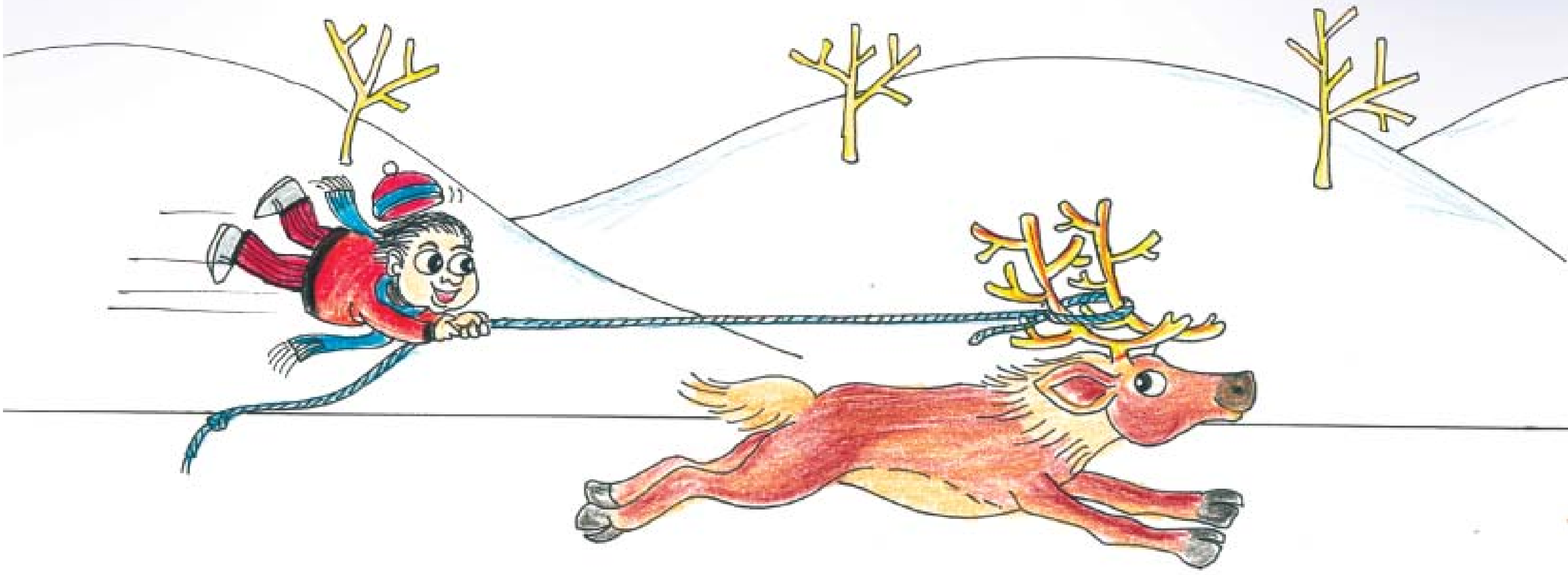
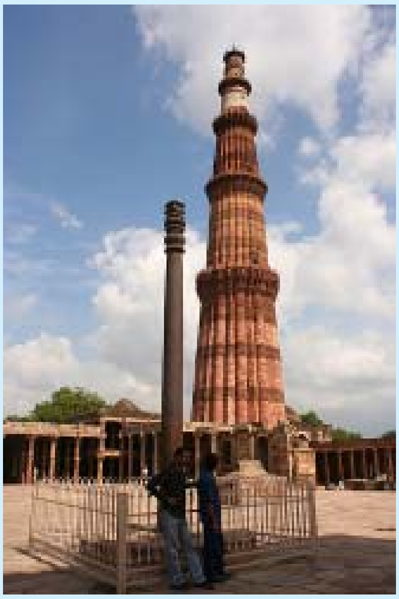
1

Slant and Spread



The tower that doesn't lean



Do you recognize the tower in the picture? It is the Qutb Minar, located in New Delhi, the capital of India. The construction of this tower was started by Qutb-ud-din Aibak in 1199 AD, who ruled India at that time. His successors added more storeys to it and it was completed in 1386 AD. It is 72.5 meters tall.

The small pillar in front of Qutb Minar is even older.

This iron pillar is estimated to have been constructed sometimes in the 4th century AD. This pillar illustrates the ability of Indians even at that time to extract iron and use it in various constructions. It has shown little rust, even though it has been exposed to sun and rain for more than one thousand five hundred years. This fact attracts researchers even today.

