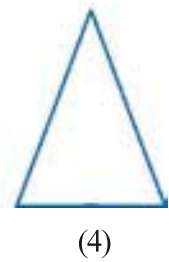
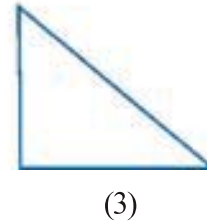
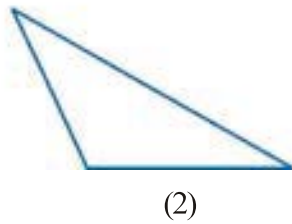
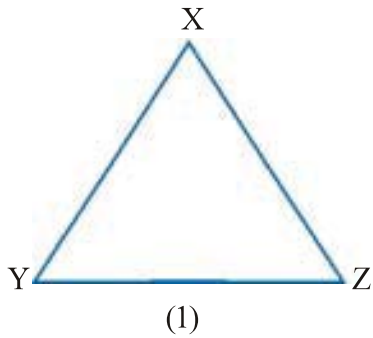


◆ Let us remember :

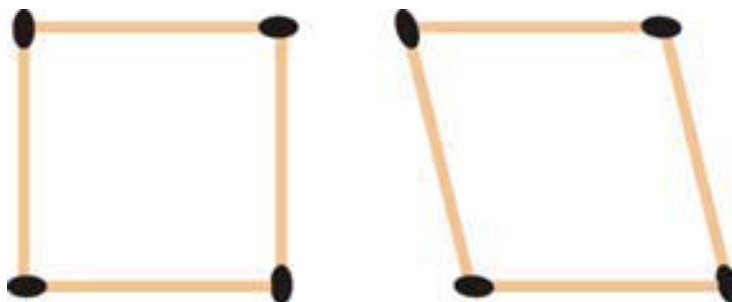


- Complete the Table by naming the each triangle with different names shown in the figure :

No.	Vertices of Triangle	Name of Triangle	Angles	Sides
(1)	X, Y and Z	$\triangle XYZ$	$\angle XYZ$ $\angle YZX$ $\angle ZXY$	$\overline{XY}$ , $\overline{YZ}$ , $\overline{ZX}$
(2)				
(3)				
(4)				

- **Activity 1 :** Make such shapes that by taking four match-sticks closed figures are obtained.

- Keep it in mind that two black ends of match-sticks do not touch each other



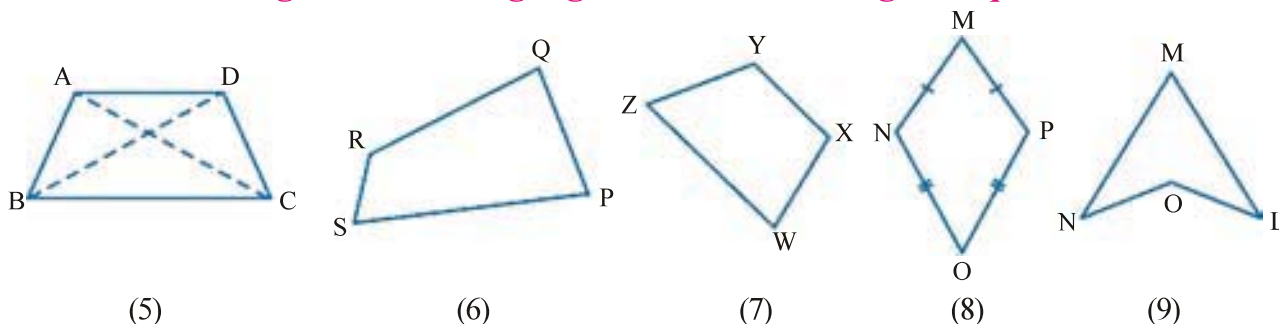
Now, think how many sides are formed ?

How many angles are formed ?

