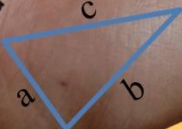


CLASS IX MATHEMATICS

HERON'S FORMULA

Heron's Formula

$$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$$
$$s = \frac{a+b+c}{2}$$




Nurturing Future

Naman Vidya

Masipirhi, Hazaribagh - 825301 (Jharkhand)

Affiliated with CBSE

From the students' hearts

Dear Friends/ Readers,

We, the students of Naman Vidya, are elated to know that in accordance with NEP 2020, CBSE is introducing several changes in the teaching pedagogy for the betterment of all students. Art integration with curriculum, competency-based education, value-based education, and stress on physical fitness, is a farsighted endeavour to make our personalities wholesome and integrated -- through development of values, individuality and intellect.

We express our gratitude towards Ms. Anita Karwal, Secretary, Department of School Education, Ministry of Human Resource Development, Mr. Manoj Ahuja (Chairman, Central Board of Secondary Education), N.C.E.R.T. and Mr. Sandeep Sethi (Education Director, M.S.M.S.II), whose invaluable inputs and constant motivation have encouraged us to curate the curricular concepts in the form of interesting graphics. We find it easy to understand concepts through these art integrated graphic novels, as these are application-based and are related to our real-life scenarios.

We are thankful to our school team for having faith in us and giving us an opportunity to showcase our creativity, imagination and most importantly to make us feel that we too can contribute in the development of the education system of our country.

We have enjoyed this process and look forward to more.

Enjoy reading!

Your friend

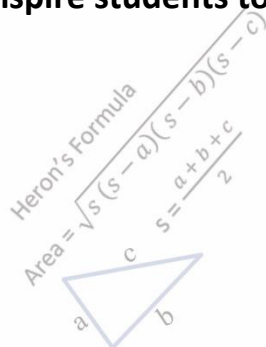
Shirsh Nath
Class IX
Naman Vidya
Hazaribagh

PREFACE

The graphic novel, “Heron’s Formula”, thoroughly explains the formula itself, as well as how to find the areas of different triangles using it. It will help improve the numerical problem-solving skills of the students by teaching concepts with real-life examples and a little fun. It tries to make the topic interesting and easy to understand. Thus, it evokes curiosity in students, which helps them gain more knowledge.

Students will find this graphic novel a creative and fun-filled support for learning new concepts. They will find it easy to understand as they can relate their learning with situations from day-to-day life. The novel comprises elements from traditional syllabus in the form of pictures and dialogues, which make it interesting to read.

In the story, a young student is shown interacting with his family in different situations to find solutions to practical problems. The outcome of those interactions in the storyline will encourage and develop social interactive skills among readers, as well as inspire students to become independent learners.



0962CH12

To access the comic book and additional interactive digital content, download the DIKSHA app from Google Play Store on your Android smartphone or tablet and scan the QR code using DIKSHA app.

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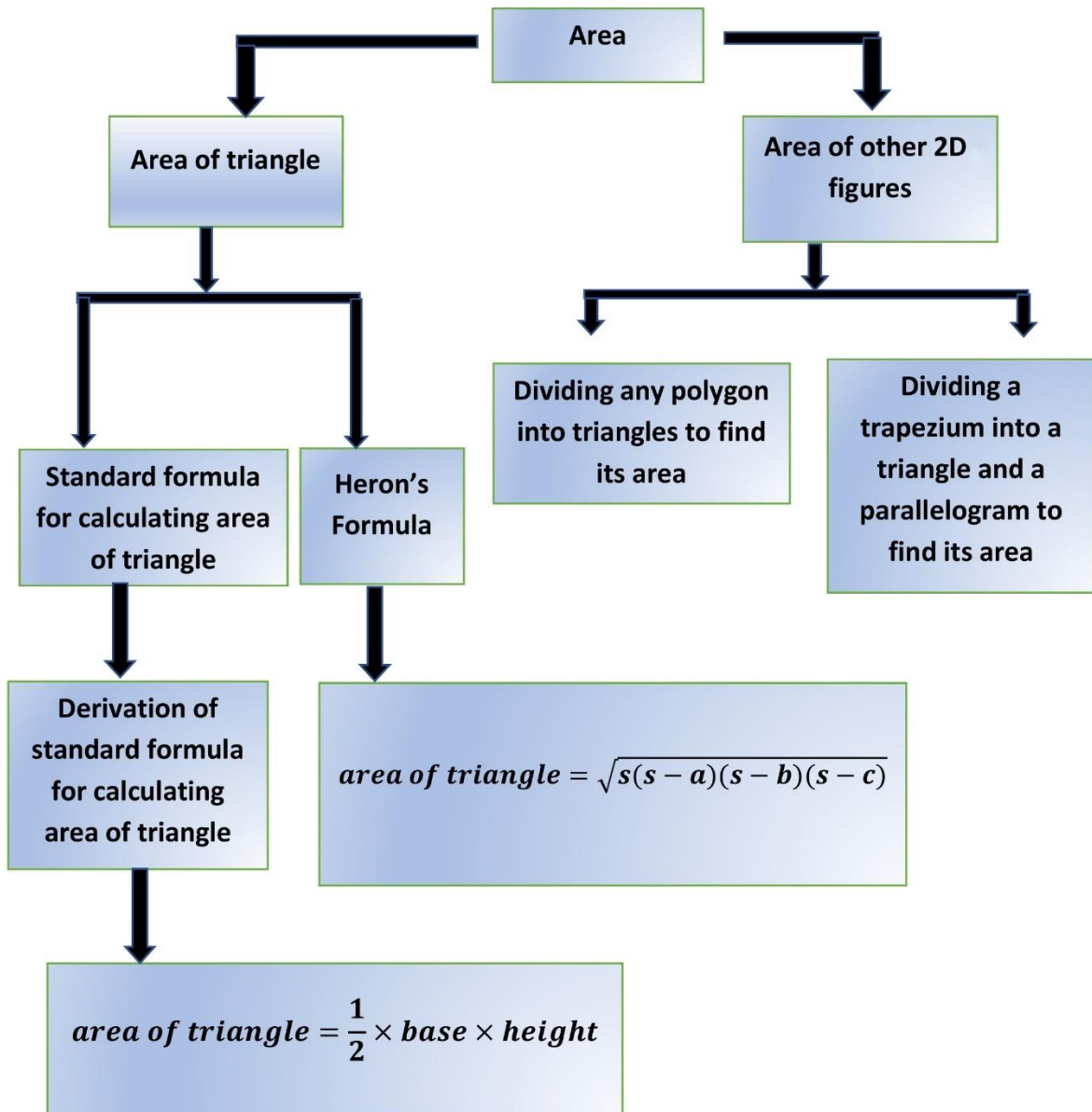
LEARNING OBJECTIVES

- 1) Calculate the area of a given triangle by the standard formula, i.e.
$$\text{area of triangle} = \frac{1}{2} \times \text{base} \times \text{height}$$
- 2) Apply Heron's formula and find the area of a triangle, i.e.
$$\text{area of triangle} = \sqrt{s(s-a)(s-b)(s-c)}$$
- 3) Breakdown a given polynomial into triangles and find the area of a given polynomial as a sum of areas of those triangles.

