

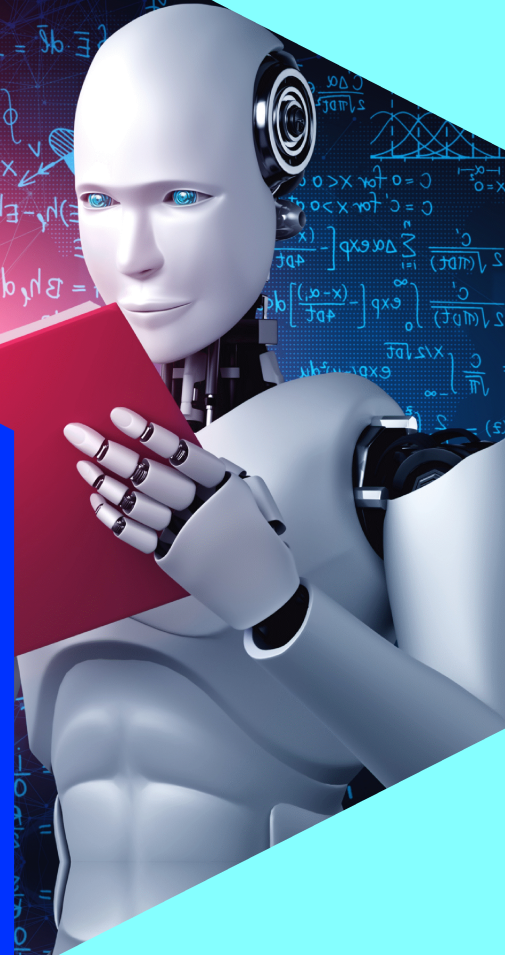


MATRIX OLYMPIAD

The Most Innovative Talent Recognition Exam

MATHEMATICS

Class - V



MATRIX

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Lines, Rays and Angles

How do different types of lines interact with different shapes?

OVERVIEW

In this lesson, we will:

- draw shapes and line segments, which satisfy a given set of rules.
- create line segments and shapes with given properties.

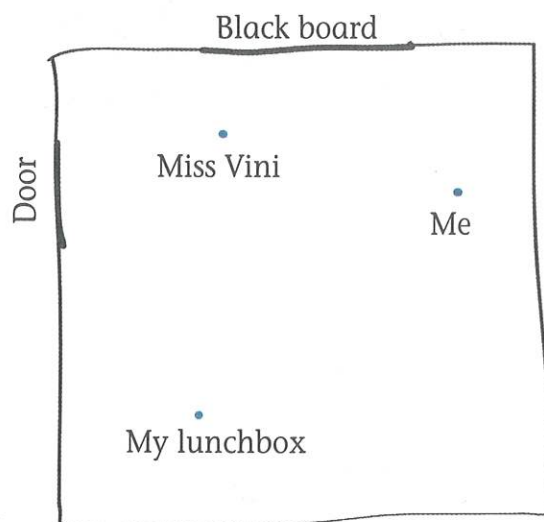


Can lines exist without a shape?



Vignesh has drawn a map of his classroom. His place is in the front of his class. He also sits very close to the wall. On the map, he marks the place he usually sits with a dot.

1.1



Draw a map of your *ThinkRoom*. Mark a dot where you sit. Mark the positions of your friends, your teacher and the place in the *ThinkRoom* you love the most.

In Mathematics, we call the dot a **point**. A point specifies a position. The points in your map indicate where you sit.



LOOK AROUND

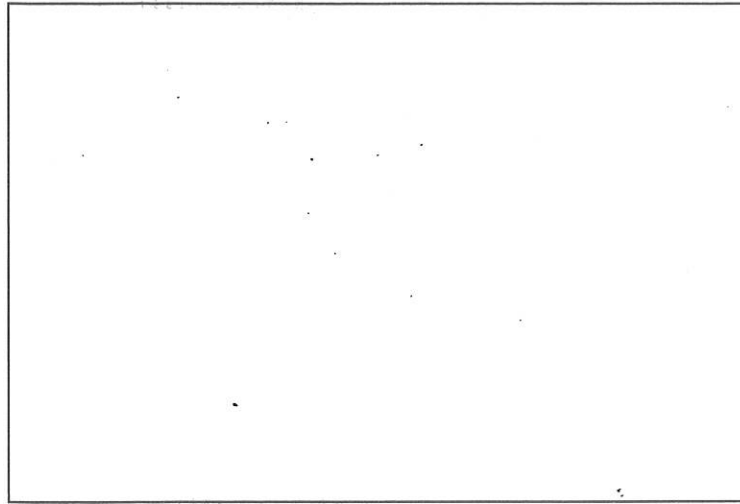
The tips of sharp pencils form points.



List two places where you have seen points.

- _____
- _____

Draw four points inside the given box and one point outside.



How will you identify one point from another? Write different ways you can identify a point in a group of points.

We use names to identify people. Similarly, we name points with capital letters to identify them, as shown in *Figure 1*.

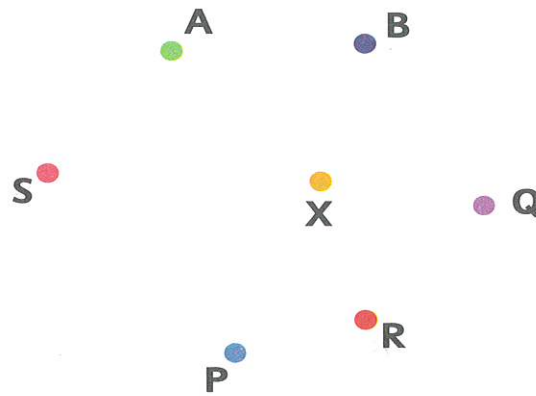


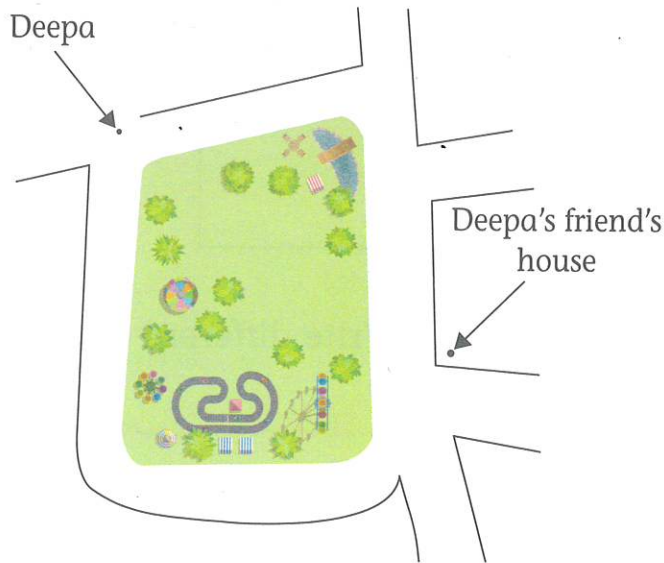
Figure 1 Points named with letters

Which is the left most point in *Figure 1*? _____



Find the shortest route connecting Deepa to her friend's house with the help of a ruler and thread.

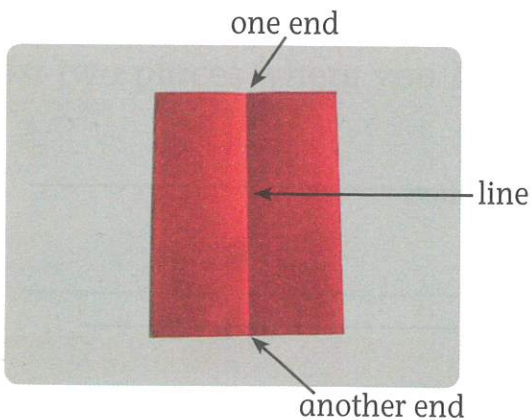
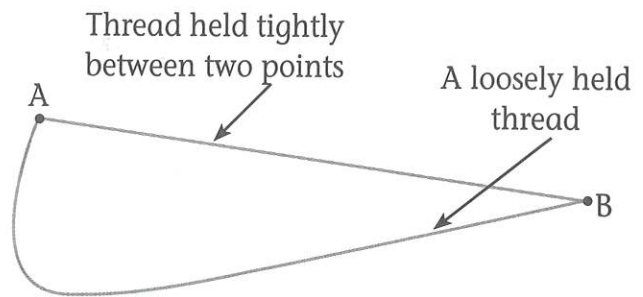
1.3



Clue: Deepa might have to walk across the playground.



When you have two points, a straight line joining them gives the shortest path. If you hold a thread tightly between the two points, the thread will look like a straight line too. The straight line in *Look Deep 1.3* has two points, one at each end.



Fold a piece of paper and unfold it, as shown in *Figure 2*. The crease created forms a straight line with two ends.

Figure 2 Crease on a piece of paper

A straight line running from one corner of the table to another is shown in *Figure 3*. Mark another line on it with two ends.

A line having two ends is called a **line segment**.

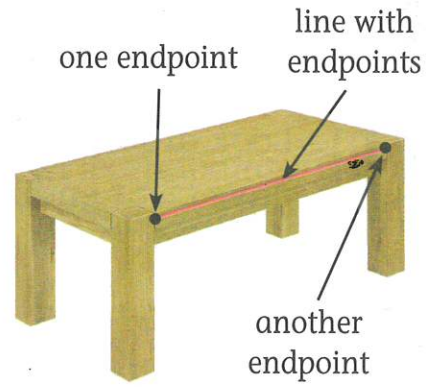


Figure 3 A line with two ends



Figure 4 Line segment between points A and B

The points at the end of a line segment are called its **endpoints**. The line segment in *Figure 4* is called \overline{AB} , because A and B are its endpoints. We can also call it \overline{BA} , since \overline{BA} is also the line segment joining points B and A.

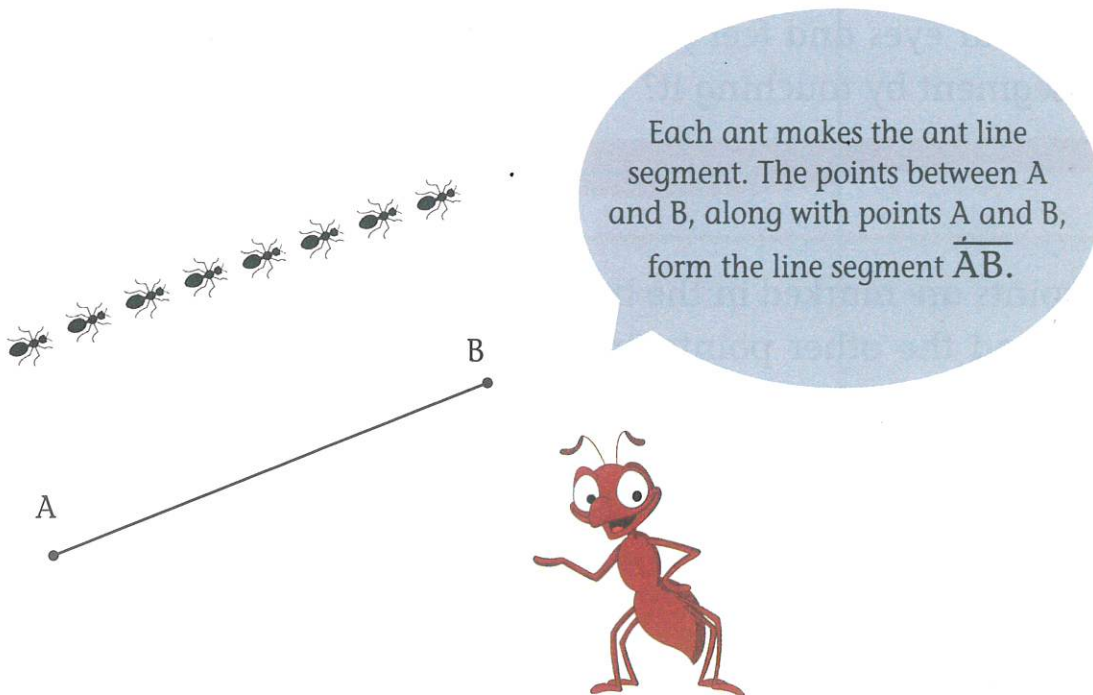


Figure 5 Line segments

We can count the number of ants in the ant line segment given in *Figure 5*. But we cannot count the number of points in a line segment.



LOOK AROUND

1. Look around your classroom and find two lines that have clear ending points.

1.4


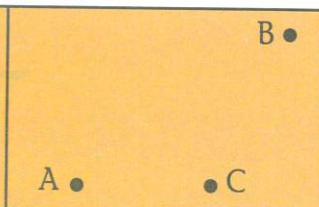
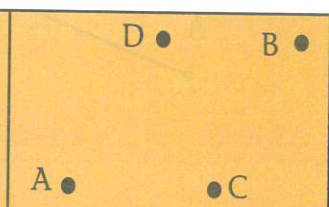
	Where you found it	Drawing of the line with two endpoints marked
a.		
b.		
c.		

2. Close your eyes and feel your way around. Can you discover a third line segment by touching it?



A few points are marked in the box. Draw line segments between point A and the other points, in each box. Complete the table by writing the number of line segments formed in each box and their names.

1.5

			
Number of line segments			
Name of the line segments			

Measure the length of the line segment MN using a ruler.



The length of a line segment is the distance between its endpoints. The length can be in mm, cm, m or km. If \overline{AB} has a length of 5 cm, then we write $AB = 5$ cm.



1. Look around and spot two line segments whose length is in centimetres and one whose length is more than a metre. Measure and record them in the table.



Number	Measured in	Object where you found the line segment	Length
a.			
b.			
c.			

2. Think of a line segment which should be measured in kilometres. Guess how long it might be.





Figure 6 shows a line segment. All the points on this line segment represent days. Imagine that point B represents the day you were born and point T represents today.

1.7

Mark important events in your life as points on this line segment.



Figure 6 A line segment showing time

Describe this line segment.

Pick any two points you marked and write why they are important to you.

• _____

• _____

Companion

Name and measure the given line segments.

1a

Extend all the line segments in the diamond given in *Figure 7* till they touch the sides of the box.

Then extend these to touch the boundary of this page at 8 different points.

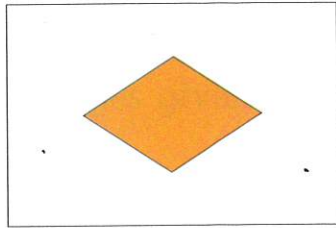


Figure 7 *Diamond*

A 'segment' means a part or piece of a larger object. Which larger object is a 'line segment' a part of?

A longer line segment can be formed by extending a given line segment beyond its endpoints.



When you extend beyond the endpoints of a line segment, you get a **line**. It extends in both the directions without an end. A line is the mother of line segments, with no endpoints.

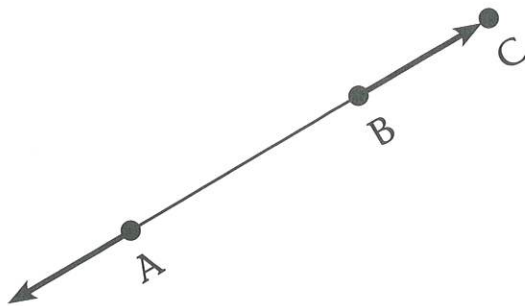


Figure 8 *Extending a line segment*

A line segment is named using its two endpoints. How do you think a line is named?

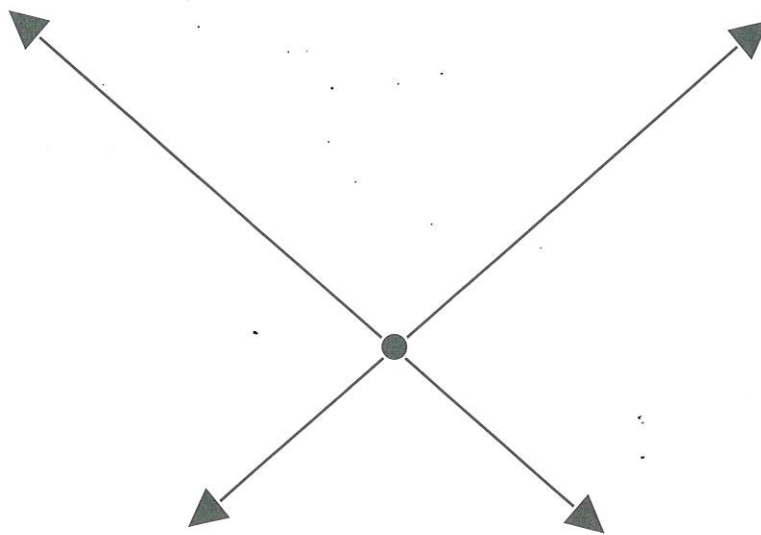
A line is named using **any** two points on it. The line in *Figure 8* can be called \overleftrightarrow{AB} . You can also call it \overleftrightarrow{BA} . The arrows marked at each end shows that the line extends in both directions.

Point C is also on this line and can be used to name the line.

Write four other names for this line.

Mark points on the lines to name both the lines and any two line segments.

1.9



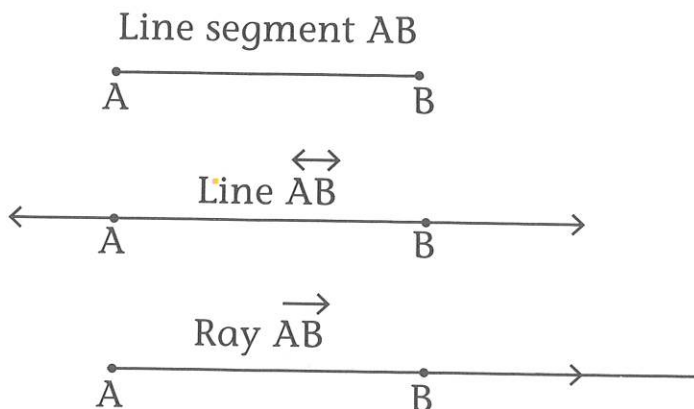
Name of line 1:

Name of line 2:

Name of line segment 1:

Name of line segment 2:

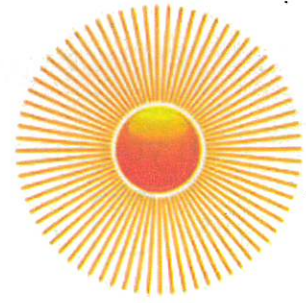
We saw that a line segment runs between two points called endpoints. A line extends in both directions beyond the endpoints. We can also keep one endpoint fixed and extend the line in the other direction. We call this a **ray**. The fixed endpoint of a ray is called the **starting point**. The ray in *Figure 9* is called \overrightarrow{AB}



Is \overrightarrow{BA} the same as \overrightarrow{AB} ?


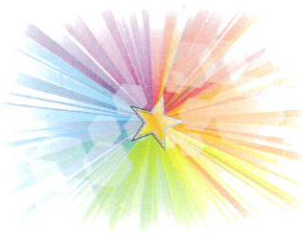

Figure 9 Line segment, line and ray

Light rays originate from the Sun and travel across space with no end. A light ray is an example of a ray. It has its starting point on the surface of the Sun and it moves in a direction away from it.



Observe the images given in the table. Are these examples of a ray? Explain why.

1.10

	Is this a ray?	Why?
 <p>A line in the ticket counter</p>		
 <p>Light rays from a star</p>		
 <p>An arrow pointing at the board</p>		





Can you measure a ray or a line?

Yes No

1.11

The reason for this is _____

Figure 10 shows one ray starting from P. Two rays start from Q. Study Figure 10 and answer the following questions.

1.12

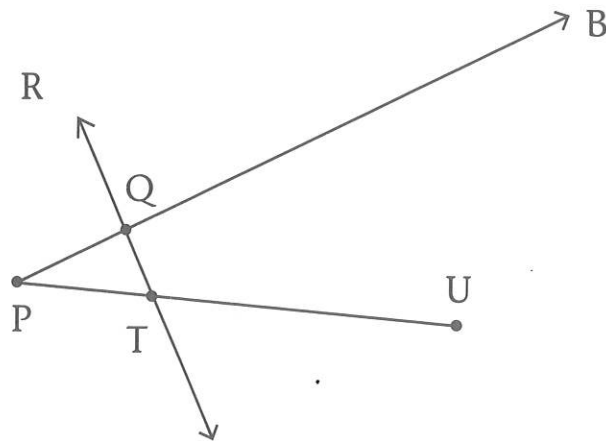


Figure 10 Some lines, rays and line segments

1. Name the rays which start from point Q. _____
2. Name the rays that have point Q on them. _____
3. Name the line that have point Q on them. _____
4. Name all the lines in the figure. _____
5. Draw the line of which the line segment UP is a part of.
6. Name the three line segments on \overleftrightarrow{RT} . _____, _____, _____
7. Mark a point V on the ray \overrightarrow{PQ} such that $\overline{PV} = \overline{PU}$.

Companion

Identify and name the lines and rays.

1b



When we talk, we use words, sentences and paragraphs. So, if the starting letter of a word is a point, what do you think would be the line segment starting from that point?

1.13



Figure 11 shows a circle with centre O.

1.14

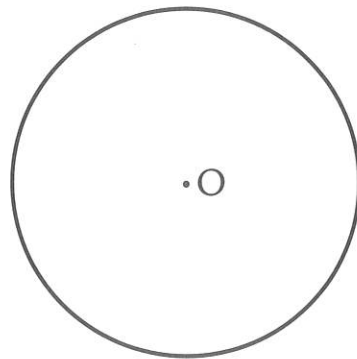


Figure 11 A circle with centre O

1. Draw a line that touches the circle at two points. Name the points P and Q.
2. Draw a line that touches the circle at two points and also passes through O. Name the points A and B. What can you call the line segment joining A and B? _____.

Now, I can:	✓/✗
• identify and name lines, rays and line segments.	○
• measure line segments.	○
• draw lines and line segments	○



How does changing the line segments change the shape they make?



Create a five-sided closed shape. Four of its sides should be 4 cm.



Measure and write the length of the fifth side. The length of the fifth side is _____ cm.

Mark the endpoints of all the line segments in your shape as A, B, C, D and E. The names of your line segments will be _____.



In the shape drawn in *Pep 1.15*, the endpoint of one line segment is also an endpoint of another line segment.

Different line segments meet at their endpoints to form a shape. We call the endpoints of these line segments the vertices of the shape. One such endpoint is called a vertex.

What are the line segments in the triangle in *Figure 12*?

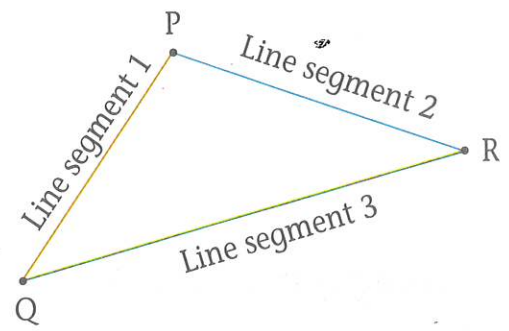
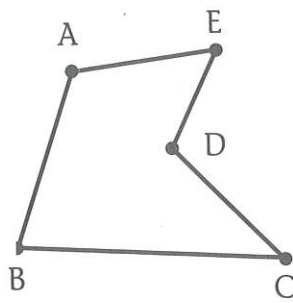


Figure 12 Three line segments forming a triangle

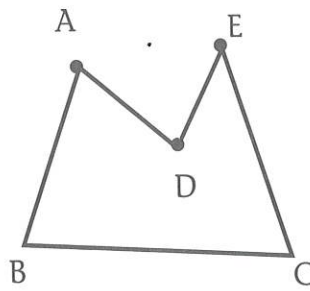
What are the vertices?

Figure 13 shows 5 points A, B, C, D and E.

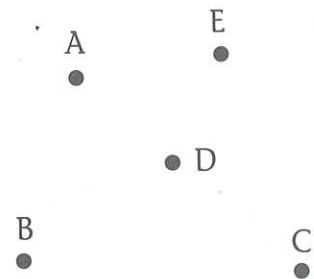
Two different five-sided shapes are drawn with these points. Can you draw another that is different from the first two?



Shape 1



Shape 2



Shape 3

Figure 13 Three shapes

Vertices of all three shapes are _____

Line segments in Shape 1 are _____

Line segments in Shape 2 are _____

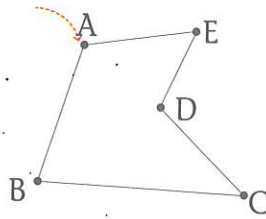
Line segments in Shape 3 are _____

The same set of vertices can have different line segments. Thus, the same vertices form different shapes.

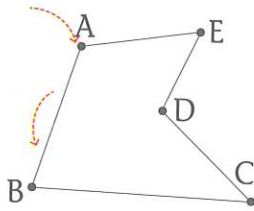
How can we identify one shape from the other?

A simple trick would be to start from one point of the shape.

1. Let us take point A of Shape 1.

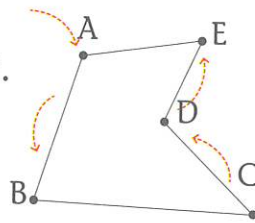


2. Going anti-clockwise ↺ from A along the shape, we get point B. Write AB.



3. Going anti-clockwise ↺ from B, we get points C, D and E. We write the

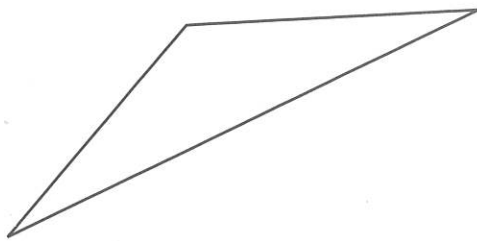
name of shape 1 as ABCDE.



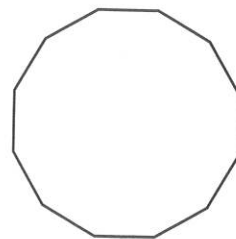
If we start at vertex A of Shape 2, the name of the shape will be _____.

If we start at vertex A of Shape 3, name of the shape will be _____.

Name the vertices and the shapes.



Name: _____



Name: _____

Look at the triangle in *Figure 14*.

When starting from vertex A, the triangle is named _____.

When starting from vertex B, the triangle is named _____.

When starting from vertex C, the triangle is named _____.

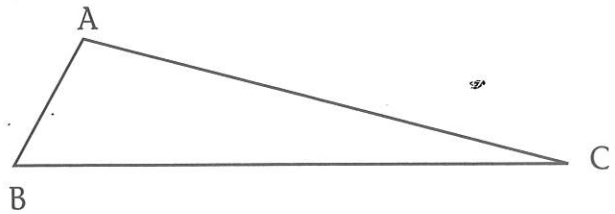
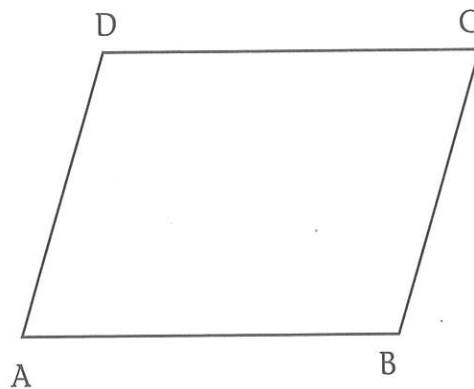


Figure 14. A triangle with vertices A, B and C

Which of the given options are not names for this quadrilateral?



CDAB

ACDB

BADC

BCDA

Companion

Find the odd one out.




Companion

Form new shapes by adding line segments.



Some shapes are given in the table. Fill in the table with the name of the shape. Measure all the line segments of the given shapes and write their lengths.