## 6 : Quadrilateral

◆ **Let us learn new :**

● **Examining the following figures, answer the given questions :**

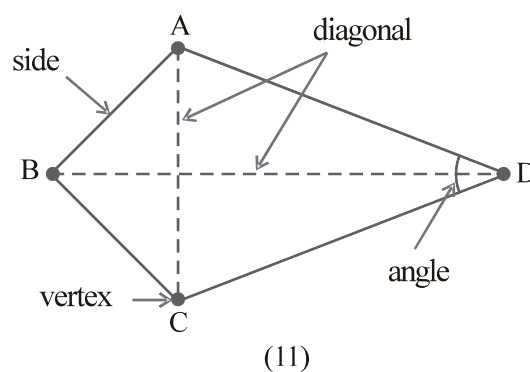
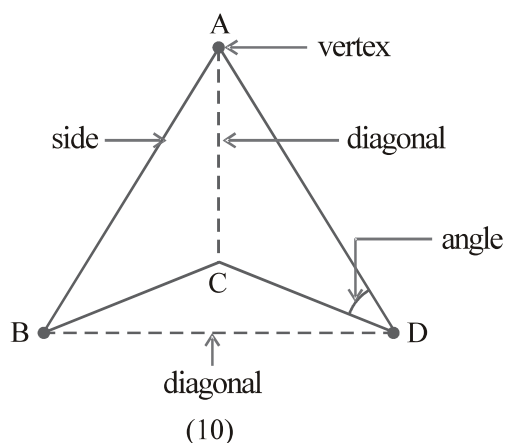


Join the opposite vertices in figures from (5) and (9) and write the line-segment so formed :

No.	(5)	(6)	(7)	(8)	(9)
Line-segment	$\overline{AC}$ , $\overline{BD}$				

- (1) How many vertices are there in above each figure ? .....
- (2) In the above each figure are there any three vertices in only one line ? .....
- (3) How many sides are there in each figure ? .....
- (4) How many angles are there in each figure ? .....
- (5) ..... is the figure in which line-segments intersect.
- (6) ..... is the figure in which line-segments do not intersect.

● **Examine the following figures and understand :**



● **Understand :**

In the above figure (10) and (11)

● A, B, C, D are the vertices of a quadrilateral.

## 6 : Quadrilateral

- $\overline{AB}$ ,  $\overline{BC}$ ,  $\overline{CD}$ ,  $\overline{DA}$  are the sides of quadrilateral.
- $\angle ABC$ ,  $\angle BCD$ ,  $\angle CDA$ ,  $\angle DAB$  are the angles.
- $\overline{AC}$  and  $\overline{BD}$  are their diagonals.
- **A closed figure made by four line-segments having four angles and not intersecting each other at any point except the end points is a quadrilateral.**

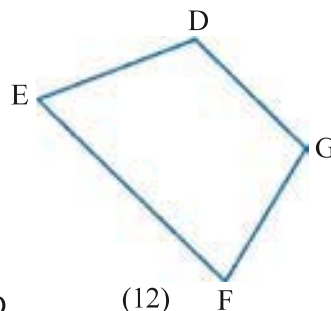
□ ABCD can be written as in set form as under :

$$\square ABCD = \overline{AB} \cup \overline{BC} \cup \overline{CD} \cup \overline{DA}$$

- Therefore, a quadrilateral is the union of four line-segments.
- Each line-segment which is formed by connecting opposite vertices of a quadrilateral is called a diagonal.
- If the diagonals of a quadrilateral intersect each other then that quadrilateral is called a convex quadrilateral.
- If the diagonals of a quadrilateral do not intersect each other then that quadrilateral is called a concave quadrilateral.
- Each quadrilateral contains four sides, four angles and two diagonals.

Here, we will discuss about the convex quadrilateral.

In the figure, D, E, F, G are the vertices of a quadrilateral, therefore, its name is given quadrilateral DEFG. Symbolically it is written as □ DEFG.