LEARNING OUTCOME

- Application of appropriate formulae in order to find areas of all types of triangles.

Story Board



CHARACTERS



Rohit: A boy of class 9



Rohan: Rohit's brother, a student of class 10



Amrita: Mother of Rohit and Rohan



Rakesh: Father of Rohit and Rohan

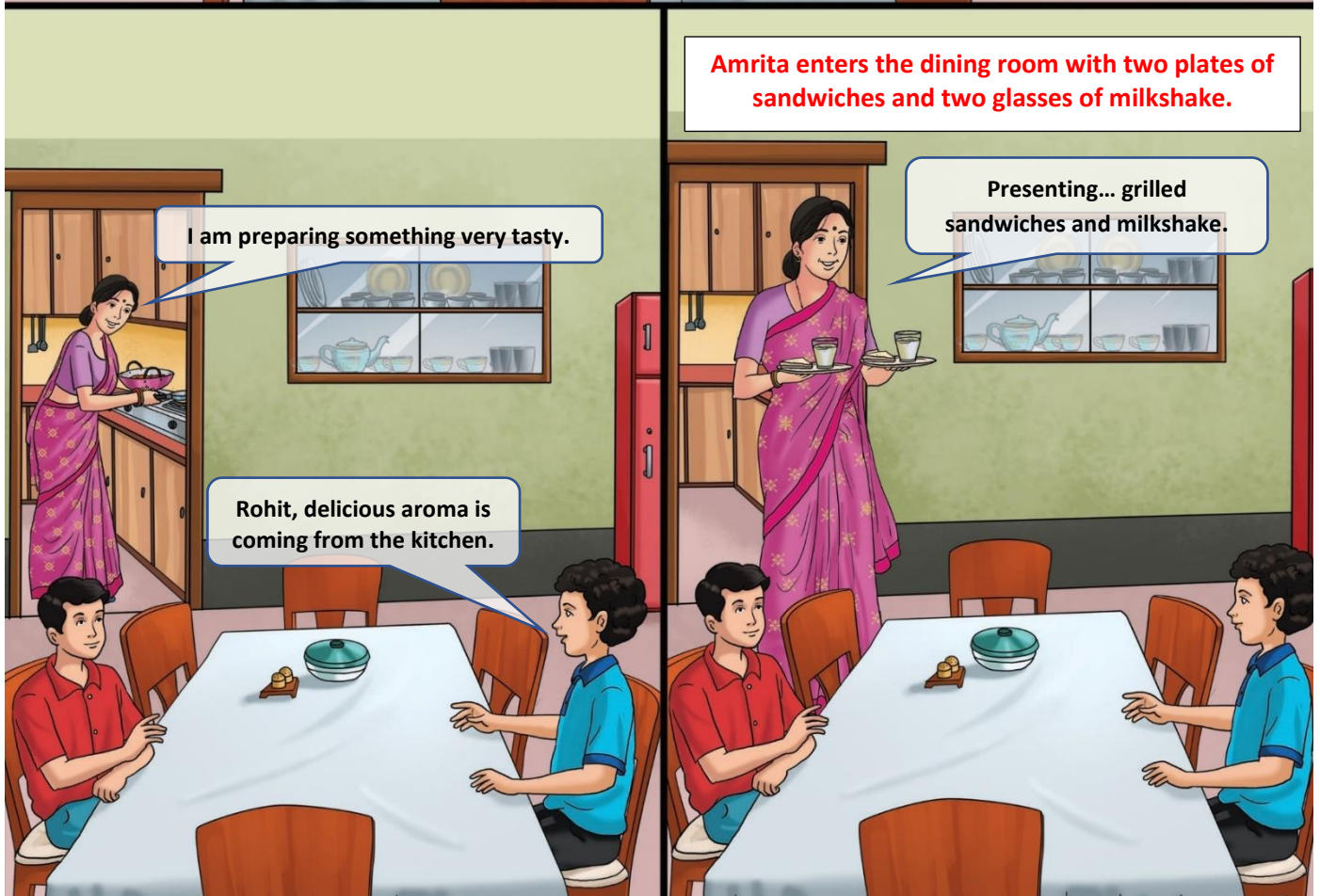
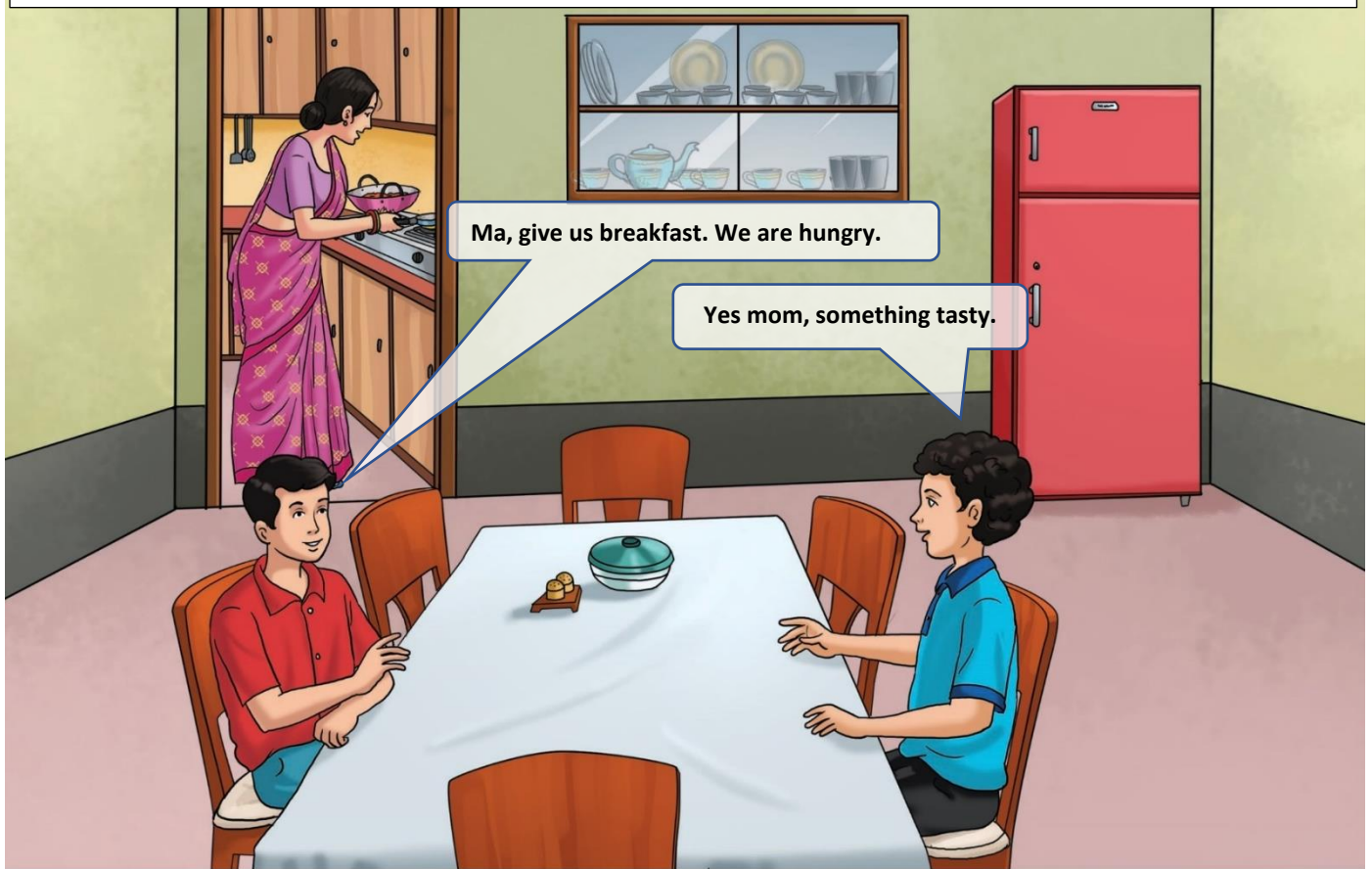


