

MATHEMATICS

Part - 1

Standard
VI



Government of Kerala
Department of General Education

Prepared by
State Council of Educational Research and Training (SCERT) Kerala

2025



THE NATIONAL ANTHEM

Jana-gana-mana adhinayaka, jaya he
Bharatha-bhagya-vidhata
Punjab-Sindh-Gujarat-Maratha
Dravida-Utkala-Banga
Vindhya-Himachala-Yamuna-Ganga
Uchchala-Jaladhi-taranga
Tava subha name jage,
Tava subha asisa mage,
Gahe tava jaya gatha
Jana-gana-mangala-dayaka jaya he
Bharatha-bhagya-vidhata
Jaya he, jaya he, jaya he,
Jaya jaya jaya, jaya he.

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders, respect and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone, lies my happiness.

Mathematics

6

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Typesetting and Layout : SCERT

First Edition : 2025

Printed at : KBPS, Kakkanad, Kochi-30

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Dear children,

We have already learned about different dimensions of Mathematics. We, also, have gained a clear understanding of counting numbers, various operations, basic concepts of geometric shapes, number relations, fractions and decimal forms in previous classes. The content of this book will help us to apply the concept we have learned and create new ideas. These lessons will guide us to increase our Mathematical skills, solve problems logically and understand Mathematics based on observations and conclusions. Let's confidently enter into the fascinating and curious world of Mathematics.

With best wishes,

Dr. Jayaprakash R.K.

Director,
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The icon below is used in this
textbook for convenience



Let's do the problems

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a ¹**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the ²[unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

-
1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec. 2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
 2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec. 2, for "Unity of the Nation" (w.e.f. 3.1.1977)

ANGLES



When lines join

Remember how we drew various shapes joining lines straight up and slanted? (The section **Line math** of the lesson **Lines and Circles** in the class 5 textbook).



Each of these figures has four corners; and at each corner, two lines meet.

Let's look at these different pairs of lines in the first figure:



What about the pairs in the second figure?



A figure formed by two lines meeting at a point is called an **angle**.

Thus each of the three figures seen first has four angles. Now look at the bottom-left corners of these:

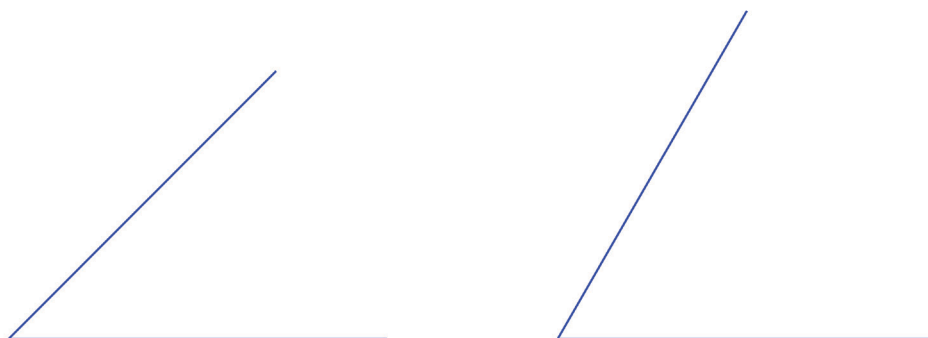


The lines in the middle figure are a bit more spread out than the lines in the right figure, isn't it?

In the left figure, the lines are spread out even more; and the top line is straight up.

So, we can say that the angle on the right is the smallest, the middle one larger and the left one the largest.

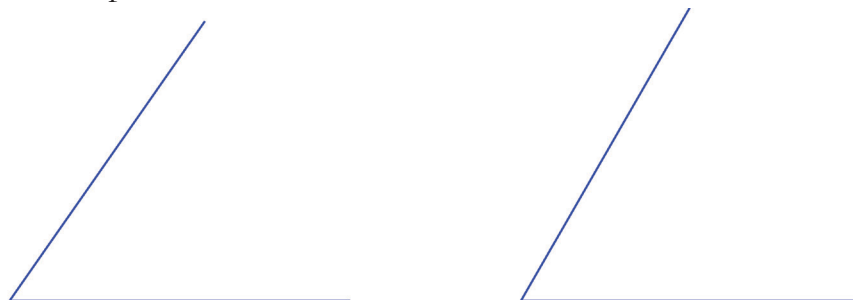
See these pictures:



Which is the larger angle?

The lines of the angle on the right are more spread out; and so it is the larger angle.

What about these pictures?



Difficult to say, isn't it?

To compare these, we must be able to measure angles exactly. There is an instrument in your geometry box just for this.

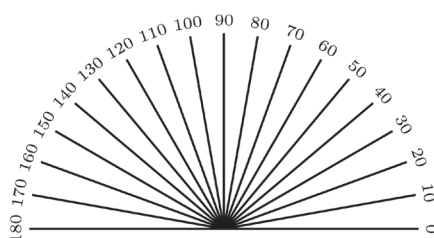
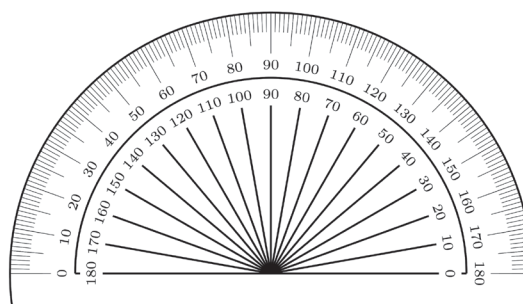


It is called a **protractor**.

See the several lines on it.

At the end of each line, there are two numbers, one below the other.

Look at the bottom numbers:



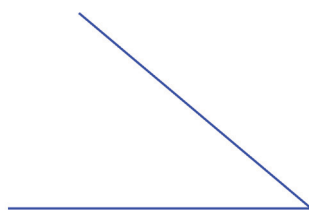
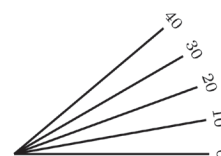
Starting with the bottom line marked 0, there are other lines upward; and as they move up, the angles between them and the bottom line become larger and larger. The numbers at their ends show the sizes of these angles.

The number at the end of the first line is 10, right? We say that the angle between this line and the bottom line is 10 degrees and write 10° . And the angle between the bottom line and the line marked 40 is 40° :

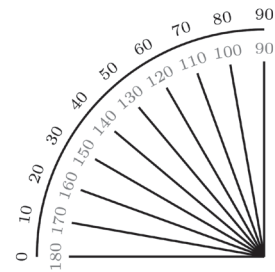


In other words, an angle of 40° is 4 angles of 10° stacked up:

We can draw an angle like this also:



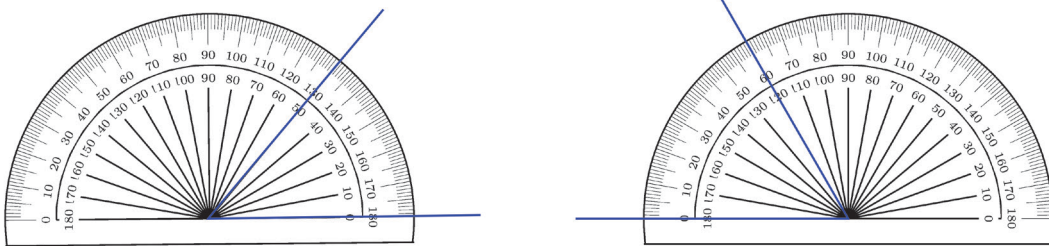
It is to draw and measure angles to the left, that the protractor has another round of numbers on top.



Now let's see how we measure angles using a protractor. For example, see these angles:



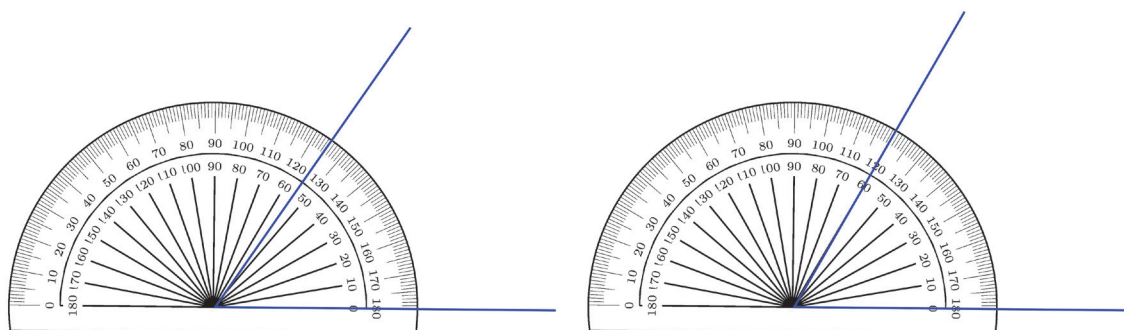
Place the protractor at the corner of each angle, as shown below:



Don't you see that the angle on the left is 50° and the angle on the right is 60° ? We mark them as shown below:



Now let's look at the angles we couldn't compare earlier:



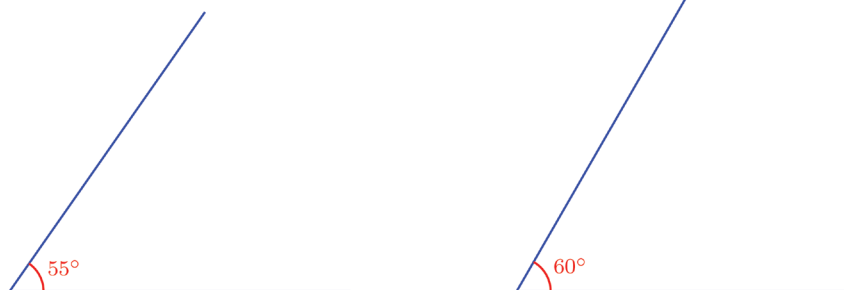
We can see that the angle on the right is 60° . What about the angle on the left?

The slanted line of this angle passes between 50 and 60 on the protractor, doesn't it?

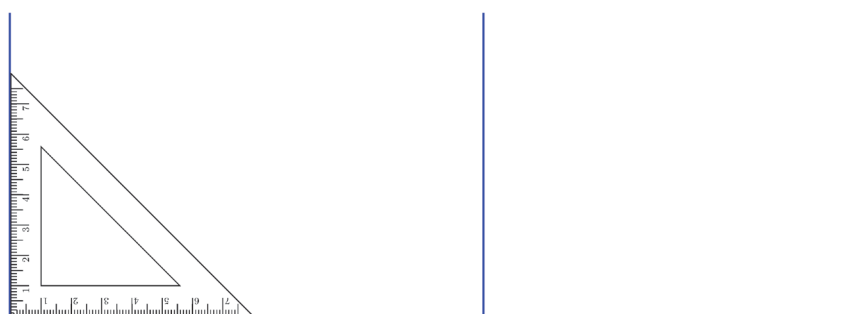
Do you see the small lines in the protractor which divide the gaps between the multiples of 10 into ten equal parts? Each of them shows a difference of 1° .

In our picture, the slanted line goes through the fifth (slightly larger) line between 50 and 60.

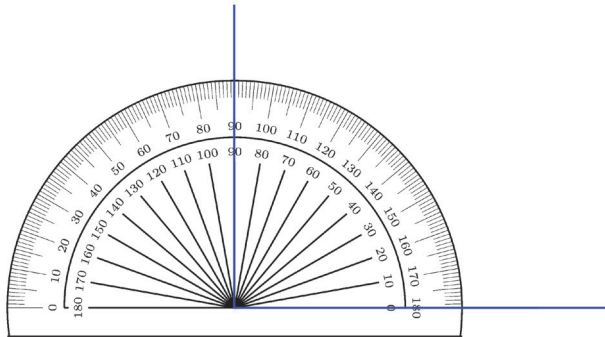
This means the angle is 55° .



Now draw a line, place the square corner of the set square at one end and draw a line (The section **Line math** of the lesson **Lines and Circles** in the class 5 textbook).



Measure this angle using the protractor:

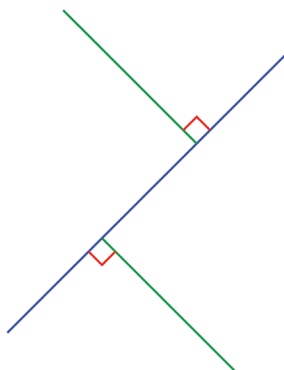


So, the angle at a square corner is 90° . This angle is also called a **right angle**.

In pictures, we mark a right angle like this:



A line making an angle of 90° with another line is said to be **perpendicular** to the first line. For example in the picture below, both the green lines are perpendicular to the blue line:



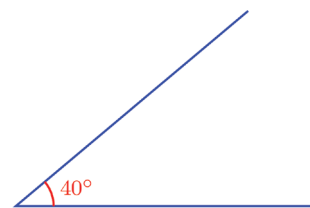
In a rectangle, any pair of sides which meet are perpendicular to each other:



Drawing angles

Next let's see how we can draw an angle of specified size using a protractor.

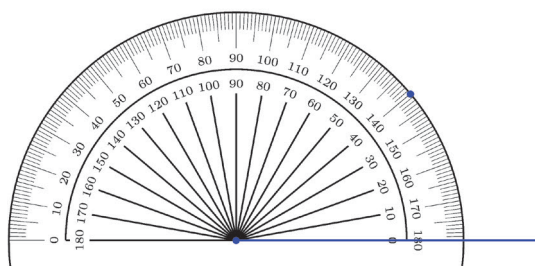
For example, how do we draw the angle shown in the figure?



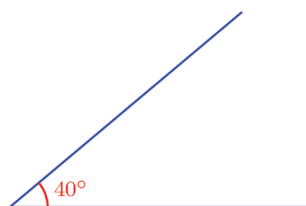
First draw a horizontal line:



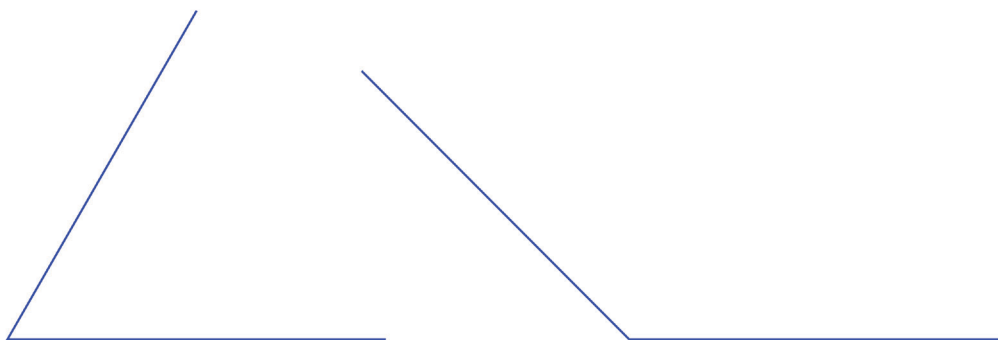
Then place the protractor at its left end as shown below and mark a point at the number 40 in it.

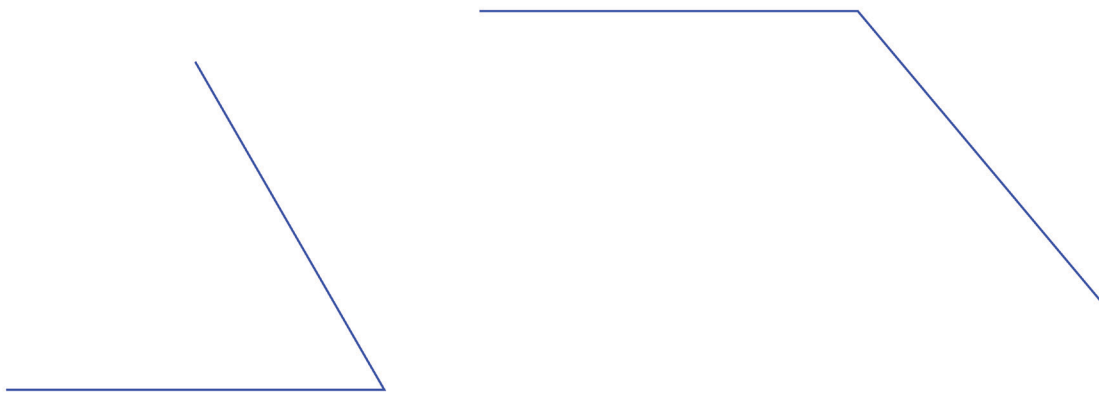


Now remove the protractor and join this point and the left endpoint of the first line to get a 40° angle:

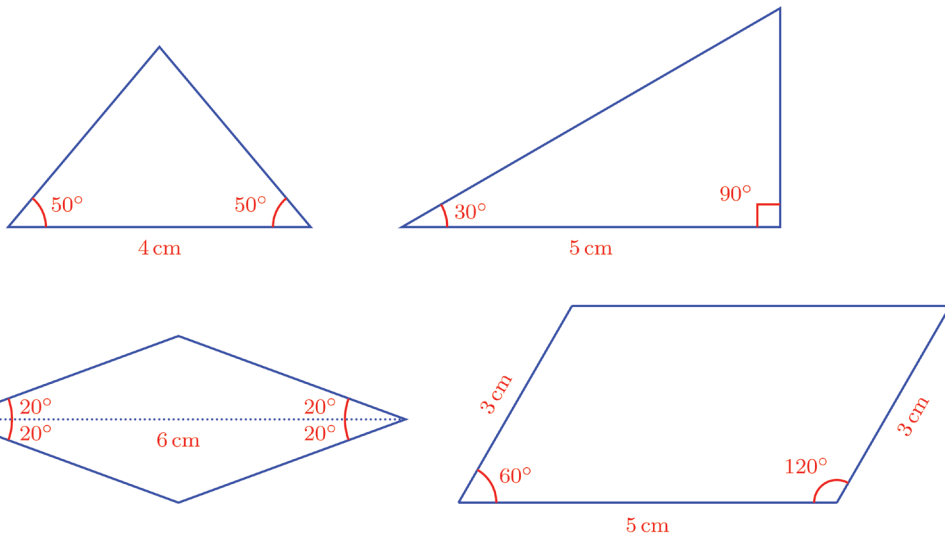


(1) Measure and mark each angle below:



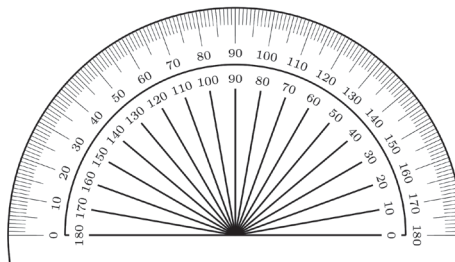


(2) Draw the pictures below in the notebook:



Circle division

A protractor is a semicircle, that is half a circle, right?



The small lines in it at the very top divide the semicircle into 180 equal parts. That is, if these lines are extended to the centre of the semicircle, we get 180 angles of the same size.

We have already mentioned that the size of each of these angles is 1° .

Thus if in a semicircle we draw 181 equally spaced radii, then the angle between two nearby radii would be 1° .

