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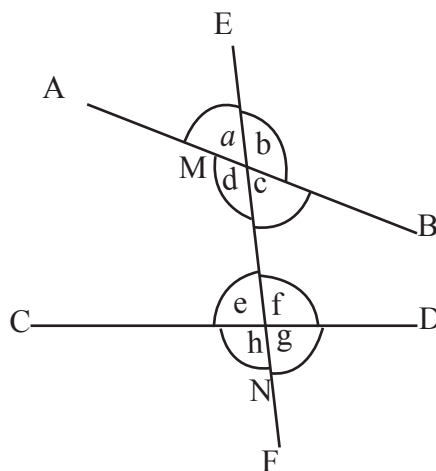
Angles

After studying this lesson, you can get a good understanding of

- ★ alternate angles, corresponding angles and allied angles formed when two lines are intersected by a transversal.
- ★ adjacent angles, complementary angles, supplementary angles and vertically opposite angles and the relations among them.
- ★ calculating the value of an angle using angles on a straight line and angles at a point.

Three pieces of eakle were held vertically on a table and when they were released the figure shows how they fell on the table.

In this figure **EF** is drawn to intersect the two straight lines **AB** and **CD**. Such a line drawn to intersect two or more straight lines is known as a transversal. When you examine this figure you can see that a few angles of various shapes which you know have been formed.



There are 4 angles at the point **M** and 4 angles at the point **N**.

Let us identify a relation between the angles formed at **M** and the angles formed at **N**.

Angle **b** at **M** is on the right above the line **AB**.

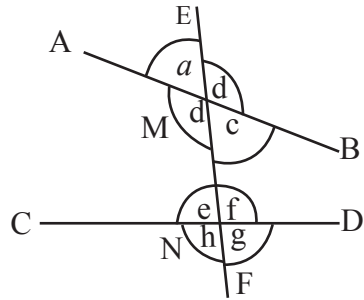
Similarly the angle at the point **N** on the right above the line **CD** is **f**.

Angle **b** and **f** are known as **corresponding angles**.

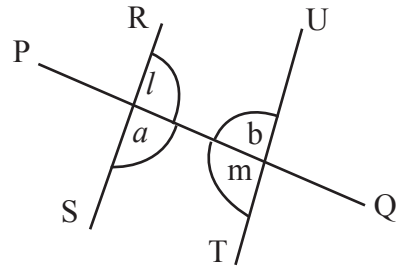
Similarly what is the angle relevant to angle **c** at **M** which is on the right below the line **AB**? It is **g** Hence **c** and **g** are corresponding angles. Similarly **d** and **h**, **a** and **e** are also corresponding angles.

See the figure again. The line **MN** is common to both angles **c** and **e**. The two angles are on either side of the common arm. Such angles are known as **alternate angles**.

Accordingly, **c** and **e** are alternate angles
d and **f** are **alternate angles**.

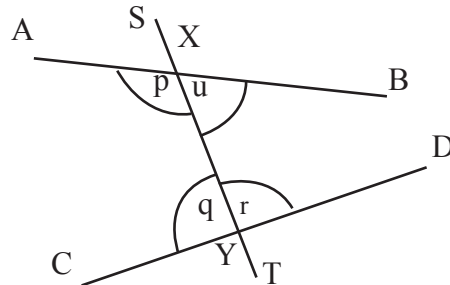


In this figure **l** and **m** are alternate angles.
 Name another pair of alternate angles.



See the two angles **p**, **q**. They are on the same side of common arm. Such a pair of angles is known as allied angles.

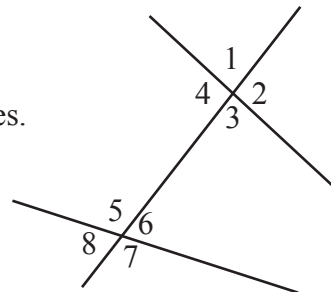
u and **r** are also **allied angles**.