Trees and towers

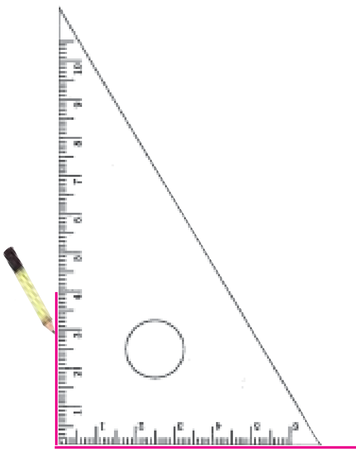
Look at these coconut trees. Some stand straight, some lean a little, some are bent a bit, ...

What about this tower?

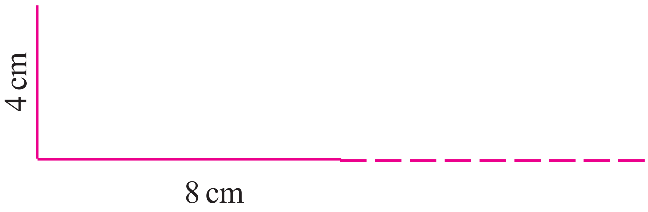
Let's draw a rectangle

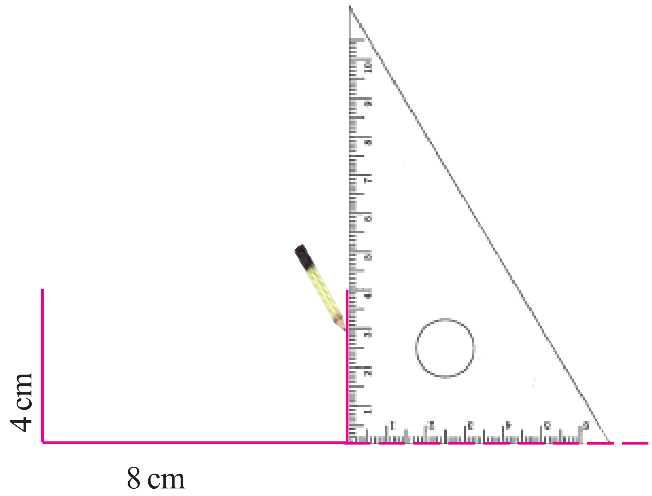
Do you remember drawing a rectangle with a set square?

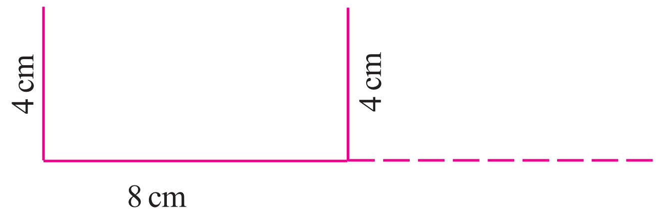
How do we draw a rectangle of length 8 centimeters and breadth 4 centimeters?

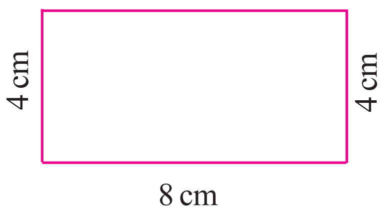


8 c.m.









Why do we use a set square to draw the two sides on the left and right?

Now draw a rectangle of length 6 centimeters and breadth 2 centimeters in a similar way.

The leaning tower

The first page shows a tower that leans a little. It is the famous leaning tower of Pisa, situated in the town of Pisa in Italy.

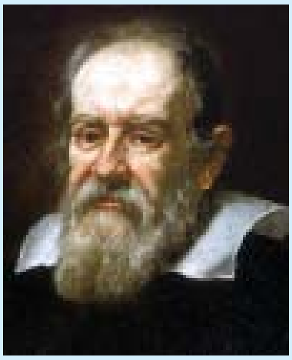
Work on it started in 1173 AD. After five years, on completion of the third storey, the tower began to lean. A weak foundation on loose soil was the cause. Work was suspended for about a century and restarted in 1272. The remaining storeys were constructed by increasing the height on the opposite side to check the leaning. (And this resulted in the whole tower being bent a little). The seventh storey was completed in 1319.

In 1964, it was found that the tower was slowly leaning more and more. Engineers and mathematicians sat together and discussed the problem. Heavy lead plates were fixed on the raised end of the base. Soil was removed under the raised lead and supporting cables were attached to the top of the tower. With all these in 2001, the tilt was reduced to what it was on 1838.

Even though it could have been made to stand upright, the tilt was preserved deliberately, to attract tourists.

Setting straight at the leaning tower

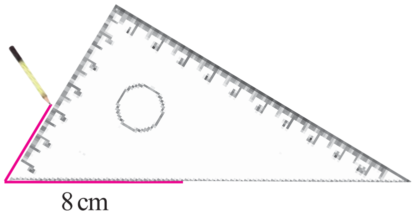
Galileo Galilei was a famous scientist who lived in Italy during the seventh century AD. There is a story about him and the leaning tower of Pisa in his first biography.