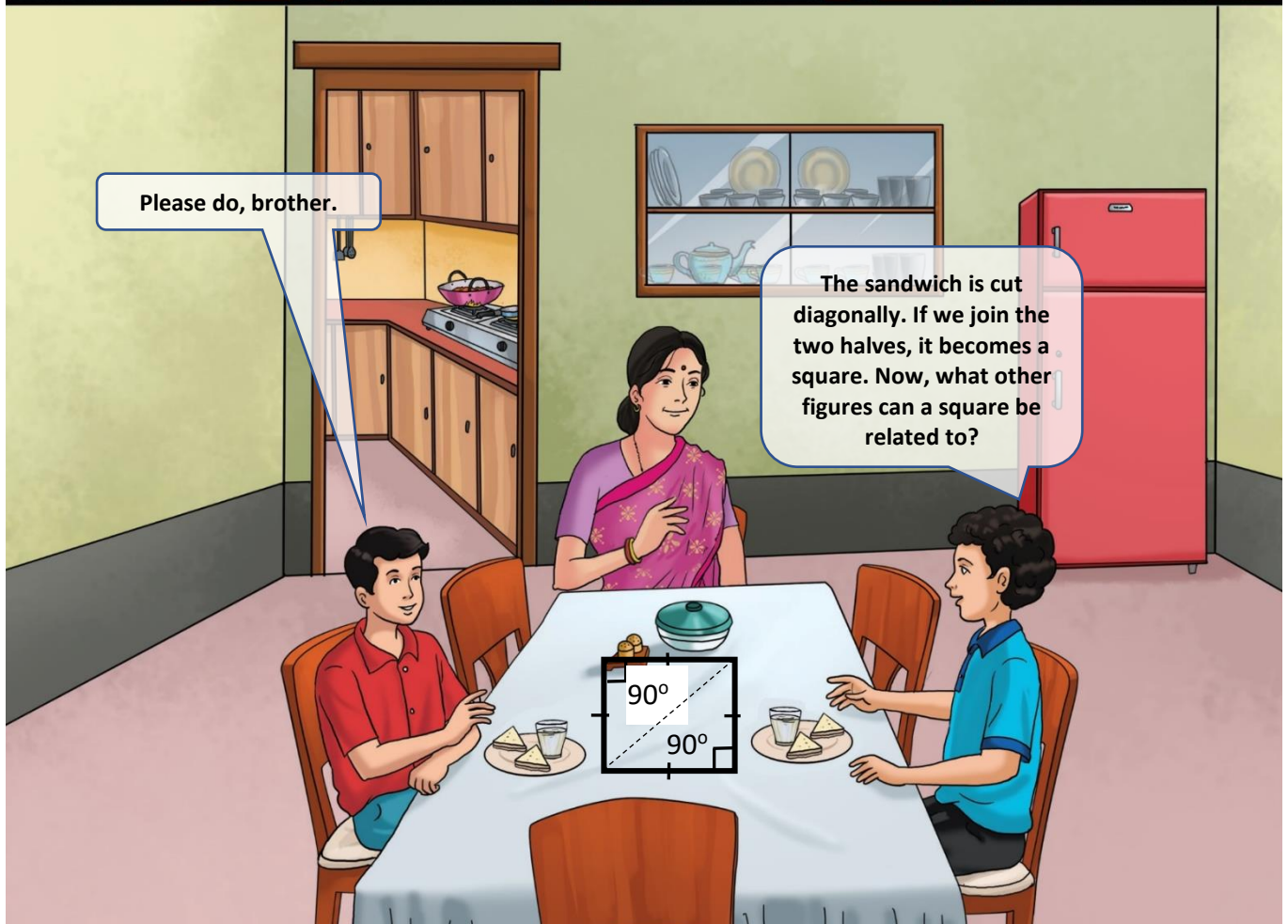
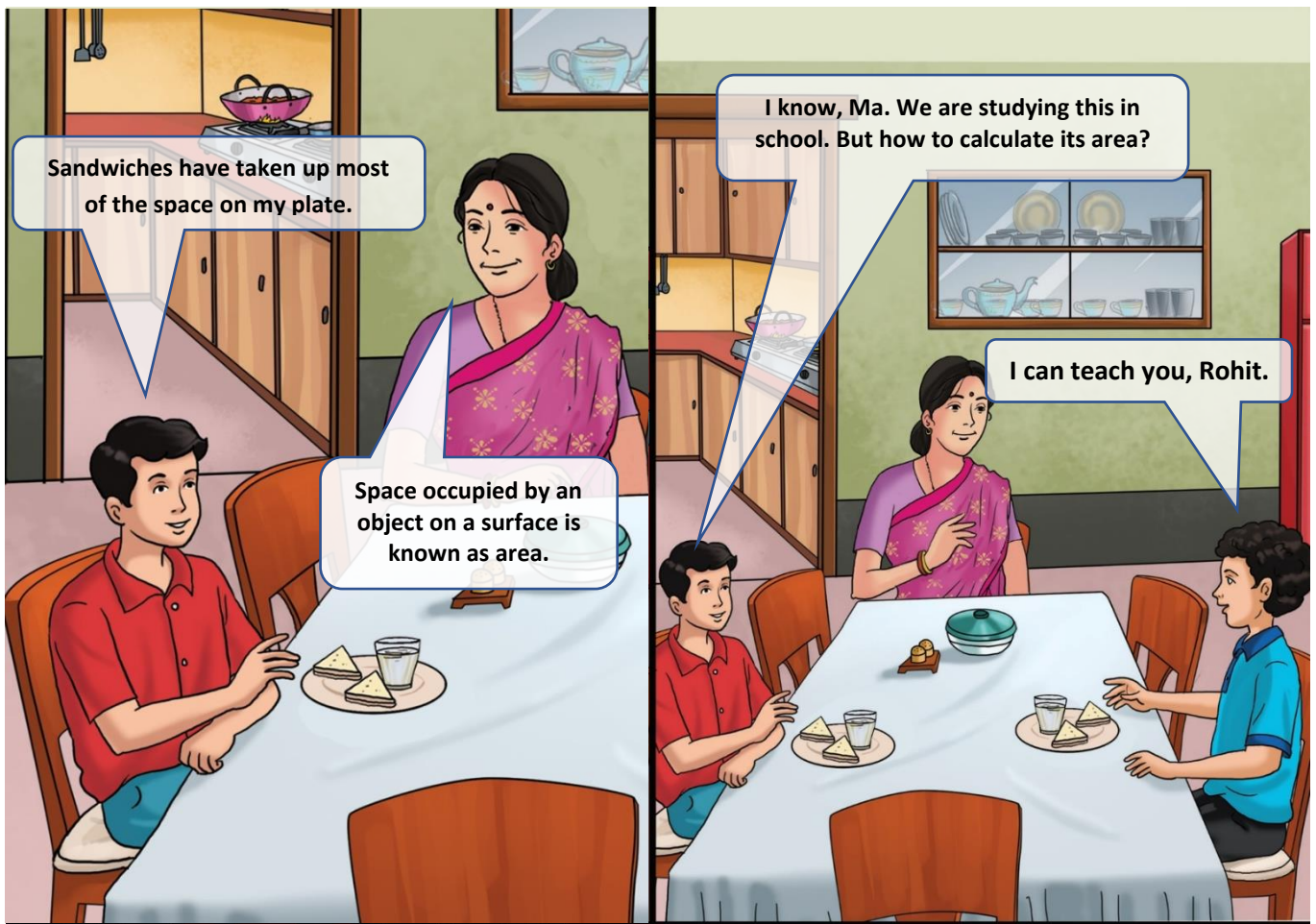
Sukhdev: Person working as tiler in the house