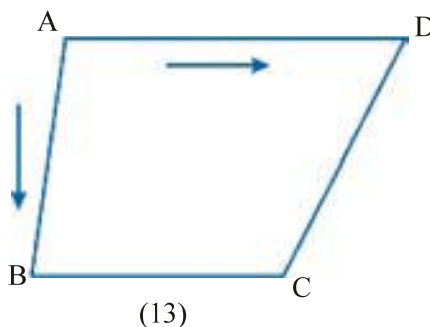


(12)

**Read as :** Quadrilateral DEFG

- **Naming of quadrilateral :**

□ ABCD  
□ BCDA  
□ CDAB  
□ DABC



(13)

□ ADCB  
□ DCBA  
□ CBAD  
□ BADC

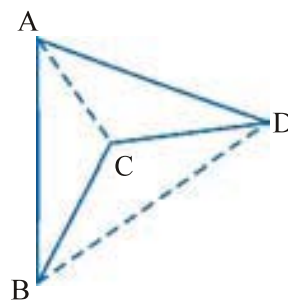
- A quadrilateral can be given name by two methods as clockwise and anticlockwise.
- Fill the details of the Table on the basis of above figures (12) and (13) :

Figures	Sides	Angles	Diagonals	Diagonals intersect ?
(12)				
(13)				

## 6 : Quadrilateral

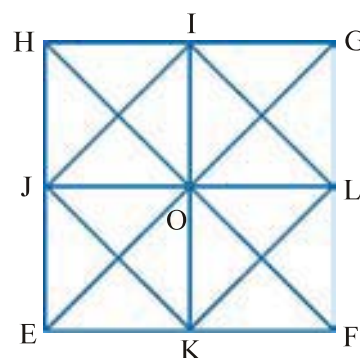
### Remember the following :

- A quadrilateral is formed with four coplanar points.
- Among four distinct coplanar points no three are collinear in a quadrilateral.
- A quadrilateral in which diagonals do not intersect is called a concave quadrilateral according to given figure.
- Here,  $\overline{AC}$  and  $\overline{BD}$  are diagonals.



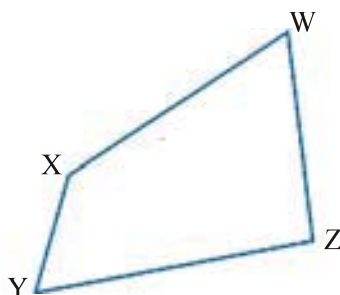
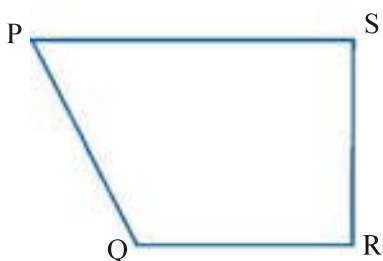
### Practice 1

1. By studying the given figure, write all the possible quadrilaterals formed in your notebook. Out of these write informations of any three in the table :



No.	Name of quadrilateral	Sides	Angles	Diagonals
1.	$\square EFGH$	$\overline{EF}$ , $\overline{FG}$ , $\overline{GH}$ , $\overline{HE}$	$\angle EFG$ , $\angle FGH$ , $\angle GHE$ , $\angle HEF$	$\overline{FH}$ , $\overline{EG}$

2. Write all the possible methods of writing names of the following quadrilaterals :



3. Draw and give names of such a quadrilateral whose vertices are S, T, U and V.

\*

## 6 : Quadrilateral

- **The opposite sides and opposite angles, adjacent sides and the adjacent angles of a quadrilateral :**

In figure (14),  $\overline{PQ}$  and  $\overline{RS}$  are opposite sides.

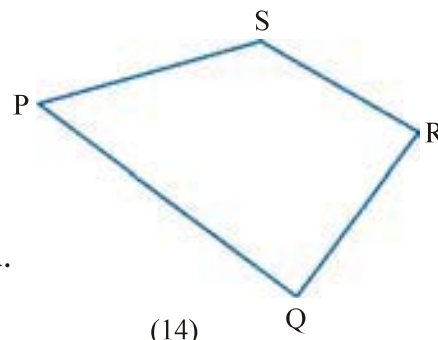
$\overline{QR}$  and  $\overline{PS}$  are opposite sides.

