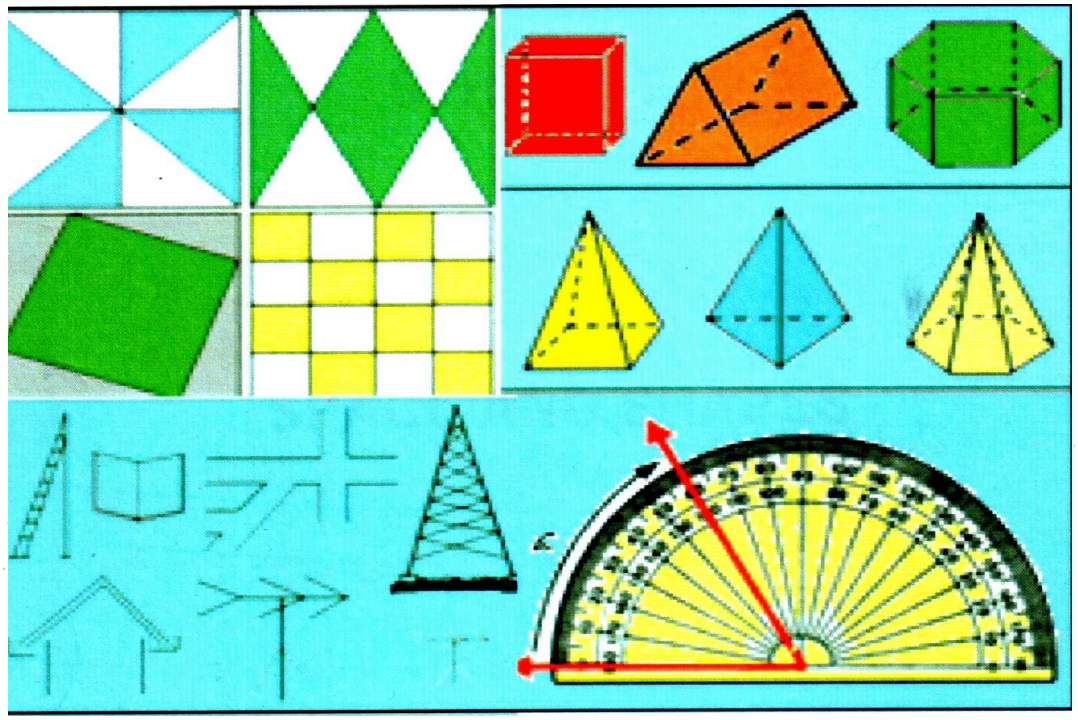
DEPARTMENT OF EDUCATION

GRADE 7

MATHEMATICS

STRAND 2



SPACE AND SHAPES

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PAPUA NEW GUINEA

GRADE 7

MATHEMATICS

STRAND 2

SPACE AND SHAPES

SUB-STRAND 1: ANGLES AND SHAPES

SUB-STRAND 2: SHAPES

SUB-STRAND 3: NETS

SUB-STRAND 4: TESSELLATION

Acknowledgements

We acknowledge the contributions of all Secondary and Upper Primary Teachers who in one way or another helped to develop this Course.

Special thanks to the Staff of the mathematics Department of FODE who played active role in coordinating writing workshops, outsourcing lesson writing and editing processes, involving selected teachers of Madang, Central Province and NCD.

We also acknowledge the professional guidance provided by the Curriculum Development and Assessment Division throughout the processes of writing and, the services given by the members of the Mathematics Review and Academic Committees.

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MR. DEMAS TONGOGO
Principal- FODE

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SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is part and parcel of the new reformed curriculum. The learning outcomes are student-centered with demonstrations and activities that can be assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution and Government Policies. It is developed in line with the National Education Plans and addresses an increase in the number of school leavers as a result of lack of access to secondary and higher educational institutions.

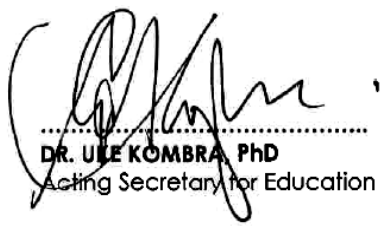
Flexible, Open and Distance Education curriculum is guided by the Department of Education‟s Mission which is fivefold:

- to facilitate and promote the integral development of every individual
- to develop and encourage an education system that satisfies the requirements of Papua New Guinea and its people
- to establish, preserve and improve standards of education throughout Papua New Guinea
- to make the benefits of such education available as widely as possible to all of the people
- to make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced through this course to provide alternative and comparable pathways for students and adults to complete their education through a one system, two pathways and same outcomes.

It is our vision that Papua New Guineans‟ harness all appropriate and affordable technologies to pursue this program.

I commend all the teachers, curriculum writers and instructional designers who have contributed towards the development of this course.



DR. UKE KOMBRA, PhD
Acting Secretary for Education

STRAND 2: INTRODUCTION

Dear Student,

This is the Second Strand of the Grade 7 Mathematics Course. It is based on the NDOE Upper Primary Mathematics Syllabus and Curriculum Framework for Grade 7.

This Strand consists of four Sub-strands:

Sub-strand 1:	**Angles and Shapes**
Sub-strand 2:	**Shapes**
Sub-strand 3:	**Nets**
Sub-strand 4:	**Tessellation**

Sub-strand 1 **Angles and Shapes:** You will learn to construct and determine properties of angles as well as the interior and exterior angles of triangles and quadrilaterals.

Sub-strand 2 **Shapes:** You will learn to draw, investigate and make physical models of polygons and quadrilaterals.

Sub-strand 3 **Nets:** You will learn to design and construct nets of various solid such as cubes, cuboids and prisms as well as nets of cones and pyramids.

Sub-strand 4 **Tessellation:** You will learn to create irregular shapes that tessellates.

You will find that each lesson has reading material to study, worked examples and a Practice Exercise. The answers to the practice exercise are given at the end of each sub-strand.

All the lessons are written in simple language with comic characters to guide you. The practice exercises are graded to help you to learn the process of working out problems.

We hope you enjoy learning this Strand.

All the best!

Mathematics Department
FODE

STUDY GUIDE

Follow the steps given below as you work through the Strand.

Step 1: Start with SUB-STRAND 1 Lesson 1 and work through it.

Step 2: When you complete Lesson 1, do Practice Exercise 1.

Step 3: After you have completed Practice Exercise 1, check your work. The answers are given at the end of SUB-STRAND 1.

Step 4: Then, revise Lesson 1 and correct your mistakes, if any.

Step 5: When you have completed all these steps, tick the check-box for Lesson, on the Contents Page (page 3) like this:

☑ Lesson 1: Meaning of Angles

Then go on to the next Lesson. Repeat the same process until you complete all of the lessons in Sub-strand 1.

As you complete each lesson, tick the check-box for that lesson, on the Content Page 3, like this ☑.This helps you to check on your progress.

Step 6: Revise the Sub-strand using Sub-strand 1 Summary, then do Sub-strand Test 1 in Assignment 2.

Then go on to the next Sub-strand. Repeat the same process until you complete all of the four Sub-strands in Strand 2.

Assignment: (Four Sub-strand Tests and a Strand Test)
When you have revised each Sub-strand using the Sub-strand Summary, do the Sub-strand Test in your Assignment. The Course book tells you when to do each Sub-strand Test.

When you have completed the four Sub-strand Tests, revise well and do the Strand Test. The Assignment tells you when to do the Strand Test.

The Sub-strand Tests and the Strand Test in the Assignment will be marked by your Distance Teacher. The marks you score in each Assignment will count towards your final mark. If you score less than 50%, you will repeat that Assignment.

Remember, if you score less than 50% in three Assignments, your enrolment will be cancelled. So, work carefully and make sure that you pass all of the Assignments.

SUB-STRAND 1

ANGLES AND SHAPES

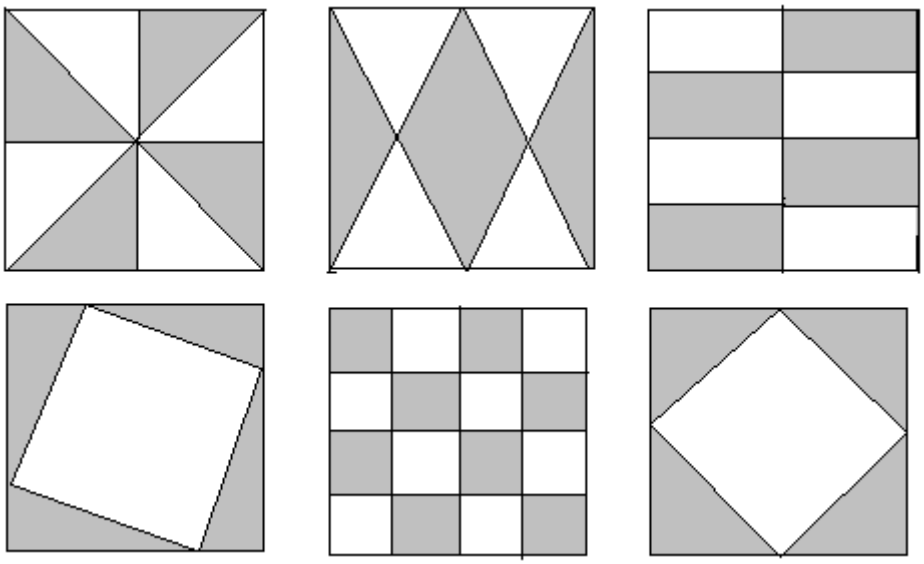
SUB-STRAND 1: ANGLES AND SHAPES

Introduction

You learnt some things about angles and shapes in your Grade 6 Mathematics. In this Sub-strand, you will revise some of the things that you learnt and you will also learn many new things about angles and shapes.

There are shapes and forms in everything around us. Geometric figures or shapes are represented everywhere from the starfish to the spider"s web, from the windows of houses to sky-high buildings.

Look at the following geometric figures or shapes.



The environment seems orderly because of its shapes and forms. Knowledge of geometric figures helps us realise how useful these are in real life, especially in the areas of construction and design.

In this Sub-strand, you will draw and work out properties of angles as well as the interior and exterior angles of triangles and quadrilaterals.

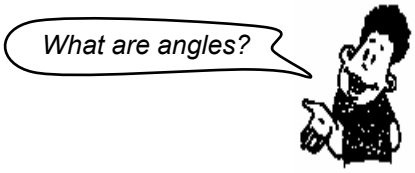
Lesson 1: Meaning of Angles

You learnt something about angles in your grade 6 Mathematics.

In this lesson, you will:

- name and label angles
- classify angles as right , acute, obtuse, reflex, or a revolution.

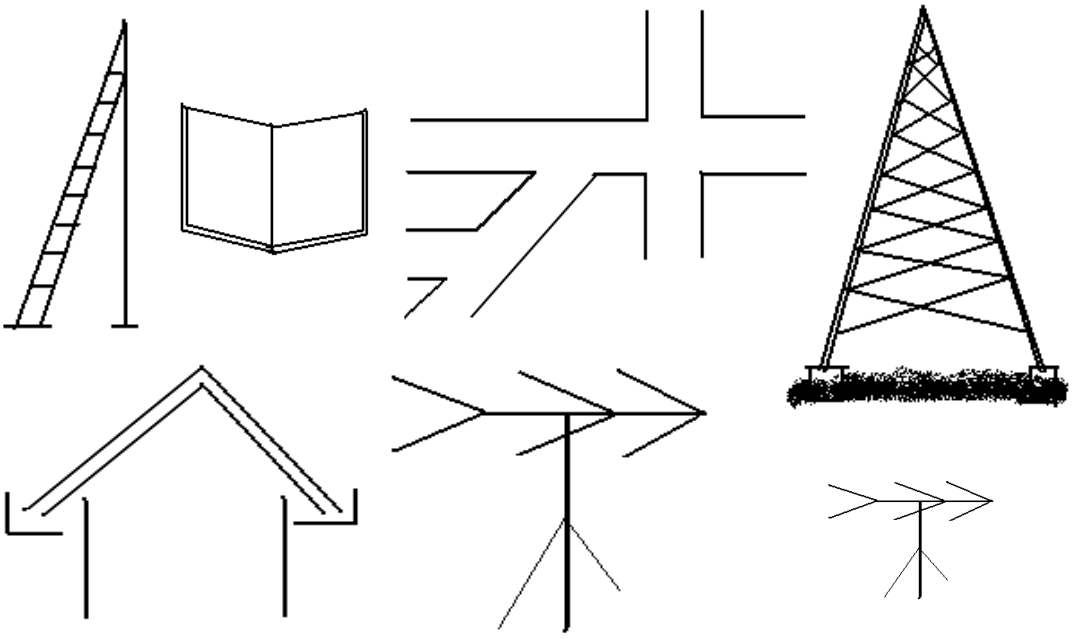
First you will learn the meaning of angles.



There are many everyday objects and situations which illustrate angles. The V sign for victory which is made with fingers is an angle. The two hands of the clock also demonstrate different kinds of angles. So is the position of your arm and forearm.

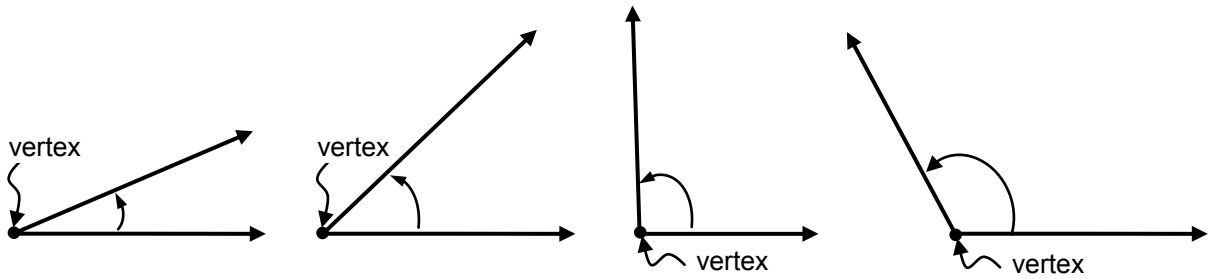
Dancers are able to form different angles with their bodies and limbs. The branch and twigs of plants and trees also show angles.

Here are some illustrations of angles.



Angles are all around our environment. When we see and recognize them; we become more aware of their importance in our lives.

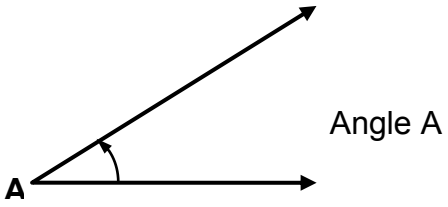
Look at the figures below.



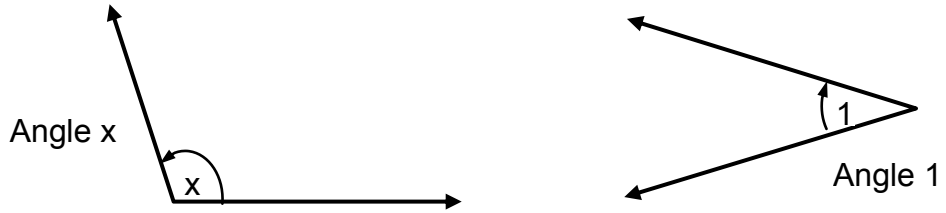
These are angles. An **angle** is formed by two different rays having the same endpoint. Each ray extends indefinitely in one direction. The common endpoint is called the **vertex** of the angle.

Angles are identified or named in the following ways:

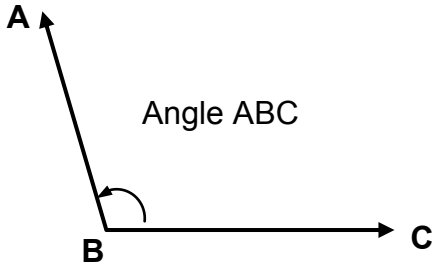
a) By reading the capital letter at the vertex



b) By reading the inside letter or numeral



c) By reading the three letters associated with the sides and the vertex.



The symbol to denote or stand for the word angle is „∠". The angles above may be $\angle A$, $\angle x$, $\angle 1$ or $\angle ABC$ with the letter at the vertex in the middle.

In $\angle ABC$, the sides are $\overrightarrow{BC}$ and $\overrightarrow{BA}$.

$\longrightarrow$ is the symbol for ray. The first letter is its endpoint.

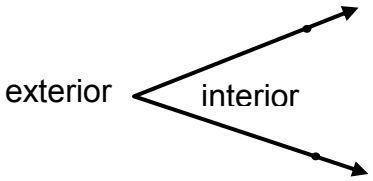
REMEMBER:

An angle is a plane figure formed by two rays or lines which have a common endpoint and do not lie on a straight line. The common endpoint is the **vertex** and the two rays are the **sides**.

An angle can be named by a capital letter at the vertex, by a numeral, or by the three letters associated with the sides and vertex.

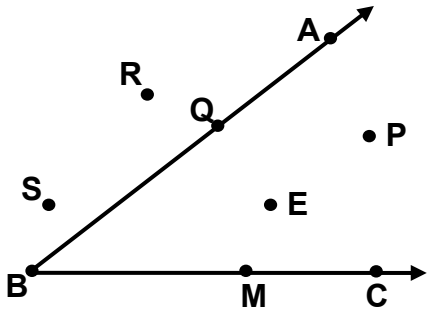
The region between the sides of an angle is called the **interior**.

The region not enclosed by an angle is called the **exterior** of that angle.



An angle separates a plane into three different parts – the interior of the angle, the exterior of the angle and the angle itself.

In the figure below, points P and E are in the interior of $\angle ABC$, points R and S are in the exterior, points Q and M are on the angle.

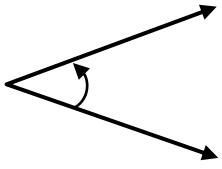


When we talk about angles, we can describe them according to their size.

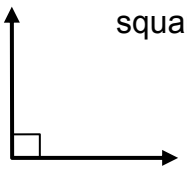
Angles are classified according to their sizes.

Types of angles

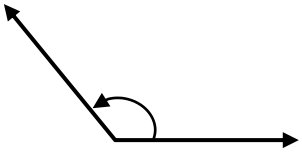
Acute Angle – has a measure greater than 0º but less than 90º.



Right Angle – has a measure of 90º or one quarter turn indicated by the little square.

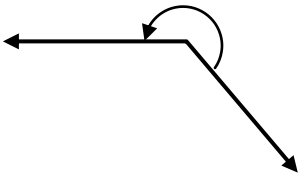


Obtuse Angle – has a measure greater than 90º but less than 180º.

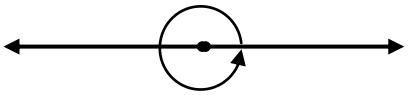


Straight Angle – has a measure of 180º or one half turn.

Reflex Angle – has a measure greater than 180º but less than 360º.



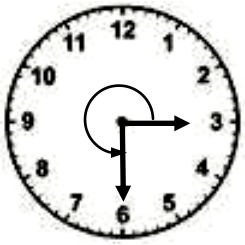
Perigon or Full Circle – has a measure of 360º or one revolution.



Example

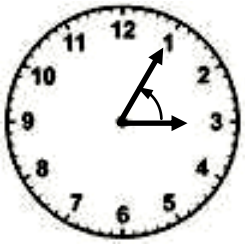
What types of angles is determined by the hands of each clock face indicated by the arrow below.

(a)



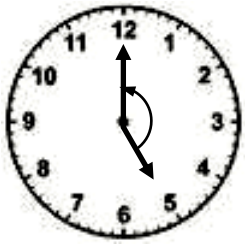
Answer: **Reflex angle**

(b)

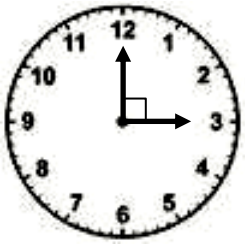


Answer: **Acute angle**

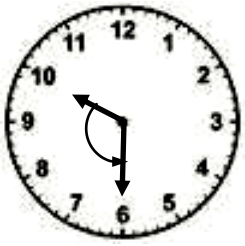
(c)



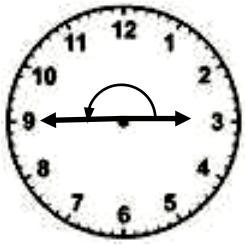
Answer: **Obtuse angle**



Answer: **Right angle**



Answer: **Obtuse angle**



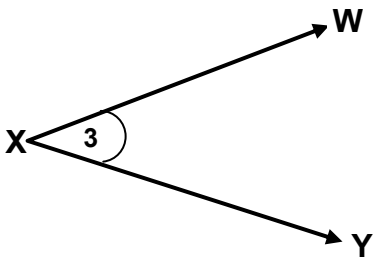
Answer: **Straight angle**

NOW DO PRACTICE EXERCISE 1

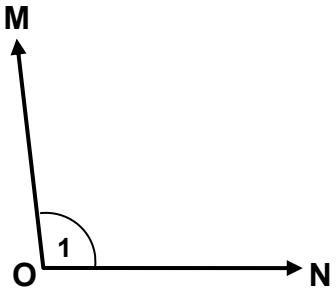
Practice Exercise 1

1. Name each of the following angles in three different ways. The first one is done for you.

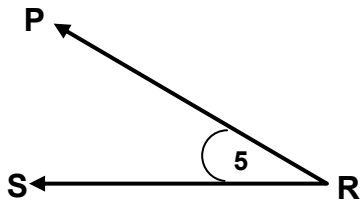
a)



b)



c)



Answer:

a) ∠x, ∠3 or ∠WXY b) _____, _____, _____ c) _____, _____, _____

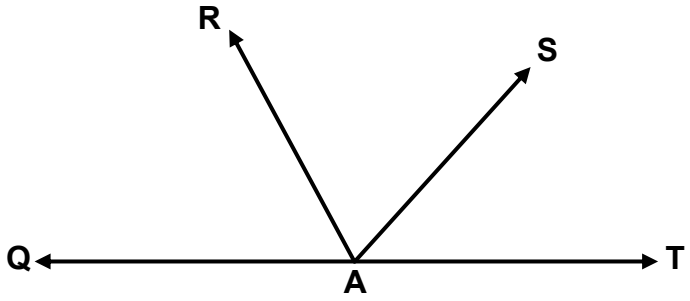
2. Name the sides and the vertex of the angles in Question 1.

Answers: a) Sides:_____, _____Vertex: _____

b) Sides:_____, _____Vertex: _____

c) Sides:_____, _____Vertex: _____

3. How many angles are there in the figure below?



Answer: _____

4. What type of angle is determined by the hands of the clock at

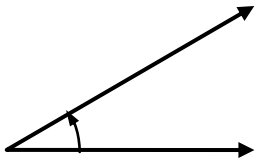
a) three o"clock **Answer:**_____

b) two o"clock **Answer:**_____

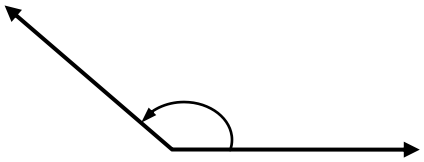
c) five o"clock **Answer:**_____

d) eight o"clock **Answer:**_____

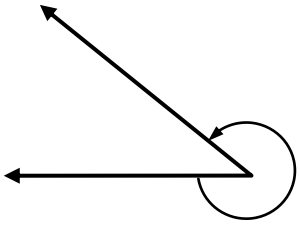
5. What type of angle is each of the following?



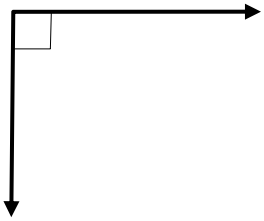
a) _____



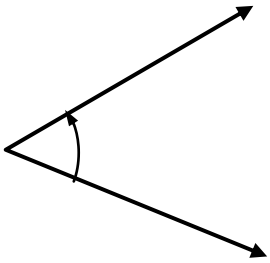
b) _____



c) _____



d) _____



e) _____

f) _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1.

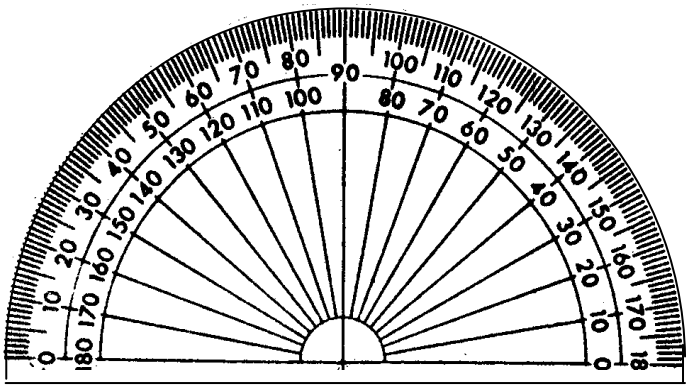
Lesson 2: Measuring Angles

In Lesson 1, you learnt to name, label and classify angles.

In this lesson, you will:

- estimate angles
- measure angles.

Angles are measured by using an instrument called a **protractor** shown below.



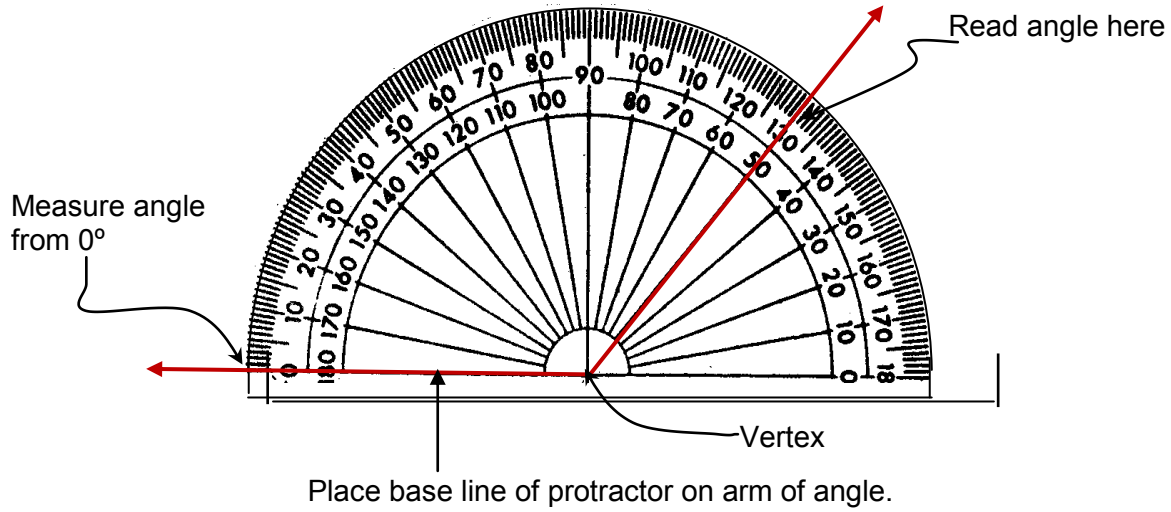
The unit in which angles are measured is called the **degree** (º).

0º is read „zero degree"

90º is read „ninety degrees"

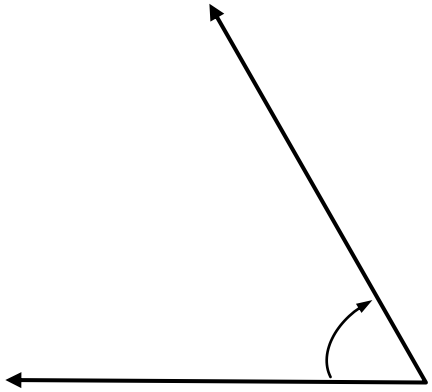
Protractors are semi-circular (the shape of half a circle) and can measure any angle up to a straight line or 180º. They have two sets of numbers from 0 to 180º so that you can measure from any direction. When you measure an angle with a protractor, place the centre of the protractor on the vertex and one arm on the base line.

Look at the diagram below in order for you to see and learn how to measure an angle.

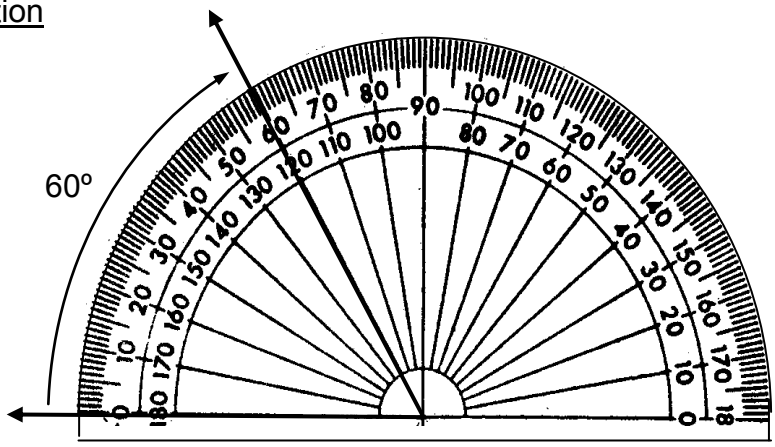


Example 1

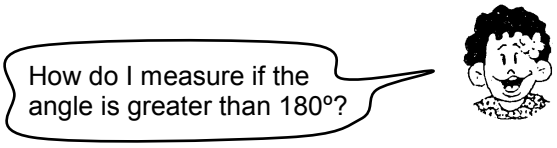
Use a protractor to measure the following acute angle.



Solution



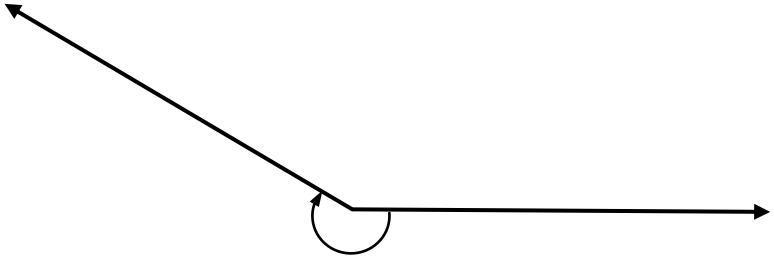
Make sure that the vertex of the angle is at the centre point and that one arm of the angle is on the base line of the protractor.



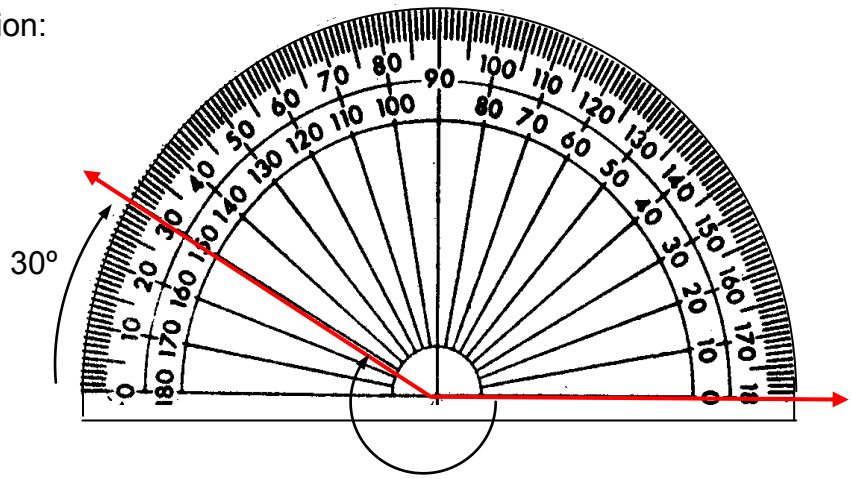
For angles greater than 180º you can measure the smaller angle on the other side of the angle and add this value to 180º to obtain the measure of the angle you want.

Example 2

Use a protractor to measure this reflex angle.



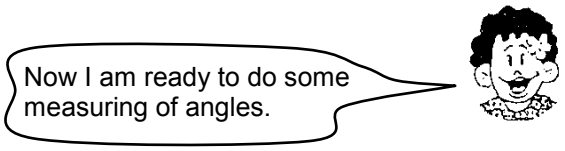
Solution:



$30^\circ + 180^\circ = 210^\circ$

$m\angle = 210^\circ$

The measure (*m*) of an angle is the amount of degrees the angle contains. If the angle "say ABC" contains (n) degrees then $m\angle ABC = n$.



NOW DO PRACTICE EXRECISE 2

Practice Exercise 2

1. Using the protractor below, write or give the measure of each of the following angles.

a) $m\angle AOB$

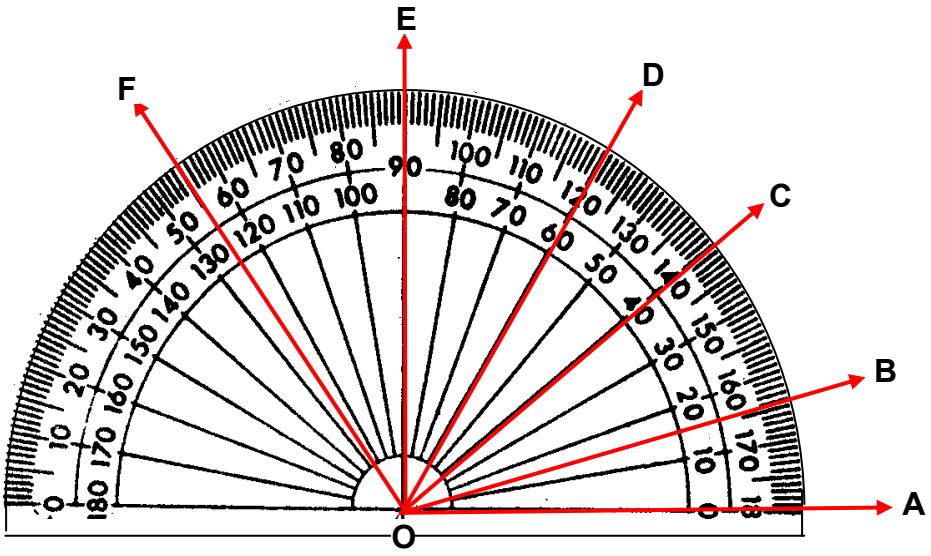
b) $m\angle AOC$

c) $m\angle AOD$

d) $m\angle AOE$

e) $m\angle AOF$

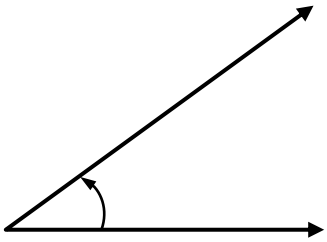
f) $m\angle COE$



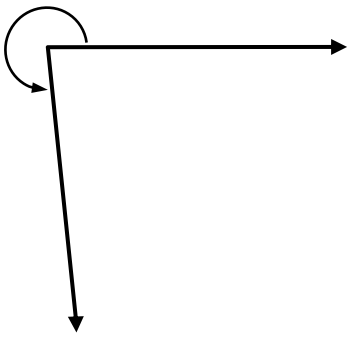
2. Without measuring the angles below, estimate whether they are:

- between 0º and 90º
- between 90º and 180º
- between 180º and 270º
- between 270º and 360 º

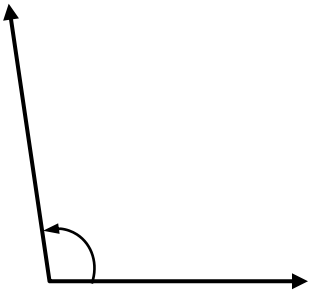
Measure the angles using a protractor and check your answer.



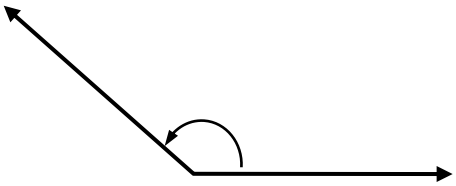
a) _____



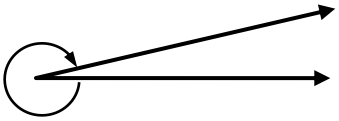
b) _____



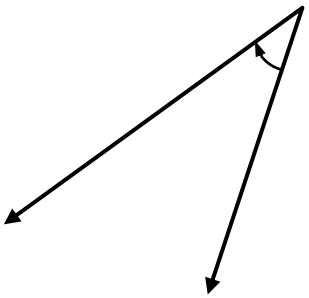
c) _____



d) _____



e) _____



f) _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1.

Lesson 3: Constructing Angles

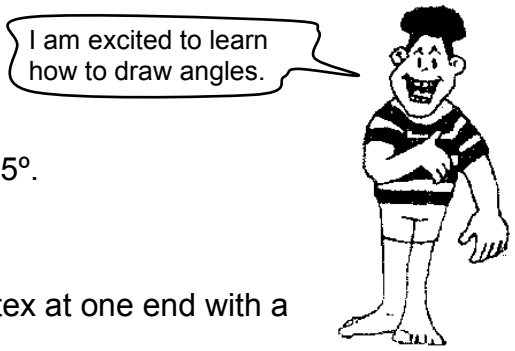
In Lesson 2, you learnt to estimate and measure angles.

In this lesson, you will:

- construct and measure angles.

First you will learn to draw and construct angles of measures using a protractor.

Now let us draw angles.



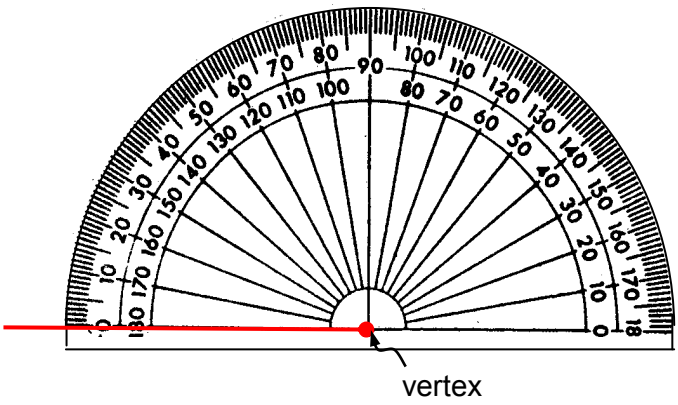
Example 1

Using a protractor, let us draw the angle $\angle A = 65^\circ$.

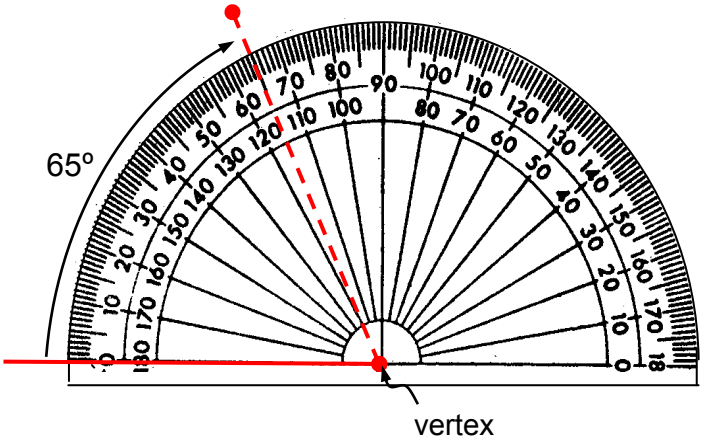
Here are the steps you have to follow.

Step 1: Draw a base line and mark the vertex at one end with a dot.

Step 2: Use the base line drawn as one arm of your angle. Place the protractor on the base line with its centre, 0, on the vertex dot.

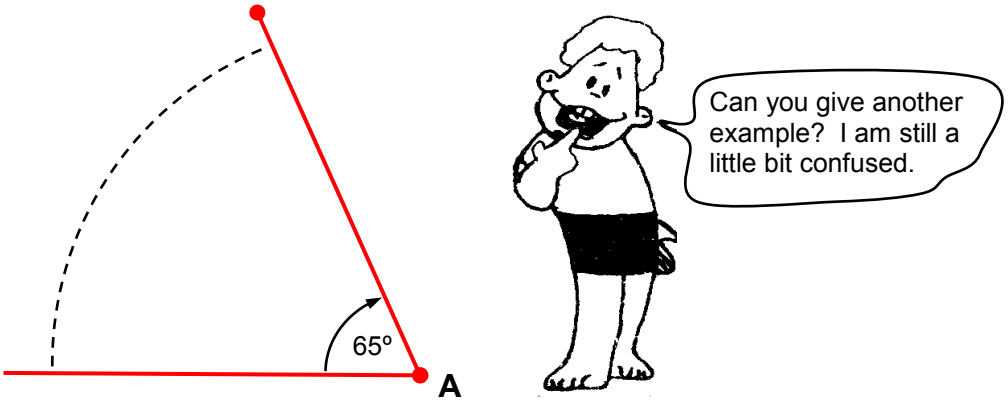


Step 3: Count from 0º mark till you get to the number of degrees you want. Place another dot at the desired angle marked 65º.



Step 4: Remove the protractor and draw a line between the vertex dot and the second dot you have drawn. You have drawn the second arm of the angle. Mark in the desired angle with an arc.

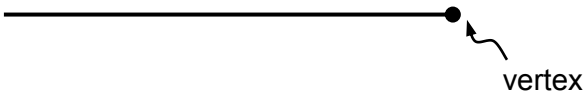
Here is your result for $\angle A = 65^\circ$.



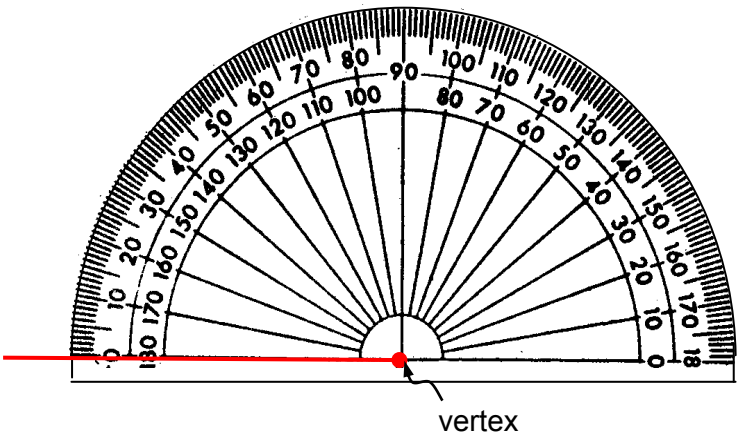
Example 2

Let us draw the $\angle B = 120^\circ$.

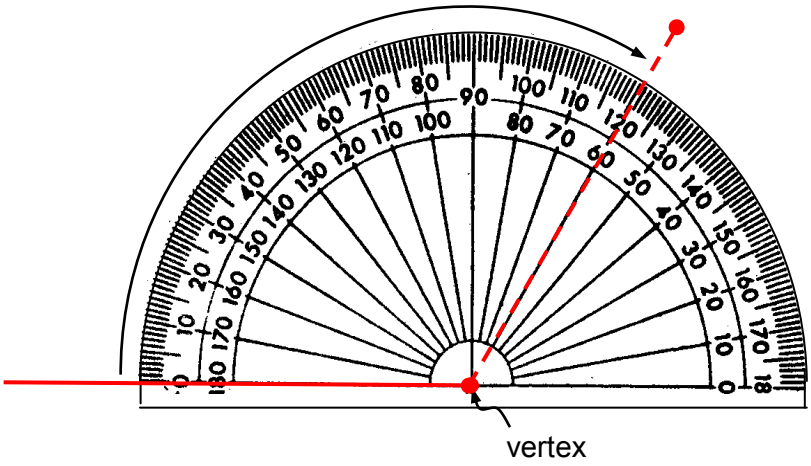
Step 1: Draw a base line and mark the vertex at one end with a dot.



Step 2: Use the base line drawn as one arm of your angle. Place the protractor on the base line with its centre, 0, on the vertex dot.

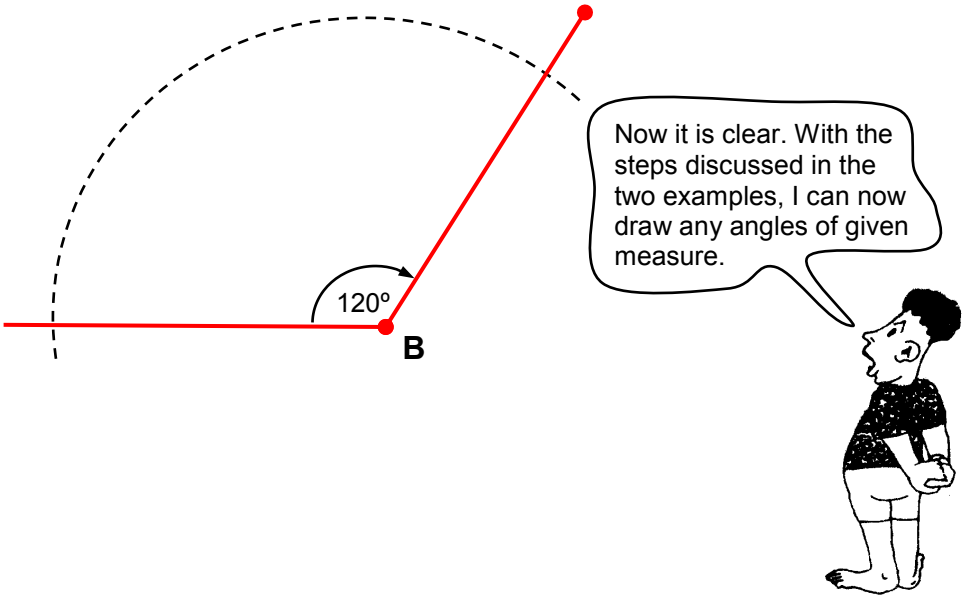


Step 3: Count from 0º mark till you get to the number of degrees you want. Place another dot at the desired angle marked 65º.



Step 4: Remove the protractor and draw a line between the vertex dot and the second dot you have drawn. You have drawn the second arm of the angle. Mark in the desired angle with an arc.

Here is your result for $\angle B = 120º$.