Shambhu: A nurseryman

It's morning. Rohit and Rohan are waiting at the dining table for breakfast, which is being prepared by their mother in the kitchen.





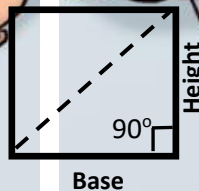
This sandwich is a square as its all the sides are equal and all the angles are 90° . As the opposite sides are equal and angles are 90° , it is also a rectangle.

Interesting

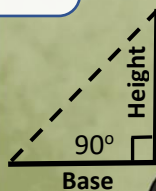
It is also a parallelogram as the pair of opposite sides are equal and parallel.

You are right. Area of a parallelogram is base $\times$ height. As a diagonal divides the sandwich into two equal parts, its area will also become half.

So, the area of each half part will be $\frac{1}{2} \times \text{base} \times \text{height}$.



So, the area of a triangle = $\frac{1}{2} \times \text{base} \times \text{height}$.



Wow, interesting way to derive the formula.

Now, finish your breakfast. Don't be late.

At noon, Rohit and his father Rakesh are checking their new house, which they will shift to in about 6 months. They enter a room in which the tile work is still incomplete.



The tiler (Sukhdev) enters the room.

Sir?

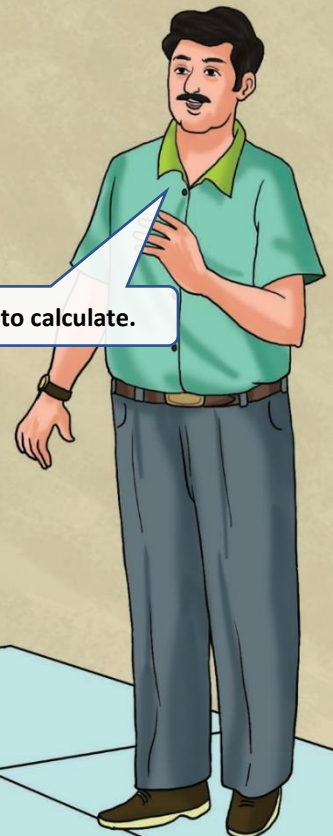
We want a triangular design at the center with 3m base and 2m altitude and please tell the rate of the tiles per m^2 .



Okay sir; please bring the required white tiles for the area. The rate of tiles is 915 Rupees per sq. m.



We need to calculate.



Rohit calculates in a notebook.

Let's just apply the formula: *area of triangle* = $\frac{1}{2} \times \text{base} \times \text{height}$.

In this case, base is 3m and height is 2m. Hence, *area of triangle* = $\frac{1}{2} \times 3m \times 2m$

This gives, *area of triangle* = $3m^2$.



TEST YOUR SKILLS

Q1. The region occupied by any object is called _____.

Q2. Area of a parallelogram is _____.

Q3. To derive the standard formula of area of triangle, the area of parallelogram is divided by _____.

Q4. Square is also a _____.