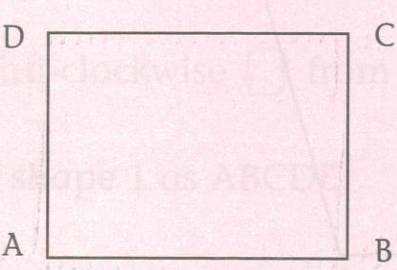
My name is _____ 


Line segment _____ is _____ cm

Line segment _____ is _____ cm

Line segment _____ is _____ cm

Line segment _____ is _____ cm



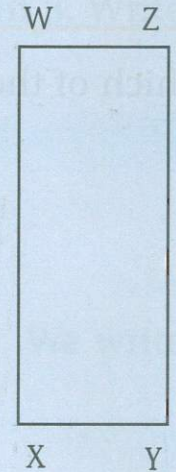
My name is _____ 


Line segment _____ is _____ cm

_____ is _____ cm

_____ is _____ cm

_____ is _____ cm



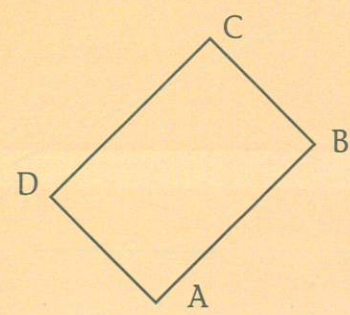
My name is _____ 


Line segment _____ is _____ cm

Line segment _____ is _____ cm

Line segment _____ is _____ cm

Line segment _____ is _____ cm



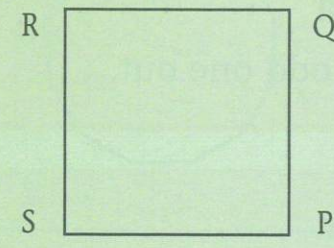
My name is _____ 

Line segment _____ is _____ cm

Line segment _____ is _____ cm

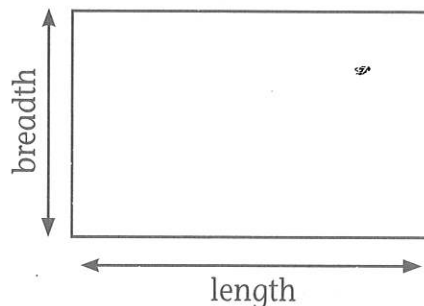
Line segment _____ is _____ cm

Line segment _____ is _____ cm

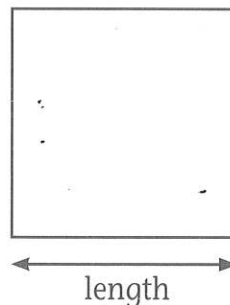


In some shapes, each side has a different length, while in other shapes, particular line segments are equal in length.

In a rectangle, there are pairs of opposite sides which are equal in length. We call the size of the longer line segment the **length** of the rectangle. The size of the shorter line segment is called its **width** or **breadth**.

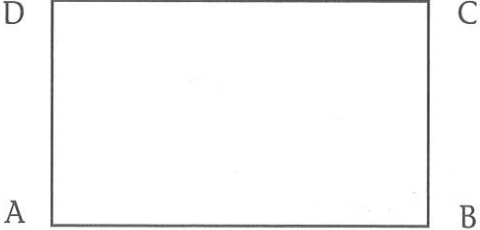
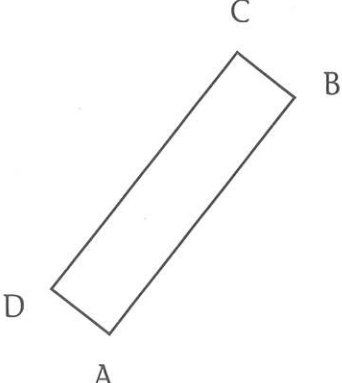


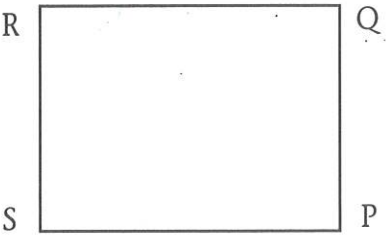
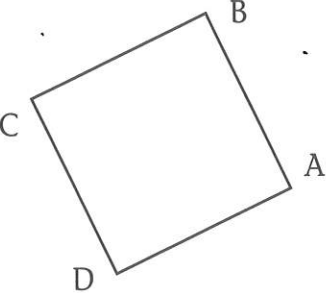
In a square, there are _____ equal line segments. Thus, a square has only 'length'.



A few shapes are given in the table. Complete the table by measuring their lengths and breadths.

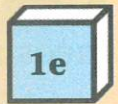


Shape	Length	Breadth
		
		

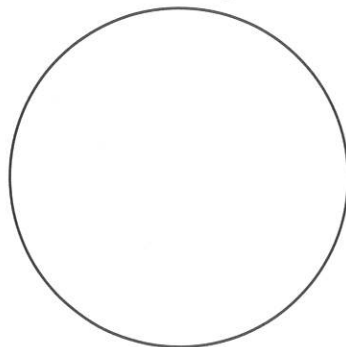
Shape	Length	Breadth
		
		

Companion

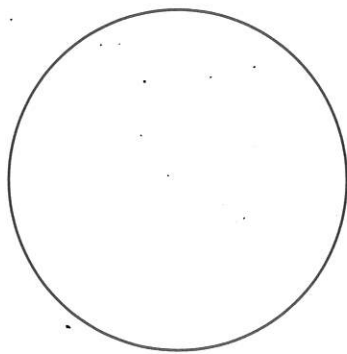
Find the length and breadth of the given rectangles and squares.



1. Draw a triangle inside the circle such that:
 - a. its vertices lie on the circle.
 - b. two of its sides are of equal length.

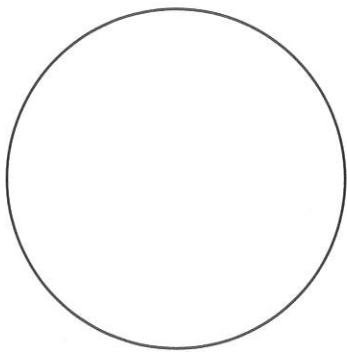


2. Draw a square inside the circle such that its vertices lie on the circle.



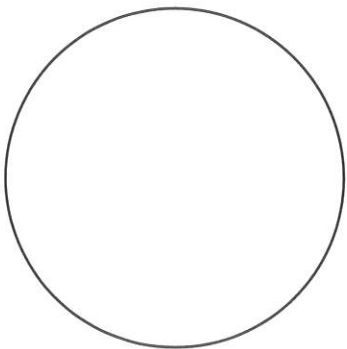
3. Draw a six-sided figure inside the circle such that:

a. its vertices lie on the circle.



4. Draw an eight-sided figure inside the circle such that:

a. its vertices lie on the circle.



Now, I can:



- **name** basic shapes.
- **identify** the line segments in them.
- **identify** the length and breadth of a shape.
- **create** shapes of different number of sides.

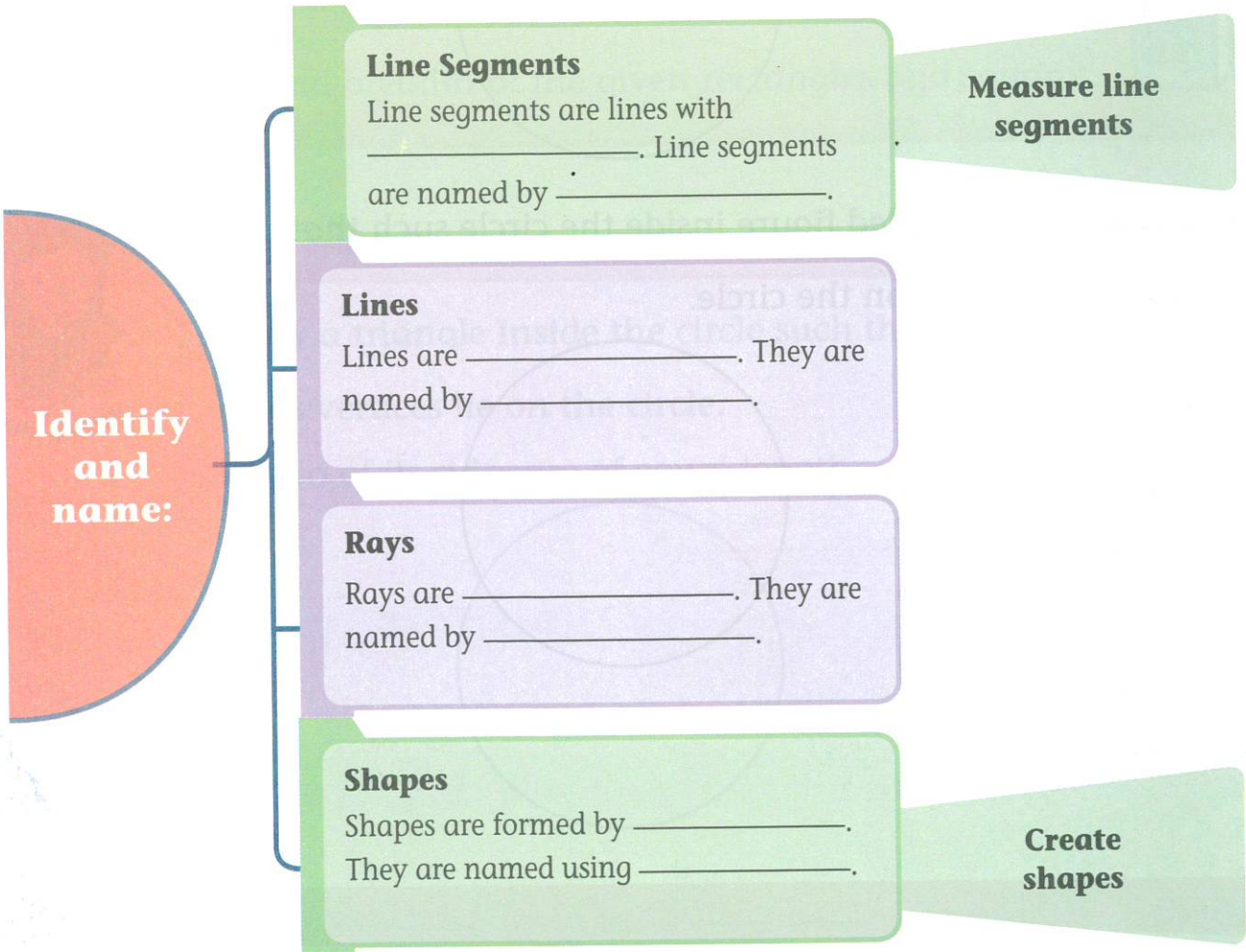


Companion (Project Time)

Create shapes with matchsticks.

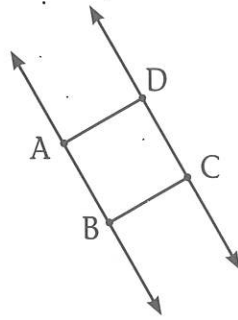


Complete the concept map:



Question Time

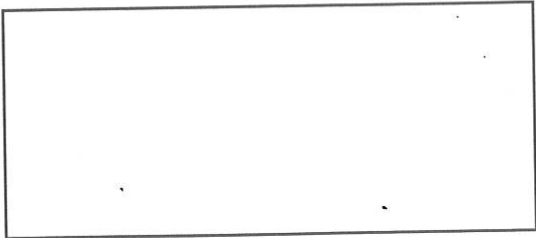
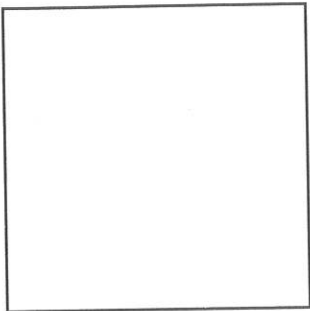
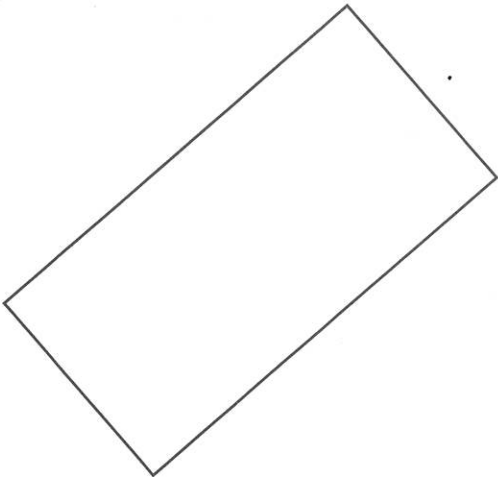
1. There are two lines in the given figure. Name the lines, two possible rays and line segments in this figure. Mark and name additional points if necessary.



2. Name these shapes after naming their vertices.

	Shape	Name
1.		
2.		
3.		

3. Measure the lengths and breadths of these rectangles and squares.

	Shape	Length	Breadth
1.			
2.			
3.			

Angles Around You

How are geometric shapes formed?

OVERVIEW

In this lesson, we will:

- identify, classify and measure angles.
- explore the different types of symmetry.



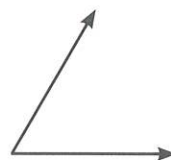
How wide can we rotate a ray?



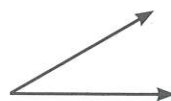
Rohan uses a clapperboard during a movie shoot. A clapperboard consists of a wooden slate with a clapstick attached on the top. Match the shape in the second column with the different clapstick positions by writing the number in the box.

2.1

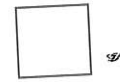
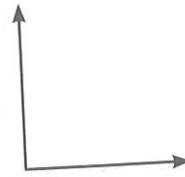
1.



2.



3.



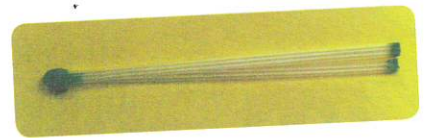
In *Pep 2.1*, each time Rohan opens the clapstick, it rotates away from the slate. When one ray rotates away from another ray through a common point, geometric elements called **angles** are formed. The angle changes as we change the amount of rotation.

Hands-on

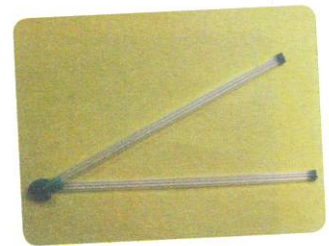
Let us see what happens when a ray is rotated away from another through a common point.



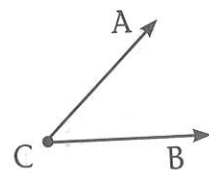
1. Connect two straws using clay as shown.



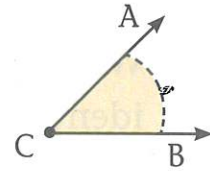
2. Rotate one straw away from the other.



3. Draw the angle formed in your notebook and label the rays.



4. Colour the space between the two rays. This gives the amount of rotation.



5. Repeat the steps to form three different angles. Draw and label them in the space provided.

Angle 1:	Angle 2:	Angle 3:

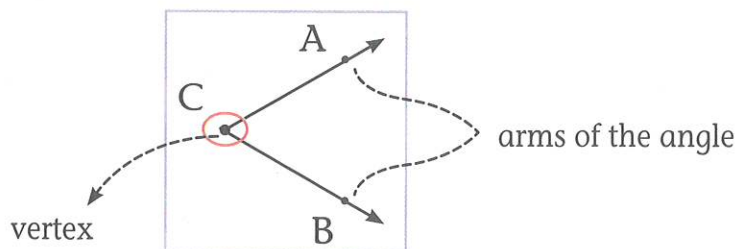


Figure 1 *Parts of an angle*

In *Figure 1*, the common point C of the two rays is known as the **vertex**. And the two rays CA and CB, which make up the angle, are known as the **arms of the angle**.

We use the symbol \angle to denote an angle. So, the angle in *Figure 1* can be written as $\angle ACB$, with the vertex in the middle. It can also be written as angle BCA with the vertex in the middle. Note that in each name the vertex C is in the middle.



LOOK AROUND

With your partner, walk around your *ThinkRoom* and identify different objects that have angles.

2.3

Draw the objects and mark all the possible angles.

Large empty rectangular box for drawing objects and marking angles.

How did your partner like your working?

Two things you did well:

One thing I wish you to work on:



Two horizontal lines for writing feedback.



Two horizontal lines for writing feedback.

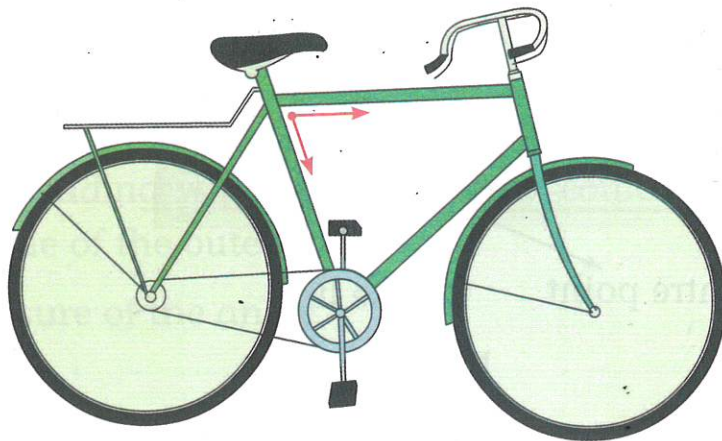


Two horizontal lines for writing feedback.



Find angles in the bicycle and draw rays to mark them. One has been done for you.

2.4



Companion

Name the angle and its vertex and arms.

2a

The shape of an angle depends on the amount of rotation of one arm from the other around the vertex. This gives the measure of the angle.

In *Figure 2*, the amount of rotation of $\angle XYZ$ is different from the amount of rotation of $\angle MNO$.

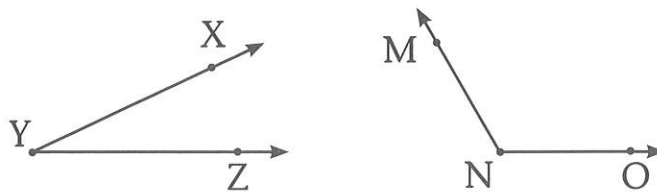


Figure 2 Amount of rotation

The standard unit for measuring an angle is **degrees** or **radians**. It is denoted by $^\circ$.

To measure angles, we use an instrument called the protractor. You will find one in your geometry box. Protractors measure angles in degrees. They have two scales — an outer scale and an inner scale. Both scales have 0° to 180° , but in opposite directions. The different parts of a protractor are given in *Figure 3*.

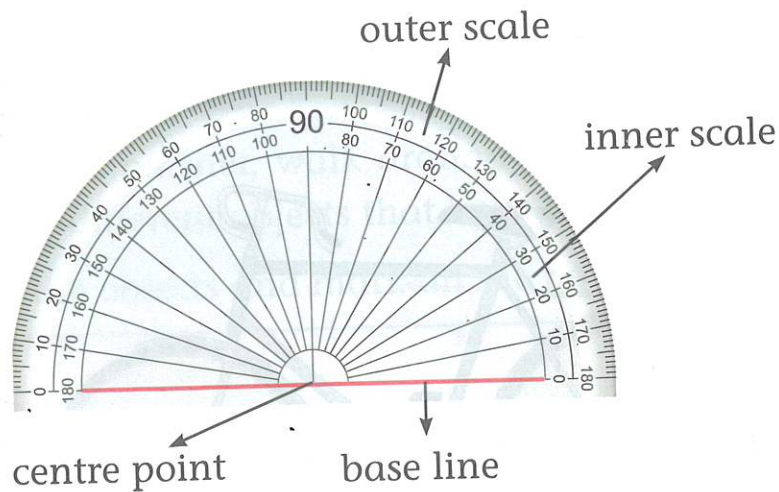


Figure 3 Protractor

In Figure 4, the coloured area represents the angle of measure 30° .

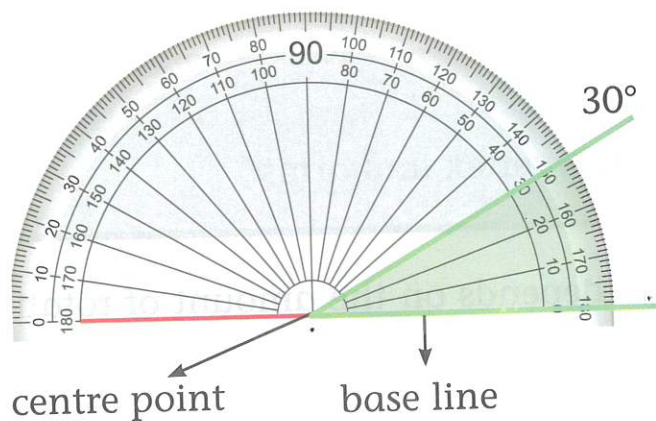
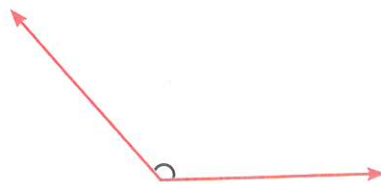


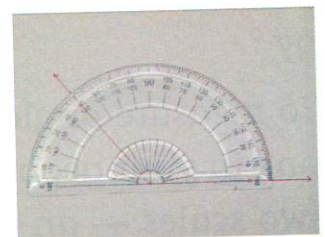
Figure 4 Protractor Showing 30°

Let us measure the angle given.

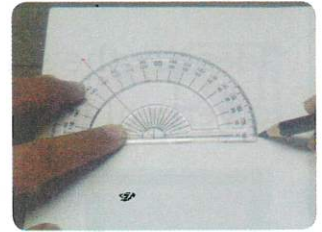


Step 1: Place the protractor such that:

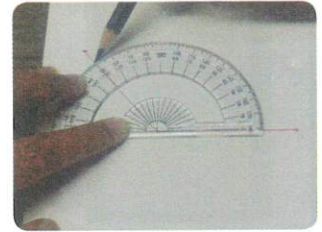
- the centre point coincides with the vertex of the angle.
- the baseline coincides with one of the rays.



Step 2: Look at the zero of the inner scale, which is in the direction of the ray.

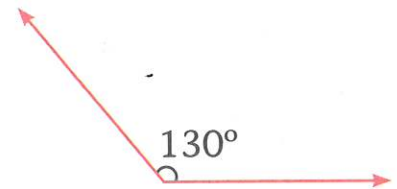


Step 3: Start reading from 0 as 10, 20, 30 and so on until you reach the reading where the other ray coincides with the line of the outer scale.



This gives the measure of the angle.

Step 4: Show the measure of the angle using an arc.

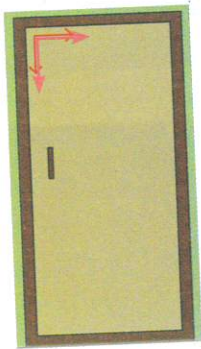


Can we use a ruler to measure angles? Why?

2.5

Identify the sides of the rectangular door where a horizontal and a vertical line meet.

2.6



Trace along them to draw rays. One has been done for you.

Do these rays form an angle?

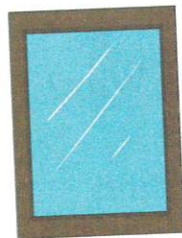
Yes

No

In Activity 2.6, the angles formed by the horizontal and vertical lines measure 90° . Such angles that measure 90° are called **right angles**.

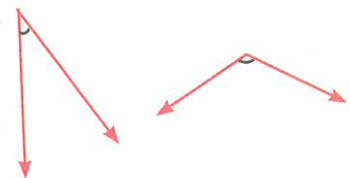
Find and mark the right angles in the pictures, in red.

2.7



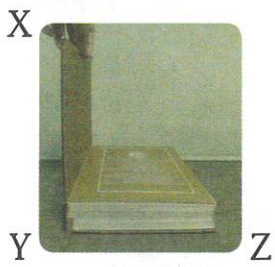
We represent the right angle with a square.

And all other angles are represented with an arc.



Observe the angle formed by the book.

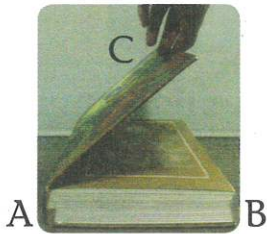
2.8



Is the angle formed a right angle?

Yes No

Observe the angle formed by the book at this position.

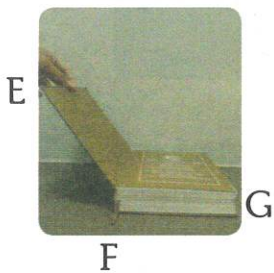


Is the angle formed a right angle?

Yes No

Is the angle smaller than the right angle or bigger than the right angle?
Measure the angle to find out. _____

Observe the angle formed by the book at this position.



Is the angle formed a right angle?

Yes No

Is the angle smaller than the right angle or bigger than the right angle?
Measure the angle to find out. _____

In *Activity 2.8*, $\angle CAB$ is smaller than a right angle.
Any angle smaller than a right angle is called an **acute angle**.

In *Activity 2.8*, $\angle EFG$ is bigger than a right angle.
Any angle bigger than a right angle is called an **obtuse angle**.

Acute angles measure
between 0° and 90° .

Obtuse angles measure
between 90° and 180° .

Hands-on

With the help of your teacher, learn to form different angles using your arm.



Look at the way Ramya is forming angles using her arm. She has folded her lower arm over her upper arm, which is like one line segment placed over another.



She is opening her arm to form different angles. Form similar angles using your arms and write the type of angle formed.

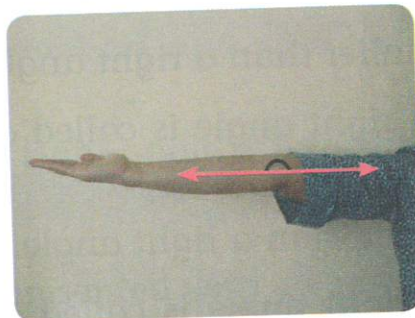


The angle formed is a _____ angle.



The angle formed is a _____ angle.

Now, Ramya has stretched her arm. The angle formed is a **straight angle**.



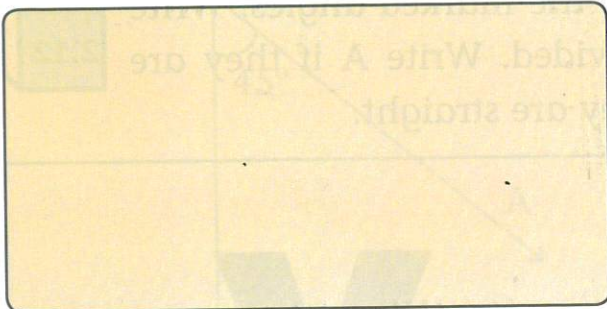
Straight angles have a measure of 180° .



LOOK DEEP

When do you think an angle will be 0° ?

2.10





LOOK AROUND

Draw rays to identify the angles and their types in the following numbers.

2.11





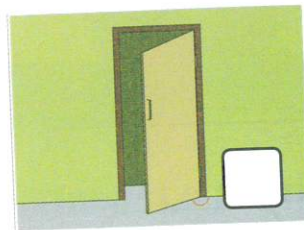
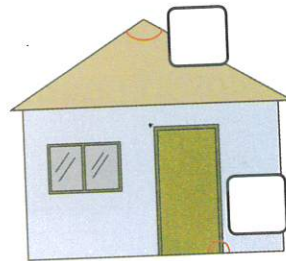
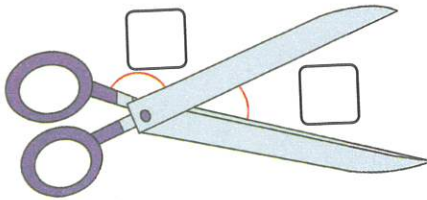
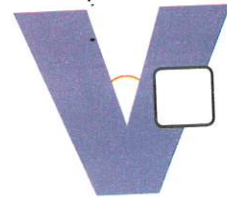
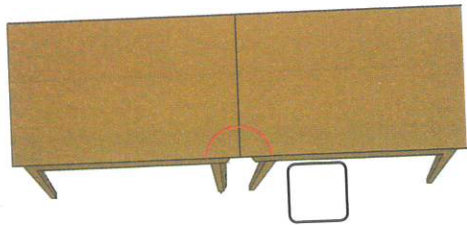
Companion

Identify the angles.

2b

Look at the given objects and identify the marked angles. Write the types of angles in the boxes provided. Write A if they are acute, O if they are obtuse and S if they are straight.

2.12



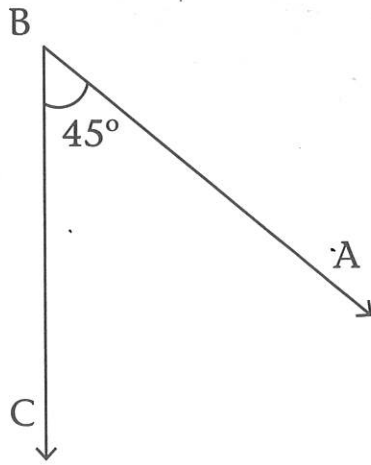
Companion

Identify the types of angles in each image.

2c

Measure the angles using a protractor. Write the name of the given angles and their type. One has been done for you.

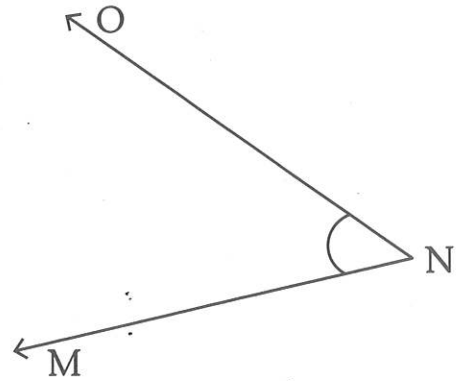
1.