This is usually stated in terms of a full circle, instead of a semicircle:

If in a circle 360 equally spaced radii are drawn, then the angle between any two nearby radii is 1° .

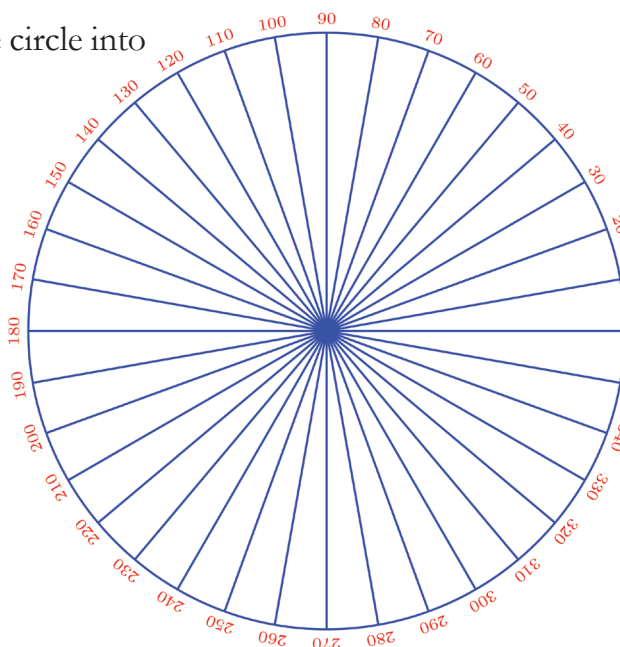
The sides of a 1° angle are very close to each other, right? To see this angle, we will have to extend the sides quite a bit:



What we have said above can be put the other way round: in a circle, we can draw 360 radii, 1° apart; and they divide the circle into 360 equal parts.

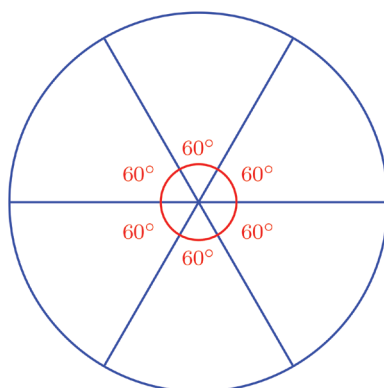
What if we draw radii 10° apart?

We get 36 radii which divide the circle into 36 equal parts:

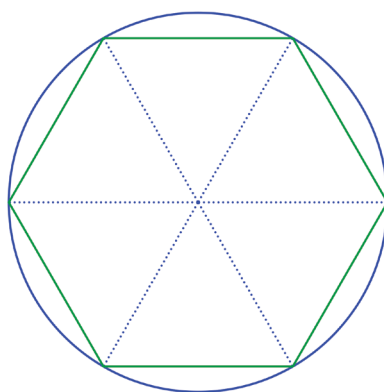


And radii 60° apart?

Since $360 \div 60 = 6$, we get 6 radii and 6 equal parts of the circle:

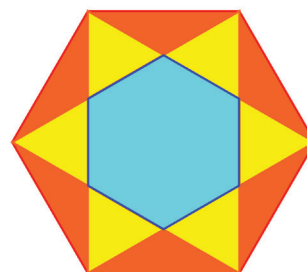
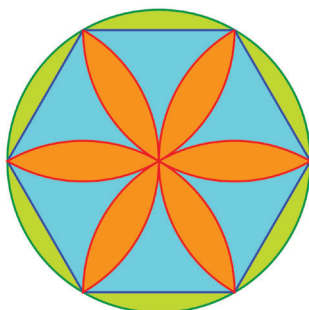


If we join the ends of these radii, we get a six-sided figure:



Remember drawing this figure using three circles in class 5? (The section **Circle math** of the lesson **Lines and Circles**).

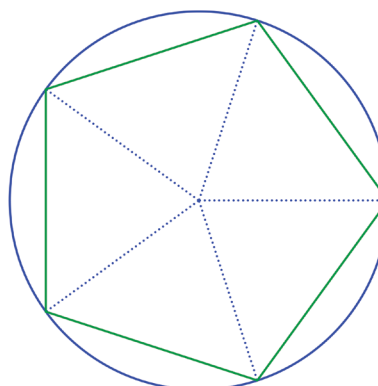
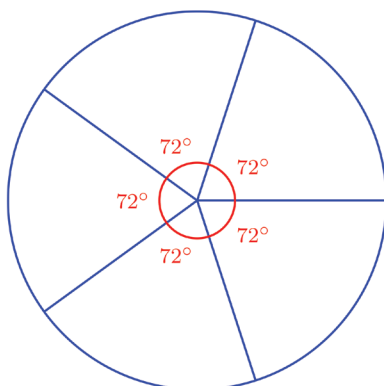
So, drawing these pictures from the class 5 textbook is now a little easier:



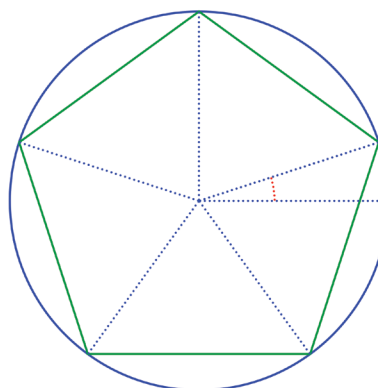
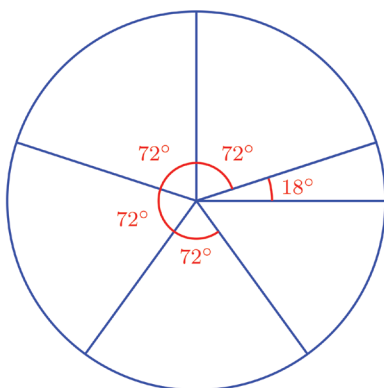
What if we want to draw a five-sided figure?

What angle should we take?

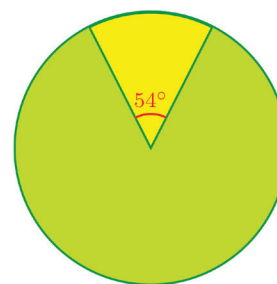
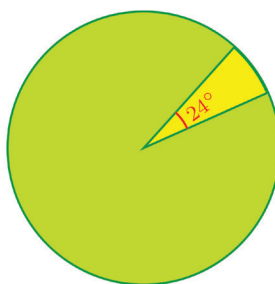
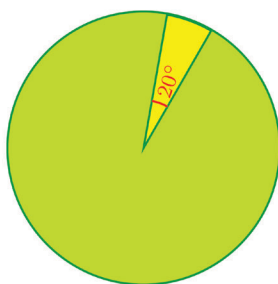
$$360^\circ \div 5 = 72^\circ.$$

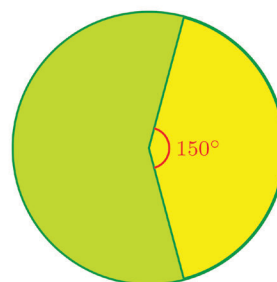
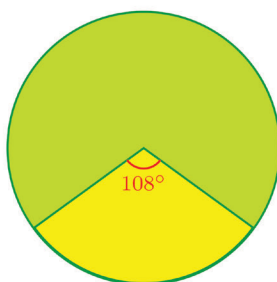
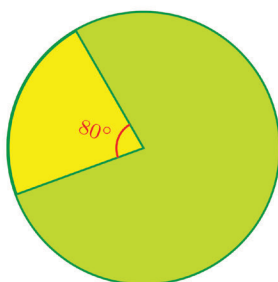


To get the figure upright without tilting, first draw a horizontal radius and a radius making an angle of $90^\circ - 72^\circ = 18^\circ$ with it. Then the radii 72° apart can be drawn:



- (1) In each of the pictures below, calculate what fractions of the circle are the yellow and green parts:





(2) Mark each of the fractions below as part of a circle and colour the pictures.

(i) $\frac{3}{8}$

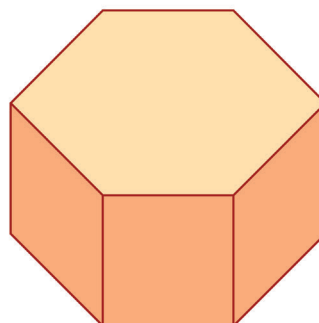
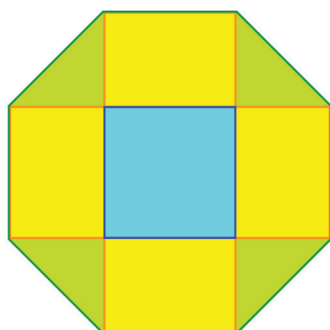
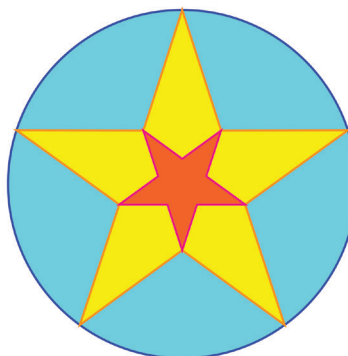
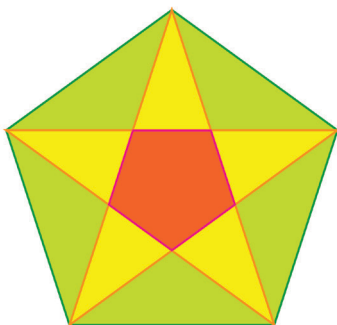
(ii) $\frac{2}{5}$

(iii) $\frac{4}{9}$

(iv) $\frac{5}{12}$

(v) $\frac{5}{24}$

(3) Draw the pictures below:

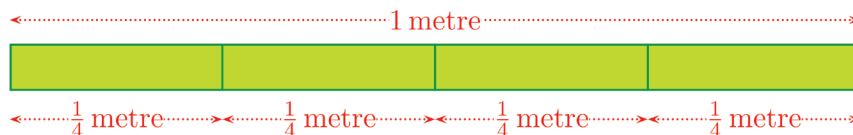
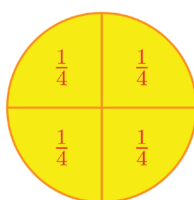
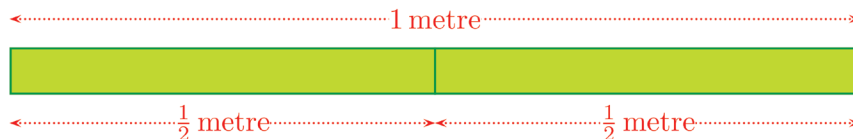
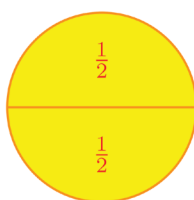


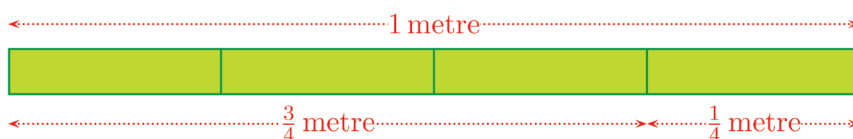
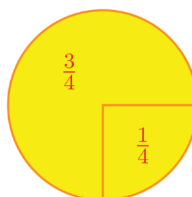
ONE FRACTION MANY FORMS



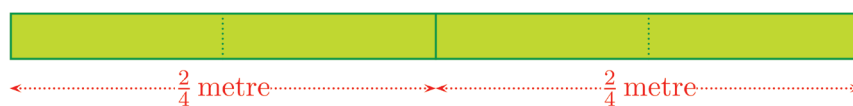
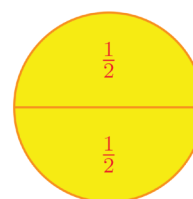
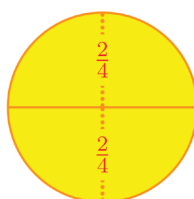
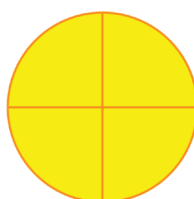
Numerator and denominator

We have seen in class 5, how parts of a measure can be written as fractions:

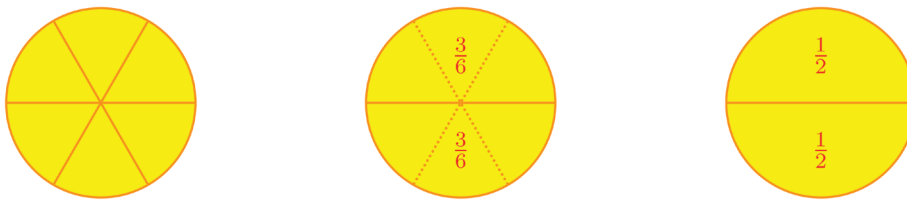




We have also seen that fractions in different forms can be the same measure. For example, $\frac{2}{4}$ and $\frac{1}{2}$ give the same part:



Similarly we have seen $\frac{3}{6}$ is also $\frac{1}{2}$.



Thus we have

$$\frac{1}{2} = \frac{2}{4} = \frac{3}{6}$$

How do we get different forms of $\frac{1}{2}$?

- If an object or a measure is divided into two equal parts, each is $\frac{1}{2}$ of the whole.



- What if each of these two equal parts is again split into two equal parts?



* $2 \times 2 = 4$ equal parts in all.

* To get $\frac{1}{2}$ of the whole, we must take 2 of these.



* $\frac{1}{2} = \frac{2}{4}$

- What if each of the two equal parts is split into three equal parts?



* $2 \times 3 = 6$ in all

- * To get $\frac{1}{2}$ of the whole, we must take 3 of these.



* $\frac{1}{2} = \frac{3}{6}$

We can continue like this as many times as we want.

For example, suppose we divide each of the two equal parts into 50 equal parts

$50 \times 2 = 100$ equal parts in all.

To get $\frac{1}{2}$ of the whole, how many of these should we take?

What another form of $\frac{1}{2}$ do we get from this?

In the fraction $\frac{50}{100}$ the lower number 100 shows the number of equal parts we have divided the whole into ; and the upper number 50 shows how many of these equal parts we take.

50 is called the **numerator** and 100 is called the **denominator** of the fraction $\frac{50}{100}$.

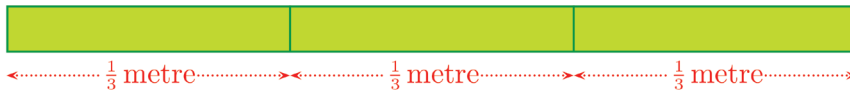
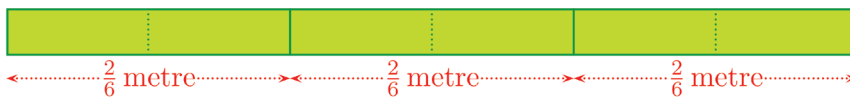
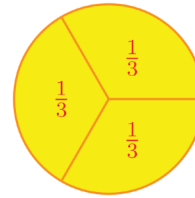
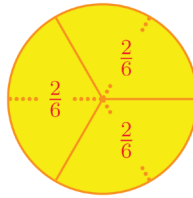
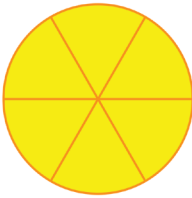
Now look at the many forms of $\frac{1}{2}$

$$\frac{1}{2}, \frac{2}{4}, \frac{3}{6}, \frac{4}{8}, \dots$$

In all these, the denominators 2, 4, 6, 8, ... are multiples of 2; and the numerators 1, 2, 3, 4, ... the numbers by which 2 is multiplied.

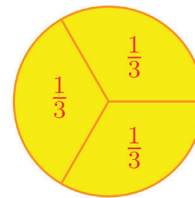
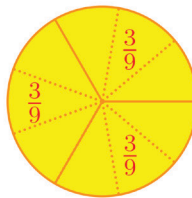
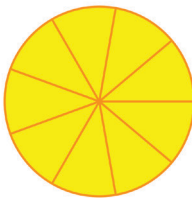
Next let's look at $\frac{1}{3}$.

We have seen that $\frac{1}{3}$ and $\frac{2}{6}$ give the same part.

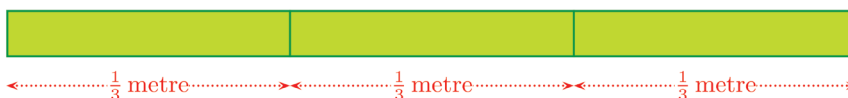
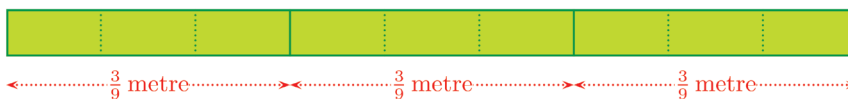


In what other ways can we write $\frac{1}{3}$?

What if we split a circle into 9 equal parts? How many parts should we take to get $\frac{1}{3}$ of the whole?



In the same manner, if we divide 1 metre into 9 equal parts and take three of them, we get $\frac{1}{3}$ metre.



We can continue this also, as in the case of $\frac{1}{2}$.

- If an object or a measurement is divided into three equal parts, each is $\frac{1}{3}$ of the whole.
- What if each of these three equal parts is again split into two equal parts?
 - * $2 \times 3 = 6$ equal parts in all.
 - * To get $\frac{1}{3}$ of the whole, we must take 2 of these.
 - * $\frac{1}{3} = \frac{2}{6}$
- What if each of the three equal parts is split again into three equal parts?
 - * $3 \times 3 = 9$ in all
 - * To get $\frac{1}{3}$ of the whole, we must take 3 of these.
 - * $\frac{1}{3} = \frac{3}{9}$

What if we divide each of the 3 equal parts into 25 equal parts?

How many parts in all ?

How many of them should be taken to get $\frac{1}{3}$ of the whole?

What another form of $\frac{1}{3}$ do we get from this?

Now look at these forms of $\frac{1}{3}$:

$$\frac{1}{3}, \frac{2}{6}, \frac{3}{9}, \frac{4}{12}, \dots$$

In all these, the denominators 3, 6, 9, 12, ... are multiples of 3 ; and the numerators 1, 2, 3, 4, ... are the numbers by which 3 is multiplied.



(1) Find the fractions specified below :

- (i) The form of $\frac{1}{2}$ with denominator 24
- (ii) The form of $\frac{1}{2}$ with numerator 24
- (iii) The form of $\frac{1}{3}$ with denominator 24
- (iv) The form of $\frac{1}{3}$ with numerator 24
- (v) The form of $\frac{1}{4}$ with numerator 100

(2) Write three different forms of $\frac{1}{4}$.