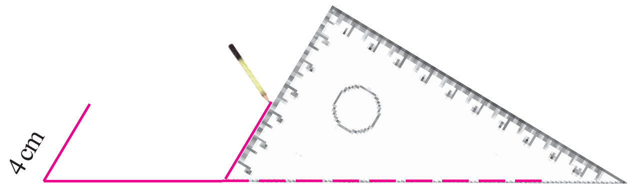


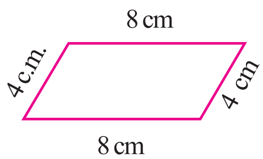
The ancient Greek philosopher Aristotle belevied that when objects fell to the ground, the heavier ones would fall faster. This was accepted by the sucessor scientists also. The story is that Galileo dropped things of different weights from the top of the leaning tower and showed that they fell to the ground at about the same time. This was the end of a two thousand years old beief. It is a basic principle in modern science that objects falling freely to the earth do so with the same velocity. Galileo was the first to present this idea. But some historians doubt whether Galileo actually did the leaning tower experiment to formulate it.

Funny rectangles

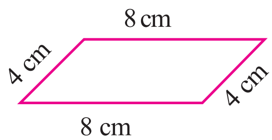
Appu had an odd idea. Why not use a different corner of a set square to draw something like a rectangle?





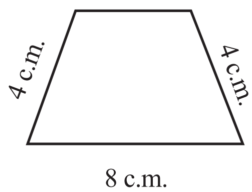


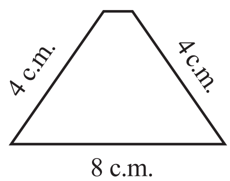
This is interesting, he thought. He drew another figure with the third corner of the set square.



Now you can also have a go at drawing such figures.

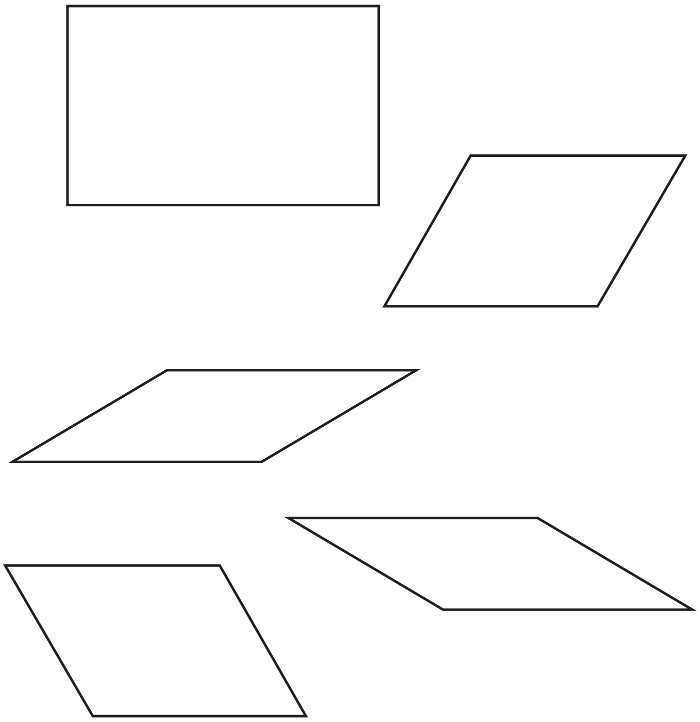
Many figures, such as those shown below, could be drawn using different corners of set squares. Try!





Leaning and slanting

Look at these figures:



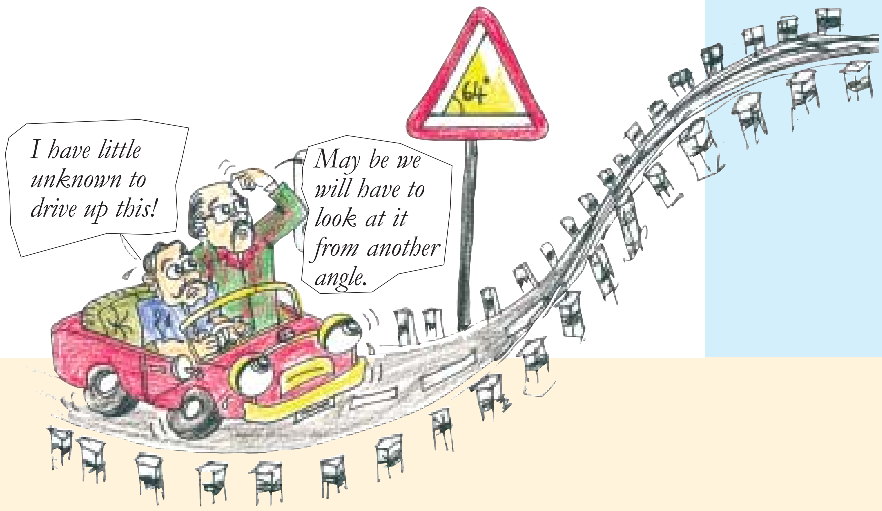
These are drawn with different corners of the two set squares in the geometry box. Measure the opposite sides in each figure. What do you find?