NOW DO PRACTICE EXERCISE 3

Practice Exercise 3

1. Draw the following angles:

   (a) acute $\angle$MON (b) right $\angle$2 (c) obtuse $\angle$CEO

   (d) straight $\angle$PQR (e) reflex $\angle$WXY

2. Use your protractor to draw the following angles. Ensure that they are correctly labeled.

   (a) $\angle$XYZ = 105º (b) $\angle$W = 40º (c) $\angle$ABC = 75º

   (d) $\angle$F = 270º (e) $\angle$M = 35º

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

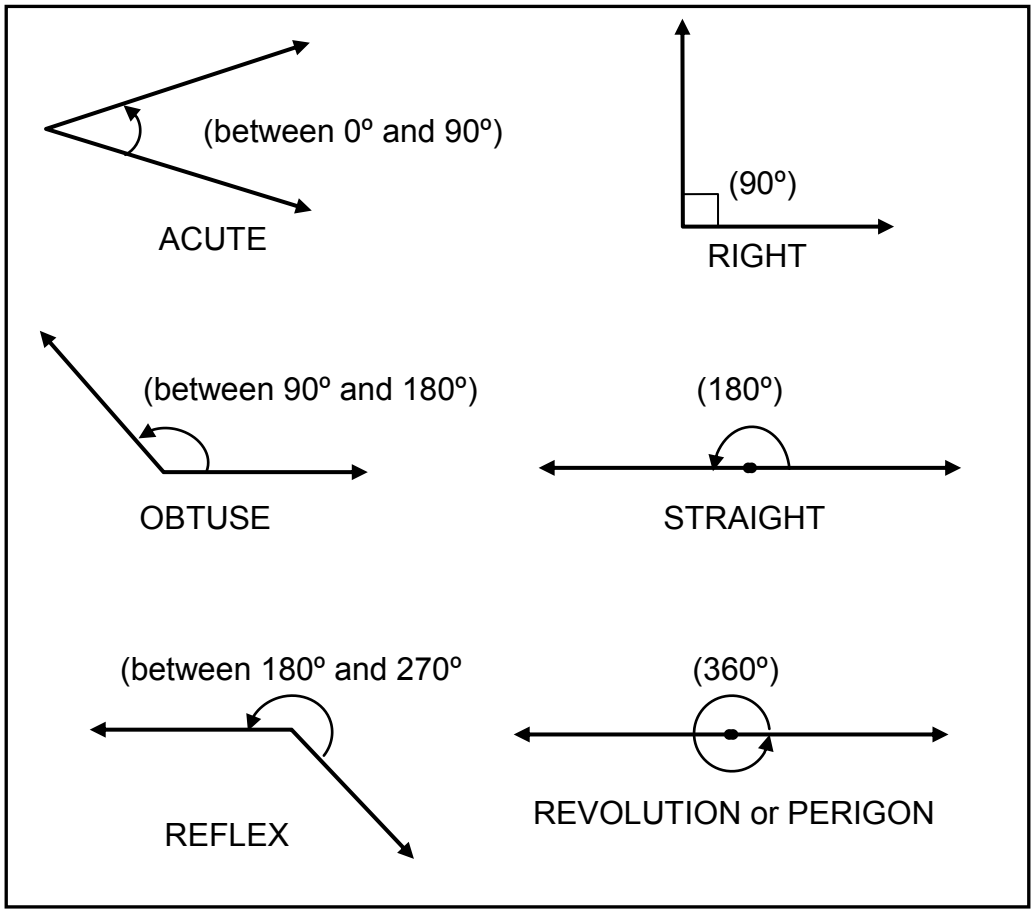
Lesson 4: Angle Pairs

In Lesson 2, you learnt that angles are classified as acute, obtuse, right, straight, reflex and revolution.

In this lesson, you will:

- identify and name angles formed by the intersection of straight lines
- define complement and supplement
- use „complementary" and „supplementary" for angles adding to 90º and 180º respectively
- use the terms „complement" and „supplement".

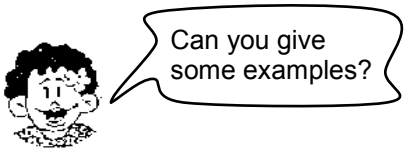
Here are the types of angles again.

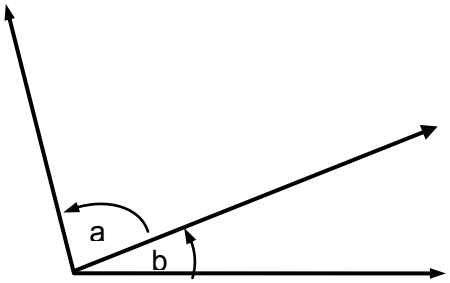


You are now going to learn about **adjacent angles**.

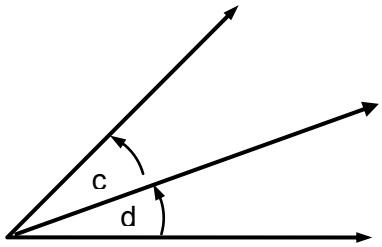
New Word

ADJACENT means "next to" or "beside". (You say "ad-jay- sent").

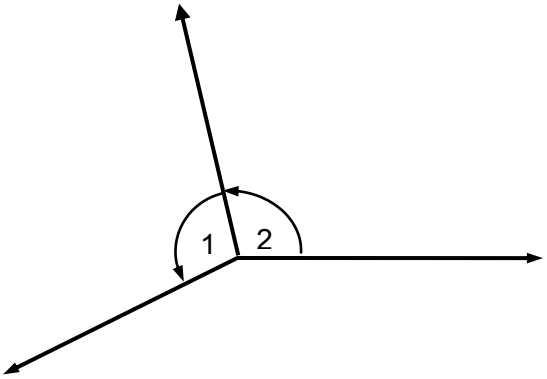




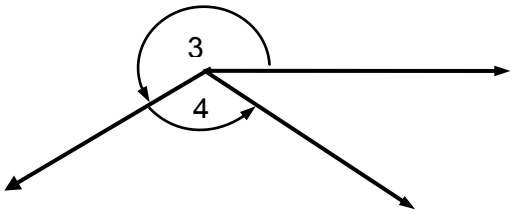
a and b are adjacent angles



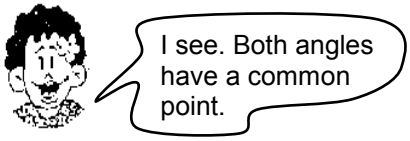
c and d are adjacent angles

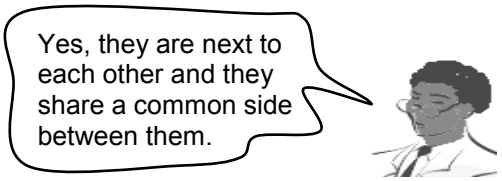


1 and 2 are adjacent angles



3 and 4 are adjacent angles





Adjacent angles are two or more angles which are next to each other and have a common vertex and a common side between them.

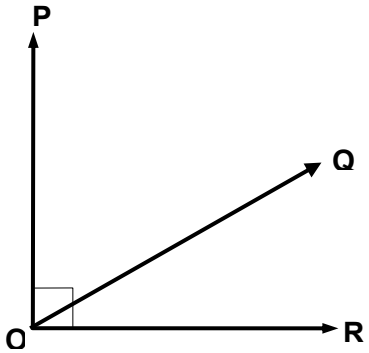
Now we will use the idea of adjacent angles to learn other angle pairs.

Measure ∠POQ and ∠QOR. What is the total measure of the two angles?

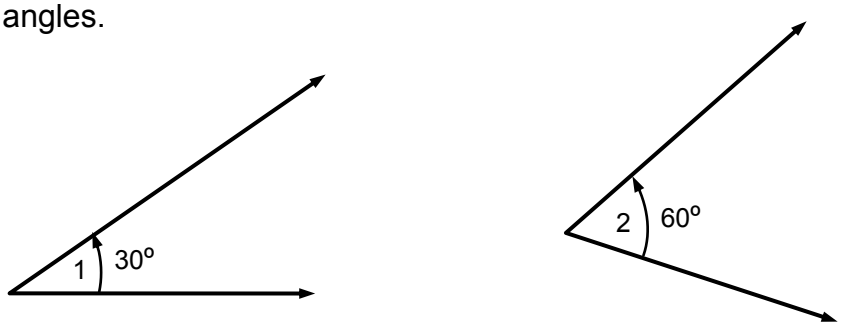
∠POQ + ∠QOR = 90

∠POQ and ∠QOR are complementary angles with a common side. They are called **adjacent complementary angles**.

Adjacent angles are complementary if they add up to 90º and form a right angle.



Here are two angles.

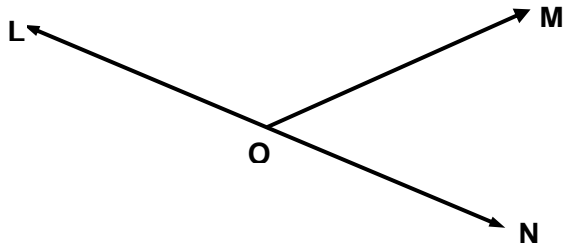


$\angle 1$ and $\angle 2$ are complementary angles since $\angle 1 + \angle 2 = 30º + 60º = 90º$.

We say, $\angle 1$ is the complement of $\angle 2$ and $\angle 2$ is the complement of $\angle 1$.

Now look at the angles below.

$\angle$LOM and $\angle$MON form a straight line and add up to 180º.

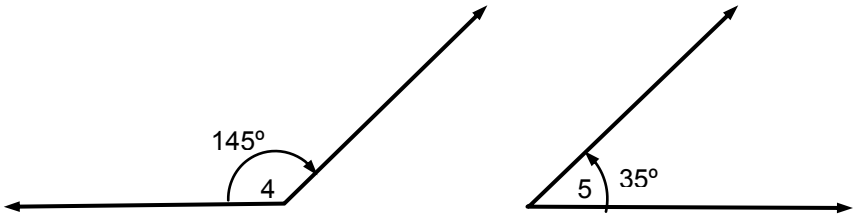


$\angle$LOM + $\angle$MON = 180º

$\angle$LOM and $\angle$MON are supplementary angles and shared a common vertex. They are called **adjacent supplementary angles.**

Adjacent angles are supplementary if they add up to 180º and form a straight angle.

Here are another two angles.



$\angle 4 + \angle 5 = 145º + 35º = 180º$

$\angle 4$ and $\angle 5$ are supplementary angles.

We say $\angle 4$ is the supplement of $\angle 5$.

Complementary angles are two angles whose sum is 90º and make a right angle.

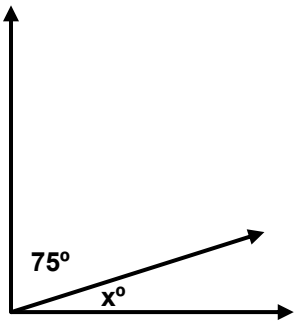
Supplementary angles are two angles whose sum is 180º and make a straight angle.

You can use the idea of adjacent complementary and supplementary angles to help us solve problems.

We can sometimes work out the size of an angle if we know the size of its adjacent angle, its complement angle or its supplement angle.

Example 1

Find the size of the angle marked **xº** in the following figure below?



Solution: xº and 75º are adjacent angles. Together they make a right angle, 90º

Therefore, they are complementary.
So, subtract 75º from 90º to find the complement xº.

xº = 90º - 75º

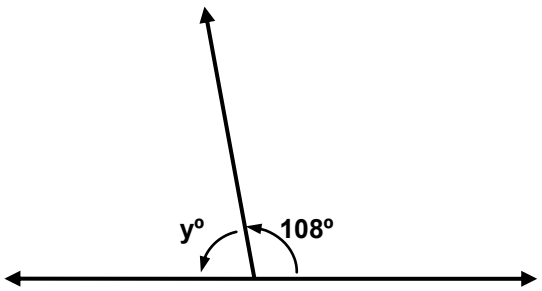
x = 15º

Therefore: ∠x = 15º

We say, the complement of 75º is 15º.

Example 2

Now, work out the size of angle y in the figure below.



yº and 108º are adjacent angles.
Together they make a straight angle, 180º.
Therefore they are supplementary.
To find yº, subtract 108º from 180º.

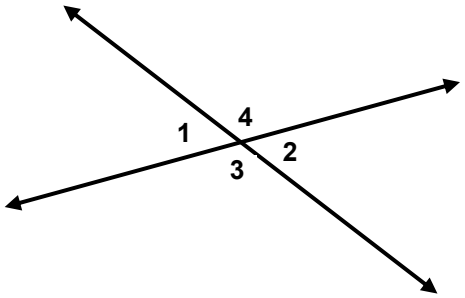
y = 180º - 108º

y = 72º

So, the supplement of 108º is 72º.

Now you are going to learn vertical angles.

Look at the diagram.



Vertical Angles are formed by intersecting lines (**lines that cut or cross each other**). $\angle 1$ and $\angle 2$ are vertical angles. What is the other pair of vertical angles in the figure?

Measure $\angle 1$ and $\angle 2$, $\angle 3$ and $\angle 4$
What do you notice with the measure of the vertical angles?

Vertical angles are **congruent,** that is, they have the same size and shape.

We write in symbols, $\angle 1 \cong \angle 2$ and $\angle 3 \cong \angle 4$. **Congruent angles** have equal measures.

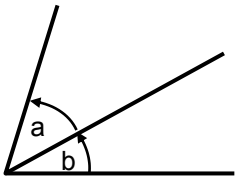
NOW DO PRACTICE EXERCISE 4

Practice Exercise 4

1. Are angles **a** and **b** in the diagrams below adjacent angles?

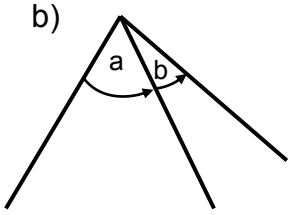
   Write YES or NO under each diagram.

a)



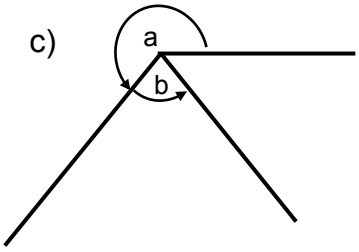
Answer: _____

b)



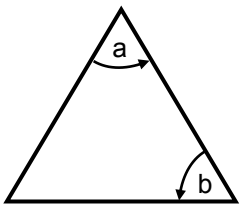
Answer: _____

c)



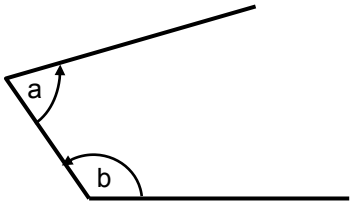
Answer: _____

d)



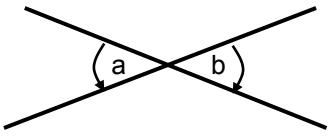
Answer: _____

e)



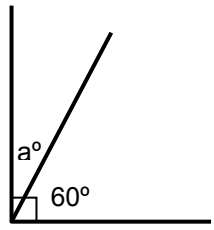
Answer: _____

f)

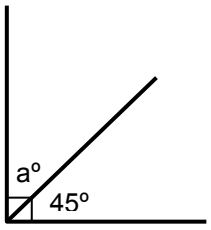


Answer: _____

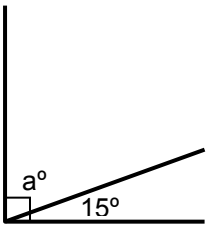
2. Find the size of angle aº in each of the following.



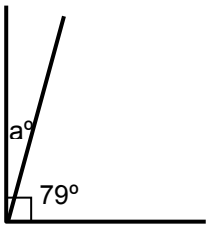
a) _____



b) _____



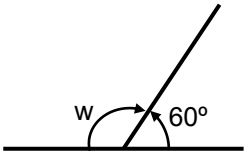
c) _____



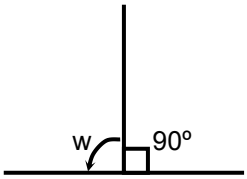
d) _____

---

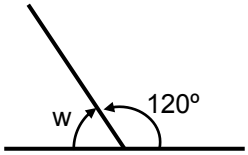
3. Find the size of angle wº in the following diagrams



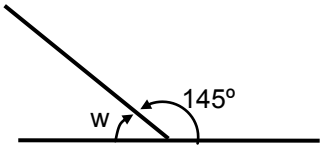
a) _____



b) _____



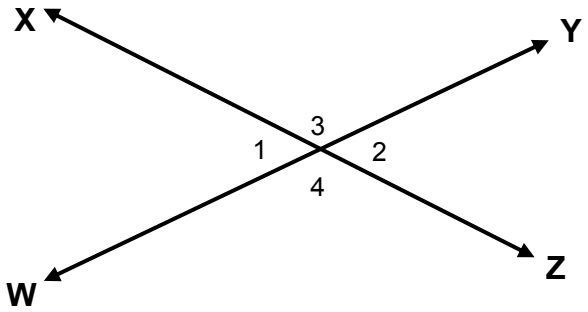
c) _____



d) _____

---

4. Refer to the figure below and answer the questions a to i.



a) ∠1 = _____

b) ∠3 = _____

c) _____ and _____ are adjacent to ∠2

d) _____ and _____ are adjacent to ∠1

e) _____ and _____ are vertical angles

f) _____ and _____ are vertical angles

g) _____ and _____ are supplementary to ∠1

h) _____ and _____ are supplementary to ∠2

i) if ∠1 measures 70º , ∠4 = _____ , ∠2 = _____ and ∠3 = _____.

CORRECT YOUR WORK ANSWERS ARE AT THE END OF SUB-STRAND 1.

Lesson 5: Angles in a Triangle

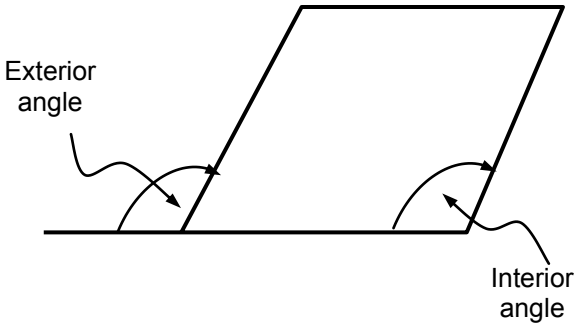
You learnt about angle pairs in Lesson 4.

In this lesson, you will:

- determine the angle properties of triangles
- measure the sum of the interior and exterior angles of triangles.

First, you will learn about the meanings of an interior and an exterior angle.

The diagram below, shows the interior and exterior angles



Interior angle is an angle inside of a shape.
Exterior angle is an angle outside of a shape

Measures of the Angles of a Triangle

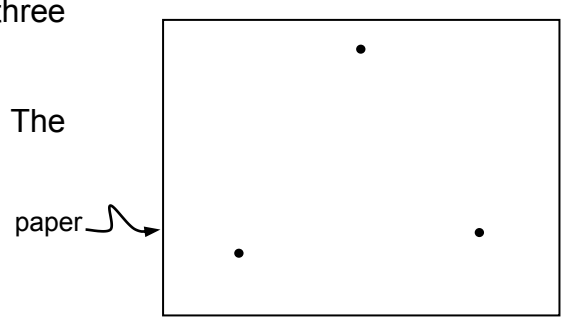
An interesting property of the sum of the measures of the angles of a triangle can be seen through the following activities.

You will need: Ruler, pen or pencil, paper, scissors and protractor.

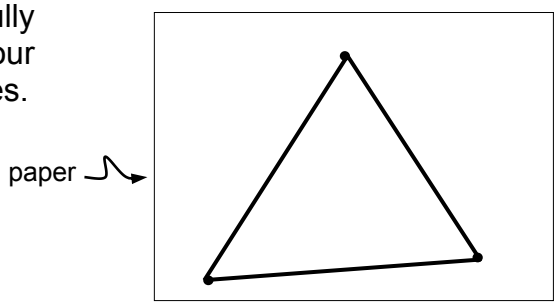
Activity 1:

Step 1: On your paper, mark three points.

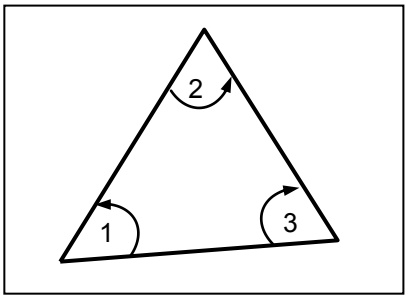
They will be the vertices. The points should be far apart.



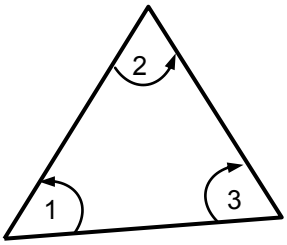
Step 2: Using your ruler, carefully draw the three sides of your triangle by joining the vertices.



Step 3: Mark the angles of your triangle with the numbers 1, 2, 3.

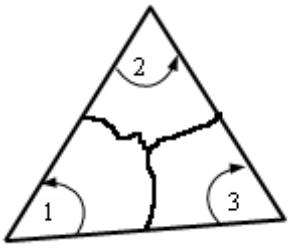


Step 4: Using your scissors, cut out the triangle you have drawn.

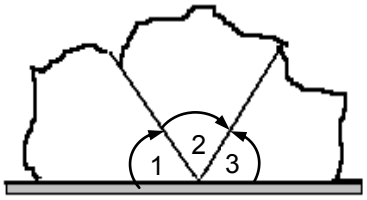


Step 5: Tear your triangle into 3 pieces as shown.

Each piece must have one of the angles in it.



Step 6: Place your angles 1, 2, and 3 adjacent to each other along a straight edge of your ruler as shown.



You should find that the three angles fit exactly to make a straight angle!

REMEMBER:

The sum of the angles of a triangle is 180º.

$\angle 1 + \angle 2 + \angle 3 = 180^{o}$

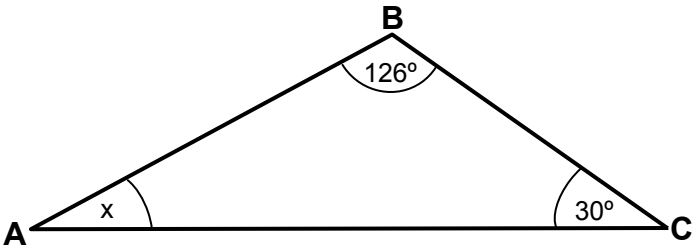
So now we can work out the size of any angle in a triangle if we know the other two angles.

Example

Consider a triangle in which we do not know the size of one of the angles.

Below is the triangle, ΔABC. We know the size of two angles: ∠B = 120º and ∠C = 30º.

We will work out the size of ∠A, which is marked x.



Solution:

Step 1: We know that the sum of the angles of a triangle is 180º

So, x + 126º + 30º = 180º

Step 2: Add: 126º + 30º = 156º

Step 3: Subtract 156 from 180º to find the value for x.

x = 180º – 156º

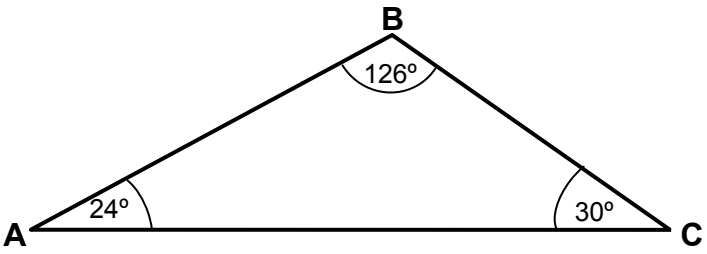
x = 24º

So, the size of ∠A = 24º

Check the answer. Do the three angles add up to 180º?

24º + 126º + 30º = 180º ✓ YES

Write the size of ∠A on the diagram: x = 24º

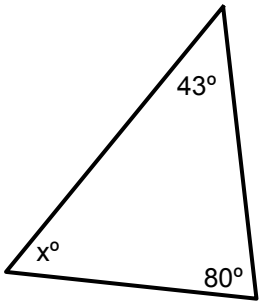


NOW DO PRACTICE EXERCISE 5A

Practice Exercise 5A

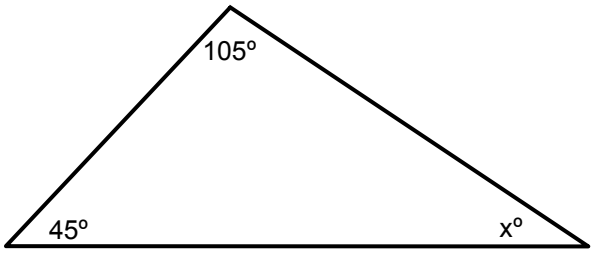
Calculate the size of the third angle in each of the following triangles.

1.



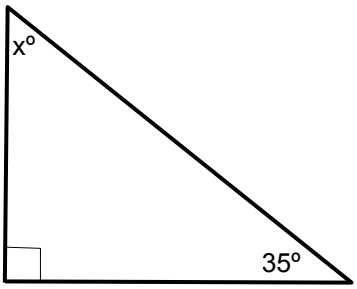
Answer: _____

2.



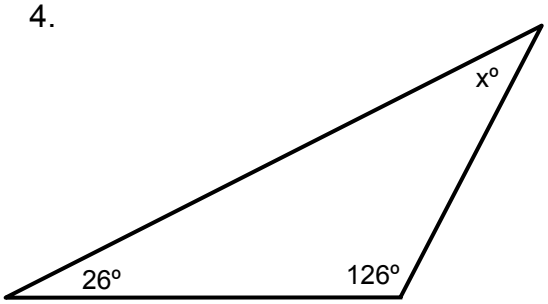
Answer: _____

3.



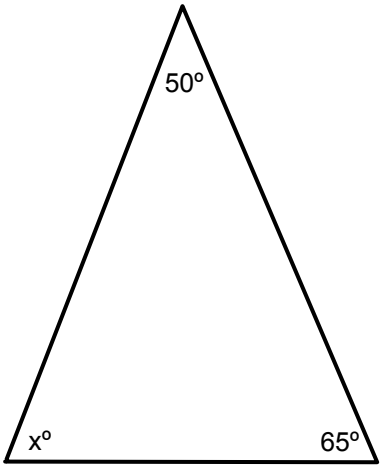
Answer: _____

4.



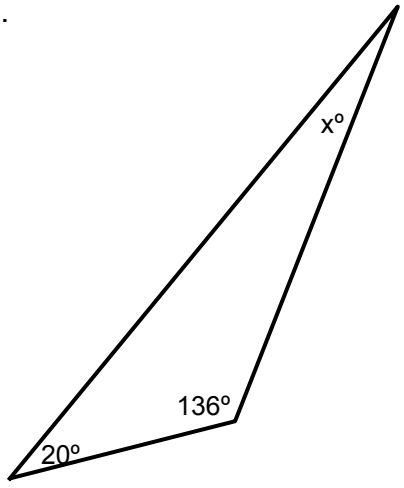
Answer: _____

5.



Answer: _____

6.



Answer: _____

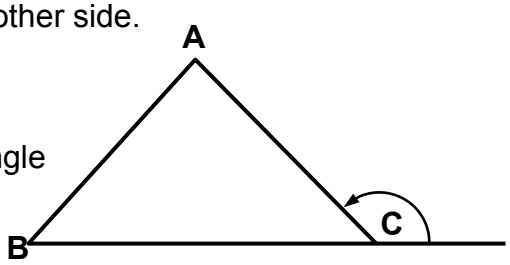
CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

Do you remember learning about exterior angles on page 30?

An **exterior angle of a triangle** is the one drawn on the outside of a triangle between a side that has been extended and the other side.

Look at the triangle.

Angle **C** is known as an exterior angle in the triangle



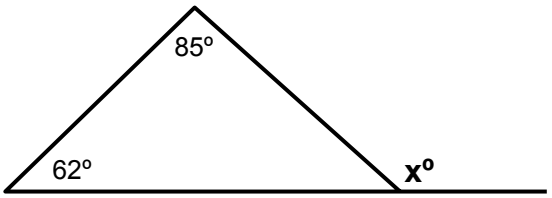
In any triangle, the sum of the two interior opposite angles is equal to the size of the exterior angle.

That is, $\angle A + \angle B = \angle C$

Now you are going to learn about the measure of an exterior angle of a triangle.

Example

Find the size of the angle marked **x^o** in the diagram.



Solution: $x^o = 85^o + 62^o$

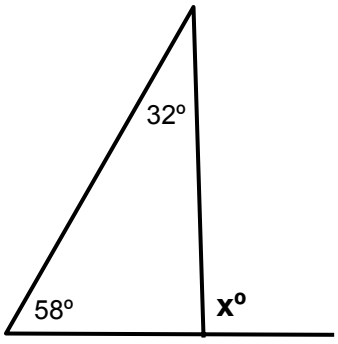
$x = 147^o$

NOW DO PRACTICE EXERCISE 5B

Practice Exercise 5B

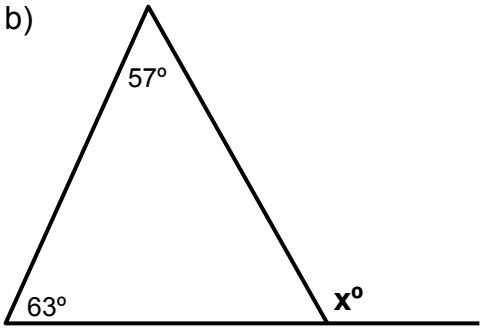
Using the exterior angle property of triangles, find the unknown angle marked **x** in the following triangles.

a)



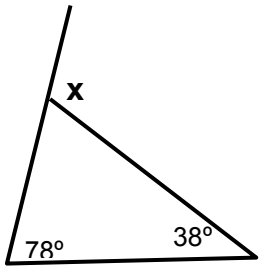
Answer: _____

b)



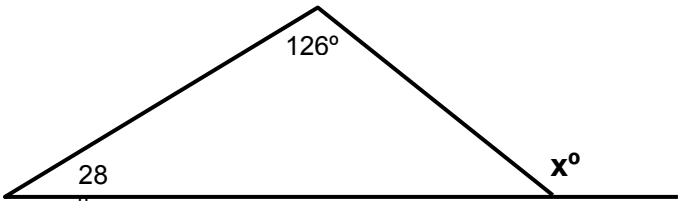
Answer: _____

c)



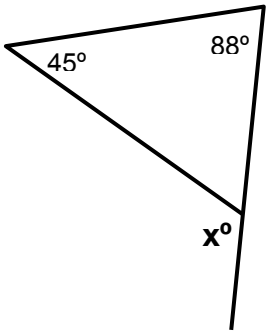
Answer: _____

d)



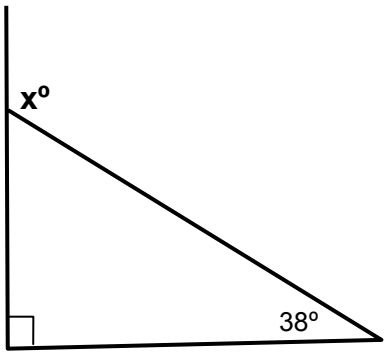
Answer: _____

e)



Answer: _____

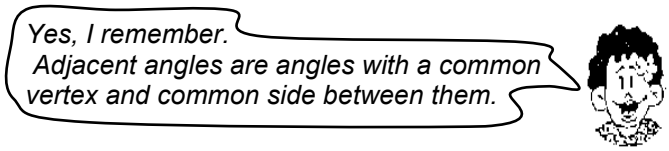
f)



Answer: _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1

Do you remember learning about adjacent angles in Lesson 4?

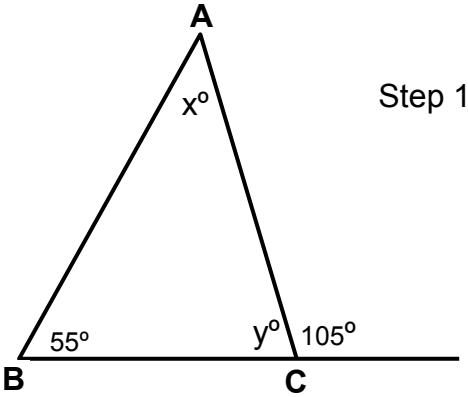


Look again at Lesson 4 if you do not remember this work.

We will use adjacent angles to help us work out some problems about angles of triangles.

Example 1

Here is a triangle, ΔABC. We know ∠B = 55º, but we don"t know the measure of ∠A and ∠C which are marked as xº and yº respectively. Can we find ∠A and ∠C?



Step 1: Find y.

We know that yº + 105º = 180º because the angles yº and 105º are adjacent and together they make a straight angle of 180º.

So, yº = 180º - 105º

yº = 75 or y = 75º

Check if the answer is correct. CHECK: 105º + 75º = 180º ✓

Step 2: Find x.

We know that $\angle A + \angle B + \angle C = 180^o$

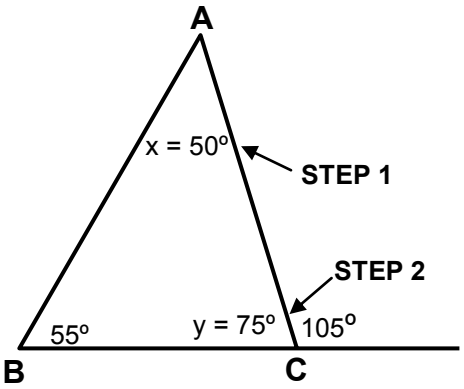
So, $x^o + 55^o + 75^o = 180^o$

$x^o + 130^o = 180^o$

Subtract 130^o on both sides → $x^o = 180^o - 130^o$

$x = \underline{50^o}$

CHECK: $\underline{50^o} + 55^o + 75^o = 180^o$ ✓



Write the answer for y and x on the diagram as you work them out.
If you are asked to find x only, you still have to follow steps 1 and 2.

Example 2

Find the size of x in the triangle ABC.

Step 1: Find y.

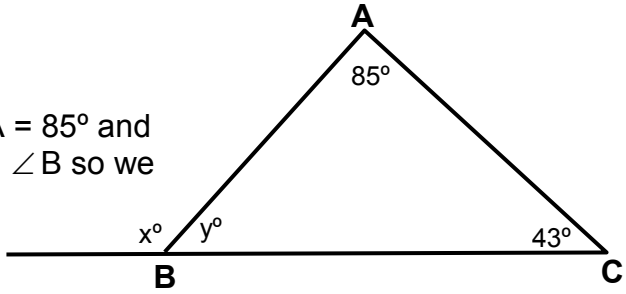
We know that in ΔABC, $\angle A = 85^o$ and $\angle C = 43^o$. We do not know $\angle B$ so we must work it out.

$y + 85^o + 43^o = 180^o$

$y + 128^o = 180^o$

$y = 180^o - 128^o$ ← Subtract 128^o on both sides

$y = \underline{52^o}$



Check: $\underline{52^o} + 85^o + 43^o = 180^o$ ✓

Write your answer for y in the correct place on the diagram.

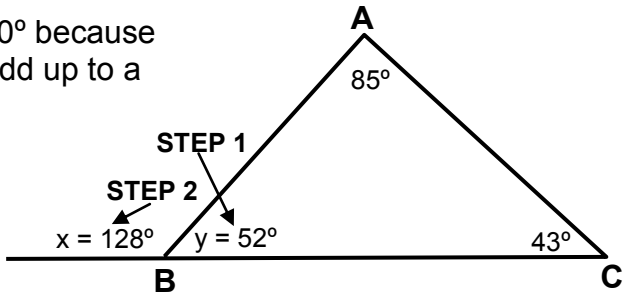
Step 2: Find x.

We know that $x + 52^o = 180^o$ because x and y are adjacent and add up to a straight angle, 180^o.

$x = 180^o - 52^o$

$x = \underline{128^o}$

Check: $\underline{128^o} + 52^o = 180^o$ ✓



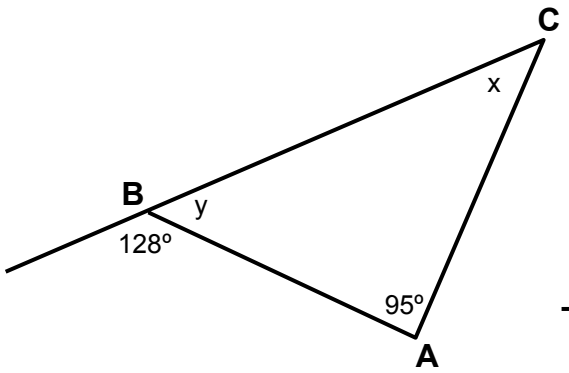
Write your answer for x in the correct place in the diagram.

NOW DO PRACTICE EXERCISE 5C

Practice Exercise 5C

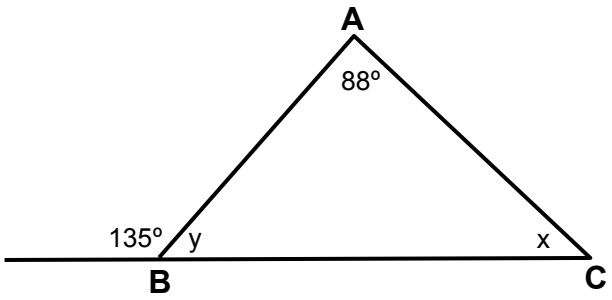
Work out the size of the angle marked **x** and **y** in the diagrams below.

1)



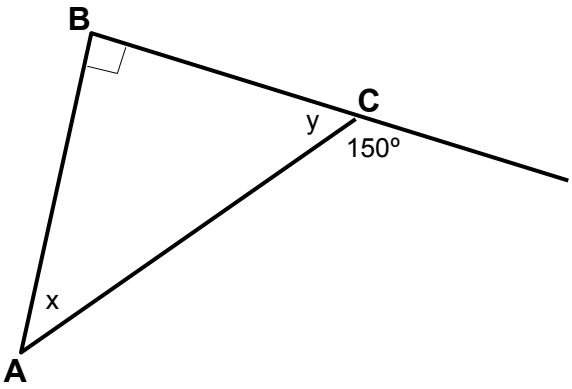
Answer: _____

2)



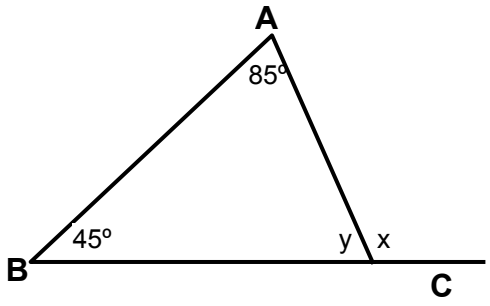
Answer: _____

3)



Answer: _____

4)



Answer: _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1

Lesson 6: Angles of Quadrilaterals

In Lesson 5, you learnt to measure the angles of a triangle.

In this lesson, you will:

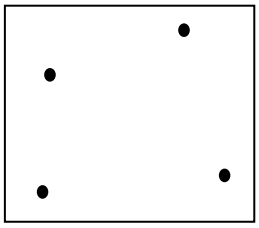
- measure the sum of the interior angles of quadrilaterals.

An interesting property of the sum of the measures of the angles of a quadrilateral can be seen through the following examples.

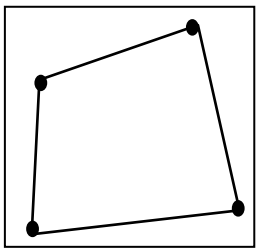
You will need: Ruler, pen or pencil, paper, scissors and protractor.

Example 1

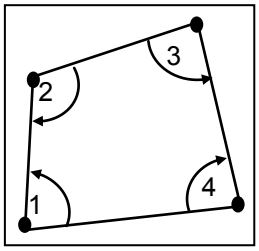
Step 1: On your paper, mark four points. They will be the vertices. The points should be far apart.



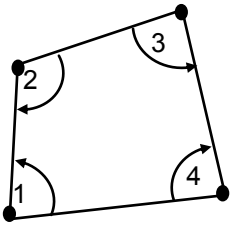
Step 2: Using your ruler, carefully draw the four sides of your quadrilateral by joining the vertices.



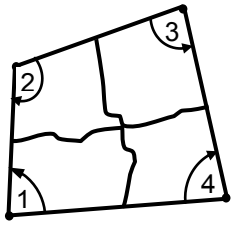
Step 3: Mark the angles of your quadrilateral with the numbers 1, 2, 3 and 4.



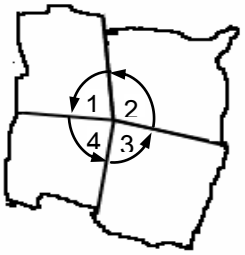
Step 4: Using your scissors, cut out the quadrilateral you have drawn.

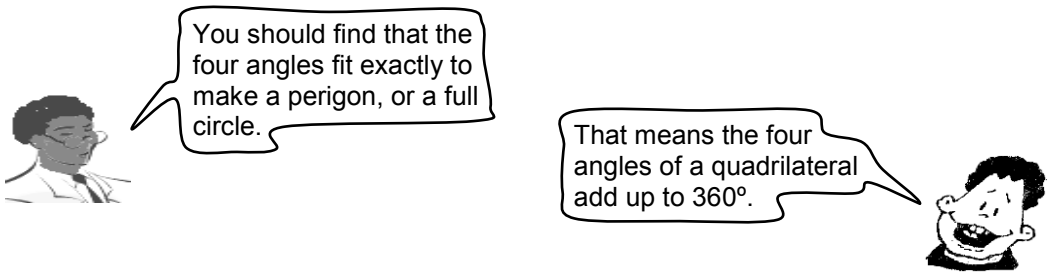


Step 5: Tear your quadrilateral into 4 pieces as shown. Each piece must have one of the angles in it.



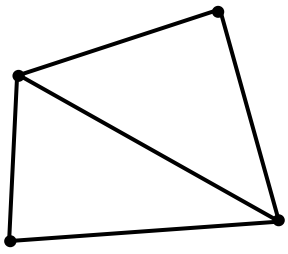
Step 6: Place the corners of your angles 1, 2, 3 and 4 adjacent to each other.





We can also show that the sum of the interior angles of a quadrilateral add up to 360º in another way.

We know that there are 180º in a triangle. You must also know that a quadrilateral can be divided or split into two triangles as shown,



Each triangle has 180º and the two triangles of the quadrilateral is 2 x 180º = 360º.

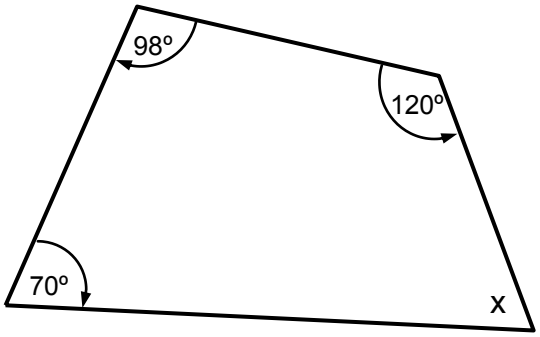
REMEMBER:

The sum of the interior angles of a quadrilateral is 360º.

$\angle 1 + \angle 2 + \angle 3 + \angle 4 = 360º$

Example 2

If you know the size of the three angles in a quadrilateral, can you find the fourth angle?



To find the size of $\angle x$, follow these steps:

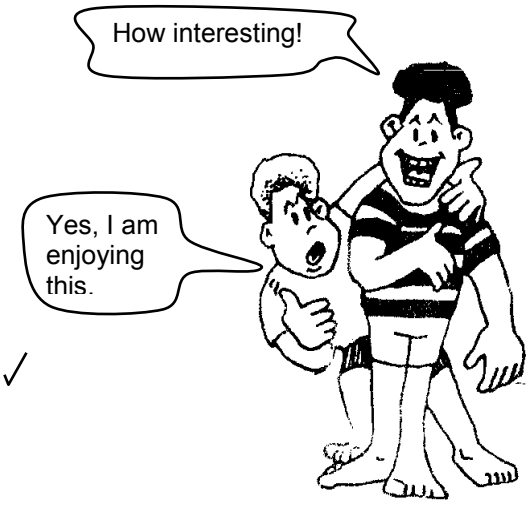
Step 1: We know that the sum of the angles of a quadrilateral is 360º.

So, $x + 70º + 98º + 120º = 360º$

Step 2: Add together the three angles we know.

$70º + 98º + 120º = 288º$

So, $x + 288º = 360º$



Step 3: To find x, subtract 288º from 360º.

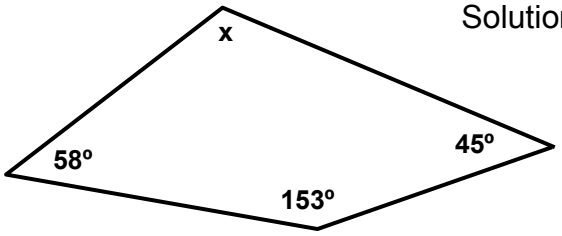
$x = 360º - 288º$

$x = \underline{72º}$

Check: $\underline{72º} + 70º + 98º + 120º = 360º$ ✓

Example 3

Find the missing angle.



Solution: The shape is a quadrilateral.

There are 360º in a quadrilateral.

So, $x + 58º + 45º + 133º = 360º$

Add together the known angles.

$58º + 45º + 133º = 236º$

To find x, subtract 236º from 360º.

$x = 360º - 236º$

$x = \underline{124º}$

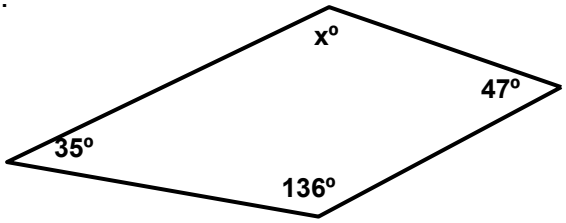
Check: $\underline{124º} + 58º + 45º + 133º = 360º$ ✓

NOW DO PRACTICE EXERCISE 6

Practice Exercise 6

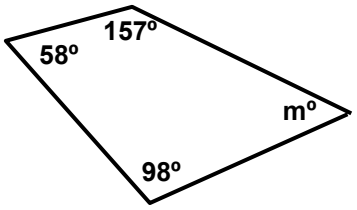
Find the size of the unknown angle marked in the following quadrilaterals.

1.



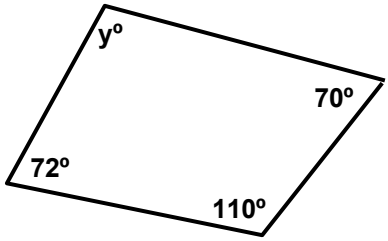
Answer: _____

2.



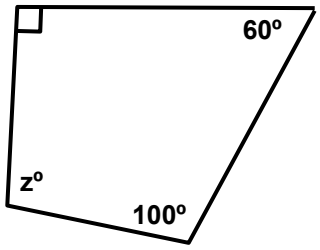
Answer: _____

3.



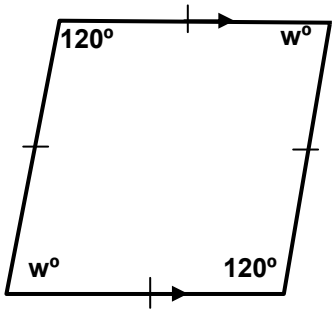
Answer: _____

4.



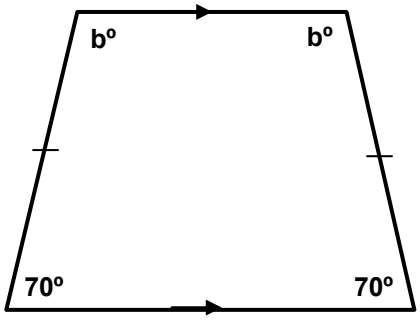
Answer: _____

5.



Answer: _____

6.



Answer: _____

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1

SUB-STRAND 1: SUMMARY

This summarises some of the important ideas and concepts to remember.

