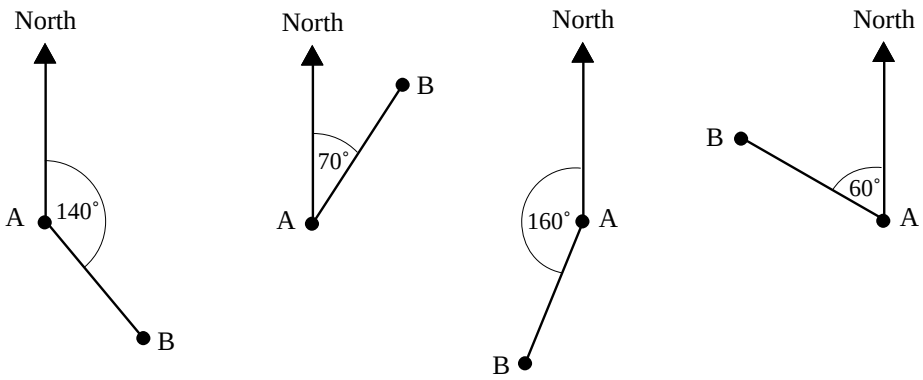
(c) What is the compass direction of *Sheepwash* from *West Leigh*?

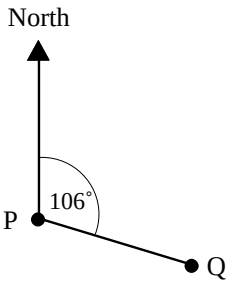
(d) How many miles is
(i) *Bratton* from *Cove* (ii) *Harcombe* from *Bragfoot*?

(e) Make a tracing of the map and mark the positions of
(i) *Darley*, which is 3 miles due south of *Harcombe*,
(ii) *Lee*, which is 4 miles south east of *Bragfoot*.

2. For each of the following, write down the bearing of B from A.

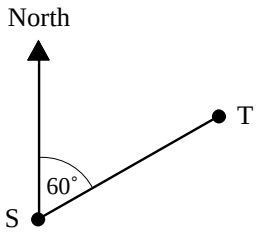
(a) (b) (c) (d)



3. 

What is the bearing of (a) Q from P

(b) P from Q?

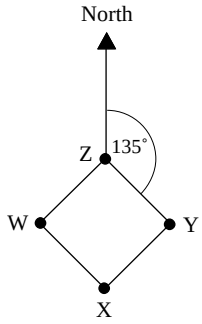
4. 

What is the bearing of (a) T from S?

(b) S from T?

5. Draw a diagram with 4 towns marked, so that that three of the towns are equidistant from the fourth town, P, and have bearings from P of

(a) 036° (b) 132° (c) 265°.

6. 

A field is in the shape of a square, with corners W, X, Y and Z.

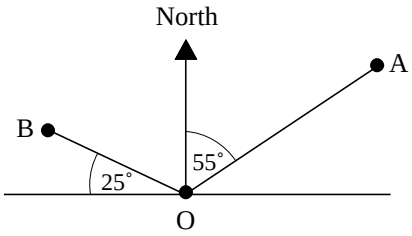
The bearing of Y from Z is 135°.

Find the bearing of (a) Y from X (b) W from Z.

7. What is the bearing of

(a) A from O (b) B from O

(c) O from A (d) O from B?



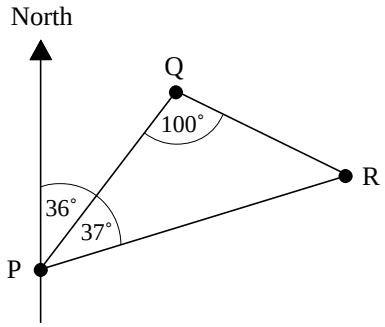
8. The figure shows the positions of P, Q and R.

What is the bearing of

(a) Q from P (b) P from Q

(c) R from P (d) P from R

(e) Q from R (f) R from Q?



9. A point B is 280 m due North of the point A. A man walks from A in the direction 050°. Calculate how far he walks before he is

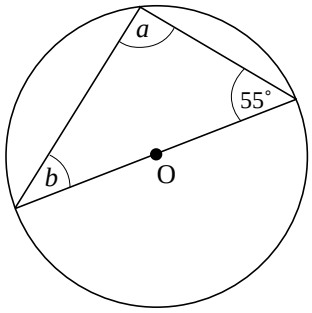
(a) equidistant from A and B, (b) as close as possible to B,

(c) due east of B.

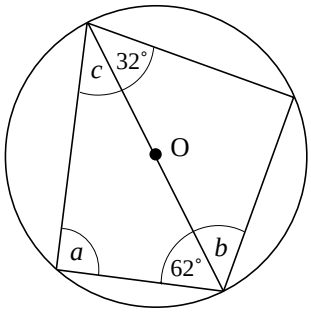
3.8 Angles and Circles 1

1. Find the angles marked with a letter in each of the following diagrams. (In each case O is the centre of the circle.)

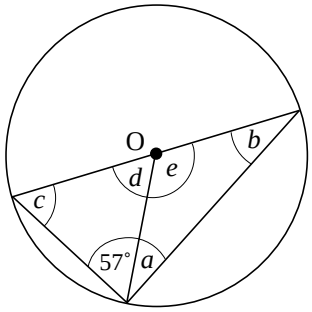
(a)