Activity 3.1

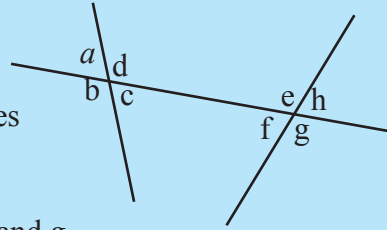
In the figure two straight lines are intersected by a transversal. Fill in the blanks of the following statements.

- (i) The corresponding angle to 1 is
- (ii) The corresponding angle to 4 is
- (iii) 2 and are a pair of corresponding angles.
- (iv) The alternate angle to 3 is
- (v) 4 and are a pair of alternate angles
- (vi) The allied angle to 3 is
- (vii) 6 and are a pair of allied angles.

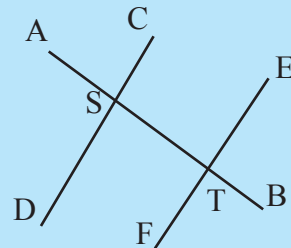


Exercise 3.1

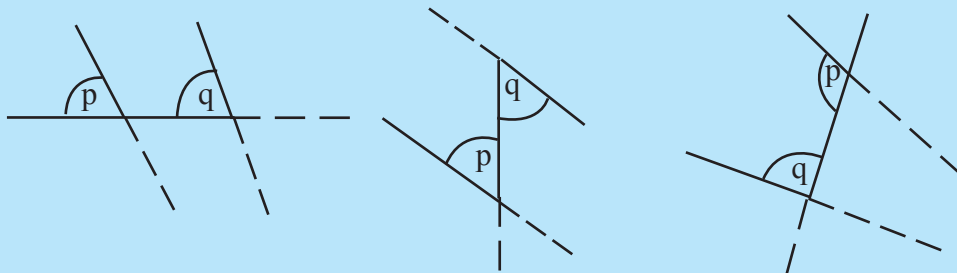
- (1) According to the data in the figure write
- three pairs of corresponding angles
 - two pairs of alternate angles
 - a pair of allied angles.
 - what kind of a pair of angles is c and g



- (2) According to the figure
- name a corresponding angle to $\hat{A}S\hat{C}$
 - name an alternate angle to $\hat{D}S\hat{T}$
 - what kind of angles are $\hat{C}S\hat{T}$ and $\hat{E}T\hat{S}$
 - can an alternate angle be named to $\hat{B}T\hat{F}$
 - name a pair of allied angles.



- (3) In each of the following figures a pair of angles is shown by dark lines.



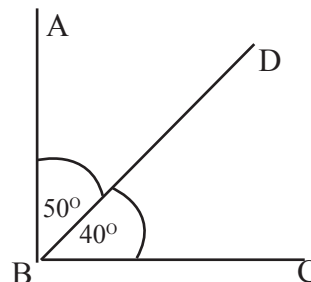
- What kind of angles are marked in each of these figures ?
- Each of these pairs of angles has a similarity to an English letter. Accordingly, propose a method to keep the formation of each pair in mind.

3.1 Complementary angles

The sum of the pair of angles $\hat{A}B\hat{D}$ and $\hat{D}B\hat{C}$ in the figure is

$$\hat{A}B\hat{D} + \hat{D}B\hat{C} = 50^\circ + 40^\circ = 90^\circ$$

Pairs of angles of which the sum is 90° are called **complementary angles**.



In the triangle \hat{PQR} ,
 $\hat{QPR} + \hat{QRP} = 48^\circ + 42^\circ = 90^\circ$

$\therefore \hat{QPR}$ and \hat{QRP} are complementary angles.

The complement of \hat{QPR} is \hat{QRP}

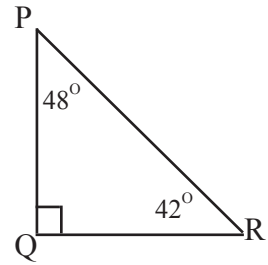
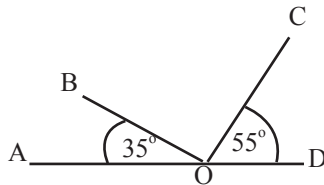
Similarly the complement of \hat{QRP} is \hat{QPR}

What is the value of the complement of an angle of 68° ?

Complement of 68° is 22° .

