PRATHAM BOOKS
A Book in Every Child's Hand

Level 3

Happy Maths : Measurements

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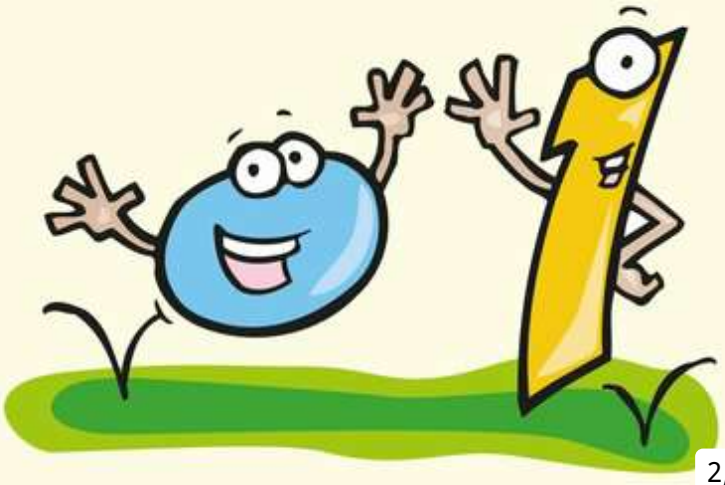
Illustrator: Angie & Upesh

Sankhya and Ganith have been learning a lot of things in their mathematics class. Join Sankhya and Ganith in their happy discoveries about mathematics. Zzero and Eka are friends of Sankhya and Ganith.

In this book, Sankhya and Ganith have fun measuring a lot of things.



Sankhya and her younger brother Ganith enjoy each other’s company.

They go to school together and they play together.Sometimes they fight with each other.

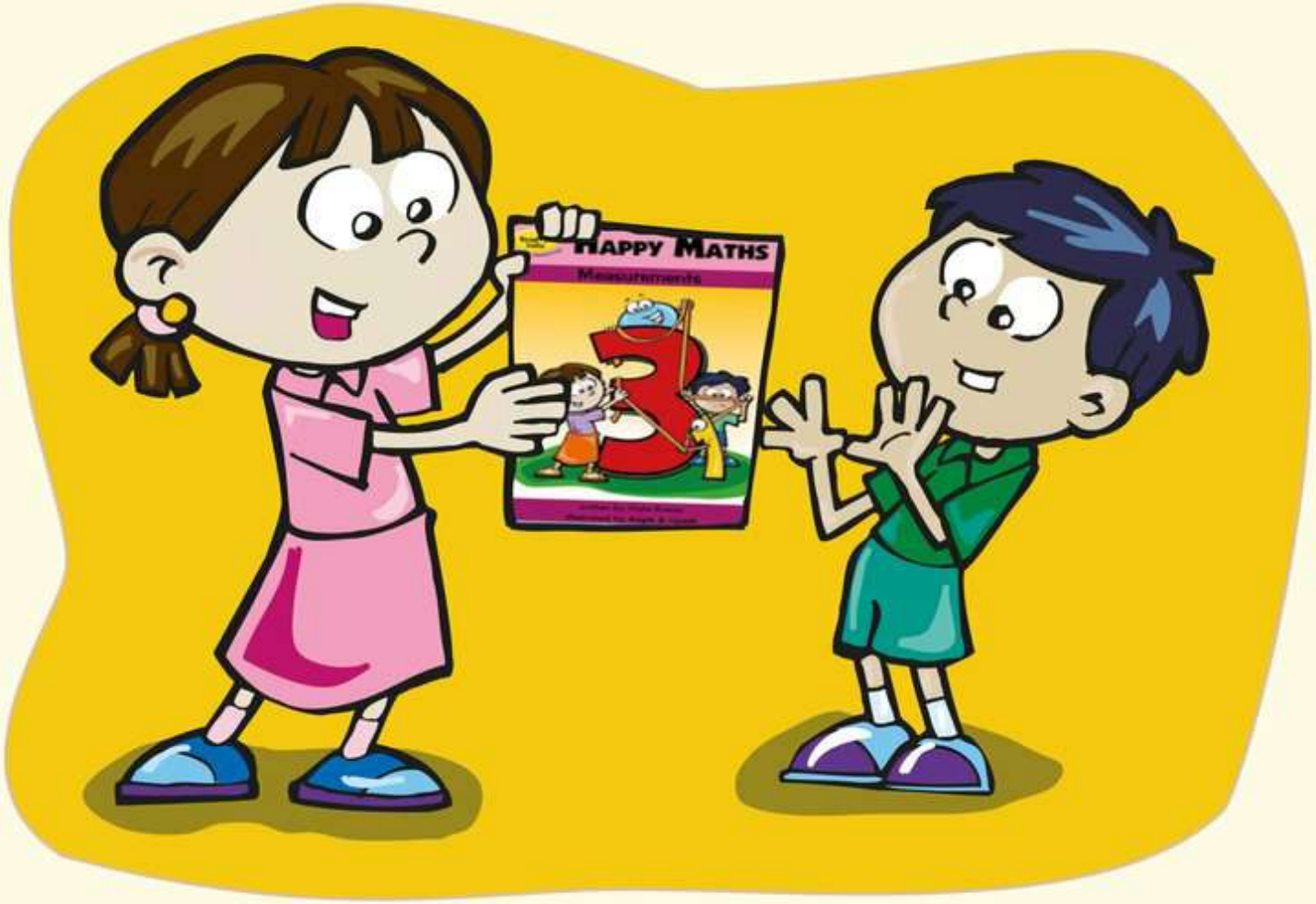
One day they climbed to the top of Meghdoot Hill. They shouted as loudly as they could.

“I can shout louder than you!” shouted Sankhya. “No, I can shout louder than you,” screeched Ganith.

Sankhya and Ganith have learnt to measure many things. They were surprised to learn that we can measure almost anything.

We can even measure how loudly we shout! Measurement and managing information are part of mathematics. Using mathematics in our life can be very entertaining and useful.

Let’s Measure



How big is this book? “It’s very long,” says Sankhya. “It’s not so thick,” declares Ganith.

“It is broader than our history textbook,” says Sankhya.
An object has several sides to be measured. Measurement is used to compare sizes. We use different units to measure each part of an object.

A book has a regular shape and is easy to measure. Let’s see how many fingers wide the top of the book is. “12 fingers,” says Sankhya, using four fingers of her left hand, then four fingers of her right, and again four fingers of her left hand.

“10 fingers,” says Ganith, whose fingers are a little chubbier than Sankhya’s.