(3) For each of the pair of fractions below, find three forms with the same denominator:

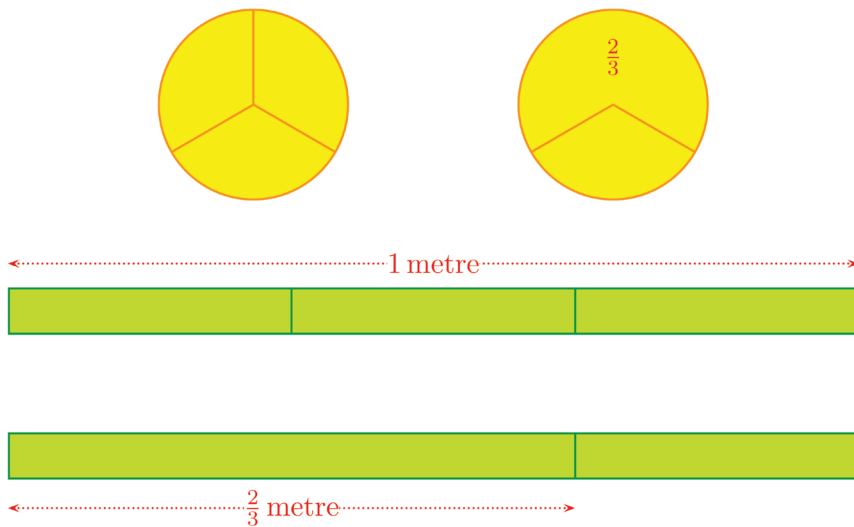
(i) $\frac{1}{2}, \frac{1}{3}$ (ii) $\frac{1}{2}, \frac{1}{4}$ (iii) $\frac{1}{3}, \frac{1}{4}$

(4) Does $\frac{1}{3}$ have another form with denominator 10, 100 or 1000 ? Give reasons.

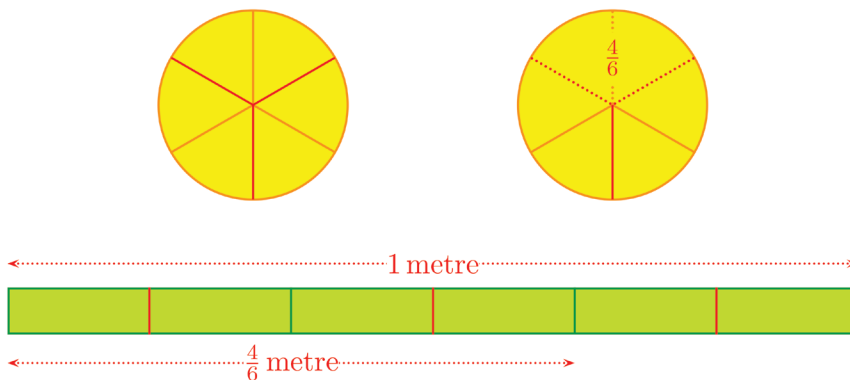
Let's look at another kind of fractions.

How do we find different forms of $\frac{2}{3}$?

We get $\frac{2}{3}$ by dividing an object or measure into 3 equal parts and taking 2 of these:



What if we divide each of the three equal parts again into two equal parts?



$2 \times 3 = 6$ equal parts in all; and the 2 large equal parts taken earlier now become $2 \times 2 = 4$ small equal parts.

In other words, as the total number of equal parts is doubled, the number of parts taken also is doubled.

$$\frac{2}{3} = \frac{4}{6}$$

This can also continue. What if we divide each of the first 3 equal parts into 3 equal parts ?

- $3 \times 3 = 9$ equal parts in all
- The 2 equal parts taken first become $3 \times 2 = 6$ equal parts.

That is, as the total number of equal parts is tripled, the number of parts taken also is tripled.

Thus in all the different forms of $\frac{2}{3}$, the denominators are all multiples of 3; and the numerators are 2 multiplied by the number by which 3 is multiplied.

We can compute different forms of any fraction like this. In general, we can say this:

Multiplying the numerator and denominator of a fraction by the same natural number gives a form of the same fraction.



Now can't you fill up the following table, by multiplying the numerator and denominator by a number?

Fraction	Multiplier	Numerator	Denominator	Another form
$\frac{2}{3}$	4	8	12	$\frac{2}{3} = \frac{8}{12}$
$\frac{2}{3}$	6			
$\frac{3}{4}$			12	
$\frac{3}{4}$		12		

Let's look at another kind of problem:

Can we write the fraction $\frac{10}{15}$ in another form with a smaller numerator and denominator?

Both 10 and 15 have 5 as a factor.

$$10 = 2 \times 5$$

$$15 = 3 \times 5$$

In other words, we get 10 and 15 by multiplying 2 and 3 by the same number 5. So by the result above,

$$\frac{10}{15} = \frac{2}{3}$$

How do we reduce $\frac{18}{24}$ like this?

18 and 24 are even numbers; that is, both have 2 as a factor:

$$18 = 9 \times 2$$

$$24 = 12 \times 2$$

So, as above,

$$\frac{18}{24} = \frac{9}{12}$$

Do 9 and 12 have a common factor?

3 is a factor, right? So,

$$\frac{9}{12} = \frac{3}{4}$$

Thus,

$$\frac{18}{24} = \frac{9}{12} = \frac{3}{4}$$

Like this, if the numerator and denominator of any fraction have a common factor, then we can remove this to get another form with smaller numerator and denominator.

In general, we have this result :

If the numerator and denominator of a fraction have a common factor, then dividing them by this common factor gives a form of this fraction.

In the second example above, we first divided the numerator and denominator of $\frac{18}{24}$ by the common factor 2 and wrote it as $\frac{9}{12}$; then divided the numerator and denominator again by 3 to reduce it further and wrote it as $\frac{3}{4}$.

We can't make the numerator and denominator still smaller, can we? Why?

$\frac{3}{4}$ is called the form of $\frac{18}{24}$ **in lowest terms**.

In general, the form of a fraction in lowest terms is got by removing all common factors of the numerator and denominator by division.



Write each of the following fractions in lowest terms:

(i) $\frac{32}{64}$

(ii) $\frac{27}{81}$

(iii) $\frac{30}{45}$

(iv) $\frac{12}{21}$

(v) $\frac{45}{54}$

Fraction as division

If a 2 metres piece of rope is divided into 3 equal pieces, what would be the length of each piece?

We have seen in class 5 that it is $\frac{2}{3}$ metre (The section **Fractional share** of the lesson **Fractions**).

What if we cut 6 metres long rope into 3 equal pieces?

This we compute as a division:

$$6 \div 3 = 2$$

We have seen in class 5 that, this too can be written as a fraction (The section **Fraction and division** of the lesson **Fractions**).

That is,

$$6 \div 3 = \frac{6}{3} = 2$$

Any division can be written as a fraction like this. For example:

$$8 \div 2 = 4$$

$$\frac{8}{2} = 4$$

$$15 \div 3 = 5$$

$$\frac{15}{3} = 5$$

$$30 \div 10 = 3$$

$$\frac{30}{10} = 3$$

Since any natural number divided by 1 gives that number itself, we can write all natural numbers as fractions:

$$1 \div 1 = 1$$

$$1 = \frac{1}{1}$$

$$2 \div 1 = 2$$

$$2 = \frac{2}{1}$$

$$3 \div 1 = 3$$

$$3 = \frac{3}{1}$$

This raises a question: In fractions written as divisions also, can we remove the common factors of the numerator and denominator?

This too can be done, as we have seen in class 5 (the section **Common factors** of the lesson **Within Numbers**).

For example to compute $12 \div 6$, we first write these numbers as

$$12 = 6 \times 2$$

$$6 = 3 \times 2$$

Then we can remove the common factor 2 and do the division as

$$12 \div 6 = 6 \div 3 = 2$$

These computations can be written in the form of fractions as

$$\frac{12}{6} = \frac{6 \times 2}{3 \times 2} = \frac{6}{3} = 2$$

So, natural numbers can be written as fractions in various ways :

$$1 = \frac{1}{1} = \frac{2}{2} = \frac{3}{3} = \dots$$

$$2 = \frac{2}{1} = \frac{4}{2} = \frac{6}{3} = \dots$$

$$3 = \frac{3}{1} = \frac{6}{2} = \frac{9}{3} = \dots$$

Again, we have seen in class 5 that divisions which involve remainders can also be written as fractions (the section **New fractions** of the lesson **Fractions**).

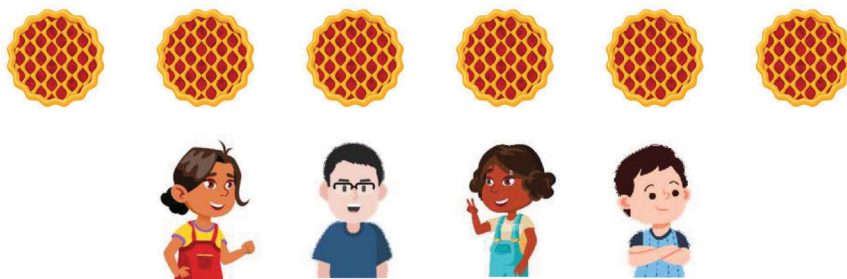
For example, if 3 cakes are divided equally between 2 children, each gets a full cake and half a cake. That is $1 + \frac{1}{2} = 1\frac{1}{2}$ cake. This also we can write as a fraction:

$$3 \div 2 = \frac{3}{2} = 1\frac{1}{2}$$

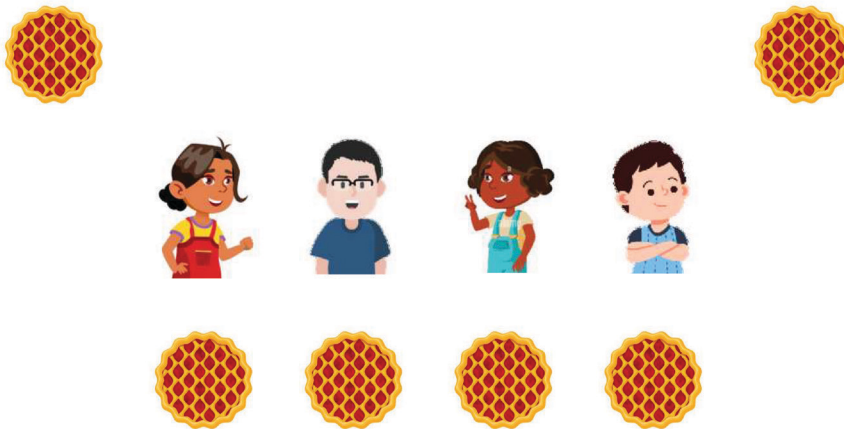
In such fractions also, can we remove common factors of the numerator and denominator?

For example, see this problem :

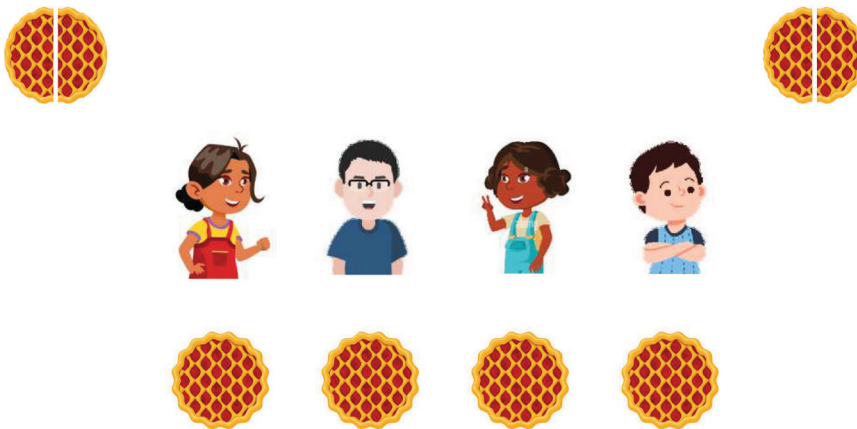
If 6 cakes are divided equally among 4 children, how much would each get?



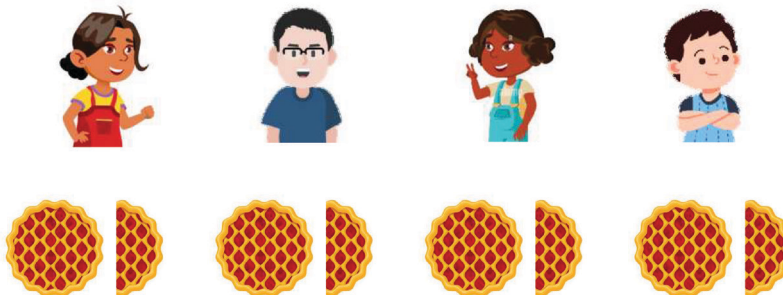
After giving one cake to each , there will be 2 cakes left:



If each of these is cut into half, there would be 4 pieces, each of them $\frac{1}{2}$ of a cake:



If these pieces are also distributed one to each, then what each gets altogether is $1\frac{1}{2}$ cake:

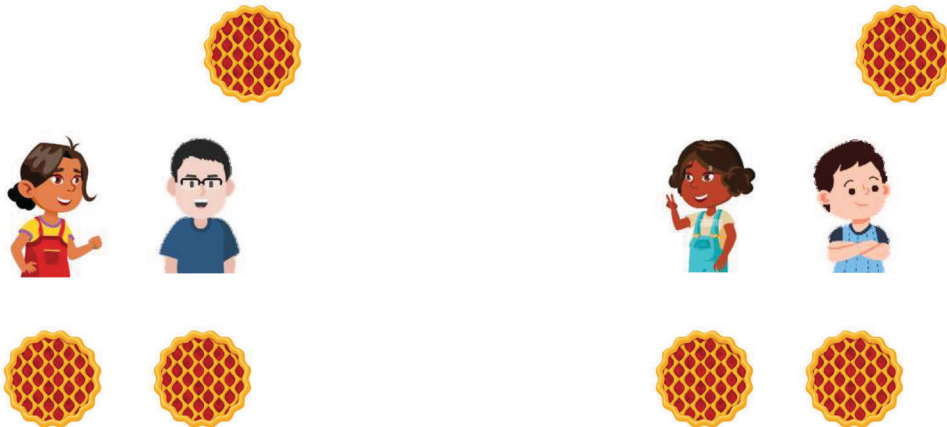


This can be done in another way:

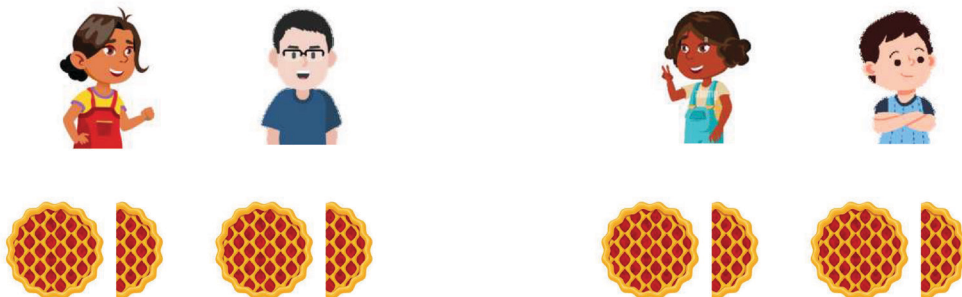
To divide 6 cakes between 4 children, we can split the kids into 2 sets of 2 and give 3 cakes to each set:



In each set, when one cake is given to each of the 2 kids, one cake will be left:



If the remaining one cake in each group is cut into half and a piece given to each of the two children, then everyone gets half a cake more.



What did we see here?

$$\frac{6}{4} = \frac{3}{2} = 1\frac{1}{2}$$

Let's look at another problem:

If 33 litres of milk is divided equally between 12 persons, how much would each get?

Here we first split 33 and 12 like this:

$$33 = 11 \times 3 \qquad 12 = 4 \times 3$$

So we can think like this, as in the previous problem:

Split the 12 persons into 3 groups of 4 and give 11 litres to each group.

When the 4 persons in each group divide the 11 litres equally among themselves, each person gets $\frac{11}{4}$ litres.

That is,

$$\frac{33}{12} = \frac{11}{4}$$

Now how do we write $\frac{11}{4}$ as a whole number and a fraction?

First we divide 11 by 4 and write as multiple and remainder:

$$11 = (2 \times 4) + 3$$

Dividing the remainder 3 also by 4, we can write $3 \div 4 = \frac{3}{4}$.

So,

$$\frac{33}{12} = \frac{11}{4} = 2\frac{3}{4}$$

Thus each gets $2\frac{3}{4}$ litres.

In general, if we remove common factors of the numerator and denominator of a fraction, then we get another form of the same fraction.

That is, in writing divisions with remainders as fractions, we can remove common factors of the numerator and denominator.



- (1) 20 litres of water is used to fill 8 identical bottles. How much litres of water is there in each bottle?
- (2) A rope of length 140 centimetres is cut into 16 equal pieces. What is the length of each piece?
- (3) If 215 kilograms of rice is divided equally among 15 people, how much kilogram of rice would each get?

VOLUME



Large and small

Athira has collected many things and has arranged them into different lots.



Look at the two things from the first lot.



Which is bigger?

How did you find out?

Now look at the two things from the second lot:



How do we find out which is bigger?

To find out the bigger of the two sticks, we need only measure their lengths.

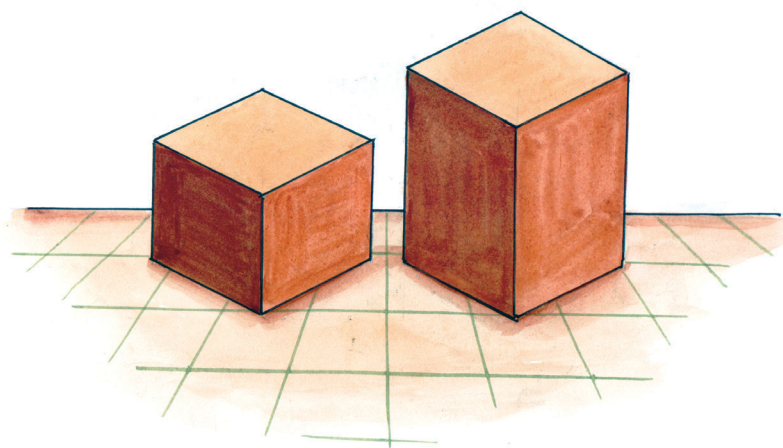
What about two rectangles?

We have to calculate their areas, right?

Rectangular blocks

Look at two wooden blocks from Athira's collection.

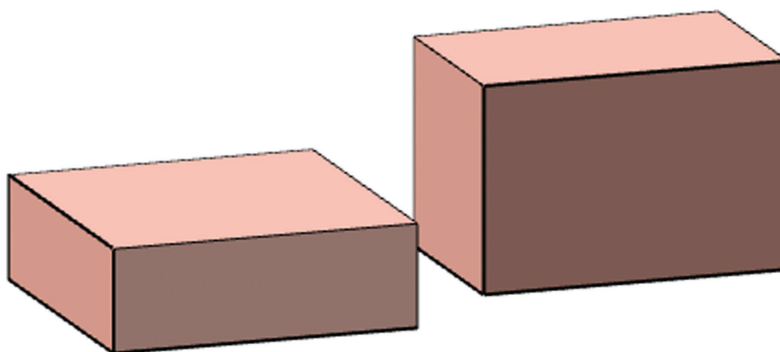
Which is larger?



How did you decide?

Now look at these two.