- An **angle** is formed when two lines or rays meet at a point called a **vertex**.
- The symbol for angle is $\angle$.
- Angles can be named in three ways:
    - by reading the capital letter at the vertex
    - by reading the inside letter or numeral
    - by reading the three letters associated with the sides and the vertex with the letter at the vertex always at the middle.
- A **protractor** is an instrument for measuring angles.
- A unit measure for angles is the **angle degree** (**º**)**.**
- Angles are classified according to their size as follows:
    - acute angle – has a measure greater than 0º but less than 90º.
    - right angle – has a measure of 90º
    - obtuse angle - has a measure greater than 90º but less than 180º
    - straight angle – has a measure of 180º
    - reflex angle – has a measure greater than 180º but less than 360º
    - Perigon or 1 revolution – has a measure of 360º
- **Complementary angles** are two angles whose sum is 90º and make a right angle.
- **Supplementary angles** are two angles whose sum is 180º and make a straight angle.
- **Intersecting lines** form vertical angles
- **Vertical angles** are congruent.
- **Interior angle** is an angle on the inside of a shape
- **Exterior angle** is an angle on the outside of a shape
- In any triangle, the sum of the two interior opposite angles is equal to the size of the exterior angle.
- The sum of the interior angles of a triangle is **180º**.
- The sum of the interior angles of any quadrilateral is **360º**.

REVISE LESSONS 1-6 THEN DO SUB-STRAND TEST 1 IN ASSIGNMENT 2.

ANSWERS TO PRACTICE EXERCISES 1- 6

Practice Exercise 1

1. a) $\angle X$, $\angle 3$, $\angle WXY$ b) $\angle O$, $\angle 1$, $\angle MON$ c) $\angle R$, $\angle 5$, $\angle PRS$

2. a) Sides = $\overrightarrow{WX}$, $\overrightarrow{XY}$ Vertex = Point X

   b) Sides = $\overrightarrow{MO}$, $\overrightarrow{ON}$ Vertex = Point O

   c) Sides = $\overrightarrow{PR}$, $\overrightarrow{RS}$ Vertex = Point R

3. 6 angles

4. a) right angle c) obtuse angle
   b) acute angle d) reflex angle

5. a) acute angle d) right angle
   b) obtuse angle e) acute angle
   c) reflex angle f) straight angle

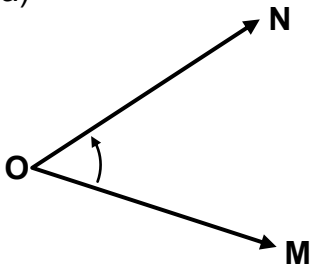
Practice Exercise 2

1. (a) $m\angle AOB = 16^o$ (d) $m\angle AOE = 90^o$
   (b) $m\angle AOC = 40^o$ (e) $m\angle AOF = 125^o$
   (c) $m\angle AOD = 60^o$ (f) $m\angle COE = 50^o$

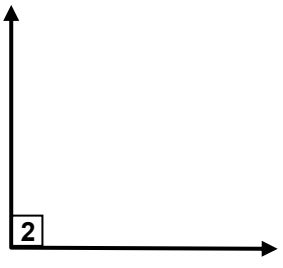
2. (a) between 0º and 90º (d) between 90º and 180º
   (b) between 270º and 360º (e) between 270º and 360º
   (c) between 90º and 180º (f) between 0º and 90º

Practice Exercise 3

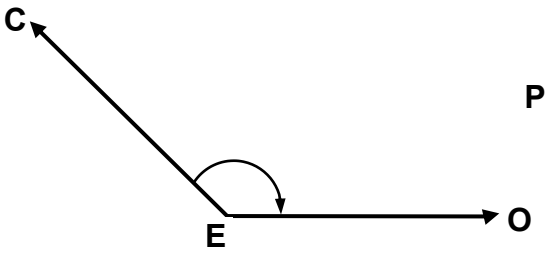
1. (a)



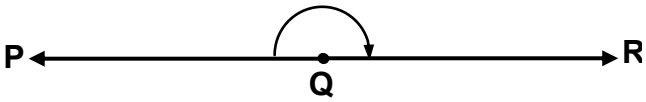
(b)



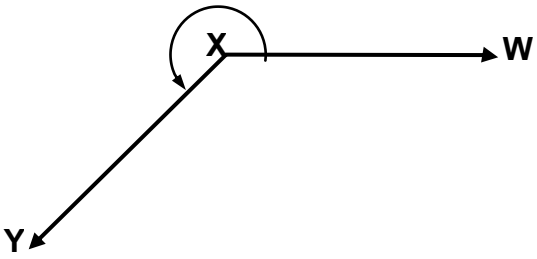
(c)



(d)

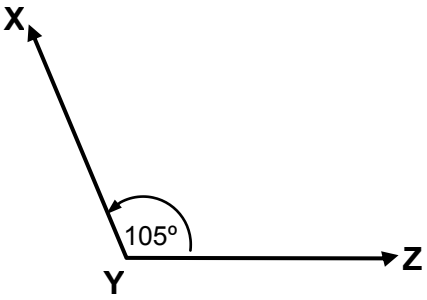


(e)

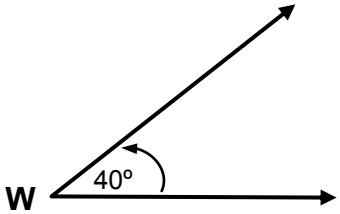


2.

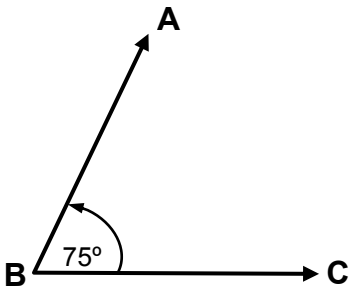
(a)



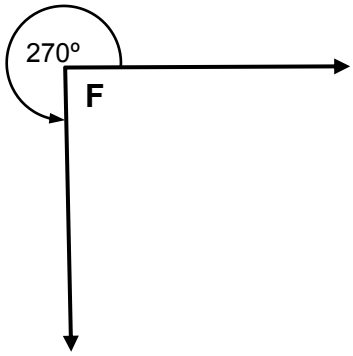
(b)



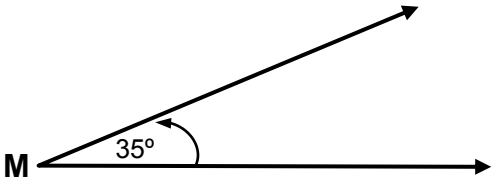
(c)



(d)



(e)



Practice Exercise 4

1. (a) YES (d) YES
   (b) YES (e) YES
   (c) YES (f) NO

2. (a) 30º (b) 45º (c) 75º (d) 11º

3. (a) 120º (b) 90º (c) 60º (d) 35º

4. (a) $m \angle 2$ (b) $m \angle 4$

   (c) $\angle 3$ and $\angle 4$ (d) $\angle 3$ and $\angle 4$

   (e) $\angle 1$ and $\angle 2$ (f) $\angle 3$ and $\angle 4$

   (g) $\angle 3$ and $\angle 4$ (h) $\angle 3$ and $\angle 4$

   (i) $\angle 4 = 110°$, $\angle 2 = 70°$ and $\angle 3 = 110°$

Practice Exercise 5A

1. 57º 2. 30º 3. 55º

4. 28º 5. 65º 6. 24º

Practice Exercise 5B

(a) 90º (b) 120º (c) 116º

(d) 154º (e) 133º (f) 128º

Practice Exercise 5C

1. x = 33º , y = 52º 2. y = 45º , x = 47º

3. y = 30º , x = 60º 4. y = 50º , x = 130º

Practice Exercise 6

1. 142º 2. 47º 3. 108º

4. 110º 5. 60º 6. 110º

END OF SUB-STRAND 1

SUB- STRAND 2

SHAPES

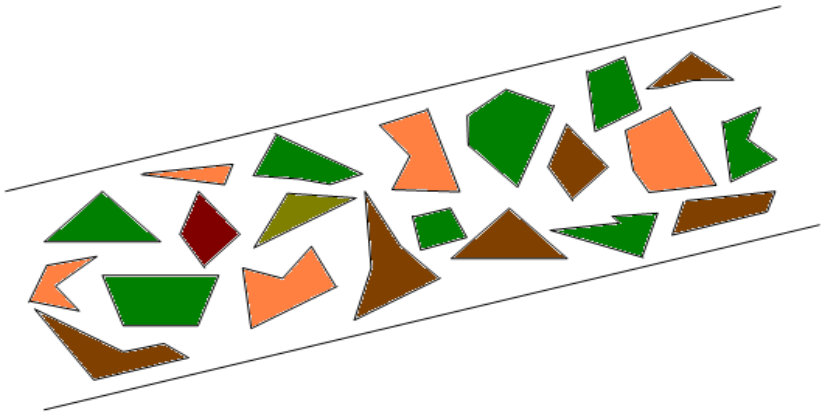
SUB-STRAND 2: SHAPES

Introduction

Dear student,

Welcome to Sub-strand 2 of Strand 2. In this sub-strand you will learn to draw, investigate and make physical models of polygons and quadrilaterals.

A path in the school grounds is made up of bricks, pieces of clay, gravel, and stone laid out like the diagram below to form a flat surface.



Name the different shapes you see?

What do all these shapes have in common?

In your Lower Primary, you learnt the names of common shapes like triangles, squares, rectangles and other quadrilaterals. In this sub-strand, you will learn to name other shapes such as polygons and identify their properties. You will also learn to draw and make model of quadrilaterals such as parallelogram, rhombus, trapezium and kite.

Lesson 7: Polygons

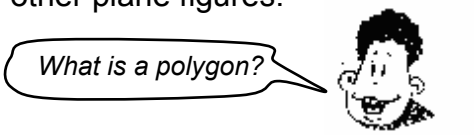
All around us we see different kinds of geometric figures. Among the figures we see are those made up of line segments. If the figure making the line segments is closed, it is called a polygon. You are already familiar with some of these, like the triangle, square and rectangle.

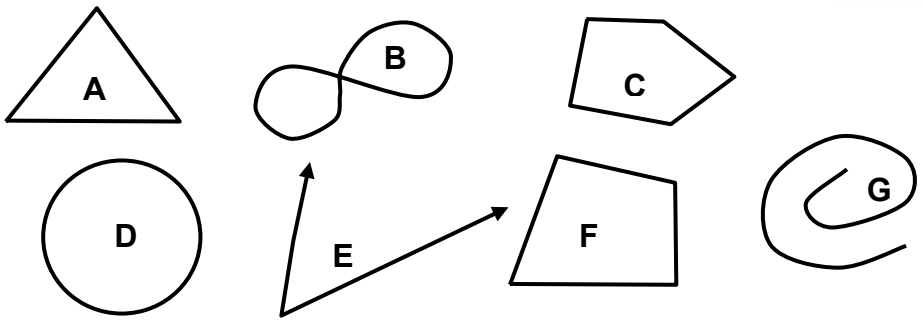
In this lesson, you will:

- draw polygons and identify their properties.
- name the different kinds of polygons.

First you will learn to distinguish a polygon from other plane figures.

Study the figures below.

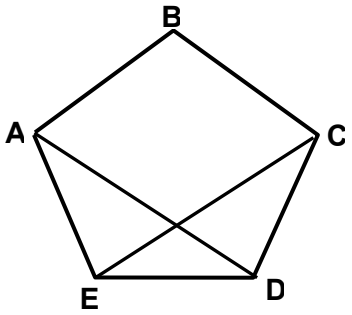




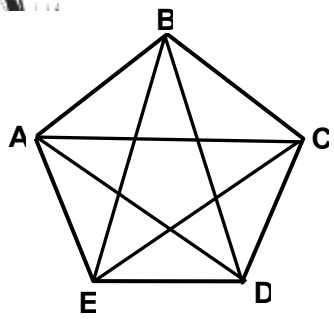
Figures A, B, C, D and F are all closed figures. Of these closed figures, A, C and F are called polygons.

- A **polygon** is a closed figure formed by at least three line segments joined only at their end points**.**
- The line segments are called the **sides** of the polygon while the end points where the segments meet (or their points of intersection) are called the **vertices.**
- The angles included by the sides are the **interior angles** of the polygon.
- A segment joining two non-consecutive vertices of a polygon is called a **diagonal.**

Here is a polygon with five sides. Two of its sides are segments **AB** and **BC.** Two of its vertices are points **A** and **B.** Two of its diagonals are **AD** and **EC.**



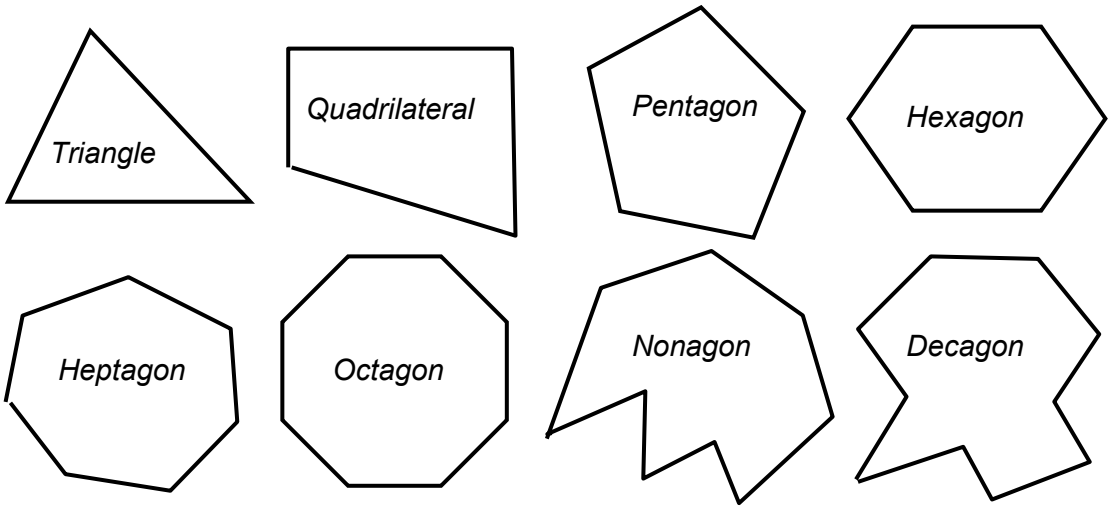
Can you name the other sides and vertices? Draw and name the rest of the diagonals of ABCDE.



Yes. The sides are segments CD, DE and EA and the vertices are points C, D and E. I can also draw the rest of its diagonals like this on the left.

We name the figure, the polygon ABCDE, taking the vertices in order.

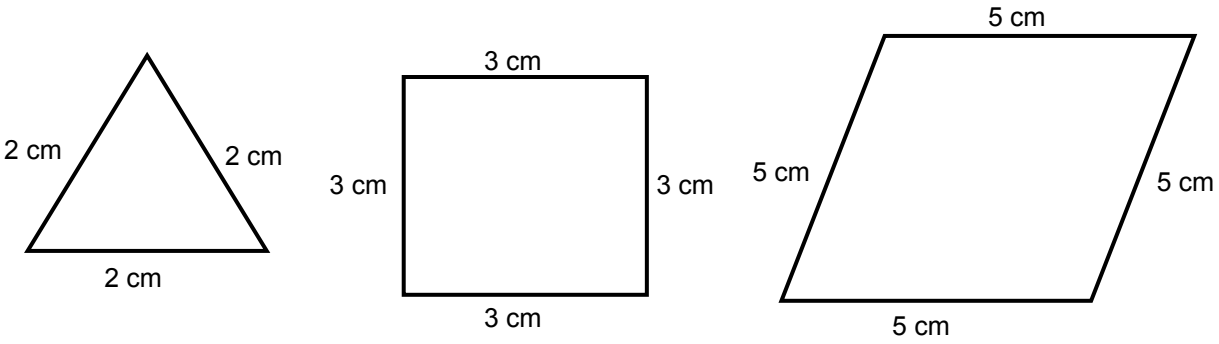
Here are more examples of polygons.



A polygon can be classified according to the number of sides they have as shown in the table.

Number of Sides	Name of Polygon	Number of Sides	Name of Polygon
3	triangle	8	octagon
4	quadrilateral	9	nonagon
5	pentagon	10	decagon
6	hexagon	12	dodecagon
7	heptagon	n	n - gon

Look at the polygons below.

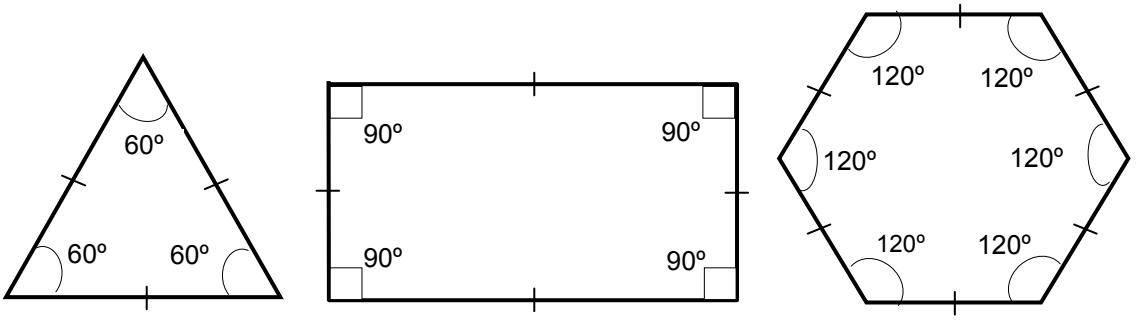


What can you say about the polygons?

Each polygon has all its sides equal in length.

Each of the polygons above is an **equilateral.**

Here are some more polygons.



Each polygon has all their angles equal in measure.

Each of the polygons above is **equiangular.**

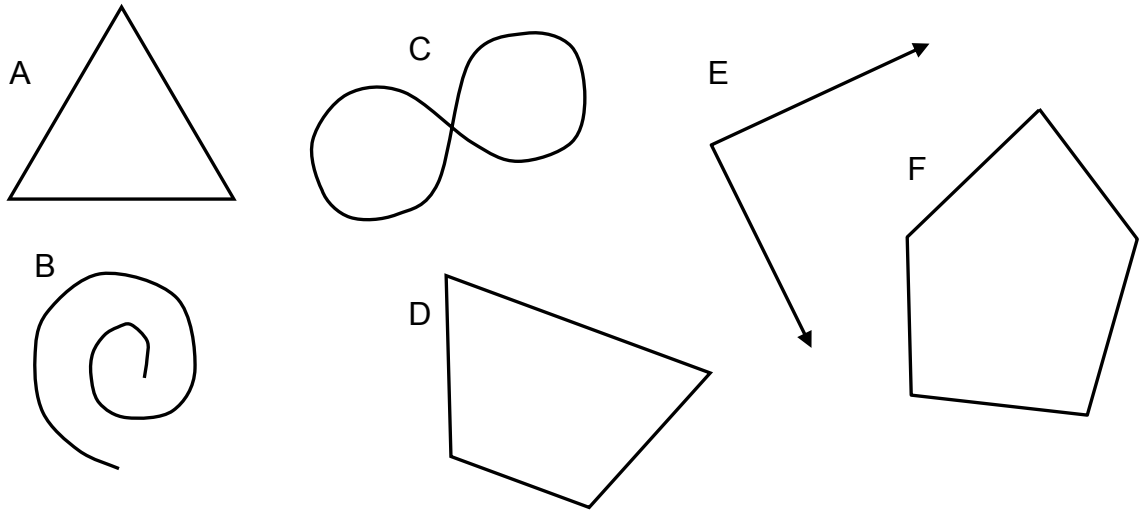
Remember these facts.

- A polygon whose sides have equal lengths is **equilateral.**
- A polygon whose angles have equal measures is **equiangular.**
- A polygon that is **both** equilateral and equiangular is **regular.**
- Segments with equal lengths are congruent.
- Angles with the same measure are also congruent.

NOW DO PRACTICE EXERCISES 7

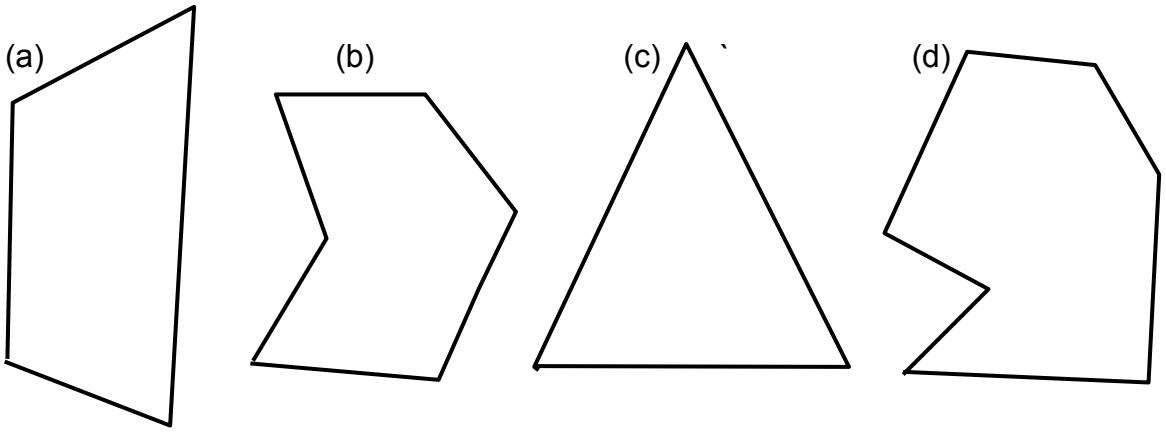
Practice Exercise 7

1. Which of the figures below are polygons?



Answers: _____

2. What kind of polygons are the figures below?



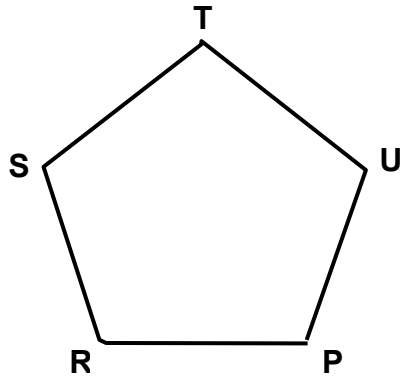
Answers:

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

3. What is the least/lowest number of sides that a polygon may have?

Answer: _____

4) Name the sides, the vertices and the angles of the polygon.



Answer:

Sides	Vertices	Angles
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

Lesson 8: Triangles

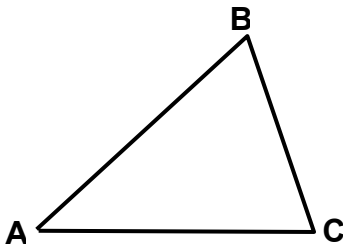
In Lesson 7, you learnt about the meaning of a triangle.

In this lesson, you will:

- identify the different kinds of triangles
- give the different names for a triangle
- describe and identify the different kinds of triangles.

First you will identify the different parts of a triangle.

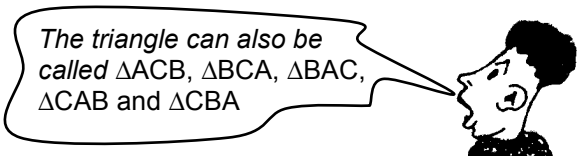
Look at the triangle.



It is made up of three line segments, $\overline{AB}$, $\overline{BC}$ and $\overline{AC}$.

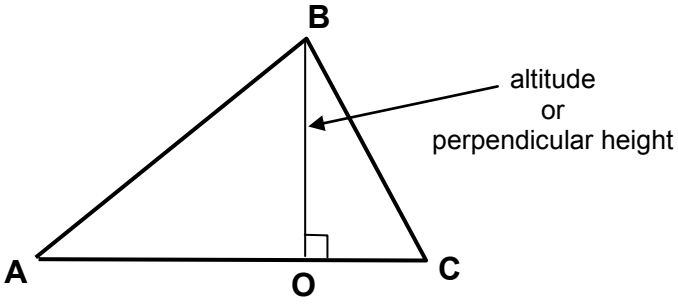
The line segments $\overline{AB}$, $\overline{BC}$ and $\overline{AC}$ are the **sides** of the triangle. The meeting points A, B and C are the **vertices**. The three **angles** are $\angle A$, $\angle B$ and $\angle C$.

A triangle is named by its vertices. The triangle may be called ΔABC and read as *triangle* ABC.

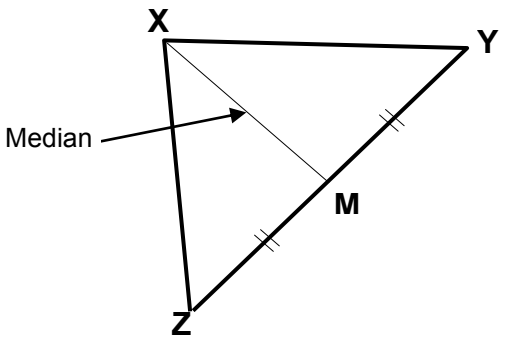


Now look at the next triangles.

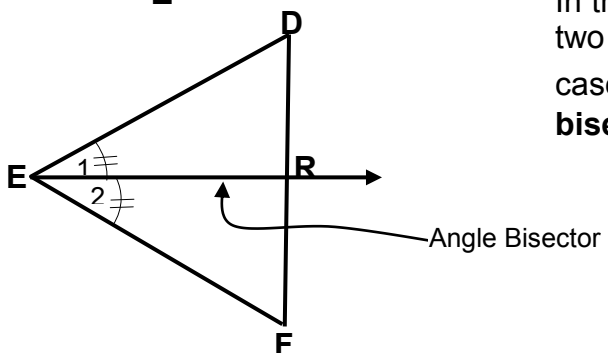
Any side of the triangle may be called a *base*. Each base has a corresponding altitude or height perpendicular (at right angles) to it.



In the triangle ABC, line segment $\overline{BO}$ is perpendicular to the base $\overline{AC}$. In the symbol $\overline{BO} \perp \overline{AC}$, „$\perp$" means „is perpendicular to." $\overline{BO}$ is the altitude from vertex B to the opposite side (base) $\overline{AC}$.



In triangle XYZ, M is the midpoint of side $\overline{YZ}$ and $\overline{YM} = \overline{ZM}$. The segment $\overline{XM}$ is the **median** of the side $\overline{YZ}$.



In the triangle DEF, $\overline{ER}$ divides $\angle DEF$ into two angles with equal measures. In this case, $\angle 1 = \angle 2$, and $\overline{ER}$ is the **angle bisector** of $\angle DEF$.

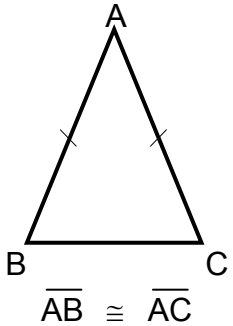
- The line segment from a vertex of a triangle perpendicular to the opposite side is an **altitude** of the triangle.
- The line segment from a vertex of a triangle to the midpoint of the opposite side is a **median**. The median divides the side upon which it is drawn into two congruent segments.
- The line segment from a vertex of a triangle passing through its interior and dividing the angle into two congruent angles is called an **angle bisector**.

How do we classify triangles?

Classification of Triangles

A triangle may be classified according to its sides.

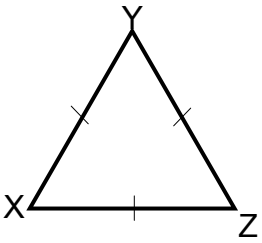
In each triangle below, the same small line marks indicate the sides of equal lengths. Line segments with equal lengths are congruent.



$\overline{AB} \cong \overline{AC}$

Isosceles Triangle

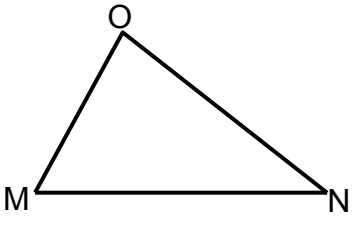
Two equal sides.



$\overline{XY} \cong \overline{YZ} \cong \overline{ZX}$

Equilateral Triangle

Three equal sides.

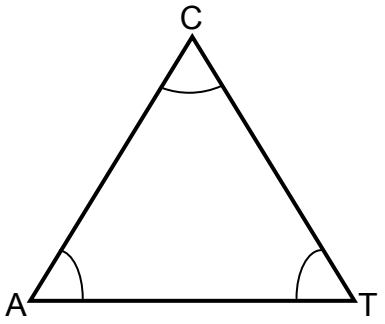


Scalene Triangle

No equal sides.

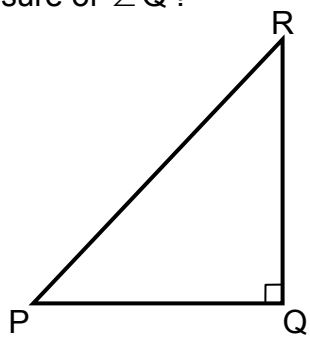
Another way of classifying triangles is according to the kind of angles they have.

Measure each angle of ∆ACT. Is there any angle which is more than 90º? What kind of angles does ∆ACT have?



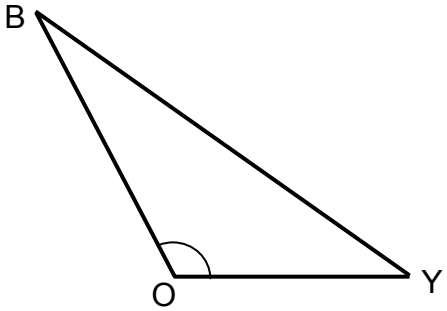
A triangle whose angles are all less than 90º is called an **acute triangle.**

In ∆PQR, what is the measure of $\angle Q$?



A triangle with a **right angle** (angle whose measure is 90º) is called a **right triangle.**

Measure each angle of ∆BOY. Is there any angle more than 90º? What kind of angle is $\angle O$?



A triangle with an angle measuring more than 90º is called an **obtuse triangle.**

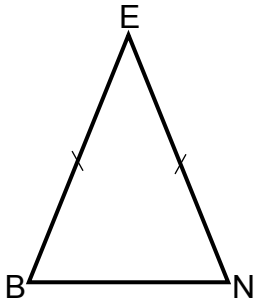
According to sides, a triangle is:

- **Equilateral**, if the three sides are equal or congruent;
- **Isosceles**, if two sides are equal or congruent;
- **Scalene**, if no two sides are equal or congruent.

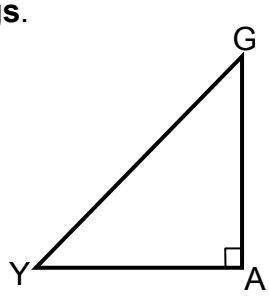
According to angles, a triangle is:

- **Equiangular,** if all angles are equal or congruent;
- **Acute**, if all the three angles are acute;
- **Right,** if there is one right angle;
- **Obtuse**, if there is one obtuse angle.

In the isosceles triangle BEN, $\overline{BE} \cong \overline{EN}$. These congruent sides are called **legs**. The side BN is the **base**, $\angle E$ is the **vertex angle**, and $\angle B$ and $\angle N$ are the **base angles**.



In the right triangle GAY, with $\angle A$ as the right angle, side GY is the **hypotenuse** and GA and YA are the **legs**.



In an isosceles triangle:

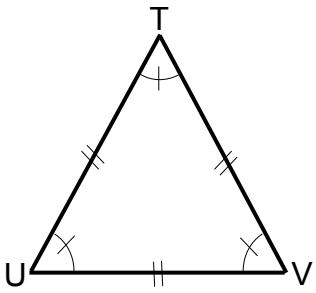
- The two sides that are congruent are called the **legs** and the third side is the **base**.
- The angle opposite the base is the **vertex angle.**
- The angles on the base are the **base angles.**

In a right triangle:

- The sides that are perpendicular (form a right angle) are the **legs.**
- The side opposite the right angle is the **hypotenuse.**

Now look at the figure.

ΔTUV is an equilateral triangle. With the aid of a protractor, measure the three angles.



What do you say about the angles of an equilateral triangle?

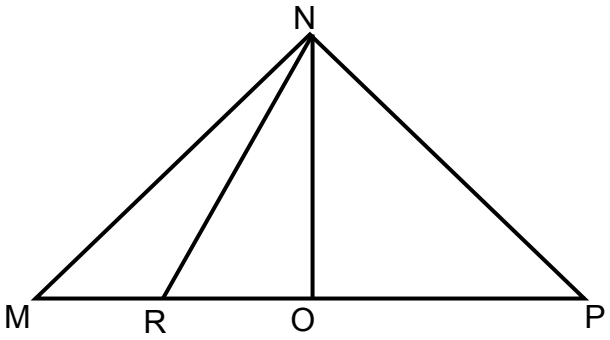
An equilateral triangle is equiangular.

NOW DO PRACTICE EXERCISE 8

Practice Exercise 8

1. Draw a triangle XYZ and name its sides, vertices and angles.

2. Name three different right triangles found in the figure below.



Answers: _____, _____, _____

3. How many altitudes can a triangle have?

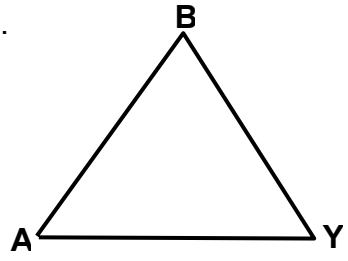
Answer: _____

4. How many medians can be drawn in a triangle?

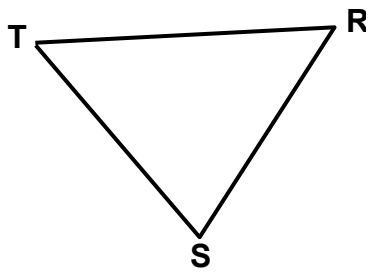
Answer: _____

5. Name each triangle in 6 different ways.

a.



b.



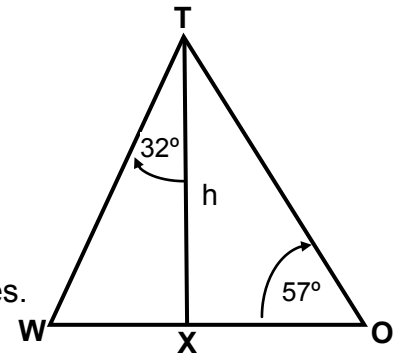
Answer: a. _____, _____, _____

_____, _____, _____

b. _____, _____, _____

_____, _____, _____

6. Refer to ∆TWO to answer and complete the following statements.



a. T, W, O are the _____.

b. **h** is the _____.

c. $\overline{TO}$ and $\overline{TW}$ are the _____.

d. $\overline{WO}$ is the _____ of ∆TWO.

e. _____ and _____ are right triangles.

f. _____ is perpendicular to $\overline{WO}$.

g. ∆TWO is a _____ triangle.

h. Is ∆TXW ≅ ∆TXO?

i – j. If $m\angle O = 57$, $\angle WTO$ = _____ while $\angle W$ = _____.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

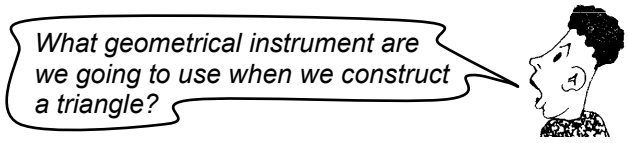
Lesson 9: Constructing Triangles

In Lesson 8, you learnt the different parts and classification of triangles.

In this lesson you will:

- construct and draw triangles using geometrical tools/instruments given different information.

To draw a triangle, we must be given certain information about the lengths of its sides and the sizes of its angles.



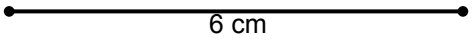
When we draw triangles, we make use of the ruler, compasses and protractor.

First we will learn how to draw scalene triangles.There are three methods.

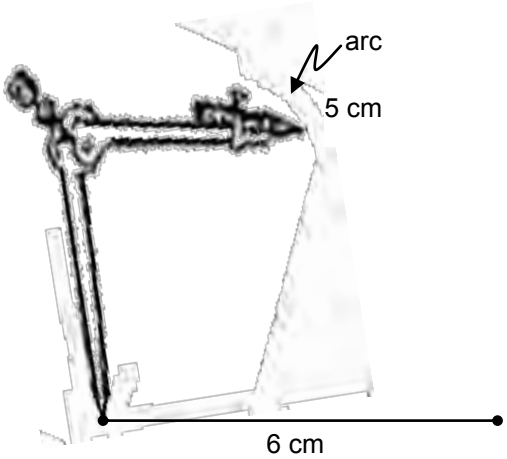
Here is the first method.

Draw a triangle that has sides of length 6 cm, 5 cm and 4 cm.

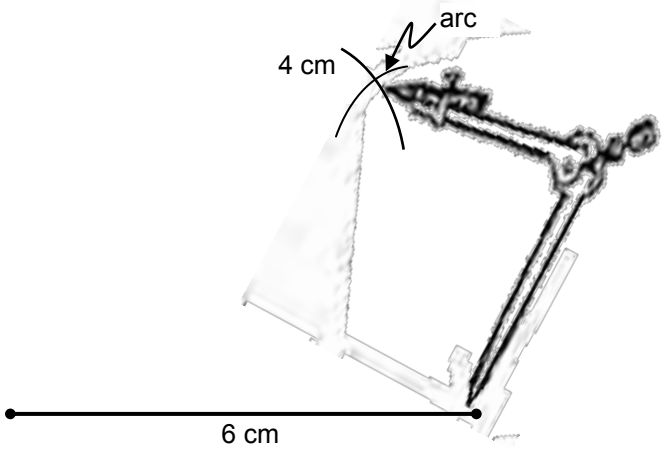
Step 1: Draw a line 6 cm long. Mark the two end points.



Step 2: Open and set the compass to 5 cm and from one end of the line draw an arc.

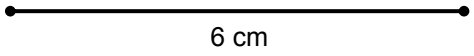


Step 3: Set the compass to 4 cm and from the other end of the line, draw another arc to cut the arc that has already been drawn.

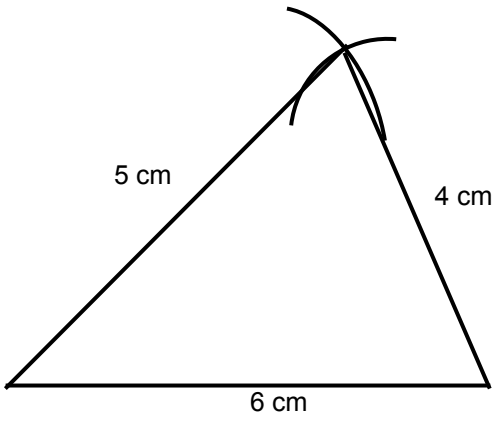


Step 4: Mark the point where the two arcs meet.

This point is 5 cm from one endpoint and 4 cm from the other endpoint of the line below.



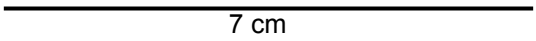
Step 5: Join the point where the arcs meet to both the ends of the line to obtain the triangle.



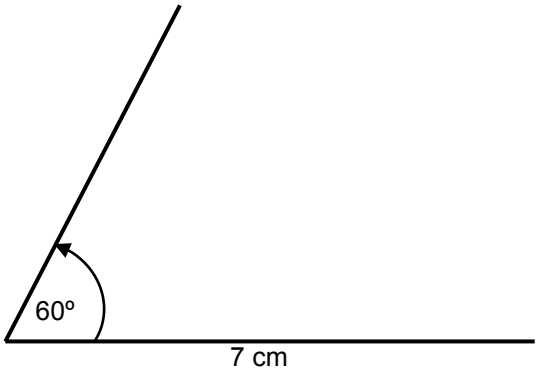
Here is the second method.

Draw a triangle that has sides of length 7 cm and 5 cm which form an angle of 60º.

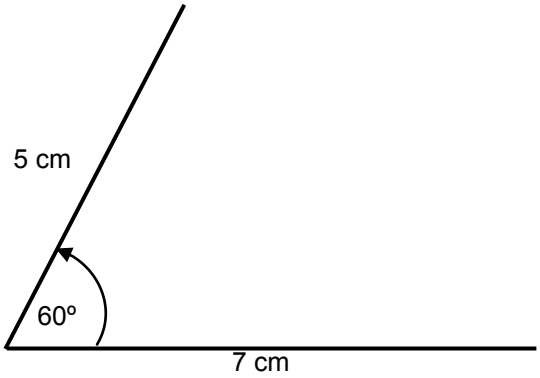
Step 1: Draw one of the sides. We will start with the one which is 7 cm long.



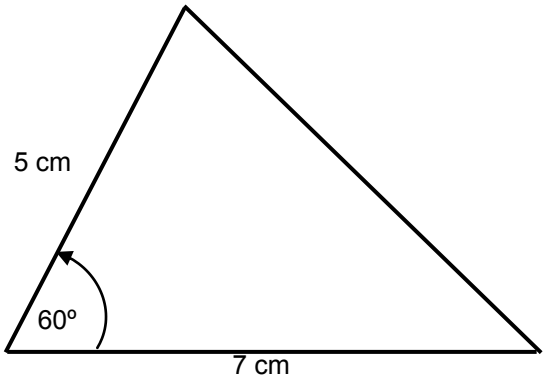
Step 2: Using one end of your 7 cm line, draw an angle 60º.



Step 3: Measure 5 cm along the other arm of the angle and mark a point.

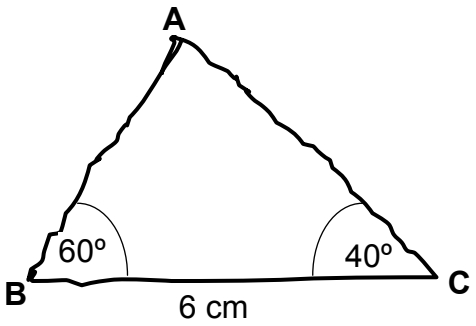


Step 4: Join the two points to form the triangle.



Activity 1

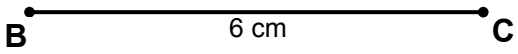
Make an accurate full sized drawing of the triangle shown here.



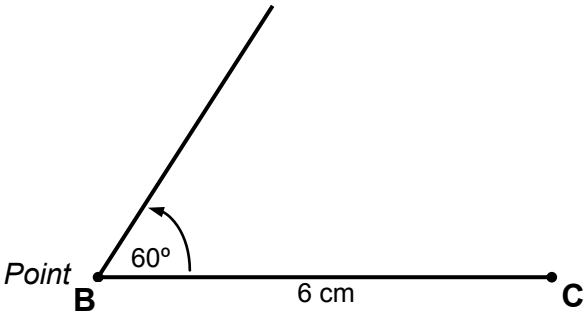
- The triangle has one side, 6 cm long.
- The angles at each end of this side are 60º and 40º.

This can be done in several ways. Here is one way.

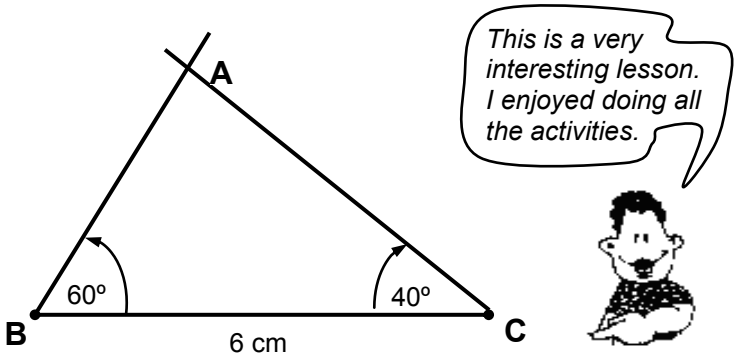
Step 1: Draw the side BC 6 cm in length.



STEP 2: Using one end of the line as the point for your first angle, draw an angle of 60º at B with your protractor.



Step 3: Using the other end of the 6 cm line, draw the second angle of 40º at C with your protractor. Extend the arms to meet at A.



NOW DO PRACTICE EXERCISE 9

Practice Exercise 9

1. Follow each step of the method on pages 60-61 and draw a scalene triangle which is 8 cm one side, 6.5 cm on another side and an angle of 50º between the sides.

1. *Rough drawing of triangle.* ⟶

2. *Careful drawing of triangle.*

Write on your triangle the lengths of the two sides and the size of the angle and answer these questions.

(a) What is the length of the other side of the triangle? _____ cm

(b) Measure the other two angles. What is the size of

(i) the angle at the other end of the 8 cm side? _____º

(ii) the angle at the other end of the 6.5 cm side? _____º

(c) Are any of the sides equal? _____

(d) Are any of the angles equal? _____

2. In the space below, draw an isosceles triangle which has two equal sides of 7 cm. The angle between the 7 cm sides is 30º.

Mark the 30º angle.

Mark the 7 cm sides.

Measure the other two angles. They are _____º.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2

Lesson 10: Quadrilaterals

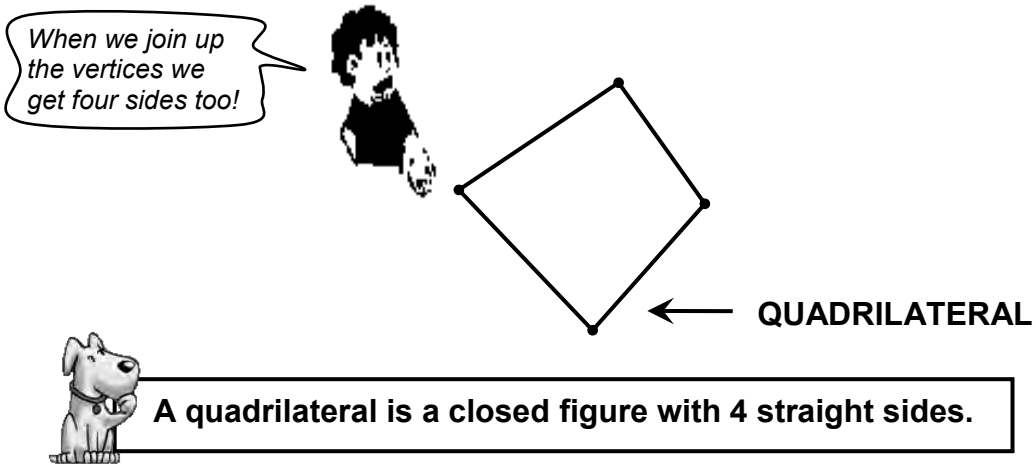
You learnt to draw and construct triangles in the last lesson.

In this lesson, you will:

- define, discuss and identify the different kinds of quadrilaterals.
- draw and describe the properties and kinds of quadrilaterals and show the relationship among them.
- distinguish between convex and concave quadrilaterals.

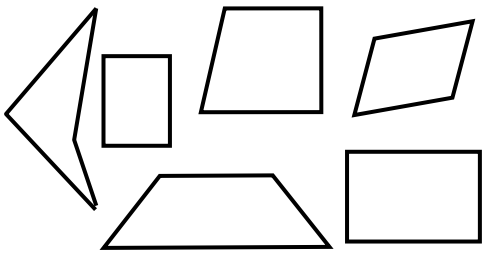
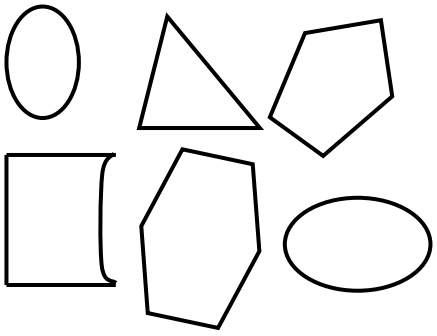
First, you will learn the meaning of quadrilateral. (You say kwod - ri - lat - er -al.)