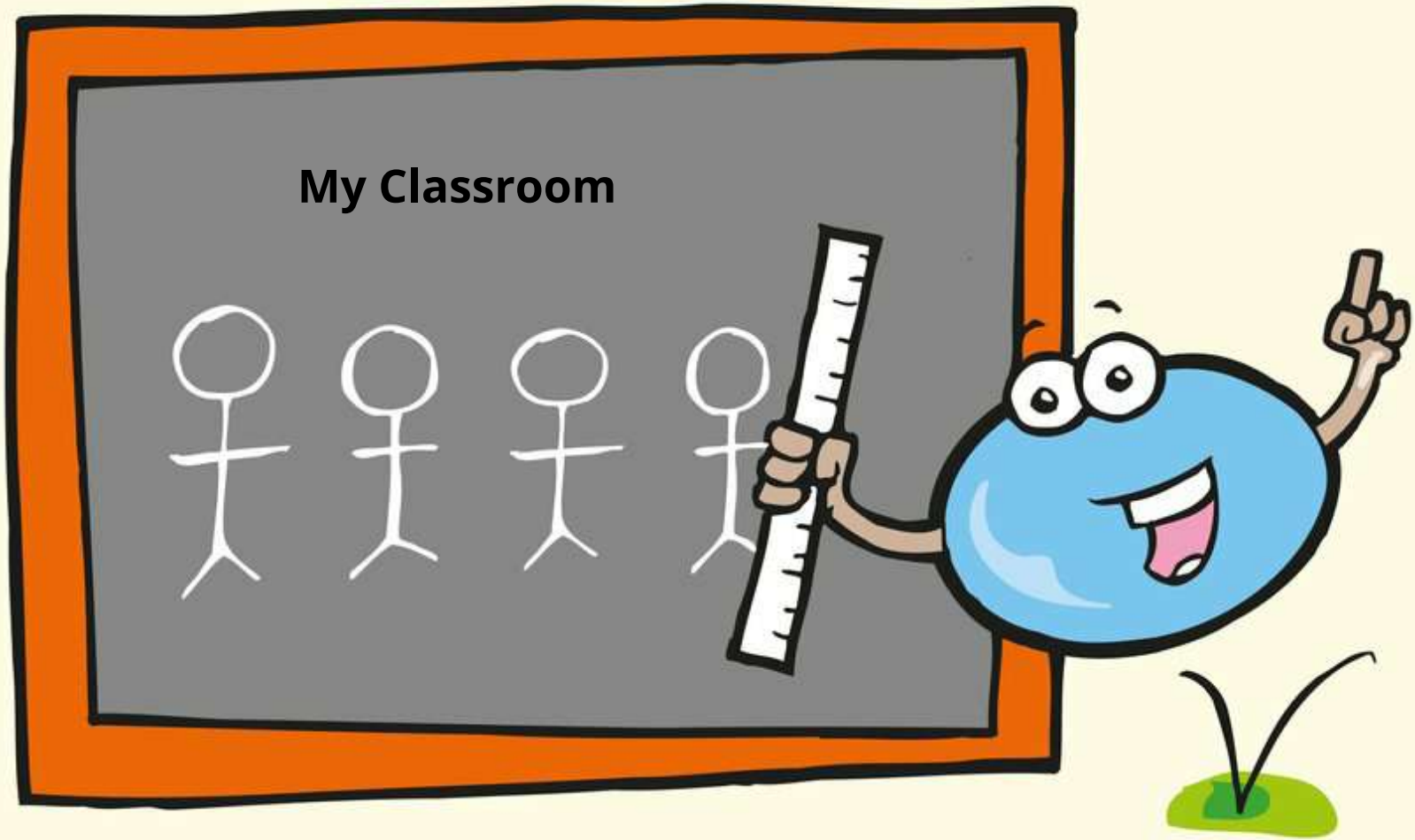
Ganith picks up a ruler, and measures the top of the book. “12 cm,” he says.

1. If the width of the book is 12 cm, on an average what is the width of each of Sankhya’s fingers?

2. What is the average width of Ganith’s fingers?

3. Use the ruler to find your height and that of your friends.

4. Can you think of ways to find the width of your classroom without using your ruler or any other measuring device repeatedly? (You may use it ONCE!)


My Classroom

My Classroom

Under a Banyan Tree Sankhya and Ganith were on a school picnic to the Big Banyan Tree, which is near Pune in Maharashtra. The teachers had warned the students not to run off on their own.

“There are more than 320 pillars of the aerial roots here, and it is easy to get lost,” warned Saroja madam. Sankhya tried counting the number of people around her. She counted up to hundred and then gave up. “Some 20,000 people can stand under this tree’s canopy,” said Venkat sir.

“This banyan tree is supposed to be the biggest one in the world. It has a perimeter of 800 m,” added Saroja madam. “What is perimeter?” asked a little boy. “Perimeter is the measure of the length of the boundary of a two-dimensional figure. Children, sit down here and I will tell you a story about perimeter.”

A Circular Plot
Story by R.K.Murthi

Maharaja Vijaya Vikram was the ruler of a state in India. He was fair and just, kind and generous.

One day, a poor villager arrived at the court of the ruler. He was stopped at the entrance of the palace by the guard. He told the guard that he would like an audience with the Maharaja. The villager was thin and famished. He wore clothes that were clean, but had several tears mended deftly. It was clear that the man was indeed very poor. The guard glared at him with contempt.

“Vermin of the land,” he spat out, in a loud voice. “Get back to where you belong. The Maharaja is busy discussing affairs of the state with his advisers. He has no time for people like you,” the guard, a new recruit, tried to turn him away.

“But I am his subject. And it is his duty to look after his subjects and to attend to their needs and welfare,” the villager pleaded.

“Are you trying to tell me how the Maharaja should conduct the affairs of the state?” the guard rolled his eyes angrily, while telling the man to scoot.

“I will wait,” said the villager.

“You can wait till the cows come home,” the guard laughed in contempt.

But his laughter died in his throat when he found Maharaja Vijaya Vikram walking down the broad footpath that led to the main entrance. With him was his chief adviser, Pandit Vidyasagar. He perked up, gently shoved the villager to one side and stood at attention. When the Maharaja reached the gate, he saluted the Maharaja and said, “Maharaja Vijay Vikram ji ki jai ho.”

The villager repeated the call. His voice was sharp and tangy.

The Maharaja heard the man and turned to him. The villager bowed.

The Maharaja smiled at the villager. “What brings you here, my friend?” he asked.

“O Noble Maharaja, I am a poor man. I own no land. I work on land that belongs to others. I work all day long. But I get very low wages. Often I find no work. Then I starve. So do my wife and children. Give me a piece of land. One on which I can work and raise enough food to keep my family above want,” the man spoke clearly.

The Maharaja’s eyes quickly ran over him. He was so thin that he reminded the Maharaja of a walking skeleton. Yet his voice was clear. And he presented his appeal clearly. He did not stutter or stammer, as most people did when they came face to face with the Maharaja.

That impressed the Maharaja. “You speak well, man,” the Maharaja looked pleased.

“Your Highness! When I was a boy, I studied under Pandit Vijayeswara. He taught me how to read, write and count.

He introduced me to squares and circles. He taught me how to calculate perimeter and area and the volume of figures. It was difficult, but my beloved teacher was patient. He explained every detail, again and again.
I wanted to learn more, but he died suddenly. If only he had lived longer! Then I would have learned enough to be a teacher. Now I live in poverty. If only I own a piece of land! I shall till the land, make enough to rise above poverty," the villager paused.

“You studied under Pandit Vijayeswara? He was the wisest man of our state! How we miss him, even today,” the Maharaja sighed. Then he turned to Pandit Vidyasagar and said, “Give him what he wants.”

“Yes, Maharaja,” Pandit Vidyasagar replied. “Where will you give him land?”

“To the east of the capital lies a vast tract of arid land. Nothing grows there. We have prepared a plan to reclaim the land for cultivation. We have laid a canal.

It cuts through this tract. Here we have settled some farmers. We can give this man some land there,” the minister replied.

“How much land do you need ?” the King asked.

“A piece of land with a perimeter of ten thousand feet,” the farmer replied readily.

“Perimeter! What is so great about perimeter? We have never heard such a request in all these years. People usually ask for an acre or two of land. They bother about the area of the land, not the perimeter,” the adviser raised his voice ever so slightly.

“Oh Revered Sire! Can beggars be choosers? I will accept whatever you allot. But you asked me what I want. So I expressed my wish,” the farmer spoke politely, yet clearly.

The ruler bent forward, looked into the eyes of the farmer and asked, “I think you have something in your mind. What is it?”