$\angle P$  and  $\angle R$  are opposite angles.

$\angle Q$  and  $\angle S$  are opposite angles.

Therefore, two pairs of opposite sides are obtained.

Similarly two pairs of opposite angles are obtained.



Now, The adjacent sides of  $\overline{PQ}$  are  $\overline{PS}$  and  $\overline{QR}$ .

The adjacent sides of  $\overline{QR}$  are  $\overline{PQ}$  and  $\overline{RS}$ .

The adjacent sides of  $\overline{RS}$  are  $\overline{QR}$  and  $\overline{SP}$ .

The adjacent sides of  $\overline{PS}$  are  $\overline{PQ}$  and  $\overline{RS}$ .

The adjacent angles of  $\angle P$  are  $\angle Q$  and  $\angle S$ .

The adjacent angles of  $\angle Q$  are  $\angle P$  and  $\angle R$ .

The adjacent angles of  $\angle R$  are  $\angle Q$  and  $\angle S$ .

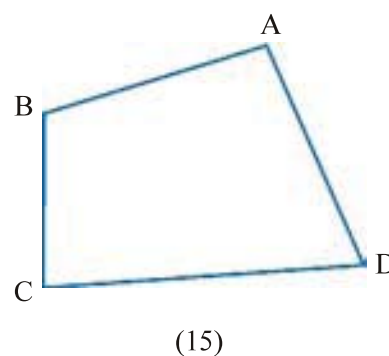
The adjacent angles of  $\angle S$  are  $\angle P$  and  $\angle R$ .

Therefore, four pairs of adjacent sides are obtained. Similarly four pairs of adjacent angles are obtained.



**Fill in the following blanks on the basis of given figure :**

- (1) ..... is the opposite side of  $\overline{AB}$ .
- (2)  $\overline{AD}$  is the opposite side of .....
- (3) The adjacent sides of  $\overline{AB}$  are ..... and .....
- (4) ..... and ..... are the adjacent sides of  $\overline{BC}$ .
- (5) The adjacent sides of  $\overline{CD}$  are ..... and .....
- (6) ..... and ..... are the adjacent sides of  $\overline{DA}$ .
- (7) Write opposite angle of  $\angle A$ .
- (8) Which are the adjacent angles of  $\angle D$  ?
- (9) Which are the adjacent angles of  $\angle A$  ?
- (10)  $\angle A$  and  $\angle C$  are the adjacent angles of which angle ?





## 6 : Quadrilateral

### Activity 2 :

- First of all take a quadrilateral paper of any measure.
- Make the triangular from quadrilateral shape by folding from the mid of dotted line.
- Measure all the three angles of triangular region respectively by protector.
- After measuring the angles of both triangular regions, open the fold.

Now, there will be four angles of quadrilateral instead of six angles of two triangles.

- $m\angle 1 + m\angle 4 = m\angle 7$  and  
 $m\angle 3 + m\angle 6 = m\angle 8$ .
- Now find the sum of measures of four angles of quadrilateral :