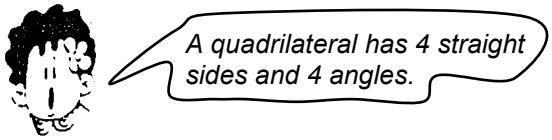
When you make a quadrilateral you need one more vertex than a triangle.



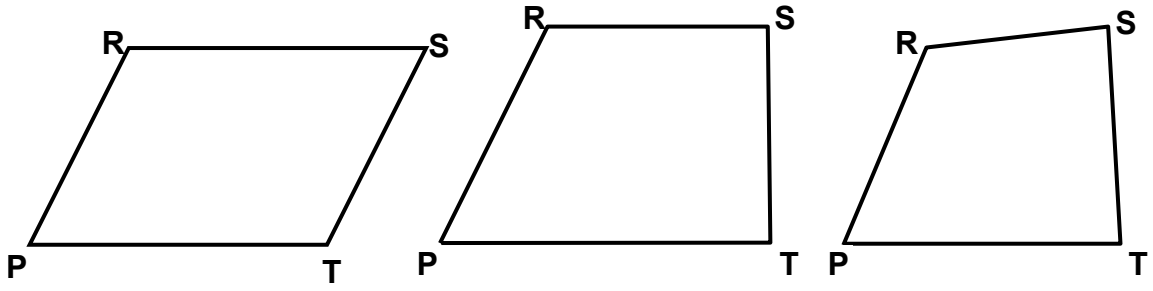
Example

.

These shapes are quadrilaterals.	These shapes are not quadrilaterals.
	
All quadrilaterals have 4 straight sides.	These shapes do not have 4 straight sides. They are <u>not</u> quadrilaterals



Now look at the figures below.



Each figure is a quadrilateral.

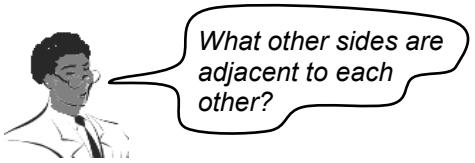
In the above quadrilaterals, $\overline{RS}$, $\overline{ST}$, $\overline{TP}$ and $\overline{PR}$ are the sides, R, S, T, and P are the

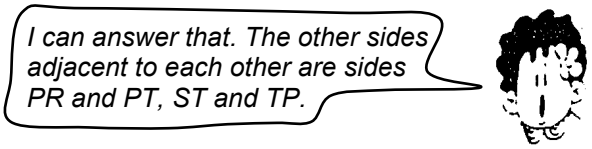
vertices, and $\angle R$, $\angle S$, $\angle T$, and $\angle P$ are the angles.

The two angles at the endpoints of a side like $\angle R$ and $\angle S$ are said to be **consecutive** or **adjacent.**

The two non-adjacent angles, like $\angle R$ and $\angle T$ are called **opposite angles.**

Two sides meeting at a vertex, like $\overline{RS}$ and $\overline{ST}$, are called **adjacent sides,** otherwise, like $\overline{PR}$ and $\overline{ST}$ they are called **opposite sides.**





REMEMBER:

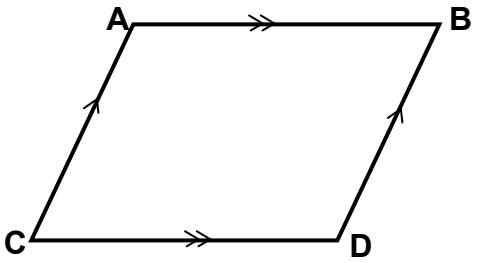
- **Two sides of a quadrilateral are opposite if they do not intersect.**
- **Two angles of a quadrilateral are opposite if no sides of the quadrilateral is common to them.**
- **Two sides of a quadrilateral are consecutive if they have a common end point.**
- **Two angles of a quadrilateral are consecutive if a side of the quadrilateral is common to them.**
- **The opposite sides of a quadrilateral may be parallel.**

Parallel lines are lines that lie on the same plane and never meet no matter how they are extended.

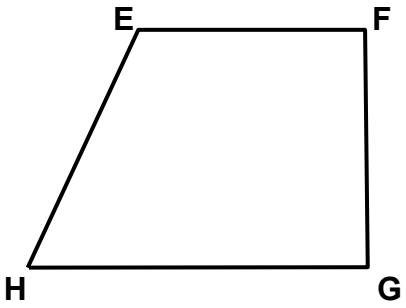
Now you will learn to identify the kinds of quadrilaterals.

A quadrilateral is classified according to its pair of opposite sides parallel.

A quadrilateral with both pairs of opposite sides parallel is a **parallelogram**. In the figure, $\overline{AB}$ is parallel to $\overline{CD}$ and $\overline{AC}$ is parallel to $\overline{BD}$. Quadrilateral ABCD is a parallelogram.

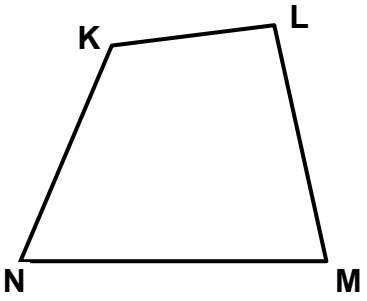


A quadrilateral with one pair of opposite sides parallel is a **trapezium.** In the figure, $\overline{EF}$ is parallel to $\overline{HG}$. Quadrilateral EFGH is a trapezium.



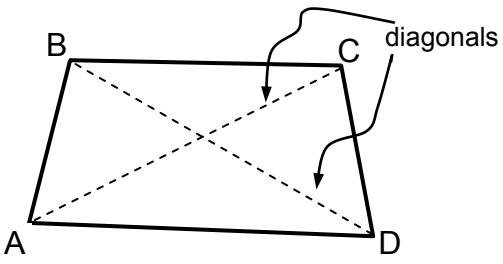
A **general quadrilateral** has no pair of opposite sides parallel.

Quadrilateral KLMN is a general quadrilateral.



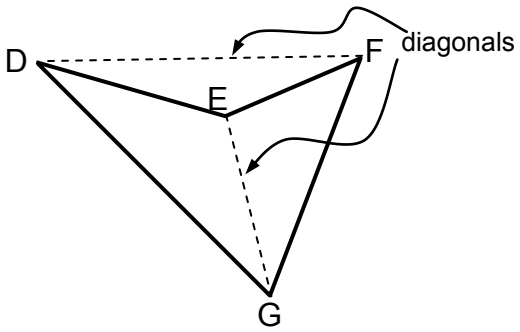
A quadrilateral is also classified according to its diagonals.

A quadrilateral is **convex** when all its diagonals lie in its interior (meaning inside the figure).



ABCD is a convex quadrilateral
AC and BD are diagonals

A quadrilateral is **concave** when at least one of its diagonals lies outside of the figure.



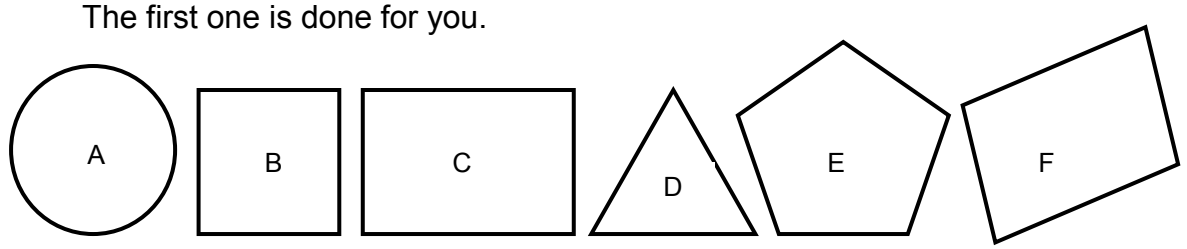
DEFG is a concave quadrilateral
DF and EG are diagonals

NOW DO PRACTICE EXERCISE 10

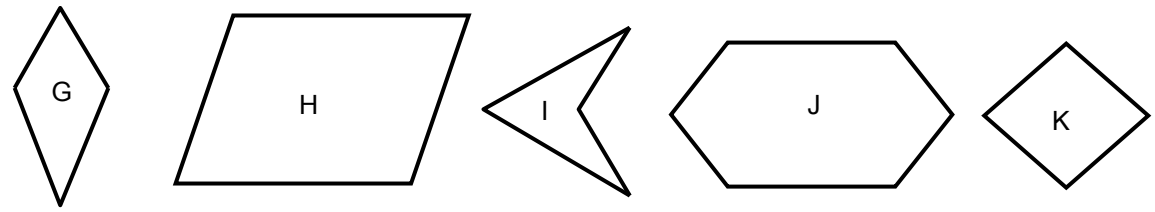
Practice Exercise 10

1. Some of these shapes are quadrilaterals and some are not quadrilaterals.

   Write YES in the answer space under the shape if it is a quadrilateral.
   Write NO if it is not a quadrilateral.
   The first one is done for you.



NO _____ _____ _____ _____ _____

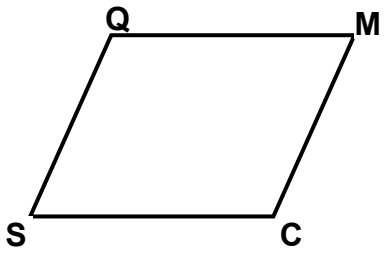


_____ _____ _____ _____ _____

---

2. Refer to the figure given on the right and answer the following questions.

a) Classify quadrilateral QMCS



Answer: _____

b) Name and list the following parts:

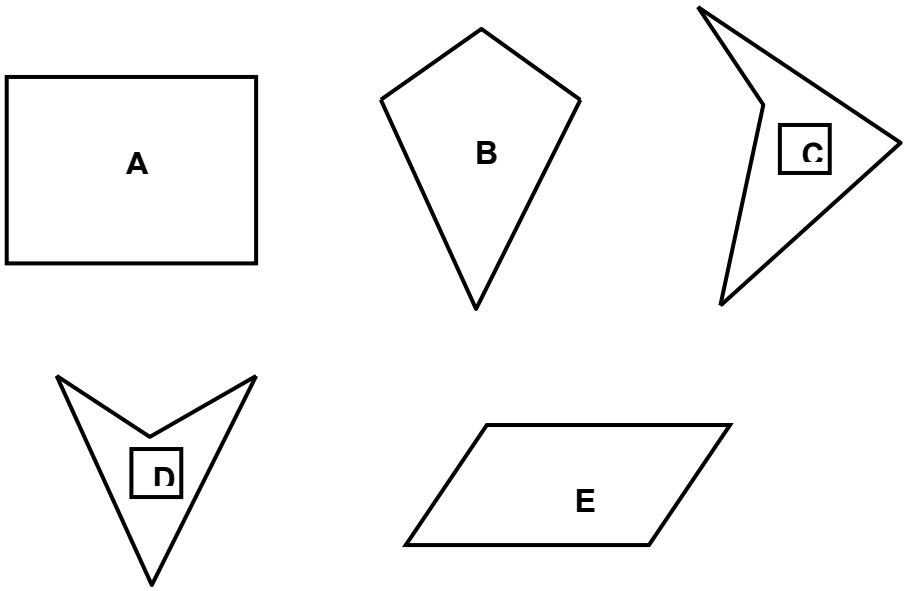
i. 2 pairs of opposite sides _____

ii. 2 pairs of consecutive or adjacent sides _____

iii. 2 pairs of opposite angles _____

iv. 4 pairs of adjacent angles _____

3. Which figures are convex?



Answers: _____, _____ and _____.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

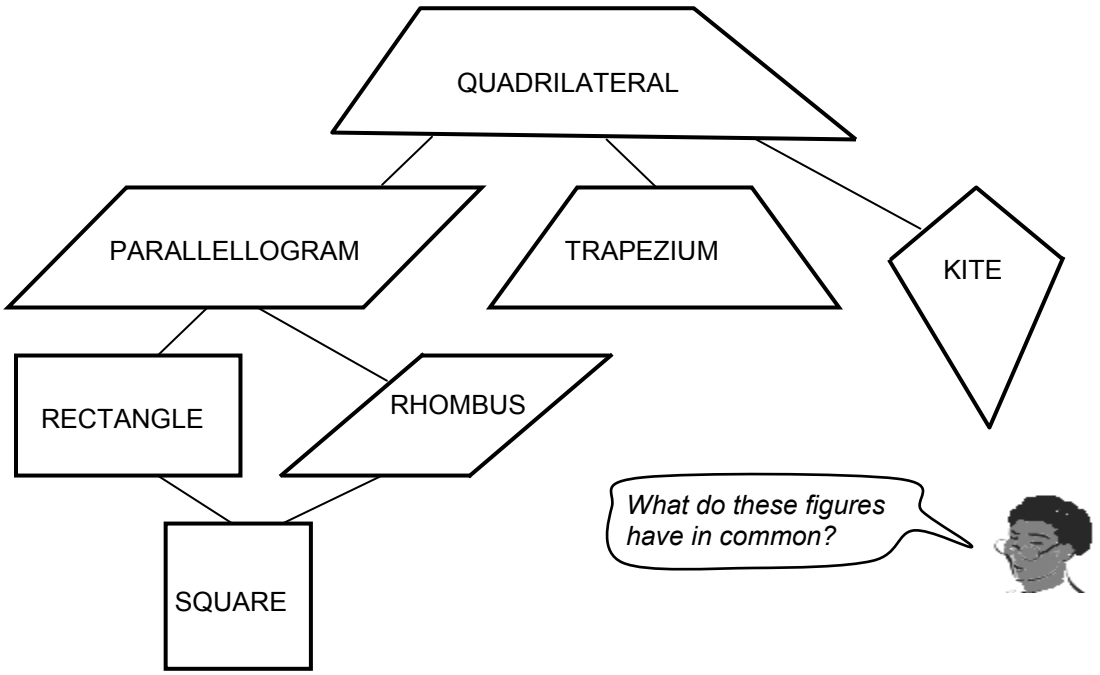
Lesson 11: Special Quadrilaterals

In Lesson 10, you learnt the meaning of a quadrilateral, its properties and kinds.

In this lesson, you will:

- draw and describe parallelograms.

First, let us look at the illustration below showing the relationship among the four – sided figures or quadrilaterals.

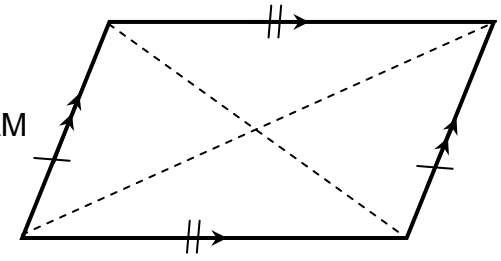


The parallelogram, rhombus, square and rectangle are special types of quadrilaterals.

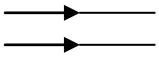
These shapes have many special properties that are related to their sides, angles and diagonals.

We will look at them one at a time now.

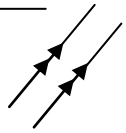
A PARALLELOGRAM



One pair of parallel sides is marked with arrows like this:

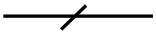


The other pair of parallel sides is marked with arrows, like this:

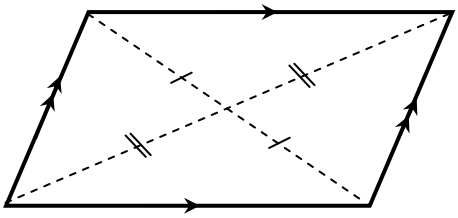


A parallelogram also has its opposite sides equal.

One pair of opposite sides is marked like this: 

The other pair of opposite sides is marked like this: 

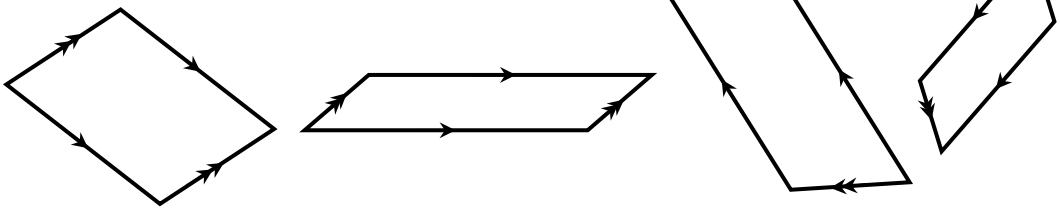
The diagonals of the parallelogram bisect one another.



If the diagonals cut each other in halves, we say they bisect each other.

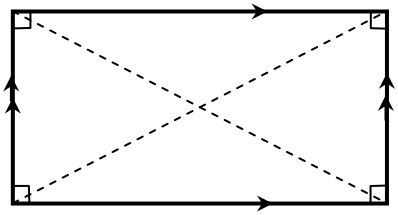
These shapes are all parallelograms.

Their opposite sides are parallel.



A parallelogram is a quadrilateral with both pairs of opposite sides parallel.

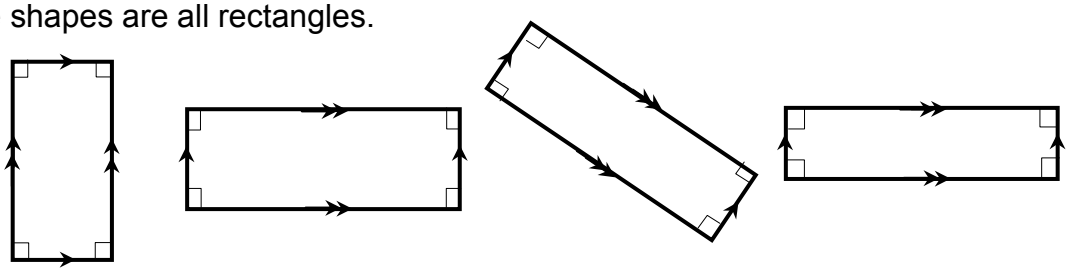
A rectangle is another subset of a parallelogram.



A RECTANGLE

You will notice that a rectangle has all the characteristics of a parallelogram where both pairs of opposite sides are congruent and all its angles are right angles. The diagonals are equal and bisect each other.

These shapes are all rectangles.



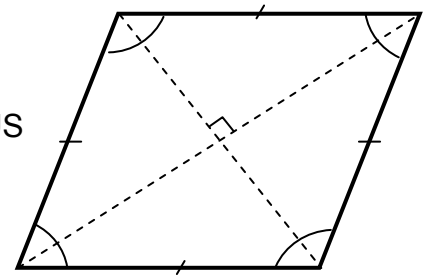
Their opposite sides are parallel. They have right angles.

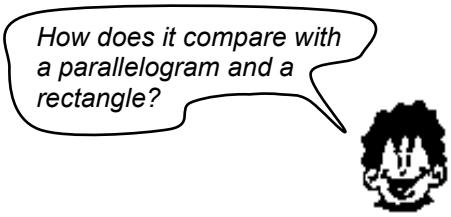
The right angles are marked like this: 

A rectangle is a parallelogram where all its angles are right angles.

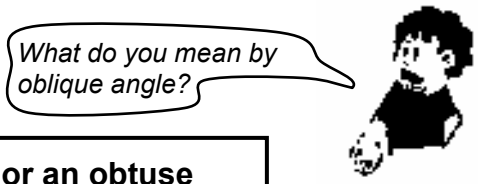
A rhombus is another subset of a parallelogram.

A RHOMBUS



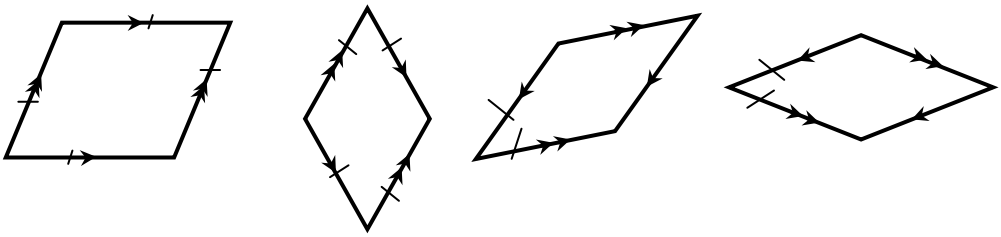


You can see that the rhombus has all the properties of a parallelogram and all sides are equal. The diagonals bisect each other at right angles and bisect the angles through which they pass. The angles are oblique.



An oblique angle is an acute or an obtuse angle.

All these shapes are rhombus:



We already know that the opposite sides of a parallelogram are equal.

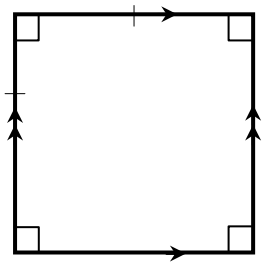
So, the opposite sides of a rhombus must also be equal.

This means that a rhombus has 4 equal sides.

A rhombus is a parallelogram with all its sides equal and whose angles are oblique. The opposite sides of a rhombus are congruent.

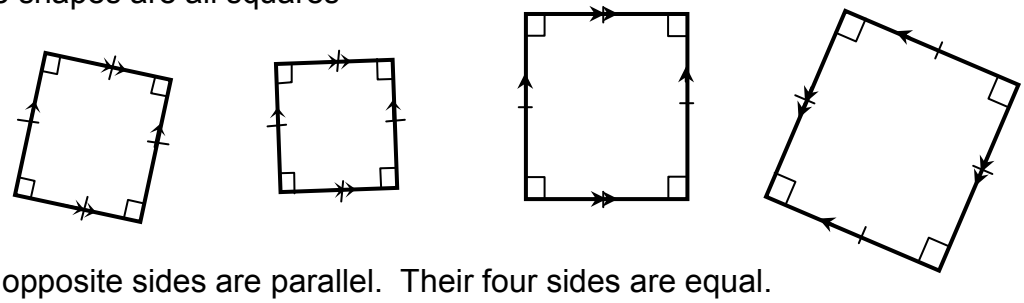
Now we will look at a square. The square is a special kind of parallelogram

A SQUARE



Just like a rectangle its four angles are right angles. It is also like the rhombus since it has four equal or congruent sides.

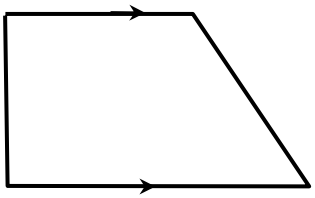
These shapes are all squares



Their opposite sides are parallel. Their four sides are equal.
They have four right angles.

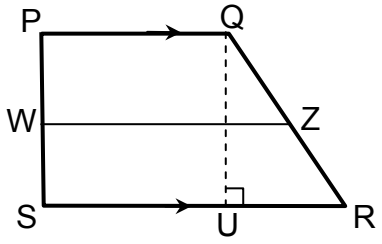
A square is a parallelogram with all its sides equal and all its angles are right angle.

Another type of quadrilateral is the trapezium.

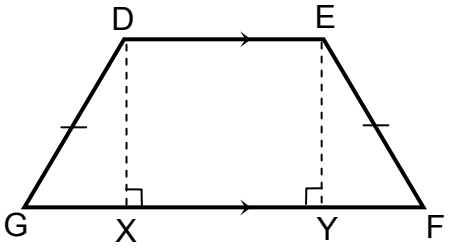
A TRAPEZIUM 

A trapezium is a quadrilateral which has one pair of opposite sides parallel.

For the trapezium PQRS, the **bases** are $\overline{PQ}$ and $\overline{SR}$, and $\overline{QU}$ is the **altitude**. $\overline{PS}$ and $\overline{QR}$ are the **legs**. If W and Z are the midpoints of the legs, then $\overline{WZ}$ is the median of the trapezium.

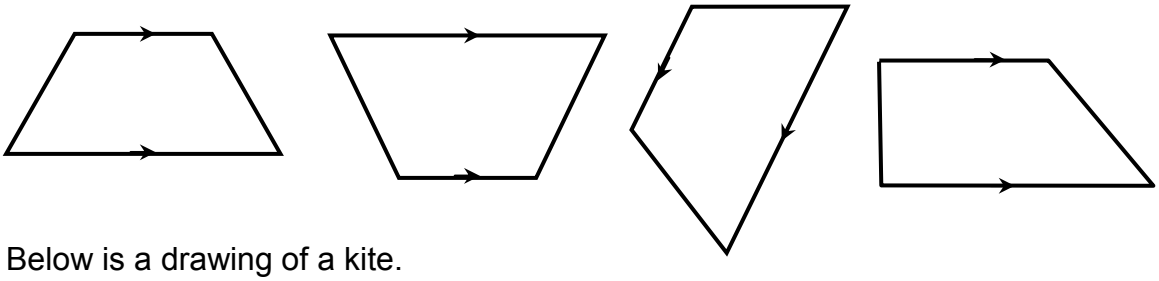


For the trapezium DEFG, $\overline{DG}$ and $\overline{EF}$ have equal lengths as indicated by the marks. The trapezium is an **isosceles trapezium.** $\overline{DX}$ and $\overline{EY}$ are the altitudes.

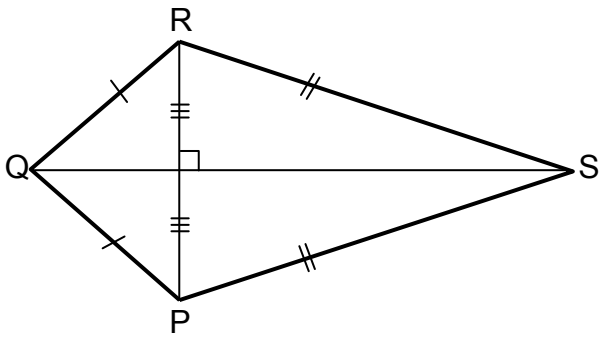


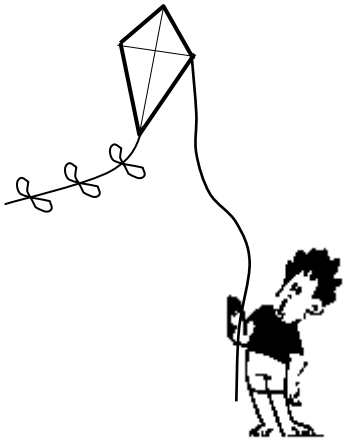
- A trapezium has two **bases**. They are the sides that are parallel to each other.
- The non-parallel sides are called **legs**. The legs of the trapezium may or may not be equal.
- If the legs of the trapezium have equal lengths, the trapezium is **isosceles.**
- The segment perpendicular to the bases is called the **height** or the **altitude** of the trapezium.

These shapes are all trapeziums.



Below is a drawing of a kite.

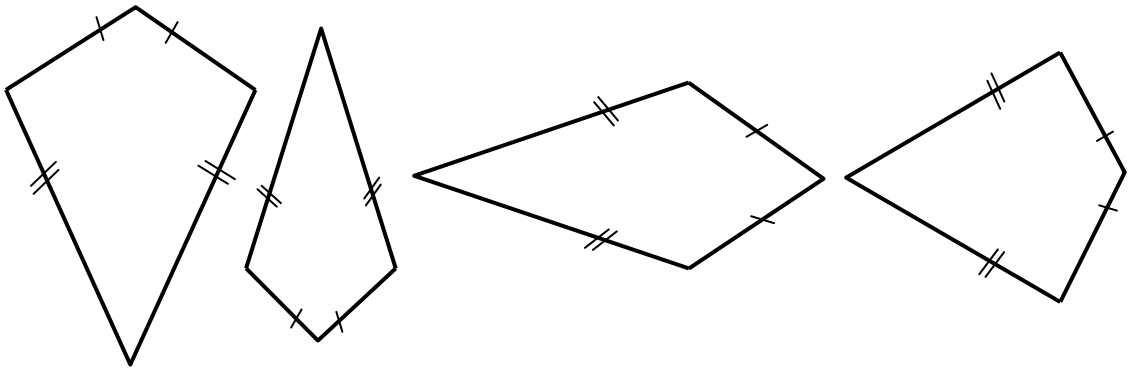




In the figure, $\overline{PQ}$ is adjacent to $\overline{QR}$ and $\overline{PS}$ is adjacent to $\overline{SR}$, $\overline{PQ} = \overline{QR}$ and $\overline{PS} = \overline{SR}$. The diagonals QS and RP are perpendicular. Diagonal $\overline{QS}$ is an **axis of symmetry** (a line that divides a shape into two identical parts that are mirror images of one another). Quadrilateral PQRS is a kite.

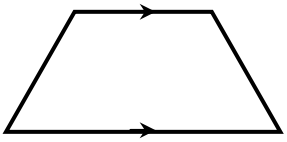
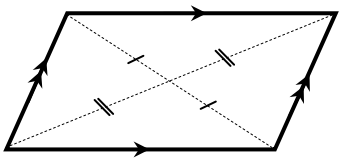
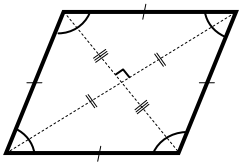
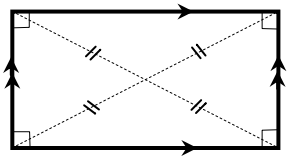
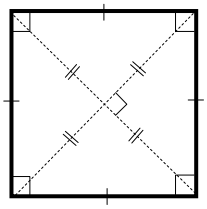
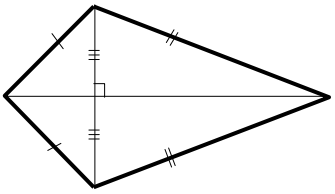
The axis of symmetry is a line that divides a shape into two identical parts that are mirror images of one another

These shapes are kites.



A kite is a quadrilateral with two pairs of adjacent sides equal.

Below is a table to emphasize the relationships among the quadrilaterals.

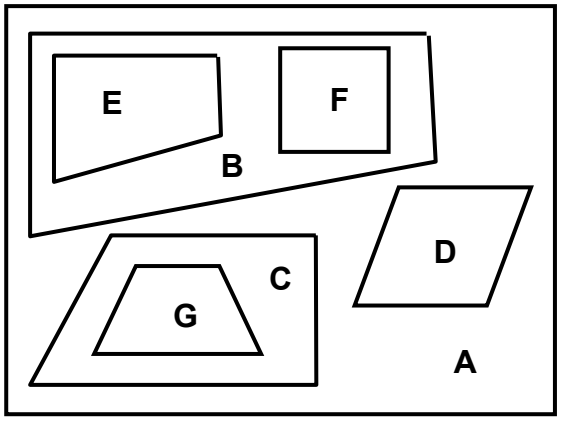
Quadrilateral	Figure	Properties
1. Trapezium		• One pair of opposite sides parallel
2. Parallelogram		• Two pairs of parallel sides • Opposite sides are equal • Opposite angles are equal • Diagonals bisect one another.
3. Rhombus		• A rhombus has all the properties of a parallelogram and… • All sides are equal • Diagonals bisect each other at right angles • Diagonals bisect the angles through which they pass.
4. Rectangle		• A rectangle has all the properties of a parallelogram and… • All angles are right angles. • Diagonals are equal.
5. Square		• A square has all the properties of a rhombus and a rectangle. • Four sides equal. • Four right angles.
6. Kite		• Two pairs of adjacent sides equal. • Diagonals are perpendicular. • One diagonal is an axis of symmetry.

NOW DO PRACTICE EXERCISE 11

Practice Exercise 11

1. Write whether each statement is True or False.
   (a) Every rhombus is a square. _____
   (b) No rectangle is a rhombus. _____
   (c) Some rectangles are squares. _____
   (d) Every rectangle is a parallelogram. _____
   (e) All quadrilaterals are trapezium. _____
   (f) Each square is a parallelogram. _____
   (g) All the angles of a rectangle are equal. _____
   (h) Opposite sides of a parallelogram are equal. _____
   (i) A square has only two right angles. _____
   (j) If the diagonals cut each other, we say they bisect each other. _____

2. The figure below includes the various kinds of quadrilaterals.



   a. Name the quadrilaterals with two pairs of opposite sides parallel and of equal lengths.

   Answers: _____

   b. Name the quadrilaterals with only one pair of parallel sides.

   Answers: _____

   c. Name the quadrilaterals which are equilateral.

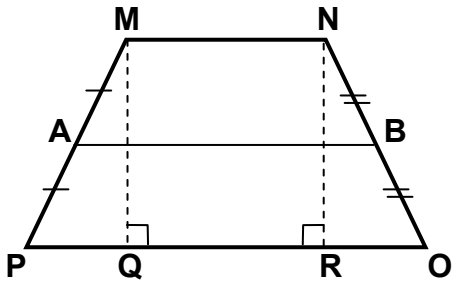
   Answers: _____

   d. Name the quadrilaterals which have oblique angles.

   Answers: _____

3. For the figure below, identify:

(a) MNOP
(b) MN and PO
(c) AB
(d) MQ and NR



Answers: **(a) _____**

(b) _____

(c) _____

(d) _____

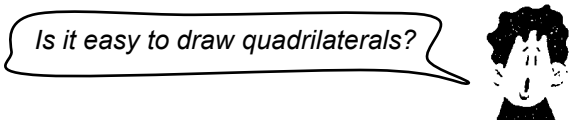
CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

Lesson 12: Constructing Quadrilaterals

In Lesson 11, you learnt the different kinds and properties of quadrilaterals.

In this lesson, you will:

- draw and construct various types of quadrilaterals.



Constructing special quadrilaterals such as squares and rectangles is relatively easy. However, some quadrilaterals are not so easy to construct.

Before starting construction, think about the information given and try to work out the steps to be taken. Often you can do the same construction in many different ways.

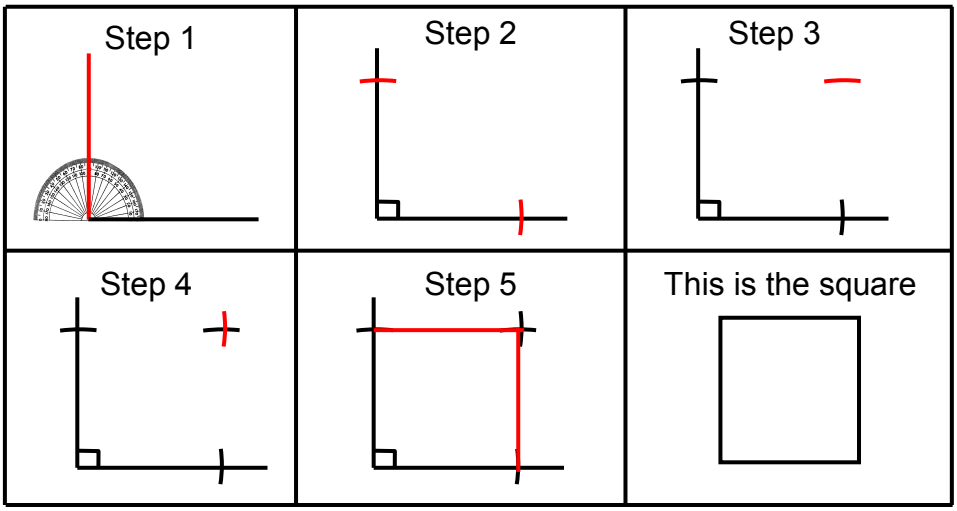
Make sure you know how to use your geometrical instruments, especially the protractor and the compass so that your work will be neat and accurate. It will be good if you draw a rough sketch first.

Example 1

Construct a square with a side length of 3 cm.

A square has four equal sides and four right angles. To construct a square, use the following steps shown in the given diagram below.

Step 1 Draw a right angle with the protractor or set square.
Step 2 Set the compass to 3 cm and mark off the length of the sides along the arms of the right angle. Use this same radius for each arc.
Step 3 From the mark on one arm, draw an arc.
Step 4 From the mark on the other arm, draw an arc to cut the arc drawn in Step 3.
Step 5 Join the point where the arcs meet to the mark on each arm to form the square.

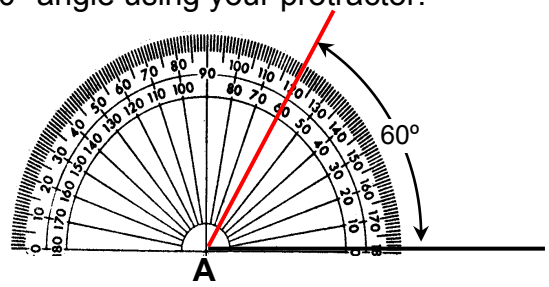


Example 2

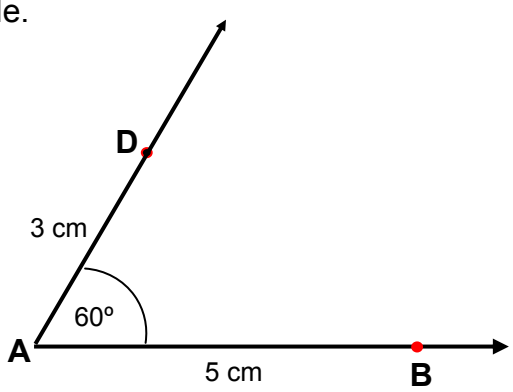
Construct a parallelogram ABCD such that $\angle A = 60^\circ$, side AD = 3 cm and side AB = 5 cm.

To construct this parallelogram, follow the following steps.

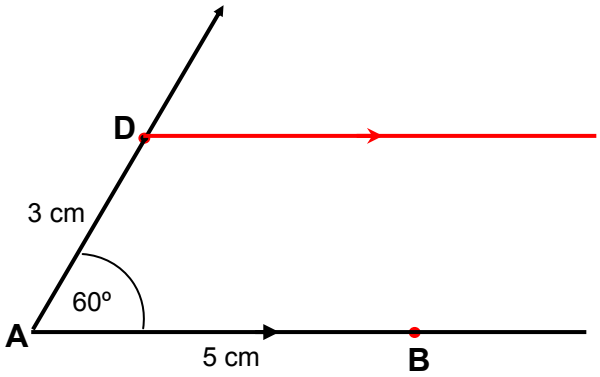
Step 1: Draw a 60º angle using your protractor.



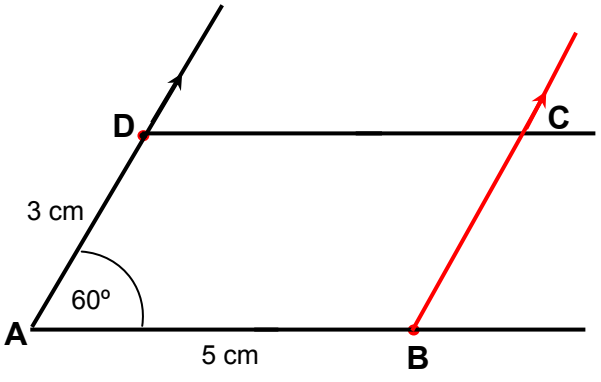
Step 2: Mark off the sides AB = 5 cm and AD = 3 cm along each of the two arms of the angle.



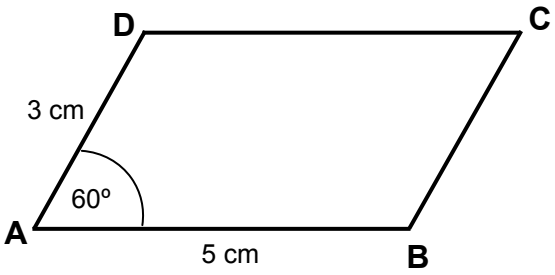
Step 3: Draw a line through D parallel to AB.



Step 4: Draw a line through B parallel to AD to cut the line already drawn in step 3.

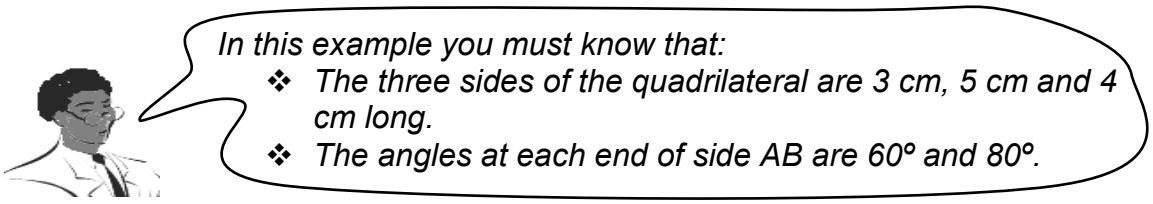


Step 5 Erase the parts that are not needed and you have the parallelogram.

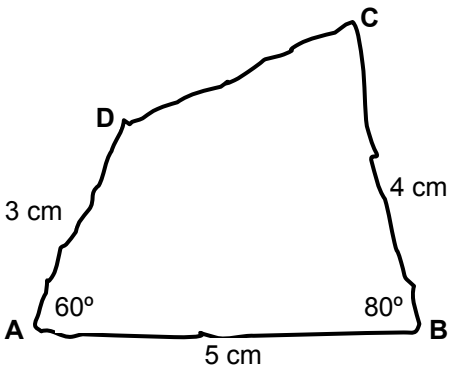


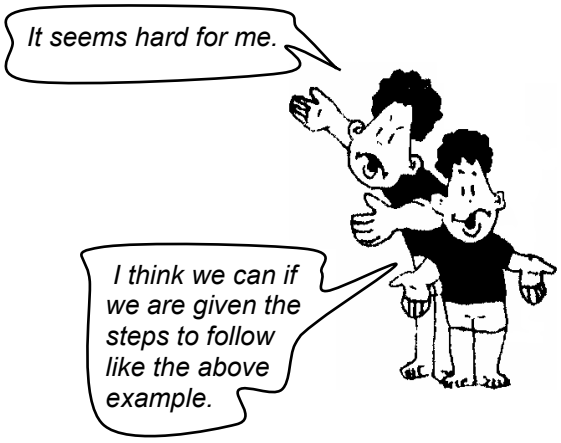
Example 3

Make an accurate full sized drawing of the Quadrilateral ABCD such that ∠A = 60º, ∠B = 80º, AB = 5 cm, AD = 3 cm and BC = 4 cm.



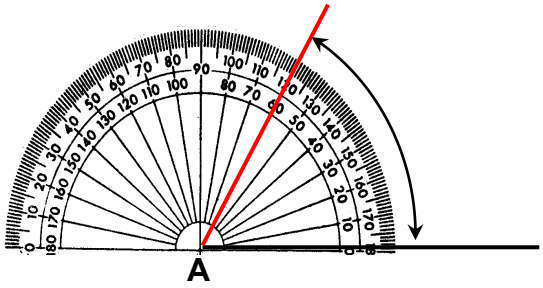
First we draw a rough sketch.



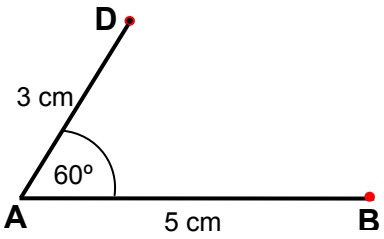


To construct the quadrilateral, follow the following steps.

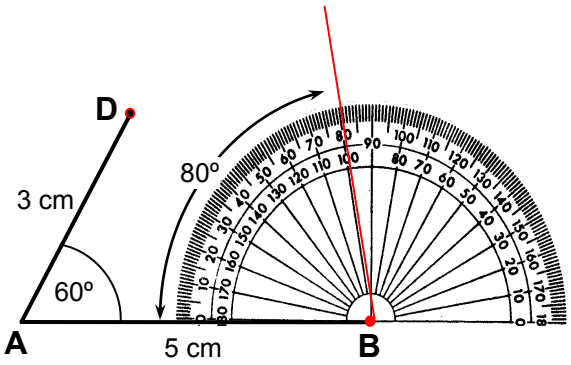
Step 1: Draw a 60º angle with the protractor.



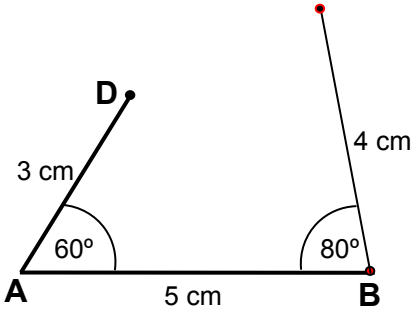
Step 2: Mark off the sides AB (5 cm) and AD (3 cm).



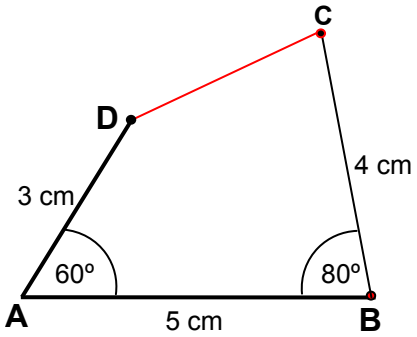
Step 3: Draw an 80º angle with its vertex at B.



Step 4: Mark off the side BC = 4 cm.



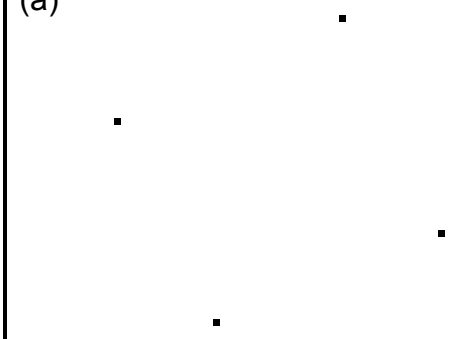
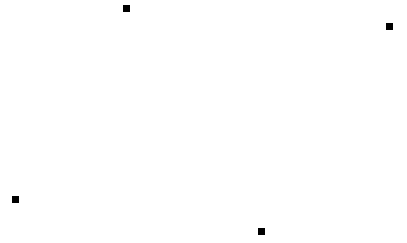
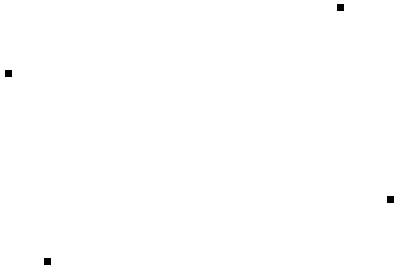
Step 5: Join CD to form the quadrilateral.



NOW DO PRACTICE EXERCISE 12

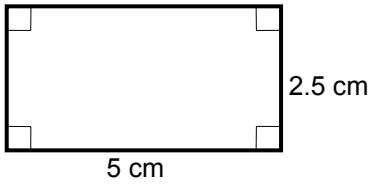
Practice Exercise 12

1. Use your ruler to join the 4 vertices shown in the diagrams below. Write the name of each quadrilateral in the space provided.