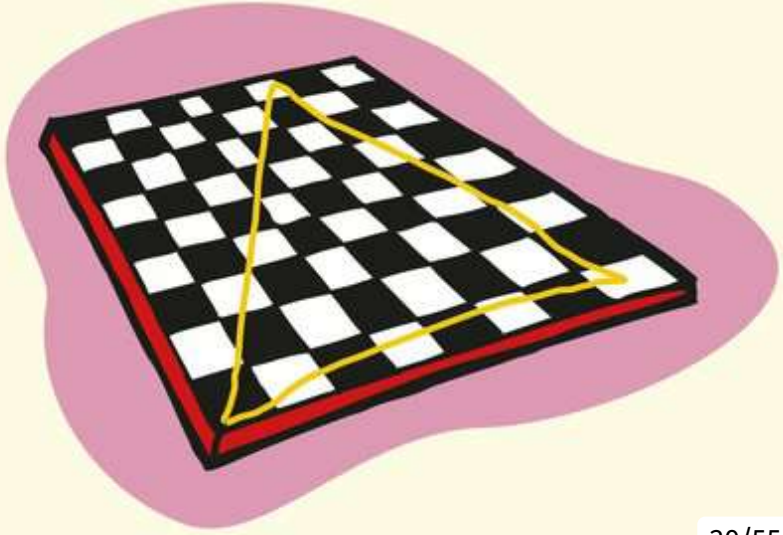
“Your Highness! Lead me to the central courtyard. Get me a string as long as my forearm and also a chessboard. I shall then show you why perimeter is important,” the farmer bowed.

“Come with me,” the Maharaja walked back to the courtyard. A guard ran to fetch a couple of chairs. He set them down. The Maharaja sat down. So did Pandit Vidyasagar. The villager sat on his haunches, on the stone-paved courtyard.

The Maharaja told the guard to fetch a chessboard and also a string as long as a man’s forearm. The guard moved out quietly and returned with the chessboard and the string.

“Let us have the grand show, my man,” the Maharaja waved his hand. The farmer sat cross-legged on the floor. He set the chessboard before him. He used the string to shape, on the chessboard, a triangle. Then he turned to the Maharaja and said, “If it pleases Your Highness, please ask someone to count the full squares that lie within the triangle. He must treat every square, most of whose area lies within the figure, as a full block. He must omit every square, most of whose area lies outside the figure,” the farmer laid down the terms.

“Would you like to do that, Pandit ji?” the Maharaja turned to Pandit Vidyasagar.

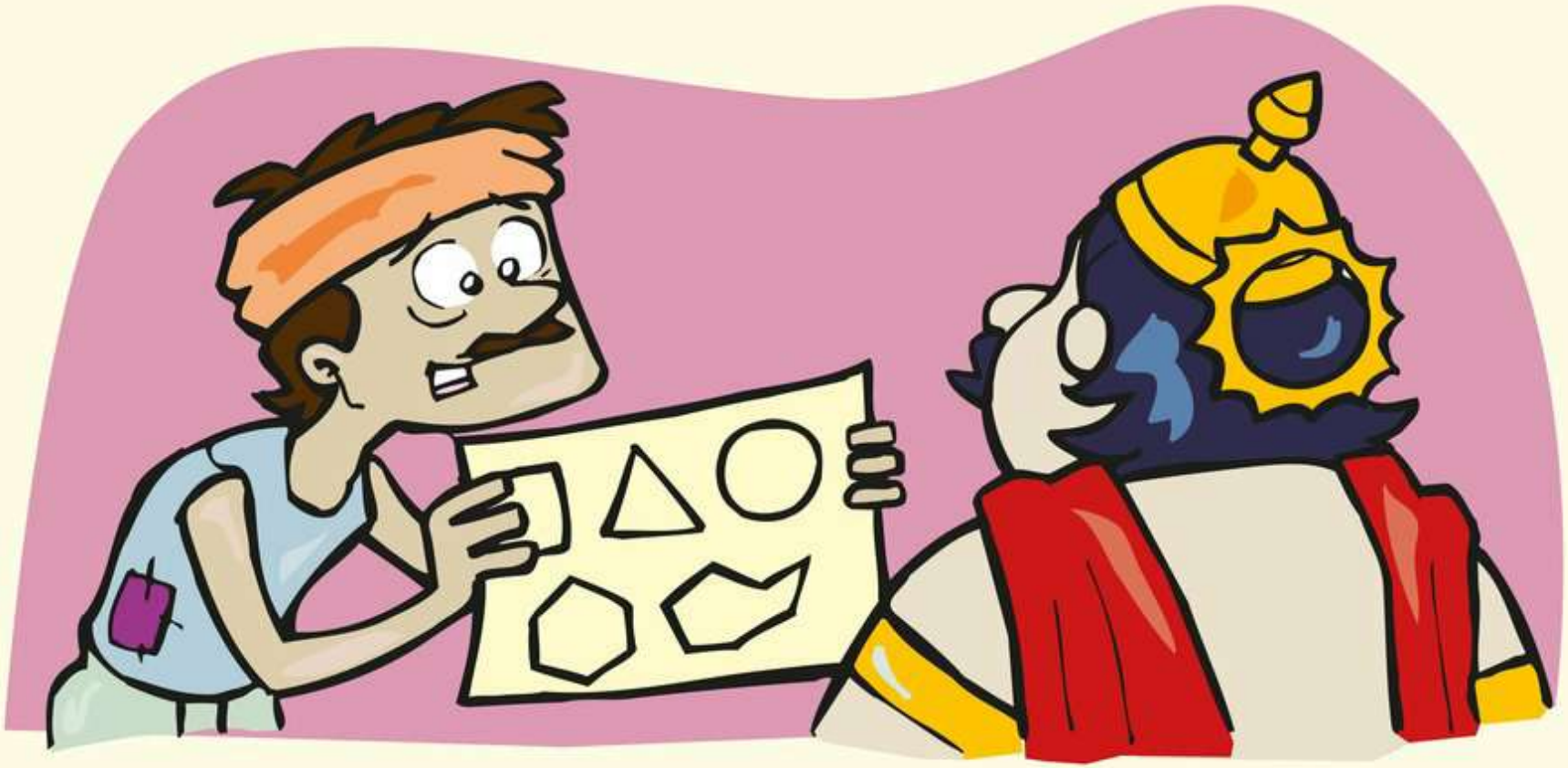


“Gladly, Maharaja,” The Pandit got up from his seat, walked across, bent down and took count of the squares enclosed by the string shaped like a triangle and noted the figure on a pad.

“That is the area of the triangle, Your Highness,” the farmer pointed out. “I know,” said the Maharaja.
The farmer now formed a square figure with the string. Pandit Vidyasagar counted the squares held within the shape and recorded the figure. The farmer formed in turn, a rectangle, a hexagon, a heptagon and a circle. The courtier recorded the number of squares held within by each shape.

The farmer took the chart from the hands of the courtier and held it in front of the king. “Your Highness! The length of the string is fixed in all the cases. So all the figures I made had the same perimeter,” he said.
“That is true,” the Maharaja agreed.

“Yet the area differed according to shape. Check this list, Maharaja. You will notice that the circle formed by the string held the maximum number of squares and hence the maximum area,” the farmer explained.



“Wonderful! Pray, tell me, how did you know that a circle holds the maximum area?”

“Your Highness! I owe that knowledge to Pandit Vijayeswara,” the man held his palms together in reverence. “My man, you get the land. You also get something more. You get a place in my court,” the Maharaja placed his hand on the farmer’s shoulder and showed his appreciation.