Then why are the figures different?

In the rectangle, the lines on the left and right go straight up from the bottom line. What about the other figures?

They lean, right?

And see how much they lean. Is it the same in all figures?

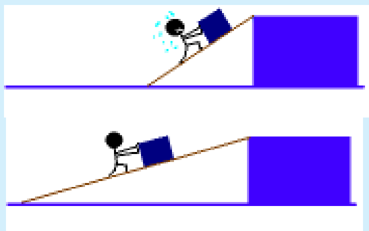


The inclined plane

Have you seen timber being loaded on a lorry? It is usually rolled up a plank or two strong pieces of wood, which leans against the lorry.

This is easier than lifting the logs up. This fact was known even in ancient times. It is believed that this was used in the construction of the Pyramids of ancient Egypt.

Look at this figure.



Along which plank, is it easier to push up the weight? Why? But which is the longer plank?

Word and meaning

An angle refers to a corner. When two lines meet at a point, a corner is formed. The word ‘angle’ was originated form the Greek word *anchilos* which means ‘crooked, not straight’.

In English, ‘ankle’ refers to the joint of the leg and the foot.

This word too has its origin in the same Greek word *anchilos*.

We do have angle at the ankle, don’t we?

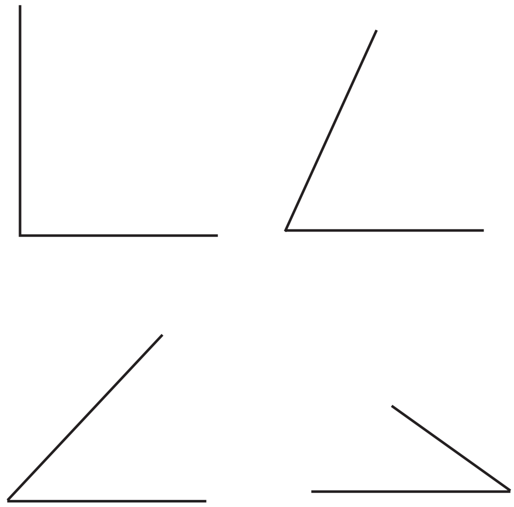
This can be put another way.

Each of these figures has four corners. And each corner is formed where two sides meet.

In the language of math, we say that when two lines meet at a point, an angle is formed.

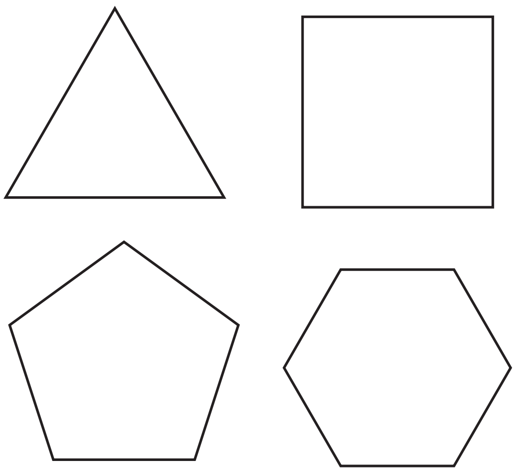
So we can say that the angles in the above figures are different.

The figures below show different angles that can be made using the two set squares in the geometry box.



Can you find out which set square was used to draw each angle?

Look at these figures.



How many angles are there in each?

Which of these can be drawn using set squares?

Some letters of the English alphabet have angles in them. Look at these examples:

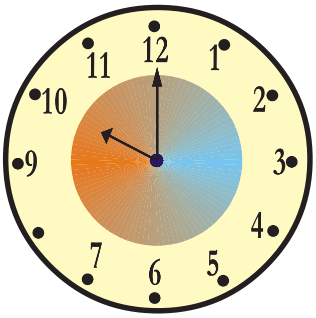
V L Z W X

How many angles are there in each?

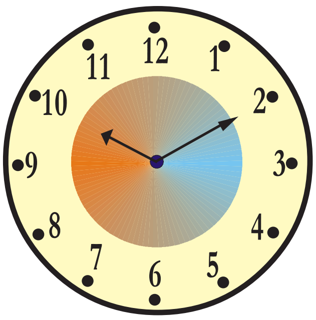
Find out other letters of the English alphabet with angles in them and count the number of angles in each.

Spreading angles

Look at this picture:



The hands of the clock make an angle. What happens a little later?