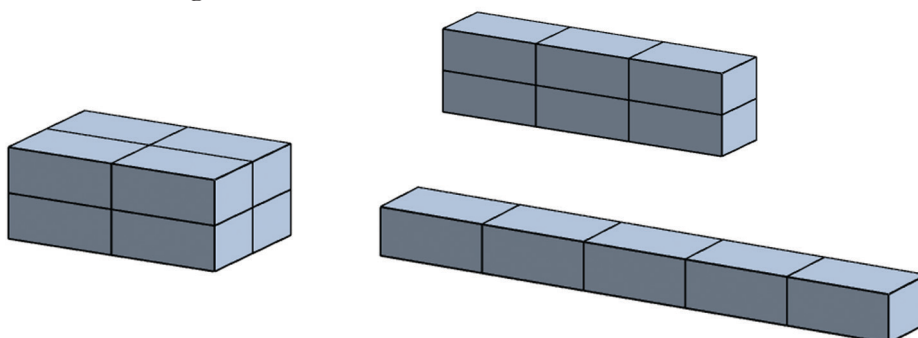
Which is larger?



Let's see how we can decide.

Size of a rectangular block

Look at these rectangular blocks:



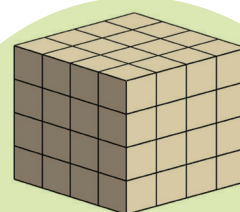
They are all made by stacking smaller blocks of the same size.

Which of them is the largest?

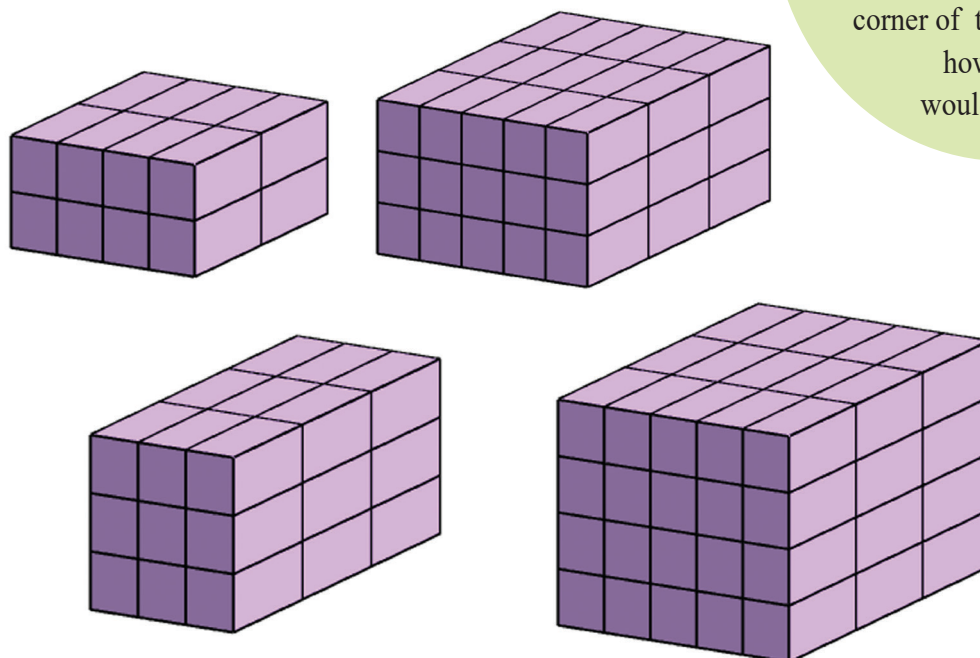
We need only count the little blocks in each, right?

Can you find how many little blocks make up each of the blocks below?

Is there a quick way to find the number of little blocks in each, without actually counting all?



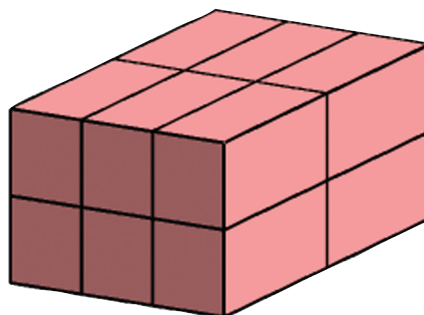
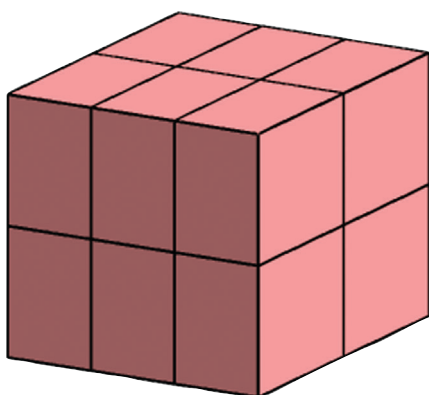
How many small cubes are used to make this large cube? If one small block is removed from each corner of the large block, how many would be left?



Which of these is the largest?

And the smallest?

Look at these blocks:



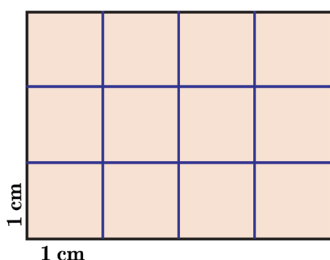
How many small blocks are there in each?

Do they have the same size?

To compare sizes by just counting, what kind of little blocks should be used in both?

Size as number

Look at this picture:

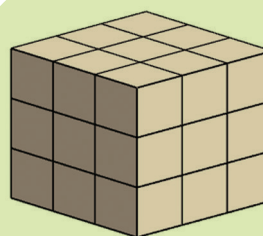


What is the area of this rectangle?

How many small squares of side 1 centimetre are in it?

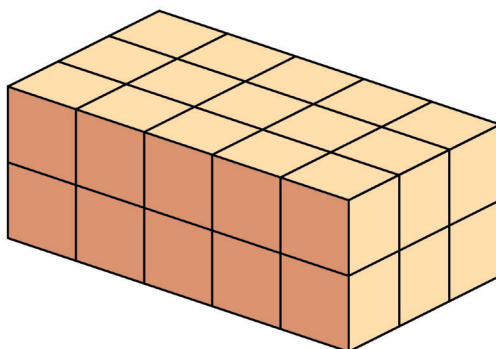
$$4 \times 3 = 12$$

The area of a square of side 1 centimetre is 1 square centimetre; the area of the whole rectangle is 12 square centimetres.



All sides of the large cube are painted. How many small cubes would have no paint at all?

Now look at the rectangular block:



It is made by stacking cubes of side 1 centimetre.

How many?

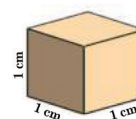
So, the size of this block is equal to 30 such cubes.

Size measured like this is called **volume** in mathematics.

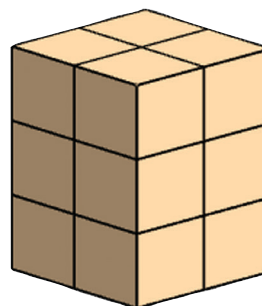
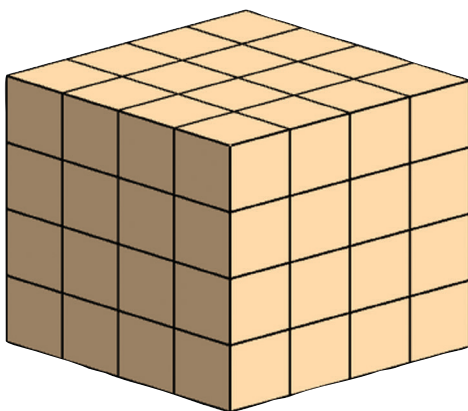
We say that a cube of side 1 centimetre has a volume of 1 **cubic centimetre**.

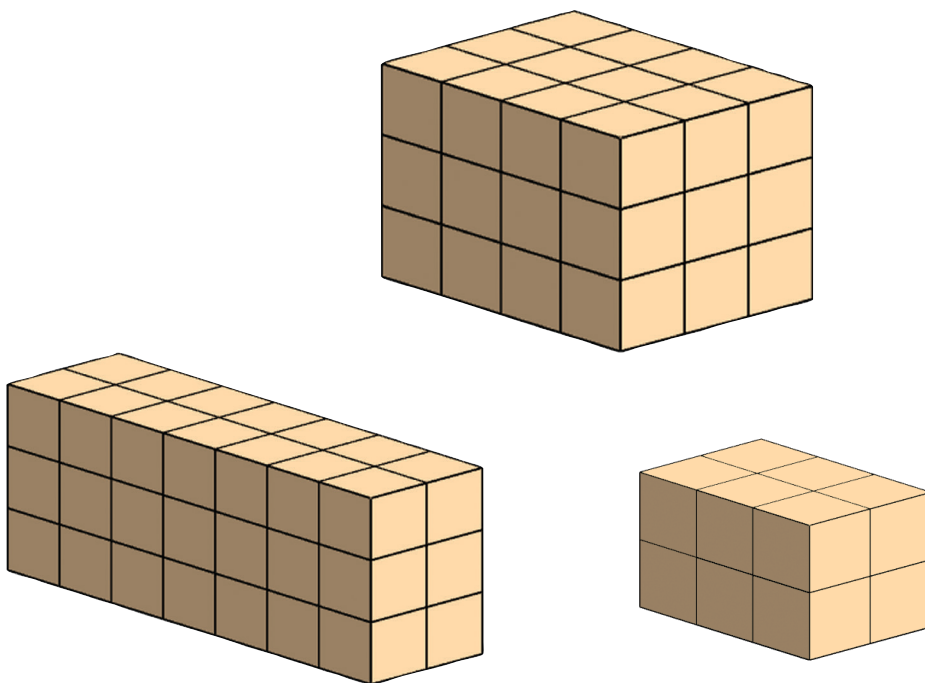
30 such cubes make the large block in the picture.

Its volume is 30 cubic centimetres.



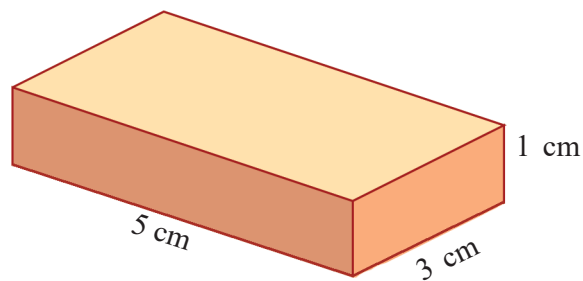
All blocks shown below are made up of cubes of side 1 centimetre.
Calculate the volume of each:





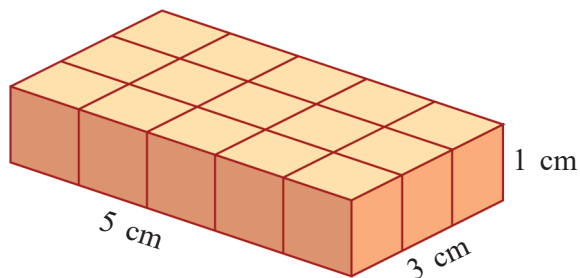
Volume calculation

See this rectangular block:



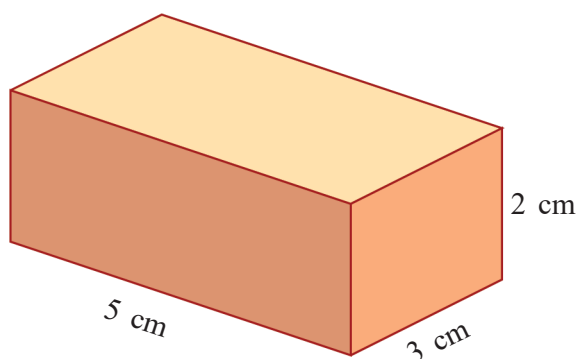
How do we calculate its volume?

For that, we must find out how many cubes of side 1 centimetre we need to make it.

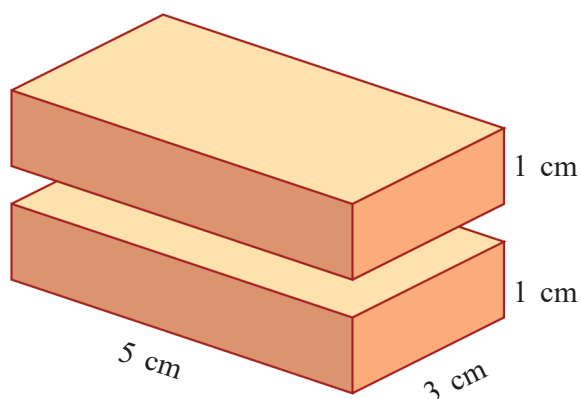


So, its volume is 15 cubic centimetres.

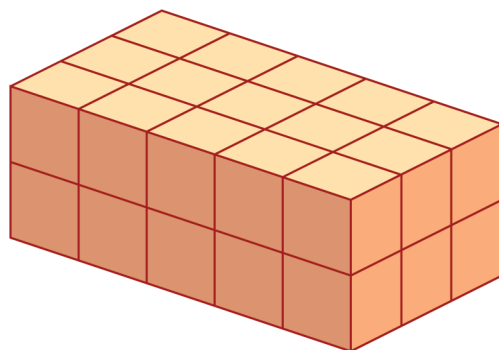
What about this block?



This can be made by stacking one over another, the two blocks seen first:

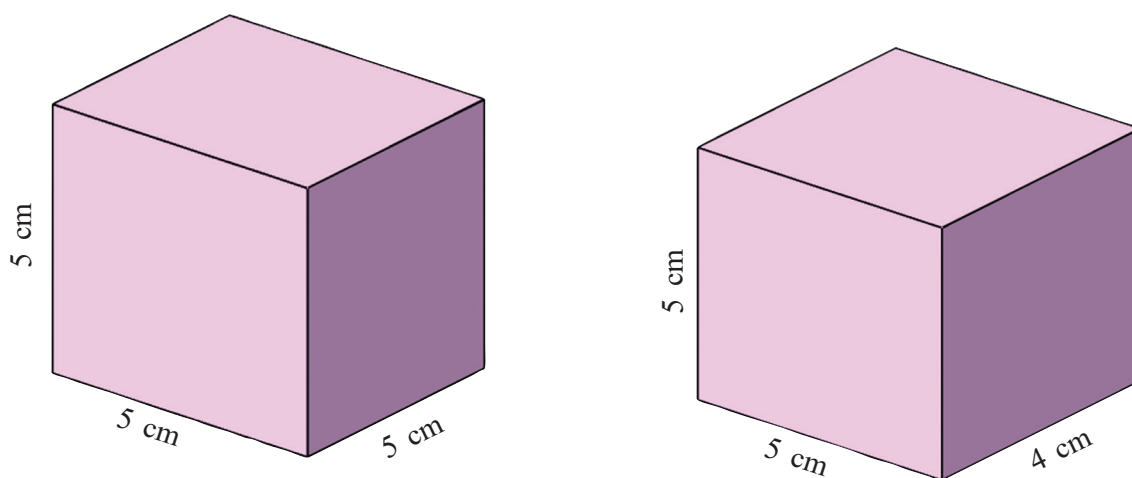
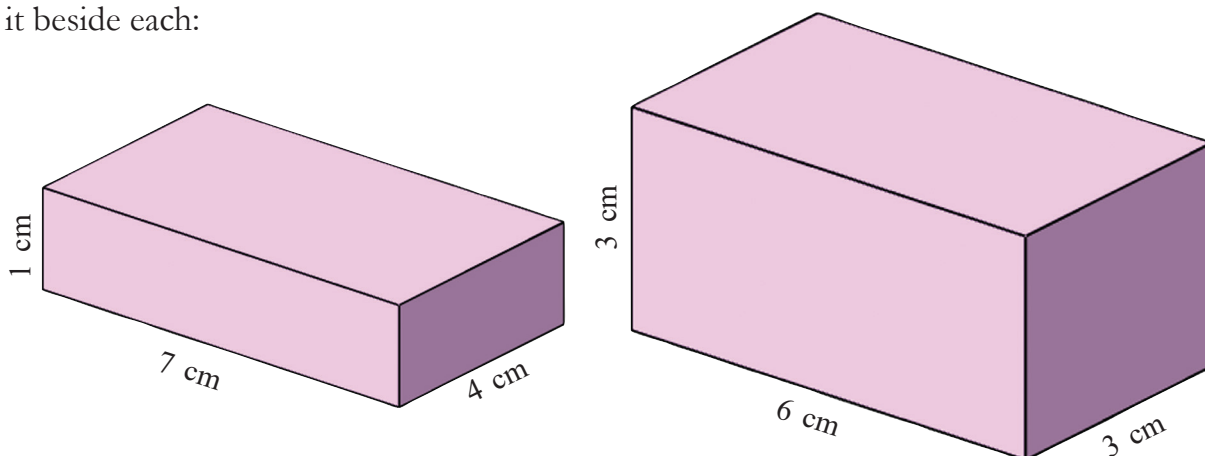


So, to make it, how many cubes of side 1 centimetre do we need?



Thus the volume of this block is 30 cubic centimetres.

Like this, calculate the volume of each of the rectangular blocks shown below and write it beside each:



So, now you know how to calculate the volume of a rectangular block, don't you?

The volume of a rectangular block is the product of its length, width and height.



- (1) The length, width and height of a brick are 21 centimetres, 15 centimetres and 7 centimetres. What is its volume?
- (2) An iron cube is of side 8 centimetres. What is its volume? 1 cubic centimetre of iron weighs 8 grams. What is the weight of the this cube?

Volume and length

A wooden block of length 9 centimetres and width 4 centimetres has a volume of 180 cubic centimetres. What is its height?

Volume is the product of length, width and height.

So in this problem, the product of 9 and 4 multiplied by the height is 180.

That is, 36 multiplied by the height gives 180.

So to find out the height, we need only divide 180 by 36.

Area and volume

What is the area of a rectangle of length 8 centimetres and width 2 centimetres? What about the volume of a rectangular block of length 8 centimetres, width 2 centimetres and height 1 centimetre?

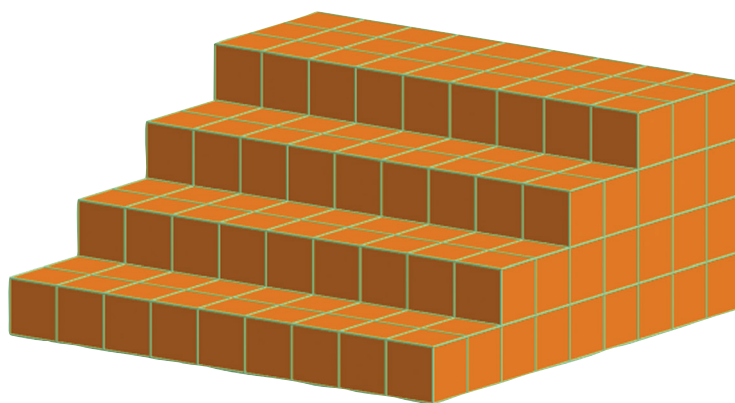


The table shows the measurement of some rectangular blocks. Calculate the missing measures.

