



तत् त्वं पूषन् अपावृणु
केंद्रीय विद्यालय संगठन

$$\frac{7}{8} + \frac{1}{8} = 1$$

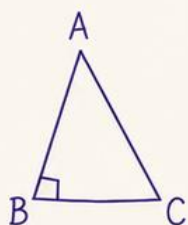


KENDRIYA VIDYALAYA SANGATHAN (KVS)

$$4x - 3 = 21$$

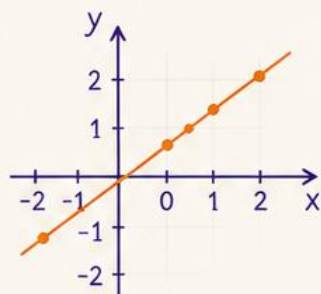
— ZIET CHANDIGARH —

$$2x - 7 = 9$$

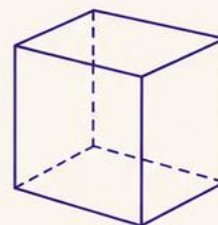


SUPPORT MATERIAL MATHEMATICS

$$(a-b)^2 = a^2 - 2ab + b^2$$



FOR CLASS VIII (PART II)



$$-6 + 14 = 8$$



CONCEPTUAL
UNDERSTANDING



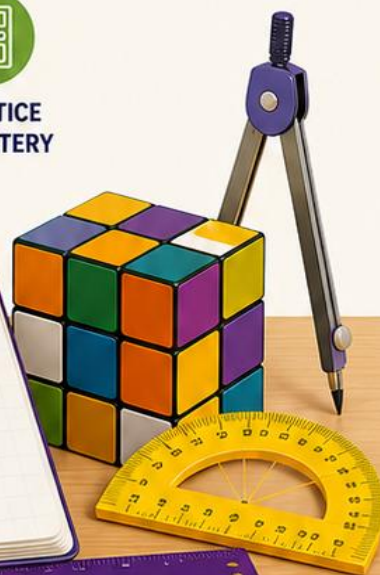
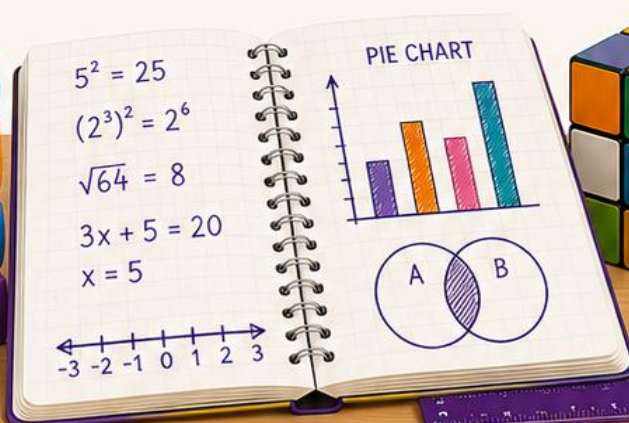
PROBLEM
SOLVING



REAL LIFE
APPLICATIONS



PRACTICE
& MASTERY



LEARN WITH
UNDERSTANDING



PRACTICE
REGULARLY



THINK
LOGICALLY



SUCCEED
CONFIDENTLY

संरक्षक

श्री विकास गुप्ता, भा. प्र. से.
आयुक्त
केन्द्रीय विद्यालय संगठन, नई दिल्ली

सुश्री चंदना मंडल
अपर आयुक्त (शैक्षिक)

सुश्री पी. बी. एस. उषा
संयुक्त आयुक्त (प्रशिक्षण)

श्रीमती श्रुति भार्गव
उपायुक्त एवं निदेशक
आंचलिक शिक्षा एवं प्रशिक्षण संस्थान, चंडीगढ़

श्री अजीत कुमार यादव
सह-कोर्स निदेशक
(प्राचार्य पीएम् श्री केंद्रीय विद्यालय -1 अम्बाला कैंट)

श्री असन कुमार
संसाधक
प्रशिक्षित स्नातक शिक्षक (गणित)
पीएम् श्री केंद्रीय विद्यालय -1 अमृतसर कैंट

श्रीमती हर्ष बाला
संसाधक
प्रशिक्षित स्नातक शिक्षक (गणित)
केंद्रीय विद्यालय खानपुर

FOREWORD

It gives me immense pleasure to present the "**Support Material for Class VIII Mathematics (Part II) based on the New NCERT Textbook – Ganita Prakash.**" This resource has been thoughtfully developed to support teachers in implementing the vision of the **National Education Policy (NEP) 2020**, the National Curriculum Framework for School Education (NCFSE) 2023, and the competency-based approach envisaged by CBSE and Kendriya Vidyalaya Sangathan.