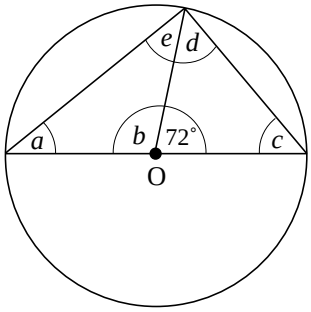
(b)



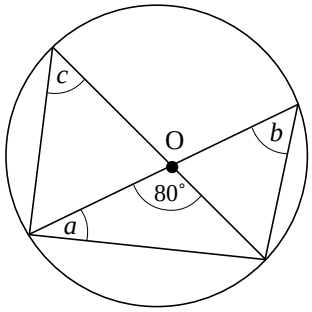
(c)



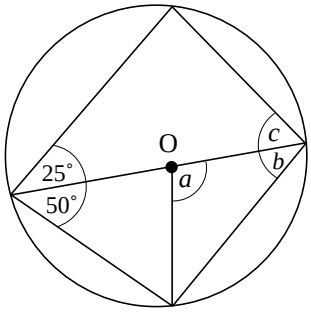
(d)



(e)

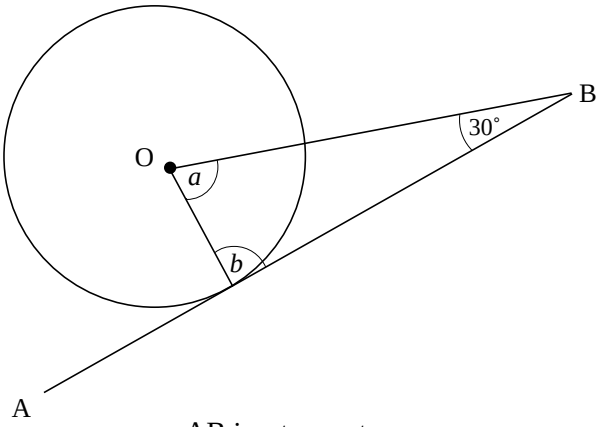


(f)



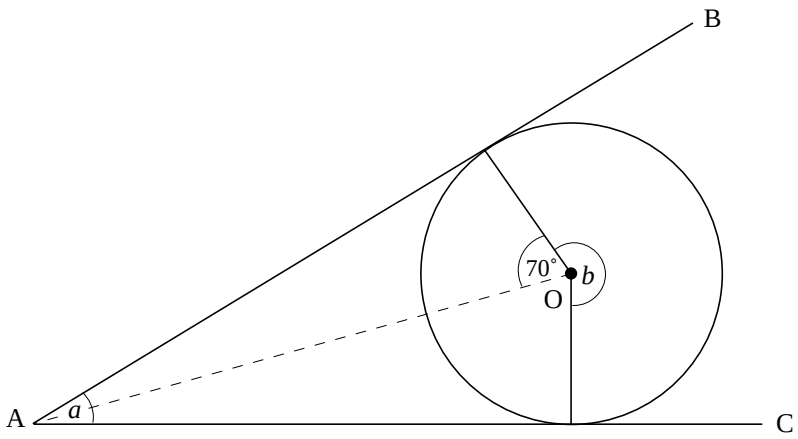
2. Find the angles marked with a letter in each diagram below. (In each case O is the centre of the circle.)

(a)



AB is a tangent

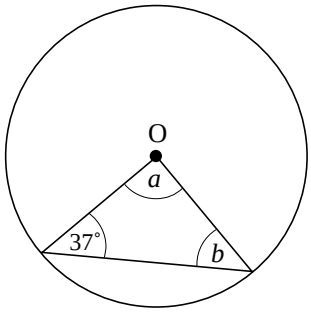
(b)



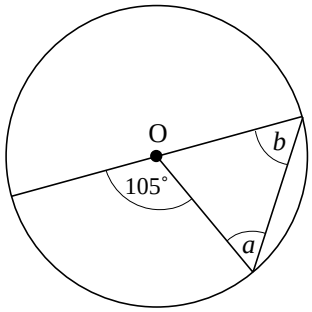
AB and AC are tangents

3. Find the angles marked with letters in each of the following diagrams. (In each case O is the centre of the circle.)

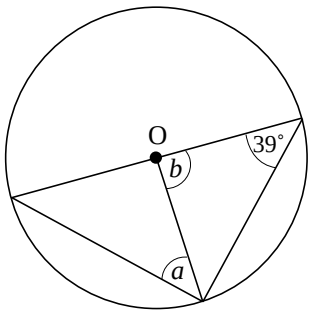
(a)



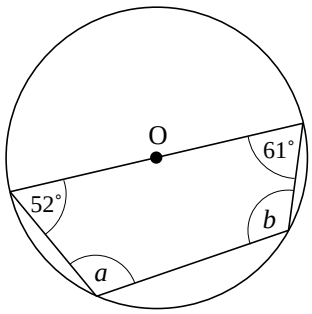
(b)



(c)

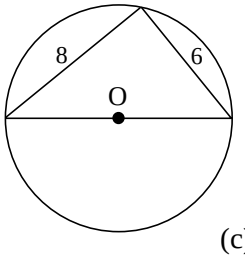


(d)

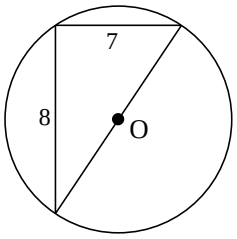


4. Find the diameter of each circle below. (In each case O is the centre of the circle.

(a)



(b)



(c)