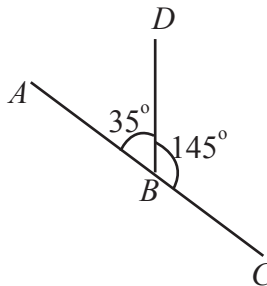
Complement of 22° is 68° .

In the figure \hat{AOB} and \hat{COD} are complementary angles.



3.2 Supplementary angles

In the figure $\hat{ABD} + \hat{CBD}$
 $= 35^\circ + 145^\circ$
 $= \underline{\underline{180^\circ}}$



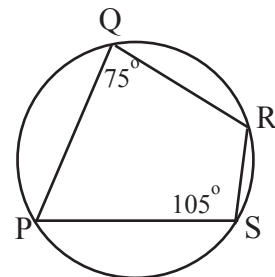
Pairs of angles of which the sum is 180° are called **supplementary angles**.

Accordingly, \hat{ABD} and \hat{CBD} is a pair of supplementary angles.

In the figure the sum of \hat{PQR} and \hat{PSR} is 180° .

$\therefore \hat{PQR}$ and \hat{PSR} are supplementary angles.

The supplement of \hat{PQR} is \hat{PSR} and the supplement of \hat{PSR} is \hat{PQR} .



Exercise 3.2

(1) Write the value of the complement of each of the following angles.

(i) 26°

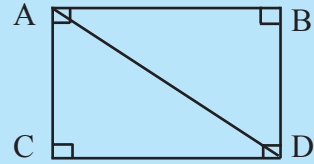
(ii) 45°

(iii) 63°

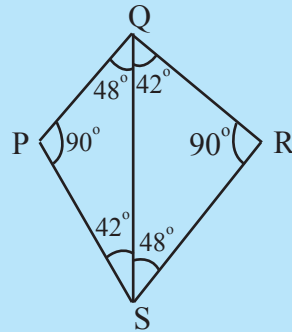
(iv) 89°

- (2) Write the value of the supplement of each of the following angles.
 (i) 16° (ii) 20° (iii) 90° (iv) 175°

- (3) The figure **ABCD** is a rectangle
 (i) Name four pairs of complementary angles in it.
 (ii) Name four pairs of supplementary angles.



- (4) Name all the pairs of complementary angles and the pairs of supplementary angles in the figure PQRS.

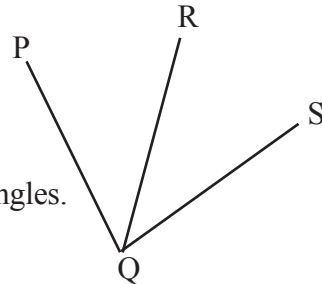


3.3 Adjacent angles

Name the angles in the figure.

They are \widehat{PQR} , \widehat{RQS} and \widehat{PQS}

Now let us complete the following table about these angles.



angle	arms of the angle	vertex of the angle
\widehat{PQR}	PQ, QR	Q
\widehat{RQS}	RQ, QS	Q
\widehat{PQS}	PQ, QS	Q

A pair of angles having a common arm, a common vertex and lying on either side of the common arm is called a pair of **adjacent angles**.

According to the above introduction as the two angles \hat{PQR} and \hat{RQS} have a common vertex Q , a common arm QR and as they are on either side of QR , they are adjacent angles.

Now consider the two angles \hat{RQS} and \hat{PQS} both have a common vertex Q and a common arm QS but they are on the same side of QS .

Therefore \hat{RQS} and \hat{PQS} are not adjacent angles.

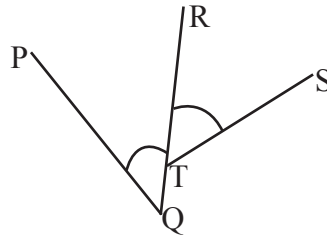
Example 1

Are the two angles \hat{PQR} and \hat{RTS} in the figure adjacent angles?

The arms of \hat{PQR} are PQ and QR , vertex is Q .

The arms of \hat{RTS} are RT or RQ and TS . The vertex is T .

The two angles are on either side of the common arm but since there is no common vertex \hat{PQR} and \hat{RTS} are not adjacent angles.