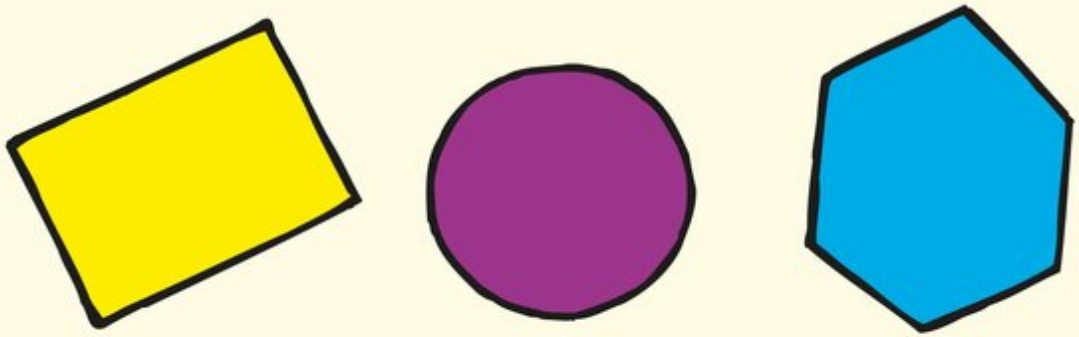
When Saroja madam finished telling her story, the students sat still. They were amazed that perimeter could be such an important measurement.

1. If a group of 100 students went to Pune’s famous Banyan Tree, suggest ways in which they could find the perimeter of the tree without using a measuring tape.

2. You have to build an enclosure for your cow. If you had to build the largest possible enclosure with the least amount of material, what shape would you chose?

3. To know the perimeter of some geometric shapes, we need to measure only a few things. To know the perimeter of a square, you only need to measure one side. Perimeter of a square is 4 times the length of one side. Do you know how to find out the perimeter of other shapes?

a) Rectangle b) Circle c) Hexagon



The Slow Horse Race

A king wanted to test the intelligence of his two sons.

“Take your horses and ride out to the end of my kingdom. The prince whose horse comes in last will be declared the winner,” proclaimed the King. “You have to come back to the palace by sunset.”

We fight over being the fastest, the highest, the farthest or the longest. Here was a problem that required the contestants to be the slowest.

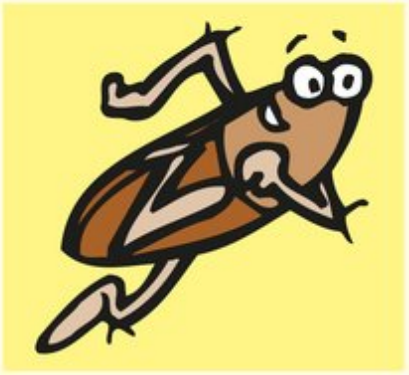
“If I try to ride slowly, you will try to ride even more slowly,” pointed out the elder prince. “If we ride very slowly, we will never be able to reach the end of the kingdom and return to the palace before sunset,” said the younger prince.

A wise old minister saw their dilemma. “Young men, why don’t you just …” he whispered. “That way, the race will get over very soon and there will be a clear winner.” Read the story very carefully. Then you may be able to guess what the wise old man suggested to the royal young men!

Fastest, Highest, Farthest

We need measurement to compare our respective positions.

We are usually not worried about being the slowest.
The Cheetah is the fastest mammal on earth.
It sprints at 110 kilometres an hour.



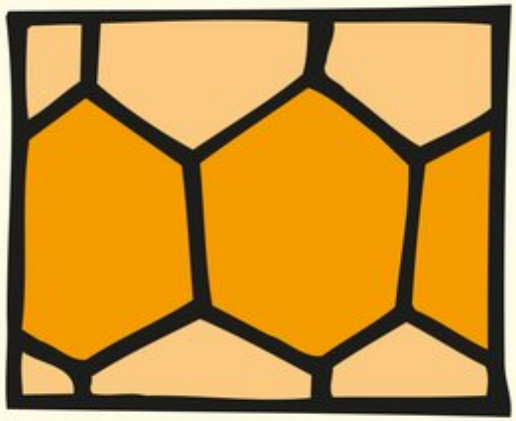
A flea (which uses a dog’s body as its playground) is a long-jump champion. It jumps a distance of 33 centimetres. With a body that measures just 1.5 millimetres, this jump is 220 times its body size.

An ant can carry 50 times its own weight.

The Swift is the fastest champion in the sky.
It can dive at the rate of 200 kilometres an hour.

Bees use 20 grams of wax to build a honeycomb
that can store 1 kilogram of honey.

The honeycomb structure of the hive made up of hexagonal cells makes it the strongest arrangement of hollow shells.



How did they do it?

On a rainy day, Sankhya and Ganith were playing a game in the veranda. “Can you guess how far that wall is from here?” asked Ganith.

“15 feet?” estimated Sankhya.

Ganith measured the distance by putting one foot ahead of the other, and said, “Sorry, sister, it’s 10 ft.”

“Alright, can you guess how many jaans wide that doorway is?” asked Sankhya.

“And what’s a jaan?”

“The average length of an outstretched palm. Now tell me, how many jaans?”
“Six,” said Ganith, looking at his stretched palm first, and then at the doorway.
Sankhya ran up to the doorway, and measured with her palm.

“You’re right! How did you guess?”
“I’m a genius, you know!” he answered.

Actually the wily fellow had measured the floor tile in front of him. The doorway was three tiles across. Ganith had checked that each tile measured two jaans, the rest was simple!

Ancient astrologers and mathematicians calculated distances almost accurately although they had very few tools for calculation. They certainly did not have a calculator.

The Indian mathematician Aryabhatta calculated that a day has 23 hours, 56 minutes, 4 seconds and a fraction.

Modern scientists with sophisticated scientific measurement tools have found the length of the day to be 23 hours, 56 minutes, 4 seconds and 0.091 fractions!

More than 600 years ago, Saayana, a scholar in the court of King Bukka I of the Vijayanagar Empire, calculated the speed of light to be 2202 *yojanas in half a nimisha.* Converting the units *yojanas and nimishas,* we get 186, 413.22 miles per second.

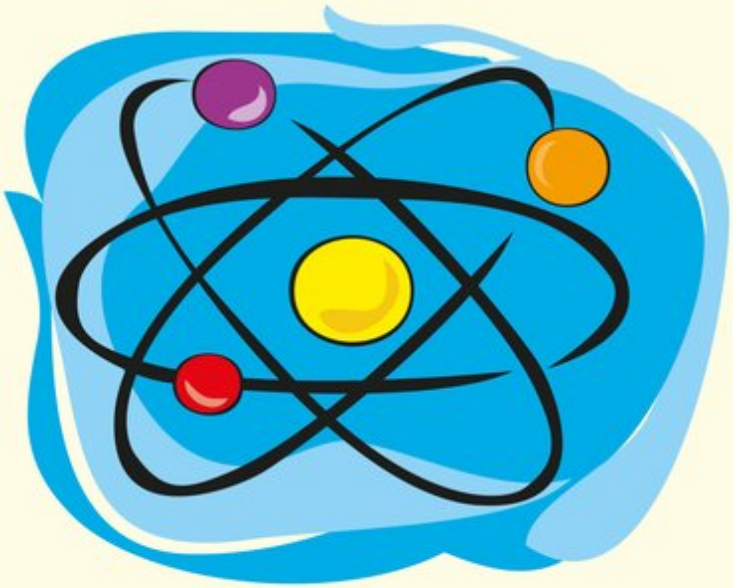
Modern calculations have found it to be 186, 300.00 miles per second.

A yojana is a Vedic measure of distance used in ancient India.
The length of one yojana is approximately 14-15 kilometres.

A nimisha is a Vedic measure of time. It is equal to 16/75 of a second.
1 nimisha =0.2 second

Indian scientists and mathematicians
could also calculate tiny sizes.

How small is an atom?



Look at the tip of a single strand of your hair. Imagine dividing that tip into hundred equal parts. Imagine one of those parts divided into hundred parts.

That is the size of an atom!

This explanation was found in the Upanishads, an ancient Indian text. Now we know it as one centimetre divided by 100000000. Have you seen the conversion table given at the beginning of most diaries?

The day Sankhya’s Uncle Guna presented her with a diary, she spent the whole day reading all the information given in the table.

She did not understand most of the things. She decided to write down at least the few things she did understand!