$$m\angle 7 + m\angle 2 + m\angle 8 + m\angle 5 = \dots\dots\dots$$

Sum of measures of  
four angles of  
quadrilateral

=

Sum of measures  
of 1st triangular  
region

+

Sum of measures  
of angles of 2nd  
triangular region

=

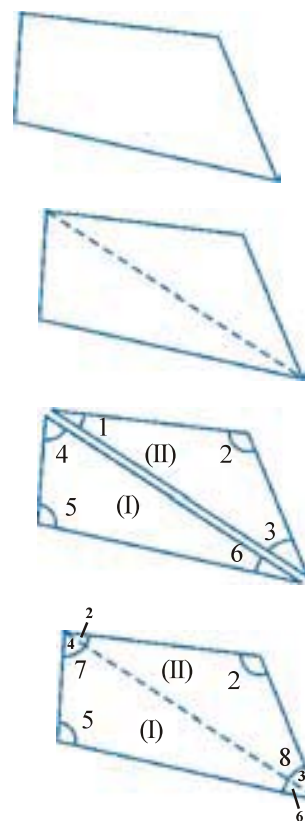
$180^\circ$

+

$180^\circ$

=

$360^\circ$



- **Activity 3 :** Draw different types of quadrilaterals in chart paper. Cut with the help of scissors. Measure all four angles of each quadrilateral with the help of protractor and write in Table :

Name of quadrilateral	measure of $\angle 1$	measure of $\angle 2$	measure of $\angle 3$	measure of $\angle 4$	$m\angle 1 + m\angle 2 + m\angle 3 + m\angle 4$

## 6 : Quadrilateral

### ■ Problems on the basis of measures of angles of quadrilateral :

**Example 1 :** The measures of three angles of a quadrilateral are  $85^\circ$ ,  $35^\circ$  and  $160^\circ$  respectively. Find measure of its fourth angle.

**The sum of measures of three angles of quadrilateral :**

$$85^\circ + 35^\circ + 160^\circ = 280^\circ$$

The measures of all four angles  
of a quadrilateral is  $360^\circ$ .

$$\text{Measure of fourth angle} = 360^\circ - 280^\circ = 80^\circ$$

$\therefore$  The measure of fourth angle is  $80^\circ$ .

or

$$m\angle 1 + m\angle 2 + m\angle 3 + m\angle 4 = 360^\circ$$

$$\therefore 85^\circ + 35^\circ + 160^\circ + m\angle 4 = 360^\circ$$

$$\therefore 280^\circ + m\angle 4 = 360^\circ$$

$$\therefore m\angle 4 = 360^\circ - 280^\circ$$

$$\therefore m\angle 4 = 80^\circ$$

**Example 2 :** The measure of three angles of a quadrilateral are equal. If measure of each angle is  $95^\circ$ , then find measure of its fourth angle.

Suppose  $\square ABCD$  is a quadrilateral.

$$\therefore m\angle A + m\angle B + m\angle C + m\angle D = 360^\circ$$

$$\therefore 95^\circ + 95^\circ + 95^\circ + m\angle D = 360^\circ$$

$$\therefore 285^\circ + m\angle D = 360^\circ$$

$$\therefore m\angle D = 360^\circ - 285^\circ$$

$$\therefore m\angle D = 75^\circ$$

$\therefore$  The measure of fourth angle is  $75^\circ$ .

**Example 3 :** The measure of three angles of a quadrilateral are equal. If measure of fourth angle is  $105^\circ$ , then find the measure of each equal angle.

The sum measures of all three equal angles

$$= 360^\circ - \text{measure of fourth angle}$$

$$= 360^\circ - 105^\circ$$

$$= 255^\circ$$

$$\text{The measure of each equal angle} = \frac{255}{3} = 85$$

$$\text{The measure of each equal angle} = 85^\circ$$

or

Suppose the measures of three equal angles is  $x^\circ$ . Now,

$$m\angle 1 + m\angle 2 + m\angle 3 + m\angle 4 = 360^\circ$$

$$\therefore x^\circ + x^\circ + x^\circ + 105^\circ = 360^\circ$$

$$\therefore 3x^\circ + 105^\circ = 360^\circ$$

$$\therefore 3x^\circ = 360^\circ - 105^\circ = 255^\circ$$

$$\therefore x^\circ = \frac{255}{3} = 85^\circ$$



### Practice 3


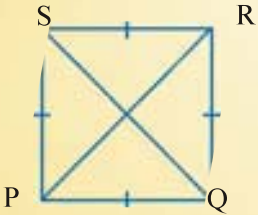
1. The measure of three angles of a quadrilateral are  $75^\circ$ ,  $65^\circ$  and  $120^\circ$  respectively, then find the measure of fourth angle of the quadrilateral.