	Length	Width	Height	Volume
1	3 cm	8 cm	7 cm	... cc
2	6 cm	4 cm	5 cm	... cc
3	6 cm	4 cm	... cm	48 cc
4	8 cm	... cm	2 cm	48 cc
5	... cm	2 cm	2 cm	48 cc
6	... cm	2 cm	4 cm	80 cc
7	14 cm	... cm	5 cm	210 cc

New shapes

We can make shapes other than rectangular block, by stacking cubes. For example, see this:



It is made by stacking cubes of side 1 centimetre. Can you calculate its volume?

How many cubes are there at the very bottom?

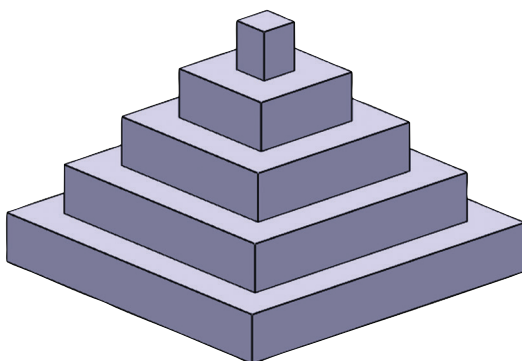
And in the step just above it?

Thus we can count the number of cubes in each step.

How many cubes in all?

What is the volume of the stairs?

Now look at this figure:



What is the volume of a rectangular block of length 4 centimetre, width 3 centimetre and height 1 centimetre?

If the length, width and height are doubled, what happens to the volume?

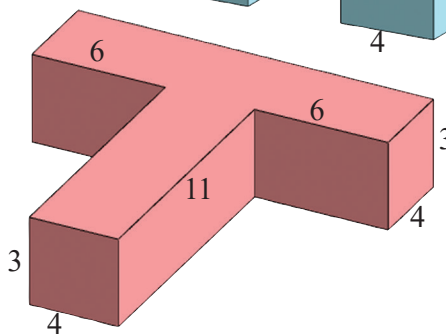
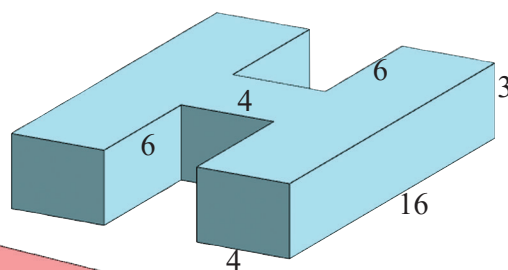
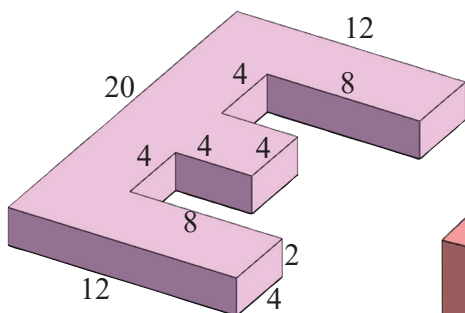
It is made by stacking square blocks. The bottom block is of side 9 centimetres. As we move up, the sides decrease by 2 centimetres at each step.

All blocks are of height 1 centimetre. What is the volume of this figure?

Just calculate the volume of each square block and add. Try it.



Calculate the volumes of the shapes shown below. All lengths are in centimetres.



Large measures

What is the volume of a cube of side 1 metre?

1 metre means 100 centimetres.

So, we must calculate the volume of a cube of side 100 centimetres.

How much is it?

We say that the volume of a cube of side 1 metre is 1 cubic metre.

So,

$$1 \text{ cubic metre} = 1000000 \text{ cubic centimetres.}$$

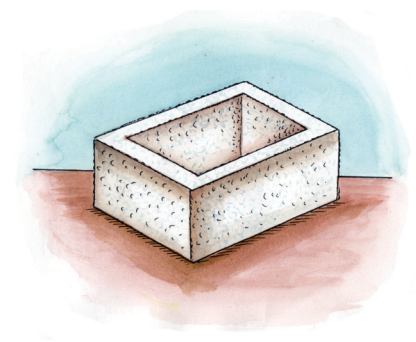
Volume of large objects are often said as cubic metres.



- (1) A truck is loaded with sand, 4 metre long, 2 metre wide and 1 metre high. The price of 1 cubic metre of sand is 1000 rupees. What is the price of this truck load?
- (2) What is the volume in cubic centimetres of a platform 6 metres long, 1 metre wide and 50 centimetres high?
- (3) What is the volume of a piece of wood which is 5 metres long, 1 metre wide and 25 centimetres high? The price of 1 cubic metre of wood is 60000 rupees. What is the price of this piece of wood?

Capacity

Look at this hollow box:



It is made with thick wooden planks. Because of the thickness, its inner length, width and height are less than the outer measurements.

The inner length, width and height are 40 centimetres, 20 centimetres and 10 centimetres.

So, a rectangular block of these measurement can exactly fit into the space within this box.

The volume of this rectangular block is the volume within the box.

This volume is called the **capacity** of the box.

Thus the capacity of this box is;

$$40 \times 20 \times 10 = 8000 \text{ cubic centimetres.}$$

So, what is the capacity of a box whose inner length, width and height are 50 centimetres, 25 centimetres and 20 centimetres?

Liquid measures

What is the capacity of a cubical vessel of inner side 10 centimetres?

$$10 \times 10 \times 10 = 1000 \text{ cubic centimetres}$$

1 litre is the amount of water that fills this vessel.

$$1 \text{ litre} = 1000 \text{ cubic centimetres}$$

We can look at this in another way. If a cube of side 10 centimetres is completely immersed in a vessel filled with water, then the amount of water that overflows would be 1 litre.

So, how many litres of water do a vessel of length 20 centimetres, width 15 centimetres and height 10 centimetres contain?

Let's look at another problem:

A rectangular tank of length 4 metres and height $2\frac{1}{2}$ metres can contain 15000 litres of water. What is the width of the tank?

If we find the product of length, width and height in metres, we get the volume in cubic metres.

Here the volume is given as 15000 litres.

Litre and cubic metre

1 litre is 1000 cubic centimetres and 1 cubic metres is 1000000 cubic centimetres. So, 1 cubic metre is 1000 litres.

In the water

A vessel is filled with water. If a cube of side 1 centimetre is immersed into it, how many cubic centimetre of water would overflow? What if 20 such cubes are immersed?



That is, 15 cubic metres.

The product of length and height is $4 \times 2\frac{1}{2} = 10$

So, width multiplied by 10 is 15.

From this, we can calculate the width as

$$\frac{15}{10} = 1\frac{1}{2} \text{ metres.}$$

Now suppose this tank contains 6000 litres of water. What is the height of the water?

The amount of water is 6 cubic metres.

So, the product of the length and width of the tank and the height of the water, all in metres is 6.

Product of length and width is $4 \times 1\frac{1}{2} = 6$

So, height is $6 \div 6 = 1$ metre.

Raising water

A swimming pool is 25 metres long, 10 metres wide and 2 metres deep. It is half filled. How many litres of water does it contain now?

$$25 \times 10 \times 1 = 250 \text{ cubic metres} \\ = 250000 \text{ litres}$$

Suppose the water level is increased by 1 centimetre. How many more litres of water does it contain now?



- (1) The inner sides of a cubical box are of length 4 centimetres. What is its capacity? How many cubes of side 2 centimetres can be stacked inside it?
- (2) The inner sides of a rectangular tank are 70 centimetres, 80 centimetres and 90 centimetres. How many litres of water can it contain?
- (3) The length and width of a rectangular box are 90 centimetres and 40 centimetres. It contains 180 litres of water. How high is the water level?
- (4) The inner length, width and height of a tank are 80 centimetres, 60 centimetres and 50 centimetres, and it contains water 15 centimetres high. How much more water is needed to fill it?
- (5) The panchayat decided to make a rectangular pond. The length, width and depth were decided to be 20 metres, 15 metres and 2 metres. How many litres of water is needed to fill this pond to a height of one and a half metres?

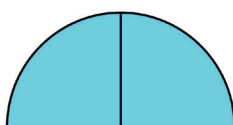
- (6) The inner length and width of an aquarium are 60 centimetres and 30 centimetres. It is half filled with water. When a stone is immersed in it, the water level rose by 10 centimetres. What is the volume of the stone?
- (7) A rectangular iron block has length 20 centimetres, width 10 centimetres and height 5 centimetres. It is melted and recast into a cube. What is the length of a side of this cube?
- (8) A tank 2 metres long and 1 metre wide is to contain 10000 litres of water. What should be the height of the tank?
- (9) From the four corners of a square piece of paper of side 12 centimetres, small squares of side 1 centimetre are cut off. The edges of this are bent up and joined to form a container of height 1 centimetre. What is the capacity of this container? If squares of side 2 centimetres are cut off, what would be the capacity?

ARITHMETIC OF PARTS



Joining parts

If a circle is divided into four equal parts and two of these are joined together, we get half a circle:



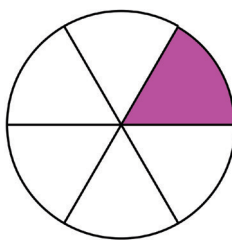
Thus a quarter circle joined to a quarter circle makes half a circle.

That is, two quarters make a half.

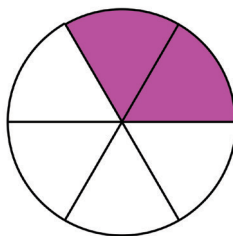
We can write it like this:

$$\frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

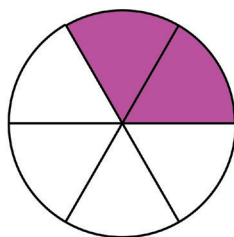
Now draw a circle and divide it into six equal parts. Colour one part :



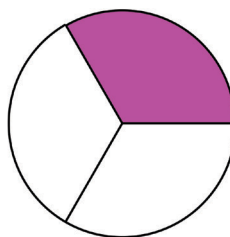
Now, colour one more part:



Now $\frac{2}{6}$ of the circle is coloured. $\frac{2}{6}$ is another form of $\frac{1}{3}$, isn't it?



$\frac{2}{6}$



$\frac{1}{3}$

We can write this also as a sum:

$$\frac{1}{6} + \frac{1}{6} = \frac{2}{6} = \frac{1}{3}$$

Suppose a circle is divided into eight equal parts and two of them are joined together. Can you mentally calculate what fraction of the circle we have now?

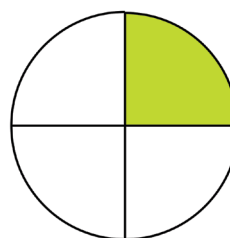
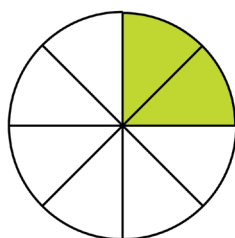
2 of 8 equal parts is $\frac{2}{8}$; also we can see that

$$\frac{2}{8} = \frac{1 \times 2}{4 \times 2} = \frac{1}{4}$$

So, we have

$$\frac{1}{8} + \frac{1}{8} = \frac{2}{8} = \frac{1}{4}$$

We can also show this by drawing circles and colouring parts:



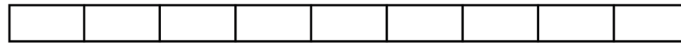
If we join $\frac{1}{8}$ of the circle and $\frac{3}{8}$ of the circle, what fraction of the circle would we get?

We took $1 + 3 = 4$ parts of 8 equal parts; that is $\frac{4}{8}$. We can reduce the numerator and denominator of this:

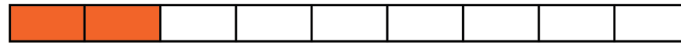
$$\frac{1}{8} + \frac{3}{8} = \frac{4}{8} = \frac{1}{2}$$

Draw pictures of circle with coloured parts to show this.

Take a long white ribbon and mark 9 equal parts:



Colour 2 parts:



Then colour 4 more:



Now $2 + 4 = 6$ parts are coloured.

We can say this in another way: first we coloured $\frac{2}{9}$ of the ribbon; and then coloured $\frac{4}{9}$ of it; altogether $\frac{6}{9}$ of the ribbon.

We can write this as a sum of fractions:

$$\frac{2}{9} + \frac{4}{9} = \frac{6}{9}$$

In this, we can reduce $\frac{6}{9}$ to the lowest terms:

$$\frac{6}{9} = \frac{2 \times 3}{3 \times 3} = \frac{2}{3}$$



Thus we have,

$$\frac{2}{9} + \frac{4}{9} = \frac{6}{9} = \frac{2}{3}$$

Now look at this picture:



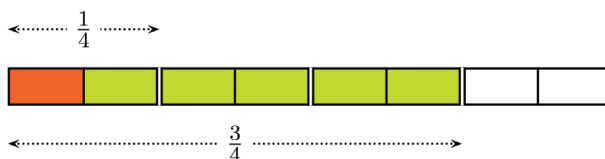
What fraction of the ribbon is coloured red?

And the fraction coloured green?

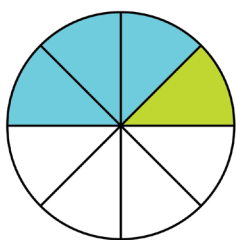
What fraction is coloured altogether?

What sum of fractions do we get from this?

$$\frac{1}{8} + \frac{5}{8} = \frac{6}{8} = \frac{3}{4}$$



In each of the pictures below, write the parts of each colour and the total coloured parts as fractions. Write the sum of fractions got from each picture in lowest terms.

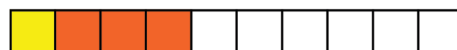


Colour Part

Colour Part

Total Part

$$\boxed{} + \boxed{} = \boxed{} = \boxed{}$$

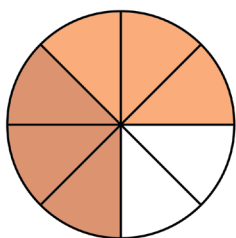


Colour Part

Colour Part

Total Part

$$\boxed{} + \boxed{} = \boxed{} = \boxed{}$$

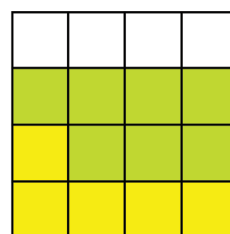


Colour Part

Colour Part

Total Part

$$\boxed{} + \boxed{} = \boxed{} = \boxed{}$$



Colour Part

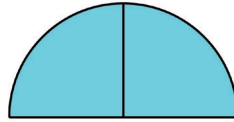
Colour Part

Total Part

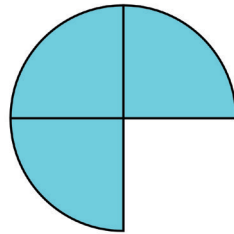
$$\boxed{} + \boxed{} = \boxed{} = \boxed{}$$

Addition of fractions

If a circle is cut into four equal pieces and two of them joined together, we get half a circle:

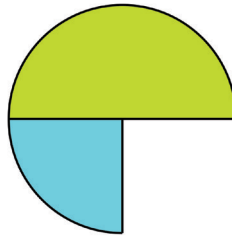


What if one more piece is joined to this?

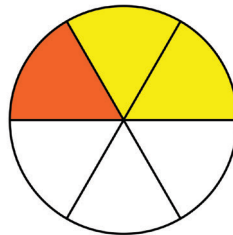


We get three quarters of a circle. Thus half and a quarter make three quarters:

$$\frac{1}{2} + \frac{1}{4} = \frac{3}{4}$$



Now see this picture:



A circle is divided into six equal pieces, one of which is coloured red and two of them coloured yellow. Total number of the pieces coloured is $1 + 2 = 3$. How do we write this as a sum of fractions?

$$\frac{1}{6} + \frac{2}{6} = \frac{3}{6}$$

In this $\frac{2}{6}$ and $\frac{3}{6}$ can be reduced to their lowest terms:

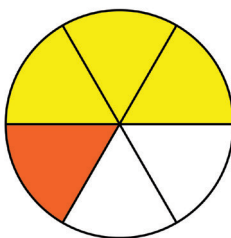
$$\frac{2}{6} = \frac{1}{3} \qquad \frac{3}{6} = \frac{1}{2}$$

So, we can write this sum as

$$\frac{1}{6} + \frac{1}{3} = \frac{1}{2}$$



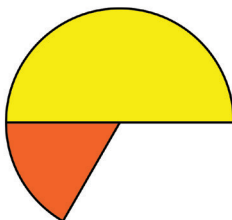
What sum do we get from the picture below?



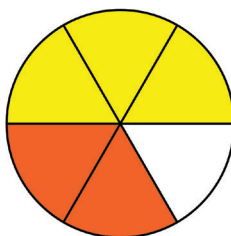
$$\frac{1}{6} + \frac{3}{6} = \frac{4}{6}$$

If we write $\frac{3}{6} = \frac{1}{2}$ and $\frac{4}{6} = \frac{2}{3}$, in lowest terms, then this sum can be written like this:

$$\frac{1}{6} + \frac{1}{2} = \frac{2}{3}$$



What about this picture?

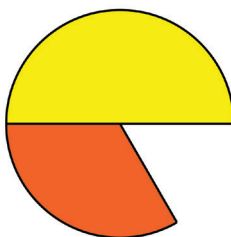


The sum we get is

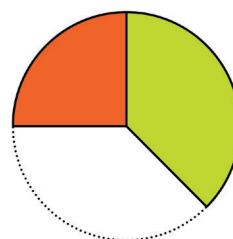
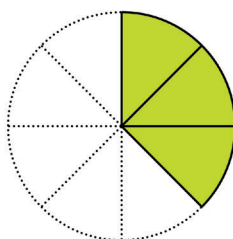
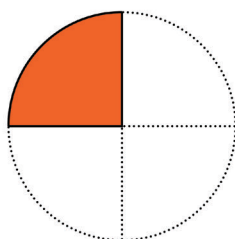
$$\frac{2}{6} + \frac{3}{6} = \frac{5}{6}$$

Reducing $\frac{2}{6}$ and $\frac{3}{6}$ to lowest terms, this becomes:

$$\frac{1}{3} + \frac{1}{2} = \frac{5}{6}$$



Now see these pictures:



$\frac{1}{4}$ of a circle and $\frac{3}{8}$ of another circle of the same size are cut out and these pieces are put together. What fraction of the full circle is this?

If the pieces are all alike, we need only count their numbers. What if we see the one-fourth of the circle as two one-eighths joined together?

$\frac{3}{8}$ is 3 such parts.

So $2 + 3 = 5$ of 8 equal parts of the circle, which make $\frac{5}{8}$.

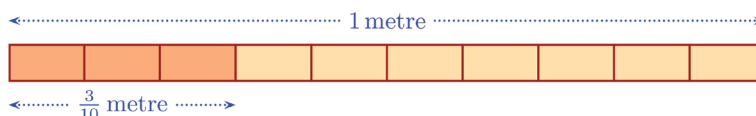
Thus we get

$$\frac{1}{4} + \frac{3}{8} = \frac{2}{8} + \frac{3}{8} = \frac{5}{8}$$

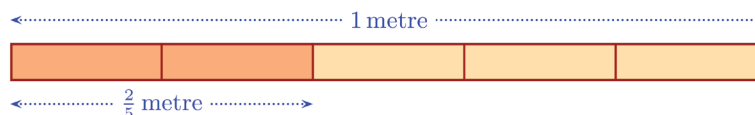
Let's look at another problem.