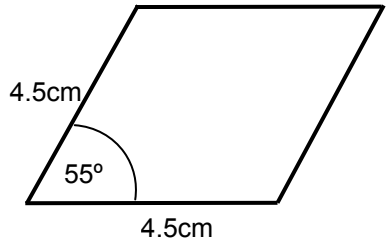
(a)  This quadrilateral is a _____	(b)  This quadrilateral is a _____
(c)  This quadrilateral is a _____	(d)  This quadrilateral is a _____
(e)  This quadrilateral is a _____	(f)  This quadrilateral is a _____

2. Use your ruler to construct the following quadrilaterals accurately.

a.



b.



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3. Make an accurate full sized drawing of quadrilateral ABCD such that $\angle A = 70º$, AB = 4 cm, AD = 4 cm BC = 3 cm and CD is 4.8 cm.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2

SUB-STRAND 2: SUMMARY

Below summarizes some of the important ideas and concepts to remember.

- A **Polygon** is a closed figure formed by three or more line segments joined only at their endpoints. The line segments are called the **sides** of the polygon while their points of intersection are called the **vertices**.
- A polygon whose sides have equal lengths is **equilateral.**
- A polygon whose angles have equal measures is **equiangular.**
- A polygon that is both equilateral and equiangular is **regular.**
- Segments with equal lengths are congruent.
- Angles with the same measure are also congruent.
- **Diagonals** are lines joining two non-consecutive vertices of a polygon.
- A **triangle** is a polygon of three sides. It is formed by three non-collinear points (*points that do not lie on the same line*) joined by three line segments.
- The **altitude** of the triangle is the line segment from a vertex of a triangle perpendicular to the opposite side.
- The **median** of a triangle is the line segment from a vertex of a triangle to the midpoint of the opposite side.
- An **angle bisector** is a line segment from a vertex of a triangle passing through its interior and dividing the angle into two equal angles.
- Triangles can be classified according to angles and according to sides.
- A triangle is: **acute,** if all the angles are acute.
  right, if there is one right angle.
  obtuse, if there is one obtuse angle.
  equilateral, if the three sides are equal.
  isosceles, if two sides are equal.
  scalene, if no sides are equal.
- A **quadrilateral** is a polygon with 4 straight sides.
- A **trapezium** is a quadrilateral which has one pair of opposite sides parallel.
- A quadrilateral with both pairs of opposite sides parallel is a **parallelogram**.
- A **rhombus** is a parallelogram with all its sides equal and whose angles are oblique. The opposite sides of a rhombus are congruent.
- A **rectangle** is a parallelogram where all its angles are right angles.
- A **square** is a rectangle with all its sides equal and all its angles are right angles.
- A **kite** is a quadrilateral with two pairs of adjacent sides equal.
- A quadrilateral is **convex** when all its diagonals lie in its interior
- A quadrilateral is **concave** when at least one of its diagonals lies outside of the figure.
- To construct or draw triangles and quadrilaterals, we must be given certain information about the lengths of its sides and the sizes of some angles. We make use of the ruler, pencil, compass and a protractor to draw triangles and quadrilaterals.

REVISE LESSONS 7-12 THEN DO SUB-STRAND TEST 2 IN ASSIGNMENT 2.

ANSWERS TO PRACTICE EXERCISE 7-12

Practice Exercise 7

1. A, D and F

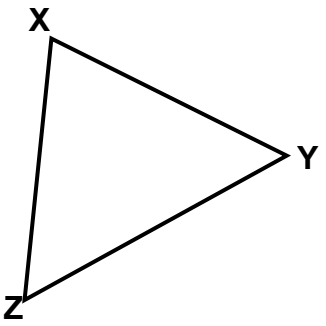
2. (a) quadrilateral (b) hexagon
   (c) triangle (d) heptagon

3. 3 sides

4. Sides = RS, ST, TU, UP AND PR
   Vertices = Points R, S, T, U and P
   Angles = $\angle$R, $\angle$S, $\angle$T, $\angle$U and $\angle$P

5. (a) 7 cm (b) 144º

Practice Exercise 8

1. 

   Sides are XY, YZ AND XZ
   Vertices are points X, Y and Z
   Angles are $\angle$ X, $\angle$Y and $\angle$Z

2. $\angle$NOM, $\angle$NOP, $\angle$NOR

3. three (3) altitudes

4. three (3)

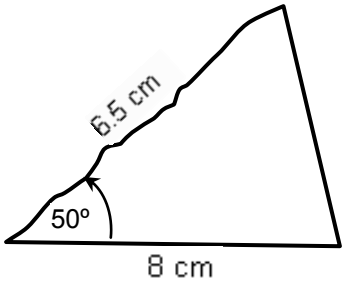
5. (a) ΔABY, ΔBAY, ΔYAB, ΔYBA, ΔAYB, ΔBYA

   (b) ΔTRS, ΔSRT, ΔRTS, ΔSTR, ΔRST, ΔTSR

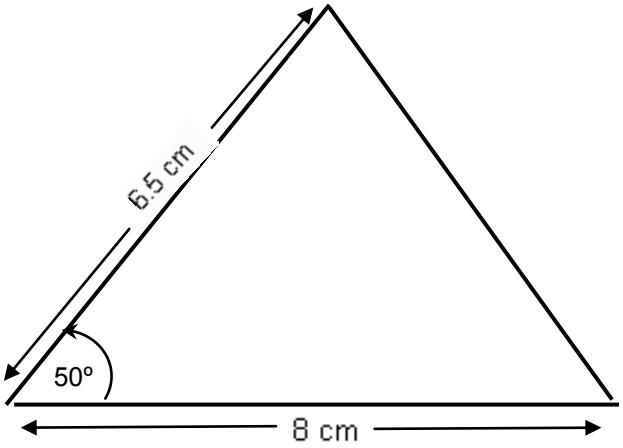
6. (a) vertices (e) ΔTXW and ΔTXO (i) 65º
   (b) altitude (f) $\overline{TX}$ (j) 58º
   (c) legs (g) scalene
   (d) base (h) no

Practice Exercise 9

1.1. Rough Drawing:

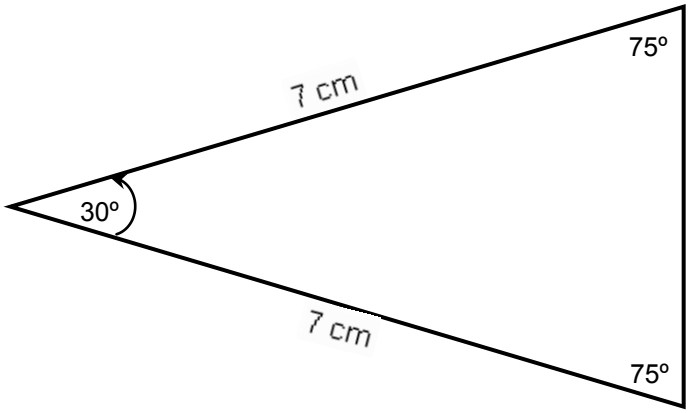


2. Careful Drawing:



(a) 6.2 cm (b) (i) 53º or 52º (ii) 77º or 78º (c) NO (d) NO

2. Careful Drawing



Other angles measure 75º.

Practice Exercise 10

1. B – yes, C - yes, D – no, E – no, F – yes,
   G – yes, H – yes, I – yes, J – no K - yes

2. (a) Quadrilateral QMCS is a Parallelogram

   (b) 1. $\overline{QS}$ and $\overline{MC}$, $\overline{QM}$ and $\overline{SC}$
   2. $\overline{QS}$ and $\overline{SC}$, $\overline{SC}$ and $\overline{CM}$, $\overline{CM}$ and $\overline{MQ}$, $\overline{MQ}$ and $\overline{QS}$
   3. $\angle S$ and $\angle M$, $\angle Q$ and $\angle C$
   4. $\angle S$ and $\angle C$, $\angle C$ and $\angle M$, $\angle M$ and $\angle Q$, $\angle Q$ and $\angle S$

3. Figures A, B and E

Practice Exercise 11

1. (a) false (f) true
   (b) false (g) true
   (c) true (h) true
   (d) true (i) false
   (e) false (j) true

2. (a) A, D and F
   (b) E, B, C and G
   (c) F and D
   (d) D and G

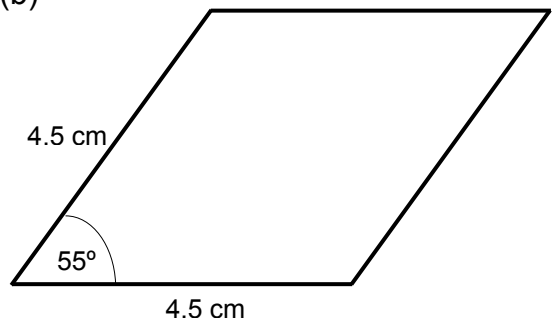
3. (a) MNOP is an isosceles trapezium
   (b) MN and PO are the bases
   (c) AB is a median
   (d) MQ and NR are altitudes

Practice Exercise 12

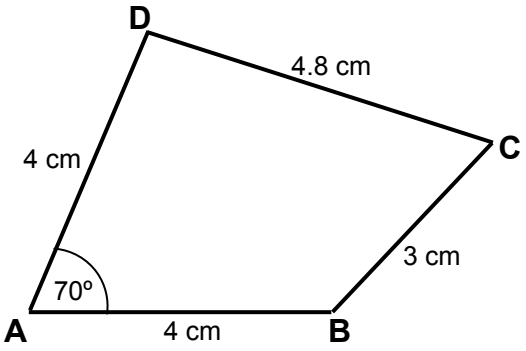
1. (a) square (b) rhombus (c) Kite
   (d) parallelogram (e) rectangle (f) trapezium

2. (a)

(b)



3.



END OF SUB-STRAND 2

SUB- STRAND 3

NETS

SUB-STRAND 3: NETS

Introduction

Dear student,

Welcome to Sub-strand 3 of Strand 2. In this sub-strand, you will learn to design nets for various solids.

Our world is three-dimensional. Many of the solid shapes around us are combinations of 3D figures such as prisms, pyramids, cones, cylinders and spheres. Graphic artists can create computer animations using 3D objects and scenes using soft-ware. The artist draws the top, front and side views of the object and places them within a scene.

Most packaging boxes are cut from a single sheet of cardboard which is folded and taped into shape. The shape that is cut out from the cardboard to form a box before folding is called the net of the prism.

In this sub-strand, you will learn the meaning of solid shapes and identify and describe their properties. You will also learn to make the nets of different solid shapes such as prism, pyramid, cone and other simple solids. In the last two lessons, you will learn to make and design solids from their nets as well as drawing pictures of solids using lines, square grid and isometric grid papers.

Lesson 13: Solid Shapes

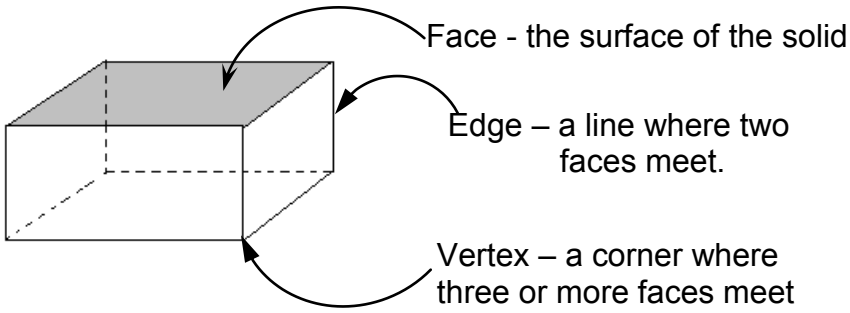
You learnt to draw and construct plane shapes in Sub-strand 2.

In this lesson, you will:

- define a solid
- describe and identify the properties of solid shapes such as prisms and pyramids.

Solids have thickness, as well as length and breadth. We say that they are three-dimensional (3D). Our world is full of solid shapes.

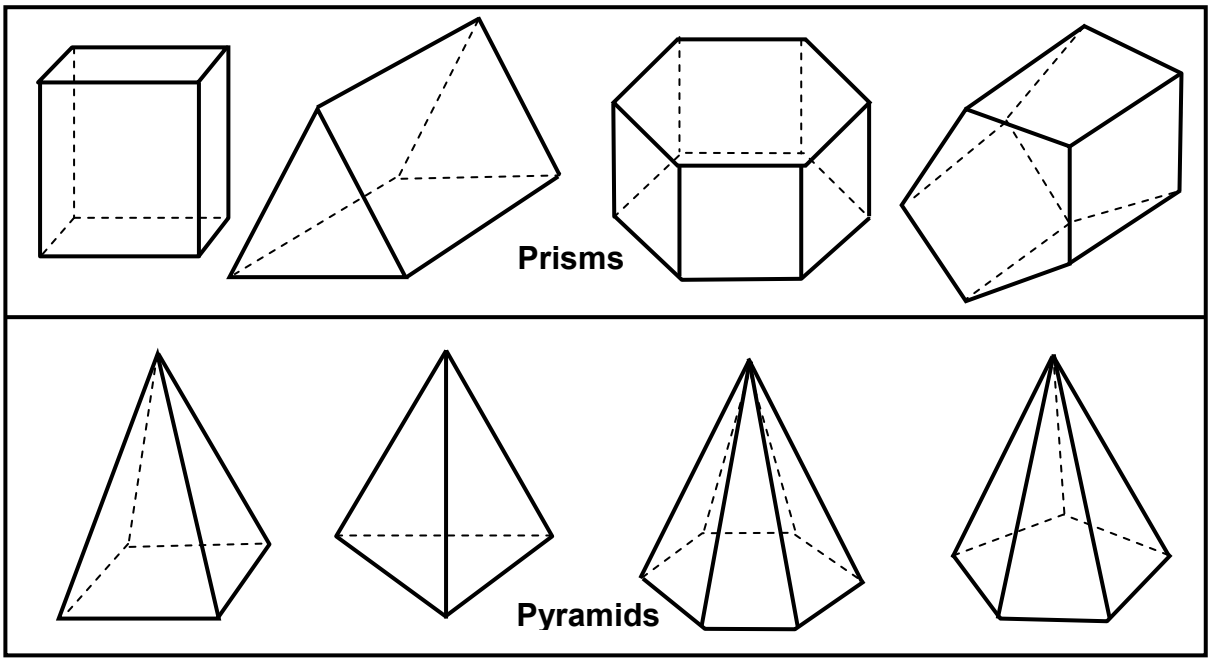
Parts of a Solid



A solid may be full or empty inside.

There are two main families of solids, the **prisms** and the **pyramids.**

Look carefully at the two family groups and see what each family has in common. Not all members of each family are shown.

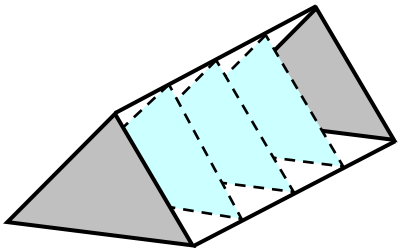


Prisms

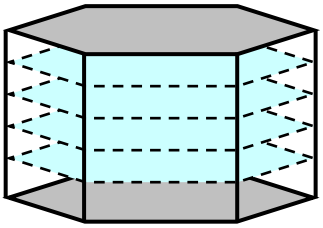
All prisms have a special pair of parallel faces. These faces are the only faces that need not be a parallelogram or rectangular in shape.

A prism is a solid shape with two polygonal bases lying in parallel planes and with other faces that are parallelograms.

If a prism is "sliced" or "cut" parallel to these faces, the same shape always results. This shape is called the **cross-section.** (See dashed shapes)



Triangular Prism



Hexagonal Prism

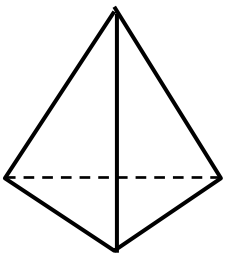
A prism is named according to the shape of its cross-section.

Pyramids

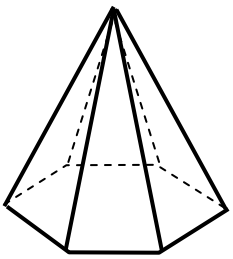
All pyramids have one face that need not be triangular. This face is called the **base** which is used to name the pyramid. A pyramid has a polygonal base. All other faces are triangular.

A pyramid is a solid shape whose base is a polygon and whose faces are triangles.

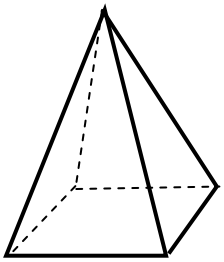
A pyramid having a regular polygonal region as its base and lateral edges of equal length is called a **regular pyramid**.



Triangular-based Pyramid



Hexagonal-based Pyramid



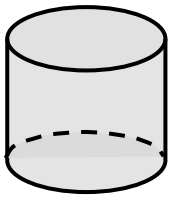
Square-based Pyramid

A pyramid cannot be sliced or cut like prisms so that identical shapes always result. This means that a pyramid does not have uniform cross-sections.

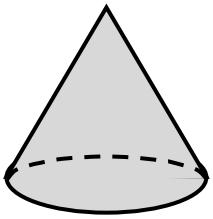
A pyramid is named according to the shape of its non-triangular face. If all its faces are triangles, the pyramid is a triangular pyramid.

Other Solids

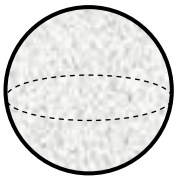
Some solids are neither prisms nor pyramids. The most common of these are the cylinder, cone and sphere, all of which have circular shapes.



Cylinder



Cone



Sphere

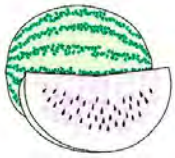
NOW DO PRACTICE EXERCISE 13

Practice Exercise 13

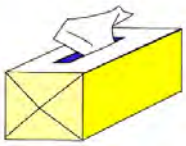
1. Look closely at the figures shown below and identify the solid shapes you can see in each.

(a) 

_____

(b) 

_____

(c) 

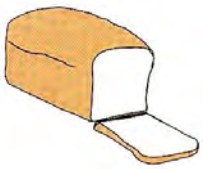
_____

(d) 

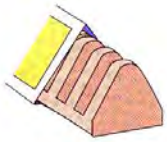
_____

(e) 

_____

(f) 

_____

(g) 

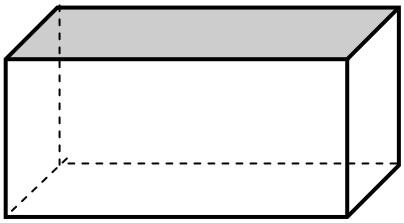
_____

(h) 

_____

2. Look at the shape carefully and find the following parts: Use arrows to indicate the parts.

1. Faces
2. Edges
3. Vertices (Corners)



3. Complete the table to show the number of faces, edges and vertices for each shape.

Solid	Number of Faces (F)	Number of Vertices (V)	Number of Edges (E)
Cube			
Hexagonal Prism			
Triangular Prism			
Rectangular pyramid			

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

Lesson 14: Nets of Simple Solids

In Lesson 13, you learnt the meaning and the different properties of solid shapes such as prisms and pyramids.

In this lesson, you will

- define nets
- design nets and make nets of simple solids on a square grid of paper.

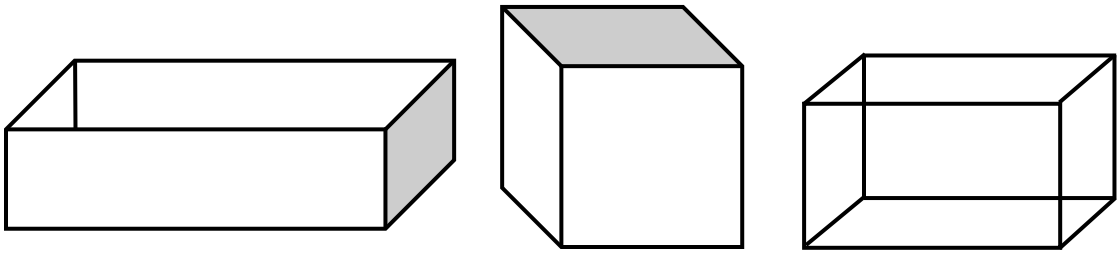
Solid shapes can be made from plane shapes. This is done by drawing the net of the solid on a piece of paper. The net shows how the faces are joined to each other. When faces are folded along their edges, the solid is formed.

The net of a solid is a two-dimensional representation that can be folded to produce a three-dimensional solid. It is the pattern it makes in two dimensions if we cut it out along edges and laid out flat.

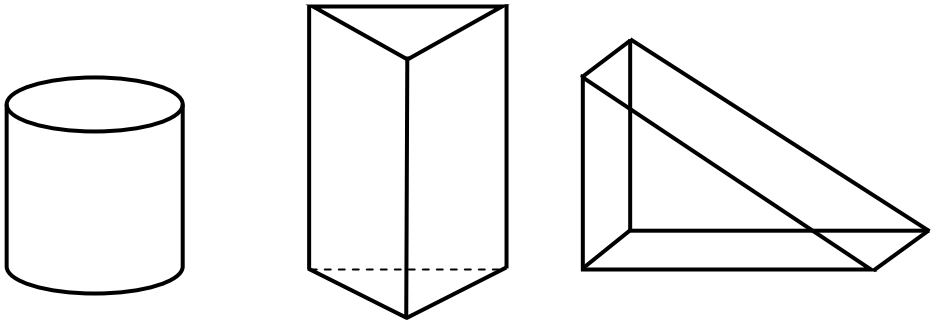
Some nets are quite easy to make while others are hard.

*We shall learn the net of simple solids whose lateral faces are rectangles called **rectangular prisms.***

Here are some examples of rectangular prisms.



These are not rectangular prisms.



You will now learn more about rectangular prisms by doing the following activities.

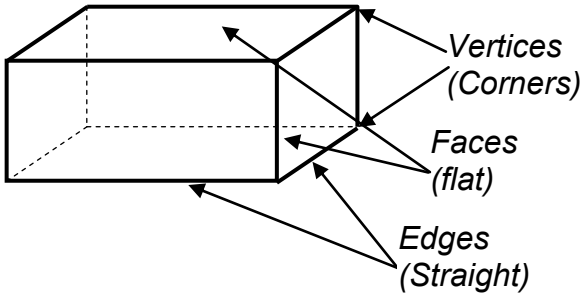
Activity 1

You will need: any one of the following (empty)

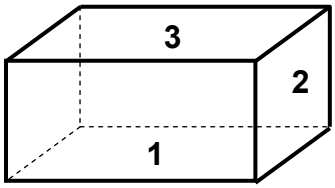
1. a match box
2. a packet of tea
3. a milk carton
4. a cigarette box

Step 1: Look at the shape carefully and find the following parts:

a) Faces
b) Edges
c) Vertices (Corners)



Step 2: Number the faces… starting from 1, 2, 3, … and count the faces.



Your answer will be 6 faces.

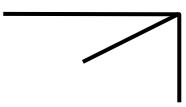
Step 3: Look at the 6 faces … one by one … again.

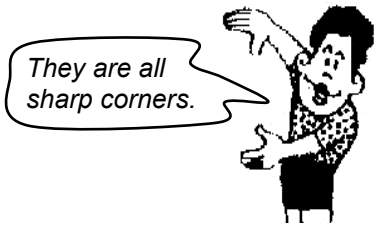
All the faces have the shape of a rectangle.

Step 4: Look at the edges of your shape.

All the edges of any rectangular prisms are straight.

Step 5: Look at the vertices (Corners).



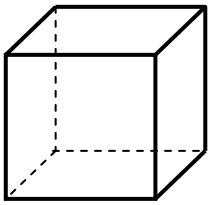


Now learn this new word.

A rectangular prism is a solid shape whose six faces are all rectangles. It may be closed or opened.

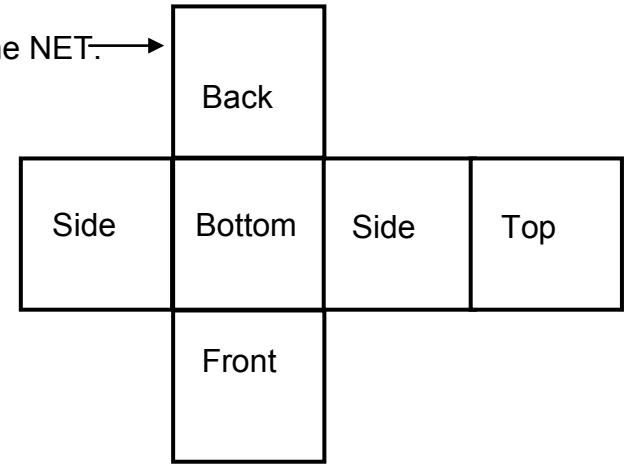
Now look at the net of a cube shown at the right.

A net is the two-dimensional pattern made when a solid is cut along the edges and laid flat.



CUBE

This is the NET.



A cube is a rectangular prism whose faces are all squares.

When trying to draw a net, you need to answer the following questions:

- What types of faces does the solid have?
- How many of each type are there?
- Which faces are joined to each other?

Then select a face of the solid and draw it. Look at the faces that join this face and then draw them.

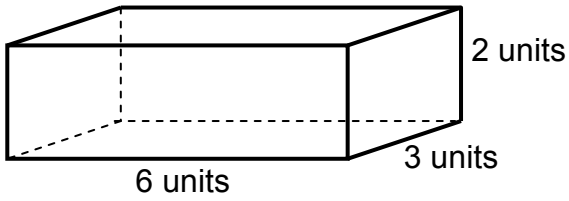
Continue in this wayuntil all the faces have been drawn.

Activity 2

In this activity, you will make and draw the net of a rectangular prism using the steps in Activity 1.

You will need:
1. a pair of scissors
2. pencil
3. ruler
4. square grid paper

Draw the net of the rectangular prism on square grid paper.



Solution:

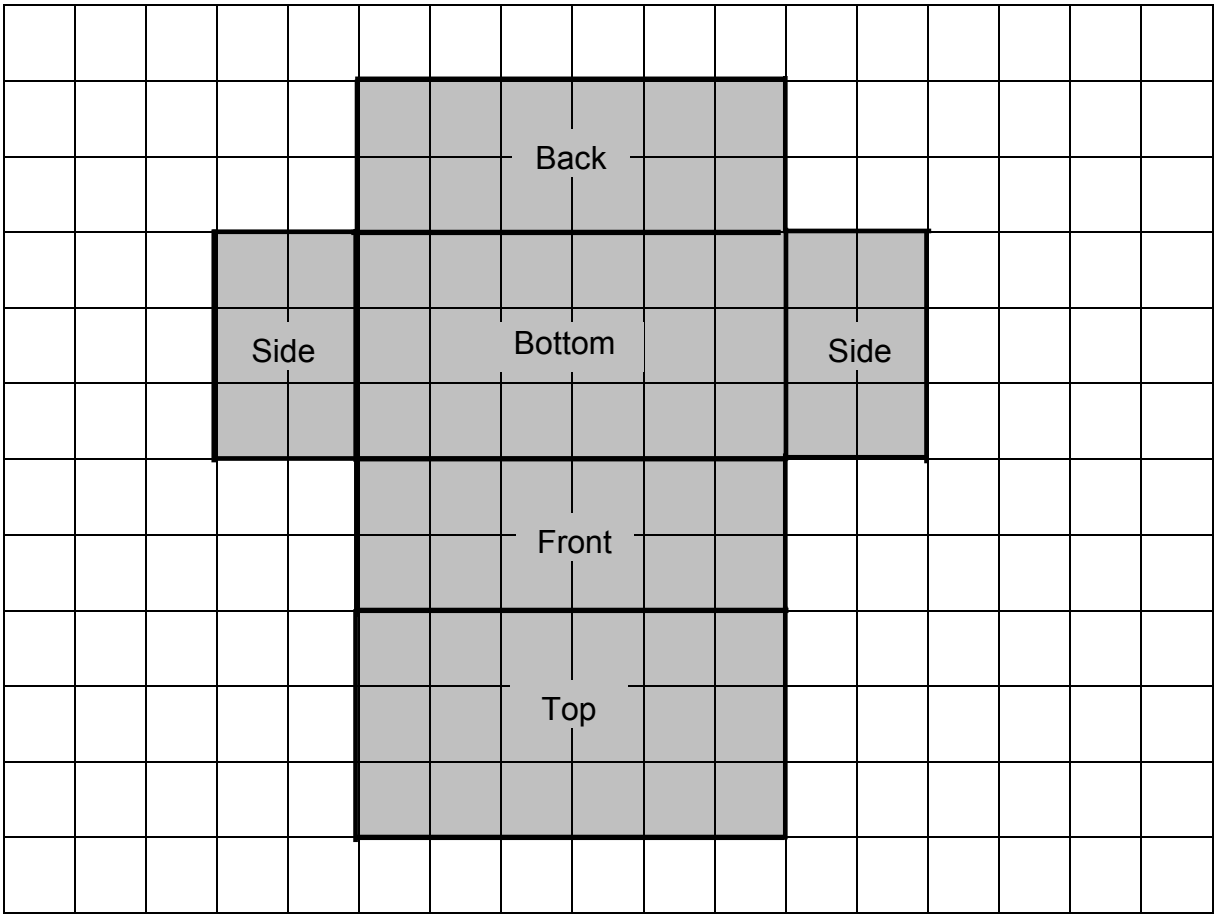
The solid has six rectangular faces. These are three pairs of different-sized rectangles.

Step 1: Draw the bottom. This is 6 square-long and 3 square-wide.

Step 2: Add the two sides that join it.

Step 3: Add the front and back that join it.

Step 4: Finally add the top, which can be joined either to the back, front or side.



Net of the Rectangular Prism

NOW DO PRACTICE EXERCISE 14

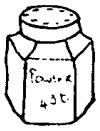
Practice Exercise 14

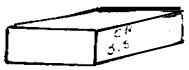
1. Which of the following shapes are rectangular prisms?

(a) 

(b) 

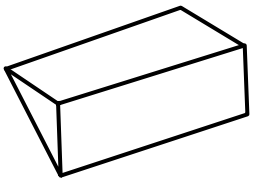
(c) 

(d) 

(e) 

The rectangular prisms are _____ and _____.

2. Look at this shape.



It has flat faces.
It has straight edges.
It also has sharp corners.

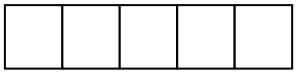
(a) Is the shape a rectangular prism? _____YES _____NO

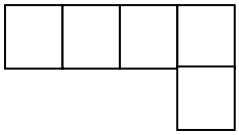
(b) Give a reason to your answer.

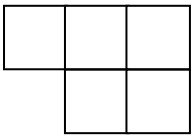
_____
_____.

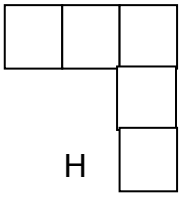
3. Five connected squares form a pentomino (a shape formed by five connected squares).

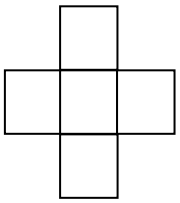
Which of the following pentominoes below form the net of an open box?

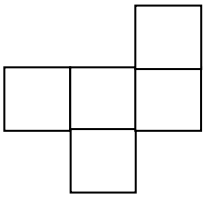
A 

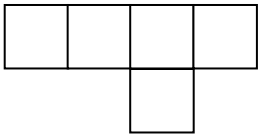
B 

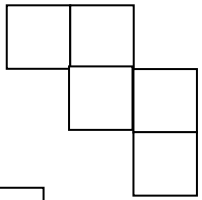
C 

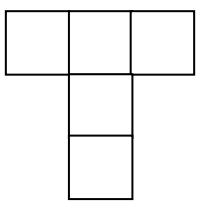
D 

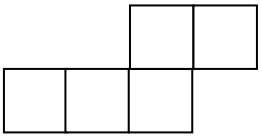
E 

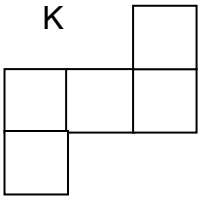
F 

G 

H 

I 

J 

K 

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3.

Lesson 15: Nets of Pyramids

You learnt how to design and make the nets of simple solids like cubes, cuboids and prisms in Lesson 14.

In this lesson, you will:

- design and make nets of pyramids.

Let us define pyramid again.

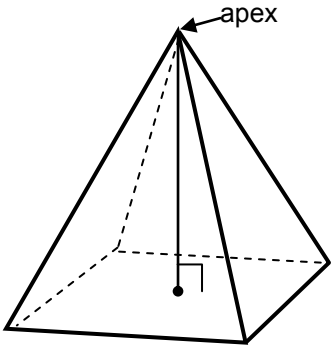
A pyramid is solid shape whose base is a polygon and whose faces are triangles.

All pyramids have one face that need not be triangular. This face is called the **base** which is used to name the pyramid. A pyramid has a polygonal base. All other faces are triangular.

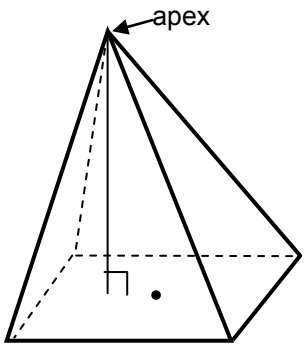
A pyramid having a regular polygonal region as its base and lateral edges of equal length is called a **regular pyramid**.

A **right pyramid** has its axis perpendicular to its base. Its top point (apex) is above the centre or midpoint of its base.

An **oblique pyramid** is one where the apex is not over the entre or midpoint of its base

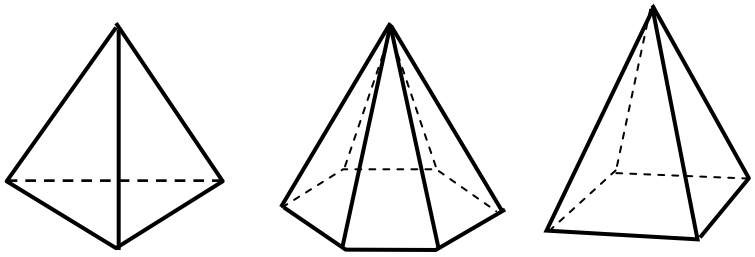


Right Pyramid



Oblique Pyramid

Here are examples of pyramids.



When trying to draw a net, you need to answer the following questions:

- What types of faces does the solid have?
- How many of each type are there?
- Which faces are joined to each other?

Then select a face of the solid and draw it. Look at the faces that join this face and then draw them.

Continue in this manner until all the faces have been drawn.

In the following activities, you will make and draw the net of rectangular prisms using the procedure above.

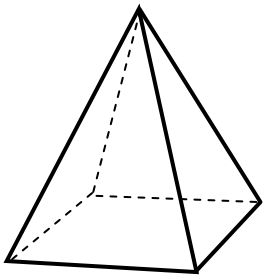
You will need the following:

Ruler, grid paper, pencil, a pair of scissors,

Activity 1

Draw the net of a square pyramid on a sheet of square grid paper.

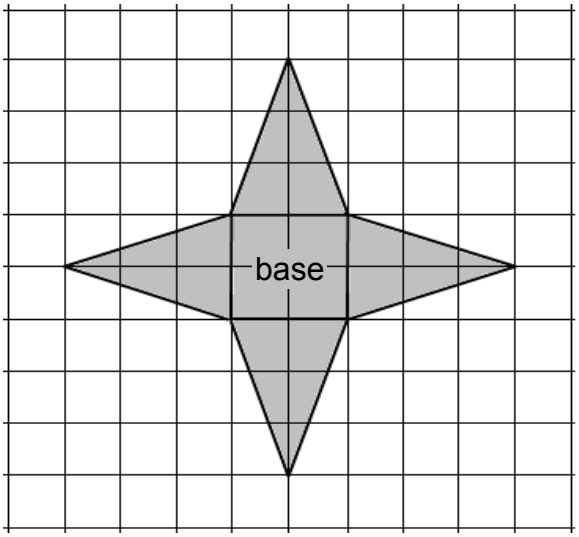
A square pyramid has four identical triangular faces joined to a square base, so:



Step 1: Draw a square base.

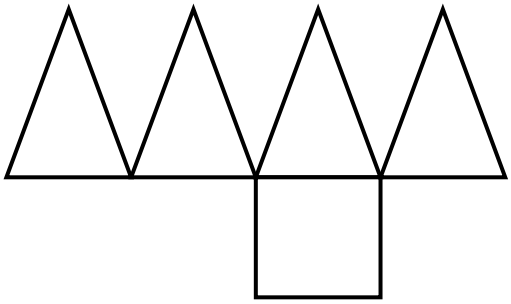
Step 2: Add the four adjoining triangles to each side of the base.

You will have the result like this:



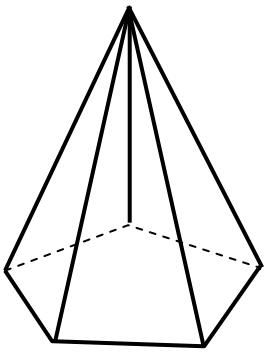
Net of the Square Pyramid

You can do this in another way. Like for example if we cut along the edges as shown below.

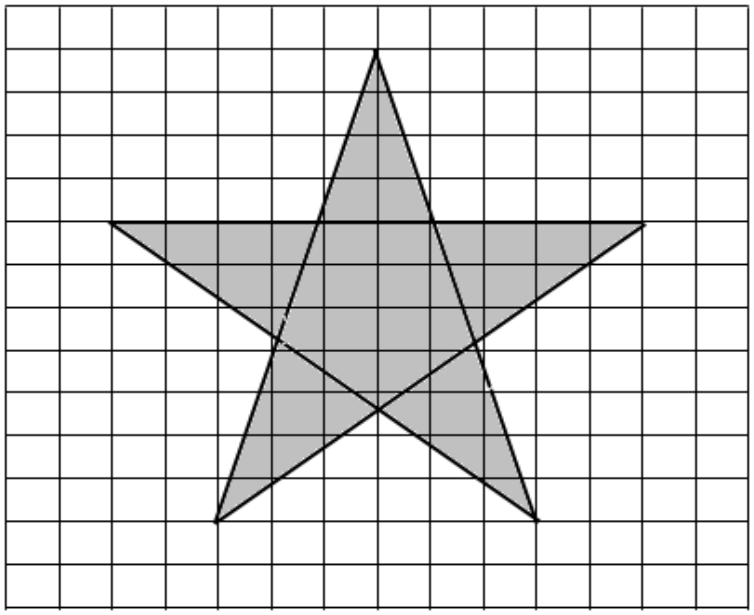


Activity 2

Draw the net of the pyramid below.



This is a pentagonal pyramid. The pentagonal pyramid has five identical triangular faces joined to a pentagonal base.



Net of the Pentagonal Prism

Step 1: Draw the pentagonal base.

Step 2: Add the five adjoining triangles to each sides of the base.

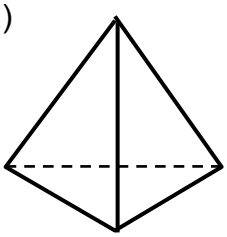
You can do this in another way.

NOW DO PRACTICE EXERCISE 15

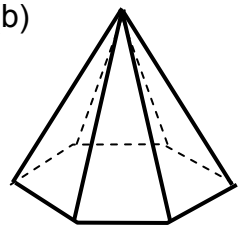
Practice Exercise 15

1. Using the square grid paper on the next page, draw the net of the following pyramid.

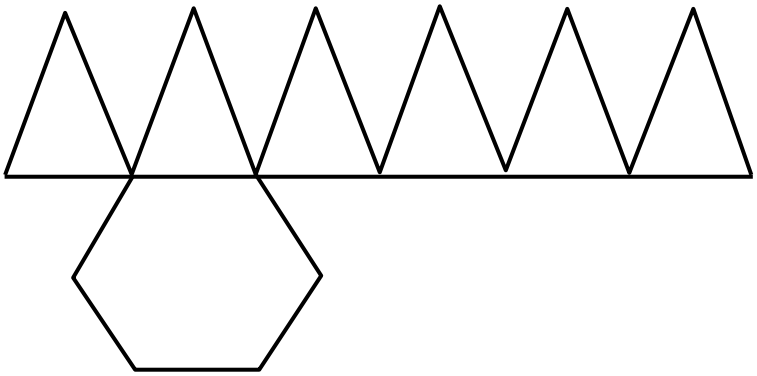
(a)



(b)



2. The net below is a net of a pyramid. Which one?



CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2

Lesson 16: Net of a Cone

In Lesson 15, you learnt how to design and make nets of pyramids.

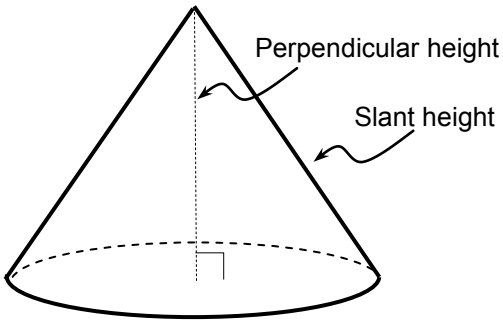
In this lesson, you will:

- design and make the net of a cone.

Many objects in real life will remind us of a cone. The figures below are only some of them.

All the above figures are shaped like a cone.

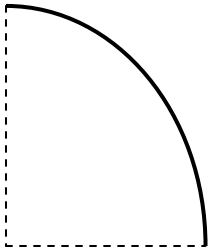
Other examples are the Hagen Round House and the Tolai DukDuk.



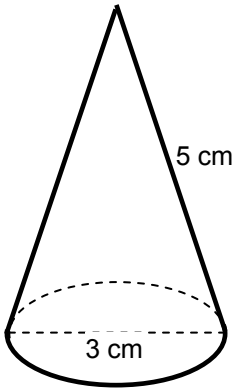
A CONE

A cone is special solid figure with a plane circular base bounded by a conical surface.

The net of a cone is a conical surface which is quarter of a circle



Example Design the net of the cone below.



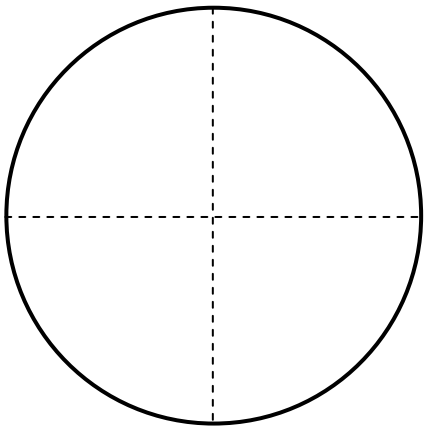
The activity below will show you how to make the net of the cone.

Activity 1

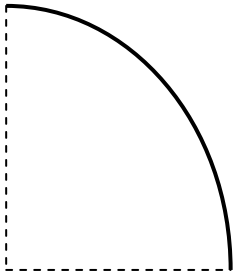
You will need:

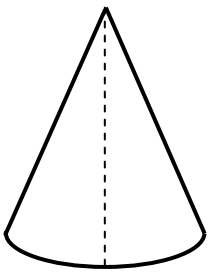
Piece of paper, pencil, compass or any circular pattern, a pair of scissors

Step 1 Draw a circle with a radius of 5 cm and divide it equally into quarters.



Step 3 Cut out one quarter of the circle which when folded joining the dotted edges will form the conical surface of the cone. (See the diagram on the right.)

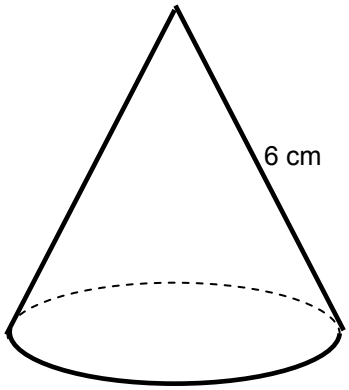




NOW DO PRACTICE EXERCISE 16

Practice Exercise 16

Draw the net of the cone accurately inside the box.



CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3.

Lesson 17: Constructing Solids from their Nets

You learnt how to design and make the nets of the different solid shapes in the previous lessons.

In this lesson, you will:

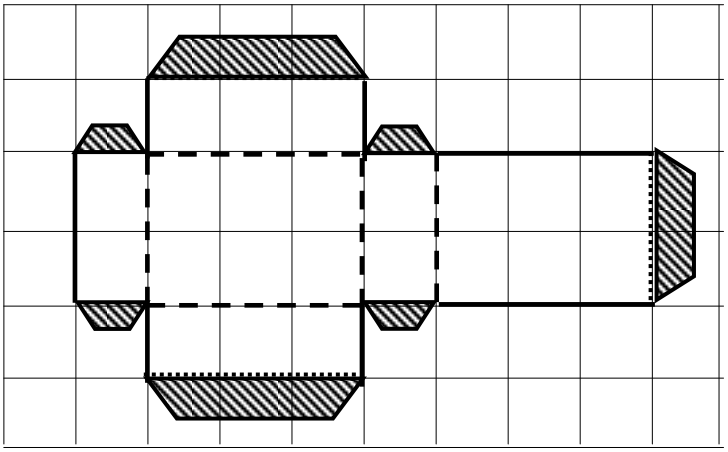
- construct and design solids from their nets.

In the following activities you will make rectangular prisms.

You will need:
1. a pair of scissors
2. glue or sticky tape.
3. A4 paper, card board or used folders

Activity 1

Step 1: Look at the diagram and copy it in an A4 paper. Then cut it out along the DARK LINES including the shaded flaps.

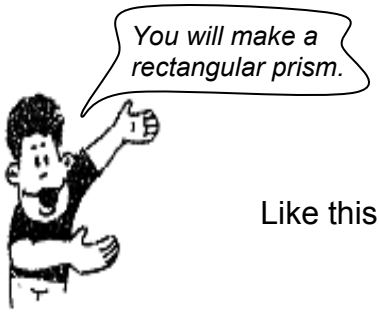


Step 2: Look at the dotted lines in the cut out shape.

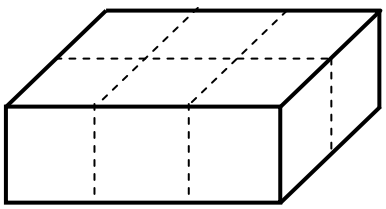
FOLD the cut-out along the dotted lines. – – – – – –

Step 3: Make a box bringing edges to correct positions to fit in.

Step 4: Paste the edges to the flaps, using glue or sticky tape.