## 6 : Quadrilateral

2. The measure of two adjacent angles of a quadrilateral are  $80^\circ$  and  $100^\circ$ . If remaining angles have equal measure then find the measures of equal angles.
3. In  $\square$  MNOP,  $m\angle N$  is  $10^\circ$  more,  $m\angle O$  is  $20^\circ$  more, and  $m\angle P$  is  $30^\circ$  more than  $m\angle M$ , then find the measures of all four angles.
4. In  $\square$  DEFG,  $m\angle D = 120^\circ$  and  $m\angle F = 140^\circ$ . If  $m\angle E = m\angle G$ , then find the measures of both angles.
5. If the measures of all four angles of a quadrilateral are equal, then find the measure of each angle.
6. One angle of a quadrilateral is a right angle and the measure of other angle is  $110^\circ$ . If remaining two angles are of equal measures, then find the measures of each equal angle.


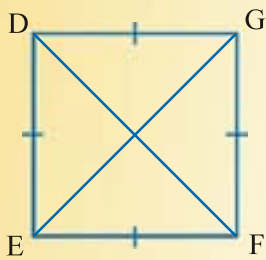
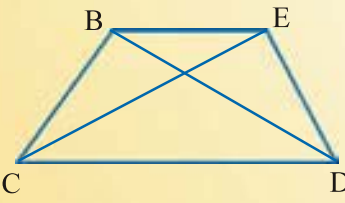
### Types of quadrilateral :

See and understand :

No.	Figure and name	Definition	Characteristics
1.	<b>Parallelogram</b> 	<p>If both the pairs of opposite sides of a quadrilateral are parallel, then the quadrilateral is called a parallelogram.</p> <p><math>\overline{AD} \parallel \overline{BC}</math> and <math>\overline{AB} \parallel \overline{CD}</math></p>	<ul style="list-style-type: none"> <li>■ Diagonals bisect each other.</li> <li>■ Diagonals are not of equal measures.</li> <li>■ The measures of opposite sides are equal.</li> <li>■ The measures of opposite angles are equal.</li> </ul>
2.	<b>Rhombus</b> 	<p>If all the sides of a parallelogram are equal, then it is called a rhombus.</p> <p><math>\overline{QR} \parallel \overline{PS}</math> and <math>\overline{PQ} \parallel \overline{SR}</math>  <math>QR = RS = SP = PQ</math></p>	<ul style="list-style-type: none"> <li>■ Diagonals are not of equal measurement.</li> <li>■ Diagonals bisect each other at right angles.</li> </ul>



## 6 : Quadrilateral

No.	Figure and Name	Definition	Characteristics
3.	<b>Rectangle</b> 	<p>If all the angles of a parallelogram are right angles, then the parallelogram is called a rectangle.</p> <p><math>\overline{LO} \parallel \overline{MN}</math>, <math>\overline{LM} \parallel \overline{ON}</math>  <math>m\angle L = m\angle M =</math>  <math>m\angle N = m\angle O = 90^\circ</math></p>	<ul style="list-style-type: none"> <li>Diagonals are equal in measures.</li> <li>Diagonals bisect each other.</li> </ul>
4.	<b>Square</b> 	<p>If the measures of four angles and four sides are equal, then that parallelogram is called a square.</p> <p><math>\overline{DG} \parallel \overline{EF}</math>, <math>\overline{DE} \parallel \overline{GF}</math>  <math>DG = GF = FE = ED</math>  <math>m\angle D = m\angle E = m\angle F = m\angle G = 90^\circ</math></p>	<ul style="list-style-type: none"> <li>The measures of diagonals are equal.</li> <li>Diagonals bisect each other at right angles.</li> </ul>
5.	<b>Trapezium</b> 	<p>If in a quadrilateral one and only one pair of opposite sides are parallel then such quadrilateral is called a trapezium.</p> <p><math>\overline{BE} \parallel \overline{CD}</math></p>	<ul style="list-style-type: none"> <li>The measures of diagonals are not equal.</li> <li>Diagonals do not bisect each other.</li> </ul>