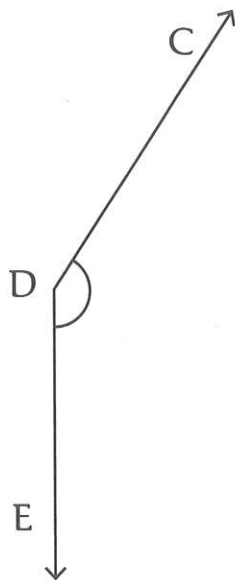
$\angle ABC = 45^\circ$

Acute angle

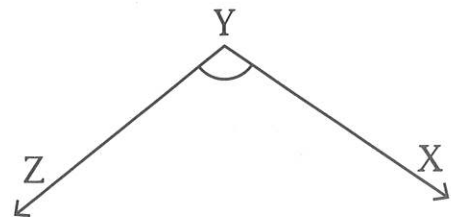
2.



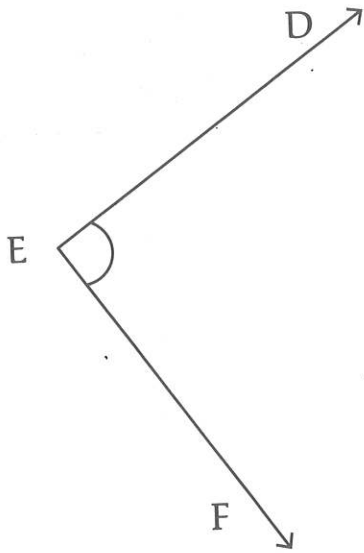
3.



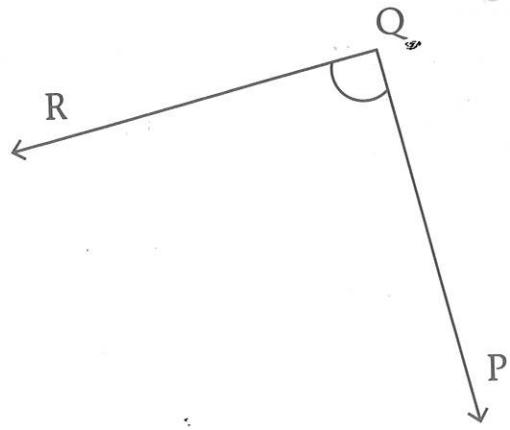
4.



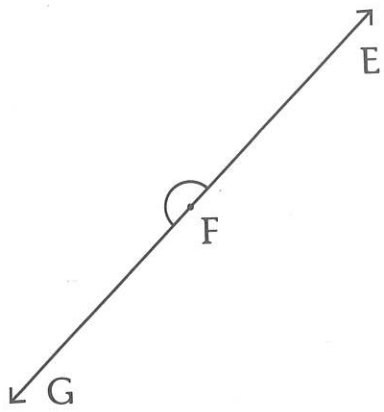
5.



6.



7.



8.



The shape of an angle that is formed depends on how much a ray has rotated away from another, having the same starting point.

Classify the angles measured in *Activity 2.13*. Write the names of the angles in the respective box.

2.14

Acute angle	Obtuse angle	Right angle	Straight angle

What can you say about the angles?

Complete the sentences using the lesser than (<) or greater than (>) symbol.

Straight angle _____ Obtuse angle

Obtuse angle _____ Right angle

Right angle _____ Acute angle

Now, list the angles in descending order.

_____, _____, _____

Companion

Measure the given angles using a protractor.

2d



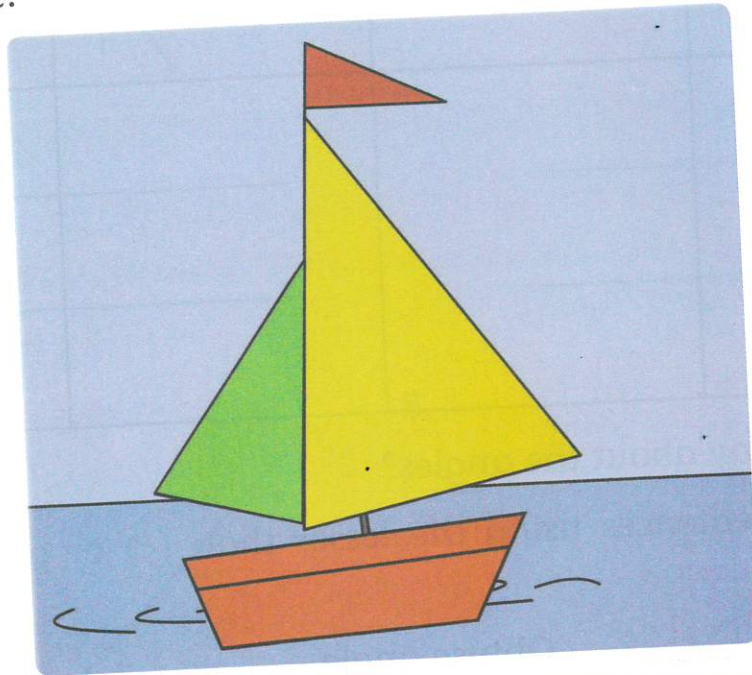
Step 1: Identify as many angles as you can in the given picture.

2.15

Step 2: Name the angles.

Step 3: Using a protractor, measure the angles.

Step 4: Complete the table by filling in the type of the angle and its measure.



Name of the angle	Type of the angle	Angle (degrees)

Now, I can:	✓/✗
• identify angles in objects around us.	○
• classify angles as acute, right, obtuse and straight angles.	○
• measure angles using a protractor.	○



Can images look the same from different positions?



Reya bought a few bars of chocolate, but she wants to eat half of each chocolate and save the remaining for tomorrow.

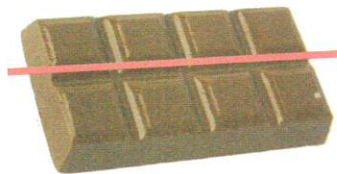
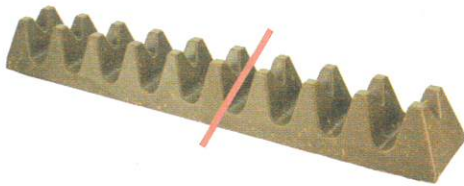


Figure 5 *Chocolate bars*

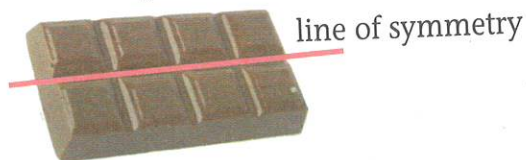
Reya has cut each chocolate bar along the given lines, into halves. Circle the chocolate bars where the two halves will overlap exactly.

When cut or folded along a line, certain shapes overlap exactly along the line. Such shapes are said to be symmetrical with respect to that line. This type of symmetry is called **line symmetry** or **reflectional symmetry**.

The line that divides the shape into overlapping parts is called the **line of symmetry** or the **axis of symmetry**.

The line of symmetry in *Figure 5* divides the chocolate bar into two overlapping parts.

2.17



Can Reya divide the chocolate bar in another way to make two overlapping halves? Draw the line of symmetry in *Figure 6* to show your answer.

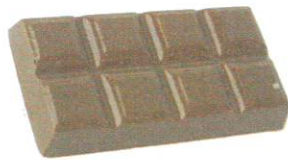
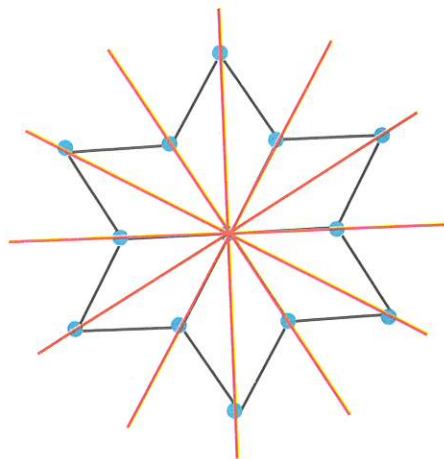
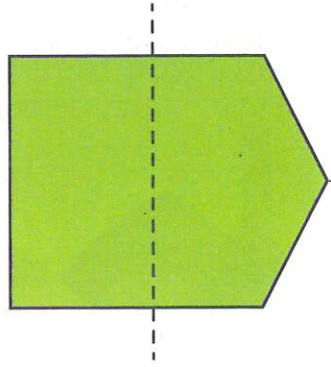


Figure 6 Line of symmetry

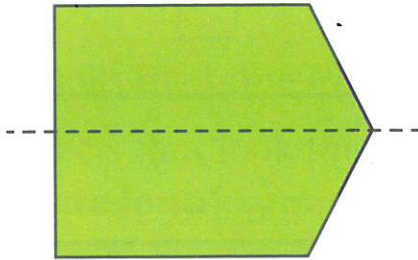
A shape can have many lines of symmetry. In *Activity 2.17*, the chocolate bar has two lines of symmetry.

Look at the simple *kolam*. It has six lines of symmetry.





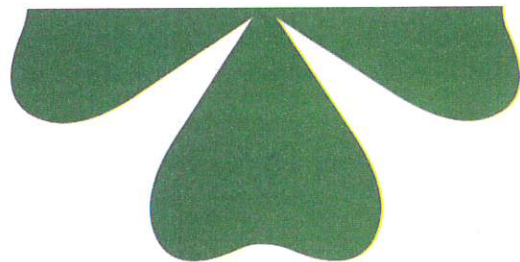
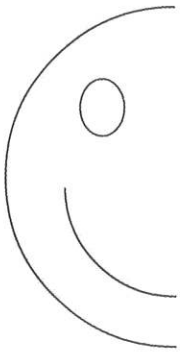
This shape is not symmetrical. The two parts do not overlap.



No, it is symmetrical. A shape may not be symmetrical with respect to one line of symmetry, but it can be symmetrical with respect to another line. Try drawing the line of symmetry like this.

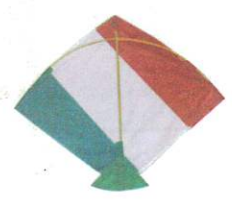
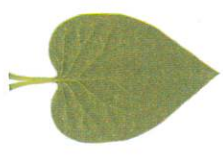
Complete the images and make them symmetrical.

2.18



Draw the line(s) of symmetry for the given images. Write the number of lines of symmetry.

2.19



LOOK DEEP

Place a small mirror on the line in *Figure 7*.
What do you observe?

2.20

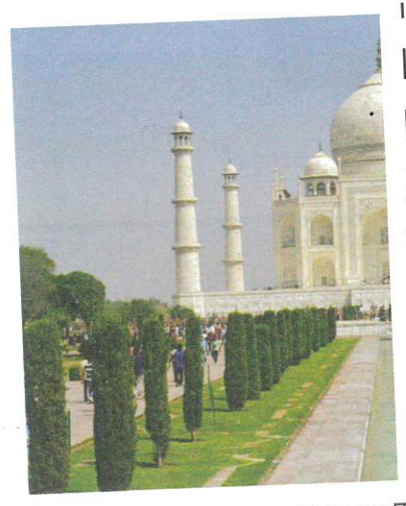


Figure 7 *Taj Mahal*

From your observation, what other name can be given to 'line of symmetry'?

Rotational Symmetry

Observe the different positions of the blades of the windmill in *Figure 8*.

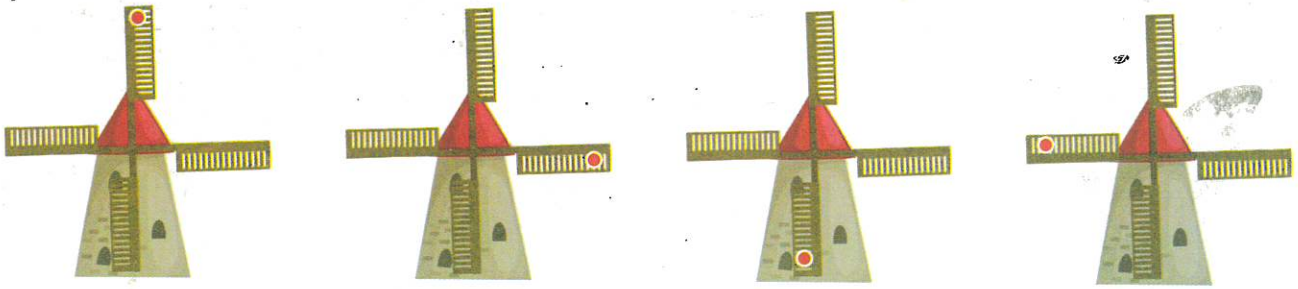


Figure 8 Windmill

The windmill looks the same every time the blade rotates through a $\frac{1}{4}$ turn. Shapes and objects that look the same after a certain amount of rotation are said to have **rotational symmetry**.

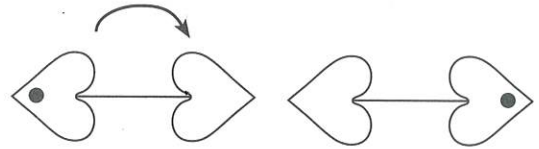
Companion

Circle the shapes that will look the same after a $\frac{1}{4}$ turn.



Half Turn ($\frac{1}{2}$ turn)

Some shapes look the same after half a turn.



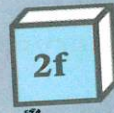
Look at the shapes in the table. A dot has been placed to help you observe the turns.

Shape	$\frac{1}{4}$ turn	$\frac{1}{2}$ turn

The shapes look the same after $\frac{1}{2}$ turn.

Companion

Circle the shapes that will look the same after a $\frac{1}{2}$ turn.



One-third Turn ($\frac{1}{3}$)

Some shapes look the same after a one-third turn.

Look at the shapes in the table. A dot has been placed to help you observe the turns.

Shape	$\frac{1}{3}$ turn

Companion

Circle the shapes that will look the same after a $\frac{1}{3}$ turn.



One-sixth Turn ($\frac{1}{6}$)

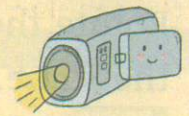
Some shapes look the same after a one-sixth turn.

Look at the shapes in the table. A dot has been placed to help you observe the turns.

Shape	$\frac{1}{6}$ turn

Audio-Visual

Watch an audio-visual to see how shapes look when rotated.



Companion

Circle the shapes that will look the same after a $\frac{1}{6}$ turn.



Hands-on

Take a square piece of chart and draw lines, as shown in *Figure 9*.



Place a board pin in the centre where the lines meet. The pin represents the centre of rotation.

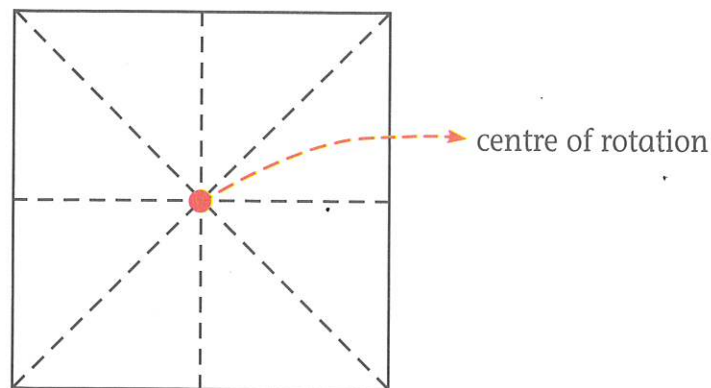



Figure 9 Square paper

Choose a picture from a newspaper or magazine. Cut the picture to make a perfect square. Now, place the chosen picture on the board and secure it with a pin.

Rotate the picture and identify after how many turns the picture looks the same. Repeat the activity for a few more pictures and complete the table. One has been done for you.



$\frac{1}{4}$ turn

	$\frac{1}{4}$ turn



LOOK AROUND

Do all objects show symmetry?

List three objects from your *Studio* and complete the table.



2.22

Object	No symmetry	Line symmetry	Rotational symmetry

Certain words have symmetry too.

1. Identify the type of symmetry for the given words.
2. Draw the line of symmetry for the words.



2.23



OHIO
BOX
COOKIE

3. Identify the capital letters that have reflectional and rotational symmetry, and draw them.

Certain figures look the same in different positions because of symmetry.



1. Look at the image of Wheel X in Figure 10. Draw the line of symmetry for the wheel.

2.24

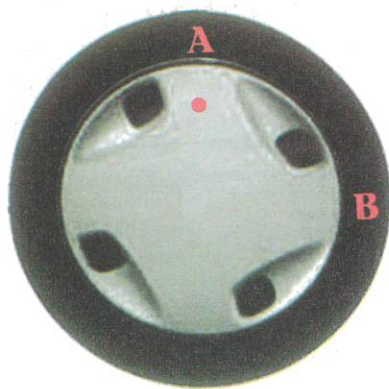


Figure 10 Wheel X

In Figure 10, Wheel X looks the same when it rotates and A takes the position of B.

How many turns has the wheel taken from A to B?

$\frac{1}{2}$ turn

$\frac{1}{4}$ turn

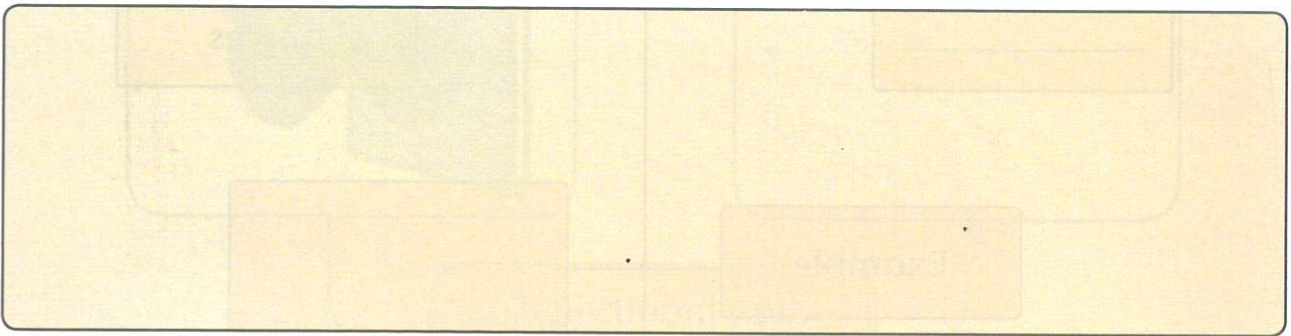
$\frac{1}{6}$ turn

2. Look at the image of Wheel Y in *Figure 11*. Does this wheel show rotational symmetry? Explain your answer.



Figure 11 *Wheel Y*

3. Draw at least one shape that has both reflectional and rotational symmetry.



Now, I can:	✓/✗
• identify line(s) of symmetry in shapes.	<input type="radio"/>
• identify reflectional and rotational symmetry in shapes.	<input type="radio"/>
• create shapes with reflectional and rotational symmetry.	<input type="radio"/>

Companion (Project Time)

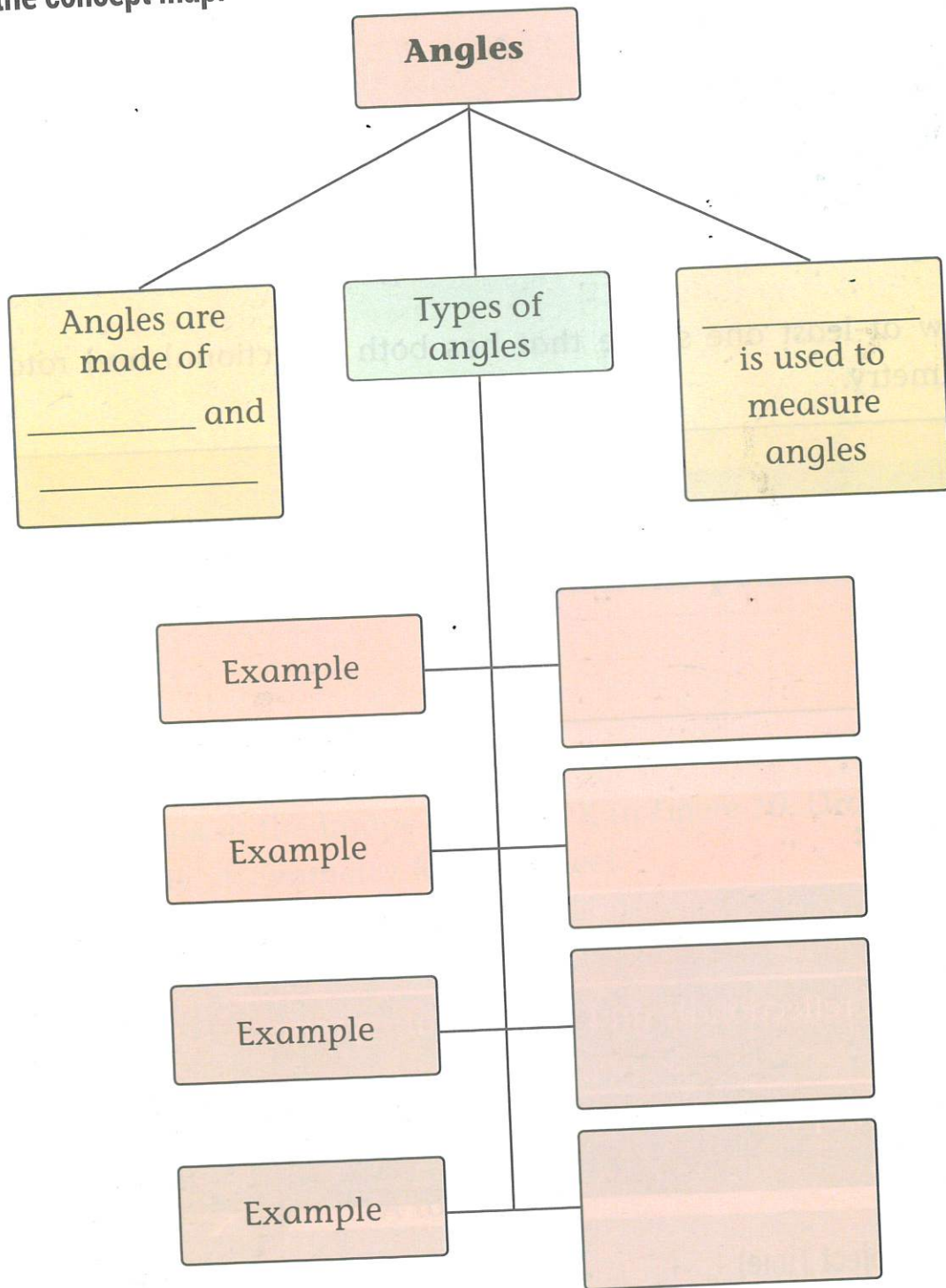
Create a route map from your home to your school.



Journal

Reflect your experiences in this lesson.

Complete the concept map.

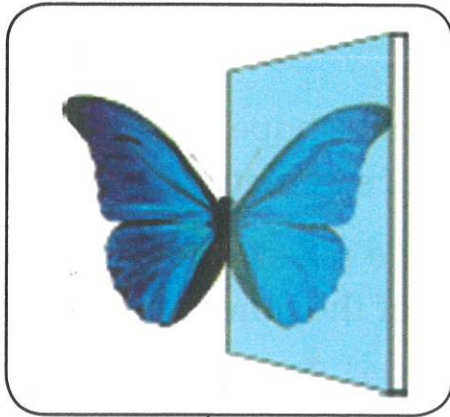


Symmetry

Line of symmetry

Rotational symmetry

Examples:



Reflectional and rotational symmetry

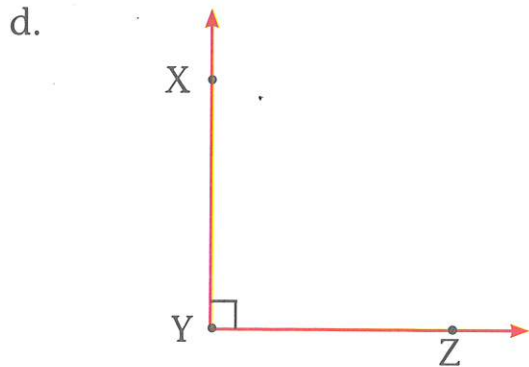
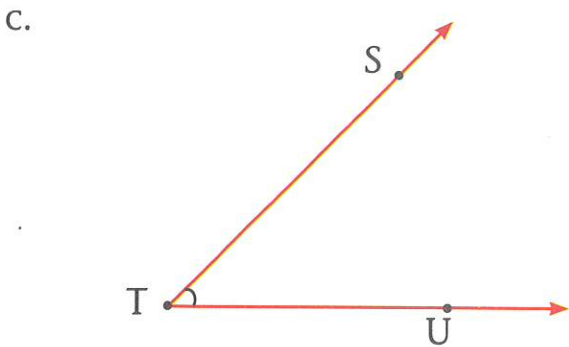
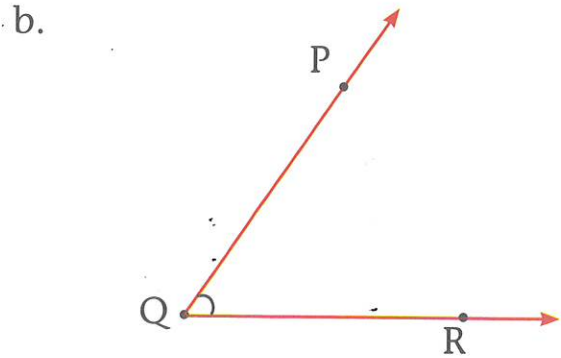
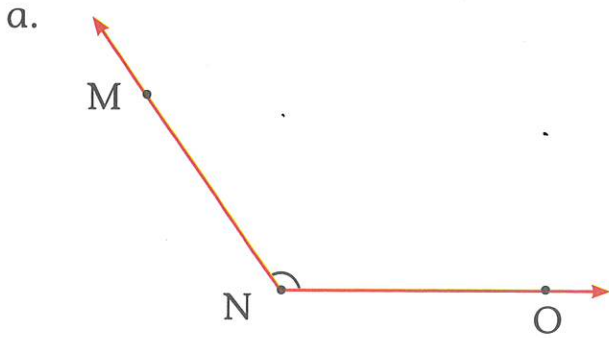
Examples:

Glossary

Angle	When one ray rotates away from another ray through a common point, angles are formed
Right angle	An angle that measures 90° is called a right angle
Obtuse angle	An angle that measures more than 90° , but less than 180° is called an obtuse angle
Acute angle	An angle that measures more than 0° , but less than 90° is called an acute angle
Straight angle	An angle that measures exactly 180° is called a straight angle
Line of symmetry	The line which divides any shape into two overlapping parts is called the line of symmetry
Reflectional symmetry	An image is said to have reflectional symmetry if one half is a mirror image of the other half with respect to a line
Rotational symmetry	An image is said to have rotational symmetry if it looks the same even after a certain amount of rotation around a centre point

Question Time

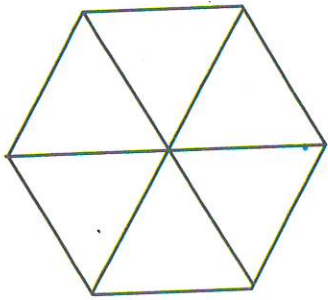
1. Use a protractor to measure each of the following angles. Write the measure of the angle near the arc. Fill in the box with the name of the angle and its type.



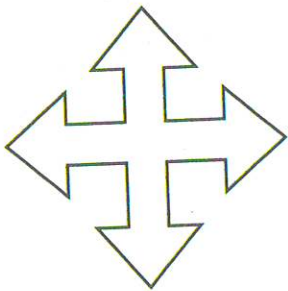
2. Circle the numbers that will look the same after a $\frac{1}{2}$ turn.

0	1	2	3	4	5	6	7	8
---	---	---	---	---	---	---	---	---

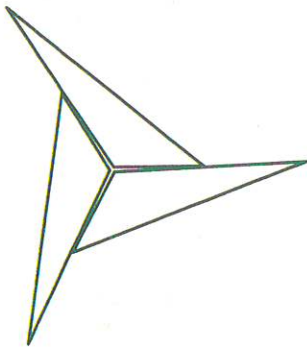
3. Observe the given shapes. Match the shapes to the turns that will make them look the same.



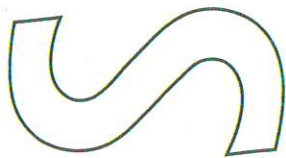
$\frac{1}{4}$ turn



$\frac{1}{2}$ turn



$\frac{1}{6}$ turn



$\frac{1}{3}$ turn

Arithmetic Operations

What can I know about the solution before solving the problem?

OVERVIEW

In this lesson, we will:

- learn how to find approximate solutions.
- use arithmetic operations on numbers with seven digits.
- use approximation to check solutions.



Is it always necessary to find the exact solution to a problem?



The following passages are taken from newspaper articles. The highlighted words tell us that the numbers given are not very accurate. Write a reason why they could not include the accurate value here.