Two ribbons of lengths $\frac{3}{10}$ metre and $\frac{2}{5}$ metre are joined end to end. What is the total length?

The first ribbon is 3 of 10 equal parts of a 1 metre long ribbon:

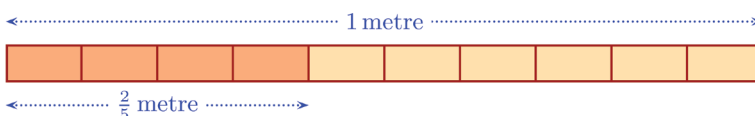


The second ribbon is 2 of 5 equal parts of a 1 metre long ribbon:

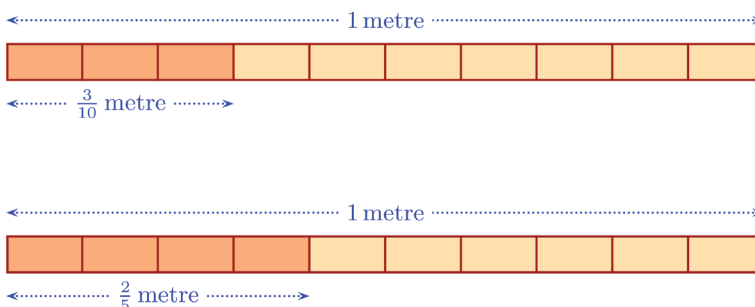


Both are parts of 1 metre, but when we put them together, they are not equal parts. So how do we write it as a fraction of a metre?

We can look at $\frac{2}{5}$ metre as 4 of 10 equal parts of a metre:



Thus the first ribbon is 3 of 10 equal parts of a metre and the second is 4 of 10 equal parts of a metre; altogether 7 equal parts:



Thus the total length is $\frac{7}{10}$ metre.

As a sum of fractions:

$$\frac{3}{10} + \frac{2}{5} = \frac{3}{10} + \frac{4}{10} = \frac{7}{10}$$

What if we join $\frac{1}{2}$ metre and $\frac{2}{5}$ metre?

What did we see in all these problems?

To find the sum of two fractional measures put together, we must see them as sets of the same equal pieces.

In other words, we must convert both to forms with the same denominator.

For example, let's compute:

$$\frac{1}{4} + \frac{2}{5}$$

First we must change them into forms with the same denominator.

In all the different forms of $\frac{1}{4}$, the denominator is a multiple of 4.

In all the different forms of $\frac{2}{5}$, the denominator is a multiple of 5.

So the same denominator we want for both must be a multiple of 4 and 5.

$4 \times 5 = 20$ is a multiple of both 4 and 5, isn't it?

$$\frac{1}{4} = \frac{5 \times 1}{5 \times 4} = \frac{5}{20}$$

$$\frac{2}{5} = \frac{4 \times 2}{4 \times 5} = \frac{8}{20}$$

Now we can calculate the sum:

$$\frac{1}{4} + \frac{2}{5} = \frac{5}{20} + \frac{8}{20} = \frac{5+8}{20} = \frac{13}{20}$$

Let's calculate

$$\frac{5}{8} + \frac{2}{3}$$

like this.

To write these as forms with the same denominator, what number do we take as the denominator?

$$\frac{5}{8} = \frac{3 \times 5}{3 \times 8} = \frac{15}{24}$$

$$\frac{2}{3} = \frac{8 \times 2}{8 \times 3} = \frac{16}{24}$$

Now we can add these:

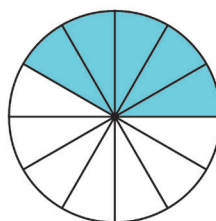
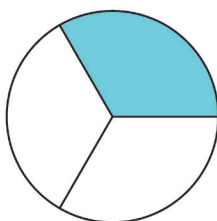
$$\frac{5}{8} + \frac{2}{3} = \frac{15}{24} + \frac{16}{24} = \frac{15+16}{24} = \frac{31}{24}$$

In this, we can write $\frac{31}{24}$ as

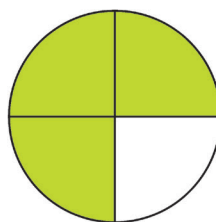
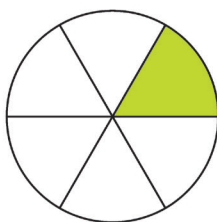
$$\frac{31}{24} = \frac{24+7}{24} = \frac{24}{24} + \frac{7}{24} = 1 + \frac{7}{24} = 1\frac{7}{24}$$



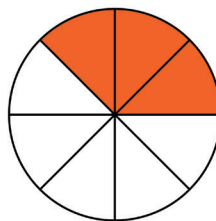
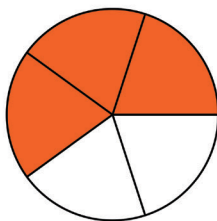
- (1) In each pair of pictures below, find the fraction of the circle we get by cutting up the coloured pieces of both circles and putting them together:



$$\square + \square = \square + \square = \square = \square$$



$$\square + \square = \square + \square = \square = \square$$



$$\square + \square = \square + \square = \square$$

- (2) Calculate the sums given below:

(i) $\frac{1}{4} + \frac{1}{8}$

(ii) $\frac{3}{4} + \frac{1}{6}$

(iii) $\frac{1}{3} + \frac{2}{5}$

(iv) $\frac{1}{2} + \frac{2}{5}$

(v) $\frac{2}{3} + \frac{1}{5}$

- (3) There are two taps to fill a tank with water. If the first tap alone is opened, the tank would fill up in 10 minutes. If the second tap alone is opened, it would take 15 minutes to fill up the tank.
- (i) If the first tap alone is opened, what fraction of the tank would be filled in one minute?
 - (ii) If the second tap alone is opened, what fraction of the tank would be filled in one minute?
 - (iii) If both the taps are opened, what fraction of the tank would be filled in one minute?
 - (iv) If both the taps are opened, how much time would it take for the tank to be filled up?

Some other sums

See these sums :

$$\frac{1}{2} + \frac{1}{2} = 1$$

$$\frac{1}{3} + \frac{2}{3} = 1$$

$$\frac{1}{4} + \frac{3}{4} = 1$$

$$\frac{1}{5} + \frac{4}{5} = 1$$

$$\frac{2}{5} + \frac{3}{5} = 1$$

What do we do in all these?

Of the two fractions added, one is some parts of one divided into equal parts taken together; and the other is the remaining parts taken together. When both these are taken together, we get all the parts, right? In other words, we get the whole.



For each fraction given below, can you mentally calculate the fraction to be added to make it 1?

(i) $\frac{2}{7}$

(ii) $\frac{4}{7}$

(iii) $\frac{3}{8}$

(iv) $\frac{3}{10}$

Now, look at this problem:

A jar contains three - quarter litre of milk,
and half a litre more is poured into it.
How much does it contain now ?

Suppose the half litre is poured into it in two steps, a quarter litre each time. Then the first quarter makes one litre (three quarters and a quarter) in the jar. How much when the second quarter is also added? One and a quarter litres.



Let's write this as a sum of fractions :

$$\begin{aligned}\frac{3}{4} + \frac{1}{2} &= \frac{3}{4} + \frac{1}{4} + \frac{1}{4} \\ &= 1 + \frac{1}{4} \\ &= 1\frac{1}{4}\end{aligned}$$

What about doing this sum as before, by equalizing the denominators ?

$$\frac{3}{4} + \frac{1}{2} = \frac{3}{4} + \frac{2}{4} = \frac{5}{4}$$

Then we can split $\frac{5}{4}$ like this :

$$\frac{5}{4} = \frac{4+1}{4} = \frac{4}{4} + \frac{1}{4} = 1 + \frac{1}{4} = 1\frac{1}{4}$$

So, we can do it either way.

What about adding three - quarter litre itself to three - quarter litre ?

Three quarters and a quarter make one; half more is to be added. Altogether one and a half litres.

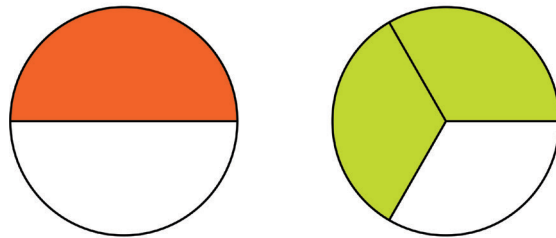
$$\begin{aligned}\frac{3}{4} + \frac{3}{4} &= \frac{3}{4} + \frac{1}{4} + \frac{2}{4} \\ &= 1 + \frac{1}{2} \\ &= 1\frac{1}{2}\end{aligned}$$

We can also add like this :

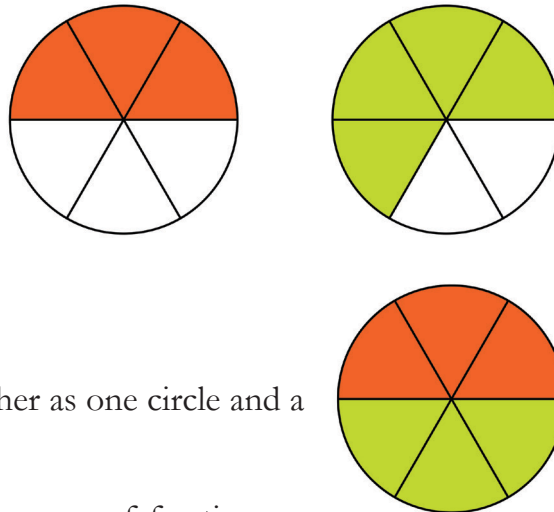
$$\frac{3}{4} + \frac{3}{4} = \frac{6}{4} = \frac{3 \times 2}{2 \times 2} = \frac{3}{2} = \frac{2+1}{2} = \frac{2}{2} + \frac{1}{2} = 1 + \frac{1}{2} = 1\frac{1}{2}$$

Let's look at another problem :

Draw two circles of the same size and colour half of one and two thirds of the other. If we cut out these pieces, can we put them together ?



What if we cut them like this ?



We can put them together as one circle and a remaining small part.



Let's write this down as a sum of fractions :

$$\begin{aligned}\frac{1}{2} + \frac{2}{3} &= \frac{3}{6} + \frac{4}{6} \\ &= \frac{3}{6} + \frac{3}{6} + \frac{1}{6} \\ &= 1 + \frac{1}{6} \\ &= 1\frac{1}{6}\end{aligned}$$

Another problem:

Anoop and his father went to buy material for shirts. One and a half metres for Anoop and two and a quarter metres for father. If they buy the same kind of material for both, how much in all?



We can do it like this:

One and two make three; half and quarter make three quarters. So, three and three quarter metres in all.

That is,

$$\begin{aligned} 1\frac{1}{2} + 2\frac{1}{4} &= \left(1 + \frac{1}{2}\right) + \left(2 + \frac{1}{4}\right) \\ &= (1 + 2) + \left(\frac{1}{2} + \frac{1}{4}\right) \\ &= 3 + \frac{3}{4} \\ &= 3\frac{3}{4} \end{aligned}$$



(1) Calculate the sums below :

(i) $\frac{5}{6} + \frac{1}{3}$ (ii) $\frac{7}{8} + \frac{1}{4}$ (iii) $\frac{5}{6} + \frac{1}{4}$ (iv) $\frac{5}{8} + \frac{3}{4}$ (v) $2\frac{1}{3} + 3\frac{1}{2}$

(2) One jar contains one and a half litres of milk and another contains two and a three quarters litres of milk. How much milk in both the jars together?

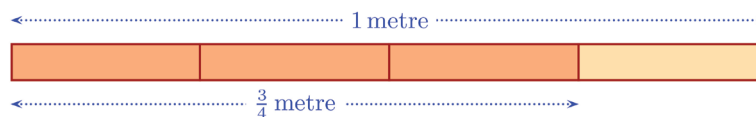
(3) Two strings of lengths one and a half metres are joined end to end. What is the total length?

(4) Ahirath bought one and a half kilograms of beans and three quarter kilograms of yam. What is the total weight?

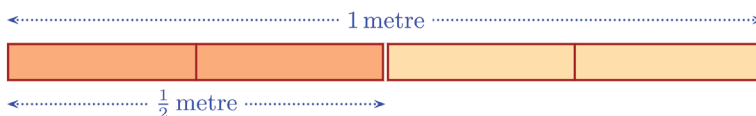
Removing parts

From a ribbon three quarters of a metre long , a quarter metre piece is cut off; What is the length of the remaining piece?

$\frac{3}{4}$ metre means 3 of 4 equal pieces into which one metre is divided:



Each of these equal parts is $\frac{1}{4}$ metre long. So, cutting off $\frac{1}{4}$ metre means removing one of these equal parts.



What remains is 2 of the 4 equal parts; that is

$$\frac{2}{4} = \frac{1}{2}$$

Thus the remaining piece is half a metre long.

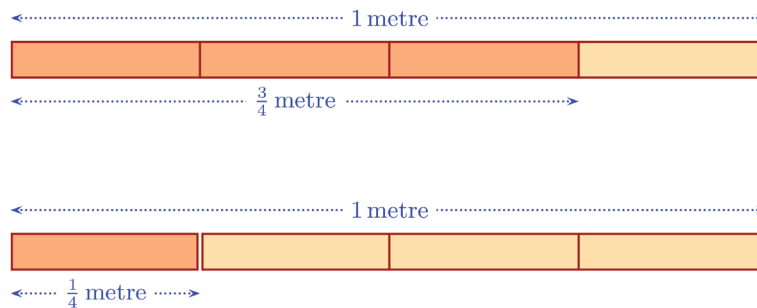
We can write the calculation like this:

$$\frac{3}{4} - \frac{1}{4} = \frac{1}{2}$$

We can do this subtraction just as we did addition of fractions:

$$\frac{3}{4} - \frac{1}{4} = \frac{3-1}{4} = \frac{2}{4} = \frac{1}{2}$$

If a half metre piece is cut off from a three-quarter metre long ribbon, then the remaining piece is a quarter metre long:



We write this computation as

$$\frac{3}{4} - \frac{1}{4} = \frac{1}{2}$$

As in the case of sums, we can do this by equalising denominators:

$$\frac{3}{4} - \frac{1}{2} = \frac{3}{4} - \frac{2}{4} = \frac{3-2}{4} = \frac{1}{4}$$

What if one-third of a metre is removed from half a metre?

We must compute $\frac{1}{2} - \frac{1}{3}$.

We can do this by equalising denominators:

$$\frac{1}{2} - \frac{1}{3} = \frac{3}{6} - \frac{2}{6} = \frac{3-2}{6} = \frac{1}{6}$$

Thus what remains is $\frac{1}{6}$ metre.



(i) $\frac{1}{2} - \frac{1}{8}$ (ii) $\frac{3}{4} - \frac{1}{8}$ (iii) $\frac{1}{3} - \frac{1}{5}$ (iv) $\frac{2}{5} - \frac{1}{3}$ (v) $\frac{2}{3} - \frac{1}{5}$

We have seen some pairs of fractions which add up to 1. We can rewrite them as subtractions:

Sum	Difference	
$\frac{1}{2} + \frac{1}{2} = 1$	$1 - \frac{1}{2} = \frac{1}{2}$	
$\frac{1}{3} + \frac{2}{3} = 1$	$1 - \frac{1}{3} = \frac{2}{3}$	$1 - \frac{2}{3} = \frac{1}{3}$
$\frac{1}{4} + \frac{3}{4} = 1$	$1 - \frac{1}{4} = \frac{3}{4}$	$1 - \frac{3}{4} = \frac{1}{4}$
$\frac{1}{5} + \frac{4}{5} = 1$	$1 - \frac{1}{5} = \frac{4}{5}$	$1 - \frac{4}{5} = \frac{1}{5}$
$\frac{2}{5} + \frac{3}{5} = 1$	$1 - \frac{2}{5} = \frac{3}{5}$	$1 - \frac{3}{5} = \frac{2}{5}$

Now look at this problem:

From one litre of milk, a quarter litre was used up. How much milk is left?

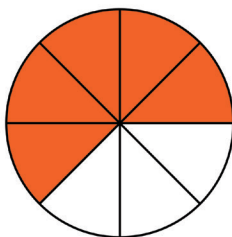
A quarter and three quarters make one; so, what remains is three-quarter litre of milk. We write it like this:

$$1 - \frac{1}{4} = \left(\frac{3}{4} + \frac{1}{4}\right) - \frac{1}{4} = \frac{3}{4}$$

We can also do it like this:

$$1 - \frac{1}{4} = \frac{4}{4} - \frac{1}{4} = \frac{4-1}{4} = \frac{3}{4}$$

Now see this picture:



What fraction of the circle is coloured?

What fraction remains to be coloured?

The fraction to be coloured can be calculated like this:

$$1 - \frac{5}{8} = \frac{3}{8}$$

This we can also do as

$$1 - \frac{5}{8} = \frac{8}{8} - \frac{5}{8} = \frac{8-5}{8} = \frac{3}{8}$$

Another problem:

From a two and a half kilograms yam, one and a quarter kilograms piece is cut off. What is the weight of the remaining piece?

We can do it in head like this: One kilogram cut off from two kilograms leaves one kilogram and a quarter kilogram cut off from half a kilogram leaves a quarter kilogram. So what remains is one and a quarter kilograms.



We can write it out like this:

$$2\frac{1}{2} - 1\frac{1}{4} = \left(2 + \frac{1}{2}\right) - \left(1 + \frac{1}{4}\right) = (2 - 1) + \left(\frac{1}{2} - \frac{1}{4}\right) = 1 + \frac{1}{4} = 1\frac{1}{4}$$

What if we changed the cloth problem done earlier like this?

One and a half metres of cloth was bought for Anoop and two and a quarter metres for his father. How much more was bought for father?

Here, we cannot subtract half a metre from a quarter metre. So, let's think of another way.