### Remember :

- The name of a quadrilateral can be given by two ways : clockwise and anti-clockwise.
- The quadrilateral name can be written by starting with any vertex.
- Each quadrilateral has two pairs of opposite sides and two pairs of opposite angles.
- Each quadrilateral has four pairs of adjacent sides and four pairs of adjacent angles.
- The sum of the measures of all our angles of any quadrilateral is  $360^\circ$ .  
Therefore, for  $\square ABCD$ ,  $m\angle A + m\angle B + m\angle C + m\angle D = 360^\circ$

## 6 : Quadrilateral



1. Draw such a quadrilateral whose diagonals are  $\overline{DG}$  and  $\overline{EF}$ . Name it. How many types can it be named ? Write all the names.
2. Make figure of  $\square XYZW$  and write its all pairs of adjacent sides and adjacent angles.
3.  $\angle S$  is a right angle in  $\square STUV$ . If  $m\angle T = m\angle U$  and  $m\angle V = 80^\circ$ , then find  $m\angle T$  and  $m\angle U$ .
4. In  $\square PQRS$ ,  $m\angle Q$  is  $10^\circ$  less,  $m\angle R$  is  $20^\circ$  less and  $m\angle S$  is  $30^\circ$  less, then  $m\angle P$ , then find measure of each angle.
5. The measure of an angle of a quadrilateral is  $120^\circ$ . The measures of remaining angles are equal, then find the measure of each angle.
6. Answer the following questions :
  - (1) Write the number of sides, angles and diagonals of a quadrilateral.
  - (2) What is the sum of measures of four angles of quadrilateral ?
  - (3) What is the sum of measures of three angles of a square ?
  - (4) Which quadrilaterals have equal measures of four sides ?



### Answers

#### Practice 2

- |                                    |                     |                                    |                                    |                                    |
|------------------------------------|---------------------|------------------------------------|------------------------------------|------------------------------------|
| (1) $\overline{CD}$                | (2) $\overline{BC}$ | (3) $\overline{BC}, \overline{AD}$ | (4) $\overline{AB}, \overline{CD}$ | (5) $\overline{BC}, \overline{AD}$ |
| (6) $\overline{AB}, \overline{CD}$ | (7) $\angle C$      | (8) $\angle A, \angle C$           | (9) $\angle B, \angle D$           | (10) $\angle B$ and $\angle D$     |

#### Practice 3

- |                          |  |   |
|--------------------------|--|---|
| (1) $100^\circ$          | (2) $90^\circ, 90^\circ$                     | (3) $75^\circ, 85^\circ, 95^\circ, 105^\circ$ |
| (4) $50^\circ, 50^\circ$ | (5) $90^\circ, 90^\circ, 90^\circ, 90^\circ$ | (6) $80^\circ, 80^\circ$                      |

### Exercise

1.  $\square DEGF, \square EGFD, \square GFDE, \square FDEG, \square DFGE, \square FGED, \square GEDF, \square EDFG$
2. (1)  $\overline{XY}$  and  $\overline{ZW}$       (2)  $\overline{YZ}$  and  $\overline{XW}$   
 (3) The adjacent angles of  $\angle X$  are  $\angle W$  and  $\angle Y$ . The adjacent angles of  $\angle Y$  are  $\angle X$  and  $\angle Z$ . The adjacent angles of  $\angle Z$  are  $\angle Y$  and  $\angle W$ . The adjacent angles of  $\angle W$  are  $\angle Z$  and  $\angle X$ .
3.  $m\angle T = 95^\circ, m\angle U = 95^\circ$       4.  $105^\circ, 95^\circ, 85^\circ, 75^\circ$       5.  $80^\circ, 80^\circ, 80^\circ$
6. (1) 4, 4, 2      (2)  $360^\circ$       (3)  $270^\circ$       (4) Square, Rhombus