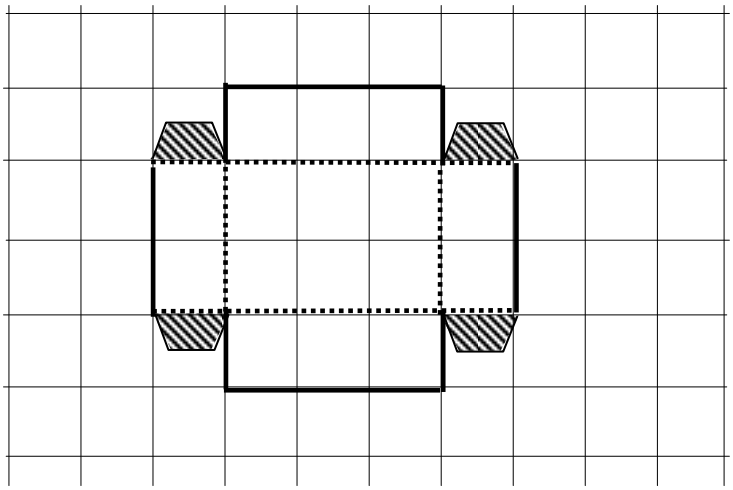


Like this: →

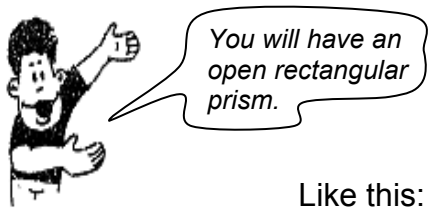


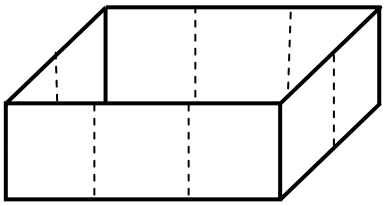
Activity 2

Now you will make a rectangular prism using the net below.



Repeat Steps 1, 2, 3 and 4 of Activity 1 for this activity.

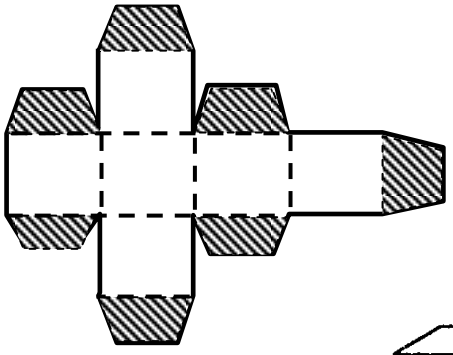


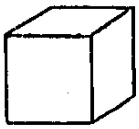
Like this: 

Activity 3

Repeat Steps 1, 2, 3 and 4 of Activity 1 and make the solid represented by the net below.

.

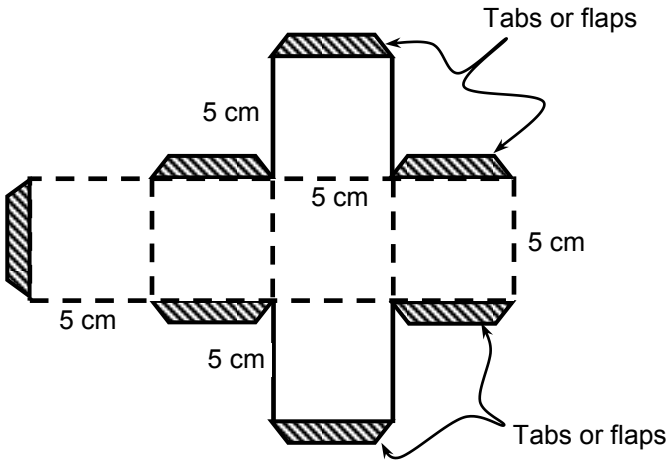


You will get a solid like this: 

Activity 4

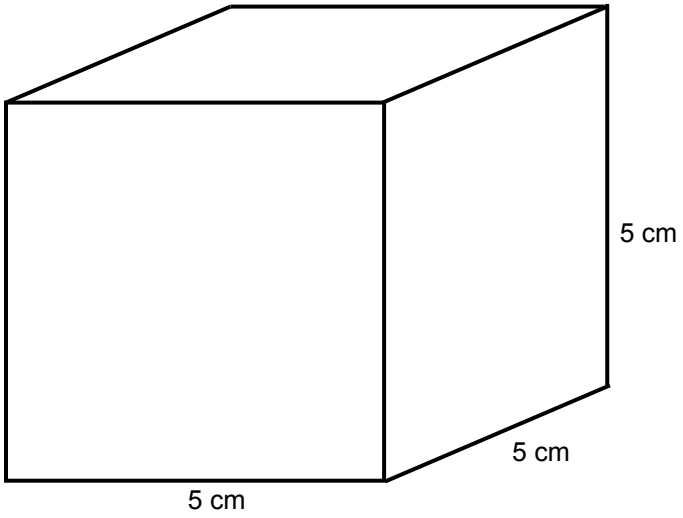
Now you will make a solid using A4 paper or a used folder.

Note: The diagram is not drawn to scale.



On a sheet of A4 paper or used folder, construct the net given above using the given dimension accurately. Cut it out and fold it up to form a cube. Glue or paste the edges to the tabs or flaps to seal the cube.

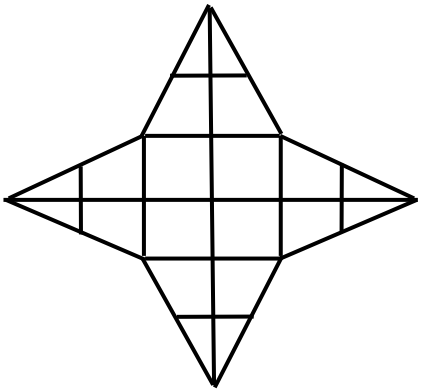
Your solid should look like this:



NOW DO PRACTICE EXERCISE 17

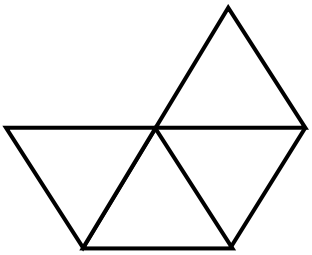
Practice Exercise 17

1. Cut out a larger version of the net shown and fold it to form a pyramid.



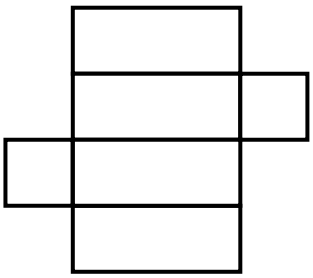
2. Name the solid that can be formed by the nets below.

a.



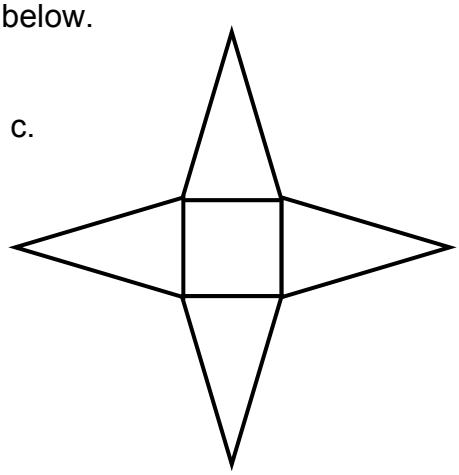
_____

b.



_____

c.



_____

3. Draw the solids you have drawn in Question 2.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3.

Lesson 18: Drawing Pictures of Solids

In Lesson 17, you learnt how to construct solids from their nets.

In this lesson, you will:

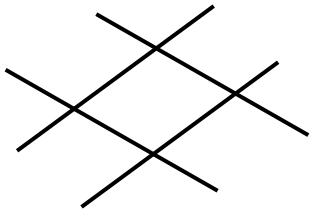
- draw pictures of solids using lines, square grid and isometric grid papers.

Drawing pictures of solids can be made easier by using one of the following methods.

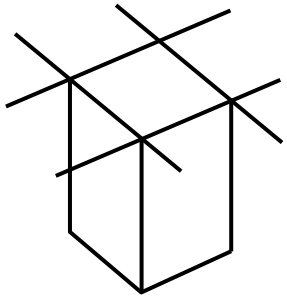
Method 1

Prisms and pyramids can be drawn using parallel lines. You have studied what parallel lines are in Sub-strand 2 Lesson 10.

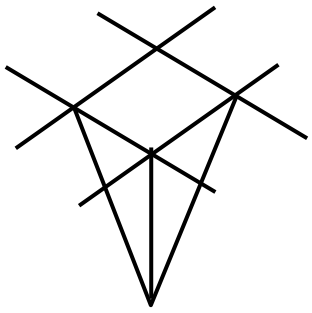
Step 1: Draw two pairs of parallel lines that cross like this.

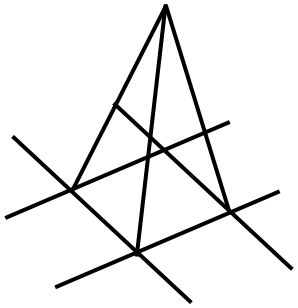


Step 2: Draw three lines of equal length straight down from the corners. Join the ends to get a prism as shown.



Step 3: Choose a point in the middle, below or above the figure. Draw lines from three corners to this point to get a pyramid as shown.

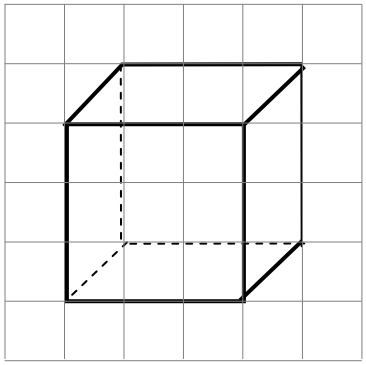
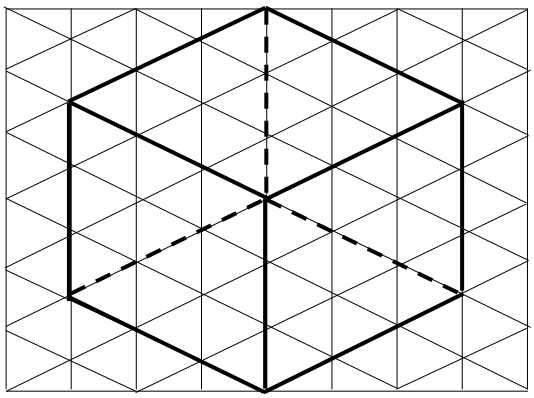
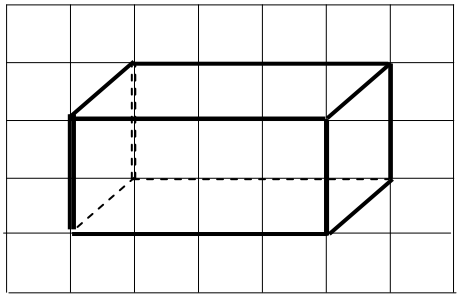
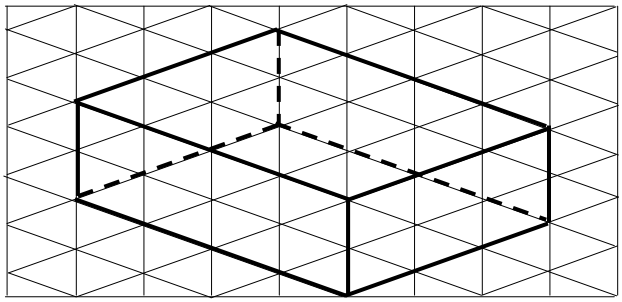




Method 2

We can sketch or draw solids on square grid or isometric grid paper. How we draw the solids depends on which view we wish to project and represent.

Below, a cube and a rectangular prism have been drawn using two different projections.

Oblique Drawing	**Isometric Drawing**
CUBE	
	
Using square grid paper	Using isometric grid paper
RECTANGULAR PRISM	
	
Using Square grid paper	Using isometric grid paper

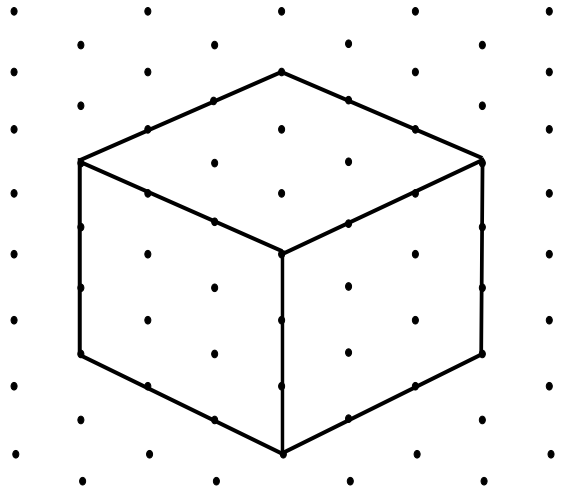
You will notice that in both projections, deliberate distortions (twists) have been made to make things “look right”. For example, the square and rectangular faces have not all been drawn as squares and rectangles.

Also, in the drawings made on the square grid, the face that appears to be going backwards into the paper is drawn less than the correct distance. This is because of an optical illusion that results if the edge is drawn the correct length.

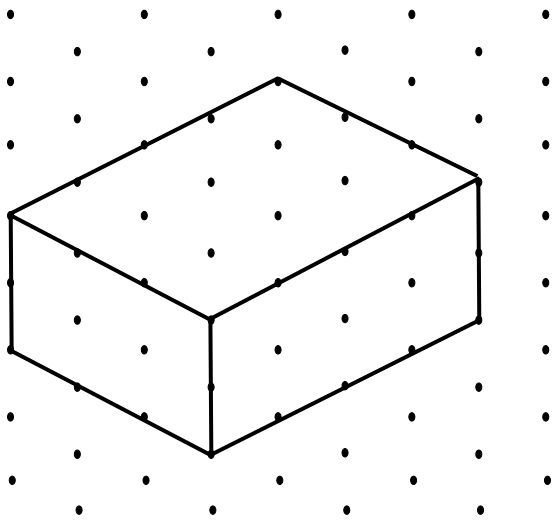
Notice also that in both the projections, edges that are hidden from view and cannot be seen are shown by dotted or dashed lines.

- **Isometric drawings show a corner view.**
- **Oblique drawing shows a front view.**

Here are some sketches of solids on isometric graph or dot paper.



This cube has side length 3 units.



This rectangular prism has length 4, width 3 and height 2 units.

Isometric drawings use a vertical edge as the front line. The vertical edge is the height of each solid.

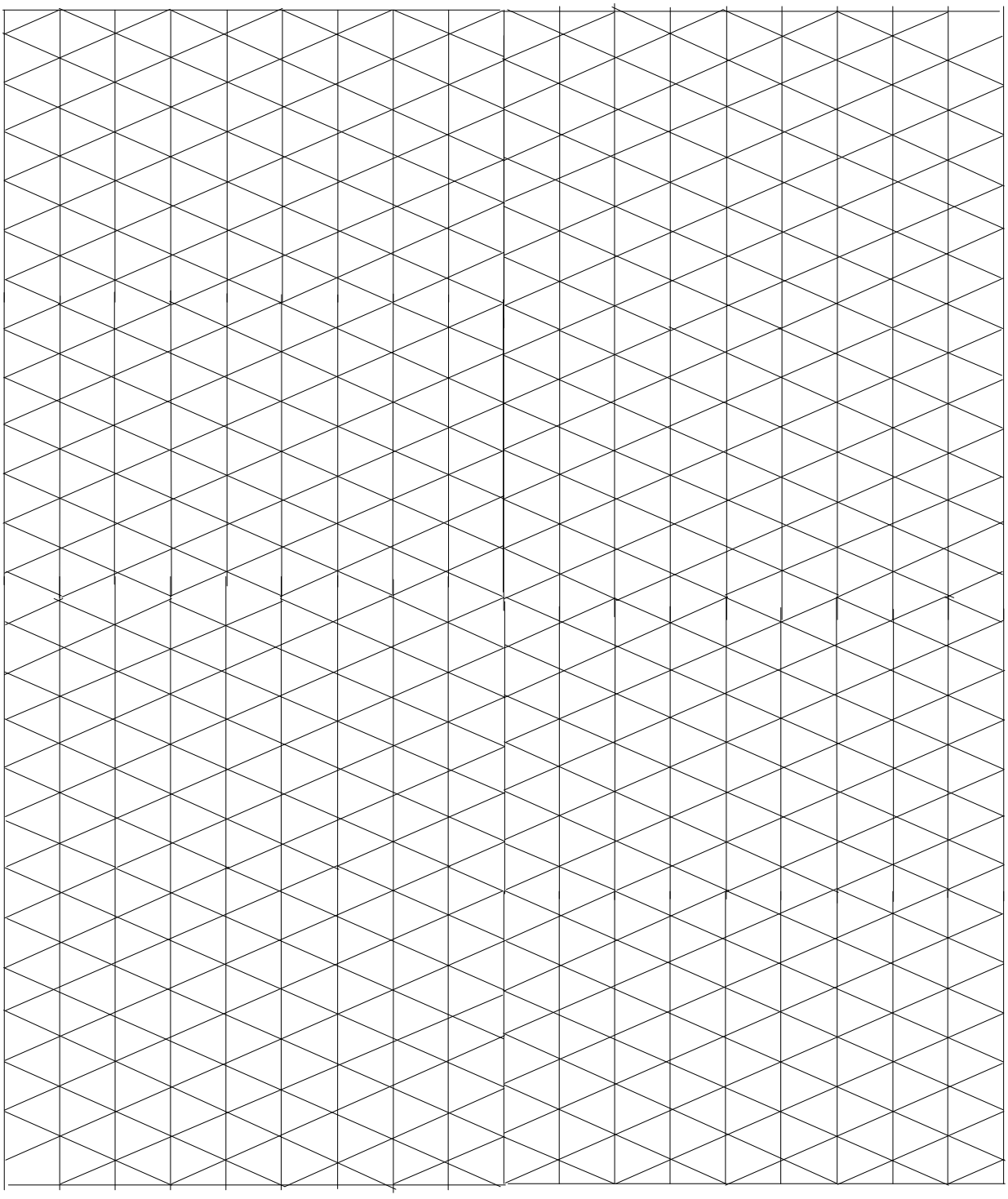
NOW DO PRACTICE EXERCISE 18

Practice Exercise 18

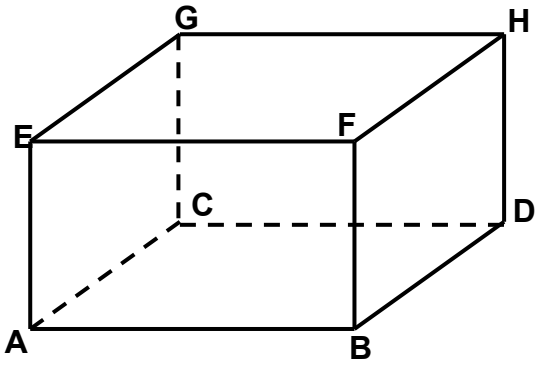
1. Draw the following solids with the given dimensions on an isometric grid paper.

   a) Cube of side length 4 units

   b) Rectangular prism that has length 6, width 5 and height 4 units.



2. A computer game involves a Martian called Martin who is trapped in a system of tunnels in outer space. The tunnels form the 12 edges of a cube. Martin starts at Point A and wants to travel to point H where his spaceship awaits. He can only travel along each tunnel once and never returns to point A.



a. Find the minimum number of tunnels required to reach his spaceship?

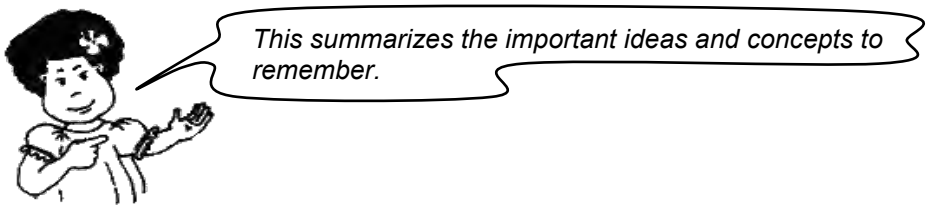
b. Find the maximum number of tunnels required to reach his spaceship?

c. Is it possible to travel along exactly four tunnels?

d. Investigate all possible paths. How many different paths are possible?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3.

SUB-STRAND 3: SUMMARY



- A **solid** has three dimensions: length, breadth and height. We say they are **three-dimensional** (3D).
- There are two main families of solids, the prisms and the pyramids
- A **prism** is a three-dimensional solid which has a uniform cross-section.
- A prism is named according to the shape of its cross-section.
- **Rectangular prism** is a prism whose six faces are rectangles.
- A **cube** is a prism whose six faces are squares. It is also called a **square prism.**
- A **pyramid** is a solid shape whose base is a polygon and whose faces are triangles.
- A pyramid is named according to its non-triangular face. If all its faces are triangles, the pyramid is a **triangular pyramid**.
- The **net of a solid** is the pattern it makes in two dimensions if we cut along its edges and lay it flat. A net shows how the faces of the solid are joined to each other. When this faces are folded, the solid is formed.
- To **draw the net of a solid**, you need to know the types of faces the solid has, the number of each type of face and which faces are joined to each of the other faces. Then select a face of the solid and draw. Look at the faces that join this face then draw them. Continue in this manner until all the faces have been drawn.
- To **draw the picture of a solid**, use the following methods:

  Method 1 using parallel lines

  Method 2 using square grid or isometric grid or dot paper
- To draw a solid depends on which view you wish to project and represent it.
- **Oblique drawings** show a front view.
- **Isometric drawings** show the corner view.

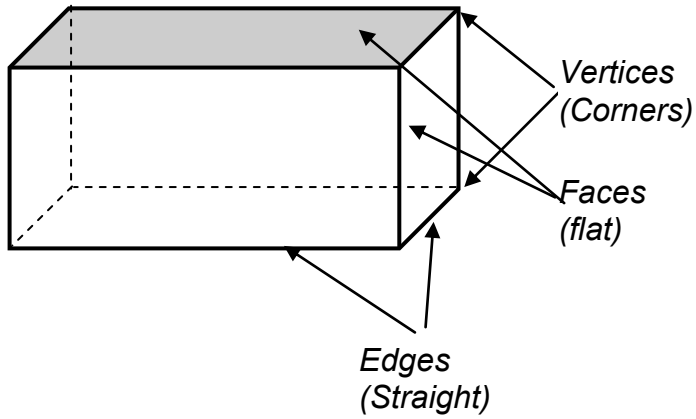
REVISE LESSONS 13-18 THEN DO SUB-STRAND TEST 2 IN ASSIGNMENT 2.

ANSWERS TO PRACTICE EXERCISES 13 -18

Practice Exercise 13

1. (a) cylinder
   (b) sphere
   (c) rectangular prism
   (d) cylinders
   (e) cone and hemisphere
   (f) rectangular prism or cuboid
   (g) triangular prism
   (h) rectangular prism or cuboid and triangular prism

2..



3.

Solid	Number of Faces (F)	Number of Vertices (V)	Number of Edges (E)
Cube	6	8	12
Hexagonal Prism	8	12	18
Triangular Prism	5	6	9
Rectangular pyramid	5	5	8

Practice Exercise 14

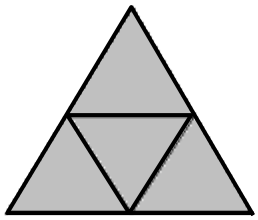
1. c and e

2. (a) NO
   (b) the solid has only five faces, 3 rectangles and 2 triangles. Meaning it does not comply with the definition of a rectangular prism whose six faces are all rectangles.

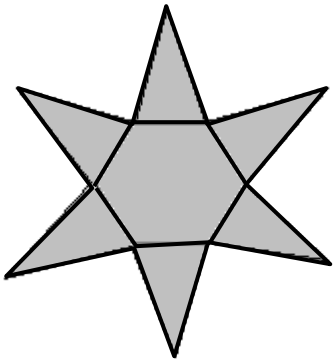
3. B, E, F, G, H, I, J, K

Practice Exercise 15

1. (a)

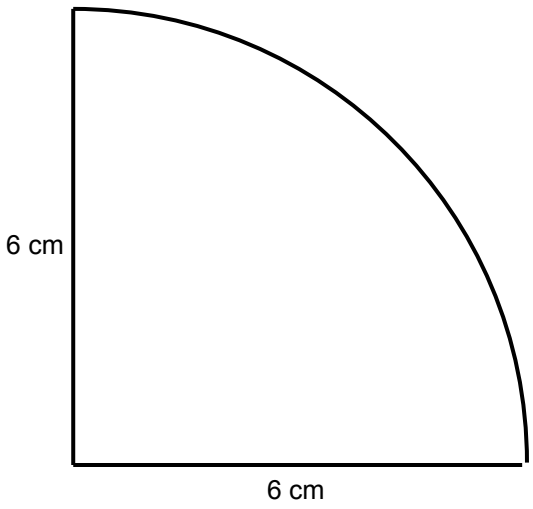


(b)



2. Hexagonal prism

Practice Exercise 16



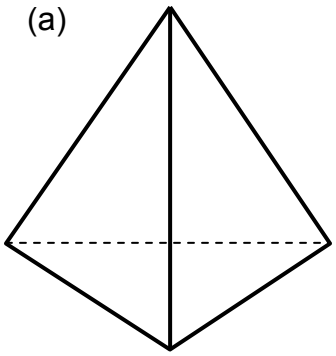
Practice Exercise 17

1. answers may vary

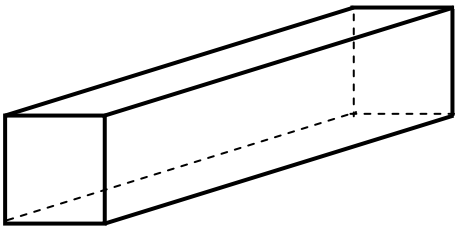
2. (a) triangular pyramid
   (b) rectangular prism
   (c) square pyramid

3.

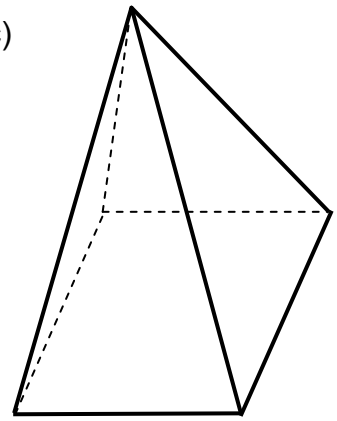
(a)



(b)

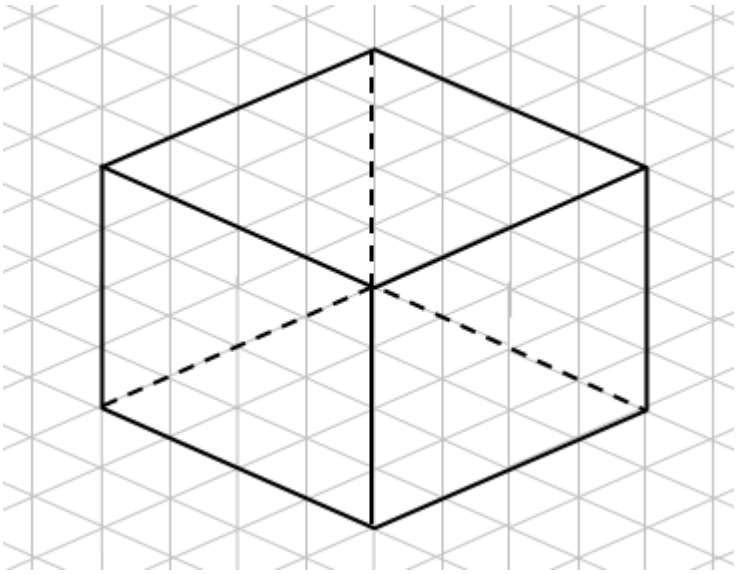


(c)

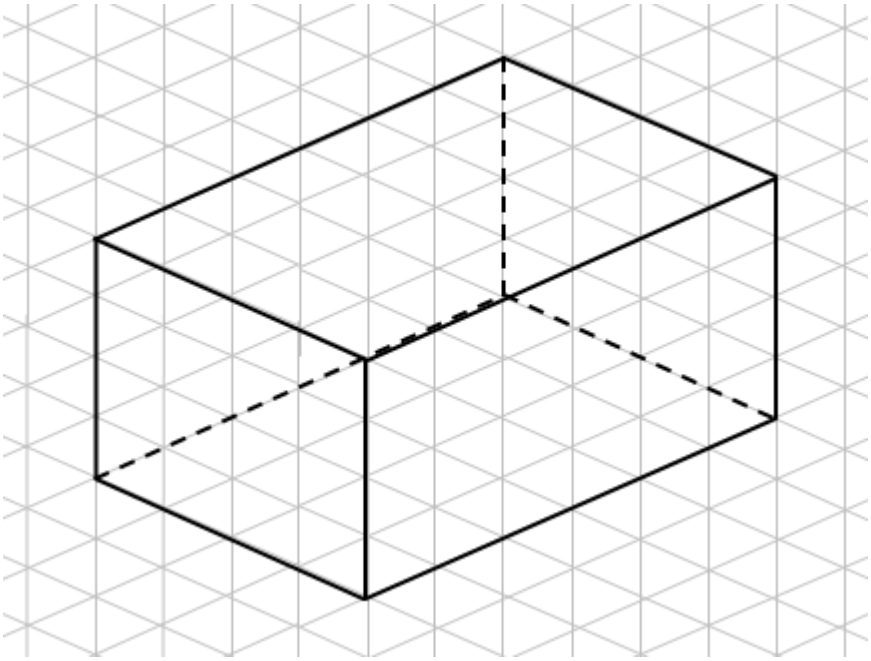


Practice Exercise 18

1. (a)



(b)



2. (a) 3
   (b) 7
   (c) not possible
   (d) 18

END OF SUB-STRAND 3

SUB-STRAND 4

TESSELLATION

SUB-STRAND 4: TESSELLATION

Introduction

Dear Student,

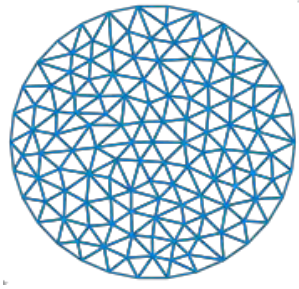
Welcome to Sub-strand 4 of your Strand 2. In this sub-strand you will create regular and irregular shapes that tessellate.

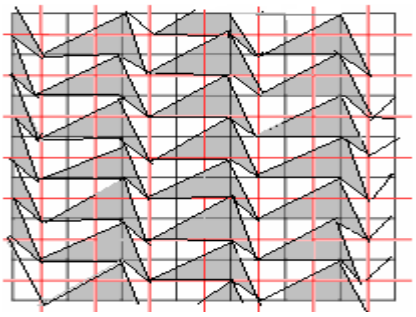
You have seen floors or walls constructed with ceramics or vinyl tiles. This is not new. The Romans made extensive use of tiles to decorate walls, floors, and ceilings of buildings, and even sidewalks, with geometric designs and patterns. The Romans called these small tiles **tessellae**. Tessellations are seen throughout art history, from ancient architecture to modern art.

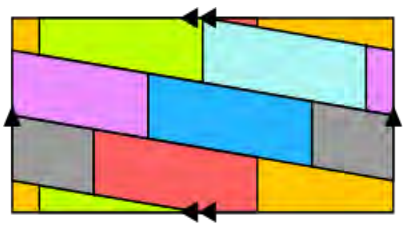
We usually associate tessellations with tiling or the filling of a two dimensional space. Tiled walls and floors in bathrooms, and tiled paths and porches around the homes are examples of tessellations.

A **tessellation** or **tiling** of the plane is a collection of plane figures that fill the plane with no overlaps and no gaps.

Interesting tessellations can be derived from polygons that are regular, others from irregular polygons. A **regular tessellation** is a highly symmetric tessellation made up of congruent regular polygons. Only three regular tessellations exist: those made up of equilateral triangles, squares, or hexagons.







In this sub-strand, you will learn the meaning of symmetry and identify symmetrical shapes. You will also learn how to draw and make symmetrical shapes which leads on for you to be able to make tessellations using regular and irregular shapes.

Lesson 19: Symmetry

You learnt how to make and design nets of various solids in the previous lessons.

In this lesson, you will:

- define symmetry
- identify pictures and shapes which are symmetrical
- make symmetrical shapes.

In this lesson you will first learn about symmetry.
Learn how to say this word, "SIM – a –tree."

A lot of activities in this lesson will help you find out about Symmetry. Your friends Eope and David will be there to help you.

Activity 1

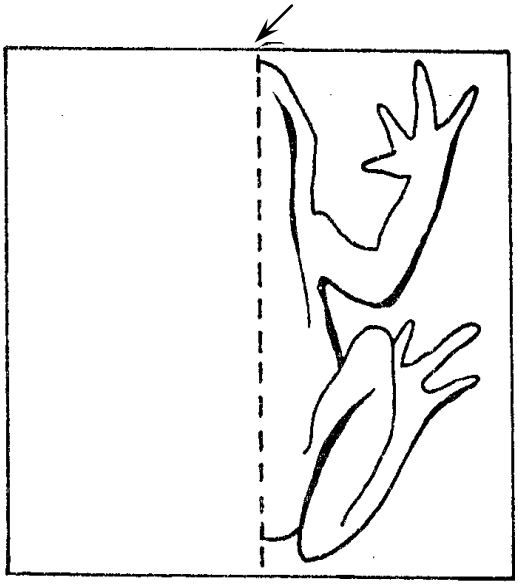
You will need: Pencil or pen, paper, pin, ruler

This is what you do:

1. Rule a dotted line down the middle of a piece of paper as in the picture on the right.

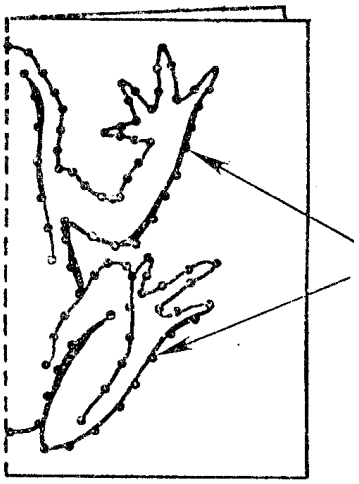
2. Place your paper on top of the drawing in the first picture. Make sure your dotted line is **exactly** on top of the line shown.

3. Very carefully, trace around the outline of the half frog, using your pen or pencil.



4. Fold your paper exactly along the dotted line you have drawn.

5. Make pin pricks right through the two sides of the folded paper, going around all the lines you have drawn on your half frog. (See the second picture at the right.)



6. Open your folded piece of paper. What do you see?

Join up the dotted lines, to correspond with (= matches) the lines of the half frog which you have traced from the first picture

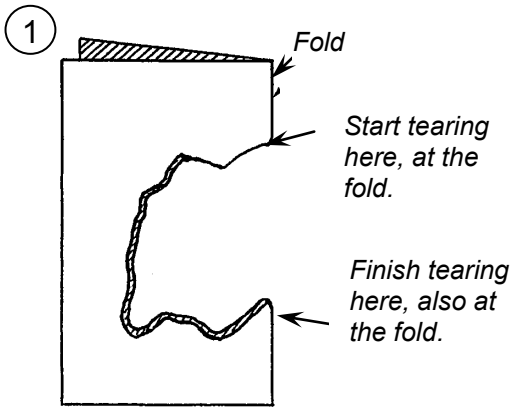
Activity 2

This is what you do.

1. Take a piece of paper and fold it in half.

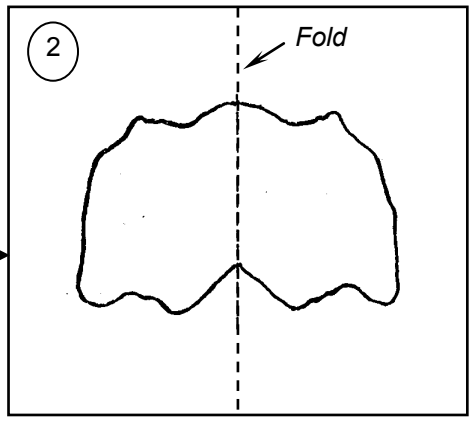
   Tear out a shape from the fold.

   Start tearing at the fold, and finish at the fold.



2. Open the torn out paper.

This is how your torn-out shape should look like.

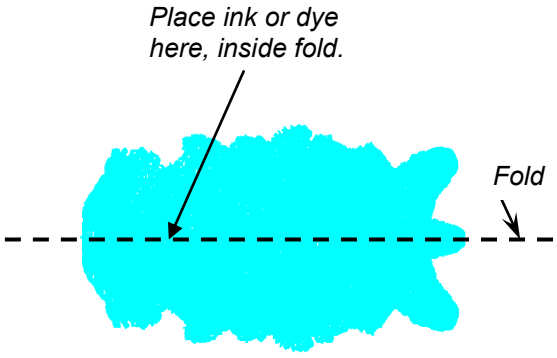


Activity 3

You will need: paper, ink (or dye, or paint, or some other brightly colored liquid)

Here is what you do:-

1. Fold your piece of paper in half.
2. Place a small amount of ink, paint or dye (e.g. one or two drops) in the fold.
3. Close the folded paper and press it to make the ink go in different directions.
4. Open your paper again. You have made your own ink design.



Ink Design

You have now done three different activities.

What do you notice about all the shapes you have made?

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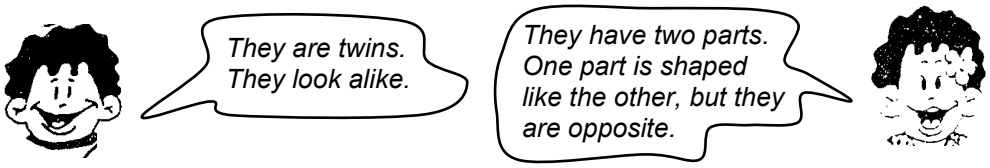
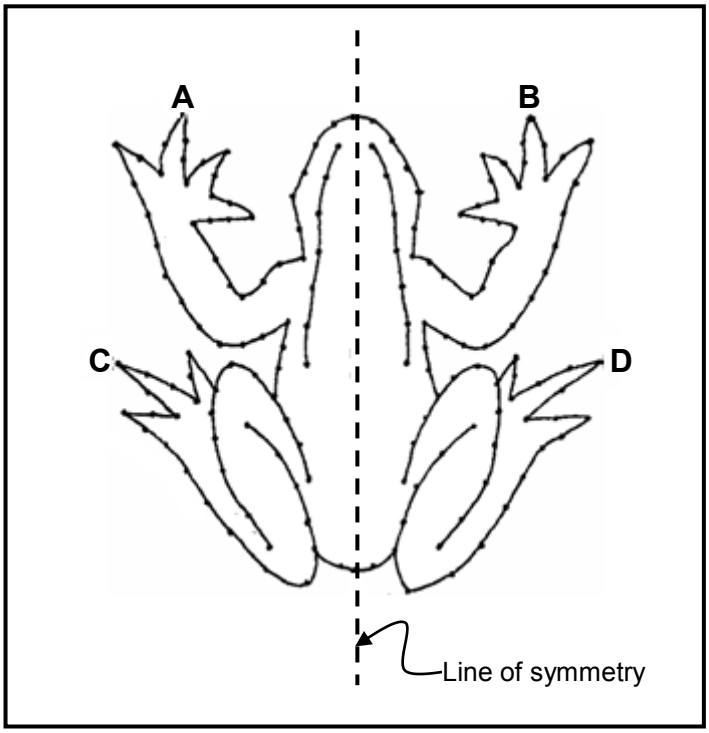


We say that these shapes have symmetry.
They are symmetrical. This means that they seem well balanced and in the right proportion.
One half of the shape fits exactly over the other half of the shape.
Each half of the shape has the same area.

In the symmetrical shapes which you have made, every point on one side of a line corresponds with, or matches, a point on the other side of the line.



In the picture of a frog,

Point A *matches Point* B.

Point C *matches Point* D and so on.

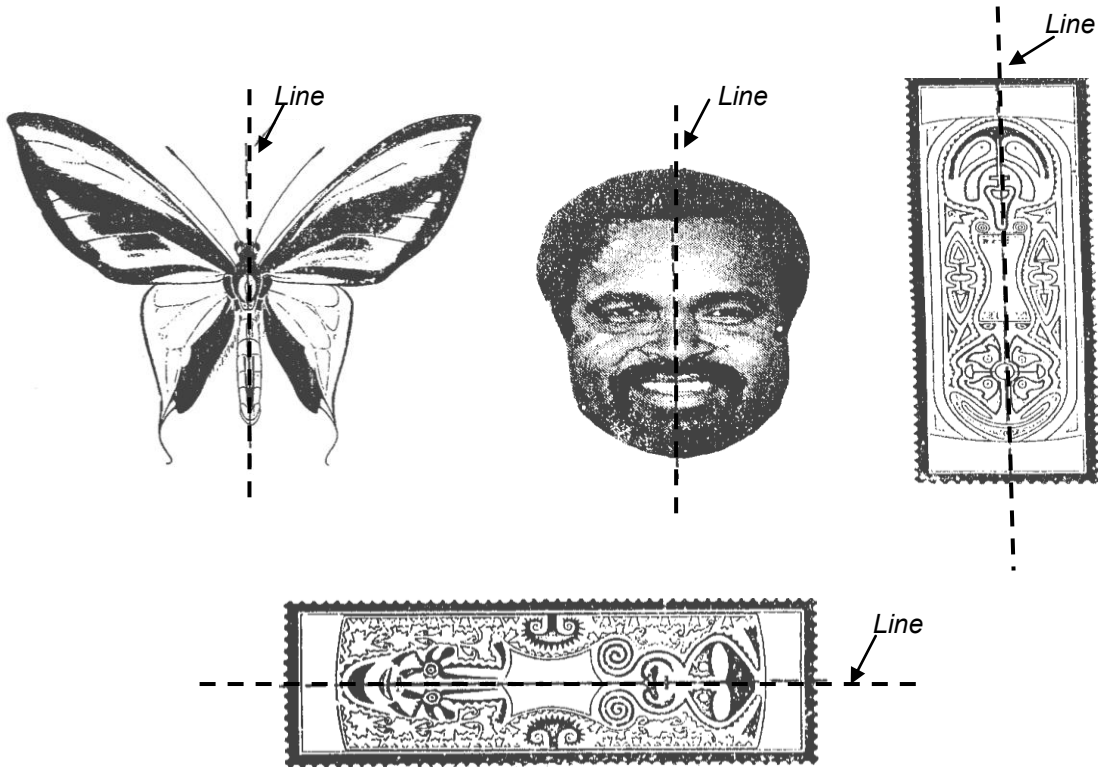
The drawing of the frog has SYMMETRY about the line as shown.

This is in the position where you made the FOLD.

REMEMBER:

- **A shape has *line symmetry* if a line can be drawn on it, so that each point on one side of the line has a corresponding *(* = *matching)* point on the other side.**
- **The axis of symmetry is the line dividing the shape into two identical parts that are mirror images of one another. (*Note:* *the plural for "axis" is "axes", pronounced „axe-ease".)***

Here are some pictures which have symmetry.



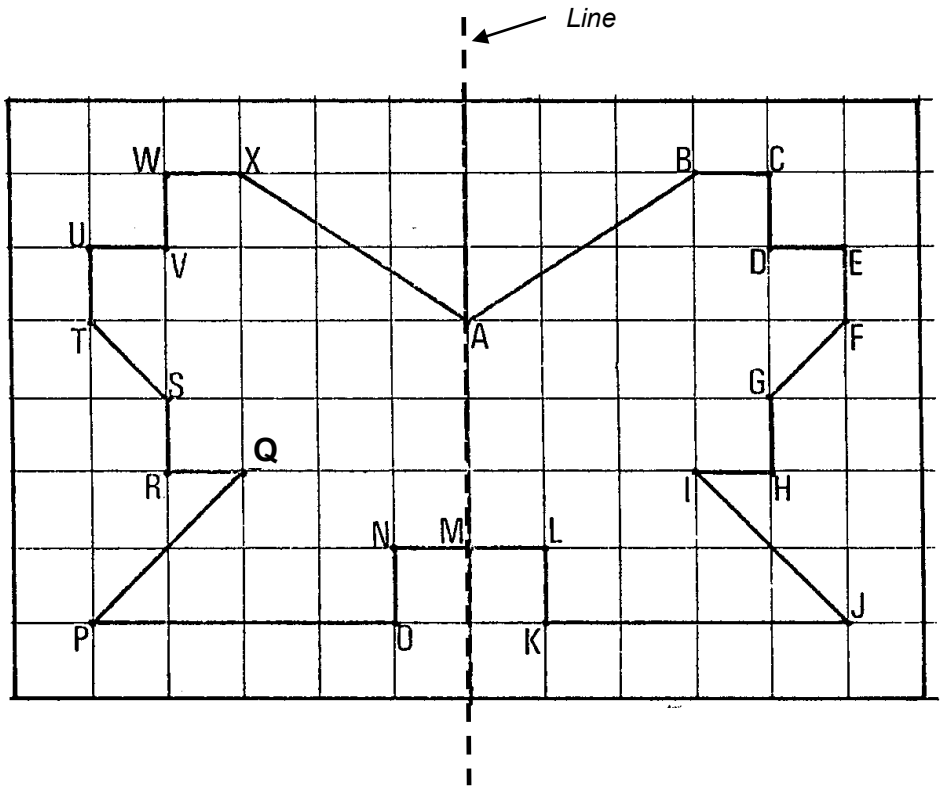
- **Symmetry means exact likeness in size and shape between the two sides of something.**
- **A shape has line symmetry if it can be divided by a line into two identical parts that are mirror images of one another.**
- **A shape is symmetrical if a line can be drawn on it so that each point on one side of the line has a corresponding point on the other side.**
- **The dividing line is called an axis of symmetry.**

NOW DO PRACTICE EXERCISE 19

Practice Exercise 19

1. The diagram shows a shape which is symmetrical about a line.
   Make a list of the corresponding points on the shape.
   An example is done for you.

B *matches* X
matches
matches
matches



2. Fill in the missing word.
   In a symmetrical shape, every point on the shape will have another _____ point which is opposite to it.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4.