Half a metre added to one and a half metres makes two metres; another quarter of a metre added makes two and a quarter metres. Total added is half and a quarter, which is three quarters. So, three quarters of a metre more. That is,

$$2\frac{1}{4} - 1\frac{1}{2} = \frac{3}{4}$$

Let's write down our reasoning:

- $2 = 1\frac{1}{2} + \frac{1}{2}$
- $2\frac{1}{4} = 2 + \frac{1}{4} = 1\frac{1}{2} + \frac{1}{2} + \frac{1}{4}$
- $2\frac{1}{4} = 1\frac{1}{2} + \frac{3}{4}$
- $2\frac{1}{4} - 1\frac{1}{2} = \frac{3}{4}$



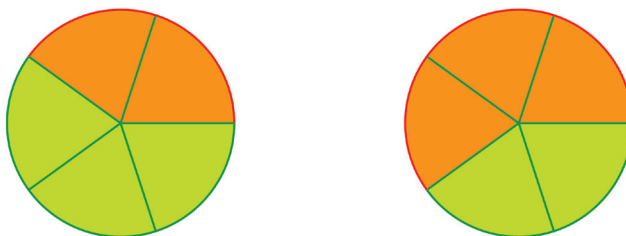
- (1) Natasha drew a circle and coloured $\frac{5}{12}$ of it. What fraction of the circle remains to be coloured?
- (2) A bucket can hold 10 litres of water and it contains $3\frac{3}{4}$ litres. How much more is needed to fill it?
- (3) From a string, one and three quarters of a metre long, a piece half a metre long is cut off. What is the length of the remaining piece?
- (4) A panchayat constructed a new road, $14\frac{3}{4}$ kilometres long last year. This year, a road $16\frac{1}{4}$ kilometres long was constructed. How much more was constructed this year?
- (5) Ashadev bought 20 metres of string. He cut off a piece $5\frac{3}{4}$ metres long first, and then a piece $6\frac{1}{2}$ metres long later. What is the length of string left?
- (6) The milk society got $75\frac{1}{4}$ litres in the morning and $55\frac{1}{2}$ litres in the evening. Of this, $85\frac{3}{4}$ litres of milk is sold. How much milk is left?

Large and small

Which is larger, $\frac{2}{5}$ or $\frac{3}{5}$?

How did you decide that $\frac{3}{5}$ is larger?

$\frac{2}{5}$ is 2 parts of 5 equal parts taken together. To get $\frac{3}{5}$ we must take 3 such parts together.



Thus the number $\frac{2}{5}$ is less than the number $\frac{3}{5}$. We write it like this:

$$\frac{2}{5} < \frac{3}{5}$$

On the other hand, $\frac{3}{5}$ is greater than $\frac{2}{5}$.

This we write in shorthand as

$$\frac{3}{5} > \frac{2}{5}$$

Similarly, which of $\frac{3}{8}$ and $\frac{5}{8}$ is smaller and which is larger?

How do we write these in shorthand?

In general, we can say this

Of two fractions with the same denominator, the one with larger numerator is the larger and the one with smaller numerator is the smaller.

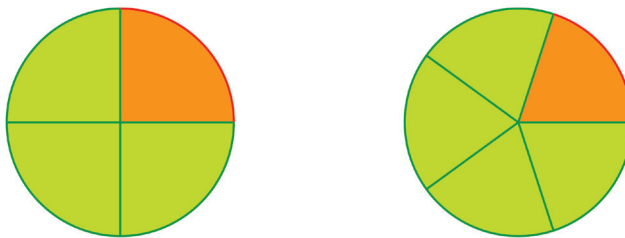
In other words, by increasing the numerator alone makes a fraction larger. For example:

$$\frac{1}{5} < \frac{2}{5} < \frac{3}{5} < \frac{4}{5}$$

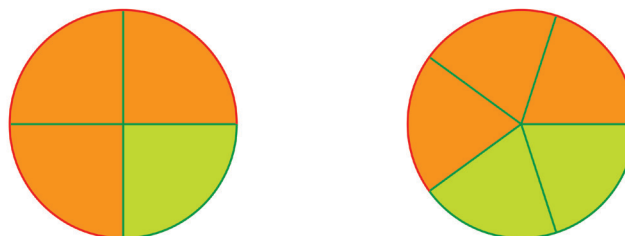
On the other hand, what happens if the denominator alone is increased?

For example, let's take $\frac{3}{4}$ and $\frac{3}{5}$

Each of 4 equal parts is larger than each of 5 equal parts:



So, 3 of the first kind of pieces taken together is larger than 3 of the second kind of pieces:



This means $\frac{3}{4} > \frac{3}{5}$

What can we say in general?

Of two fractions with the same numerator, the one with larger denominator is smaller and the one with smaller denominator is larger

We can say it like this: if the denominator alone of a fraction is increased, the fraction becomes smaller. For example,

$$\frac{5}{6} > \frac{5}{7} > \frac{5}{8} > \frac{5}{9}$$

To compare two fractions with the same denominator, we need only compare the numerators; to compare two fractions with the same numerator, we need only compare the denominators.

What if both the numerator and denominator are different?

For example, which of $\frac{1}{2}$ and $\frac{2}{3}$ is the larger?

We can convert any two fractions into forms with the same denominators, right?

$$\frac{1}{2} = \frac{3}{6} \qquad \frac{2}{3} = \frac{4}{6}$$

Which of $\frac{3}{6}$ and $\frac{4}{6}$ is the larger?

So, which of $\frac{1}{2}$ and $\frac{2}{3}$ is the larger?

$$\frac{1}{2} < \frac{2}{3}$$



(1) Find the larger and smaller of each pair of fractions below and write this using the $<$ or $>$ symbol:

(i) $\frac{2}{5}, \frac{3}{5}$ (ii) $\frac{2}{5}, \frac{2}{3}$ (iii) $\frac{2}{5}, \frac{3}{4}$ (iv) $\frac{3}{7}, \frac{2}{9}$ (v) $\frac{2}{7}, \frac{3}{8}$ (vi) $\frac{4}{9}, \frac{3}{8}$

(2) Arrange each triple of fractions below from the smallest to the largest and write it using the $<$ symbol :

(i) $\frac{2}{5}, \frac{3}{4}, \frac{3}{5}$ (ii) $\frac{3}{7}, \frac{2}{9}, \frac{2}{7}$ (iii) $\frac{1}{2}, \frac{1}{3}, \frac{2}{3}$

DECIMAL FORMS



Decimal places

We have seen in class 5 how various measures can be written as fractions and as their decimal forms (The lesson **Measure Math**).

For example, the length of a pencil can be said in different ways:

- 5 centimetres 7 millimetres
- $5\frac{7}{10}$ centimetres
- 5.7 centimetres



We can write other measures also like this:

$$5\frac{7}{10} \text{ litres} = 5.7 \text{ litres}$$

$$5\frac{7}{10} \text{ kilograms} = 5.7 \text{ kilograms}$$

We can drop all references to measures and simply say that 5.7 is the decimal form of the number $5\frac{7}{10}$.

$$5\frac{7}{10} = 5.7$$

Similarly, 4.29 is the decimal form of $4\frac{29}{100}$

$$4\frac{29}{100} = 4.29$$

We must note another thing here. We write natural numbers using ones, tens, hundreds and so on. For example:

$$247 = 2 \text{ hundreds} + 4 \text{ tens} + 7 \text{ ones}$$



What about 247.3 ?

First we split it as the sum of a whole number and a fraction, as

$$247.3 = 247\frac{3}{10} = 247 + \frac{3}{10}$$

The $\frac{3}{10}$ here can be written as

$$\frac{3}{10} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10}$$

That is, 3 tenths. So, we can write 247.3 in terms of hundreds, tens, ones and tenths:

$$247.3 = 2 \text{ hundreds} + 4 \text{ tens} + 7 \text{ ones} + 3 \text{ tenths}$$

How do we split 247.39 like this?

First, we write it as

$$247.39 = 247\frac{39}{100} = 247 + \frac{39}{100}$$

Then, we can split $\frac{39}{100}$ as

$$\frac{39}{100} = \frac{30+9}{100} = \frac{30}{100} + \frac{9}{100} = \frac{3}{10} + \frac{9}{100}$$

The $\frac{3}{10}$ here is 3 tenths; and $\frac{9}{100}$ is 9 hundredths. So,

$$247.39 = 2 \text{ hundreds} + 4 \text{ tens} + 7 \text{ ones} + 3 \text{ tenths} + 9 \text{ hundredths}$$

In general,

In the decimal form of a number, the dot separates the whole number part and the fractional part. Digits to the left of the dot show the multiples of ones, tens, hundreds and so on; the digits to the right show the multiples of tenths, hundredths, thousandths and so on.

For example, the two numbers used in the above examples can be split according to place value like this:

	100	10	1	$\frac{1}{10}$	$\frac{1}{100}$
247.3	2	4	7	3	
247.39	2	4	7	3	9



Split the numbers below according to place value:

(i) 4.5

(ii) 4.57

(iii) 4.572

(iv) 45.72

(v) 457.2

Let's look at the decimal form of some measures again. For example, what is the decimal form of 23 metres and 40 centimetres?

$$23 \text{ metres } 40 \text{ centimetres} = 23\frac{40}{100} \text{ metres} = 23.40 \text{ metres}$$

Taking only the numbers, we have

$$23\frac{40}{100} = 23.40$$

We can write the $\frac{40}{100}$ here as

$$\frac{40}{100} = \frac{4}{10}$$

So, we get

$$23\frac{40}{100} = 23\frac{4}{10} = 23.4$$

This means

$$23.40 = 23.4$$

We can see this using place values also:

	10	1	$\frac{1}{10}$	$\frac{1}{100}$
23.40	2	3	4	0
23.4	2	3	4	

Thus we can write 23 metres and 40 centimetres in two different ways:

$$23 \text{ metres } 40 \text{ centimetres} = 23.40 \text{ metres}$$

$$23 \text{ metres } 40 \text{ centimetres} = 23.4 \text{ metres}$$

What about 23 metres and 4 centimetres?

4 centimetres is $\frac{4}{100}$ of a metre; that is $\frac{4}{100}$ metre.

$$23 \text{ metres } 4 \text{ centimetres} = 23\frac{4}{100} \text{ metres}$$

We can split $23\frac{4}{100}$ according to place value:

$$23\frac{4}{100} = 2 \text{ tens} + 3 \text{ ones} + 4 \text{ hundredths}$$

	10	1	$\frac{1}{10}$	$\frac{1}{100}$
$23\frac{4}{100}$	2	3	0	4

So what is the decimal form of $23\frac{4}{100}$?

$$23\frac{4}{100} = 23.04$$

In our problem of lengths,

$$23 \text{ metres } 4 \text{ centimetres} = 23.04 \text{ metres}$$

What about 23 metres and 4 millimetres?

4 millimetres means $\frac{4}{1000}$ metres. So

$$23 \text{ metres } 4 \text{ millimetres} = 23\frac{4}{1000} \text{ metres}$$

How do we split $23\frac{4}{1000}$ according to place value?

	10	1	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
$23\frac{4}{1000}$	2	3	0	0	4

So, we can write the decimal form of $23\frac{4}{1000}$ as

$$23\frac{4}{1000} = 23.004$$

In terms of lengths

$$23 \text{ metres } 4 \text{ millimetres} = 23.004 \text{ metres}$$



Now try to write 4 kilograms and 55 grams as kilograms in decimal form.

Convert the measures below into the measures specified, using fractions and decimal forms.

Measure	Fractional form	Decimal form
4 metres 30 centimetres	$4\frac{30}{100}$ metres	4.3 metres
4 metres 3 centimetres	... metres	... metres
4 metres 3 millimetres	... metres	... metres
3 kilograms 200 grams	... kilograms	... kilograms
3 kilograms 250 grams	... kilograms	... kilograms
3 kilograms 25 grams	... kilograms	... kilograms
30 kilograms 250 grams	... kilograms	... kilograms
10 litres 750 millilitres	... litres	... litres
10 litres 75 millilitres	... litres	... litres
10 litres 705 millilitres	... litres	... litres
100 litres 750 millilitres	... litres	... litres

Decimals and fractions

We have seen how measures of various kinds, given as decimals, can be converted to fractions.

For example,

$$7.3 \text{ centimetres} = 7\frac{3}{10} \text{ centimetres}$$

We can also write it as millimetres

1 centimetre means 10 millimetres; so

$$7 \text{ centimetres} = 70 \text{ millimetres}$$

What about $\frac{3}{10}$ centimetres?

$\frac{3}{10}$ is three $\frac{1}{10}$

And $\frac{1}{10}$ centimetres is 1 millimetre;

so, $\frac{3}{10}$ centimetres = 3 millimetres

Now we can write

$$\begin{aligned} 7.3 \text{ centimetres} &= 7\frac{3}{10} \text{ centimetres} \\ &= 73 \text{ millimetres} \end{aligned}$$

We can change this again. 73 millimetres mean 73 of $\frac{1}{10}$ centimetres

$$73 \text{ millimetres} = \frac{73}{10} \text{ centimetres}$$

In terms of just numbers without using measures, this means

$$7.3 = \frac{73}{10}$$

Similarly, how do we write 7.31 metres as a fraction?

First, we write it as a whole number and a fraction, as seen in class 5:

$$7.31 \text{ metres} = 7\frac{31}{100} \text{ metres}$$

1 metre is 100 centimetres, so that

$$7 \text{ metres} = 700 \text{ centimetres}$$

On the other hand, since $\frac{1}{100}$ metres means 1 centimetre,

$$\frac{31}{100} \text{ metres} = 31 \text{ centimetres}$$

Thus

$$\begin{aligned} 7.31 \text{ metres} &= 7\frac{31}{100} \text{ metres} \\ &= 731 \text{ centimetres} \end{aligned}$$

If 731 centimetres is converted back to metres,

$$731 \text{ centimetres} = \frac{731}{100} \text{ metres}$$

Thus,

$$7.31 \text{ metres} = \frac{731}{100} \text{ metres}$$

In terms of numbers alone

$$7.31 = \frac{731}{100}$$

In this way, how do we write 7.319 litres as a fraction?

$$7.319 \text{ litres} = 7\frac{319}{1000} \text{ litres}$$

In this

$$7 \text{ litres} = 7000 \text{ millilitres}$$

$$\frac{319}{1000} \text{ litres} = 319 \text{ millilitres}$$

From this we get

$$7.319 \text{ litres} = 7319 \text{ millilitres}$$

Converting back to litres

$$7319 \text{ millilitres} = \frac{7319}{1000} \text{ litres}$$

Thus

$$7.319 \text{ litres} = \frac{7319}{1000} \text{ litres}$$

In terms of numbers

$$7.319 = \frac{7319}{1000}$$

In all the examples above, we converted numbers in decimal form to fractions:

$$7.3 = \frac{73}{10}$$

$$7.31 = \frac{731}{100}$$

$$7.319 = \frac{7319}{1000}$$

What change do you see in the denominators of the fractions, as the number of digits after the decimal point increases?

Can you say the fractional form of the decimal 12.03?

What is the numerator of the fraction?

And the denominator?

In 12.03, how many digits are there after the decimal point?

$$12.03 = \frac{1203}{100}$$

On the other hand, what is the decimal form of $\frac{1203}{1000}$?

Looking at the denominator, can you say how many digits after the decimal point does it have?

$$\frac{1203}{1000} = 1.203$$



(1) The decimal form of some numbers are given below. Write each of them as a fraction with denominator 10, 100 or 1000.

(i) 3.7 (ii) 3.07 (iii) 30.7 (iv) 3.72 (v) 37.2 (vi) 3.072 (vii) 30.72

(2) Write the decimal form of the fractions given below.

(i) $\frac{51}{10}$ (ii) $\frac{513}{10}$ (iii) $\frac{513}{100}$ (iv) $\frac{513}{1000}$ (v) $\frac{5130}{1000}$

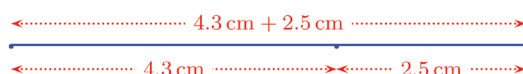
Addition and subtraction

A line 4.3 centimetres long was drawn and then extended by another 2.5 centimetres:



How many centimetres long is the line now?

We must add 4.3 centimetres and 2.5 centimetres.



We can do this in several ways.

First, we can convert these to centimetres and millimetres.

$$4.3 \text{ centimetres} = 4 \text{ centimetres } 3 \text{ millimetres}$$

$$2.5 \text{ centimetres} = 2 \text{ centimetres } 5 \text{ millimetres}$$

And add the centimetres and millimetres separately.

$$4 \text{ centimetres} + 2 \text{ centimetres} = 6 \text{ centimetres}$$

$$3 \text{ millimetres} + 5 \text{ millimetres} = 8 \text{ millimetres}$$

The length of the line is

$$6 \text{ centimetres } 8 \text{ millimetres}$$

Then we can convert back to centimetres.

$$\begin{aligned} 6 \text{ centimetres } 8 \text{ millimetres} &= \frac{68}{10} \text{ centimetres} \\ &= 6.8 \text{ centimetres} \end{aligned}$$

Or, first we can write the lengths in millimetres.

$$4.3 \text{ centimetres} = 43 \text{ millimetres}$$

$$2.5 \text{ centimetres} = 25 \text{ millimetres}$$

Now we need only add 43 and 25; and this too can be done in several ways.
For example,

$$43 + 25 = 40 + 20 + 3 + 5 = 68$$

Thus the length of the line is 68 millimetres.

This we can write as centimetres in decimal form.

$$\begin{aligned} 68 \text{ millimetres} &= 6 \text{ centimetres } 8 \text{ millimetres} \\ &= 6.8 \text{ centimetres} \end{aligned}$$

Another method is to remove the measures and write the numbers as fractions.

$$\begin{aligned} 4.3 &= \frac{43}{10} \\ 2.5 &= \frac{25}{10} \end{aligned}$$

And these fractions we can add like this:

$$\frac{43}{10} + \frac{25}{10} = \frac{43 + 25}{10} = \frac{68}{10}$$

This fraction can be written in decimal form as

$$\frac{68}{10} = 6.8$$

Now, we can add the measures and say the length of the line is 6.8 centimetres.

What if we want to add 4.3 centimetres and 2.8 centimetres?

We can add by changing the lengths to millimetres:

$$4.3 \text{ centimetres} = 43 \text{ millimetres}$$

$$2.8 \text{ centimetres} = 28 \text{ millimetres}$$

Now, we need only add 43 and 28. It can be done like this:

$$43 + 28 = 40 + 20 + 3 + 8 = 60 + 11 = 71$$

Thus the length of this line is 71 millimetres.

This we can write in centimetres as a decimal:

$$\begin{aligned} 71 \text{ millimetres} &= 7 \text{ centimetres } 1 \text{ millimetres} \\ &= 7.1 \text{ centimetres} \end{aligned}$$

We can do it by converting just the numbers to fractions.

$$4.3 = \frac{43}{10}$$

$$2.8 = \frac{28}{10}$$

Now, add the fractions:

$$\frac{43}{10} + \frac{28}{10} = \frac{43+28}{10} = \frac{71}{10}$$

Finally, convert the fraction back to the decimal form.

$$\frac{71}{10} = 7.1$$

The length of the line is 7.1 centimetres.

Another problem:

A jar contains 3.5 litres of oil and 6.25 litres more is poured into it. How much oil does the jar contain now?

First, let's convert just the numbers to fractions:

$$3.5 = \frac{35}{10}$$

$$6.25 = \frac{625}{100}$$

How do we add these?