4.1

'Accurate' - exact

'Approximate' - close to actual value, but not exact

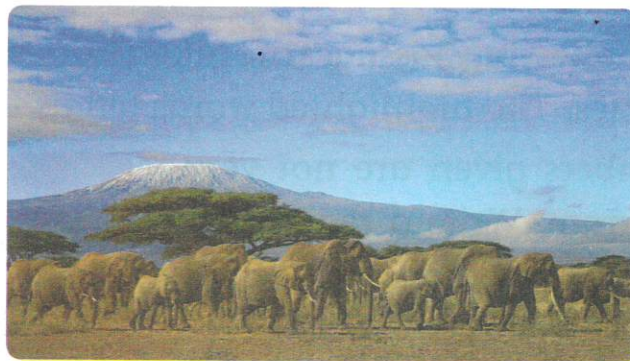
'Estimate' - to roughly calculate the value

	Passages from newspaper reports	Number in the passage	Reason the number is not exact
1.	The population of the Asian elephant in India is estimated to be around 27,000.		

2.	More than half a million viewers watched the third Women's Ashes ODI on television.		
3.	The organisers estimated that at least 3,50,000 people had turned up. Newspapers reported it as tens of thousands .		

In many cases, we calculate the accurate answer to a problem. But in some cases:

- we may not have enough information. It is not possible to count all the elephants in a country.



- we make an estimate for a future event. How many plates of food will we need for a party happening next week?



- there is no simpler way to calculate a value. The calculation is too long and complicated for the problem.



In these and other such cases, we make an approximate calculation and arrive at a number that is very close to the actual value.

Read the following examples. Place a tick (✓) in the appropriate box based on whether you would calculate an accurate answer or if an approximate answer is enough.

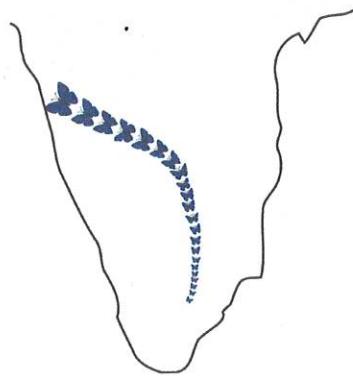
4.2

Example	An approximate answer	An accurate answer
Calculate the amount of money you should take to buy groceries on a list		
Calculate the length of cloth to buy for a pant or a skirt		
Count the number of votes two candidates got in an election		
Count the scores in a cricket game		
Calculate the total money deposited in a bank		
Calculate the number of letters received by a post office		

Write one example of your own for each.

Example	An approximate answer	An accurate answer
	✓	
		✓

Tinu belongs to a type of butterfly called the tiger butterfly. Every year, lakhs of tiger butterflies fly together from the west of India to the east. Then, their young ones fly back to the west.



Audio-Visual

Watch an audio-visual on the numbers involved in animal migrations.



How would you feel to be a part of one lakh people?

When was the last time you were a part of a huge crowd?

Did you like being in the crowd?



Do you like talking to strangers in a crowd? _____



Tinu was born in a park in Bengaluru. Her parents were from the Nilgiri mountains in Tamil Nadu. One November morning, her mother travelled west with a group of **25 lakh** butterflies. The whole sky was filled with colourful wings.



Today, Tinu is travelling to the Nilgiri mountains with a group of **16 lakh 80 thousand** butterflies.

How much bigger is her mother's group when compared to Tinu's group?

$$\begin{array}{r}
 \begin{array}{ccccccc}
 2 & 5 & 0 & 0 & 0 & 0 & 0 \\
 1 & 6 & 8 & 0 & 0 & 0 & 0
 \end{array} \\
 - \\
 \hline
 \begin{array}{ccccccc}
 & & & & & &
 \end{array}
 \end{array}$$

How big would their group be if both Tinu's group and her mother's group travelled together?

$$\begin{array}{r}
 \begin{array}{ccccccc}
 2 & 5 & 0 & 0 & 0 & 0 & 0 \\
 1 & 6 & 8 & 0 & 0 & 0 & 0
 \end{array} \\
 + \\
 \hline
 \begin{array}{ccccccc}
 & & & & & &
 \end{array}
 \end{array}$$

There were three kinds of butterflies in her group. Let us call them type 1, 2 and 3.

In the table, the number of type 1 butterflies has been given. The number of type 2 butterflies are equal to the number of type 3 butterflies. Calculate the number of butterflies in these two types.

4.3

The kind of butterfly	The number of butterflies in the group
type 1 - tiger butterfly	12,60,000
type 2 - common crow butterfly	
type 3 - double crow butterfly	
Total	16,80,000

Since there are totally 16,80,000 butterflies in Tinu's group and 12,60,000 of type 1, the number of other butterflies is $16,80,000 - 12,60,000$.

$$\begin{array}{r}
 \begin{array}{|c|c|c|c|c|c|c|}
 \hline
 \color{green}1 & \color{brown}6 & \color{grey}8 & \color{purple}0 & \color{blue}0 & \color{red}0 & \color{yellow}0 \\
 \hline
 \end{array} \\
 - \begin{array}{|c|c|c|c|c|c|c|}
 \hline
 \color{green}1 & \color{brown}2 & \color{grey}6 & \color{purple}0 & \color{blue}0 & \color{red}0 & \color{yellow}0 \\
 \hline
 \end{array} \\
 \hline
 \begin{array}{|c|c|c|c|c|c|c|}
 \hline
 \color{green}0 & \color{green}0 & \color{green}0 & \color{green}0 & \color{green}0 & \color{green}0 & \color{green}0 \\
 \hline
 \end{array}
 \end{array}$$

Since the number of type 2 and type 3 butterflies are the same, the number of type 2 butterflies is _____ $\div 2$.

Th H T O

$$\begin{array}{r}
 \\
 2 \overline{) }
 \end{array}$$

Thus, the number of type 3 butterflies = _____.

In Tinu's story, each little butterfly flies through cities and villages, over hills and rivers. Some butterflies may have stayed behind and others may have got lost. So, we need not calculate the exact solutions to these problems.

One quick way to approximate is to round off the numbers involved.

Rounding off 16,80,000 to its nearest lakhs, we get 17,00,000.

So, $25,00,000 - 16,80,000$ can be calculated as $25,00,000 - 17,00,000$.

$$\begin{array}{r}
 250000 \\
 - 170000 \\
 \hline
 \end{array}$$

16,80,000 – 12,60,000 can be rounded off to 17,00,000 – 13,00,000.

$$\begin{array}{r}
 170000 \\
 - 130000 \\
 \hline
 \end{array}$$

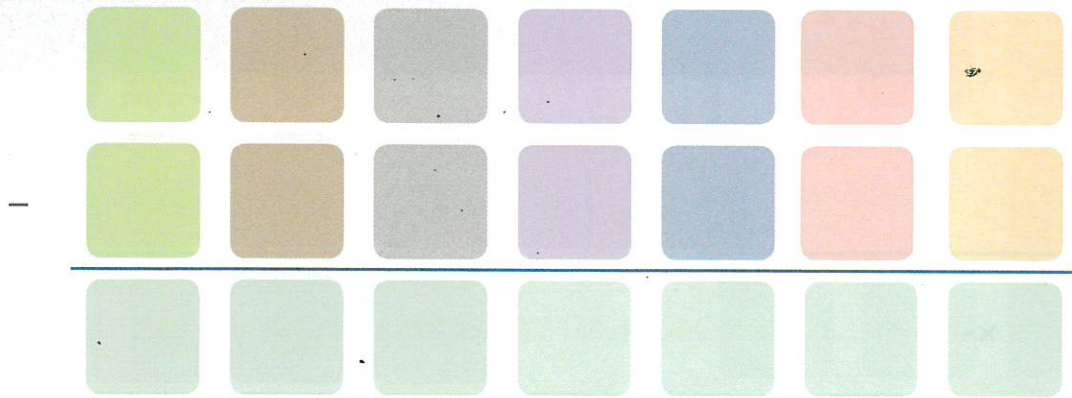
Find a solution to the given problem by rounding off the numbers to the highest place.

4.4

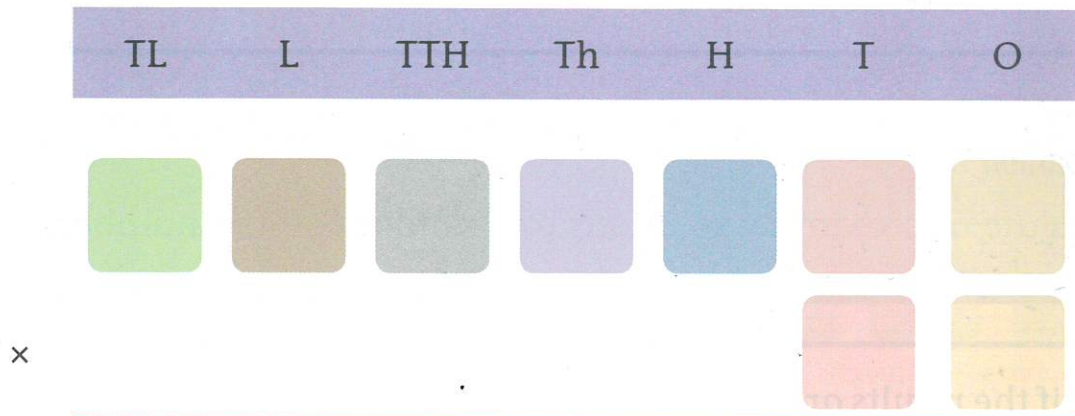
a. $55,55,557 + 1,23,499$

$$\begin{array}{r}
 \\
 + \\
 \hline
 \end{array}$$

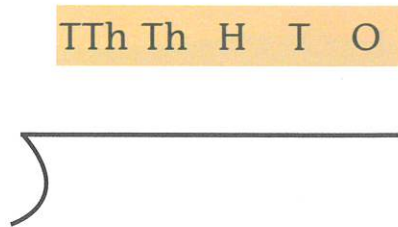
b. $10,00,000 - 10,050$



c. $10,00,010 \times 20$



d. $50,000 \div 501$



e. $5,51,005 \times 1001$

	TL	L	TTH	Th	H	T	O
x							

Companion

Calculate approximate solutions by rounding off the numbers.



Find if the results are equal by rounding off numbers to the highest place.

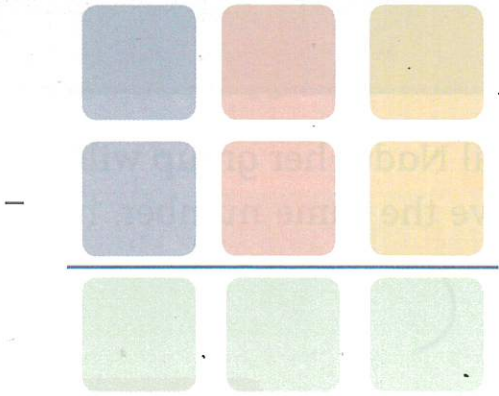


a. $10,013 \div 100$

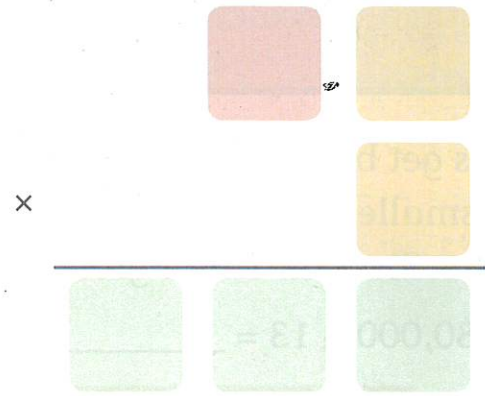
TTh Th H T O



b. $173 - 98$



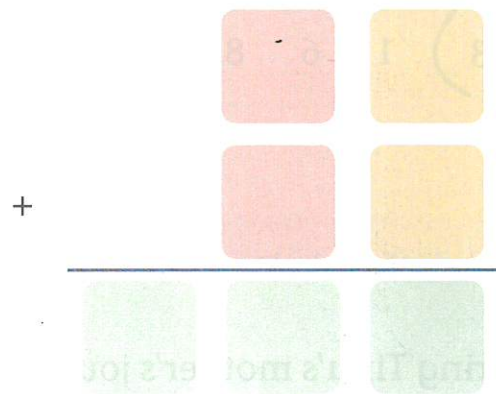
c. 23×5



d. $42 + 58$



e. $40 + 60$



Are the results equal? Yes No



Add two more sets of problems with '+', '-', 'x' or '÷' like in Activity 4.5. When the result is rounded off, it should be close to 100.

4.6

Companion

Match the calculations.

4b

Let's get back to Tinu's story. Once near Tamil Nadu, her group will split into 13 smaller groups. If each group were to have the same number, how many butterflies will Tinu's group have?

$$16,80,000 \div 13 = \underline{\hspace{2cm}} \text{ in one group}$$

TL L TTh Th H T O

$$\begin{array}{r} 13 \overline{) 1680000} \\ \end{array}$$

Since approximation is allowed, we can write 1,29,230 without writing the remainder.

During Tinu's mother's journey, 12 groups of 1,45,010 butterflies reached their homes. How many butterflies reached home?

$$1,45,010 \times 12 = \underline{\hspace{2cm}}$$

TL L TTh Th H T O

$$\begin{array}{r} 145010 \\ \times 12 \\ \hline \end{array}$$

We get different answers depending on how we approximate. We can use the approximate value as long as it is close to the actual value. The important thing is how reasonable the approximate answer is.

Find the solution to the given problems by rounding off the numbers to the highest place.

a. $1,00,001 \div 10$

L TTh Th H T O



b. $50000 \div 26$

TTh Th H T O



c. 69632×129

TTh Th H T O



x



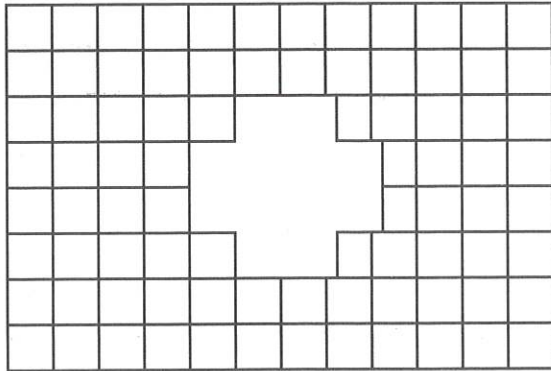


Find an approximate value for the problem and explain your working. One has been done for you.

4.8

Problem	How will you approximate each number?	Approximate value
$ \begin{array}{r} 4325672 \\ 1111111 \\ + 1000000 \\ \hline \end{array} $	<p>By adding 43,25,670, 10,00,000 and 1,00,000</p>	$ \begin{array}{r} 4325670 \\ 1000000 \\ + 1000000 \\ \hline 5425670 \end{array} $
$ \begin{array}{r} 9999099 \\ 9998000 \\ + 1000000 \\ \hline \end{array} $		
$ \begin{array}{r} 56005 \\ \times 55 \\ \hline \end{array} $		
$899566 \div 101$		

$$\begin{array}{r}
 9\ 9\ 9\ 9\ 9\ 9\ 9 \\
 -\ 8\ 9\ 9\ 9\ 9\ 8\ 9 \\
 \hline
 \end{array}$$



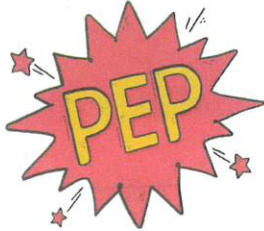
Area of the shape on the square grid



Now, I can:	✓/✗
• identify where to use approximation.	○
• solve problems using approximation.	○



How can I use approximation to check if my solutions are correct?



Ramu read this data in the newspaper.

4.9

ELECTION DATA FROM MIRPUR

Party A got 97,900 votes.

Party B got 69,135 votes.

Party C got 965 votes.

There were 100 polling booths.

Each polling booth got an equal number of voters.

Four officials were needed to monitor one polling booth.

He calculated some facts using this data. Write whether he used addition, subtraction, multiplication or division to find each fact.

Facts Ramu compiled	The operation he used
There were 400 officials monitoring the polling booths.	
Party A got 28,765 votes more than Party B.	
Totally, 1,68,000 votes were cast.	
Party A got 979 votes per polling booth.	

It is common for election data to have large numbers. Election statistics are always calculated accurately. Each vote counts and can make a huge difference in close victories.



LOOK AROUND

List two other places where you can find big numbers and operations involving them.



1. _____
2. _____

List two other places where results have to be calculated accurately.

1. _____
2. _____

Approximation is useful when verifying results. You can do quick checks to verify your answers.

Quick Tips

1. Addition and multiplication results are always higher than the numbers added or multiplied.



$$1,500 \times 25 = 37,500$$

37,500 is greater than both 1,500 and 25.

$97,916 + 69,135 + 949 = 16,800$ is wrong because

2. Subtraction and division results are always lesser than the number from which we subtract another number or the number to be divided.

$16,500 - 7,650$ has to be less than 16,500.

$16,500 \div 7,650$ will also be less than 16,500.

3. A small number subtracted from a large number gives a large number.

$10,00,000 - 73 = 19,927$ is wrong because 10,00,000 is very large when compared to 73. The answer should be very close to 10,00,000.

4. A large number subtracted from an equally large number gives a very small number.

$56,789 - 56,555 = 234$, which is a very small number when compared to 56,789 and 56,555.

Place a tick (✓) if the calculation is right and a cross (✗) if it is wrong. Write the reason for your choice. Try to answer these questions without doing the calculation.

4.11

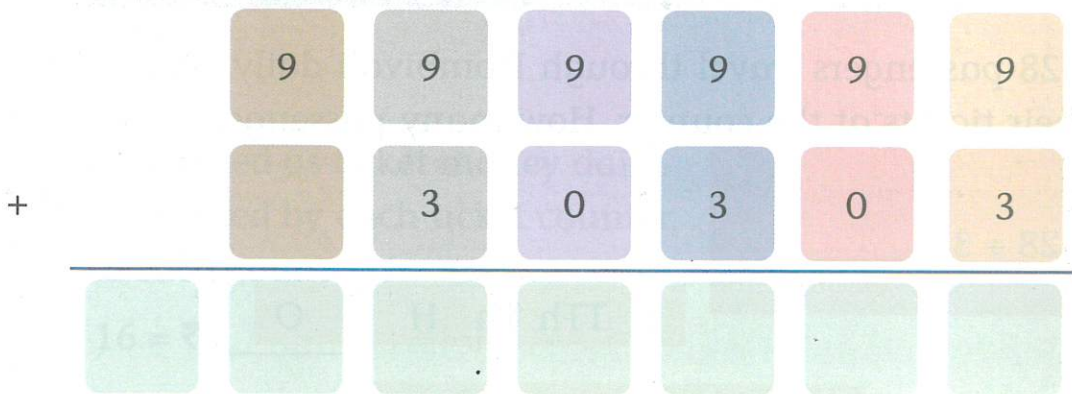
Calculation	✓/✗	Why?
$21,34,562 - 99 = 5,461$		
$34,567 \times 45,342 = 34,564$		
$6,25,011 \div 3 = 2,08,337$		
$9,99,999 + 30,303 = 1,00,002$		

A very important tool to verify a solution is to check the answer by approximation.

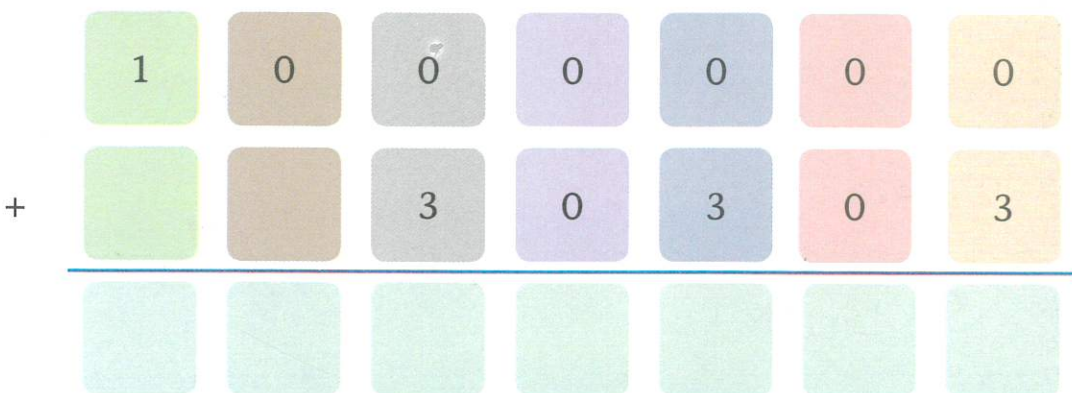
Let us look at $9,99,999 + 30,303 = 1,00,002$.

Is this right or wrong?

Why?



To check if $9,99,999 + 30,303 = 10,30,302$, round up $9,99,999$ to $10,00,000$.



Mr Wagrekar sells tickets at the Dombivali Station in Mumbai. Since his job involves a lot of money, he has to be very careful with his calculations.

4.12



2,33,428 passengers travel through Dombivali daily. One third of them buy their tickets at the counter. How many passengers buy tickets every day?

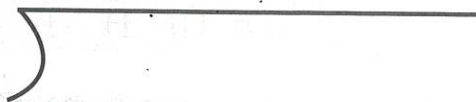
$$2,33,428 \div 3 = \underline{\hspace{2cm}}$$

L I Th. Th H T O

$$\begin{array}{r} 3 \overline{) 233428} \end{array}$$

Round off 2,33,428 to the nearest 10 to check the answer.

L TTh Th H T O



₹14,94,528 is collected as ticket money daily.
How much is collected by each ticket counter,
if there are 16 such counters.

$$16,00,000 \div 16 = 1,00,000$$

Would you say your answer is
near this?

$$14,94,528 \div 16 = ₹ \underline{\hspace{2cm}}$$

TL L TTh Th H T O

$$16 \overline{) 1494528}$$

Mr Wagrekar shares his counter with his friend, who works during the evening shift. Each of them handle about $93,408 \div 2 = ₹$ _____ per day.

L TTh Th H T O



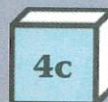
Last Monday, during Ganesh festival, the station was very busy. Each counter handled ₹1,50,479. What is the total amount handled by all 16 counters?

$$1,50,479 \times 16$$

	1	5	0	4	7	9	
×					1	6	
<hr/>							

Companion

Calculate these values and verify them using approximation.



You now know that approximation can be used as a way to check your answer.



Write three places where you will use this method for checking calculations.

1. _____

2. _____

3. _____



Some facts about a library are given. Read them and answer the following questions in the table. Make approximate calculations to check your solutions.

4.14

The Anna library has 9 floors and a capacity to store 11,57,912 books. At present, it has a collection of 5,50,000 books and is visited by 2,865 people every day.

	Solution	Approximate calculation
If each book is valued at ₹500, what is the total value of all the books in the library?		
If each floor had an equal number of books, how many books are in each floor?		

How many new books can be added based on its capacity?

A private library donated all the books from its collection to the Anna library. If 33,33,315 books were gifted by them, what is the total number of books in the Anna library now?

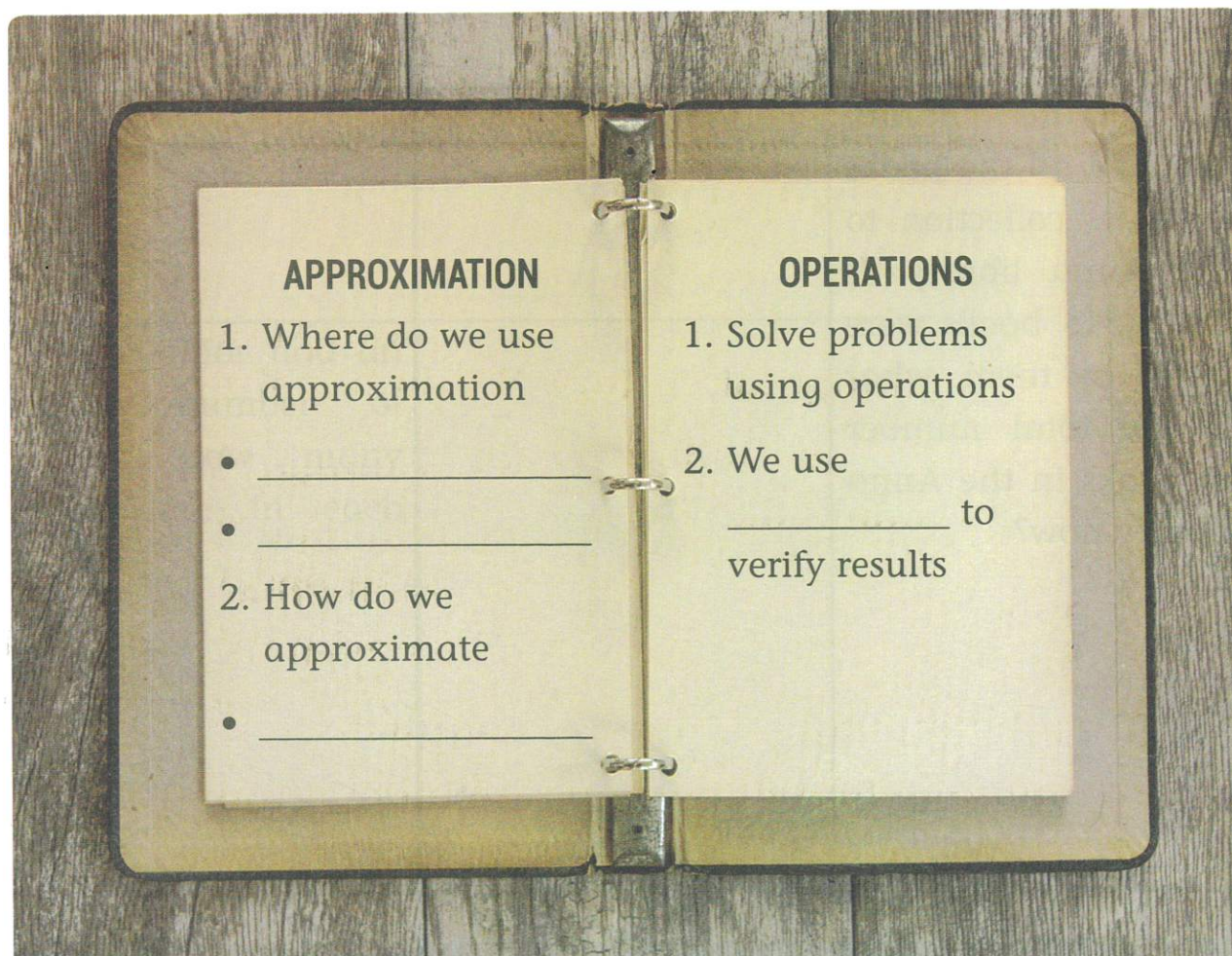
Now, I can:	✓/✗
• identify the operations needed to solve a problem.	<input checked="" type="checkbox"/>
• solve problems using arithmetic operations.	<input type="checkbox"/>
• verify solutions using approximation.	<input type="checkbox"/>

Companion (Project Time)

Make memory cards.

4d

Complete the concept map.



Question Time

1. Solve the problems and verify your solution using approximation.
 - a. Add 3,56,789 and 5,67,302
 - b. Subtract 4,98,230 from 8,34,003
 - c. Subtract 45,00,239 from 81,34,500
 - d. Add 6,00,000 and 49,65,111
 - e. Add 57,82,603 and 23,762
 - f. Subtract 9,63,004 from 10,45,884
 - g. Subtract 7,25,763 from 33,45,628
 - h. Add 6,00,163 and 56,34,734
2. 51 wooden chairs are being sent by a van to the shop (all the chairs are of equal mass). If the total mass of the chairs is 1,27,500 g, then what is the mass of each chair? Give your answer in kg and g.
3. A tea packet has a mass of 650 g. What is the mass of 225 such packets?

4. Multiply

a. $56,549$ by 34

b. $7,309$ by 368

c. $5,900$ by 724

d. $68,492$ by 98

5. Find the quotient and remainder. Divide

a. $56,34,476$ by 4

b. $46,93,000$ by 6

c. $34,835$ by 5

d. $73,009$ by 3

Factors and Multiples

Do numbers have common factors and multiples?

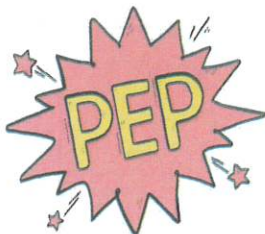
OVERVIEW

In this lesson, we will:

- apply tests for divisibility to check if a number is divisible by another number without actual division.
- learn about HCF and LCM.



Can we find whether a number is divisible by another number without actual division?

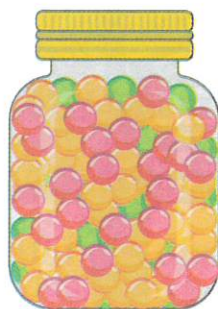


Malini has brought a big jar of candies for her class. There are 75 red candies, 24 green candies and 80 orange candies.