- a) triangle
- b) rectangle
- c) circle
- d) all the above

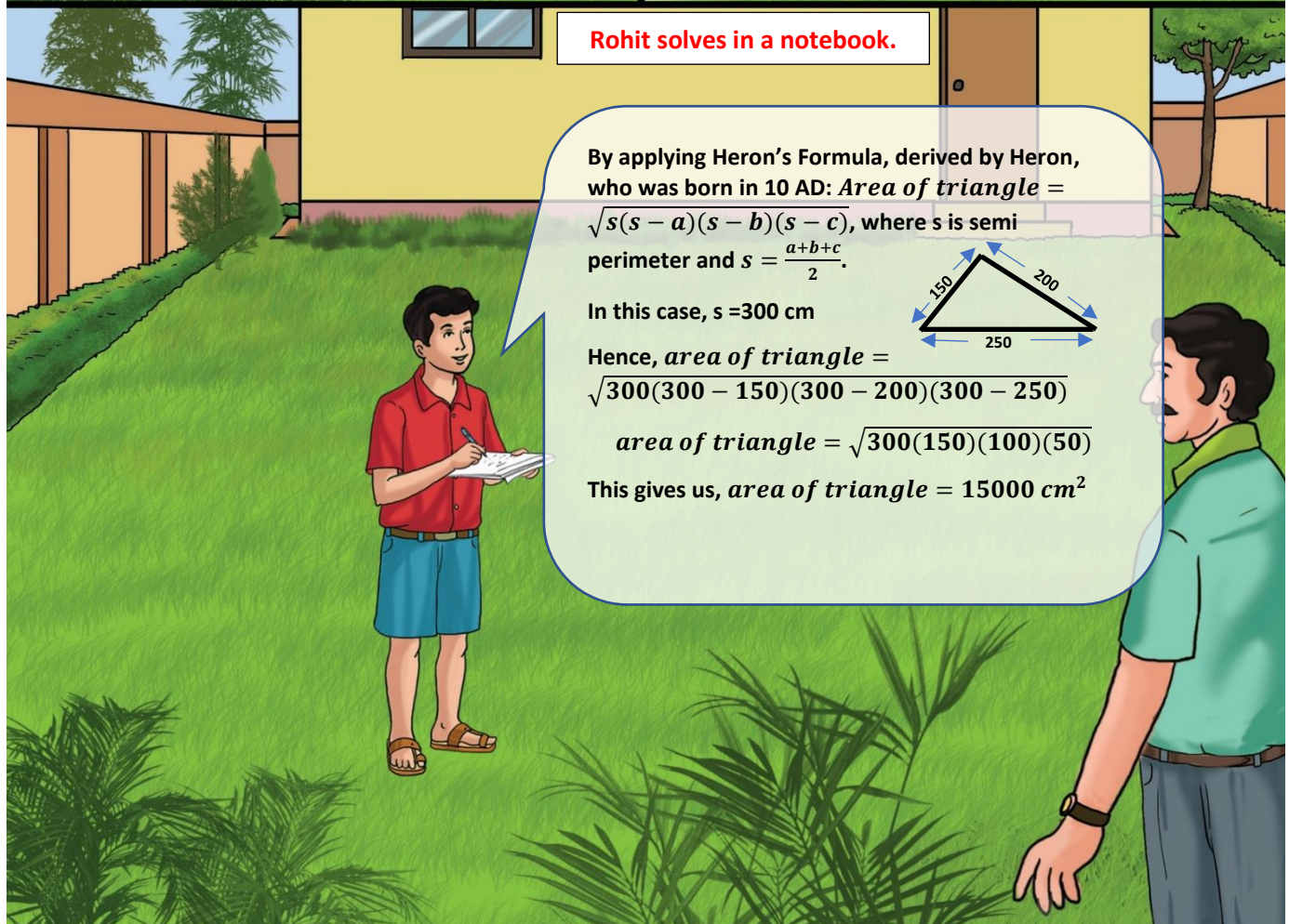
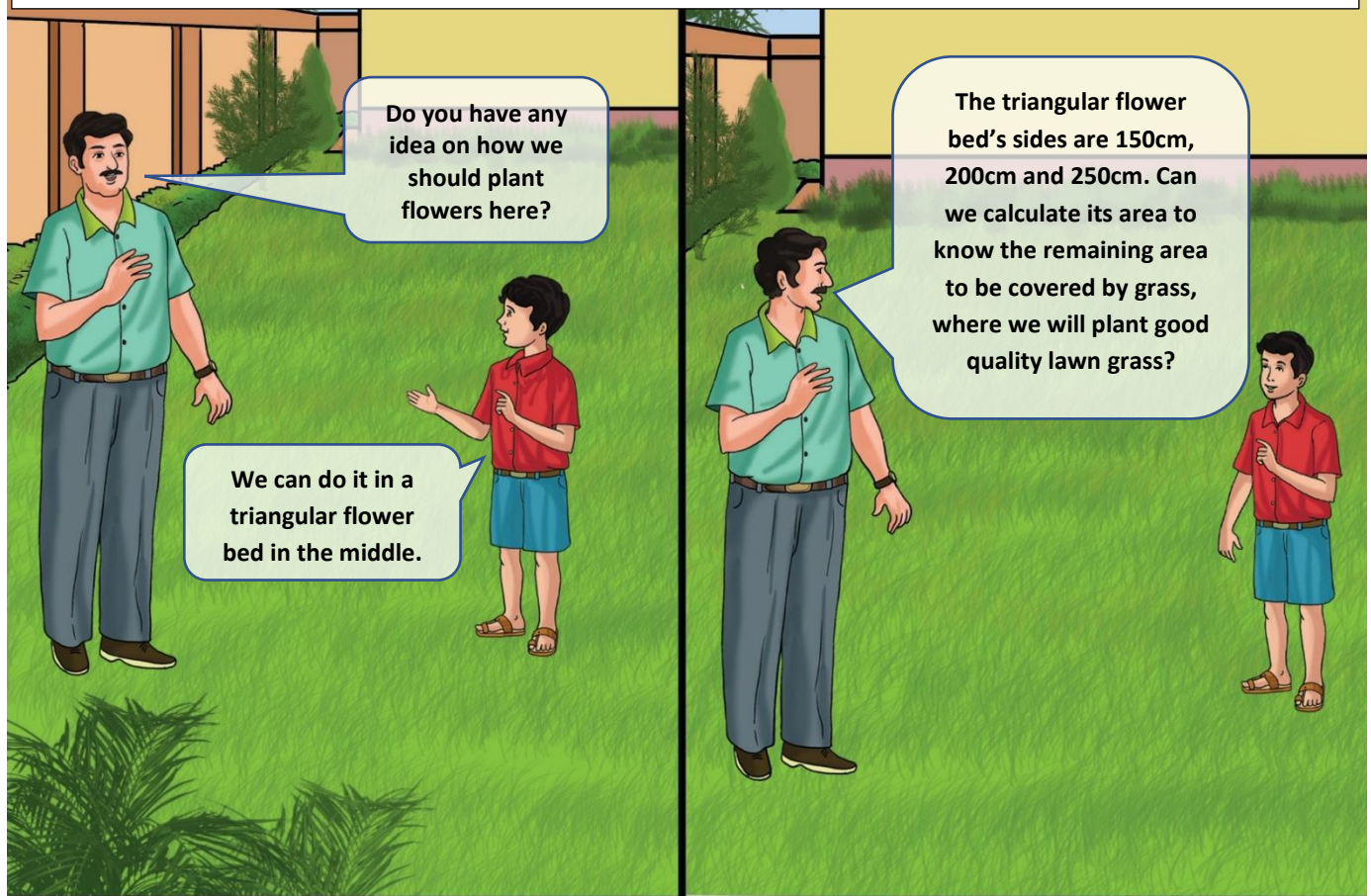
Q5. If only the height and base of a triangle are given, we can find its area using _____.

Q6. To know the region occupied by a triangle, we need to find its _____.

Q7. Find the area of these triangles, if

- (a) Base = 6m, height = 6m
- (b) Base = 10 m, height = 3m
- (c) Base = 2m, height = 100m

Rohit and Rakesh are in the backyard of the house, discussing how they should plant flowers in the garden.





SOLVE THESE

Q8. If the three sides of a triangle are given, we can find its area using _____.

Q9. Find the semi perimeter of a triangle having sides:

a) 20 cm, 10cm, 14 cm

b) 22 cm, 11cm, 13 cm

Q10. Find the area of these scalene triangles, having sides

a) 10cm, 17cm and 21cm

b) 12cm, 6cm and 15cm

c) 120cm, 170cm and 250cm

Q11. True or False.

a) Semi perimeter (s) is the sum of two longest sides of a triangle. _____.

b) Triangle having all sides equal is called an isosceles triangle. _____.

Q12. Find the area of a triangle whose sides are in the ratio 28:40:50 and its perimeter is 590cm.

Q13. Semi perimeter is the half of _____.

Rakesh and Rohit go to a nursery to buy saplings for their garden.

Welcome to our nursery, sir. We have a wide range of flowers and plants for your home.