Lesson 20: Lines of Symmetry

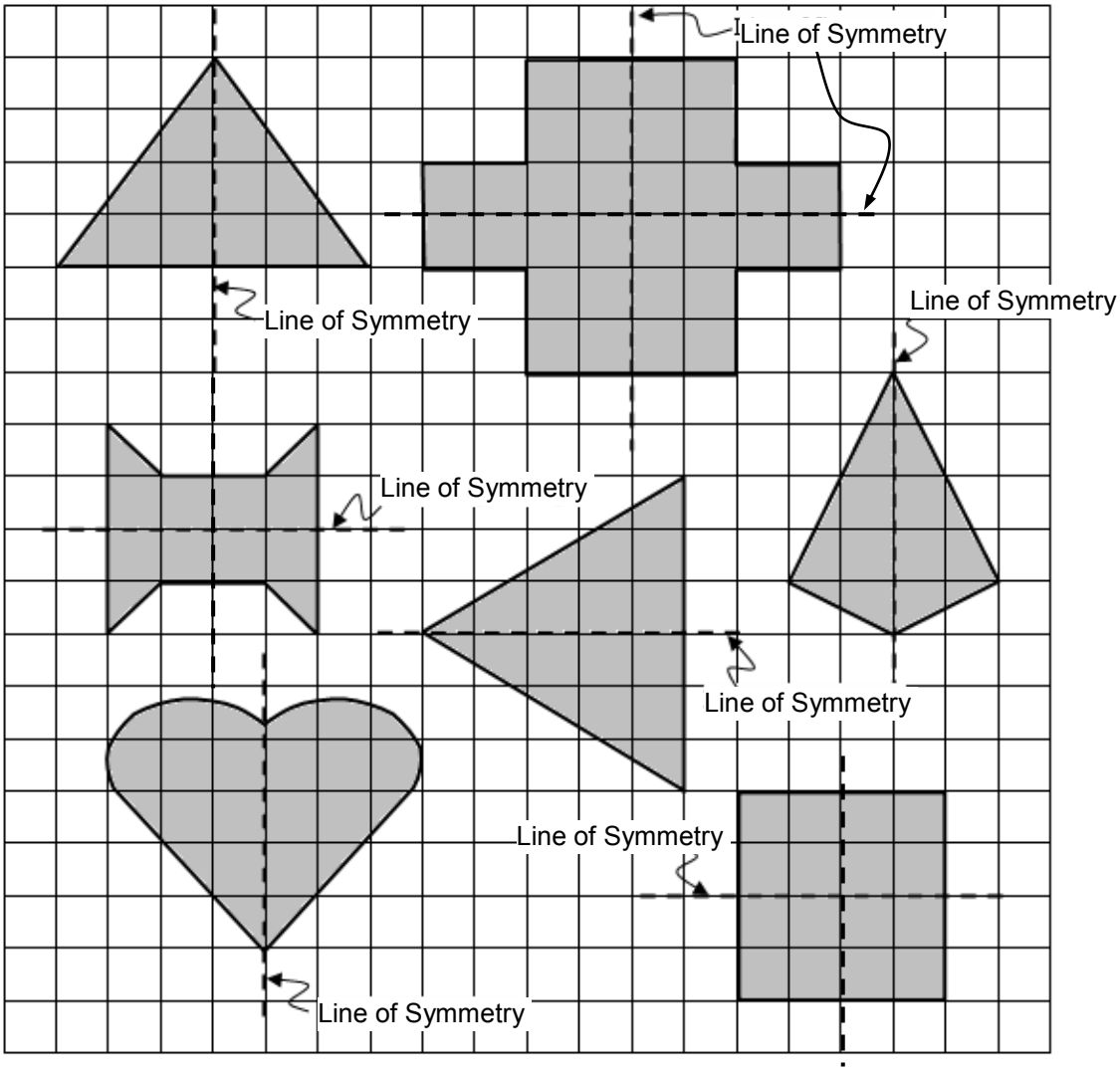
In Lesson 19, you learnt the meaning of symmetry and identify and made some pictures and shapes which were symmetrical.

In this lesson, you will:

- define line of symmetry
- draw lines of symmetry
- determine whether a given shape has a line of symmetry.

A shape has a **line of symmetry** if it can be divided by a line into two identical parts that are mirror images of one another. The dividing line is called an **axis of symmetry**. (Note: The plural of „axis" is „axes" pronounced „axe-ease".)

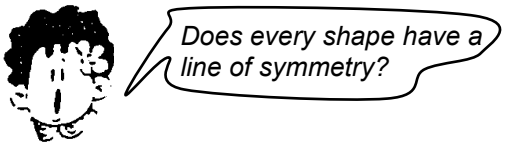
The axis of symmetry is shown on the shapes below.

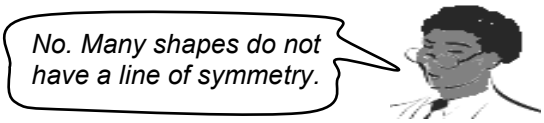


Activity 1

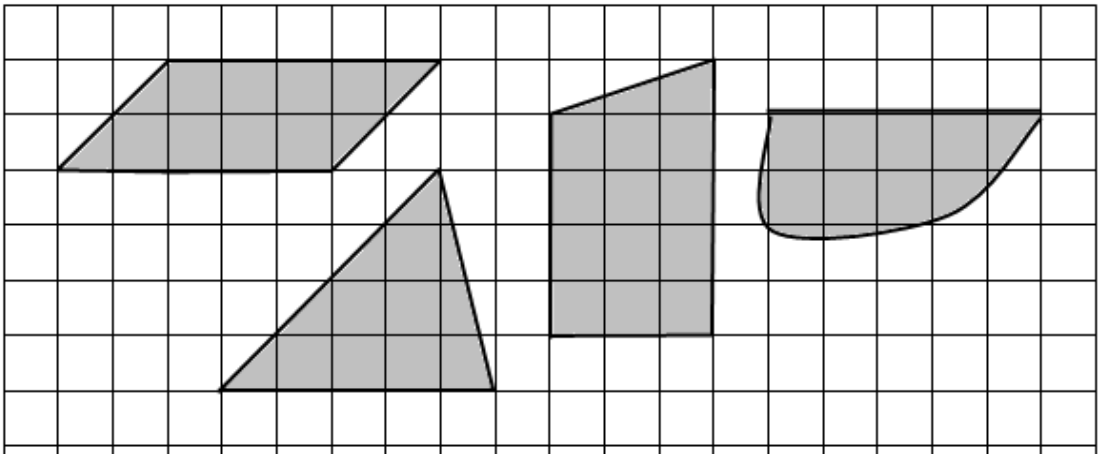
1. Trace the shapes on page 129 onto a separate piece of paper. Also trace the Line of Symmetry shown on each shape.
2. Cut out the shapes (or tear carefully, using your ruler as a guide).
3. Fold along the dotted line on each shape.
4 Does one half of the shape fit exactly over the other half? You should find that it does. The dotted line is therefore an axis of symmetry.

   The shapes are symmetrical shapes.



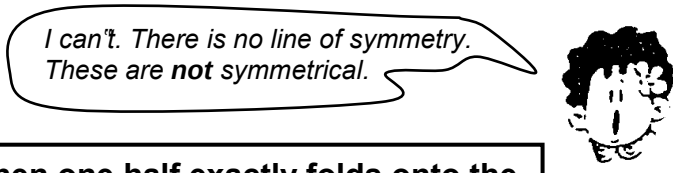


Some examples are shown below.



Activity 2

1. Trace the shapes above onto a separate piece of paper.
2. Cut out shapes or tear carefully, using a ruler as a guide.
3. Now try to fold each shape in half, to find out if one half fits exactly over the other half.
4. Try different folds. Can you make one side fit exactly over the other side?

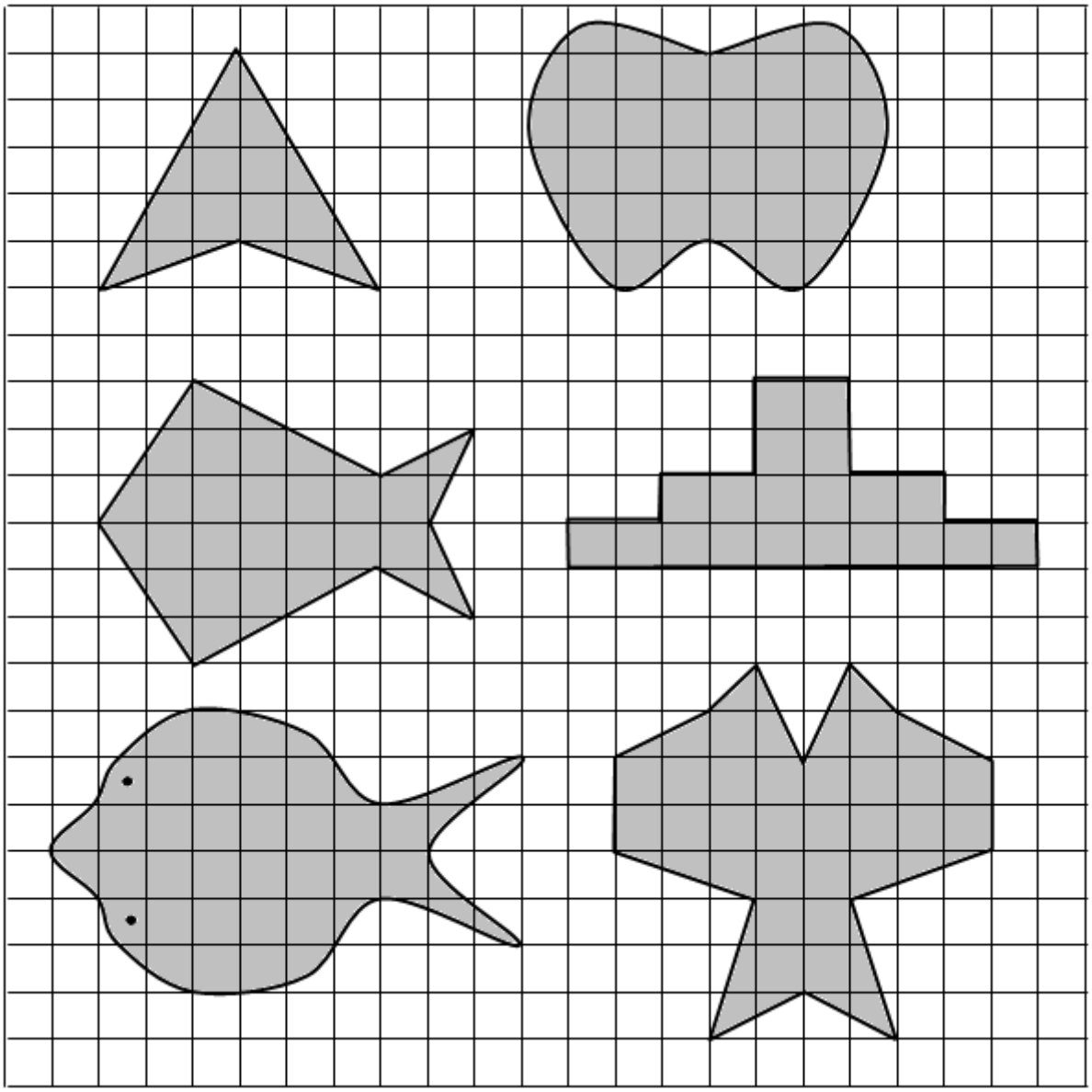


Symmetrical shapes are when one half exactly folds onto the other half.
The line or the fold which you used to make your shapes is called axis of symmetry.

NOW DO PRACTICE EXERCISE 20

Practice Exercise 20

1. Draw in the axes of symmetry on each of the following shapes.

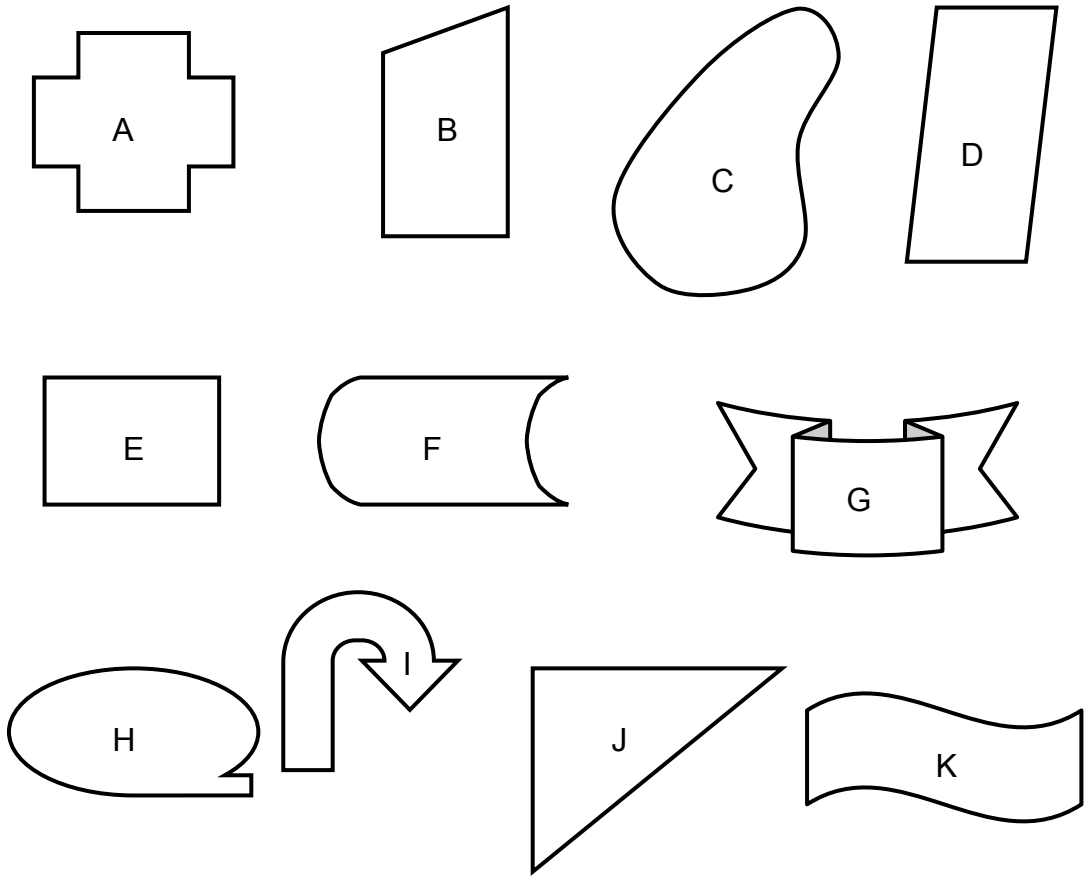


2. The axes of symmetry can be horizontal, vertical or diagonal.

   Write down all the letters of the alphabet that have axis of symmetry and show the axes of symmetry. Use capital letters.

3. Which of the letters of the alphabet have more than one axes of symmetry?

4. Circle around the shapes below which are symmetrical.



CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4.

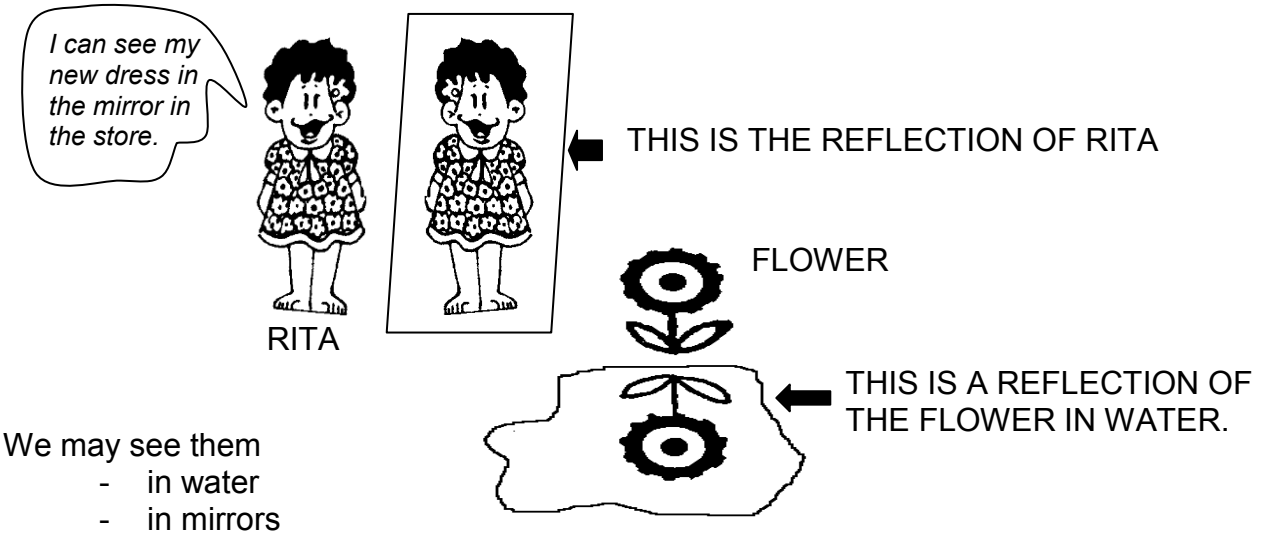
Lesson 21: Reflection

In Lesson 20, you learnt to identify and make pictures and shapes which are symmetrical.

In this lesson, you will:

- define reflection
- determine whether an image has been drawn correctly.

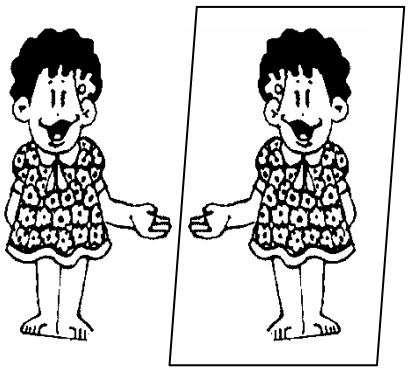
Where do we see REFLECTIONS?



We may see them

- in water
- in mirrors
- in the glass of shop windows
- in shiny surfaces

Here is an activity for you to do, you will need a mirror.



1. Place the mirror so you can see yourself in it.
2. Raise your right hand with your right side.
3. Which hand moves in the reflection?

   The right hand or the left?

(You should see that, although you move your RIGHT hand, the LEFT hand of your reflection moved.

4. Step back from the mirror, then forward again. What did your reflection do?

You should see that your reflection ALSO stepped backwards, and then stepped forward.

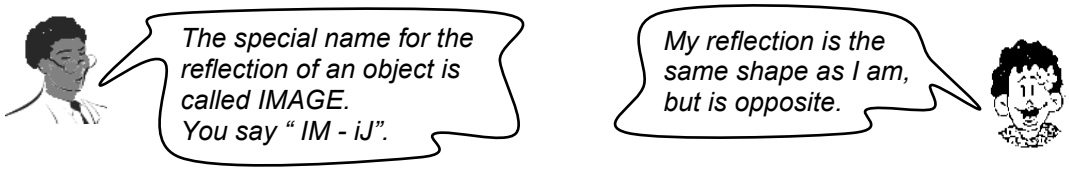
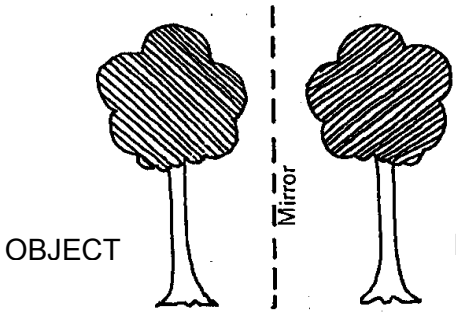


Image is a picture of something.

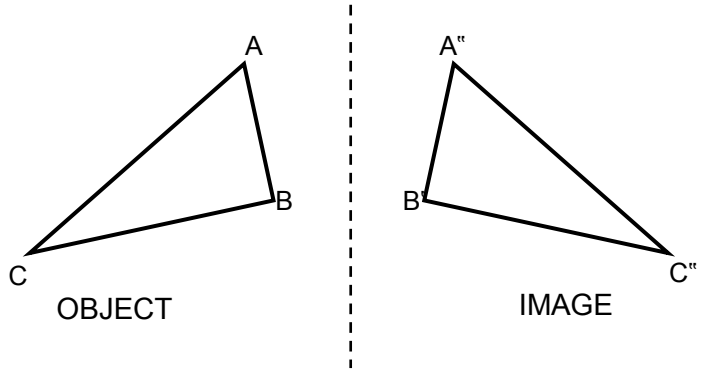
When we look in a mirror we see the image of ourselves. It is a picture of us. It is the SAME SHAPE, but it is OPPOSITE. We say the image is REVERSED or FLIPPED. The mathematical term used for flip is REFLECTION. *(It goes in the opposite direction).* We can draw an image on paper, like this:



OBJECT IMAGE *(the reflection of the object*

When we draw the POSITION OF THE MIRROR, it is a line halfway between the shape and its reflected IMAGE and is called LINE OF REFLECTION or MIRROR LINE. A shape that maps exactly onto itself about a fixed line has a line of symmetry.

Every point on an IMAGE corresponds with a point on the OBJECT.



A" *corresponds with* A
B" *corresponds with* B
C" *corresponds with* C

The corresponding points are the same distance from the mirror, on opposite sides.

NOW DO PRACTICE EXERCISE 21

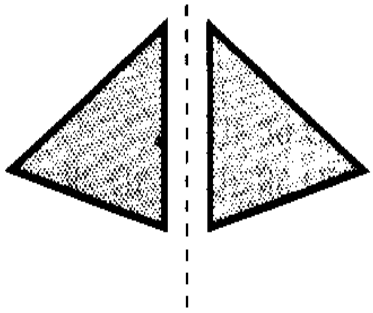
Practice Exercise 21

The position of a mirror is marked by the dotted line in the diagrams below.

The position of an OBJECT, is shown on one side of the mirror. An image has been drawn for each object, on the other side of the mirror.

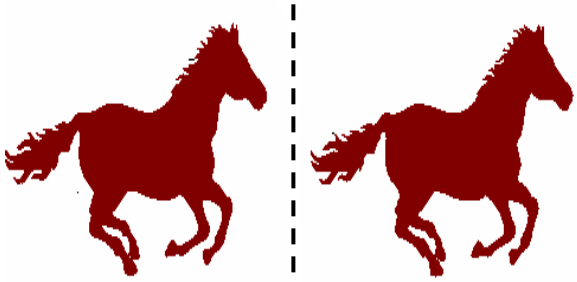
Write RIGHT if the image has been drawn correctly. Write WRONG if the image has not been drawn correctly.

OBJECT IMAGE



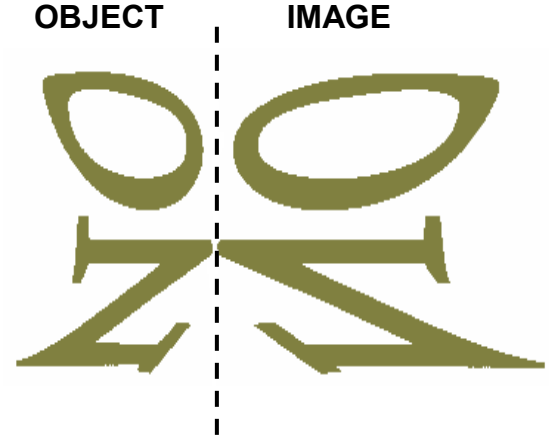
a._____

OBJECT IMAGE



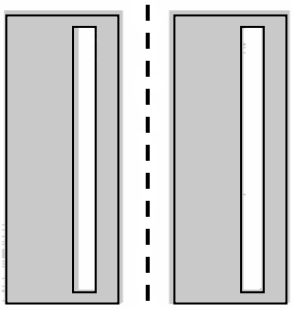
b._____

OBJECT IMAGE

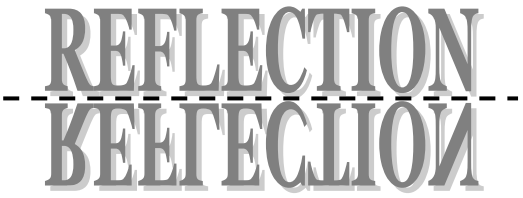


c._____

OBJECT IMAGE



d._____



e. _____

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

Lesson 22: Drawing Reflected Points and Lines

You learnt about the meaning of reflection in Lesson 21.

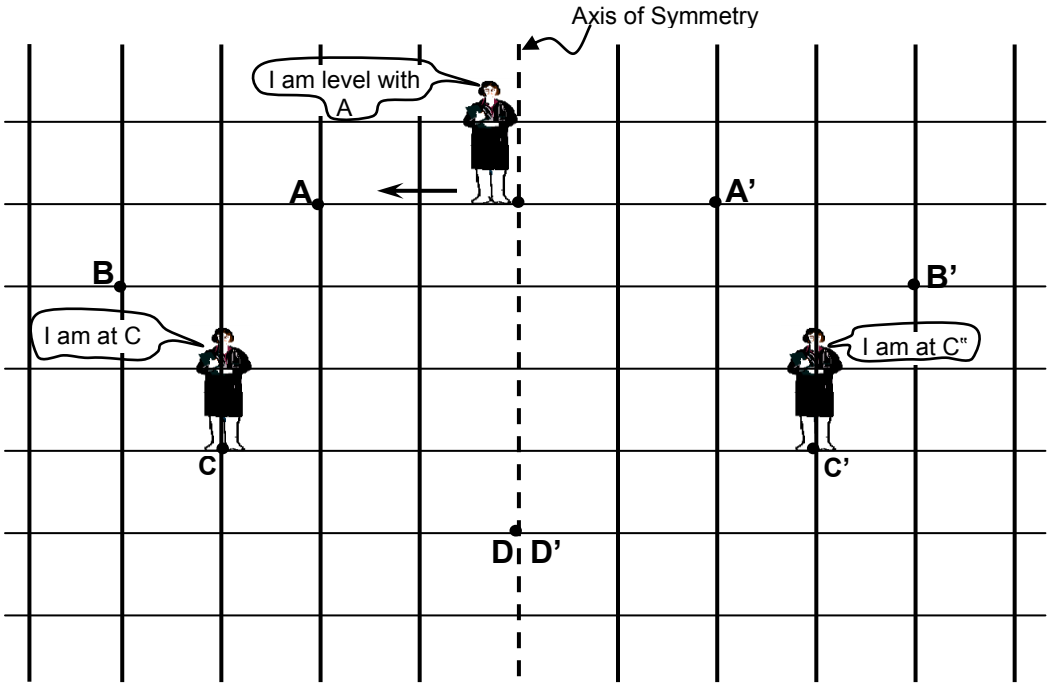
In this lesson you will learn how to

- find reflected points and lines
- draw reflected points and reflected lines on square paper grid.

Reflected Points

The first thing to learn is how to find reflected points.

Here is a grid to help you.

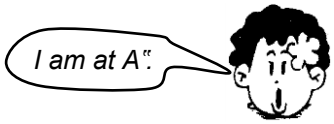


The Axis of Symmetry is shown.

1. Imagine that you are standing on the Axis of Symmetry.
2. Walk along the Axis of Symmetry until you are level with point A.
3. Walk along the Axis of Symmetry towards point A.
4. How many spaces must you walk to get to Point A?
5. Now go straight back to the Axis of Symmetry and stand on it.

Walk 2 spaces IN THE OPPOSITE DIRECTION from the way you went to point A.

Where are you now?



(*You say A PRIME)*

The point A‟ is the SAME DISTANCE from the Axis of Symmetry as the Point A but you must go in the *opposite direction* to get to it.

6. Follow the same steps (1 to 4) to get to B. Then find B‟ (Step 5). Both are 4 spaces away from the Axis of Symmetry. They are on opposite sides of the Axis of Symmetry.

7. Do the same to get to point C. Then find point C‟. Both are 3 spaces from the Axis of Symmetry in opposite directions.

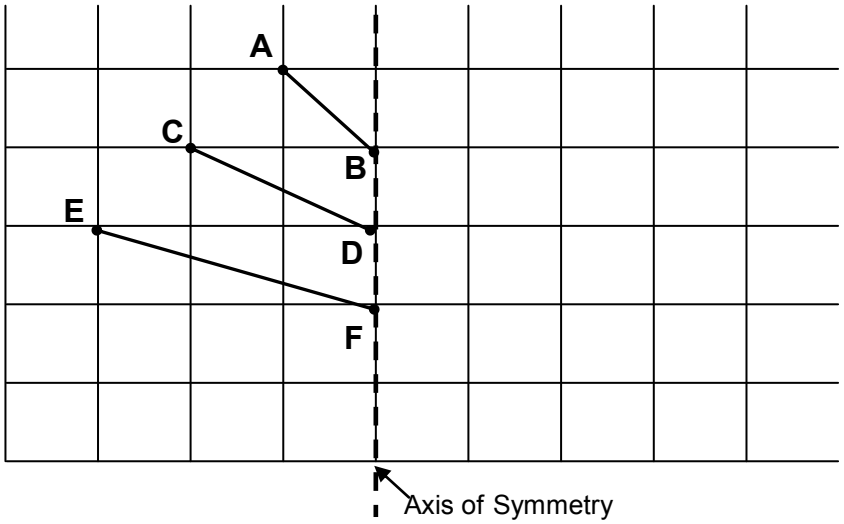
8. Now go to point D on the Axis of Symmetry. Where is point D‟? It is also on the Axis of Symmetry, in the same position as point D.

Reflected Lines

Now we will learn how to draw reflected lines.

Look at DIAGRAM 1.

Diagram 1



The Axis of symmetry is drawn.

Three lines shown on the grid are: AB, CD and EF.

The reflections of these 3 lines will be called: A‟B‟, C‟D‟ and E‟F‟.

To draw each reflected line we must first find the position of the reflected points at each end of the line.

We must find points A‟ and B‟ to draw the line A‟B‟.

Follow the steps 1 to 5 on page 138 to find A‟. A‟ is one space from the Axis of Symmetry in the opposite direction from A.

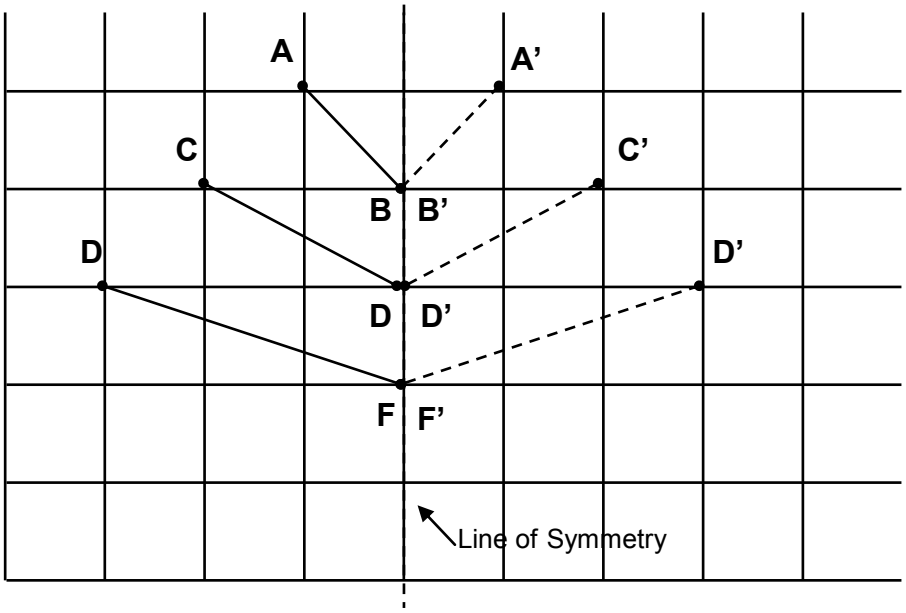
Next, find B‟. B‟ is on the Axis of Symmetry in the same position as B. Join A‟ to B‟.

You now have the reflection of the line AB.

Follow the same steps above to draw Lines C‟D‟ and E‟F‟.

The result is shown in DIAGRAM 2.

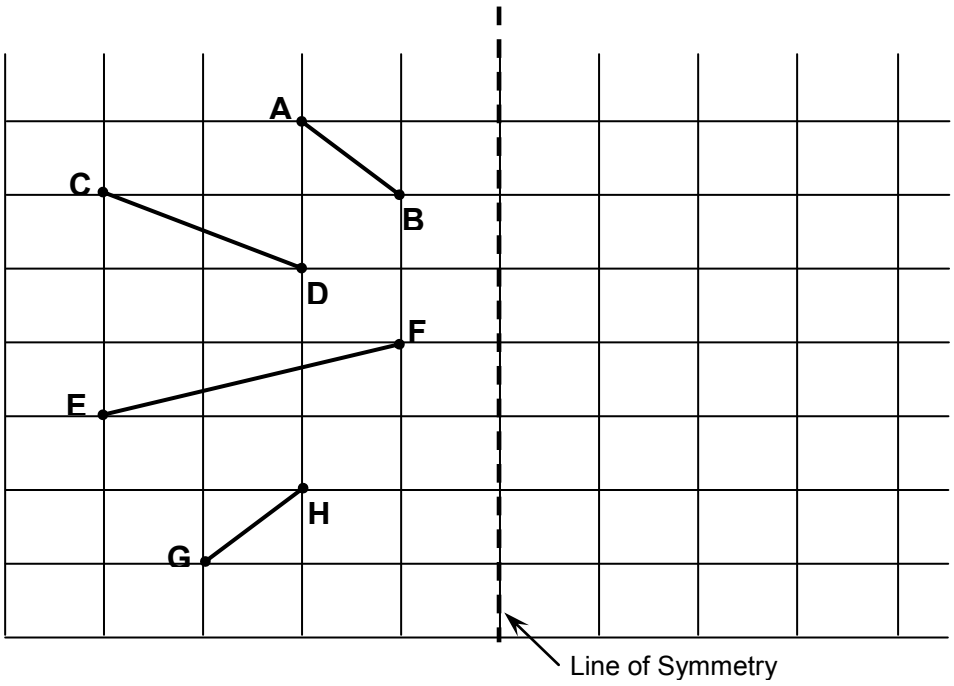
DIAGRAM 2



Here is another example:

Look at the lines shown in DIAGRAM 3.

DIAGRAM 3



The Axis of Symmetry is shown.

Lines drawn on the grid are: AB, CD, EF and GH.

To draw the line A‟B‟,we first find the reflected points A‟ and B‟.

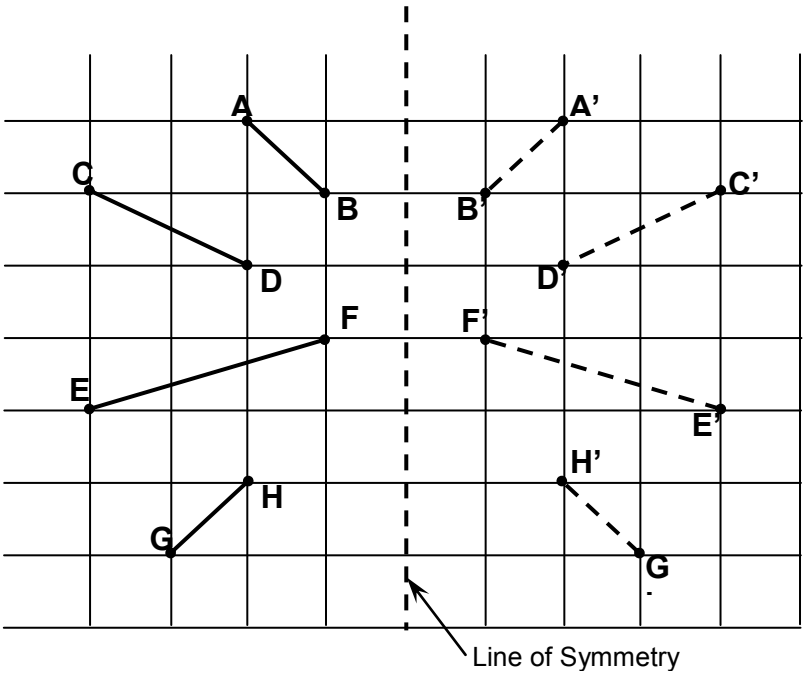
A‟ is 2 spaces from the Axis of Symmetry. B‟ is 1 space from the Axis of Symmetry.

A‟ and B‟ are on the opposite side of the Axis of Symmetry from A and B.

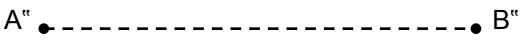
Join points A‟ and B‟ to make the line A‟B‟.

Follow the steps above to draw lines C‟D‟, E‟F‟ and G‟H‟. (See Diagram 4 for your result).

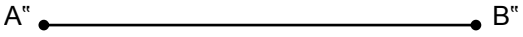
DIAGRAM 4



Note: In this example we have drawn reflected lines as dotted lines:



Usually, we will draw reflected lines as solid lines:



We have drawn them as dotted lines so you can see clearly the set of reflected lines.

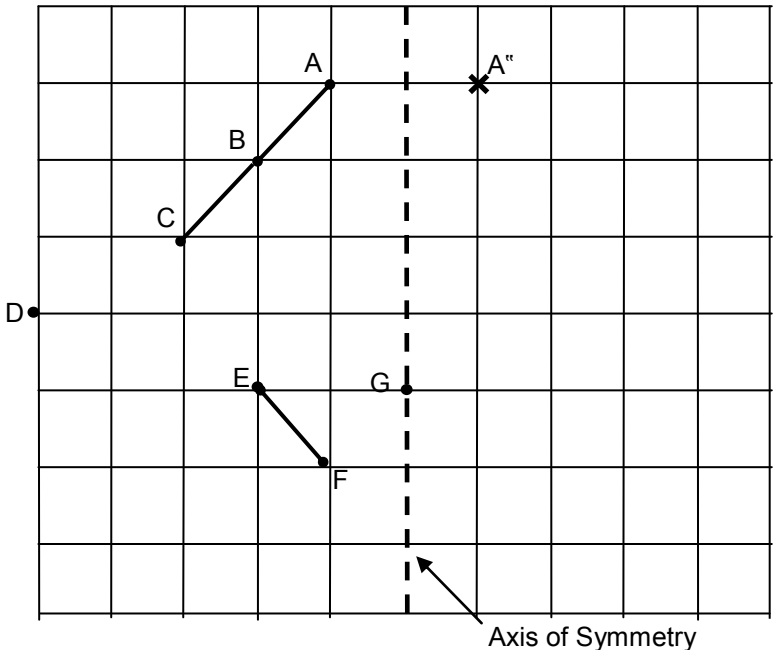
To draw the reflections of points and lines when the Axis of Symmetry is shown, the position of the reflected points and lines is the same distance from the Axis of Symmetry but on the opposite side of the Axis of Symmetry.

NOW DO PRACTICE EXERCISE 22

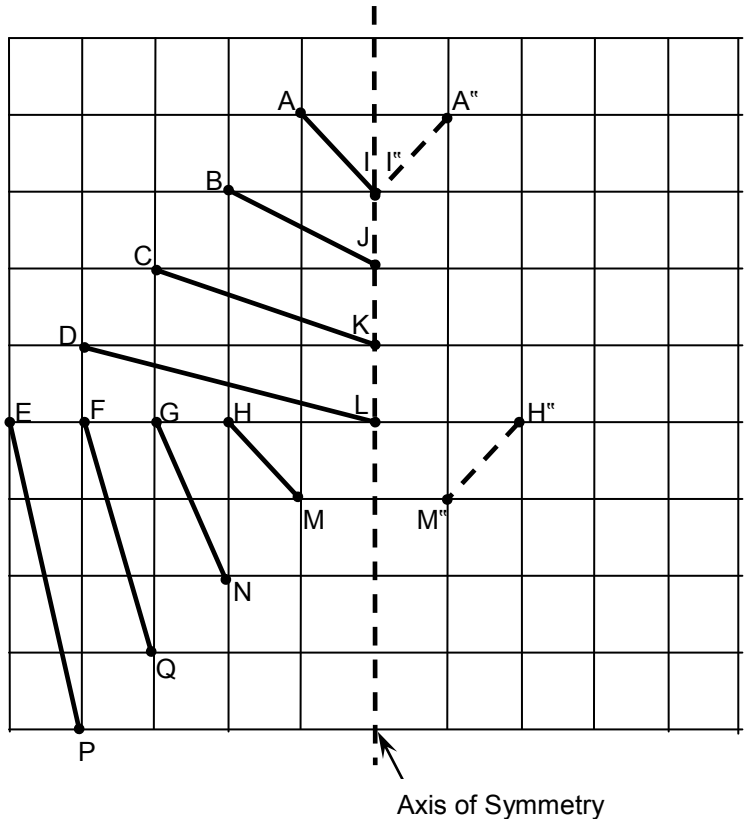
Practice Exercise 22

1. Find the reflected points A‟, B‟, C‟, D‟, E‟, F‟, G‟ on the other side of the Axis of Symmetry. Mark each point with a small x and write the name of the point beside it like this: x A‟.

   The first one has been done for you.



2.



Draw the reflected lines A‟ I‟, B‟ J‟ etc.

Two examples are done for you.

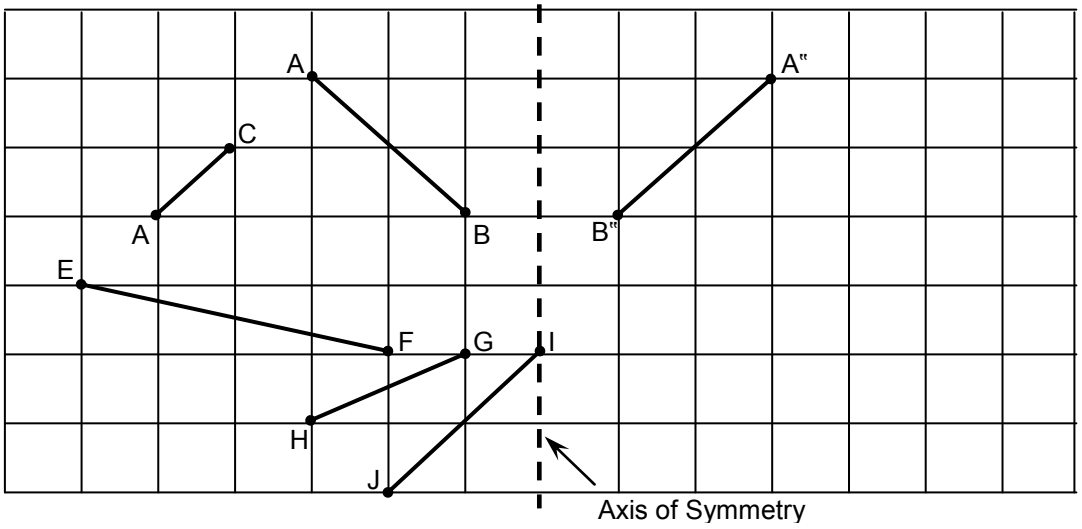
Draw the reflected lines as dotted lines:

A - - - - - - - - - I‟

3. Draw reflected lines A‟ B‟, C‟ D‟etc.

One example is done for you.

Draw the reflected lines as solid lines.



CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4.

Lesson 23: Drawing Reflected Shapes 1

In Lesson 22, you learnt how to find and draw reflected points and reflected lines in square paper grid.

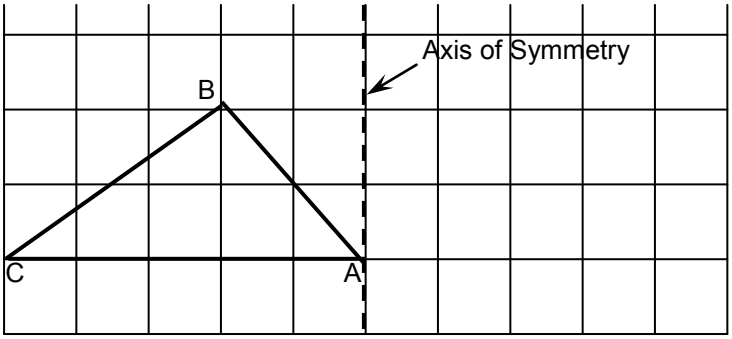
In this lesson you will

- draw reflected shapes using paper grids.

You know how to draw reflected lines. Now you are going to draw reflected shapes.

Yes. Since you know how to draw reflected lines, you can put them together and make a shape.

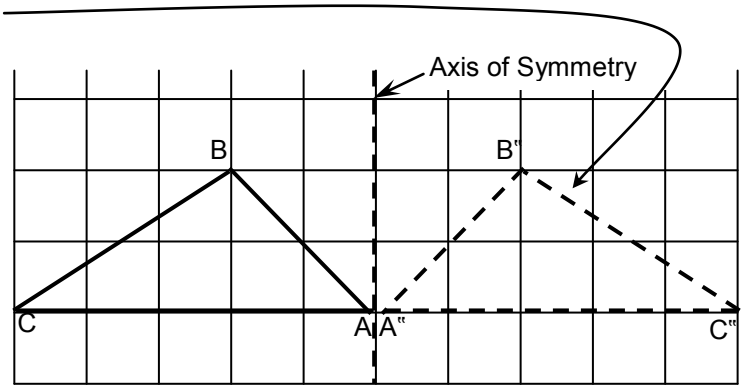
Let us look at this diagram.



To draw the reflection of the triangle ABC about the Axis of Symmetry, we first find the reflection of each point.

We mark A‟ B‟ and C‟ on the other side of the Axis of Symmetry. Then we draw the lines A‟B‟, B‟C‟ and C‟A'.

This is our result.



The shape A‟B‟C‟ is the reflection of the triangle ABC.

It is the image of the triangle ABC. (*See Lesson 21)*

Now see the activities on the next page.

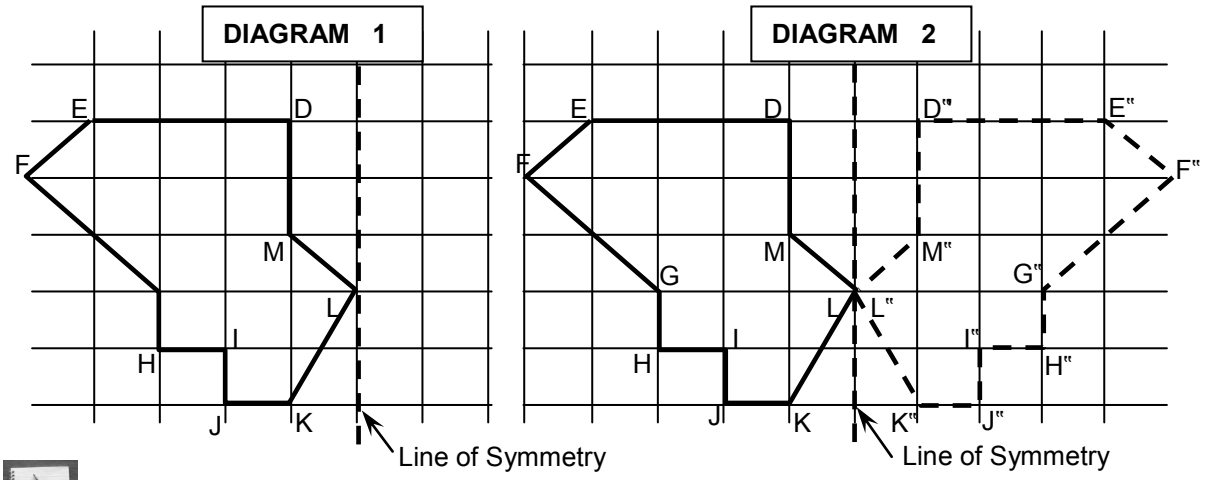
Activity 1

Find the reflection of shape DEFGHIJKLM in DIAGRAM 1 below.

Step 1: Find the reflected points D‟E‟F‟G‟H‟J‟K‟L‟ and M‟.

Step 2: Draw the reflected lines D‟E‟, E‟F‟, etc until you complete the shape.

Your result is shown in DIAGRAM 2. Your result is the IMAGE of the shape in DIAGRAM 1.