Help Malini decide if she can distribute each colour of candy equally among her classmates, if:

- a. Rita and Ram like green candies.
- b. Siya, Alina, Tom, Ali and Kavitha like red candies.
- c. The remaining ten children like orange candies.



Explain the steps you used to solve the problem.

Now, use divisibility rules to solve the problem. Explain how divisibility rules helped you solve it.

Tests for Divisibility by 3 and 9

Look at the jars at Gopi's sweets stall. The number of sweets in each jar is written on it.

Step 1: For each number, add the digits repeatedly to get a single-digit number, as shown in the *Figure 1*.

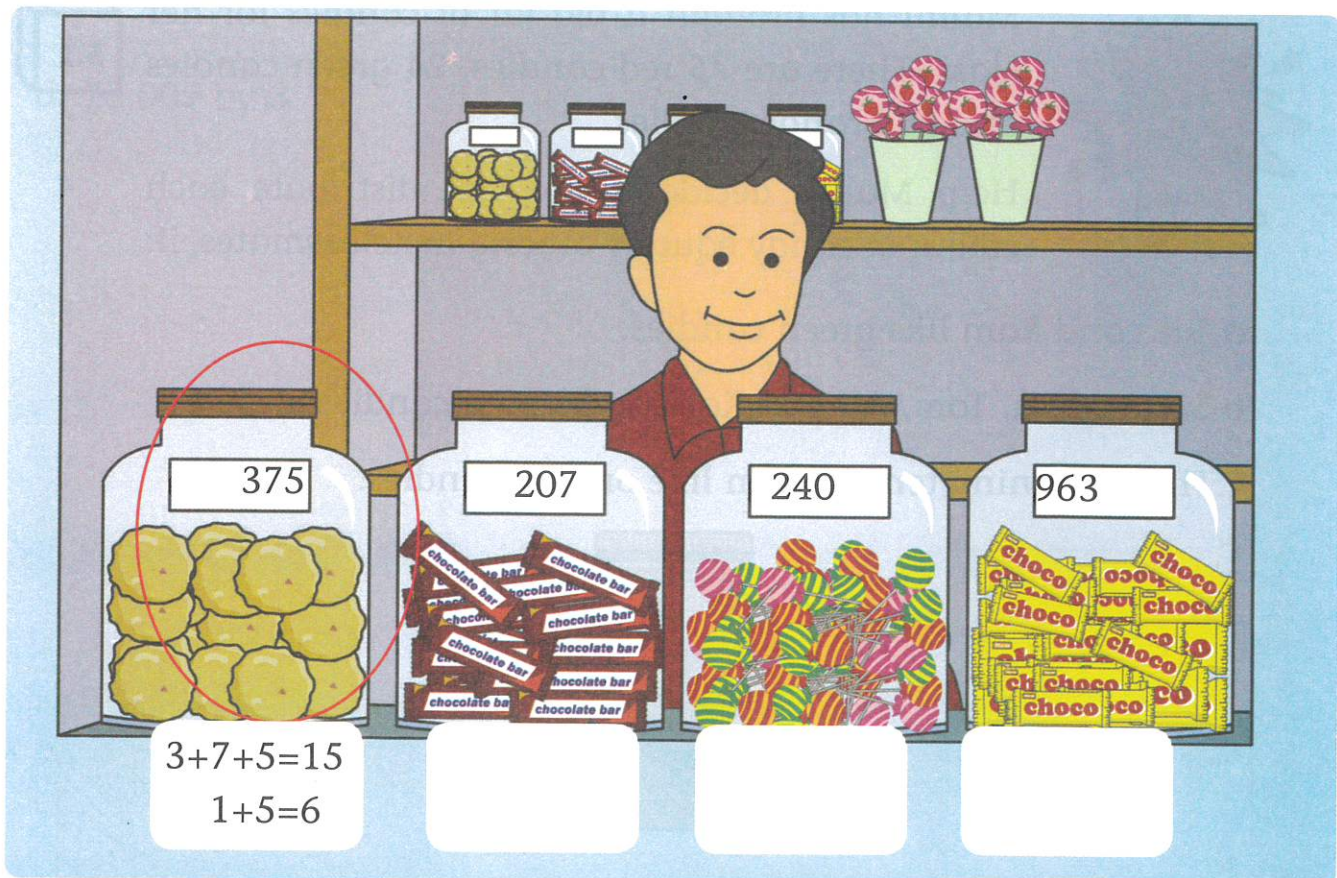


Figure 1 Gopi's sweets stall

Step 2: Circle the jars in red, if the total is divisible by 3, and in green, if the total is divisible by 9.

In *Figure 1*, the jar with the number 375 is circled in red because the total of its digits, 6, is divisible by 3.

A number is divisible by 3 if the total of its digits is divisible by 3.

A number is divisible by 9 if the total of its digits is divisible by 9.



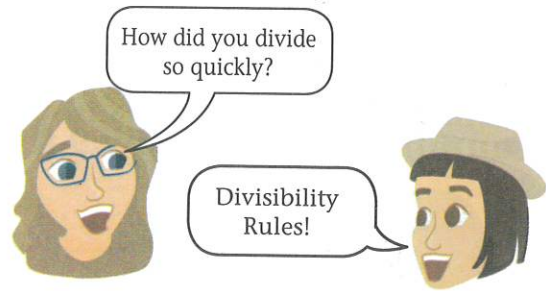
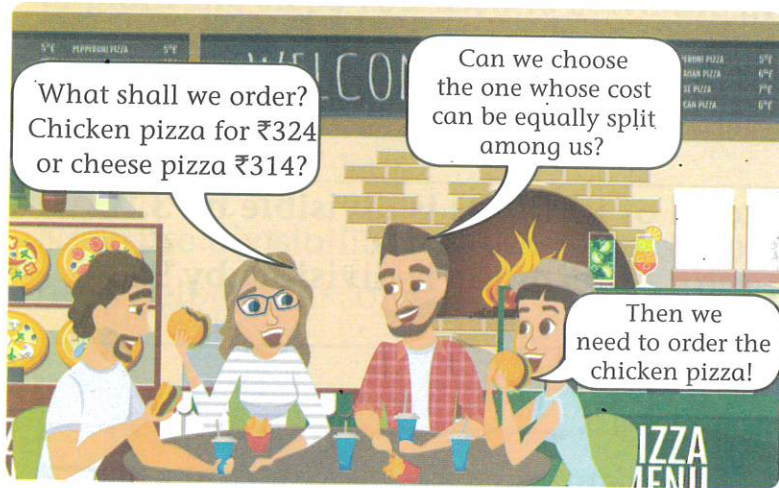
1. All numbers that are divisible by 9 are also divisible by 3. Explain this statement using the numbers given in *Figure 1*.



2. Numbers that are divisible by 3 need not be divisible by 9. Explain this statement using the numbers given in *Figure 1*.

9 is a multiple of 3, so numbers that are divisible by 9 are also divisible by 3. But numbers divisible by 3 need not be divisible by 9.

Test for Divisibility by 4



The number formed by the last two digits of 324 is 24, which is divisible by 4. So, 324 is divisible by 4.

Therefore, ₹324 can be split equally between the four friends.

The number formed by the last two digits of 314 is 14, which is not divisible by 4. So, 314 is not divisible by 4.

Therefore, ₹314 cannot be split equally between the four friends.

A number is divisible by 4 if the number formed by its last two digits is divisible by 4.

Place a tick (✓) if the number is divisible by 4. One has been done for you.

5.3

	Your working	Divisible by 4
4908	8 is divisible by 4. So, 4908 is divisible by 4.	✓
3628		
8091		
9636		
6747		

Divisibility tests help to find factors of large numbers easily.

Form a five-digit number for each of the given divisibility tests, using the number cards. Write your number in the table.

5.4



Divisible by 2	
Divisible by 3	
Divisible by 4	
Divisible by 5	
Divisible by 9	
Divisible by 10	

Companion

Check whether the given numbers are divisible by 3, 4 or 9.

5a

Practice Questions

Tick the correct answer.

- | | | |
|---|---|-------------------------|
| 1. I am divisible by 3. | 2. I am divisible by 9. | 3. I am divisible by 4. |
| a. 78,305 | a. 78,305 | a. 39,020 |
| b. 89,423 | <input checked="" type="checkbox"/> b. 12,330 | b. 12,330 |
| <input checked="" type="checkbox"/> c. 85,203 | c. 30,268 | c. 73,674 |
| d. 11,342 | d. 61,340 | d. 30,101 |

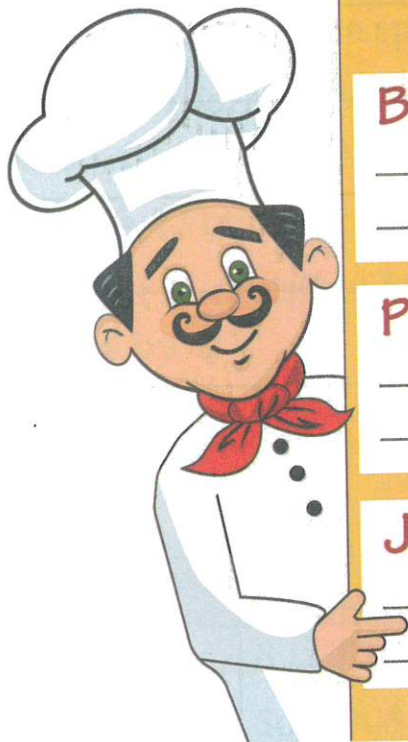
H.W.



Liu's Cafe specialises in burgers and pizzas. Help Liu design the cafe's menu. Be sure to follow his instructions.

5.5

- All dishes are priced below ₹200.
- The price of burgers should be divisible by 2 or 4.
- The price of pizzas should be divisible by 5 or 10.
- The price of fresh juices should be divisible by 3 or 9.



Liu's Cafe	
Burger 🍔	Price(₹)
_____	_____
_____	_____
Pizza 🍕	Price(₹)
_____	_____
_____	_____
Juices 🍹	Price(₹)
_____	_____
_____	_____

Now, I can:

✓/✗

- **apply** the tests for divisibility to check whether a number is divisible by 3, 4 or 9.





How can we solve problems using highest common factor?



The houses at Factor City are numbered in a strange way.



Recall that numbers that have only two factors, 1 and itself, are called prime numbers.

What can you say about the door numbers?

In *Pep* 5.6, the prime number pairs 3 and 5, 5 and 7, 11 and 13, 17 and 19 have just one number between them.

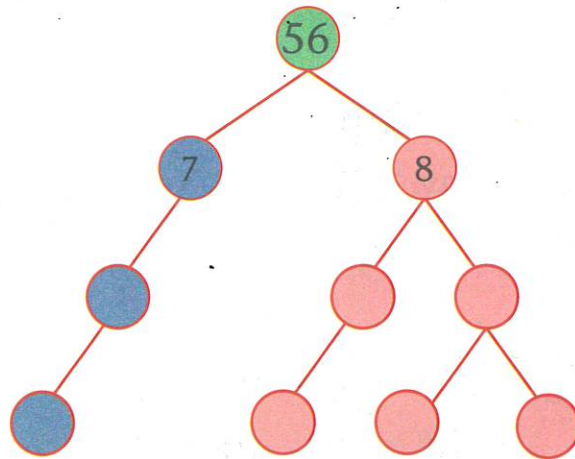
Two consecutive prime numbers having only one number between them are called **twin prime numbers**.

List all the twin primes from 1 to 50.

Prime Factorisation

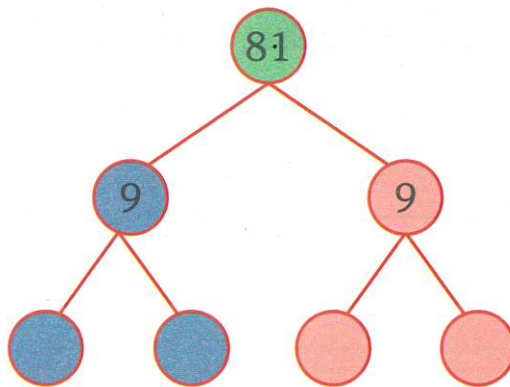
Complete the factor trees for the composite numbers 56 and 81.

Factor tree of 56



$$56 = \underline{\quad} \times \underline{\quad} \times \underline{\quad} \times \underline{\quad}$$

Factor tree of 81



$$81 = \underline{\quad} \times \underline{\quad} \times \underline{\quad} \times \underline{\quad}$$

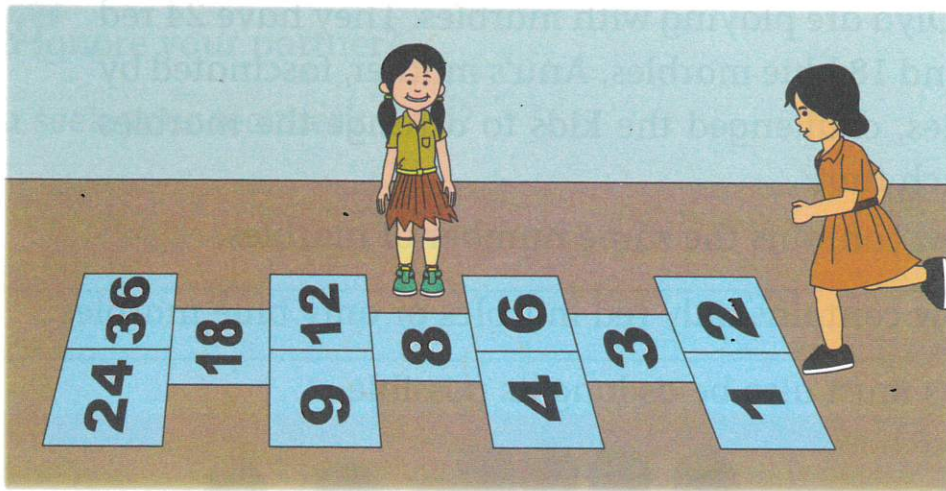
Figure 2 Factor trees of 56 and 81

In Figure 2, the numbers 56 and 81 are written as a product of its prime factors. Similarly, every composite number can be written as a product of its prime factors. This is called **prime factorisation**.

Diya and Anu are playing hopscotch. Diya has to hop on all the factors of 36 and Anu has to hop on all the factors of 24.

5.7

Look at the hopscotch grid and fill in the table.



Diya has to hop on the numbers:

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Anu has to hop on the numbers:

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Circle the numbers on which both Diya and Anu have to hop.

In Activity 5.7, the common factors of 24 and 36 are _____, _____ and _____.

A set of numbers can have two or more common factors.

Factors of 30 are - (1), 2, (3), (5), 6, 10, (15), 30

Factors of 45 are - (1), (3), (5), 9, (15), 45

The common factors of 30 and 45 are 1, 3, 5 and 15.

Of the four common factors, 15 is the greatest number.

So, 15 is the highest common factor or HCF of 30 and 45.

HCF helps to find the greatest common number that divides two or more numbers equally.

Hands-on

Anu and Diya are playing with marbles. They have 24 red marbles and 18 blue marbles. Anu's mother, fascinated by the marbles, challenged the kids to arrange the marbles in rows such that:



1. each row contains the same number of marbles.
2. each row contains only red marbles or only blue marbles.
3. the rows must also be as long as possible.



With your partner, help Anu and Diya arrange the marbles. How many marbles will be there in each row? Draw your arrangement in the space provided.

Did both of you use the same method to solve the problem?

In case of conflict:

1. Did you talk to your partner about how you felt?
2. Did you ignore your partner?
3. Did you seek your teacher's help?
4. Others



The longest possible row the marbles can be arranged is the HCF of the numbers 24 and 18. So, _____ is the HCF of the numbers 24 and 18.

Finding HCF using Listing Method

It is Diya's birthday party and her mother is arranging chairs for the guests. There are 48 blue chairs and 32 red chairs. The chairs have to be arranged such that there are equal number of chairs in each row. Also, each row should have only red chairs or only blue chairs. What is the greatest number of chairs that can be arranged in each row?



Step 1: List all the factors of each number.

Factors of 48 _____

Factors of 32 _____

Step 2: Circle the greatest factor that is common to both the numbers and write it.

In order to find the greatest number of chairs that can be arranged in equal rows, we find the HCF of the two numbers.

The common factors of 48 and 32 are _____, _____, _____ and _____.

So, _____ is the HCF of the numbers 48 and 32.

The greatest number of chairs that can be arranged in each row is _____.

One method of finding the HCF is by listing the factors of the numbers and finding the highest factor among all the common factors.



LOOK DEEP

In *Activity 5.9*, how many rows of blue chairs and how many rows of red chairs are possible?

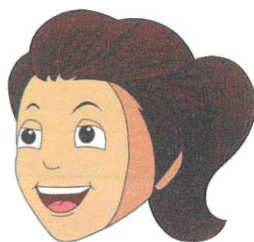
5.10

Explain your answer.

Finding HCF using Short Division Method

Diya's mother baked 48 chocolate cupcakes and 32 vanilla cupcakes. She has requested Diya to help her arrange the food on the plates such that each plate has equal number of chocolate and equal number of vanilla cupcakes. What is the maximum number of plates that can be arranged in this way? What should Diya do to find this out?

Diya arrange the snack plates! Remember that each plate should have the same number of cupcakes of each flavour.



I know what to do! I will use HCF!



Let us find the HCF of 48 and 32 using short division method.

$$\begin{array}{r|l} 2 & 48, 32 \\ \hline & 24, 16 \end{array}$$

With the help of divisibility tests, we know that 2 is one of the common factors of 48 and 32. When we divide 48 and 32 by 2, we get 24 and 16 respectively.

$$\begin{array}{r|l} 2 & 24, 16 \\ \hline & 12, 8 \end{array}$$

2 is one of the common factors of 24 and 16. When we divide 24 and 16 by 2, we get 12 and 8 respectively.

$$\begin{array}{r|l} 2 & 12, 8 \\ \hline & 6, 4 \end{array}$$

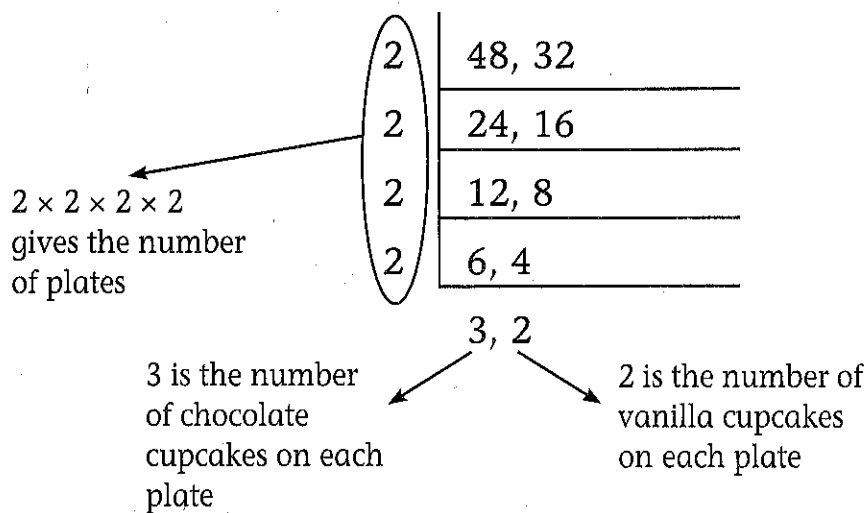
2 is one of the common factors of 12 and 8. When we divide 12 and 8 by 2, we get 6 and 4 respectively.

$$\begin{array}{r|l} 2 & 6, 4 \\ \hline & 3, 2 \end{array}$$

2 is one of the common factors of 6 and 4. When we divide 6 and 4 by 2, we get 3 and 2 respectively.

Since 3 and 2 have no common factors, we cannot divide them any further.

We can rewrite the steps as follows.



HCF of 48 and 32 is $2 \times 2 \times 2 \times 2 = 16$

Diya can arrange a maximum of 16 plates, each having equal number of chocolate and equal number of vanilla cupcakes.



A few multiples of the numbers 14 and 18 are given. Prime factorize them. A few have been done for you.



Multiples of 14	Multiples of 18
$14 - 2 \times 7$	$18 - 2 \times 3 \times 3$
$28 - 2 \times 2 \times 7$	$36 - 2 \times 2 \times 3 \times 3$
42	54
56	72
70	90
84	108
What will be the HCF of 42 and 56? _____	What will be the HCF of 18 and 36? _____
What will be the HCF of 70 and 84? _____	What will be the HCF of 90 and 108? _____

Observe the pattern in the HCF of these consecutive multiples. Discuss with your partner.

Finding HCF using Prime Factorisation Without using a Factor Tree

Diya has a red ribbon that is 560 cm long and a blue ribbon that is 770 cm long. She wants to divide both the ribbons into strips of same length and of the longest possible length. What should she do to find this out?

To divide two quantities into equal groups of the same and greatest possible size, we have to calculate the HCF of the two numbers.

The common factors of 560 and 770 would give the common length into which the ribbons can be divided equally. So, finding the _____ would give the longest common length of the strips.

Let us see how we can do prime factorisation of 560 and 770 without using a factor tree.

$$\begin{aligned} 560 &= 56 \times 10 \\ &= 7 \times 8 \times 10 \\ &= (7) \times (2) \times 2 \times 2 \times 2 \times (5) \end{aligned}$$

$$\begin{aligned} 770 &= 77 \times 10 \\ &= (7) \times 11 \times (2) \times (5) \end{aligned}$$

The common factors of 560 and 770 are _____, _____ and _____.

The HCF of 560 and 770 is the product of its common factors.

$$7 \times 2 \times 5 = 70$$

So, Diya has to cut both the ribbons into strips of 70 cm each.

Companion

Find the HCF of the given numbers using the specified method.



Complete *Figure 3* with the factors of 4 and 15.

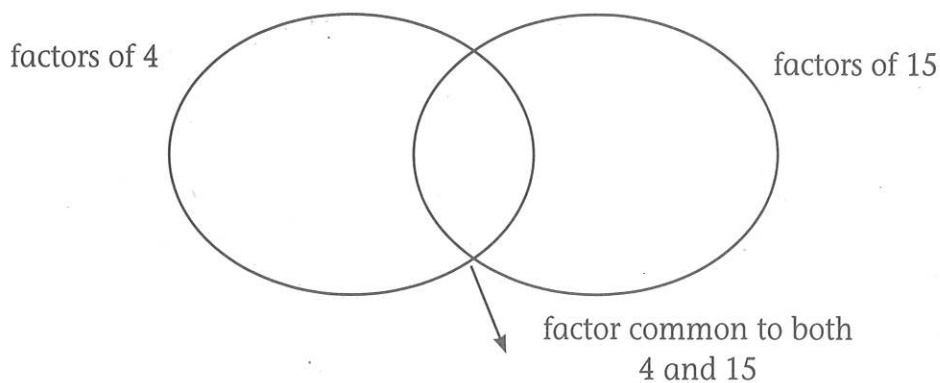


Figure 3 *Factors of 4 and 15*

The numbers 4 and 15 have _____ (one/many) factors in common.

We can see that 1 is the only common factor for the numbers 4 and 15. Such numbers are called **co-prime numbers**.

Find the common factors for the following numbers.

Factors of 8 _____

Factors of 12 _____

Circle the common factors of 8 and 12.

Do they have more than one common factor?

Yes No

Are 8 and 12 co-prime?

Yes No

List the factors of 14 and 25.

Factors of 14 _____

Factors of 25 _____

Are 14 and 25 co-prime?

Yes No



Give two examples of co-prime numbers.

5.13

Find the HCF of the numbers in each pair.

What can you say about their HCF?

Companion

Find pairs of co-primes from the numbers in the grid.



We multiply factors to get a multiple.

What are the different factors that contribute to a greener planet?



Select one factor and create a poster, here.

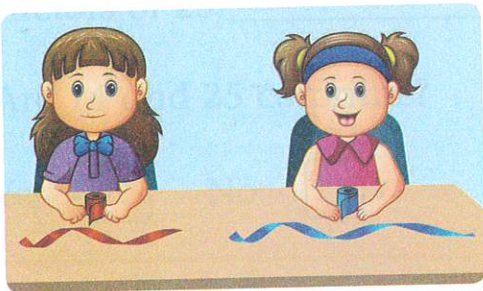
Practice Questions

1. Find the HCF of the following number pairs using the listing method.
 - a. 55, 25
 - b. 64, 96
2. Find the HCF of the following number pairs using the short division method.
 - a. 7, 21
 - b. 38, 57
3. Diya's mother has ordered a cake. The cake is 65 cm long and 25 cm wide. What will be the length of the side of the square-shaped pieces of the largest possible size?



Diya and Anu have 2 rolls of streamers for decorating a birthday hall. One roll is 150 metres long and the other roll is 200 metres long. If they want to cut the rolls to make strips of equal length, what will be the longest length of each streamer?

5.15



Now, I can:	✓/✗
• find the highest common factor for a pair of numbers.	<input type="radio"/>
• find pairs of co-prime numbers	<input type="radio"/>
• solve real life problems using HCF.	<input type="radio"/>

I am a common factor of 60 and 100.

I am divisible by 4.

Who am I?

I am an even number greater than 4.

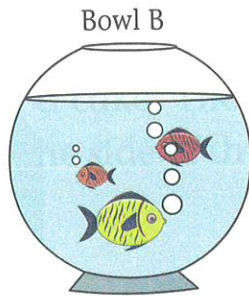
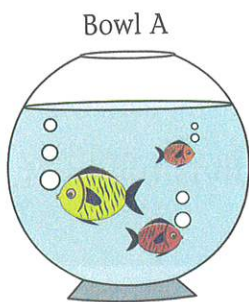


How can we solve problems using least common multiple?



Kumar bought two fish bowls on November 30. He has to change the water in Bowl A every sixth day and Bowl B every fourth day. On the calendar given, circle the dates on which he has to change the water in Bowl A, in red, and Bowl B, in blue.

Two have been done for you.



Dates for Bowl A _____

Dates for Bowl B _____

What are the common dates on which he has to change the water in both the bowls?

In *Pep 5.16*, look at the dates that you circled.

- The dates for Bowl A are multiples of 6.
- The dates for Bowl B are multiples of 4.

The common dates for Bowl A and Bowl B are the **common multiples** of 4 and 6.

Which is the earliest date on which Kumar would change the water in both the bowls? _____

The earliest date gives the **least common multiple** or **LCM** of 4 and 6.

The LCM of 4 and 6 is 12.

Hands-on

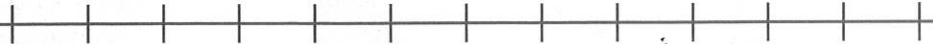


With the help of your teacher, jump on lines to find the LCM of two numbers.

Step 1: Draw two lines on the ground and mark them at equal distance, as shown.



Start



Start



Step 2: Choose two numbers between 1 and 5, one for you and one for your partner.

Step 3: Jump on the multiples of your number.

For example, let us say that your number is 2 and your partner's number is 3. You jump in multiples of 2 on your line and your partner jumps in multiples of 3 on his/her line.

Step 4: Repeat jumping in the same manner until both of you are at the same point. Note down the number where you meet. In this example, both of you will meet at number 6.

My number _____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----

My partner's number _____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----

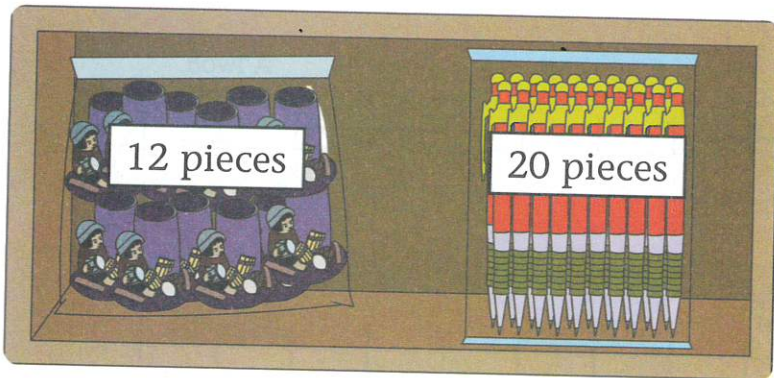
Colour the numbers where you meet.

The smallest number that you have coloured is the LCM of the two numbers.

Finding LCM using Listing Method

A stationery shop sells pens in packets of 20 and pen stands in packets of 12. What is the least number of pens and pen stands Farzana should buy so that there will be one pen stand for each pen?

5.18



To find a quantity/occurrence which is the lowest common multiple of different quantities/occurrences, we find the LCM of the numbers.

Having one pen stand for each pen means Farzana should buy _____ (same/different) number of pens and pen stands.