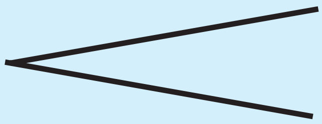
The angle has opened up a little more, right?

We can say that spread between the hands has increased. Or that the angle between them has become larger.

Size of an angle

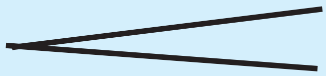
Look at this figure.

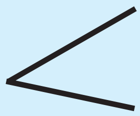
An angle made out of eerkil pieces. Suppose we open out the *eerkil* pieces a little more.



The spread of the angle has also increased, hasn't it? That is, the angle has become larger.

Now, look at these figures:

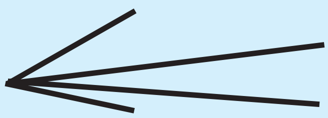




Which is the larger angle?

The angle at the top has longer sides. But what about the spread?

Put differently, the angle at the top can be placed *within* the angle at the bottom.



Mirror math

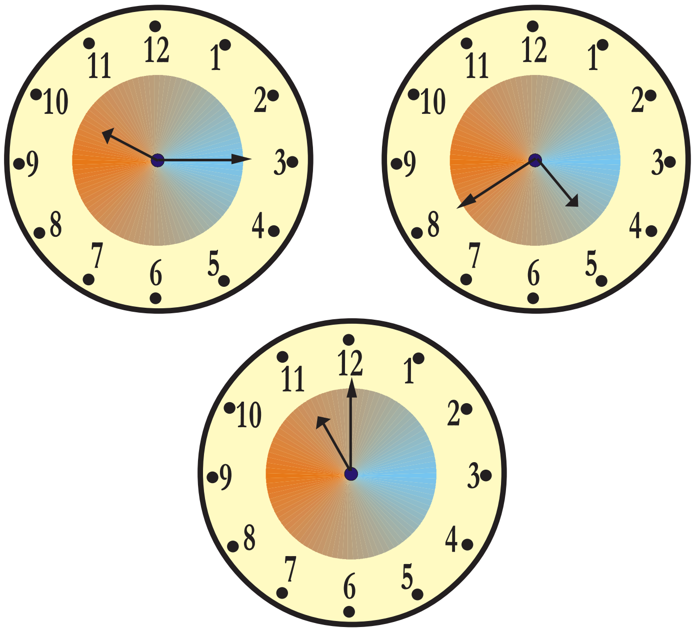
Have you seen a clock without any digits marked on it?

How do we tell time using this?

Now, a teaser: Suppose a mirror is held against this clock. If the clock in the mirror shows 8:30, what is the actual time?

Compare various times shown by the clock in the mirror with the arms shown by the real clock. Do you see any relation?

Now look at these pictures.

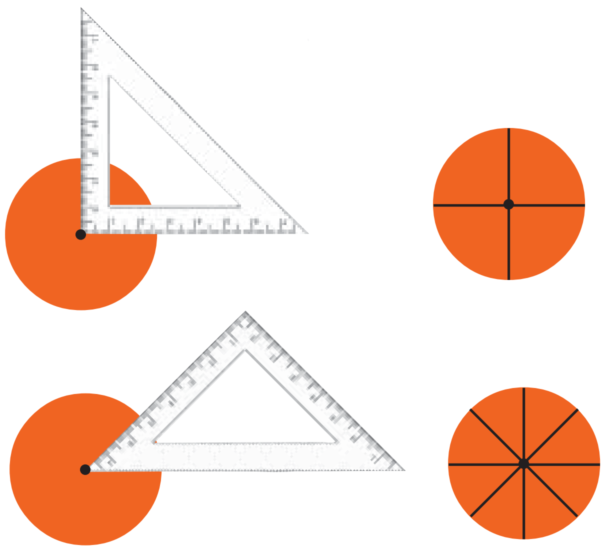


At what time do we have the largest angle?

And the smallest?

Angles in a circle

Do you remember how we divided a circle into equal parts with the help of set squares? (The lesson, *Number parts* in class 6)



In how many different ways can we divide a circle, using the angles of the other set square? Have a try!

When the angle used for dividing is made larger, does the number of parts increase or decrease?

Measure of an angle

How do we divide a circle into five equal parts?

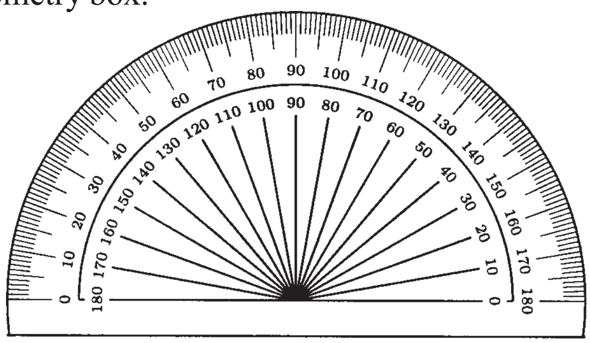
We cannot do it with a set square. We need a suitable angle.