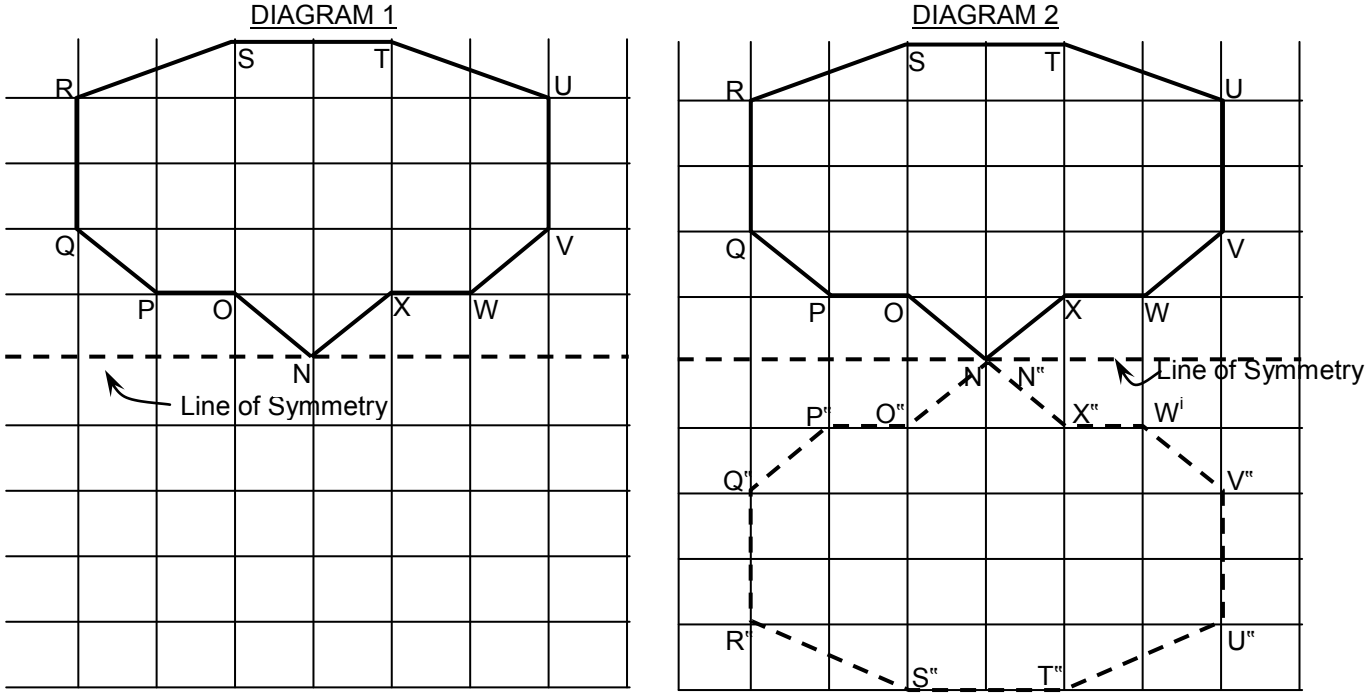
Activity 2

Find the reflection of shape NOPQRSTUVWX IN Diagram 1 below.

Step 1: Find the reflected points N‟O‟P‟Q‟R‟S‟T‟U‟V‟W‟ and X‟.

Step 2: Draw the reflected lines N‟O‟, O‟P‟, etc until you complete the shape.

Your result is shown in DIAGRAM 2. Your result is the IMAGE of the shape in DIAGRAM 1.



REMEMBER:

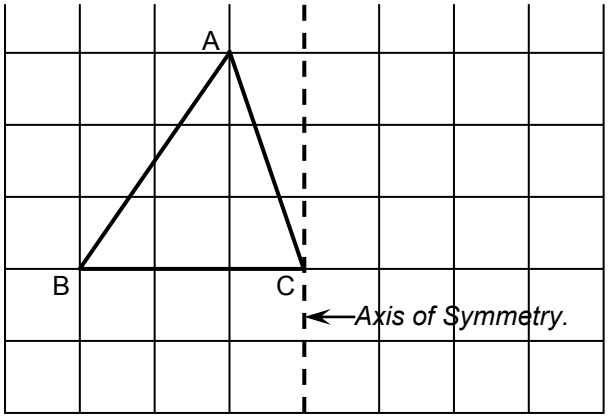
To draw the reflections of shapes when the Axis of Symmetry is shown, the position of the reflected shapes is the same distance from the axis of symmetry but on the opposite side of the Axis of Symmetry.

NOW DO PRACTICE EXERCISE 23

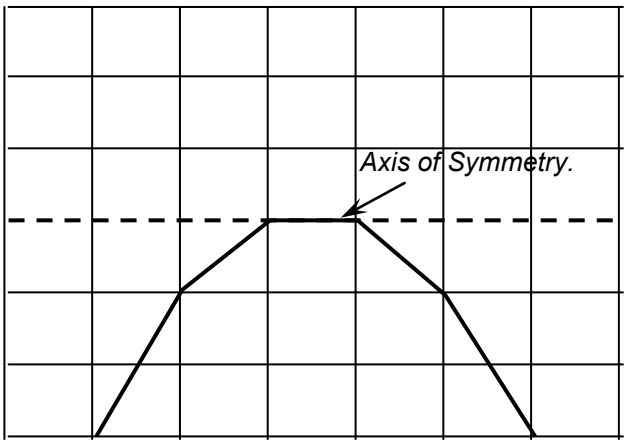
Practice Exercise 23

1. Draw the reflections of the shapes shown below. The Line of Symmetry is shown on each diagram as a dotted line.

(a)

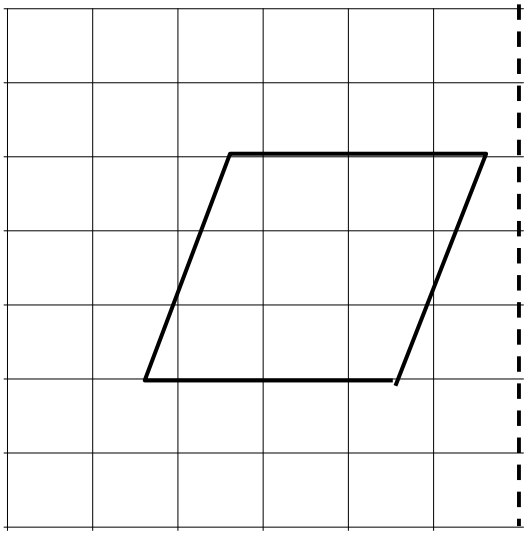


(b)

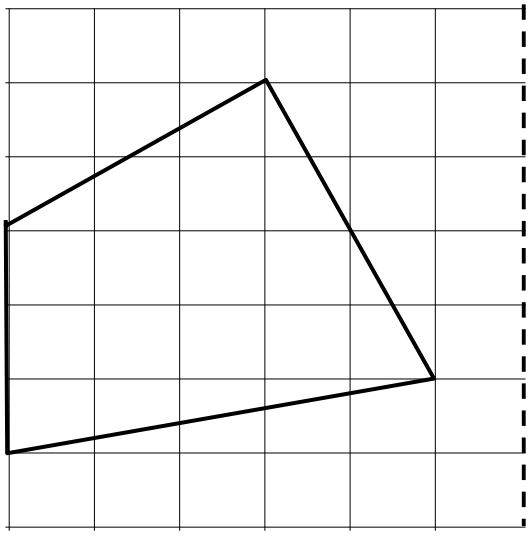


2. Copy these drawings carefully onto graph paper on page 148. Then, by counting squares on either side of the axis, draw the reflection of each figure.

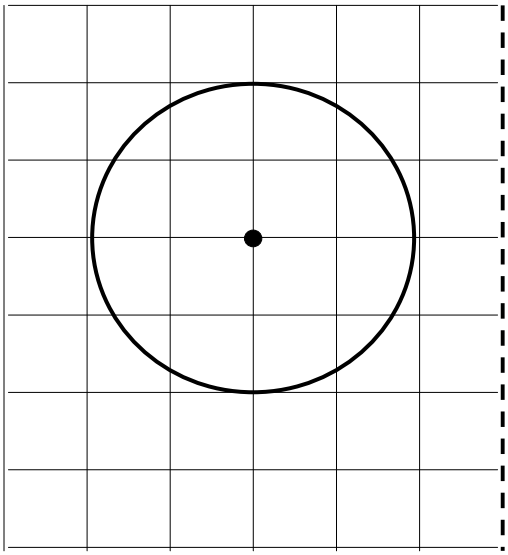
a.



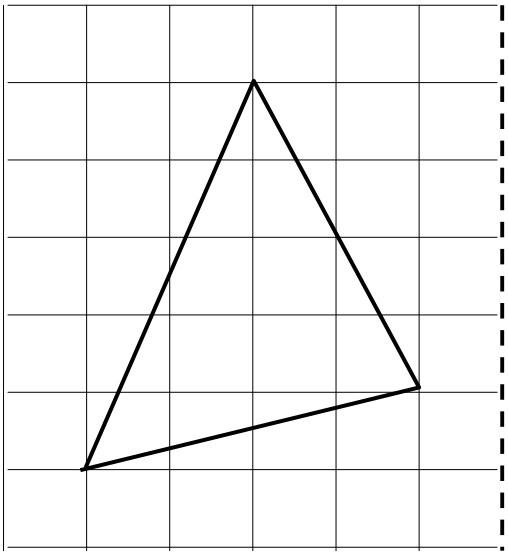
b.



c.



d.



CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4.

Lesson 24: Drawing Reflected Shapes 2

In the previous lesson, you learnt to draw reflected shapes using the square grid paper.

In this lesson, you will:

- draw reflected shapes in different positions.

You will be able to do this lesson better if you can use a mirror to help you.

Here is an Activity for you to do:

Activity 1

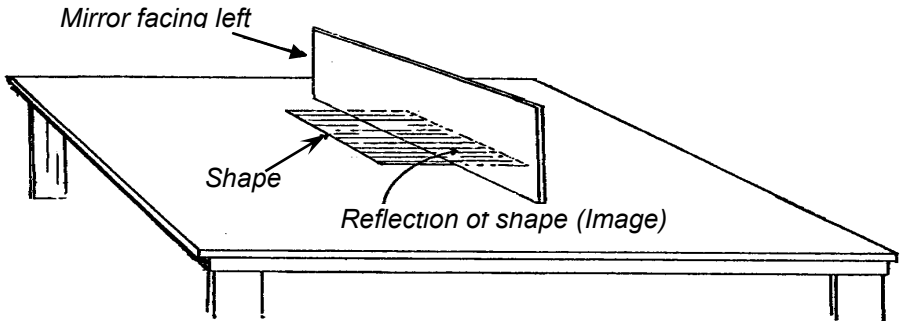
You will need:-

a mirror

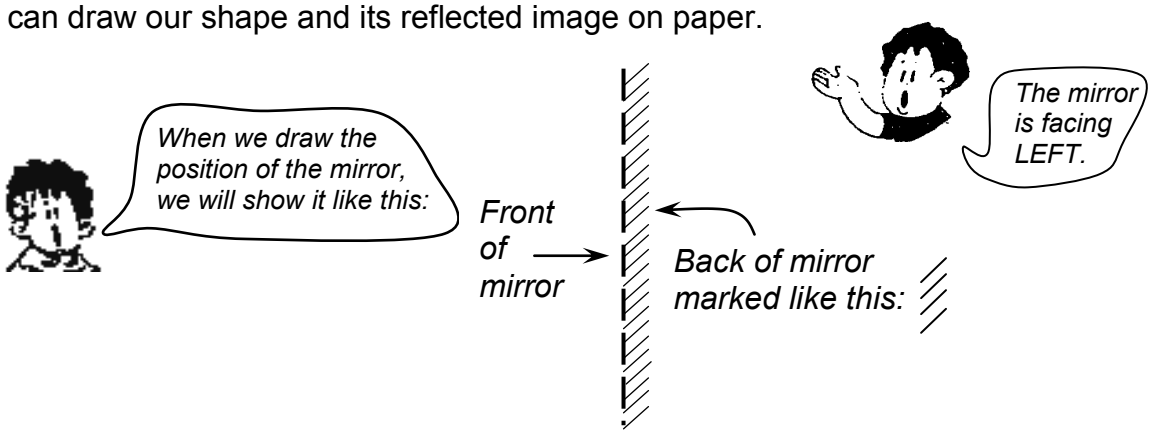
Note: If you do not have a mirror, you will have to imagine what the reflection of an object looks like.

If we put the mirror in different positions on a shape, we will be able to see different shapes in the reflections.

The mirror should be standing VERTICALLY (straight up) and the object we are looking at should be lying HORIZONTALLY (flat).



We can draw our shape and its reflected image on paper.

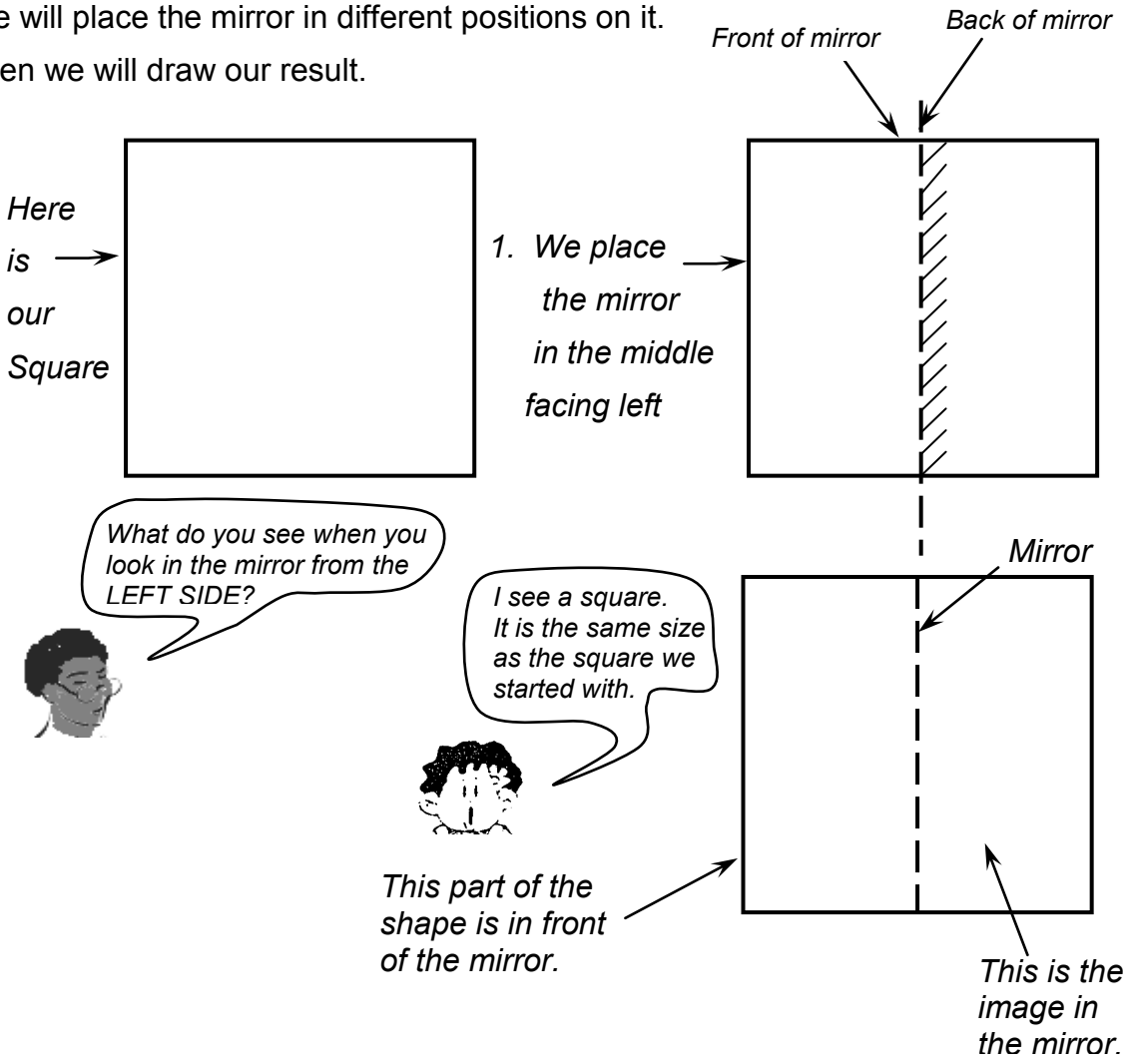


Activity 2

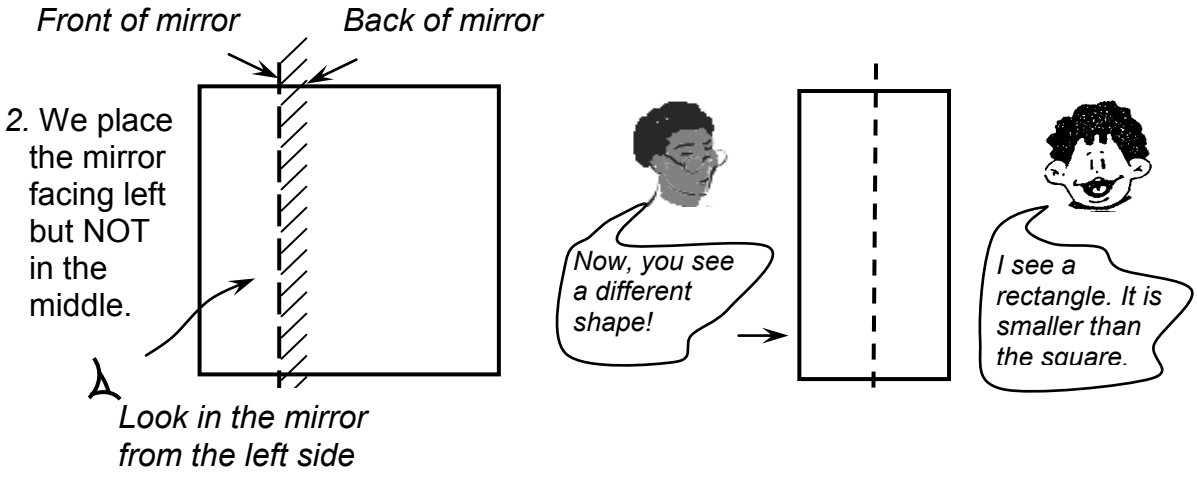
For this Activity, we will use a SQUARE shape.

We will place the mirror in different positions on it.

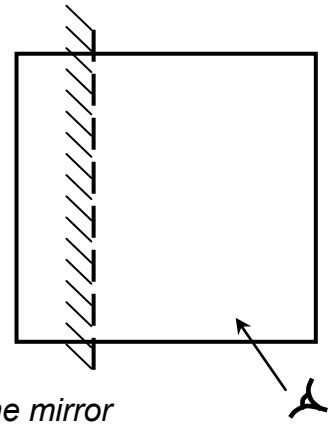
Then we will draw our result.



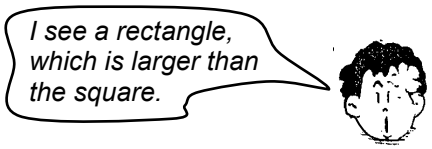
On the next page you will see what happens to the shape when we put the mirror in some different positions.

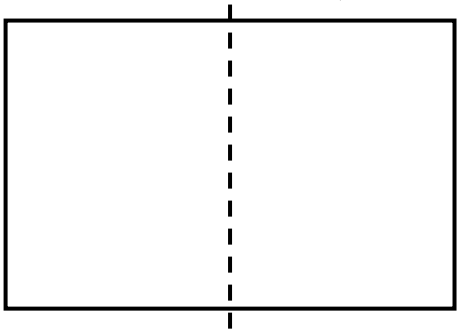


3. We place the mirror, as above, BUT facing right.

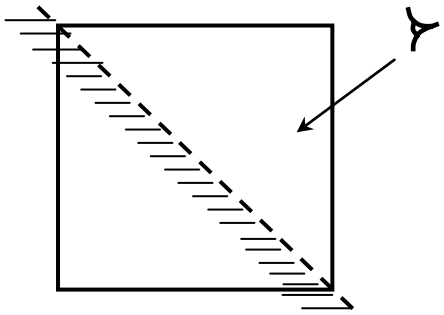


Look in the mirror from the right side.



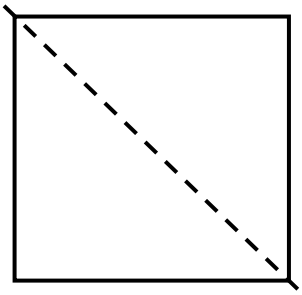


4. Now try putting your mirror in other position.

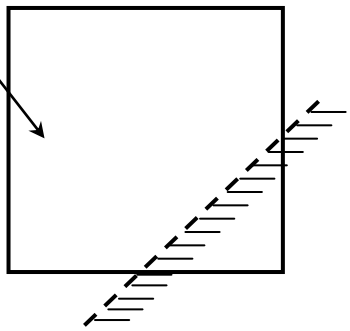


Look in the mirror

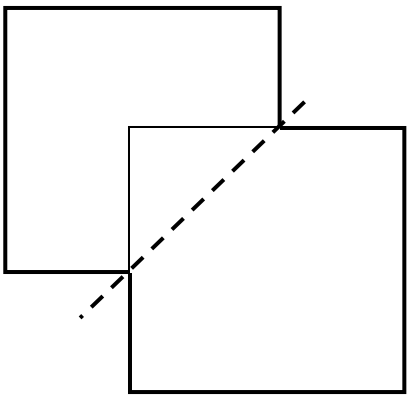
YOUR RESULT IS THIS.

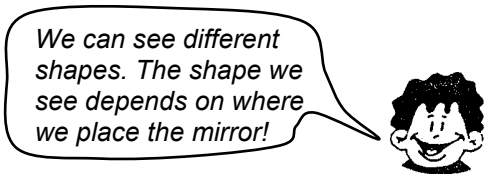


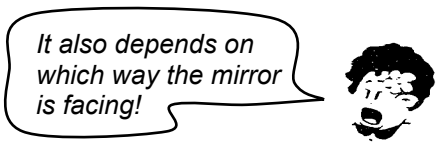
Look in the mirror



YOUR RESULT IS THIS.







The reflection of an object in the mirror depends on the way the mirror is facing. The shape of the reflection also depends on how the mirror is positioned. The size of the reflection is the same as the original object

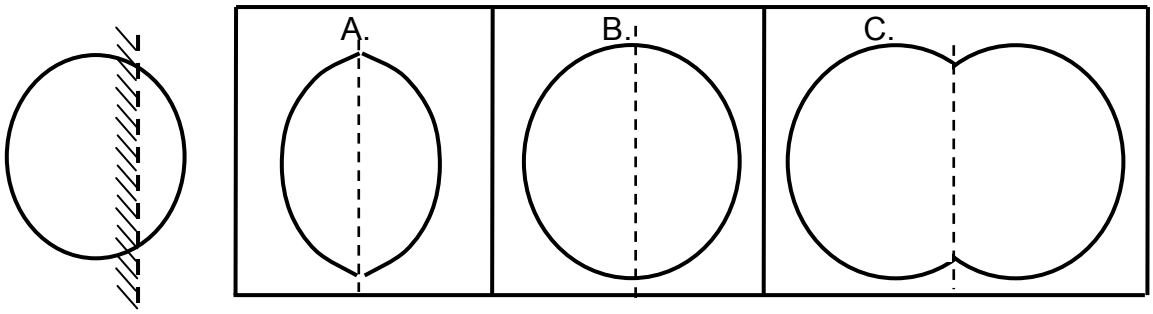
.

NOW DO PRACTICE EXERCISE 24

Practice Exercise 24

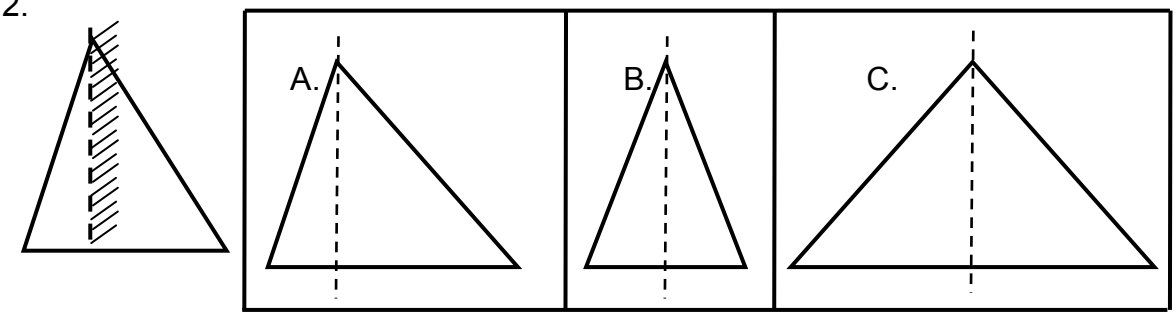
If we stand a mirror in the position shown, what shape will we see?
(Tick the right box. The first one is done for you).

1.



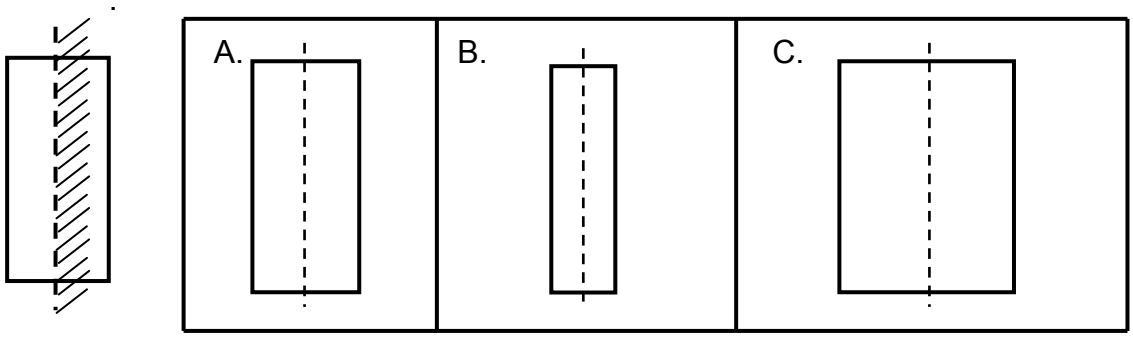
The mirror is facing RIGHT. We will see shape A.

2.



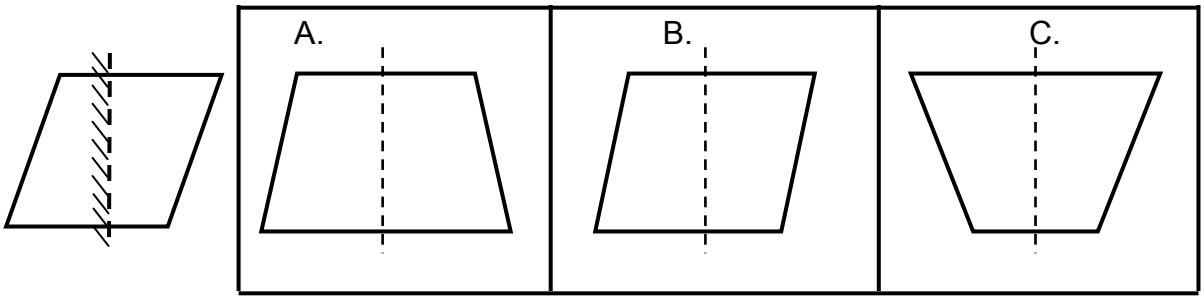
The Mirror is facing _____. We will see shape _____.

3.



The Mirror is facing _____. We will see shape _____.

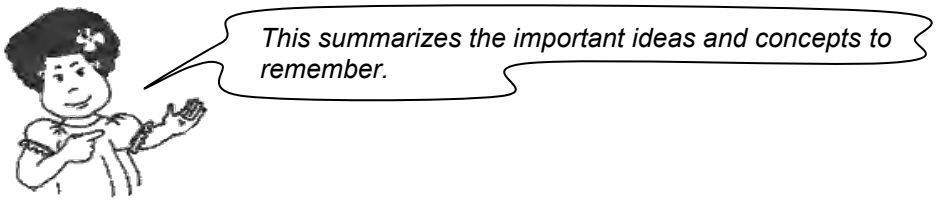
4.



The Mirror is facing _____. We will see shape _____.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

SUB-STRAND 4: SUMMARY



- **Symmetry** means exact likeness in size and shape between two sides of something.
- A shape is **symmetrical** if a line can be drawn on it so that each point on one side of the line has a corresponding point on the other side.
- A shape has **line symmetry** if it can be divided by a line into two identical parts that are images of one another. The dividing line is called an **axis of symmetry.**
- Axes of symmetry can be horizontal, vertical or diagonal.
- The **Reflection** is the image or picture of an object with the same shape but going in the opposite direction when looking into a mirror**.**
- To draw the reflections of points, lines and shapes when the axis of symmetry is shown, the position of the reflected points and lines is the same distance from but on the opposite side of the axis of symmetry.
- The reflection of an object in the mirror depends on the way the mirror is facing. The shape of the reflection also depends on how the mirror is positioned. The size of the reflection is the same as the original object.

REVISE LESSONS 19-24 THEN DO SUB-STRAND TEST 3 IN ASSIGNMENT BOOK 2

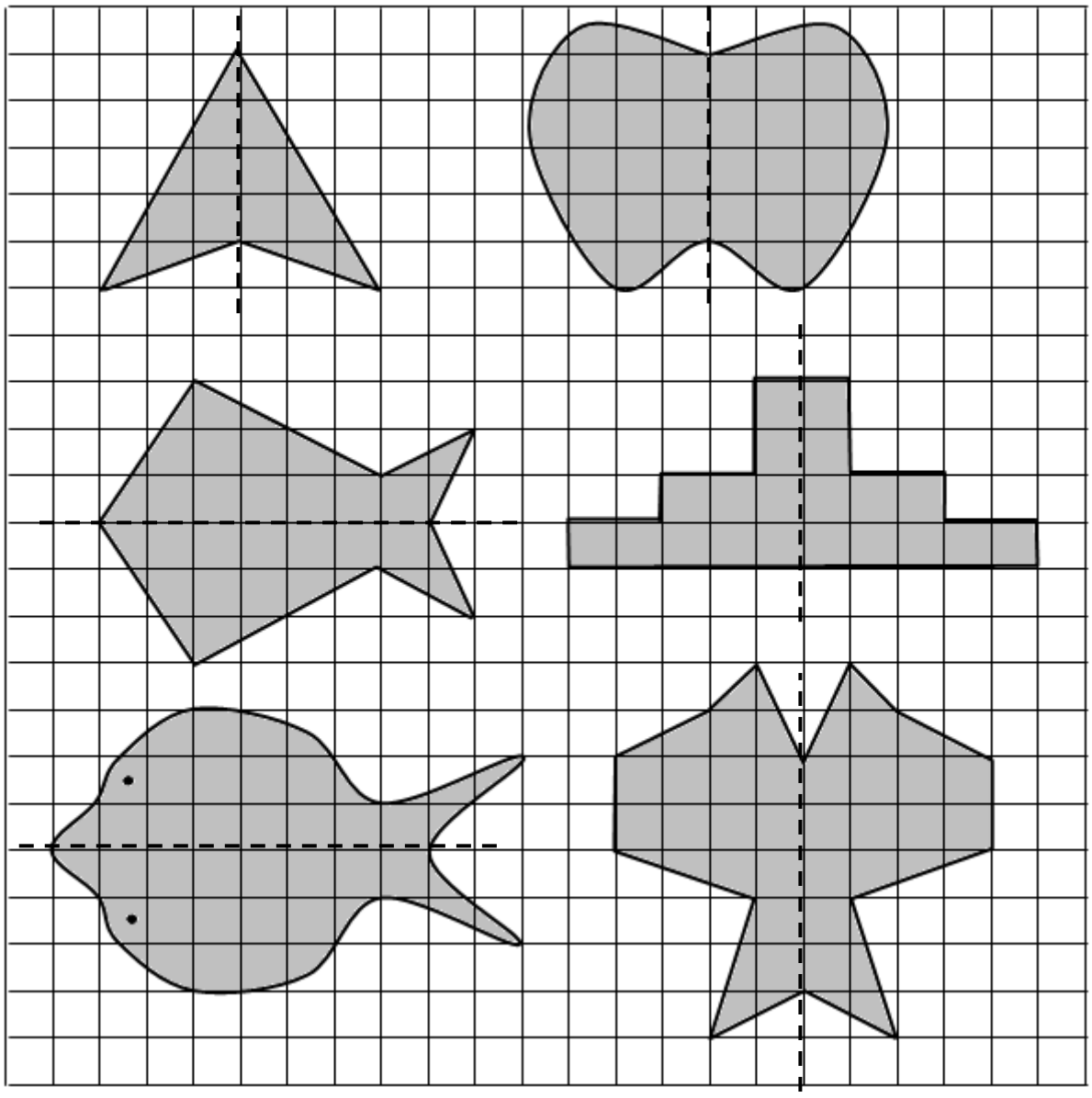
ANSWERS TO PRACTICE EXERCISES 19 - 24

Practice Exercise 19

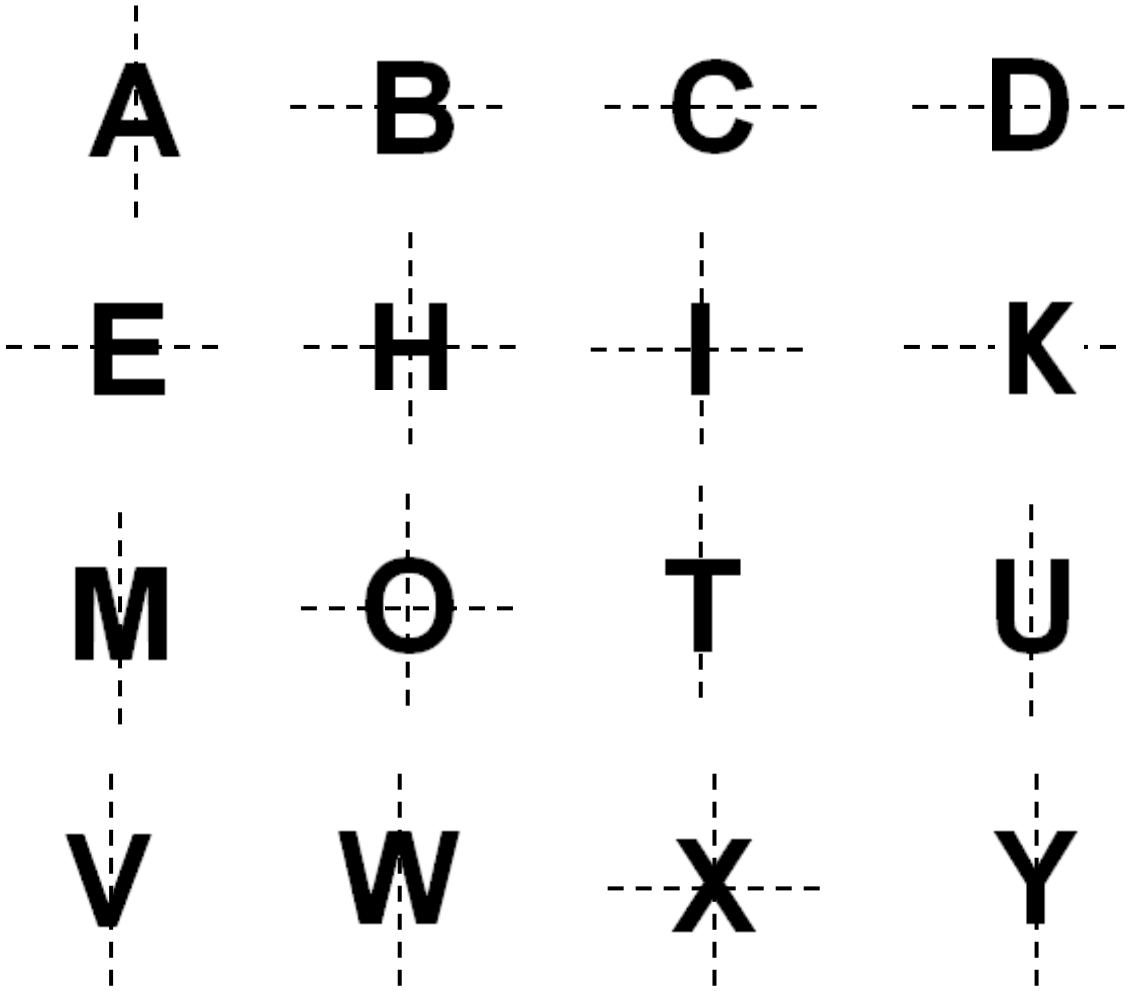
1. C matches W H matches R
   E matches U I matches Q
   D matches V L matches N
   F matches T K matches O
   G matches S J matches P

2. Corresponding

Practice Exercise 20



2.



3. H, I, O AND X

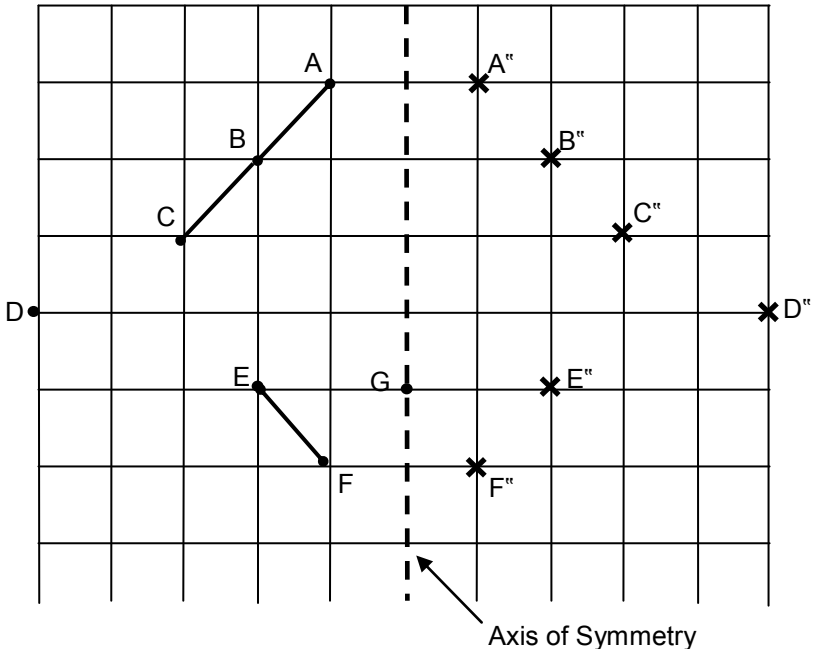
4. A, E, F, G,

Practice Exercise 21

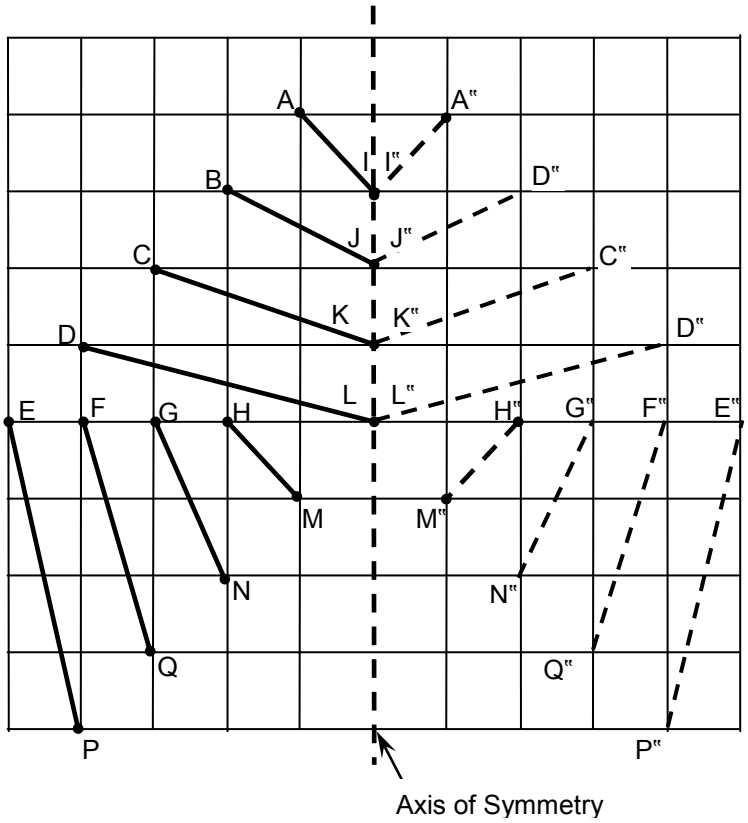
(a)	RIGHT	they have been reflected.
(b)	WRONG	the images are not mirror images.
(c)	WRONG	the shapes are not congruent.
(d)	WRONG	the images are not mirror images.
(e)	RIGHT	this a reflection

Practice Exercise 22

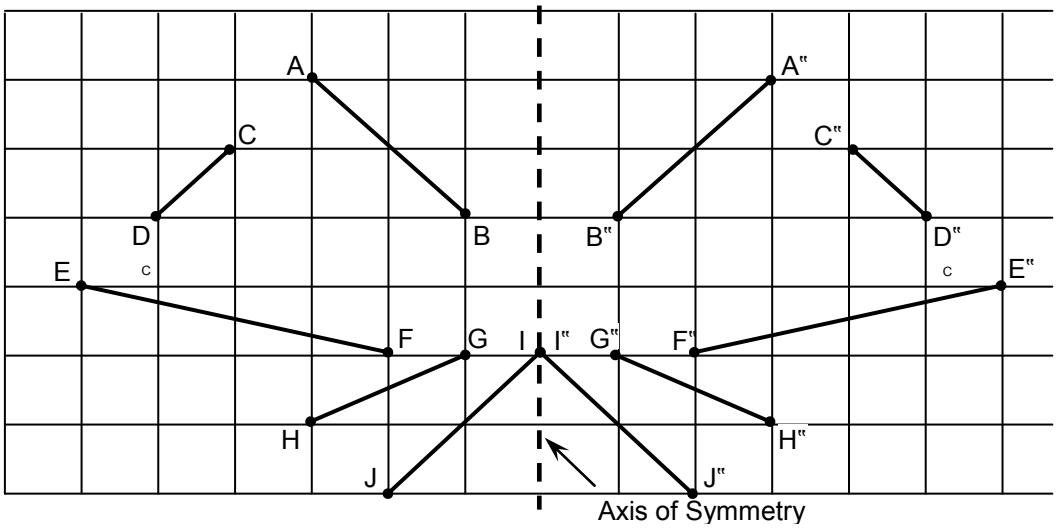
1.



2.



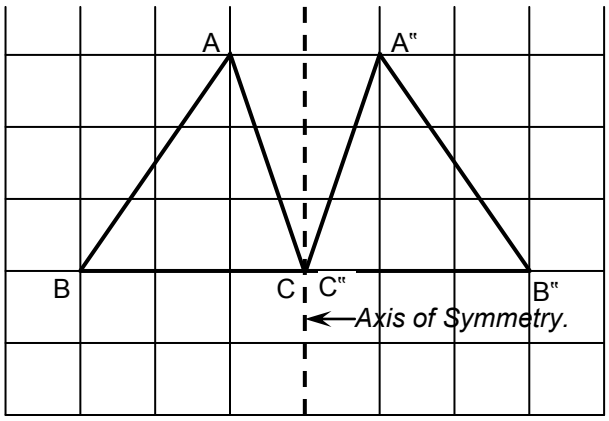
3.



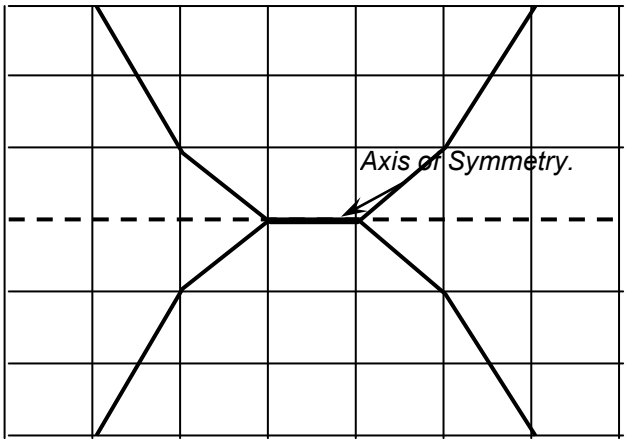
Practice Exercise 23

1.

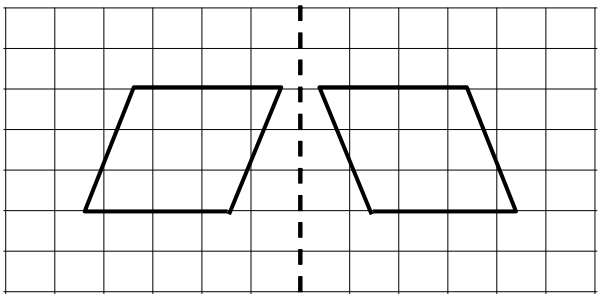
(a)



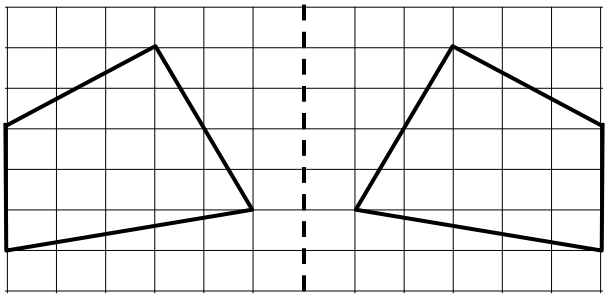
(b)



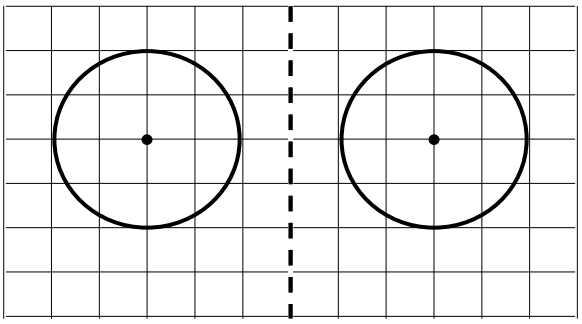
2. (a)



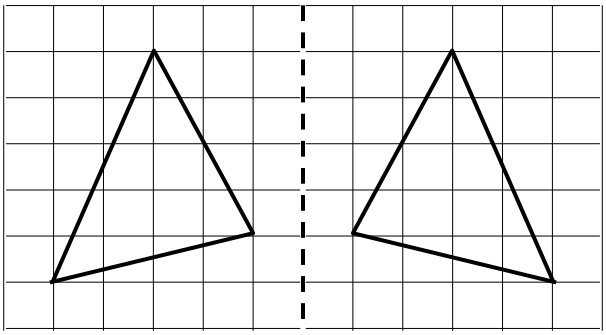
(b)



(c)



d.



Practice Exercise 24

1. **A**
2. The mirror is facing left, we will see shape **B**
3. The mirror facing left, we will see shape **A**
4. The mirror is facing right, we will see shape **C.**

END OF STRAND 2

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