The pens come in packets of 20, so buying more packets means buying in multiples of 20.

The pen stands come in packets of 12, so buying more packets means buying in multiples of _____.

We can get the least number of pens and pen stands that Farzana should buy by finding the LCM of 20 and 12.

Step 1: List the first ten multiples of each number.

Multiples of 12 _____

Multiples of 20 _____

Step 2: Circle the smallest multiples that is common to both the numbers and write it.

The common multiples of 12 and 20 are _____ and _____.

The least number of pens and pen stands packets that Farzana should buy is _____.

So, _____ is the LCM of the numbers 12 and 20.

One method of finding the LCM is by listing the multiples of the numbers and finding the smallest multiple among all the common multiples.

Finding LCM using Short Division Method

Let us find the LCM of 8 and 10 using the short division method.

$$\begin{array}{r|l} 2 & 8, 10 \\ \hline & 4, 5 \end{array}$$

With the help of divisibility tests, we know that 2 is one of the common factors of 8 and 10. When we divide 8 and 10 by 2, we get 4 and 5 respectively.

$$\begin{array}{r|l} 2 & \textcircled{4}, 5 \\ \hline & 2, 5 \end{array}$$

Since 4 and 5 have no common factors, we further divide 4 and retain 5.

$$\begin{array}{r|l} 2 & \textcircled{2}, 5 \\ \hline & 1, 5 \end{array}$$

Repeat the above step to reduce the number to 1.

$$\begin{array}{r|l} 5 & 1, \textcircled{5} \\ \hline & 1, 1 \end{array}$$

Next, divide 5 until it is reduced to 1. To find the LCM, we have to repeat the steps until the numbers are reduced to 1.

We can rewrite the steps as follows.

$$\begin{array}{r|l} 2 & 8, 10 \\ \hline 2 & 4, 5 \\ \hline 2 & 2, 5 \\ \hline 5 & 1, 5 \\ \hline & 1, 1 \end{array}$$

The LCM of 8 and 10 is $2 \times 2 \times 2 \times 5 = 40$.

Finding LCM using Prime Factorisation Without using Factor Tree

Let us write 21 and 14 as a product of their prime factors.

$$21 = 3 \times 7$$

$$14 = 2 \times 7$$

The common factor is _____.

The uncommon factors are _____ and _____.

The LCM is the product of common and uncommon prime factors of the numbers.

$7 \times 3 \times 2 =$ _____, which is the least common multiple of the numbers.

Diya and Anu attend the same music class, but they go on different days. Anu goes once every 3 days and Diya goes once every 4 days. Answer the following questions.

5.19

- a. If they start attending their class on the same day, after how many days will both Diya and Anu meet at the music class once again?

We use LCM to find when two events (both happening at regular intervals) that happen together, will happen once again at the same time.

- b. If they start attending their class from December 31, write the exact date on which they will meet again at class.

December						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

January						
SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



How many methods did you learn to find the LCM of numbers? List them.

5.20

According to you, which one of these methods is the easiest? Why?



Find the HCF and LCM of 8 and 14. Complete the table.

5.21

Product of 8 and 14	HCF of 8 and 14	LCM of 8 and 14	Product of their HCF and LCM

Can we say that the product of the two numbers is the same as the product of their HCF and LCM? Justify your answer using examples.

Take two more numbers and repeat the above steps to see if you get the same result.

From the above examples we can say:

Product of two numbers = Product of their HCF and LCM

Companion

Find the LCM of the given numbers.

5d

Practice Questions

1. Find the lowest possible number which is exactly divisible by both 12 and 16.
2. Find the LCM for the following numbers.
 - a. 20, 50
 - b. 45, 12
 - c. 62, 94
 - d. 28, 49

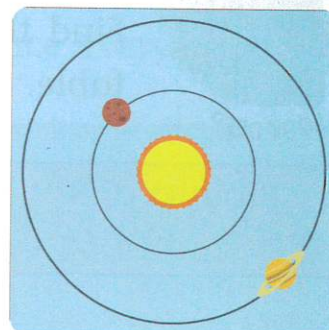


Every planet in the solar system orbits the Sun and returns to the same position after a period of time.

5.22

The scientists at ISRO have discovered two new planets — Planet X and Planet Y. Planet X takes 12 years to orbit the Sun and Planet Y takes 24 years to orbit the Sun.

Find the number of years it would take both the planets to meet at the same point once again?



Now, I can:

✓/✗

- **find** the least common multiple for a pair of numbers.
- **solve** real life problems using LCM.

Companion (Project Time)

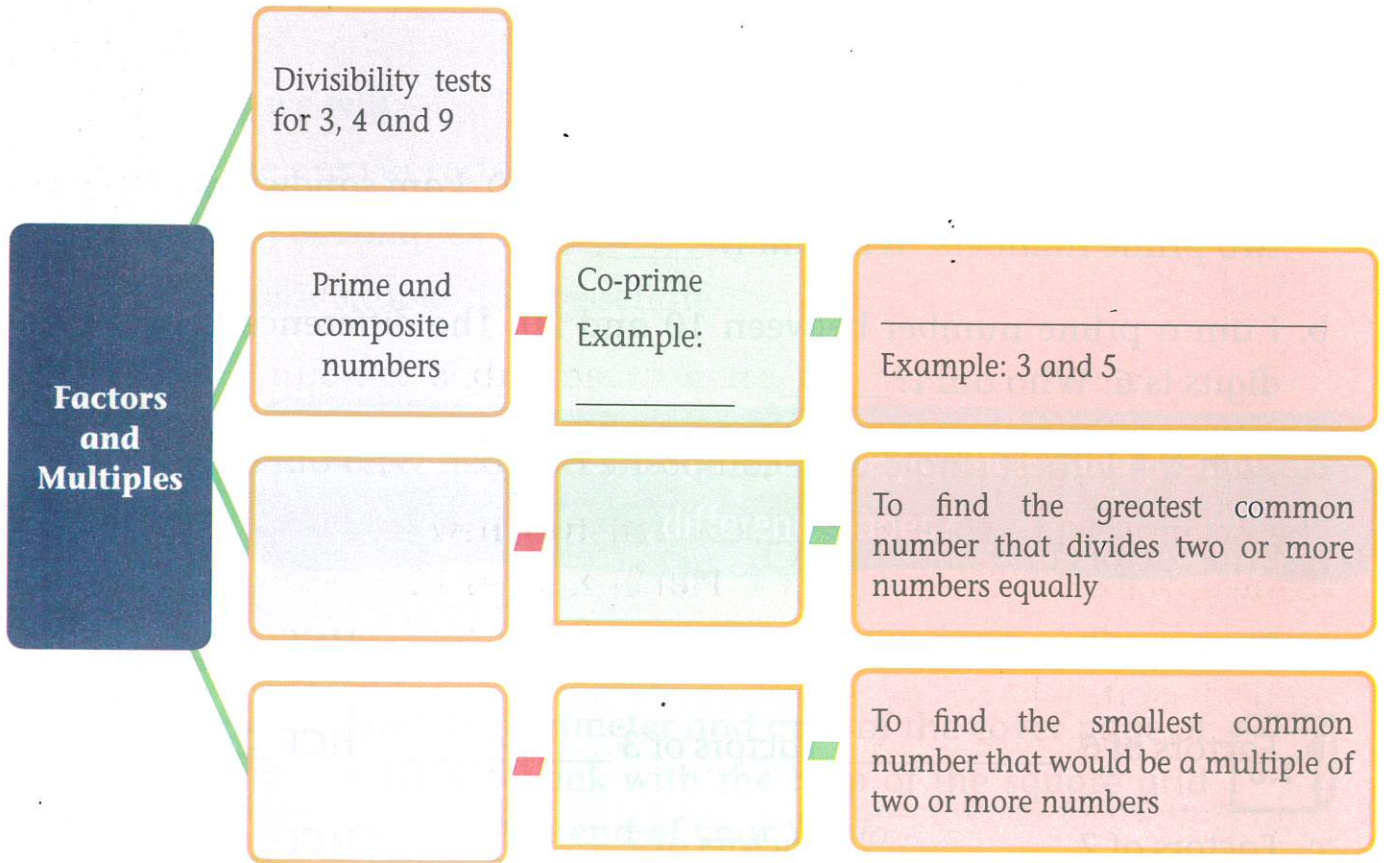
Write your own story on HCF and LCM.

5e

Journal

Reflect on your performance in this lesson.

Complete the concept map.



Glossary

Prime factorisation

Writing a composite number as a product of its prime factors

HCF

The greatest common factor that divides two or more numbers equally

LCM

The smallest number that is a multiple of two or more numbers

Question Time

1. Write whether the following are true or false.

- 1, 2, 8 and 16 are the only factors of 16.
- 1 is a factor of all numbers.
- 56 is a multiple of both 7 and 8.
- 9 is a factor of both 45 and 80.

2. Who am I?

- I am a composite number between 40 and 50. I am sandwiched between two prime numbers. Who am I? _____
- I am a prime number between 10 and 20. The difference between my digits is 6. Who am I? _____
- I am the largest single-digit composite number. Who am I? _____

3. List the factors and find the HCF.

- Factors of 2 _____ Factors of 4 _____ HCF _____
- Factors of 6 _____ Factors of 3 _____ HCF _____
- Factors of 2 _____ Factors of 7 _____ HCF _____
- Factors of 12 _____ Factors of 15 _____ HCF _____

4. Solve the following word problems.

- Levi found gift bags in packs of 5 and chocolates in packs of 6. If Levi wanted to have the same number of gift bags and chocolates, what is the smallest number of gift bags and chocolates she would have to buy?
- Two neon lights are turned on at the same time. Both lights blink when they are turned on. One light blinks every 25 seconds and the other light blinks every 35 seconds. In how many seconds will they blink together again?

Area and Perimeter

How can we fill an area by repeating shapes of smaller area?

OVERVIEW

In this lesson, we will:

- calculate the area of rectangles and squares.
- find the area of complex shapes.
- create irregular shapes that tessellate.

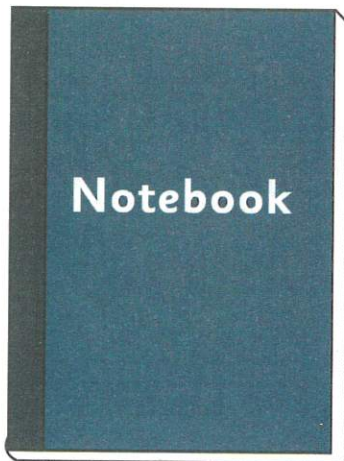


Is there an easy way to find the perimeter and area of different shapes?



Find the perimeter and area of the cover page of your notebook with the help of the square grid given at the end of your *Studio*.

6.1



The perimeter of your notebook is _____.

The area of your notebook is _____.

The total length of the boundary of a shape is called its **perimeter**.

The region occupied by a shape is called its **area**.

Let us find the formula to calculate the perimeter of any rectangle. *Figure 1* shows a rectangle with its lengths and breadths marked.

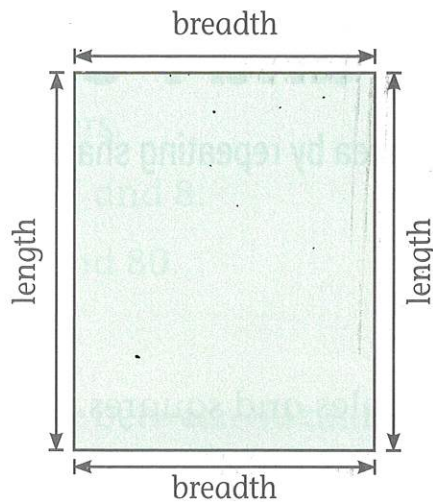


Figure 1 *Perimeter of a rectangle*

We know that the boundary of a closed shape gives its perimeter.

So, the perimeter of a rectangle = _____ + _____ + _____ + _____.

In other words, the perimeter of a rectangle = ____ × length + ____ × breadth.

The perimeter of any rectangle can be found by adding twice its length to twice its breadth.

Perimeter of rectangle = $2 \times \text{length} + 2 \times \text{breadth}$

1. Measure the length and breadth of your notebook. Find its perimeter using the formula.



Length = _____ cm

Breadth = _____ cm

Perimeter = $2 \times \text{length} + 2 \times \text{breadth}$

= $2 \times$ _____ + $2 \times$ _____

= _____ + _____

Perimeter of the notebook = _____ cm

2. Amitha is making a 'Happy Diwali' greeting card for her grandma. She cuts a rectangular sheet of 10 cm length and 8 cm breadth. She wants to decorate it with shiny red ribbon on all four sides of the card. What is the total length of ribbon she will need?



Length = _____ cm Breadth = _____ cm

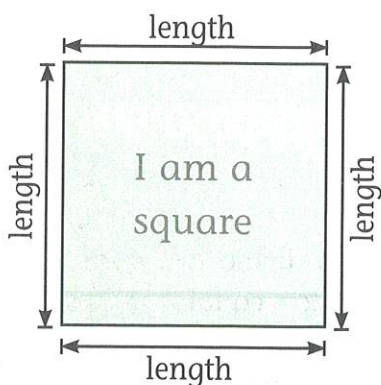
$$\begin{aligned}
 \text{Perimeter} &= 2 \times \text{length} + 2 \times \text{breadth} \\
 &= 2 \times \underline{\hspace{2cm}} + 2 \times \underline{\hspace{2cm}} \\
 &= \underline{\hspace{2cm}} + \underline{\hspace{2cm}} \\
 &= \underline{\hspace{2cm}} \text{ cm}
 \end{aligned}$$

Length of ribbon to be cut = _____ cm



Let us find the formula to calculate the perimeter of any square.

6.3



What can you say about the sides of a square?

So, the perimeter of a square is

_____ + _____ + _____ + _____.

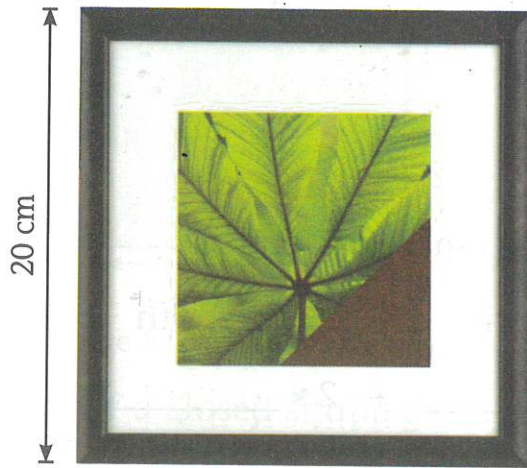
On simplifying we get, the perimeter of a square = _____ × _____.

The perimeter of a square can be found by multiplying its length by 4.

Perimeter of a square = $4 \times \text{length}$

Gouri wants to buy wood to put a frame around her photograph. Each side of her photo is 20 cm. What is the length of wood frame she should buy?

6.4



Total length of frame needed to go around the picture

Companion

Find the distance Sheila's grandmother runs every day.

6a

The line shown in *Figure 2* is 1 cm long. Draw three more lines to make it a square.



Figure 2 A square of length 1 cm

The square you have drawn has a length of 1 cm. It occupies a certain area on your *Studio*. Let us call this area **1 square centimetre**, often written as **1 sq cm**.

Figure 3 shows a rectangle formed by combining two squares of 1 cm length. The area of this rectangle will be _____ square centimetres.

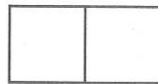


Figure 3 Rectangle formed by two squares

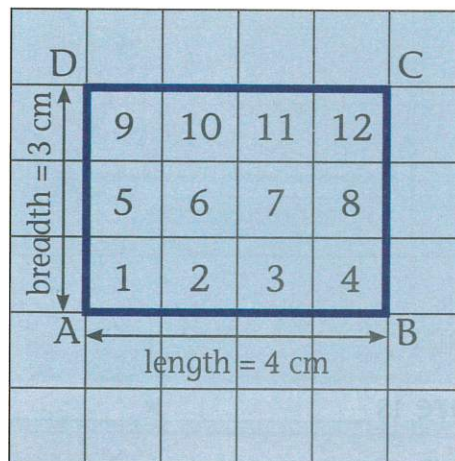
If we cut a square of 1 cm into half, the new shape will have half the area of your square. It will be half a square centimetre.



The area of any shape whose sides are in centimetre is measured in square centimetre.

How did you find the area of your notebook in *Pep 6.1*? _____

Let us find the area of the rectangle ABCD by counting squares.



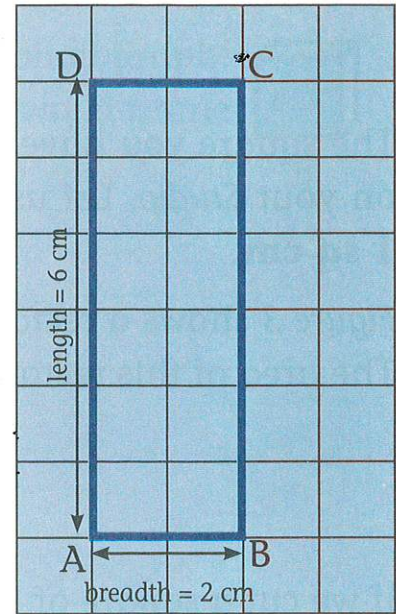
This rectangle has 12 squares, each of length 1 cm inside it. Its area is _____ sq cm.

These 12 squares are arranged in four groups of three squares. Thus, there are $4 \times 3 = 12$ squares. The area is _____ sq cm.

A rectangle of 6 cm length and 2 cm breadth will have _____ \times _____ = _____ squares.

The area of this rectangle is _____ sq cm.

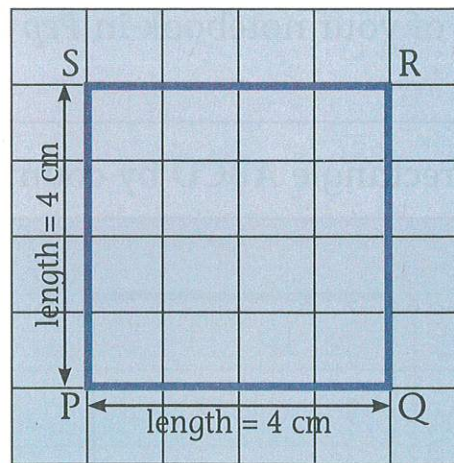
The squares are arranged in six groups of two.



The area of any rectangle is its length multiplied by its breadth.

Area of a rectangle = length \times breadth

Look at the square PQRS. For a square, the breadth should be equal to its length.



There are four groups of four.

Thus, the area of this square is _____ \times _____ = _____ sq cm.

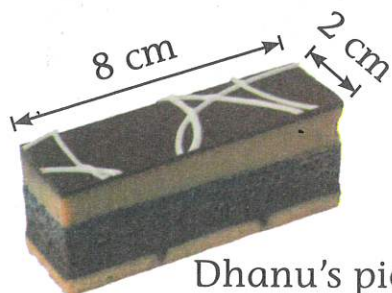
The area of any square is its length multiplied by its length.

Area of square = length \times length

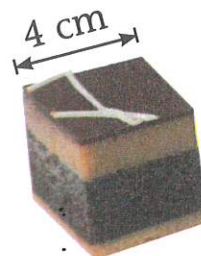
Dhanu and Manu wanted to eat the cake their mom baked. Dhanu cut two pieces of cake, one for each of them, as shown in *Figure 4*. Did Dhanu and Manu get equal shares?

6.5

If the areas of the rectangle and square are equal, then Dhanu and Manu will get an equal share of the cake.



Dhanu's piece



Manu's piece

Figure 4 Pieces cut by Dhanu

Companion

Find the perimeter and area of the design Lakshmi made.

6b

Companion

Find the area of the cloth required by Vinay.

6c

Companion

Calculate the area saved by the foldable chessboard.

6d

We have seen that different objects occupy different areas.

Some things are huge



and some things are small



We measure small objects in small units and big objects in big units. Big shapes may occupy thousands of square centimetres of area. So, to make it easier, we measure their sides in metres or kilometres and their areas in square metres or square kilometres.

Observe the table in *Figure 5*. Can you say whether the area of the given things should be in **square centimetre** (sq cm), **square metre** (sq m) or **square kilometre** (sq km)?



	Area of	Measured in
1	Sudoku grid in a newspaper	
2	Tiger's paw	
3	India	
4	Kitchen countertop	
5	Playground	
6	Cricket stadium	

Figure 5 *Unit of area*

India cannot be measured in sq cm because _____

A Sudoku grid cannot be in sq km because _____



Imagine that you have a small patch of land 50 m in length and 30 m in breadth. How would you like your garden to look? Use the rectangle in *Figure 6* to show zones for trees, plants and a pond. Write the sizes of each zone and calculate their area and perimeter.

A sample plan for a garden has been provided.

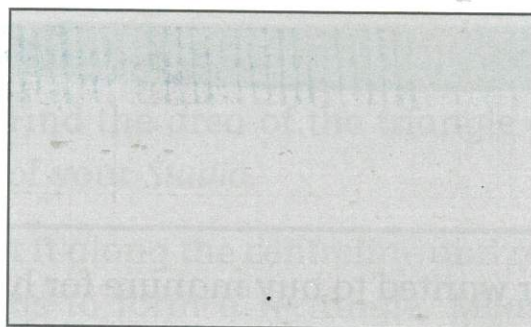
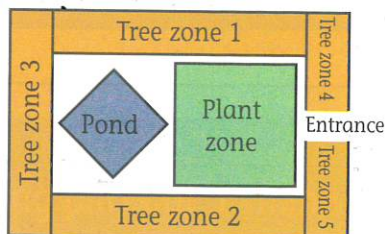


Figure 6 *Your garden plan*

Zone	Size	Area

Which is the biggest zone in your garden design? Which is the smallest?

How do you feel when you are in a garden?

How did you decide the size of each zone?



THINK AND INK

Tony's father wanted to buy manure for his new square shaped vegetable garden. He also needed to buy wire to fence the garden. Tony measured the side of the garden and found that it was 5 m.

6.8

1. What length of fencing wire does Tony need?
2. What area should the manure cover?



Now, I can:

✓/✗

- **derive** the formula for the perimeter and area of a rectangle and a square.
- **calculate** the perimeter of rectangles and squares.
- **calculate** the area of rectangles and squares.



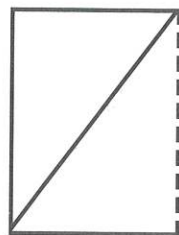
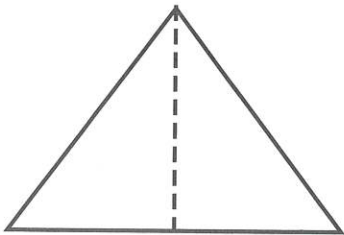
Can rearranging parts of a shape make finding its area easier?



1. Find the area of the triangle given at the end of your *Studio*.



Cut it along the centreline and rearrange the two parts to form a rectangle. Measure the sides of the rectangle and find its area.



Length of the rectangle = _____

Breadth of the rectangle = _____

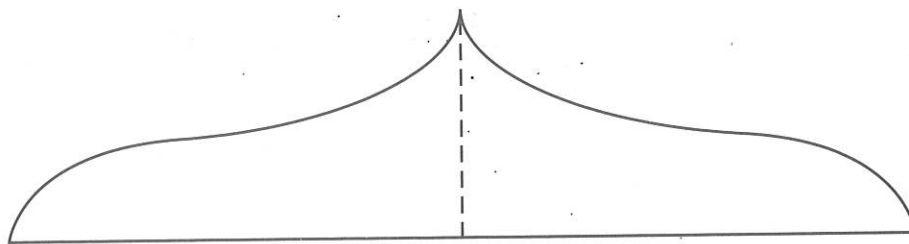
Area of the rectangle = _____

The area of this rectangle will be:

- More than the area of the big triangle
- Equal to the area of the big triangle
- Less than the area of the big triangle

Thus, the area of the triangle = _____ sq cm.

2. Find the area of this shape, also given at the end of your *Studio*, by rearranging its parts to form a rectangle.



In *Pep 6.9*, we cut a shape into pieces and moved the pieces around to form a rectangle. The area of the shape and the rectangle are equal because:

- All the parts were used to create the rectangle
- The pieces were not placed on top of each other

Use the triangle to form the shape in *Figure 7*. Measure the area of this shape with the square grid.

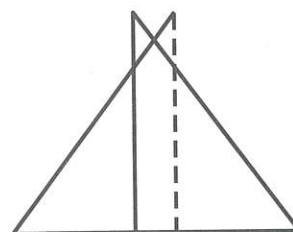
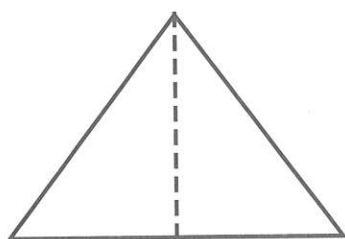
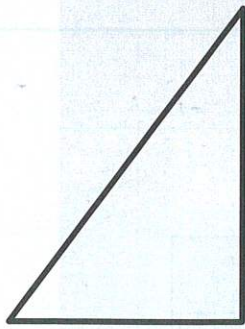


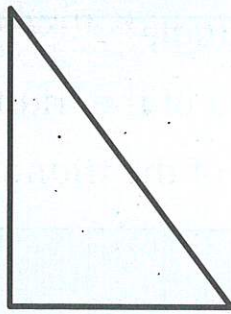
Figure 7 Overlapping parts

The shapes in *Figure 7* do not have the same area because _____

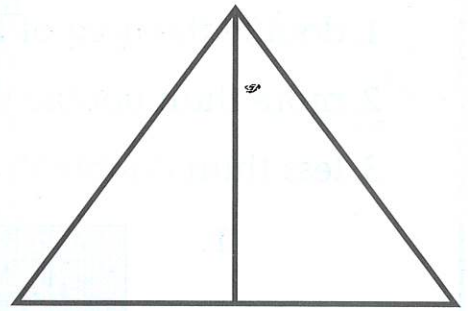
Let us say that we join two shapes to make a new shape, without overlaps.



Shape 1.



Shape 2

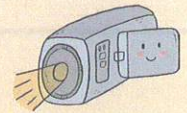


Shape 3

The area of the Shape 3 = area of Shape 1 + area of Shape 2.

Audio-Visual

Watch an audio-visual on rearranging shapes to find area.



Hands-on

The triangle in *Figure 8* has been extended to form a quadrilateral. We did this by joining another triangle to it.

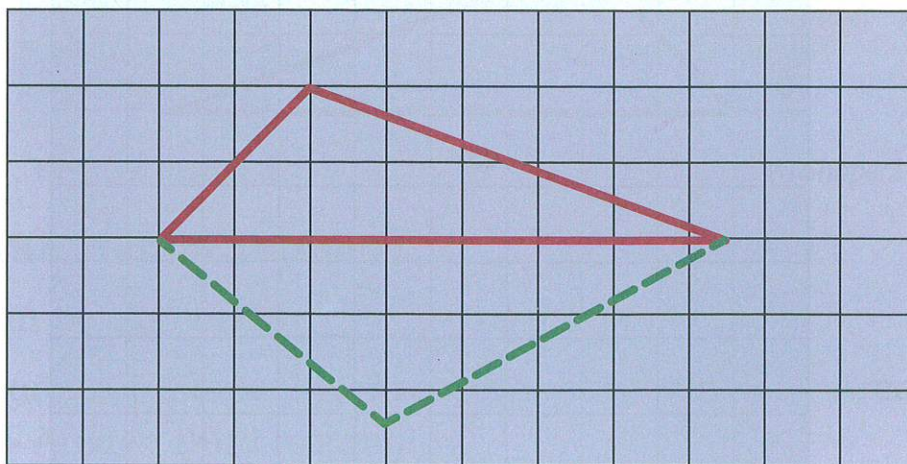
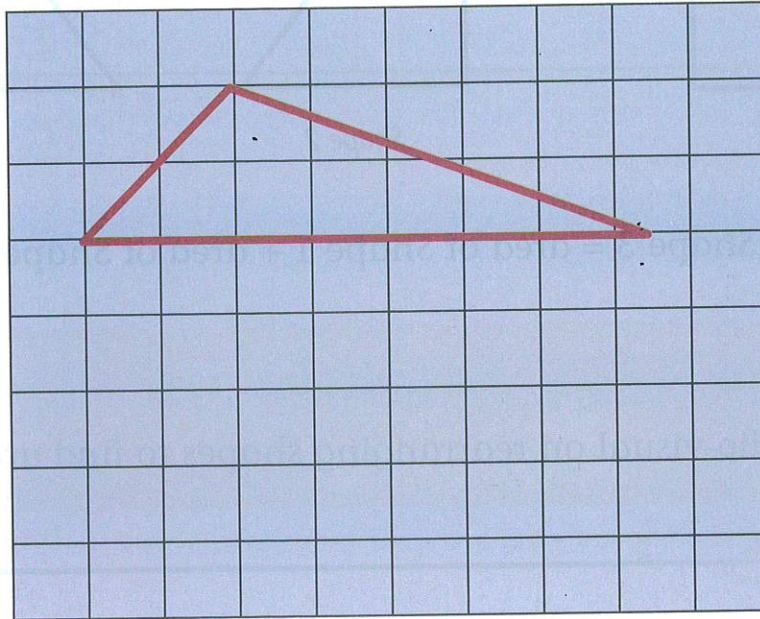


Figure 8 Making quadrilaterals from triangles

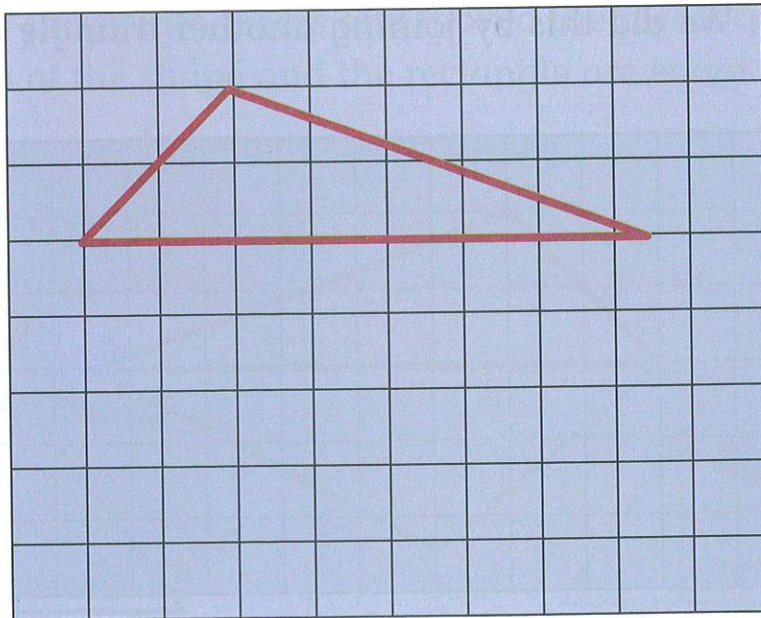
Can you extend a triangle into a quadrilateral which has:

1. double the area of the triangle?
2. more than double the area of the triangle?
3. less than double the area of the triangle?