Here is Sankhya's table:

What you can measure	New Unit	Old Unit	Connection between Units
Length (big)	Kilometre	Mile	1 mile = 1.6 Kilometres
Length (small)	Centimetre	Inch	1 inch = 2.5 Centimetres
Volume	Litre	Gallon	1 gallon = 1.5 Litres
Mass	Kilogram	Pound	1 kilogram = 2.2 Pounds

What you can measure	Units of Measurement
Sound	Decibels = dB
Speed	Kilometres per hour = km/h.
Power	Kilowatts = kW
Temperature	Degree Celsius = 0C
Electricity	Volts = V

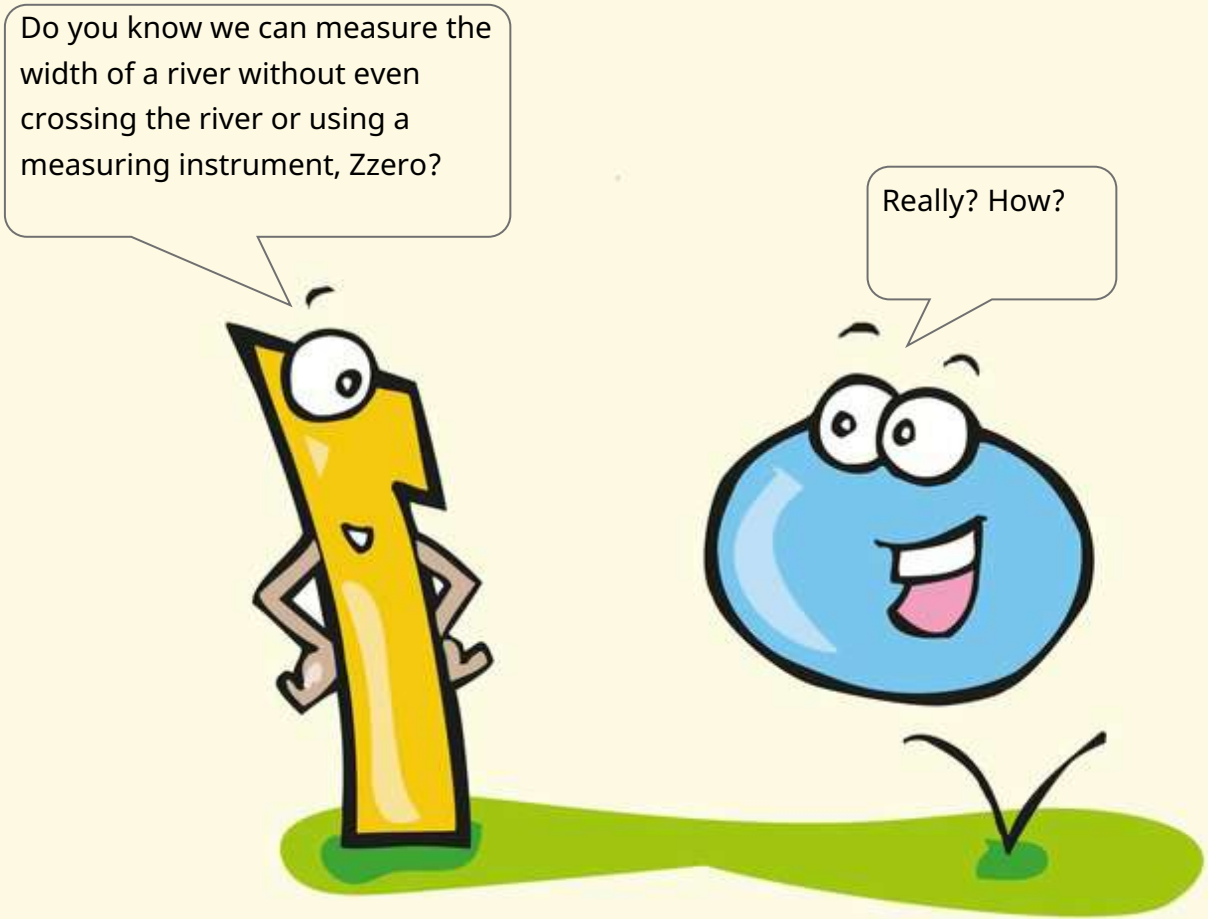
1. Which is longer - 1 mile or 1 kilometre?

2. When you whisper in class your sound measures 20 dB. Rustling leaves make a sound of 10 dB. If a motorbike makes 80 dB of sound, how much louder is it than your whisper?

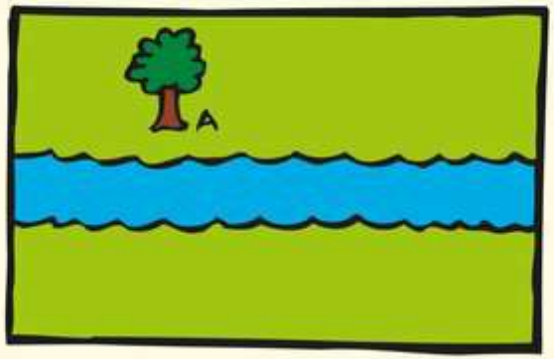
3. There is a fish-like creature in oceans called the Electric Eel. It produces 650 volts of electricity from the muscles in its tail. It uses this to stun its prey. This is nearly three times as powerful as the electricity in many of our homes! How many volts is that?

Zzero goes to the River

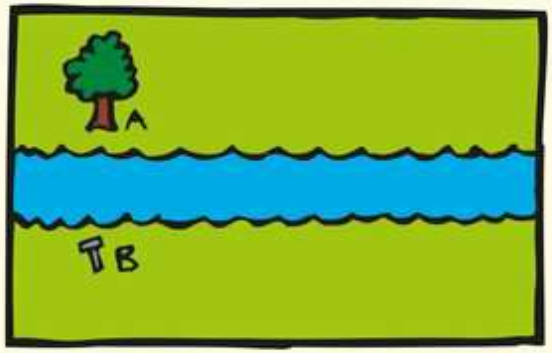
Zzero’s head starts zooming when people talk about very big numbers or very small numbers. He does not want to measure the distance from his house to the moon. But he likes to measure shorter distances.



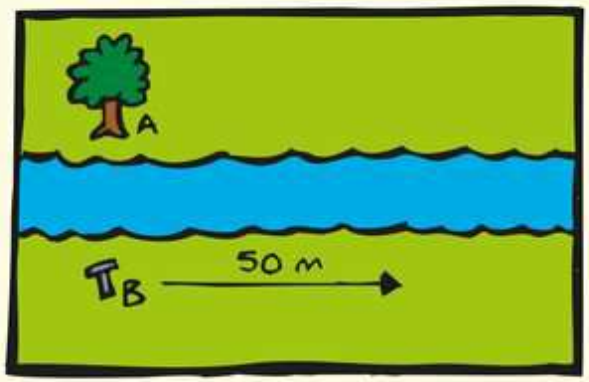
This is how Eka explained it to Zzero:



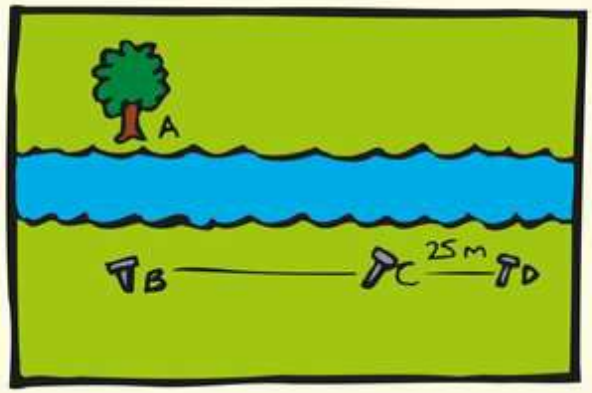
Pick out a point across the river, such as a tree (A).