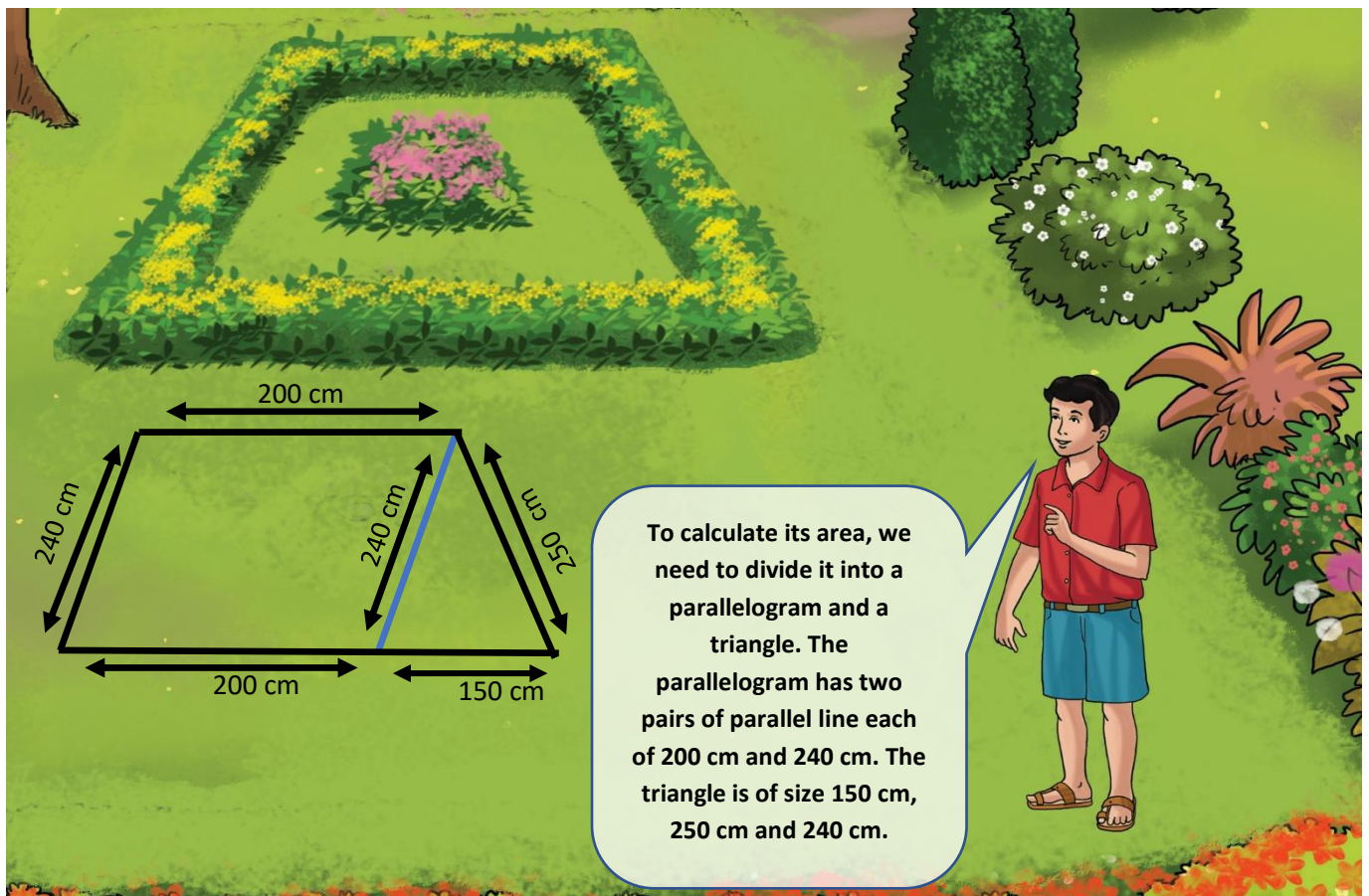
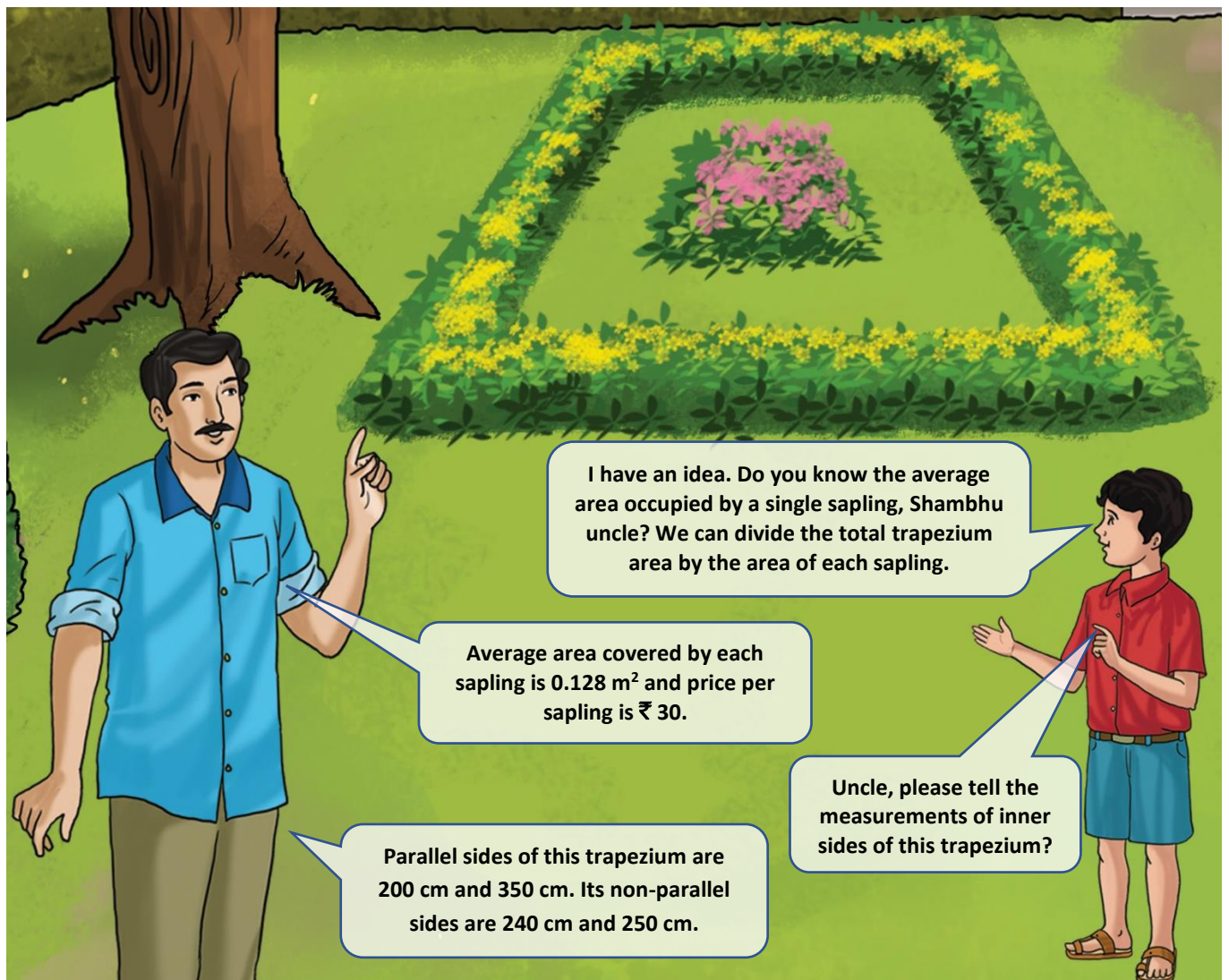
We want to plant high-quality lawn grass in 235000 sq. cm area and flowers in 15000 sq. cm triangular bed area at our backyard garden.

Sure sir, anything else?