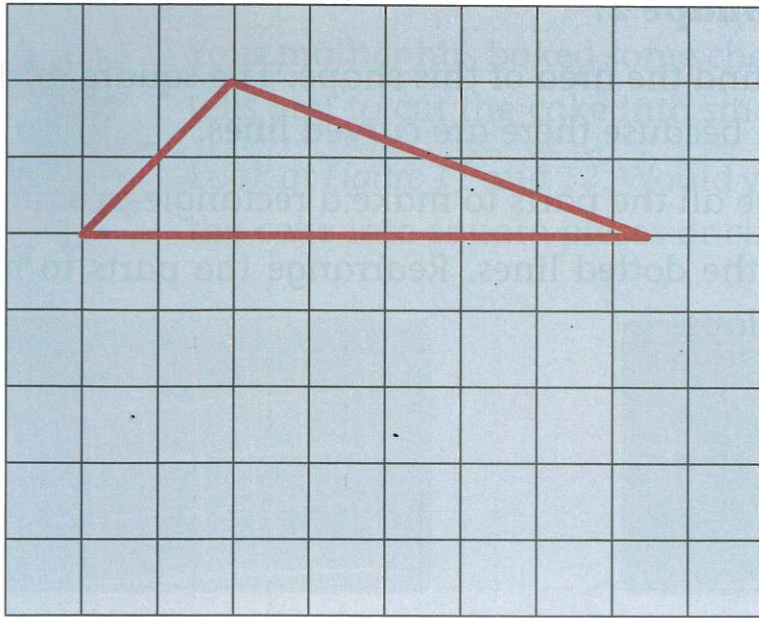
1.



2.



3.



Go to the end of your *Studio*. You will find the shapes given in *Figure 9* and *Figure 10*. Cut them out.



Find the area of these shapes.

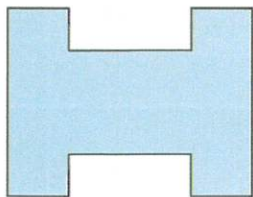


Figure 9 Shape 1

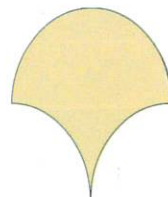


Figure 10 Shape 2

Finding the area of Shape 1:

Shape 1 can be cut into _____ rectangles.

The total area of Shape 1 = Area of first rectangle + Area of second rectangle + Area of third rectangle

Find the areas of the three rectangles and add them up.

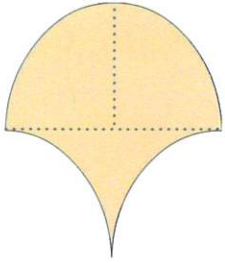
Thus, the area of Shape 1 = _____

Finding the area of Shape 2:

There is no formula to find the area of this shape. The square grid won't measure the exact area because there are curved lines.

Try to cut and rearrange all the parts to make a rectangle or square.

Cut your shape along the dotted lines. Rearrange the parts to make a rectangle, without overlaps.



Area of Shape 2 = _____

Now, I can:	✓/✗
• derive formulae for perimeter and area of rectangle and square	<input type="radio"/>
• calculate perimeter of rectangles and squares	<input type="radio"/>
• calculate area of complex shapes.	<input type="radio"/>



What kind of small shapes fill a big area when repeated?



Your mother has baked some chocolate cake. She tells you to cut the cake into smaller pieces.

Look at *Figure 11* and *12*. Would you prefer cutting the cake into square pieces or circular pieces?

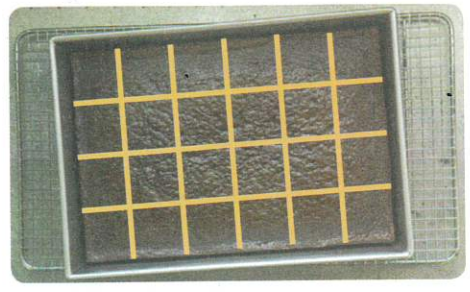


Figure 11 Square pieces

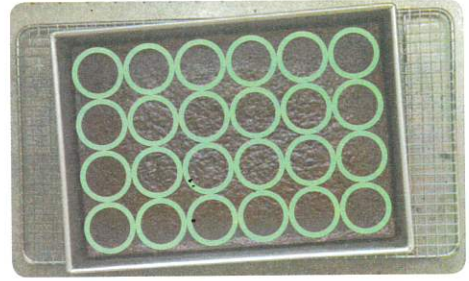


Figure 12 Circular pieces

I would prefer to cut it like *Figure* _____ because _____

If you would like to cut the cake in any other way, you can draw your plan on this cake.

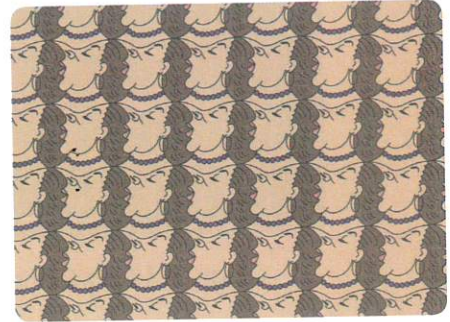
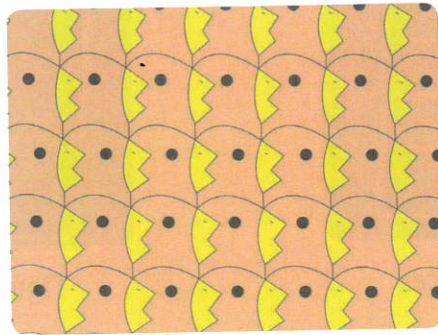
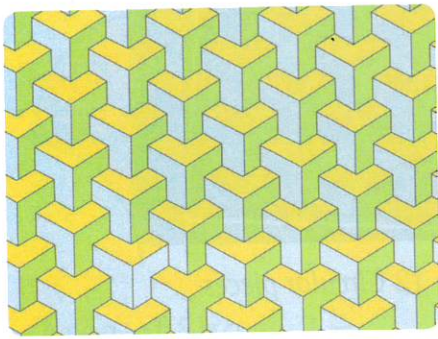


You would prefer this arrangement because _____

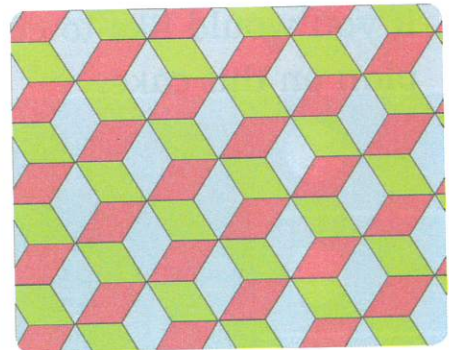
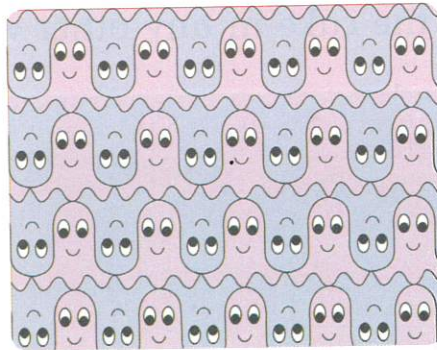
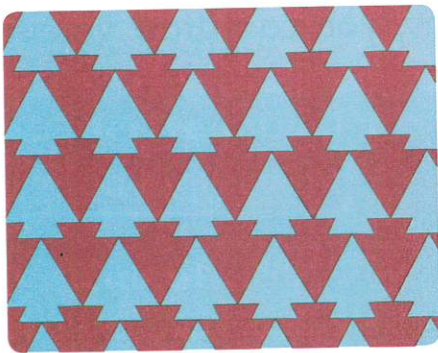
The squares completely cover the cake in *Figure 11*. But there are gaps in between the circles in *Figure 12*. To avoid wastage, we cut cakes in a shape that leaves no gaps.

When one or more shapes repeat to completely cover a space without overlapping, the shapes are said to 'tessellate'. The design they make is called a **tessellation**.

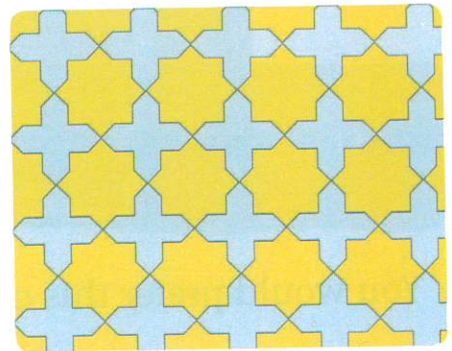
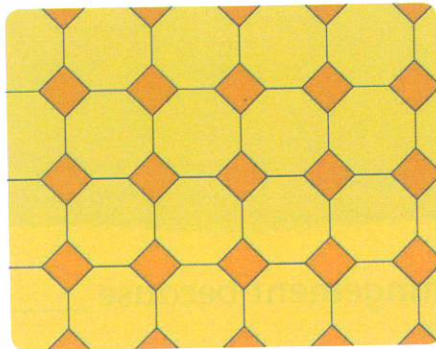
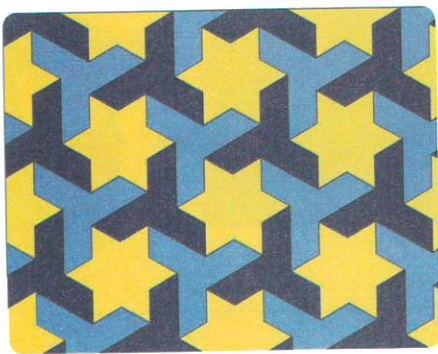
Tessellations made by a single shape



Tessellations made by a single shape which is rotated



Tessellations made by more than one shape



Did you notice that these tessellations form patterns? The type of pattern they form is _____

Figure 13 shows some tessellations found in nature. Can you guess where it is found?

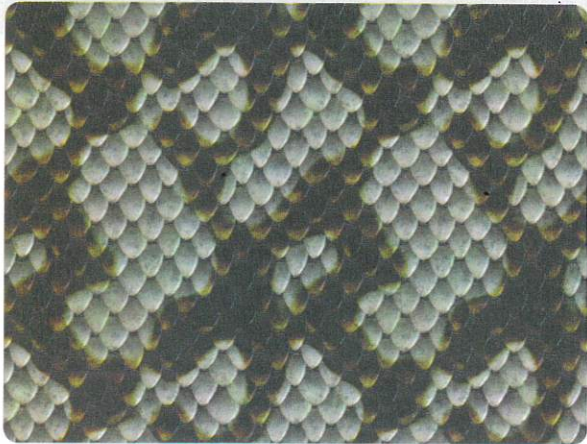

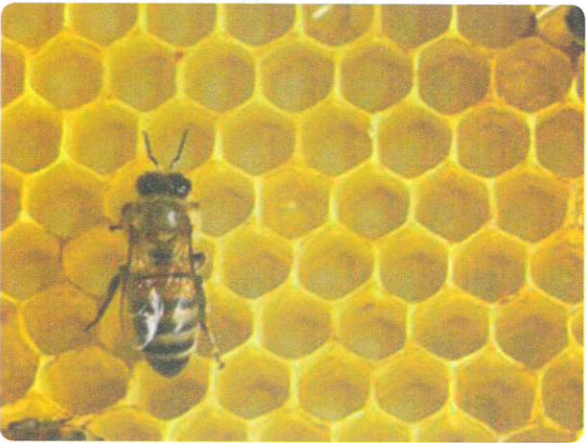
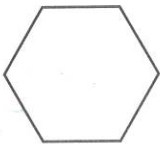
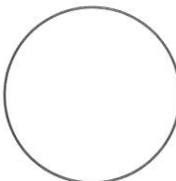
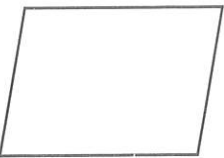
Tessellation	Where it is found
	
	
	

Figure 13 Tessellations in nature

Check if these shapes tessellate by trying to draw them without gaps. Show your working in the space provided.



Shape	Working	Does it tessellate? ✓/✗
		
		
		

Pavements are often made from one tile design. This common tile is rotated to make interesting designs without leaving gaps. This saves material and makes it simple to lay the pavement.

Pictures of a few pavements are given in *Figure 14*. Draw the shape that is repeating to form the tessellation.


	Pavement design	Repeating unit
1		
2		
3		
4		
5		

Figure 14 *Pavement designs*

Companion

Match the shapes with the tessellations they form. Colour one repeating unit in these tessellations.

6e



LOOK AROUND

Find three tessellations around you and list them.

6.16

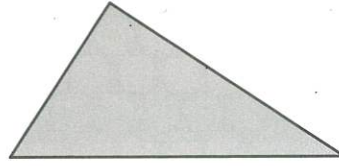
	A drawing of the tessellation	Where you found it
1		
2		
3		

Hands-on

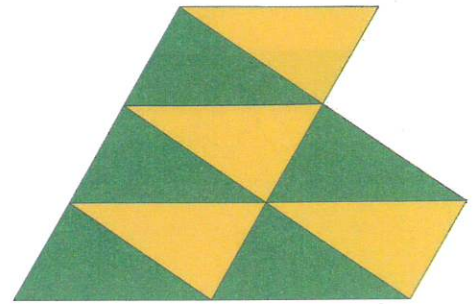
Create these tessellations.



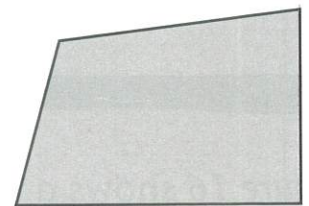
1. Draw a triangle on a piece of paper and cut it out.



Draw a tessellation in the space provided by tracing this triangle. Colour your tessellation. A sample has been provided.



2. Draw a four-sided shape and cut it out. Create a tessellation by tracing this.



3. The tessellation in *Figure 15* is formed by two shapes. Can you create a tessellation with squares and triangles?

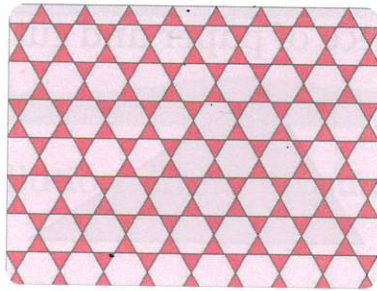


Figure 15 A tessellation with two shapes



Figure 16 shows a beehive — the house of honey bees. The hive is made of shapes with 6 equal sides called **hexagons**.

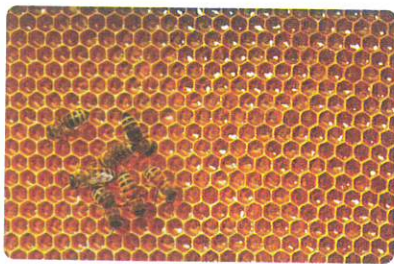
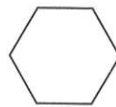
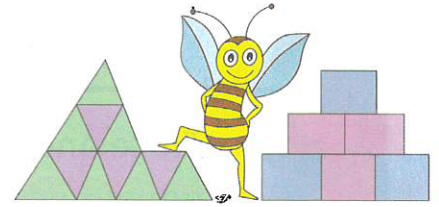


Figure 16 *Beehive*

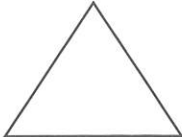

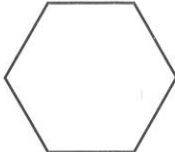
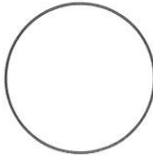
Why do honey bees use hexagons for their beehive?

Imagine that you are a honey bee building your house. You need to choose a shape for your rooms. The shape should have a large area to store all the honey that you collect. It should also have a small perimeter so that it is easy to build. So, what shape will you choose that has a small perimeter and large area?



Cut a piece of thread at least 30 cm long. Make the given shapes with the thread and measure their area with the square grid. Find which shape has the largest area.

6.18

	Shape	Area
1		
2		
3		
4		

Which shape has the largest area? _____

Which shape has the largest area and also does not leave any gaps when you make your beehive? _____





Trace one of the designs given in *Figure 17* on a sheet of paper to create a tessellation. Colour the tessellation in your favourite colours.

6.19

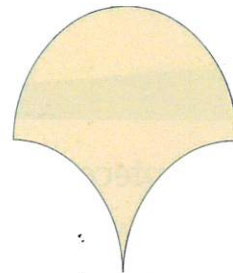
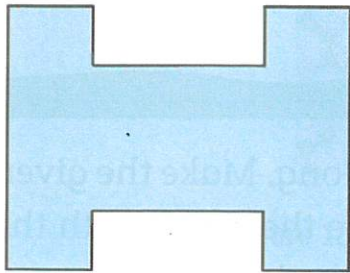


Figure 17 One repeating unit of tessellation



Now, I can:	✓/✗
• identify the repeating unit in tessellations.	<input type="radio"/>
• create different tessellations using triangles and quadrilaterals.	<input type="radio"/>
• predict if a shape can tessellate.	<input type="radio"/>
• create irregular shapes that tessellate.	<input type="radio"/>

Companion (Project Time)

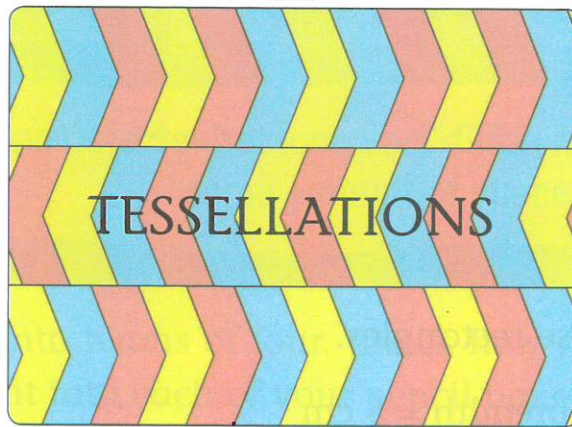
Make tessellations with complex designs.

6f

Complete the concept map.

PERIMETER	
of a rectangle = _____ _____	of a square = _____ _____

AREA		
of a rectangle = _____	of a square = _____	of complex shapes



Example:

Question Time

1. Find the perimeter of these rectangles.
 - a. length = 4 cm, breadth = 2 cm
 - b. length = 5 cm, breadth = 3 cm
 - c. length = 15 m, breadth = 9 m
 - d. length = 22 km, breadth = 15 km
 - e. length = 17 cm, breadth = 13 cm
2. Find the perimeter of these squares.
 - a. 5 cm
 - b. 8 m
 - c. 24 km
 - d. 18 m
3. Find the area of these rectangles.
 - a. length = 13 cm, breadth = 5 cm
 - b. length = 16 cm, breadth = 14 cm
 - c. breadth = 6 m, length = 8 m
4. Find the area of these squares.
 - a. 34 cm
 - b. 56 cm
5. Create tessellations using any two shapes.

Volume

How can we compare the space occupied by a solid shape and the space occupied by a liquid that has no shape?

OVERVIEW

In this lesson, we will:

- create different shapes of same volume.
- create a volume measuring device.



Can objects that look very different occupy the same amount of space?



Get into teams of four. Check how many pencils can fit into each of your pencil boxes

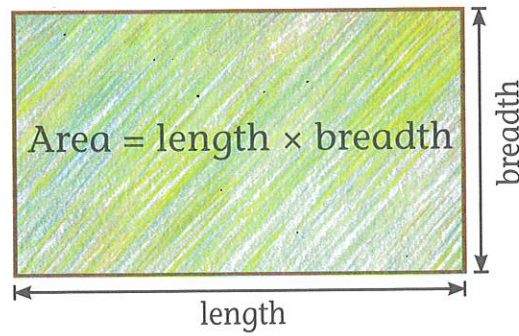


	Person's name	Number of pencils
1		
2		
3		
4		

Are all the pencils of the same size? How does the size of the pencils affect your table?



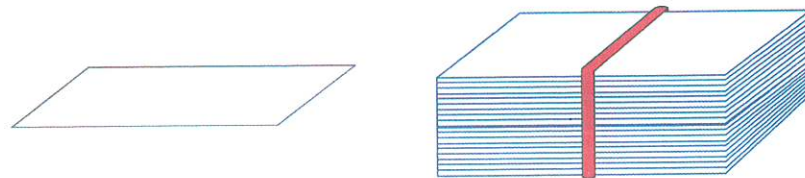
A flat shape occupies a region of space. When you draw a flat shape, it occupies a certain area of your paper.



Let us look at a solid shape like your pencil box. Its base, cover and sides are flat shapes that occupy an area.

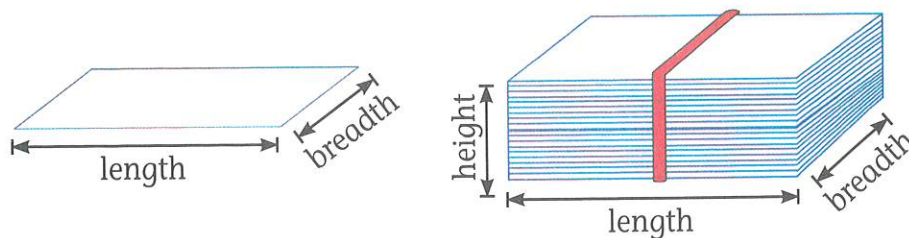


A sheet of paper is a flat shape. A bunch of papers have been put together to make the solid shape, as shown



What difference do you see between the flat shape and the solid shape?

A solid shape has length, breadth and height. The amount of space occupied by a solid shape is called its **volume**.

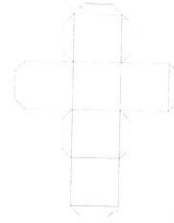


Hands-on

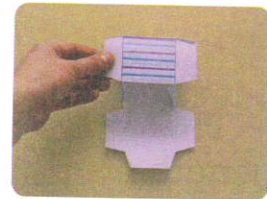
Nets are provided for two cubes of size 1 cm at the end of your *Studio*. Create cubes by following the given instructions.



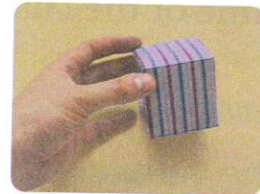
1. Cut out the cube nets from the last pages of your *Studio*.



2. Fold it along the marked lines.



3. Stick the mentioned sides together.

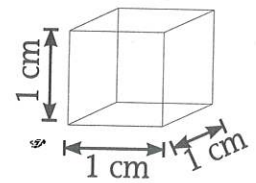


What did I do well while making the cubes?

What confused me?

How can I improve?

We call a cube with sides of 1 cm length a **unit cube**. The volume of this cube is **1 cubic centimetre**, also written as **cc**.



We always measure volume in cubic units. If each side of the cube is 1 m, then the volume will be 1 cubic _____.

Figure 1 shows two unit cubes put together.

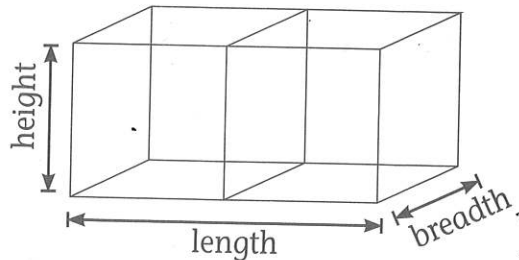


Figure 1 Two unit cubes

Which solid shape does it form? _____

It has a length of ____ cm, breadth of ____ cm and height of ____ cm.

The volume of the cuboid is ____ cc.

Companion

Find the volume of the given shelf.

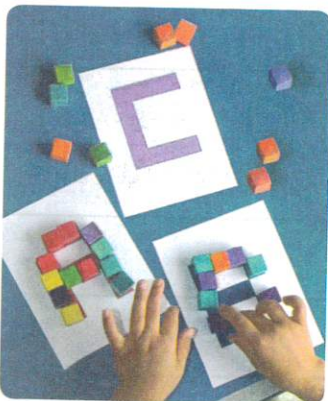


Hands-on

Get into teams of five. Make any three letters of the alphabet with the unit cubes you made in *Hands-on 7.2*.



Discuss with your team and write down the volume of each letter, along with the unit.



	Letter	Volume
1.		
2.		
3.		



The cuboid in *Figure 2* is formed by unit cubes.

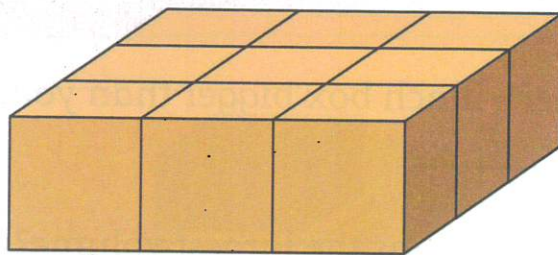


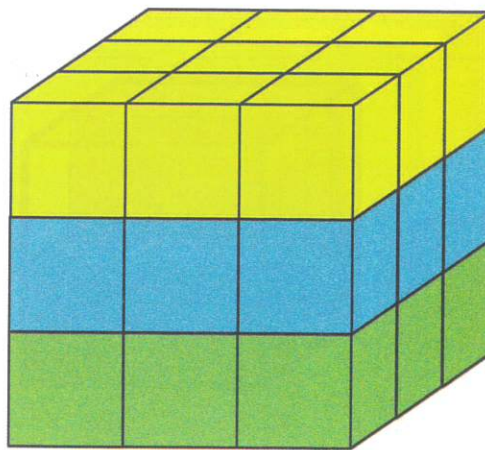
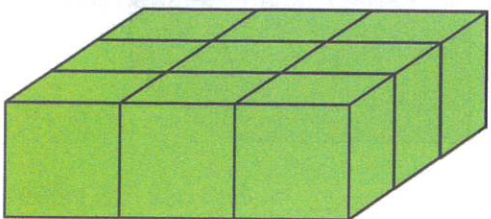
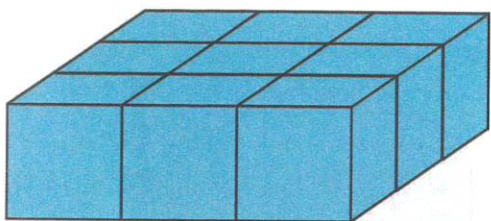
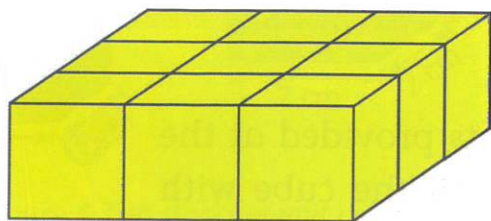
Figure 2 Cuboid formed by unit cubes

The number of unit cubes in the object is _____.

Its volume is _____.