We use a ruler to measure length, don't we? Small lengths such as centimeter and millimeter are marked on it.

Similarly, a small angle is used to measure other angles. When a circle is divided into equal parts, the angle becomes smaller as the number of parts gets larger. This small angle is got when a circle is divided into 360 equal parts.

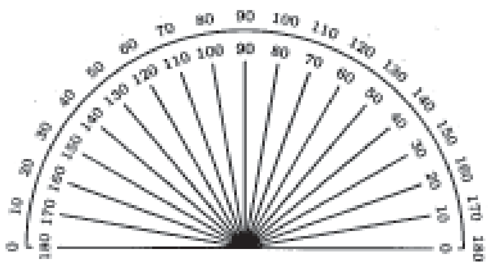
The measure of this small angle is called 1 degree and written 1°.

An instrument to measure angle is found in the geometry box.



It is called a *protractor*.

Don't you see a number of lines drawn on it?



Against each line, is written the angle which it makes with the line at the bottom.

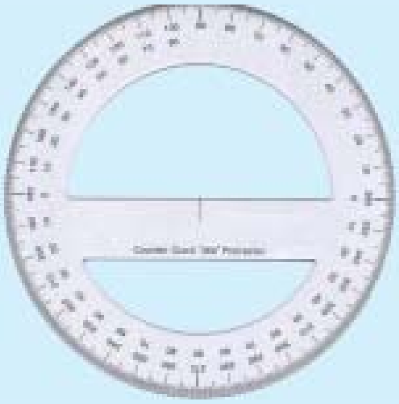
History of angle measurement

It was the astronomers of ancient Babylonia who divided a circle into 360 equal parts in order to measure an angle. This is related to their calendar. They believed a year to consist of 360 days. And this was of measuring angles helped them study changes in the positions of the stars day by day, when viewed from the earth.

In India, the *Rigveda*, believed to have been written around 1500 BC, mentions the division of a circle into 360 equal parts.

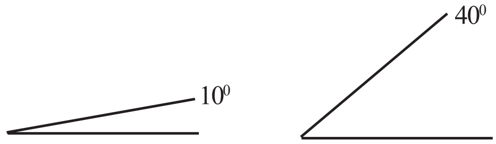
A full protractor

The protractor in the geometry box is a semicircle and is marked up 1 to 180^0. This usually suffices to measure and draw most angles. But there are protractors, which use a full circle marked from 0^o to 360^0.



This instrument is very convenient to divide a circle and do similar jobs. But the geometry box should be much larger to hold it.

For example, the spread between the bottom line and the line above is 10^0. The spread between the bottom line and the line marked 40 is 40^0 .



In other words, 4 angles each of spread 10^o make an angle of spread 40^o.

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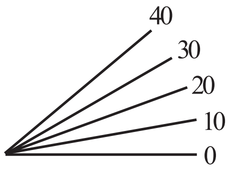
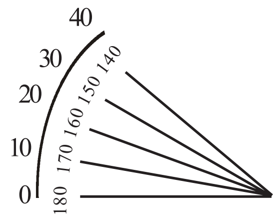
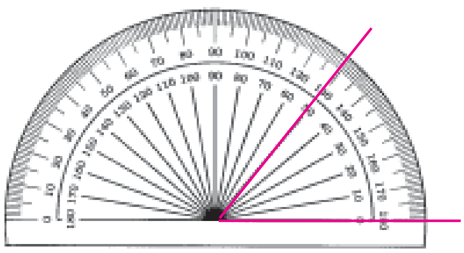


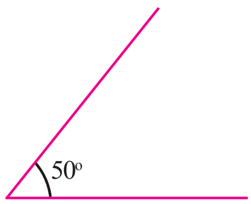
Another round (actually half-round) of numbers is marked above for measuring and drawing from the left.

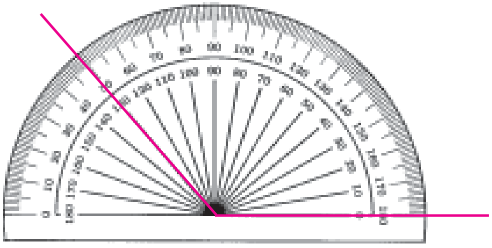


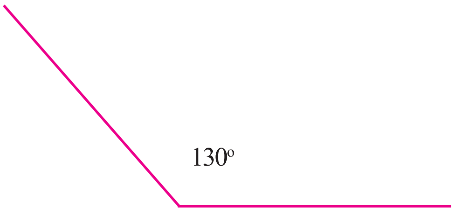
Let's measure an angle

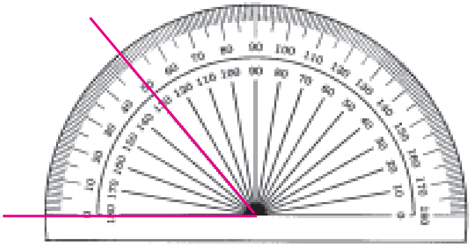
How do we measure an angle using a protractor? Look at these figures.