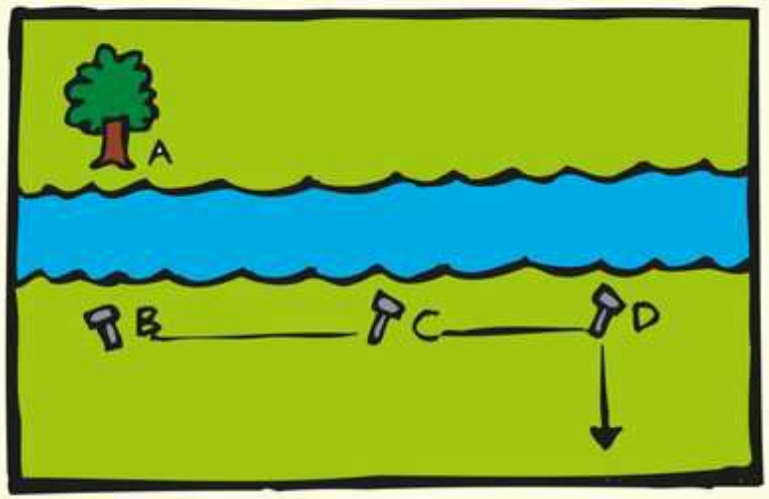
Drive a stake (B) into the ground on your side of the river in line with the tree.



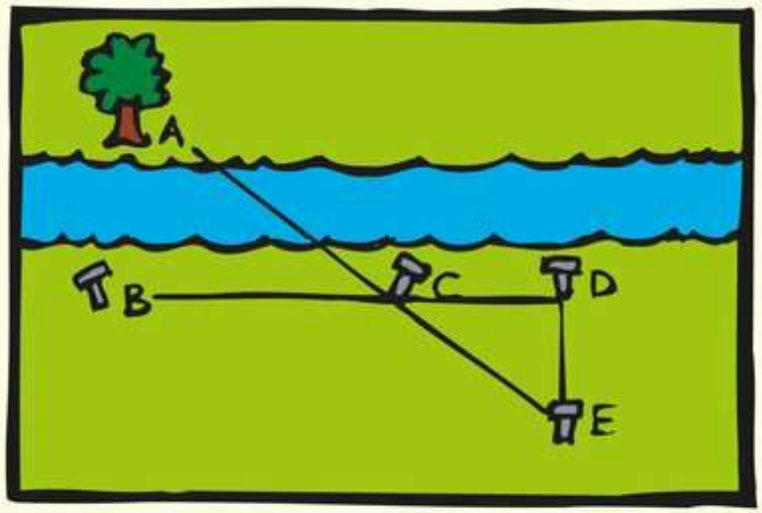
Walk parallel to the riverbank up to any convenient length, say 50 metres.



Drive a stake (C) into the ground.
Continue along the bank in the same direction for half the first distance you measured (25 metres).

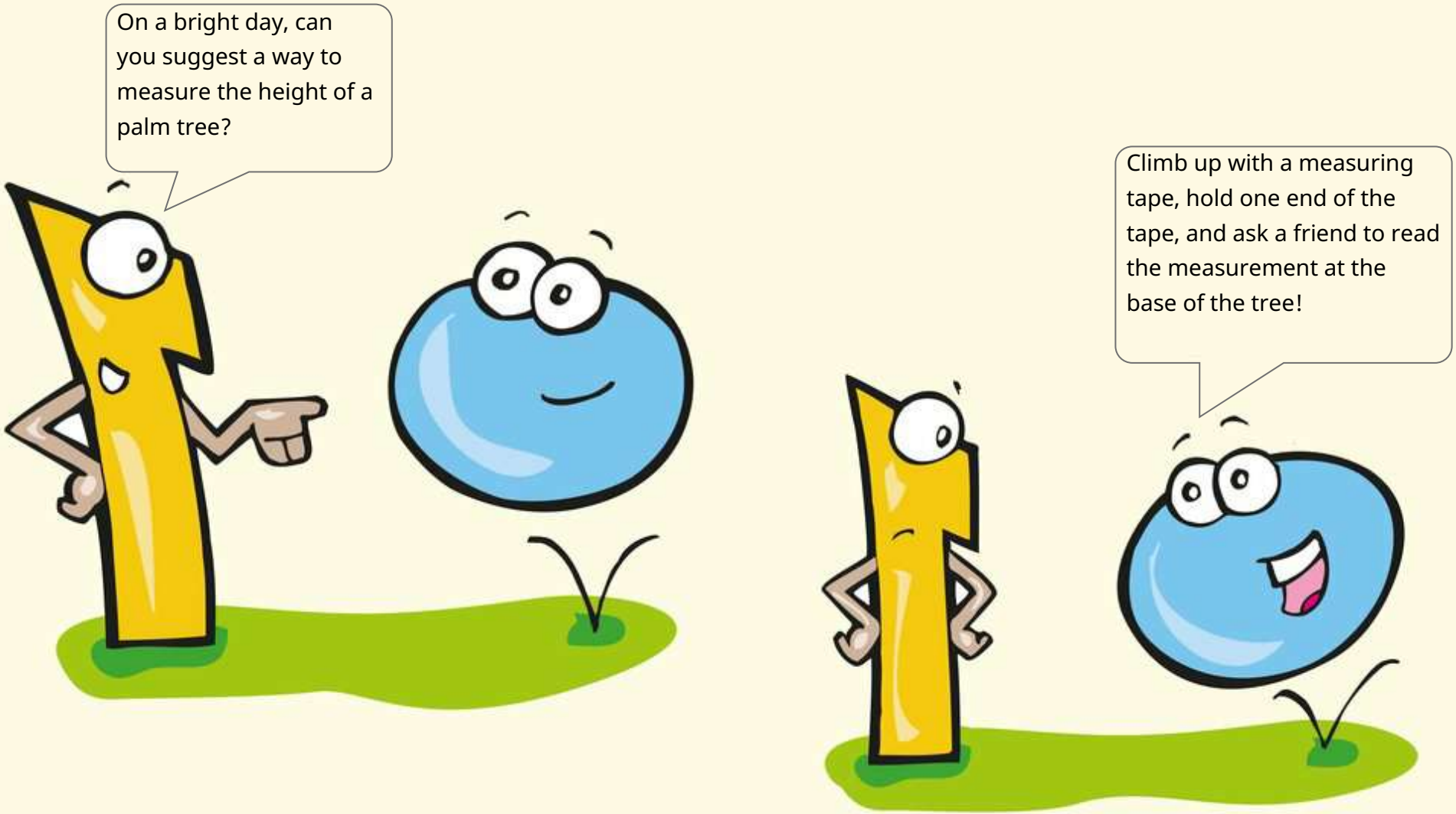


Mark the spot D.
Turn 90 degrees. Your back will now be to the river. Walk away from the river until you can see your stake C such that it is in line with the tree across the river.



Mark the spot E.
Measure the distance between the stakes D and E.
Measure DE.
Double this distance and you will have a fairly accurate estimate, as long as your sighting measurements and angles are correct.
AB = 2 X DE metres.
Now you know how wide the river is without actually crossing the river!
Ancient mathematicians used techniques like these to find the distance of faraway objects like the Sun and Moon from Earth.