Let us place three cuboids, like the one in *Figure 2*, on top of each other to form a cube. What happens to the volume now?

The volume will be _____ times the volume of the cuboid in *Figure 2*.



The volume of the cube will be _____.

We can find the volume of objects by counting how many unit cubes can fit inside the space.



Is your father's lunch box bigger than yours in volume? _____



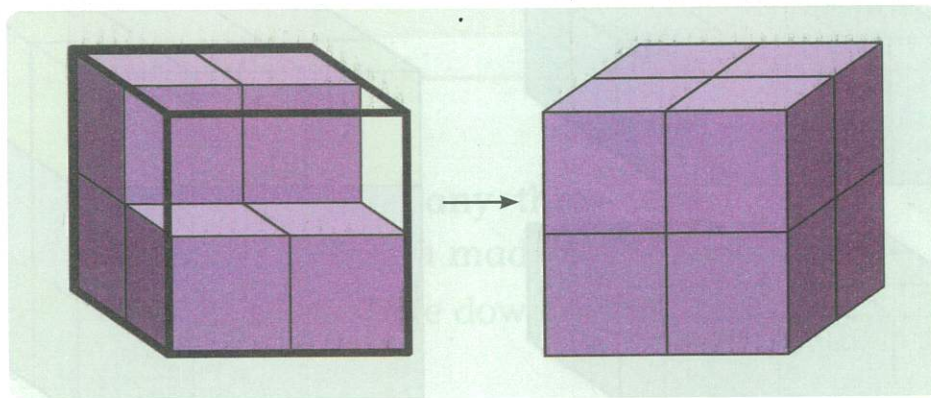
Which room in your house has the largest volume? _____

Name one object you use that you wish was bigger in volume. Why?

Name one object you use that you wish was smaller in volume. Why?

Hands-on

Make a cube side of 2 cm using the nets provided at the end of your *Studio*. Open its top side. Fill the cube with unit cubes.



How many unit cubes could you fit into the 2 cm cube? _____



The cube has a length of 2 cm. So, we can place two unit cubes along each length, as shown in *Figure 3*. So, $2 \times 2 = 4$ unit cubes. Let us call this a stack of unit cubes.

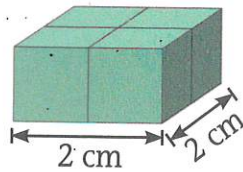


Figure 3 A stack of unit cubes

The cube also has a height of 2 cm. So, we can place two stacks of unit cubes, as shown in *Figure 4*.

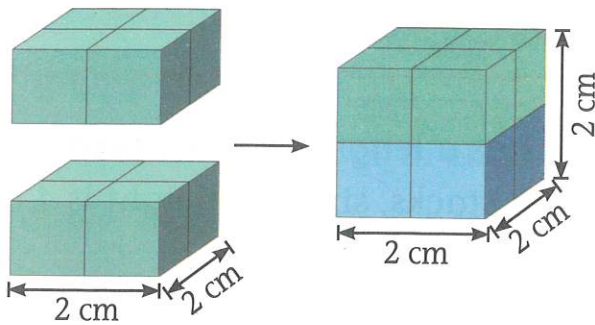


Figure 4 Two stacks of unit cubes

Number of unit cubes along the length = _____

Number of unit cubes in one stack = _____

Total number of stacks = _____

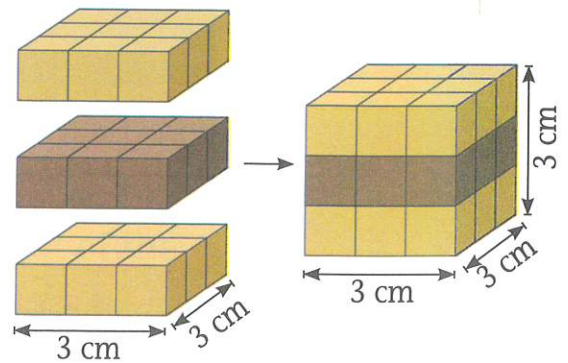
Thus, the volume of the cube is _____ \times _____ \times _____ = _____ cc.

Let us find the volume of a 3 cm cube.

Number of unit cubes along the length = _____

Number of unit cubes in one stack = _____

Total number of stacks = _____

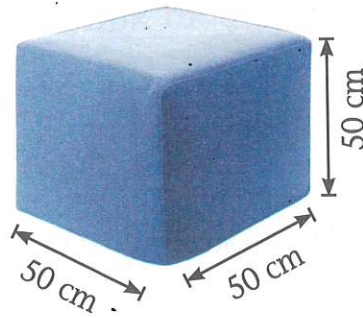


Thus, volume of the cube = _____ \times _____ \times _____
= _____

Volume of cube = length \times length \times length

Vishal's stool has 50 cm sides. What is its volume?

7.6



$$\begin{aligned} \text{Volume of the cube} &= \underline{\hspace{2cm}} \times \underline{\hspace{2cm}} \times \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \text{ cc} \end{aligned}$$

Let us look at the cuboid given in *Figure 5*. It has a length of 3 cm, breadth of 2 cm and height 4 cm. We can split it into four stacks, since its height is 4 cm.

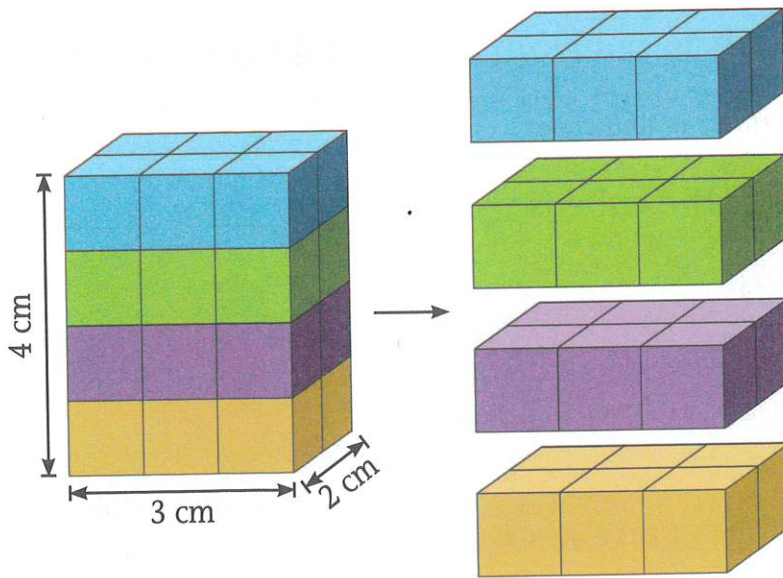
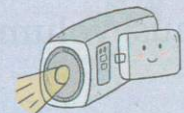


Figure 5 Cuboid made from four stacks of 6 cubes

Audio-Visual

Watch an audio-visual on how the volume formula is derived.





1. How many unit cubes are there in each stack in Figure 5?



We can fit _____ unit cubes along the length and _____ unit cubes along the breadth.

The number of unit cubes in each stack = _____ \times _____
= _____

2. How many unit cubes are there in the cuboid?

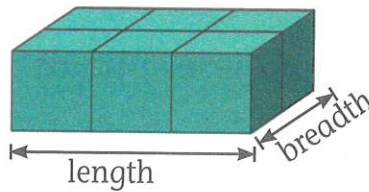
Number of stacks = _____

Number of unit cubes in each stack = _____

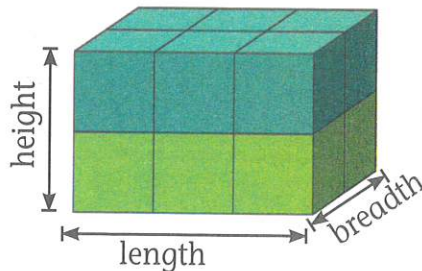
Total number of unit cubes = _____ \times _____
= _____

Volume of cuboid = _____

For any given cuboid, the number of cubes in each stack is length \times breadth.



Since the number of stacks is given by the height of the cuboid, the total number of cubes is length \times breadth \times height.



Volume of a cuboid = length \times breadth \times height



LOOK AROUND

Find a cuboid in your *ThinkRoom*. Measure its sides and calculate the volume.



7.8

The cuboid you chose is _____

Its length is _____ cm.

Its breadth is _____ cm.

Its height is _____ cm.

Its volume is _____ × _____ × _____

= _____ CC.

Companion

Help Edwin choose a box.



7b

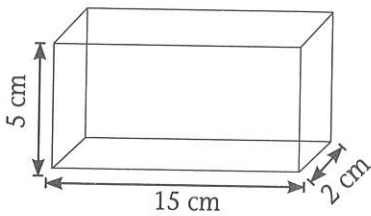


LOOK DEEP

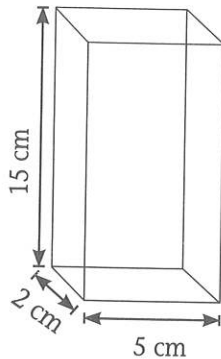
Find the volume of these cuboids and write it with the correct unit.



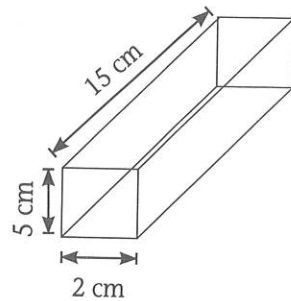
7.9



Shape 1



Shape 2



Shape 3

Shape 1: length = _____ breadth = _____ height = _____

volume = _____ × _____ × _____

= _____

Shape 2: length = _____ breadth = _____ height = _____

volume = _____ × _____ × _____

= _____

Shape 3: length = _____ breadth = _____ height = _____

volume = _____ × _____ × _____

= _____

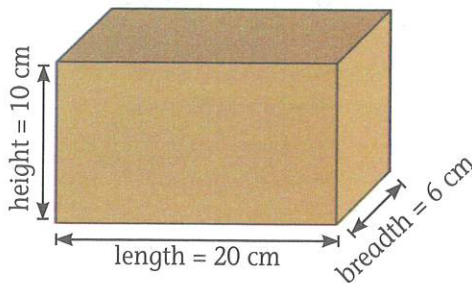
The volumes are _____ because _____

When you rotate a shape, it occupies the same volume. So, the volume of a cuboid can also be given by height × breadth × length.

Remember, the product doesn't change when you change the order of the numbers being multiplied.



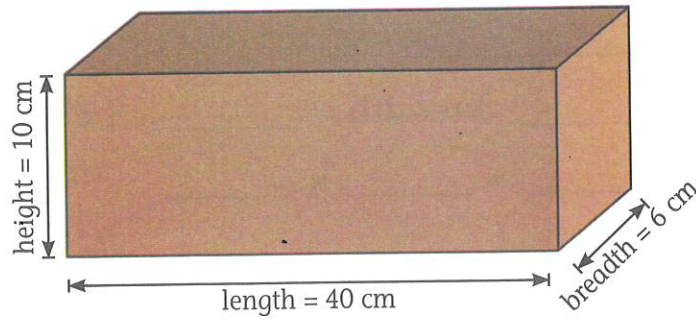
1. Neeti made a shoe box in the shape of a cuboid, as shown. What is the volume of the box?



Volume = length × breadth × height = _____ × _____ × _____

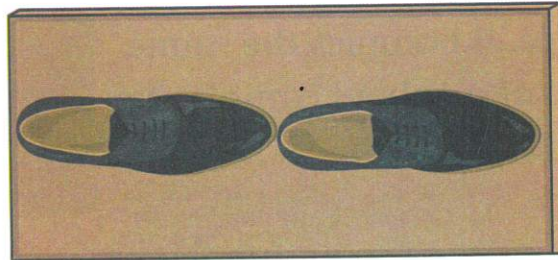
= _____

Once she finished, she found that she could keep only one shoe in it. So, she started again and this time, she doubled the length. Will she be able to fit in two shoes now?

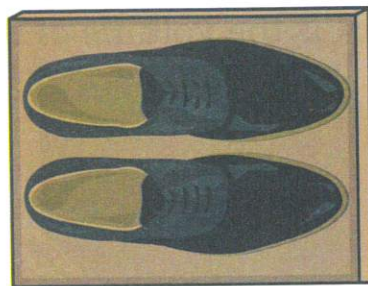


$$\text{Volume} = \text{length} \times \text{breadth} \times \text{height} = \underline{\hspace{2cm}} \times \underline{\hspace{2cm}} \times \underline{\hspace{2cm}}$$
$$= \underline{\hspace{4cm}}$$

The new volume was double the old volume, so, she could fit in two shoes. But she was not happy with the box as she had to place the shoes in front of each other.



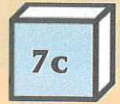
Doubling the breadth or height would also double the volume. The following image shows the shoe box with the breadth doubled.



In a cuboid, when you double any one side, the volume also doubles. In general, when we multiply one side by a number, we multiply the volume by the same number.

Companion

Find the odd one out.



1. If you use the same number of unit cubes to create different objects, they will have the _____ volume.



Create different shapes by attaching one cube of side 2 cm and two cubes of side 1 cm. You can use the cubes you made in *Hands-on 7.2* as reference. Try to draw two of the shapes you created in the space provided.

	Object	Volume
a.		
b.		

2. If you made the same object with clay instead of paper, will it still have the same volume? Why? _____
- _____

Now, I can:



- **identify** the unit of volume.
- **derive** formulae for the volume of a cube and cuboid.
- **create** different shapes of same volume.



Can a bottle of milk occupy the same space as a small bucket of water?



Take a big empty water bottle. Find two smaller bottles or cups. Let us name the objects as container 1, 2 and 3, as shown.



container 1



container 2



container 3



level of 1

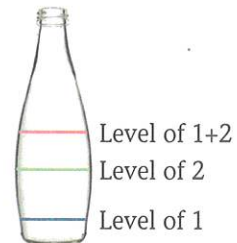
Fill container 3 with water and pour it into container 1. Mark the level of water with a piece of chalk or a pencil.

Pour the water in container 1 back into container 3.

Fill container 2 with water and pour it into container 1. Mark the level of water.



Now, pour the water in container 3 into container 1. Mark the new level.



Drink the water till the level comes down to the level of 2.

1. The volume of _____ is the highest.
2. The volume of _____ is the lowest.
3. The volume you drank is equal to the volume of _____.

The height of the water in a marked bottle tells us the volume of the water. We can use it to compare volumes of other containers.

Volume can also be measured in millilitres, written as *ml*. Figure 6 shows two marked beakers of different sizes. The big one can measure upto 1,000 millilitres. The small one can measure upto 100 millilitres. These beakers are marked with different levels that measure smaller volumes.

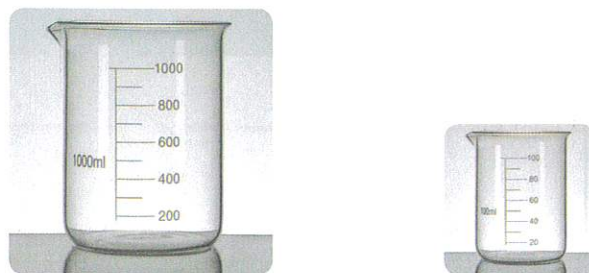
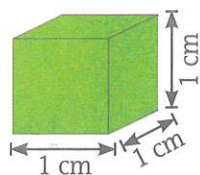


Figure 6 Two beakers of different volumes

We saw that a unit cube of size 1 cm has a volume of 1 cubic centimetre. If this cube is filled with water, it will have exactly 1 millilitre of water! Both one cubic centimetre and one millilitre denote the same volume.



1 cubic centimetre

=



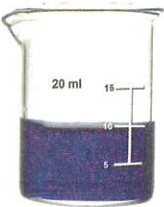

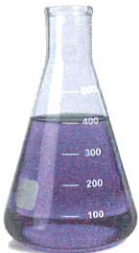
1 millilitre

If you take 1,000 millilitres, you get 1 litre.

How many cubic centimetres make a litre? _____

Look at the water level and write the volume of liquid in each beaker.

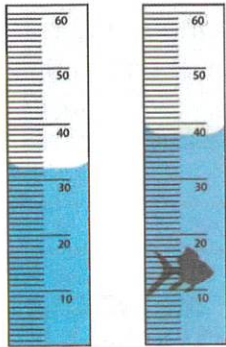
7.13

	Beaker	Volume
1.		
2.		
3.		

When you put an object in water, the water level moves up.

More than 2,000 years ago, Archimedes watched the water in his bathtub rise and spill over when he sat in it.

Voila! He discovered the connection between the volume of an object inside water and the rise in water level. He was so happy to have found this, he ran shouting, "Eureka! I have found it!"



Observe the change in the water level in the beaker shown. The level went from 32 ml to 38 ml, after the fish was dropped in. The difference of the two levels gives the volume of the fish.

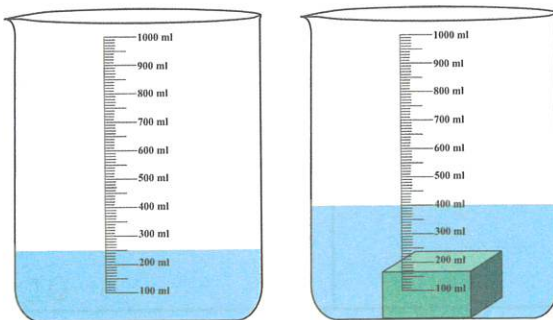
$$\begin{aligned} \text{Volume of the fish} &= 38 - 32 \\ &= 6 \text{ ml} \\ &= \underline{\hspace{2cm}} \text{ cc} \end{aligned}$$

When an object goes completely into water, the change in water level gives its volume.

Find the volume of the given objects.

7.14

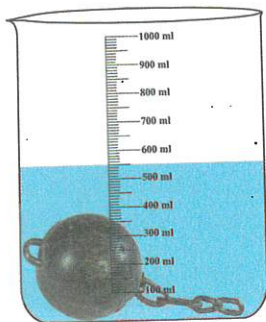
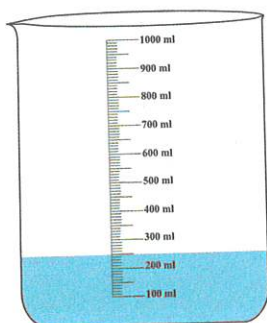
a.



Volume of the cuboid

$$\begin{aligned} &= \underline{\hspace{2cm}} \text{ ml} - \underline{\hspace{2cm}} \text{ ml} \\ &= \underline{\hspace{2cm}} \text{ ml} \\ &= \underline{\hspace{2cm}} \text{ cc} \end{aligned}$$

b.



Volume of the iron ball

= _____ ml - _____ ml

= _____ ml

= _____ cc

A cuboid's volume can be found either by using the volume formula or by placing it into a beaker of water. It is simpler to use the water method for some objects like the iron ball. But we cannot use this method for objects that float or dissolve in water.

Hands-on

With the help of your teacher, immerse objects into a beaker of water (one after the other) to find their volume.

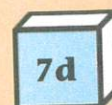


Make sure that the objects do not dissolve or float in water.

Object	Volume in ml	Volume in cc

Companion

Find the volume of the given objects.





LOOK AROUND

Find three household objects that have millilitre and litre written on them. Write the object's name in the given table and include how many litres or millilitres it contains.

7.16

Object	Volume

Kanimozhi's mother has advised her to drink 3 litres of water every day. She has a 500 millilitre water bottle. How many times should she fill the bottle to drink 3 litres?

7.17

- 4
- 6
- 10

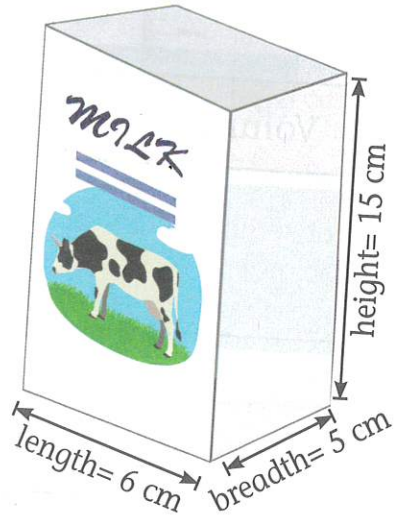
3 litres = 3 × _____

= _____ millilitre

_____ 500 millilitre bottles make 3 litres.

Tony bought a milk carton from a farm, measuring 6 cm in length, 5 cm in breadth and 15 cm in height. He had three glass bottles of volume 450 ml, 500 ml and 750 ml. Which bottle should he pour the milk into?

7.18



Volume of the cuboid = _____ × _____ × _____
 = _____ cc

Convert cc into ml.

_____ cc = _____ ml

- 450 ml bottle
- 500 ml bottle
- 750 ml bottle

Companion

Can Dheena buy oil?

7e



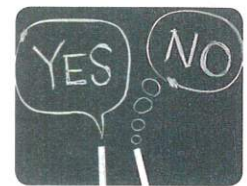
Read aloud the following sentences. Look at how the word 'volume' is being used in each sentence. Do they mean the same?



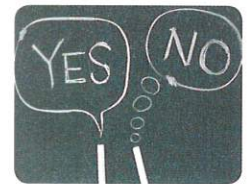
- The volume of my pencil box is 48 cc.
- Reduce the volume of your television.
- This is the first volume of my Maths *Studio*.
- I completed a huge volume of work today.

Use the word 'volume' in different situations to create a small story. Narrate it to your friends!

Did you narrate your team's story in the class?



Did you want to take the role of the narrator?



How well did you communicate what you wanted to do to your team members?

What will you do the next time you need to communicate your ideas?

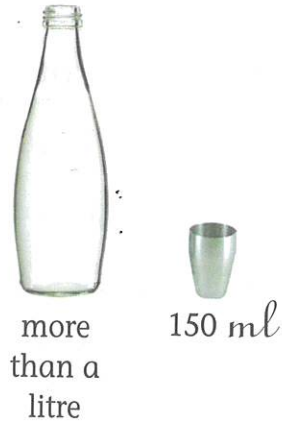




With your partner, follow these instructions to create a volume measuring device.

7.20

1. Here is a bottle and a 150 ml cup. The bottle can hold a little more than 1 litre.



We can mark the level of 150 ml on the bottle if we fill the cup with water and empty it into the bottle.



What are the other levels you can mark on the bottle with the help of the cup?

Clue: $150 \times 2 = 300$

2. Empty the water in the big bottle into a bucket. You are now given a 250 ml cup in addition to the 150 ml cup. How will you mark the 50 ml point on the big bottle?

Clue: Use the 250 ml cup and 150 ml cup to get 50 ml.

3. Now that you have 50 ml, you can use it twice to measure 100 ml, thrice for 150 ml and so on. Write all the levels you can mark on the bottle now.



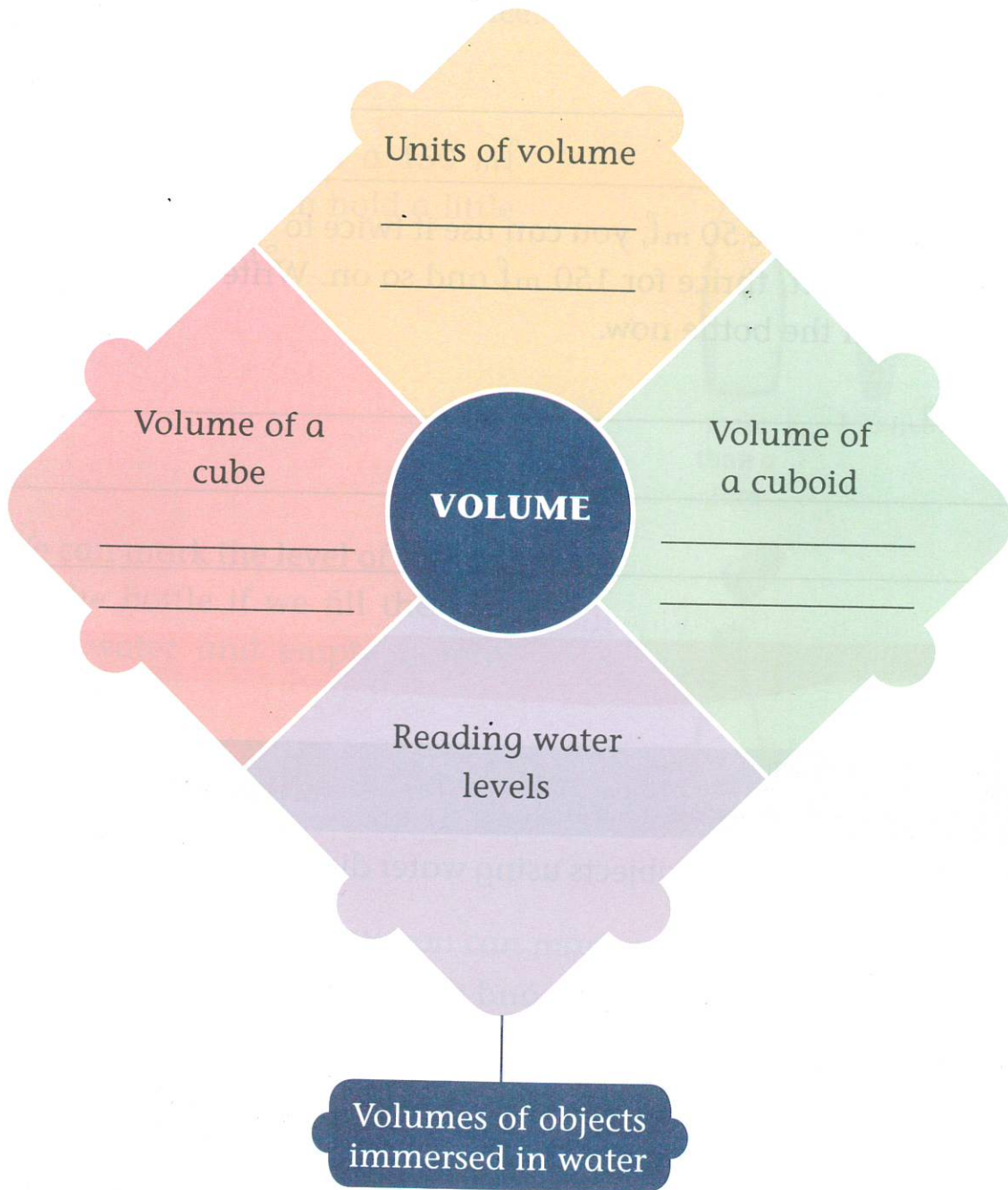
Now, I can:	✓/✗
• measure the volume of objects using water displacement method.	○
• convert between millilitre, litre and cubic centimetre.	○
• create a volume measuring device.	○

Companion (Project Time)

Create a poster on water conservation using the concepts learnt in this lesson.



Complete the concept map.



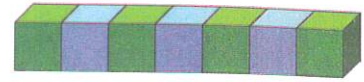
Question Time

1. Here are some shapes formed by unit cubes. Count the number of cubes to find the volume of each shape.

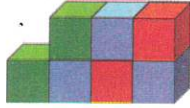
a.



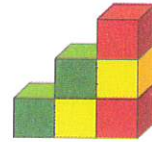
b.



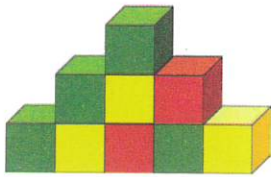
c.



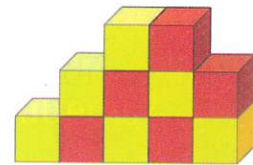
d.



e.



f.



2. Find the volume of the following solid shapes.

a.

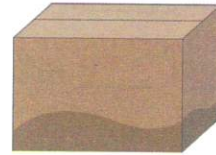


length = 15 cm

breadth = 4 cm

height = 7 cm

b.



length = 16 cm

breadth = 8 cm

height = 12 cm

c.

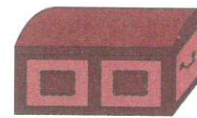


length = 9 cm

breadth = 3 cm

height = 12 cm

d.



length = 22 cm

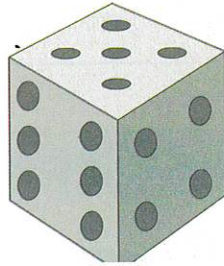
breadth = 15 cm

height = 11 cm

3. What is the volume of a geometry box whose length is 11 cm, breadth 5 cm and height 2 cm?



4. Find the volume of the given dice, which is in the shape of a cube of side 30 cm.



5. Write these cubic centimetre values as litres and millilitres.

$$2500 \text{ cc} = \underline{\quad} \text{ l } \underline{\quad} \text{ ml}$$

$$15200 \text{ cc} = \underline{\quad} \text{ l } \underline{\quad} \text{ ml}$$

$$320 \text{ cc} = \underline{\quad} \text{ l } \underline{\quad} \text{ ml}$$

$$7501 \text{ cc} = \underline{\quad} \text{ l } \underline{\quad} \text{ ml}$$