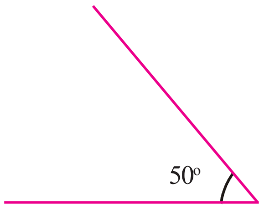










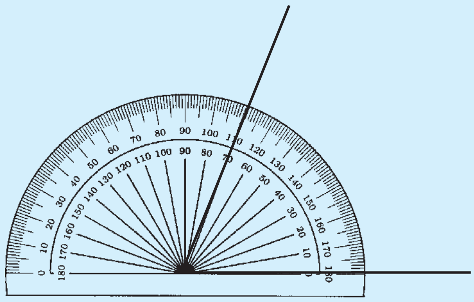


We have drawn several angles using the set squares in the geometry box. Now measure them all, using a protractor.

- In the sections *Slant and spread* (p.12), you see figures with five or six angles. Measure those angles.
- Can you find the measure of each angle of the set square in the geometry box?
- What all angles can we draw using the set squares? How do we draw an angle of measure 15° using them?

How do we measure?

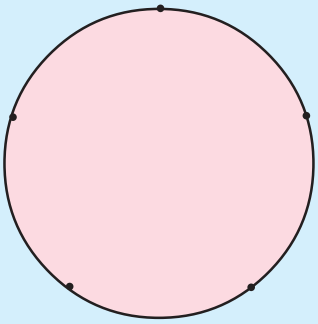
A kid wrote down the measure of the angle in the figure as 110°. Is it correct?



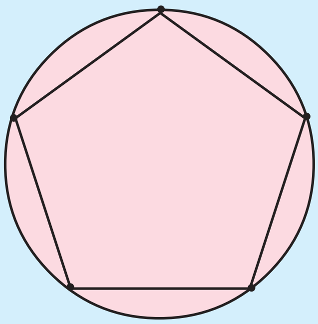
What all things should we be careful about when measuring an angle?

Deep inside

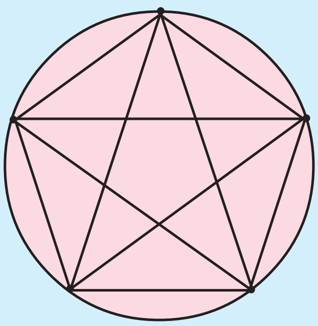
Divide a circle into five equal parts; mark the points, without actually drawing the lines.



If we join only adjacent points, we get a five sided figure.

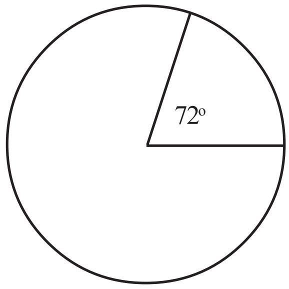


What if we we join every pair of points?



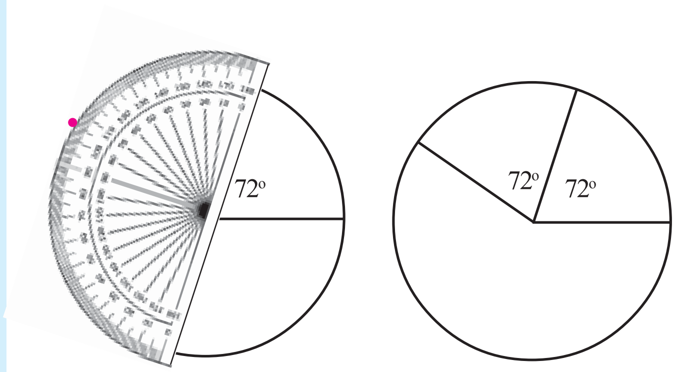
A star is seen, along with a smaller copy of the first five sided figure. We can fix the corners of the smaller figure and repeat the process.

Let's draw an angle



Draw a circle. Draw an angle of 72° at the centre, as in the figure.

Now, draw another angle of 72° on top of the first, as in the figure below.