Tree Time

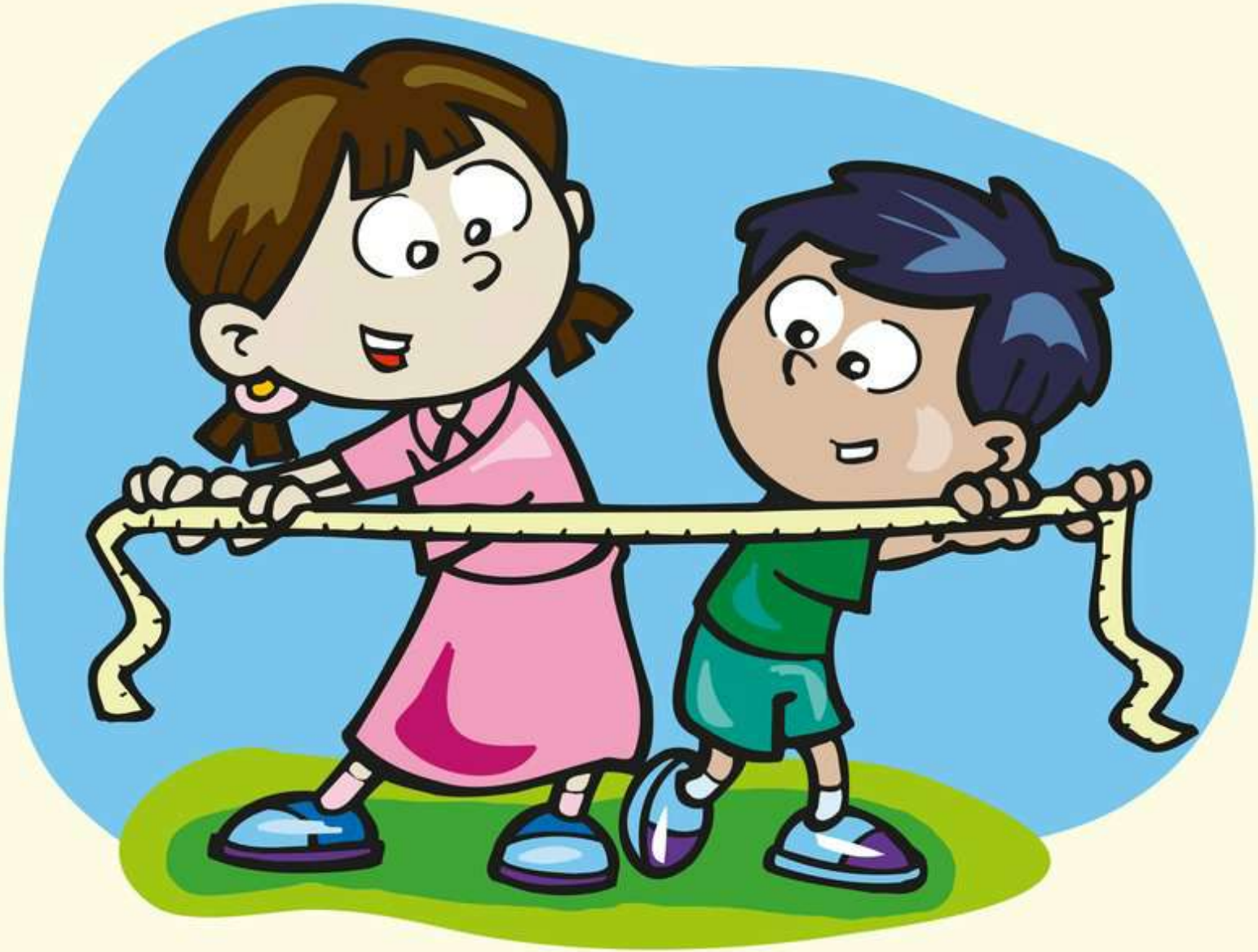

On a bright day, can you suggest a way to measure the height of a palm tree?
Climb up with a measuring tape, hold one end of the tape, and ask a friend to read the measurement at the base of the tree!

Zzero, I meant can you do it without climbing the tree? Can you?

Sankhya and Ganith have started measuring EVERYTHING!

You can too. Try to come up with different ways to measure things.
Measure your house. Measure the PT Master’s height.
Measure your weight. Measure your dog’s tail.

When you ride on a cycle, try to measure the time you take to reach a particular destination.
You may become a Cycling Champion one day!



Answers

Answers to ‘Let’s Measure’ Page 7

1. 1 centimetre. (Instead of writing ‘centimetre’ we use the shorter notation ‘cm’) 12 cm width divided by 12 of Sankhya’s fingers gives 1 cm.

2. 1.2 cm. You can also say, 1cm and 2 mm (mm is short for millimetre. 10 millimetres make 1 cm.)

3. Ganith tried measuring with his feet. Putting one foot before the other, he walked from one corner of the room to the adjacent corner. He had to put one foot in front of the other 15 times. Then he used a ruler to find the length of his foot. It measured 12 cm. The width of the room is 15 x 12=180 cm. You can use a folded newspaper as a measuring unit instead of your foot. Masons use lengths of thread to measure the walls.

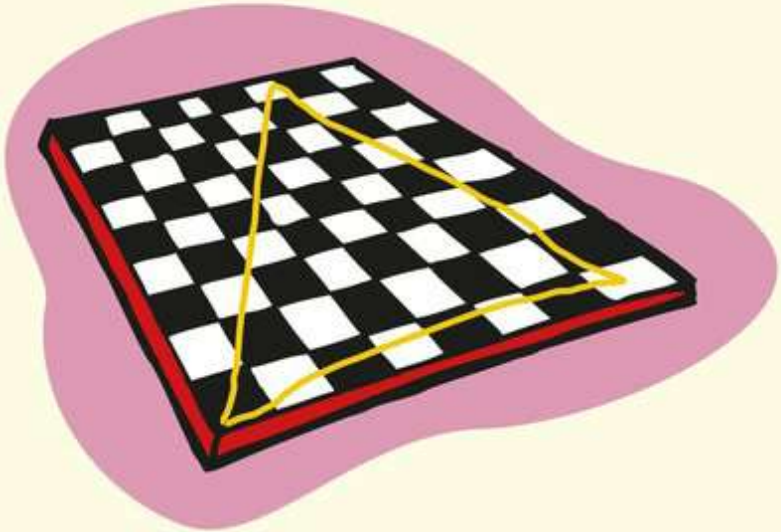
Answers to ‘Under the Banyan Tree’ Page 23

1. Sankhya and her friends actually tried to find the perimeter of the famous Banyan Tree in Pune. They stretched out their hands, and circled the tree with all its aerial roots such that each of them was holding hands with two classmates. Students then measured their stretched arms from the palm of the left hand, across the chest to the palm of the right hand. They found that most of their stretched arms measured 1 m. (1 m= 100 cm=1000 mm). The 100 students had to line up around the tree nearly 8 times, and only then could they completely cover it! Perimeter=100 students x 1 m x 8 times=800 m!

2. Circle. According to our Pandit Vijayeswara, for a given perimeter, the circle encloses the largest area.

3. a) Rectangle: Measure length and breadth. Perimeter = 2 times length + 2 times breadth.
b) Circle: Just measure the radius. Perimeter of a circle is called Circumference. Circumference=2 x Pi x r.
Pi is written as π, the first letter of the Greek word for Circle. r=radius. Pi is the number you get when you divide the circumference of a circle by its diameter. It is always the same, whatever be the size of a circle.
π= 3.14 approximately.

c) Hexagon: Measure one side. Perimeter=6 times length of one side.



Answer to ‘The Slow Horse Race’ Page 25

1. The wise old man asked the boys to EXCHANGE horses. Remember, the king said the prince whose HORSE comes last would be the winner. By riding the other’s horse, each prince would want to be first, so that his horse could come last!

Answers to ‘How Did They Do It’ Page 31

1. 1 mile is longer. To walk one mile, you must walk one kilometre, then a little more than half a kilometre!