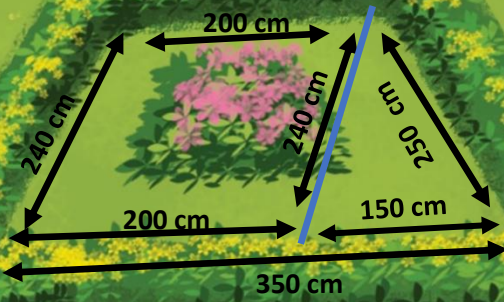
Yes, we want flowering plants for our front garden also. There are many beautiful flowers here.

Look at that trapezium shaped flower bed, father. We can make a similar flower bed in the front garden of our house.

Yes, we can fill the trapezium shaped bed with flowers. But how to calculate the number of saplings required to fill it?



Rohit solves in his notebook.



By Heron's Formula, *Area of triangle* = $\sqrt{s(s-a)(s-b)(s-c)}$, where s is semi perimeter and $s = \frac{a+b+c}{2}$.

In this case, $s = 320$ cm

Hence, *area of triangle* =

$$\sqrt{320(320-240)(320-250)(320-150)}$$

$$\text{area of triangle} = \sqrt{320(80)(70)(170)}$$

This gives us, *area of triangle* = 17454 cm^2

Now, we need to find the height.

Also, *area of triangle* = $\frac{1}{2} \times \text{base} \times \text{height}$

$$\text{So, } 17454 \text{ cm}^2 = \frac{1}{2} \times 150 \text{ cm} \times \text{height}$$

$$\text{By algebra, height} = \frac{17454 \times 2}{150} = 232.72 \text{ cm.}$$

Very good, my son

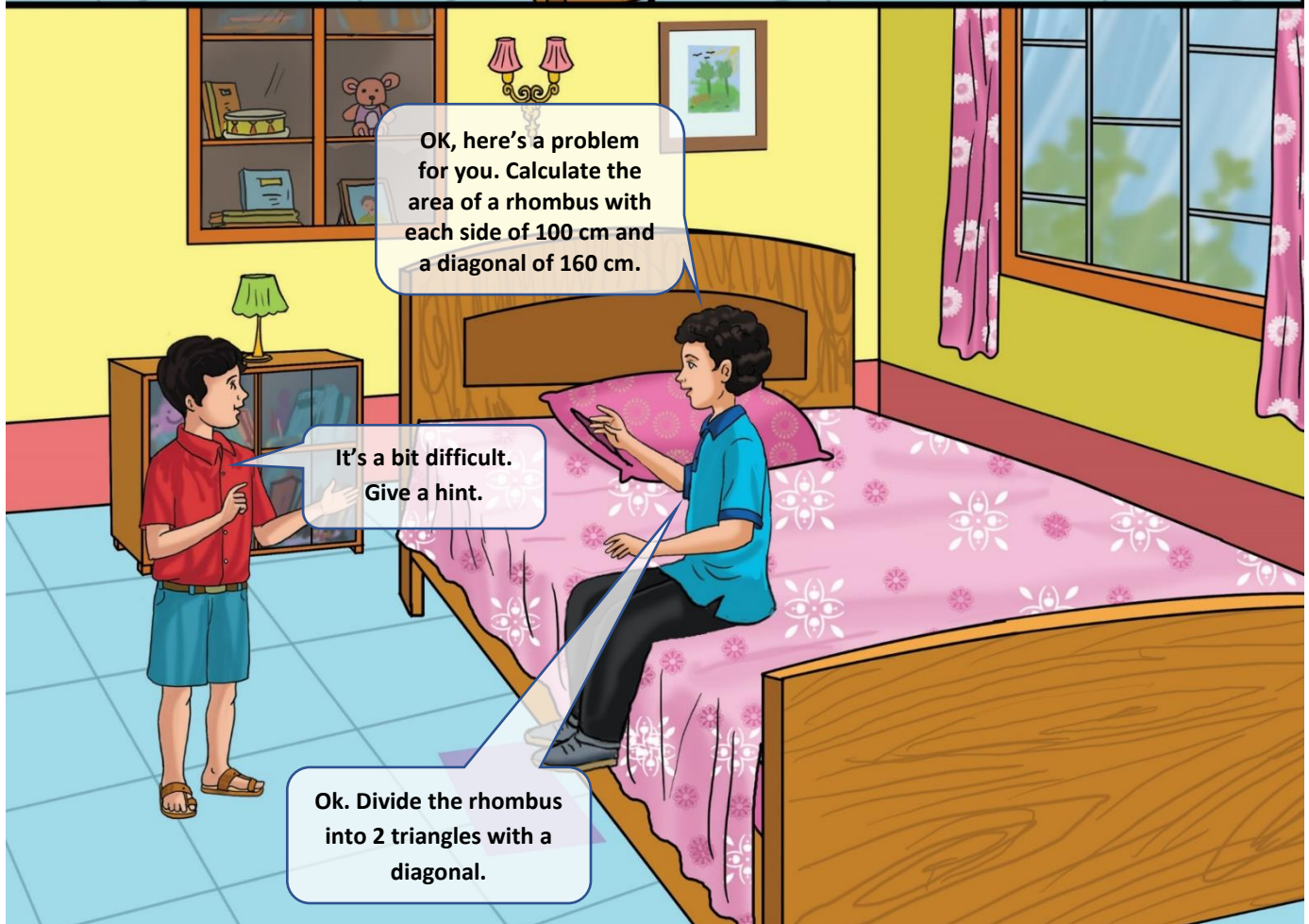
Hence,

Area of trapezium = $\frac{1}{2} \times \text{sum of parallel sides} \times \text{height}$

$$= \frac{1}{2} \times 550 \times 232.72 \text{ cm}^2 = 63998 \text{ cm}^2 = 6.4 \text{ m}^2$$



Rakesh and Rohit have returned to their old house. At home, Rohit is in his bedroom with his elder brother Rohan.



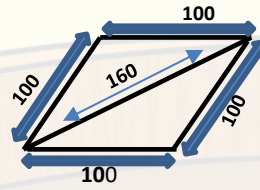
Oh, it's easy now. The area is divided between the two triangles. By Heron's Formula, *area of one triangle* = $\sqrt{s(s-a)(s-b)(s-c)}$

$$= \sqrt{180(180-100)(180-100)(180-160)}$$

$$= \sqrt{180(80)(80)(20)}$$

$$= 4800 \text{ sq. cm.}$$

Hence, area of rhombus would be $4800 \text{ cm}^2 + 4800 \text{ cm}^2 = 9600 \text{ cm}^2$



You got it right, brother!

Your hint helped.

It's simple. Divide any irregular polygon into several triangles, find area of each triangle using Heron's Formula, and add all of them to find the area of a complete polygon.

This technique is very nice.

Yes, indeed, Mathematics has great power.