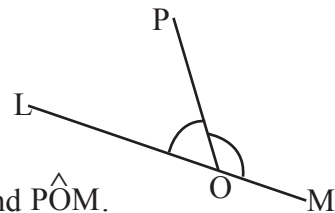


Activity 3.2

Observe the figure and draw the line PO so that it meets the line LM at O

By using a protractor measure the values of \hat{LOP} and \hat{POM} .

Find the sum of these two angles.



The sum of two adjacent angles on a straight line is 180° . They are known as a pair of **supplementary adjacent angles**.

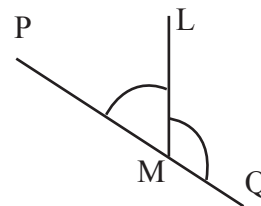
In the figure PQ is a straight line

$$\hat{PML} + \hat{LMQ} = 180^\circ$$

Activity 3.3

Draw a figure like the one above on a sheet of paper. Using a protractor measure the values of the two angles. What is the sum of the two angles?

Draw a few such figures and find whether the sum of the two angles is 180° .

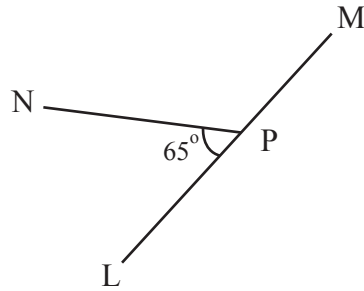


Example 2

LM is a straight line. $\widehat{NPL} = 65^\circ$. Find the value of \widehat{NPM} . Now since LM is a straight line,

$$\widehat{NPL} + \widehat{NPM} = 180^\circ$$

$$\begin{aligned} \therefore \widehat{NPM} &= 180^\circ - 65^\circ \\ &= \underline{\underline{115^\circ}} \end{aligned}$$

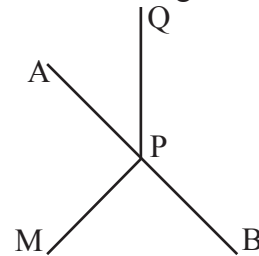


AB is a straight line. As given in the figure PQ and PM too are straight lines. Now since AB is a straight line.

$$\widehat{APQ} + \widehat{QP B} = 180^\circ$$

$$\widehat{APM} + \widehat{MPB} = 180^\circ$$

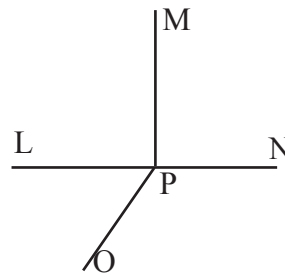
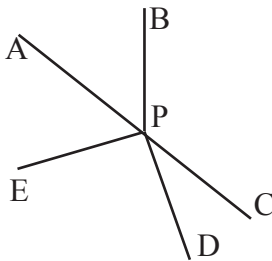
$$\therefore \widehat{APQ} + \widehat{QP B} + \widehat{APM} + \widehat{MPB} = \underline{\underline{360^\circ}}$$



The sum of the angles formed by meeting a few lines at a point is 360° .

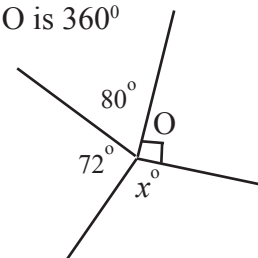
Activity 3.4

Draw two figures as given below on a sheet of paper and by measuring the angles at the point P find their sum in each case. Examine whether it is 360° .

**Example 3**

Find the value of x in the figure. The sum of the angles at O is 360°

$$\begin{aligned} 80^\circ + 72^\circ + 90^\circ + x &= 360^\circ \\ 242^\circ + x &= 360^\circ \\ x &= 360^\circ - 242^\circ \\ x &= \underline{\underline{118^\circ}} \end{aligned}$$



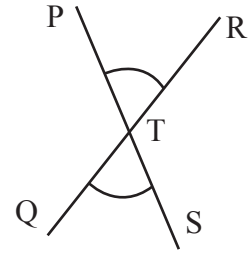
3.4 Vertically opposite angles

PS and QR are two straight lines. Examine the position of the two angles marked \hat{PTR} and \hat{QTS} . The two angles are opposite to each other.