We can write $\frac{35}{10}$ also as a fraction with denominator 100:

$$\begin{aligned} \frac{35}{10} &= \frac{35 \times 10}{10 \times 10} \\ &= \frac{350}{100} \end{aligned}$$

Now we can add like this:

$$\begin{aligned} \frac{35}{10} + \frac{625}{100} &= \frac{350}{100} + \frac{625}{100} \\ &= \frac{350+625}{100} \\ &= \frac{975}{100} \end{aligned}$$

Place values and addition

We can add numbers in decimal form without converting to fractions, using place values. For example, see how calculate

$$4.3 + 2.8$$

	1	$\frac{1}{10}$	
4.3	4	3	+
2.8	2	8	
	6	11	
	7	1	= 7.1

We now convert this fraction back to the decimal form:

$$\frac{975}{100} = 9.75$$

Thus the jar contains 9.75 litres of oil now.

Now look at this problem:

A person bought 2.5 kilograms of rice and 3.125 kilograms of vegetables. What is the total weight?

This also we do with fractions

$$2.5 = \frac{25}{10}$$

$$3.125 = \frac{3125}{1000}$$

To add these, we change $\frac{25}{10}$ to a form with denominator 1000.

$$\begin{aligned}\frac{25}{10} &= \frac{25 \times 100}{10 \times 100} \\ &= \frac{2500}{1000}\end{aligned}$$



Now, we add the fractions:

$$\begin{aligned}\frac{25}{10} + \frac{3125}{1000} &= \frac{2500}{1000} + \frac{3125}{1000} \\ &= \frac{2500 + 3125}{1000}\end{aligned}$$

One way of adding 2500 and 3125 is this:

$$2500 + 3125 = 2000 + 3000 + 500 + 125 = 5000 + 625 = 5625$$

So, we can continue our addition of fractions:

$$\begin{aligned}\frac{25}{10} + \frac{3125}{1000} &= \frac{2500 + 3125}{1000} \\ &= \frac{5625}{1000}\end{aligned}$$

Converting this to decimals:

$$\frac{5625}{1000} = 5.625$$

Thus the total weight is 5.625 kilograms.



- (1) Anu made an 8.5 metre long festoon and Sarah made a 7.8 metre long one to decorate their classroom for the school anniversary. What is the total length of the festoon they made?
- (2) Amal needs 2.25 metres of cloth and Sagar, 1.85 metres for school uniform. How many metres of cloth in all?
- (3) A tin weighs 2.85 kilograms and it is filled with 12.5 kilograms of rice. What is the total weight?
- (4) Bakul walks 2.25 kilometres in the morning and 1.5 kilometres in the evening everyday. What is the total distance she walks each day?
- (5) Two small bottles contain 0.850 litre and 0.375 litre of honey. If both the bottles are emptied into a large bottle, how much honey does it contain?

Next let's look at some instances where we have to subtract measures. See this problem:

From an 8.5 centimetres long *eerkeil*, a 3.2 centimetres long piece is broken off. What is the length of the remaining piece?

Thinking in terms of numbers alone, what we need is to subtract 3.2 from 8.5.

We change the numbers to fractions.

$$8.5 = \frac{85}{10}$$

$$3.2 = \frac{32}{10}$$

Now we can subtract:

$$\frac{85}{10} - \frac{32}{10} = \frac{85-32}{10}$$

One way to subtract 32 from 85 is this:

$$\begin{aligned} 85 - 32 &= (80 - 30) + (5 - 2) \\ &= 50 + 3 \\ &= 53 \end{aligned}$$

So we get

$$\frac{85}{10} - \frac{32}{10} = \frac{53}{10}$$

Finally, we switch back to decimals:

$$\frac{53}{10} = 5.3$$

Thus the length of the remaining piece of *eerkekil* is 5.3 centimetres.

What if we change the problem like this?

From an 8.5 centimetres long *eerkekil*, a 3.7 centimetres long piece is broken off. What is the length of the remaining piece?

We start as before by converting the decimals to fractions:

$$8.5 = \frac{85}{10}$$

$$3.7 = \frac{37}{10}$$

And then subtract

$$\frac{85}{10} - \frac{37}{10} = \frac{85-37}{10}$$

We have seen in earlier classes that subtractions like $85 - 37$ can be done in several different ways. For example,

$$85 - 37 = (85 - 35) - 2 = 50 - 2 = 48$$

$$85 - 37 = (87 - 37) - 2 = 50 - 2 = 48$$

$$85 - 37 = (85 - 40) + 3 = 45 + 3 = 48$$

Anyway, we find

$$\frac{85}{10} - \frac{37}{10} = \frac{48}{10}$$

Changing back to decimals,

$$\frac{48}{10} = 4.8$$

Place value and subtraction

We can subtract numbers in decimal form without changing them to fractions. For example, consider

$$8.5 - 3.7$$

To do this, we first write like this

	1	$\frac{1}{10}$	
8.5	8	5	—
3.7	3	7	

Since 7 tenths cannot be subtracted from 5 tenths, we rewrite this as shown below and proceed:

	1	$\frac{1}{10}$	
8.5	7	15	—
3.7	3	7	
	4	8	= 4.8

The remaining piece of *eerkekil* is 4.8 centimetres long.

Look at another problem:

There is 15 kilograms of rice in a sack. 4.25 kilograms from this is put in a bag.
How much rice remains in the sack?

Thinking just in terms of numbers, what we have to do is subtract 4.25 from 15.

We first write 4.25 as a fraction:

$$4.25 = \frac{425}{100}$$

How do we write 15 as a fraction with denominator 100?

Recall the section **Fraction as division** of the lesson **One Fraction Many Forms**.

$$15 = \frac{15}{1} = \frac{15 \times 100}{1 \times 100} = \frac{1500}{100}$$

Now can't we subtract?

$$\frac{1500}{100} - \frac{425}{100} = \frac{1500 - 425}{100}$$

We can do $1500 - 425$ in several ways:

$$1500 - 425 = 1000 + 500 - 425 = 1000 + 75 = 1075$$

$$1500 - 425 = 1425 - 425 + 75 = 1000 + 75 = 1075$$

$$1500 - 425 = 1500 - 500 + 75 = 1000 + 75 = 1075$$

Thus, we have:

$$\frac{1500}{100} - \frac{425}{100} = \frac{1075}{100}$$

Changing back to decimals:

$$\frac{1075}{100} = 10.75$$

So, there is 10.75 kilograms of rice still in the sack.



- (1) From a rod 14.7 metres long, a piece 7.75 metre long is cut off. What is the length of the remaining piece?
- (2) There was 38.7 kilograms of rice in a sack and 12.350 kilograms of this is used up. How much rice remains in the sack?
- (3) The perimeter of a rectangle is 24 centimetres and the length of one side is 6.4 centimetres. What is the length of the other side?
- (4) There was 2.50 litres of oil in a bottle and 0.475 litres of this was used for cooking . How much oil is left in the bottle?
- (5) What number we must add to 14.32 to get 16.43?

MULTIPLES AND FACTORS

Multiples of multiples

We have learnt about multiples in the lesson **Within Numbers** of the class 5 textbook.

The multiples of a natural number are the product of that number with the natural numbers 1, 2, 3, ...

For example, the multiples of 2 are the numbers 2, 4, 6, ... got by multiplying the natural numbers by 2.

The multiples of 3 are the numbers 3, 6, 9, ... got by multiplying the natural numbers by 3.

What about the multiples of 4?

Let's compare the multiples of 2 and 4:

Multiples of 2: 2 4 6 8 10 12 14 16 18 20

Multiples of 4: 4 8 12 16 20 24 28 32 36 40

All multiples of 4 are among the multiples of 2, right?

Why is this so?

Since $4 = 2 \times 2$, all multiples of 4 can be written as multiples of 2 also:

$1 \times 4 = 4$	$2 \times 2 = 4$
$2 \times 4 = 8$	$4 \times 2 = 8$
$3 \times 4 = 12$	$6 \times 2 = 12$
$4 \times 4 = 16$	$8 \times 2 = 16$
$5 \times 4 = 20$	$10 \times 2 = 20$
.....	



Similarly, 6 is a multiple of both 2 and 3.

So every multiple of 6 can be written as a multiple of what all numbers?

$$1 \times 6 = 6$$

$$3 \times 2 = 6$$

$$2 \times 3 = 6$$

$$2 \times 6 = 12$$

$$6 \times 2 = 12$$

$$4 \times 3 = 12$$

$$3 \times 6 = 18$$

$$9 \times 2 = 18$$

$$6 \times 3 = 18$$

$$4 \times 6 = 24$$

$$12 \times 2 = 24$$

$$8 \times 3 = 24$$

$$5 \times 6 = 30$$

$$15 \times 2 = 30$$

$$10 \times 3 = 30$$

.....

.....

.....

So what can we say in general?

All multiples of the multiple of a number are multiples of that number also.

We have seen in class 5 that the statements about multiples can also be put in terms of factors (The section **Division and factors** of the lesson **Within Numbers**).

For example, the statement

4 is a multiple of 2

can also be put as

2 is a factor of 4

Similarly, how do we write

6 is a multiple of 2 and 3

in terms of factors?

2 and 3 are two factors of 6

So, how do we write the general result above in terms of factors?

All multiples of a number are also multiples of any of its factors.



- (1) For each of the multiples given below, find the other numbers they are multiples of:
 - (i) Multiples of 8
 - (ii) Multiples of 10
 - (iii) Multiples of 12
- (2) Check whether each of the statements below is true or false. For true statements, explain why they are so. For the false statements, give an example in which it is not true.
 - (i) All multiples of 20 are multiples of 10
 - (ii) All multiples of 10 are multiples of 2
 - (iii) All multiples of 15 are multiples of 5
 - (iv) All multiples of 15 are multiples of 3
 - (v) All multiples of 5 are multiples of 15
 - (vi) All multiples of 3 are multiples of 15

Primary factors

A number can be written as the product of its factors in different ways. For example let's consider the number 30:

$$30 = 1 \times 30$$

$$30 = 2 \times 15$$

$$30 = 3 \times 10$$

$$30 = 5 \times 6$$

Is there any other way?

We can change the order of the factors in each. But that's trivial.

What if we write 30 as a product of three factors instead of two?

In $30 = 1 \times 30$, we can split the 30 on the right of the equation as 2×15 and write $30 = 1 \times 2 \times 15$.

But then, we can simply rewrite each of the others using 1 as another factor.

Can we write 30 as a product of three factors, without using 1?

We can write

$$30 = 2 \times 3 \times 5$$

Is there any other way? (Apart from changing just the order of the factors).

Why can't we get smaller factors without using 1?

Does 2 have any factors other than 1 and 2?

This is so for 3 and 5 also, right?

Thus, the only factors of each of the numbers 2, 3 and 5 are 1 and the number itself (For any number, 1 and the number itself are factors, aren't they?).

Can you think of any other number like this?

Is 6 such a number?

What about 7?

Let's write such numbers below 20:

1, 2, 3, 5, 7, 11, 13, 17, 19

Such numbers, excluding 1, are said to be **prime numbers**.

A natural number greater than 1, which has no factors other than 1 and itself is called a prime number.

Numbers greater than 1, which are not primes are called **composite numbers**.

For example, 6 is a composite number.

When a number is written as the product of two factors and any one of them is not a prime, then that factor can be again written as the product of two factors. This can be continued till all factors are prime.

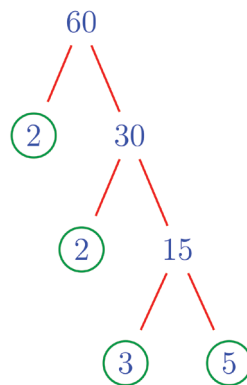
Thus we have this general statement:

Any composite number can be written as a product of primes.

For example, let's see how 60 can be written as a product of primes:

- (i) We start by writing $60 = 2 \times 30$.
- (ii) The 30 in this can be written 2×15 .
- (iii) Finally 15 can be written 3×5 .

This factorization can be shown as a picture shown below:



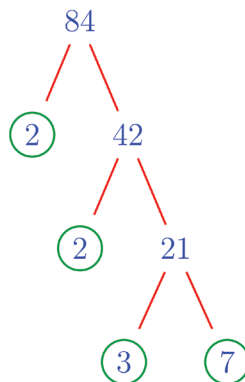
See how 84 is written as a product of primes like this:

$$\begin{aligned}
 84 &= 2 \times 42 \\
 &= 2 \times 2 \times 21 \\
 &= 2 \times 2 \times 3 \times 7
 \end{aligned}$$

From this, we see that

$$84 = 2 \times 2 \times 3 \times 7$$

We can also draw a picture like this:





Can you write the numbers below as a product of primes?

- (i) 24 (ii) 35 (iii) 36 (iv) 60 (v) 100

Once we write two numbers as a product of primes, it is easy to write the product of these numbers also as a product of primes.

For example, 12 and 30 can be split like this:

$$12 = 2 \times 2 \times 3$$

$$30 = 2 \times 3 \times 5$$

Now we can split 12×30 as shown below :

$$\begin{aligned} 360 &= 12 \times 30 \\ &= (2 \times 2 \times 3) \times (2 \times 3 \times 5) \\ &= 2 \times 2 \times 2 \times 3 \times 3 \times 5 \end{aligned}$$

On the other hand, to split a number into a product of primes, we first split it into the product of any two factors, then split each of these factors into a product of primes and finally put these prime factors together.

For example, to split 90 into a product of primes, we first write:

$$90 = 9 \times 10$$

Next write 9 and 10 as products of primes:

$$9 = 3 \times 3$$

$$10 = 2 \times 5$$

Now we can write 90 like this:

$$\begin{aligned} 90 &= 9 \times 10 \\ &= (3 \times 3) \times (2 \times 5) \\ &= 2 \times 3 \times 3 \times 5 \end{aligned}$$



Write each of the numbers below as a product of primes.

- (i) 72 (ii) 105 (iii) 144 (iv) 330 (v) 900

All factors

Once we know the prime factors of a number, we can find all its factors.

For example, the prime factors of 6 are 2 and 3; what are its other factors?

For any number, 1 and the number itself are factors.

So, 1 and 6 are also factors of 6.

Does 6 have any factors other than 1, 2, 3, 6?

Let's take 15 next. What are its prime factors?

And the other factors?

Does 15 have any factors other than 1, 3, 5, 15?

Like this, can you first write 21 as a product of two primes and then find all its factors?

In general, how do we find all factors of a number which is a product of two different primes?



Find all the factors of the numbers below:

- (i) 35 (ii) 77 (iii) 26 (iv) 51 (v) 95

Now let's look at the product of three different primes. For example,

$$30 = 2 \times 3 \times 5$$

Apart from 2, 3, 5, two other factors of 30 are 1 and 30, as seen for other numbers.

Does 30 have any other factors?

We can rewrite $30 = 2 \times 3 \times 5$ as

$$30 = 6 \times 5$$

So, isn't 6 also a factor of 30?

Can you find two other factors?

So we can arrange the factors of 30 as shown below:

$$\begin{array}{rcl}
 & 1 & \\
 & 2, 3, 5 & \text{(Prime factors)} \\
 2 \times 3 = 6 & \left. \vphantom{\begin{array}{l} 2 \times 3 = 6 \\ 2 \times 5 = 10 \\ 3 \times 5 = 15 \end{array}} \right\} & \\
 2 \times 5 = 10 & & \text{(Product of two prime factors)} \\
 3 \times 5 = 15 & &
 \end{array}$$

Like this, can you write 42 as the product of three prime numbers and find all the factors?



Write each of the numbers below as a product of three primes and find all its factors:

- (i) 66 (ii) 70 (iii) 105 (iv) 110 (v) 130

Prime numbers

The prime numbers continue like this: 2, 3, 5, 7, 11, ... The only even number among them is 2. All the primes afterwards are odd numbers. Any even number greater than 2 has the factor 2, other than 1 and the number itself.

But not all odd numbers are primes; for example $9 = 3 \times 3$

We don't see any definite pattern for the odd primes. For example, after 3, 5, 7 which are two apart, the next prime is not 9, but 11. Thus the difference between 7 and the next prime 11 is 4.

Again, after the prime 31, the next prime is 37, and their difference is 6; the prime after 89 is 97, with difference 8.

But even as such consecutive primes drift further apart, there are consecutive primes like 41 and 43 or 71 and 73 in between, which are only two apart.

There is a technique to list all primes less than a specified number. Let's see how we can use this to find all primes less than 50.

First, write all numbers up to 50 in rows and columns like this:

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	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50

Next, strike off 1 from this. Then strike off all multiples of 2, except 2:

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	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50

Now, 3 is the least number greater than 2 which is not stricken off; keep 3 and strike off all multiples of 3:

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	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50

Next, find the least number greater than 3 which is not stricken off, and it is 5. Strike all multiples of 5, except 5 itself.

If we remove the multiples of 7 other than itself also, we can see that there are no multiples, except themselves, of the other numbers remain:

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	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50

Now the numbers not struck off are

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47

and these are the primes less than 50.



- (1) Find all primes less than 100. Find the primes that differ by 2 among these.
- (2) Can the product of two natural numbers be a prime?
- (3) Can the sum of two prime numbers be prime?

[illegible]

Notes

[illegible]

CONSTITUTION OF INDIA

Part IV A

FUNDAMENTAL DUTIES OF CITIZENS

ARTICLE 51 A

Fundamental Duties- It shall be the duty of every citizen of India:

- (a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
- (b) to cherish and follow the noble ideals which inspired our national struggle for freedom;
- (c) to uphold and protect the sovereignty, unity and integrity of India;
- (d) to defend the country and render national service when called upon to do so;
- (e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
- (f) to value and preserve the rich heritage of our composite culture;
- (g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;
- (h) to develop the scientific temper, humanism and the spirit of inquiry and reform;
- (i) to safeguard public property and to abjure violence;
- (j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievements;
- (k) who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between age of six and fourteen years.

CHILDREN'S RIGHTS

Dear Children,

*Wouldn't you like to know about your rights? Awareness about your rights will inspire and motivate you to ensure your protection and participation, thereby making social justice a reality. You may know that a commission for child rights is functioning in our state called the **Kerala State Commission for Protection of Child Rights**.*

Let's see what your rights are:

- | | |
|--|--|
| <ul style="list-style-type: none">• Right to freedom of speech and expression.• Right to life and liberty.• Right to maximum survival and development.• Right to be respected and accepted regardless of caste, creed and colour.• Right to protection and care against physical, mental and sexual abuse.• Right to participation.• Protection from child labour and hazardous work.• Protection against child marriage.• Right to know one's culture and live accordingly. | <ul style="list-style-type: none">• Protection against neglect.• Right to free and compulsory education.• Right to learn, rest and leisure.• Right to parental and societal care, and protection. |
|--|--|

Major Responsibilities

- Protect school and public facilities.
- Observe punctuality in learning and activities of the school.
- Accept and respect school authorities, teachers, parents and fellow students.
- Readiness to accept and respect others regardless of caste, creed or colour.



Contact Address:

Kerala State Commission for Protection of Child Rights

'Sree Ganesh', T. C. 14/2036, Vanross Junction

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Website : www.kescpcr.kerala.gov.in

Child Helpline - 1098, Crime Stopper - 1090, Nirbhaya - 1800 425 1400

Kerala Police Helpline - 0471 - 3243000/44000/45000

Online R. T. E Monitoring : www.nireekshana.org.in