TRY THESE

- Q14. We can also find the area of trapezium by dividing it into _____ and _____.
- Q15. Find the area of a trapezium whose parallel sides are 47cm and 60cm and non-parallel sides are 25cm and 26cm.
- Q16. True or False.
Heron's Formula was derived by Heron in 9 A.D. _____.
- Q17. A rhombus-shaped field has green grass for 9 cows to graze. If each side of the rhombus is 30 m and its longer diagonal is 48 m, how much area of grass field will each cow be getting?
- Q18. Find the area of a quadrilateral where:
a) $AB = 15 \text{ cm}$, $AD = 11 \text{ cm}$, $BC = 10 \text{ cm}$, $DC = 8 \text{ cm}$, $BD = 6 \text{ cm}$
b) $PQ = 13 \text{ cm}$, $QR = 4 \text{ cm}$, $RS = 3 \text{ cm}$, $PS = 12 \text{ cm}$, $QS = 6 \text{ cm}$
- Q19. Word Search

S	S	O	B	A	S	E	L	J	P	W	R	F	M	S	T	S	M
L	R	E	T	R	Z	K	H	D	I	Q	V	O	A	Q	R	H	N
C	J	Q	I	G	N	H	R	O	O	T	N	R	L	U	I	E	D
S	U	S	V	L	U	C	M	N	V	B	U	M	T	A	A	R	O
Z	W	D	I	F	F	E	R	E	N	C	E	U	I	R	N	O	X
Q	U	A	D	R	I	L	A	T	E	R	A	L	T	E	G	N	O
U	R	H	O	M	B	U	S	F	W	X	R	A	U	O	L	L	G
W	T	J	K	W	Q	Y	P	S	I	D	E	S	D	U	E	E	Y
Y	J	E	H	P	E	R	I	M	E	T	E	R	E	F	C	C	L
D	T	Q	W	P	Y	T	H	A	G	O	R	A	S	A	X	L	I
L	X	U	A	F	H	W	U	Z	N	F	A	R	E	A	H	S	Z
A	P	O	L	Y	G	O	N	D	I	A	G	O	N	A	L	V	H

ALTITUDE
AREA
BASE
DIAGONAL
DIFFERENCE
FORMULA

HERON
PERIMETER
POLYGON
PYTHAGORAS
QUADRILATERAL
RHOMBUS

ROOT
SIDE
SQUARE
TRIANGLE

SUMMARY

1. Area of triangle with measurements of base and altitude given, is stated as

$$\text{area of triangle} = \frac{1}{2} \times \text{base} \times \text{height}$$

2. Area of a triangle with its sides as a, b and c is calculated by using Heron's formula stated as

$$\text{area of triangle} = \sqrt{s(s-a)(s-b)(s-c)}$$

3. Area of trapezium can be found by dividing it in a triangle and a parallelogram, and by using the Heron's Formula.
4. Area of a quadrilateral whose sides and one diagonal are given, can be calculated by dividing the quadrilateral into two triangles and using the Heron's Formula.

GLOSSARY

1. **Area** - Region occupied by any object over any surface.
2. **Parallelogram** - Quadrilateral having opposite sides equal and parallel.
3. **Diagonal** - Line segment joining two opposite vertices of any polygon.
4. **Triangle** - A polygon having three sides.
5. **Formula** - Group of signs, letters and numbers used in science or mathematics to express a general law or fact.
6. **Trapezium** - Quadrilateral having one pair of opposite sides parallel.
7. **Rhombus** - Quadrilateral having all sides equal and opposite sides parallel.
8. **Polygon** - A closed figure bounded by three or more than three-line segments.

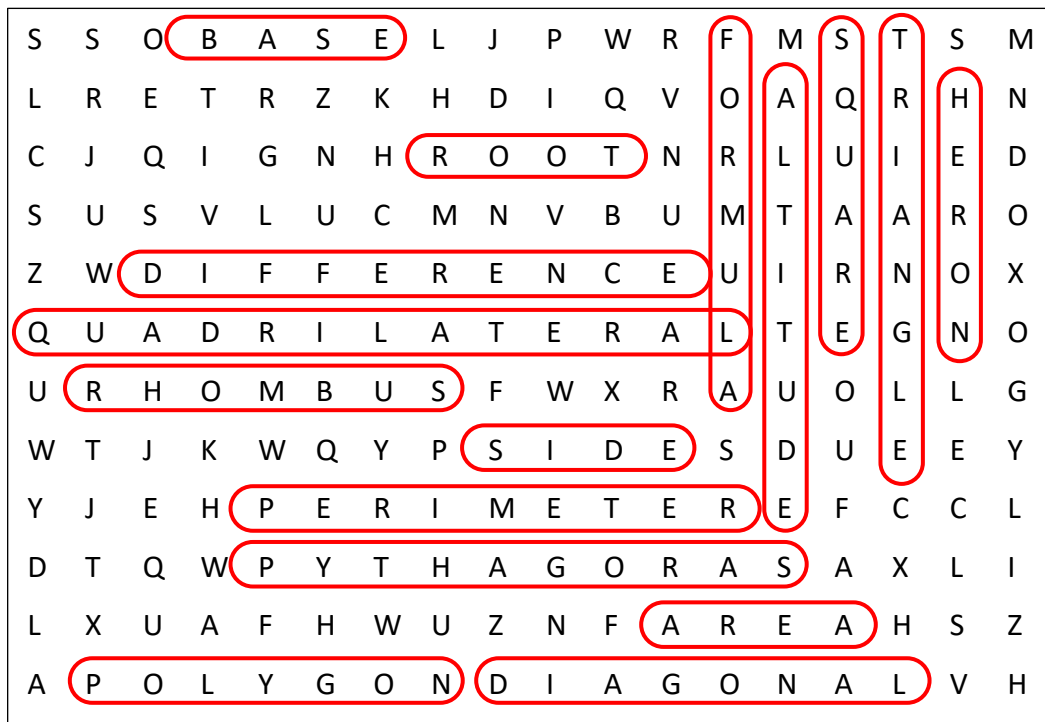
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<http://ncert.nic.in/textbook/pdf/iemh112.pdf>

SOLUTIONS

- Q1. (b) area
- Q2. Base x height
- Q3. 2
- Q4. (b) Rectangle
- Q5. (b) $area\ of\ triangle = \frac{1}{2} \times base \times height$
- Q6. area
- Q7. (a) 18 sq.m. (b) 15sq.m. (c) 100 sq.m.
- Q8. (a) Heron's Formula
- Q9. (a) 22 (b) 23
- Q10. (a) 84 cm² (b) 34.19 cm² (c) 9000 cm²
- Q11. (a) False (b) False
- Q12. 13981.21
- Q13. Perimeter
- Q14. Triangle, parallelogram
- Q15. 1315.03 cm²
- Q16. False
- Q17. 96 m²
- Q18. a) 52.28 cm²
b) 36 cm²

Q19. Word Search



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DISCLAIMER

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AN ANCIENT FORMULA WITH A MODERN APPEAL

Is it possible that in the course of an ordinary day, extraordinary mathematical concepts can be witnessed and understood with utter clarity? For the protagonist of this story, Rohit, a class IX student, the answer is one emphatic yes.

This is how it happened with him one morning and through the rest of that day.

From the diagonally-cut grilled sandwiches and milkshake for breakfast with his brother Rohan, to the planning of a triangular design on the tiled floor of their new house with his father; from the laying of trapezium flowerbeds in the lawn, to the purchasing of the correct number of saplings from the nursery for the flowerbeds... just an ordinary day, right?

Wrong! For, in each of these situations, Rohit was able to see the practical applications of Heron's Formula and get extraordinary clarity on the topic with the support of his mother, father and brother.

Come, join Rohit for a day to learn Heron's Formula in a practical and interesting way.



Nurturing Future

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