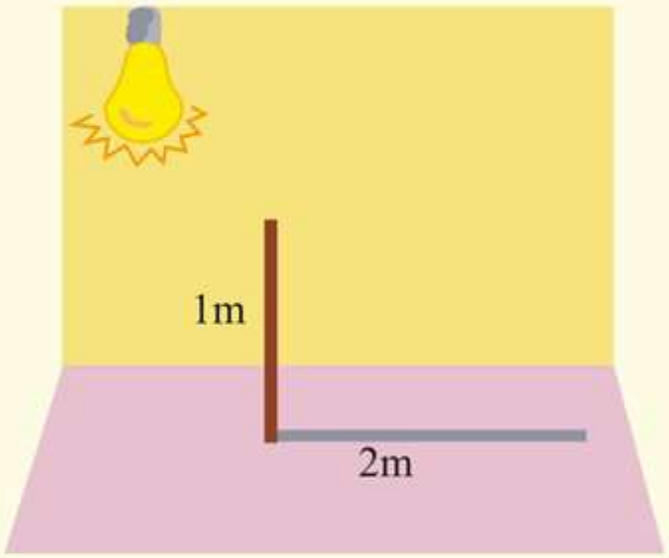
2. 4 times louder.

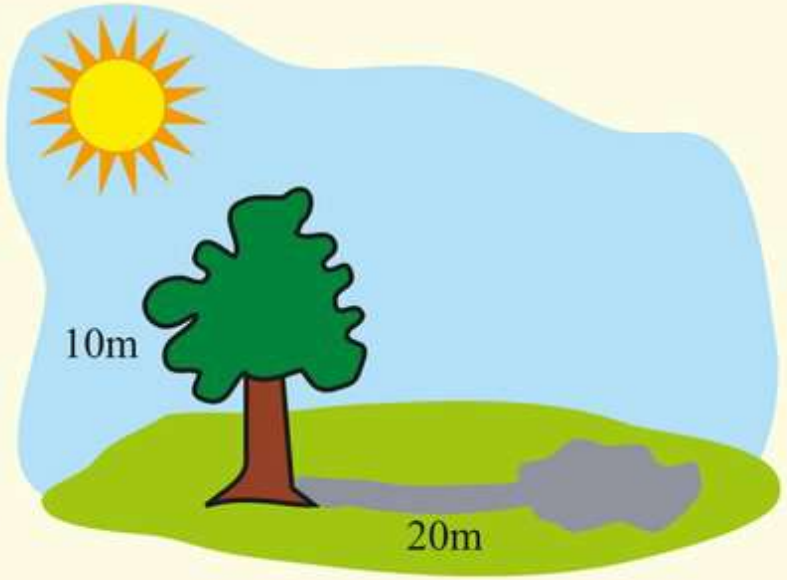
3. 216 volts. 650 volts divided by 3. Our homes usually have 220 volts.

1
MILE
1
KM

Answer to ‘Tree Time’ Page 45

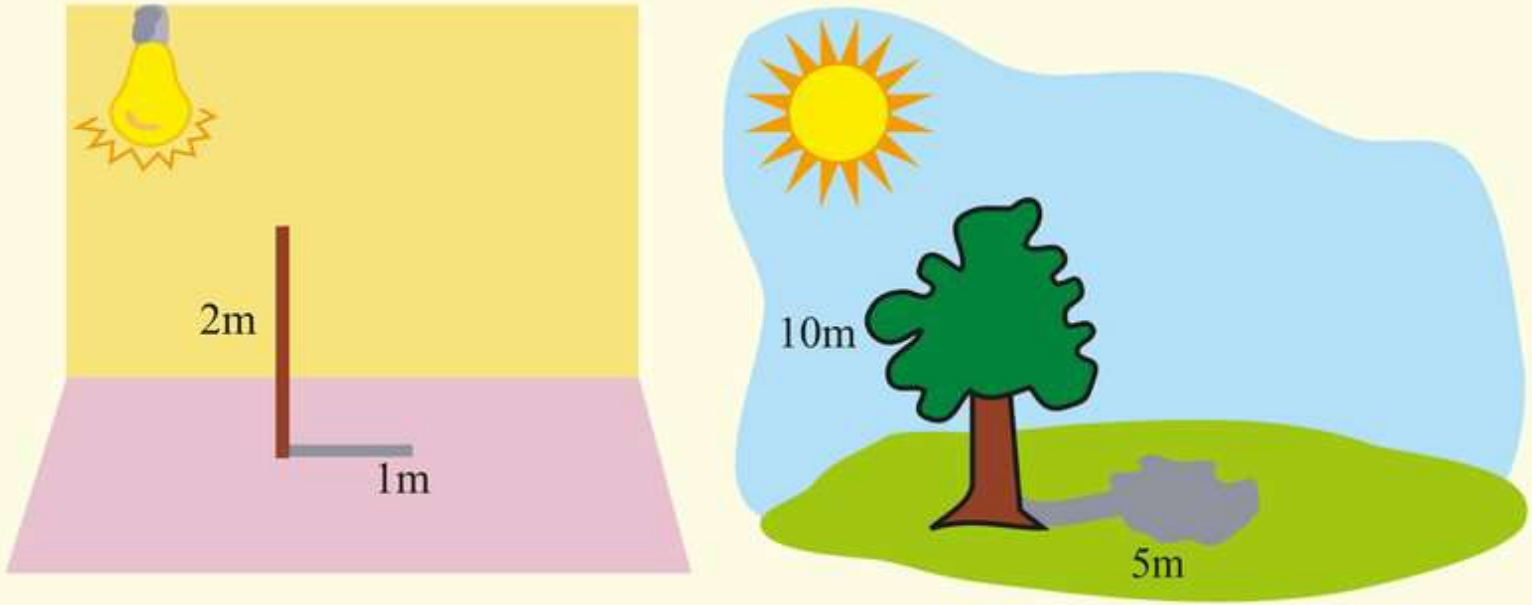
1. Look out for the shadow of the tree. Drive a small stick into the floor and measure the shadow of the stick. Also, measure the height of the stake above the ground. Now measure the length of the tree’s shadow.





Compare your measurements. If the shadow of the stick is double its height, then the shadow of the tree is double the height of the tree!

If the shadow measures 20 m, the tree is 10 m tall. On the other hand, if the shadow of the stick is half the size of the stick, then the shadow of the tree will be half the size of the tree.



If the shadow of the tree measures 5m, the tree measures 10m.

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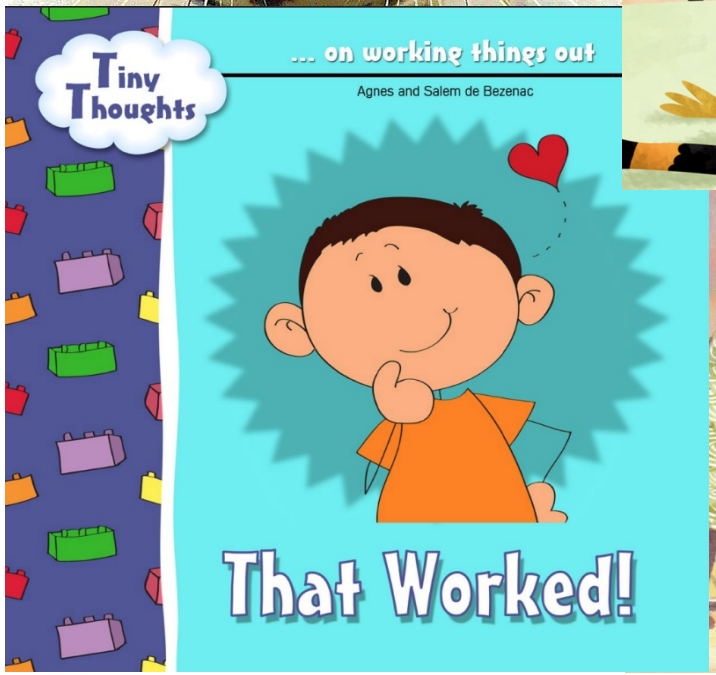

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