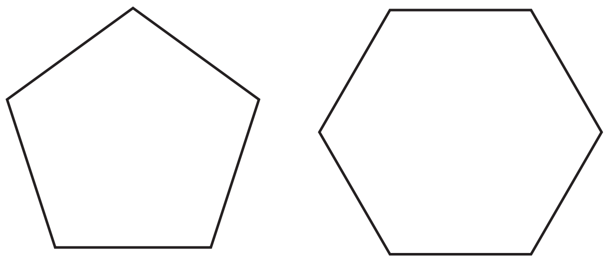


How many such angles can be drawn? And how many parts of the circle do we get? Are these parts equal in size?

Why do we get *five* equal parts?

Can we divide the circle into 10 equal parts like this? How about 9 equal parts?

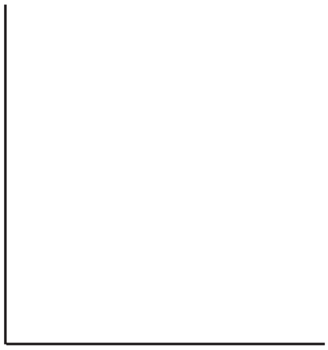
Now look at these figures:



You have already measured their angles, haven't you? Now can you draw them?

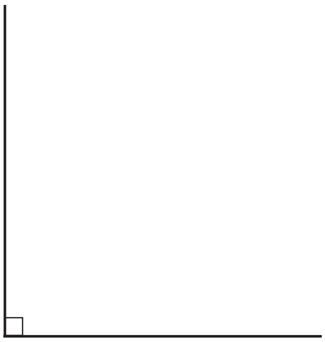
No slant, no bend

Draw a line and from one end point, draw another line vertically upwards, using a set square.



What is the angle between these lines? Measure it.

Two such lines, making an angle of 90^0 with each other are said to be (mutually) perpendicular. Such an angle is marked in a figure as shown below.



So, instead of saying that one line stands vertically on another, we say that these lines are perpendicular. For example, in a rectangle, sides nearby are perpendicular.

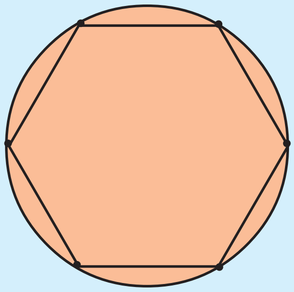
An angle of measure 90^o is also called a right angle.

So, what are the different ways of saying "vertical" in mathematics?

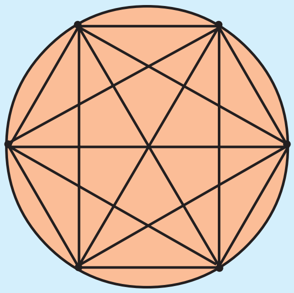
- the angle between two lines is 90^0.
- the angle between two lines is a right angle.
- two lines are prependicular to each other.

On dividing into six parts

If we divide a circle into six equal parts instead of five, we get a six sided figure.

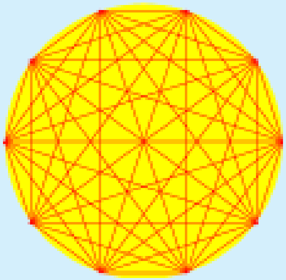


Suppose we join all points in the figure?



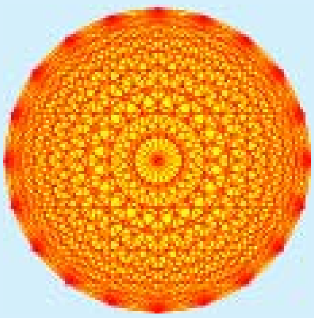
Computer picture

Divide a circle into ten equal parts and join all the points.



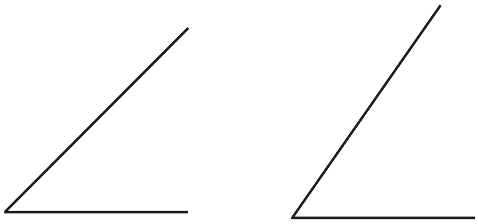
How many lines are there?

If we use a computer, any number of points may be marked and joined by lines quite easily. A computer picture of twenty points, all joined by lines is shown below.

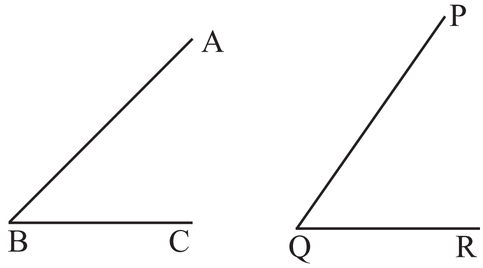


Naming an angle

Look at the angles below:



In order to distinguish between them, let's name the sides of the angle and also the point where they meet.



The first angle may be called *ABC* and the second *PQR*. Measure them. Angle *ABC* measures 45°, doesn't it? This is written

$$\angle ABC = 45^\circ$$

Similarly, measure angle *PQR* and write it down.