They are known as **vertically opposite angles**.

When two straight lines intersect two pairs of vertically opposite angles are formed.

\hat{PTQ} and \hat{RTS} is also a pair of vertically opposite angles.



When two straight lines intersect **vertically opposite angles** so formed are equal.

Activity 3.5

Draw two straight lines to intersect at O, measure the vertically opposite angles and examine whether they are equal.

Example 4

AB and CD in the figure are two straight lines. Find the values of x , y and z .

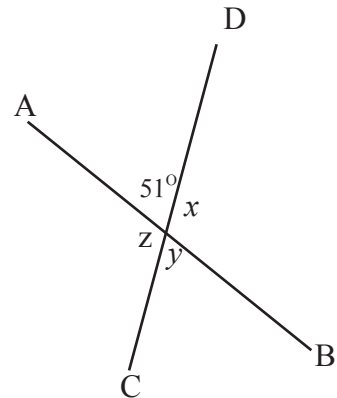
$$y = \underline{51^\circ} \text{ (vertically opposite angles)}$$

since AB is a straight line

$$x + 51^\circ = 180^\circ$$

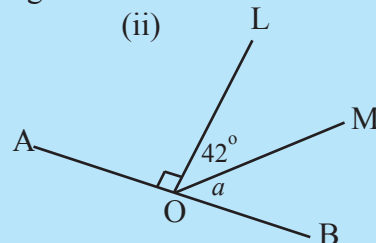
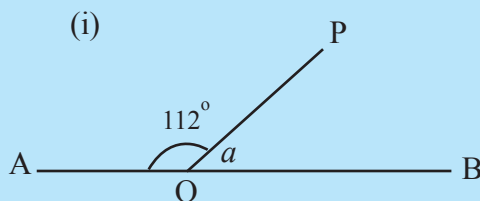
$$x = 180^\circ - 51^\circ = \underline{129^\circ}$$

$$z = \underline{129^\circ} \text{ (vertically opposite angles)}$$

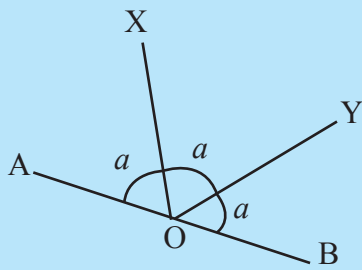


Exercise 3.3

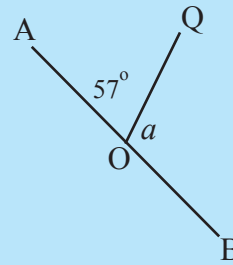
(1) In each of the following figures, AB is a straight line. Find the values of a .



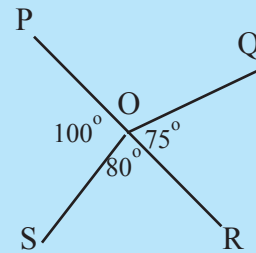
(iii)



(iv)

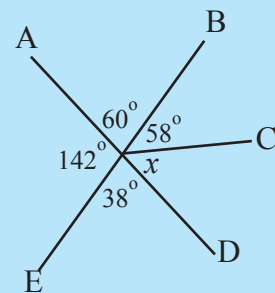


- (2) (i) Name a pair of adjacent angles in the figure
(ii) Find the value of \widehat{POQ}



- (3) According to the data given in the figure,

- (i) name a straight line
(ii) give reasons for it to be a straight line
(iii) find the value of x



Summary

- ★ Alternate angles, corresponding angles and allied angles are formed when two straight lines are intersected by a transversal.
- ★ Two angles of which the sum is 90° are known as complementary angles.
- ★ Two angles of which the sum is 180° are known as supplementary angles.
- ★ Two angles having a common vertex a common arm and lying on either side of the common arm are known as adjacent angles.
- ★ The sum of two adjacent angles on a straight line is 180° .
- ★ The vertically opposite angles formed when two straight lines intersect are equal.