The new NCERT textbook introduces mathematics through meaningful contexts, hands-on learning, logical reasoning, and problem-solving. It encourages students to explore concepts through activities, discussions, and real-life situations rather than relying solely on procedural learning. This support material has been prepared with the objective of assisting teachers in translating these pedagogical principles into effective classroom practices.

The material includes chapter-wise learning objectives, concept summaries, competency-based questions, higher-order thinking tasks. It is designed to strengthen conceptual understanding, promote mathematical thinking, and encourage joyful learning among students.

I appreciate the sincere efforts of the Associate Course Director, Resource Persons and Mathematics teachers who have contributed their expertise and dedication to the preparation of this publication. Their commitment towards enhancing the quality of mathematics education is truly commendable.

I am confident that this support material will serve as a valuable companion for teachers and will contribute significantly to improving students' mathematical understanding, confidence, and achievement.

I extend my best wishes to all teachers and students for a rewarding and enriching learning journey.

Deputy Commissioner & Director
Kendriya Vidyalaya Sangathan
Zonal Institute of Education & Training, Chandigarh

CONTENT PREPARED BY:

TOPIC	NAME OF TEACHER (TGT Maths)	NAME OF KV	REGION
FRACTIONS IN DISGUISE	INDU SHARMA	3 BRD CHANDIGARH	CHANDIGARH
THE BAUDHĀYANA PYTHAGORAS THEOREM	SUSHIL SHARMA	FARIDKOT	CHANDIGARH
PROPORTIONAL REASONING-2	SUBE SINGH YADAV	NO. 4 BHATINDA	CHANDIGARH
EXPLORING SOME GEOMETRIC THEMES	PARVEEN KUMAR	NO. 1 HUSSAINPUR	CHANDIGARH
TALES BY DOTS AND LINES	RITU	NABHA CANTT	CHANDIGARH
ALGEBRA PLAY	BALJIT KAUR	NO. 1 PATHANKOT	CHANDIGARH
AREA	KHEM KUMAR	REONA UCHA FATEHGARH SAHIB	CHANDIGARH

MODERATED BY:

TOPIC	NAME OF TEACHER (TGT Maths)	NAME OF KV	REGION
FRACTIONS IN DISGUISE	GARIMA BHATT	ITBP BHANU	GURUGRAM
THE BAUDHĀYANA PYTHAGORAS THEOREM			
PROPORTIONAL REASONING-2	MEENAKSHI SINGH	NO. 1 AMBALA CANTT.	GURUGRAM
EXPLORING SOME GEOMETRIC THEMES			
TALES BY DOTS AND LINES			
ALGEBRA PLAY			
AREA	NEELAM YADAV	PALWAL	GURUGRAM



1. UNDERSTANDING PERCENTAGES

- The symbol '%' is read as per cent.
- 'Per cent' comes from the Latin "per centum", meaning "by the hundred" or "out of hundred".
- z% means z out of every 100.

Key Idea

$$z\% \text{ of a quantity } s = \frac{z}{100} \times s$$

$$\text{Example: } 50\% \text{ of } s = \frac{50}{100} \times s = \frac{1}{2} s$$

Percentages are fractions with denominator 100.

Examples:

$$20\% = \frac{20}{100} = \frac{2}{10} = \frac{1}{5}$$

$$33\% = \frac{33}{100}$$

★ Percentages help us express parts of a whole in a common and easy-to-understand form.

2. OBSERVING SIMILARITY IN CHANGE

Digital images can be resized (changed in size or orientation). Some images look similar, while others look different.



Image A



Image B



Image C



Image D



Image E

Measurements (in mm)

Image	Width	Height
Image A	60	40
Image B	40	20
Image C	30	20
Image D	90	60
Image E	60	60

- Images A, C and D look similar. Their widths and heights change by the same factor (through multiplication).
- Images B and E look different. Their widths and heights do not change by the same factor.

If width and height change by the same factor, the images look similar. Such changes are **PROPORTIONAL**.

3. RATIOS

A ratio compares two quantities of the same kind. Written as $a : b$ and read as "a is to b".

- a and b are the terms of the ratio.
- In $a : b$, for every 'a' units of the first quantity, there are 'b' units of the second quantity.

Ratio of width : height

$$\text{Image A} = 60 : 40$$

$$\text{Image C} = 30 : 20$$

$$\text{Image D} = 90 : 60$$

Example

In image A:
For every 60 mm of width,
there are 40 mm of height.



4. RATIOS IN THEIR SIMPLEST FORM

Two ratios are **PROPORTIONAL** if their simplest forms are the same. To get simplest form → divide both terms by their HCF.

Image	Ratio (W : H)	HCF	Simplest Form
A	60 : 40	20	3 : 2
B	40 : 20	20	2 : 1
C	30 : 20	10	3 : 2
D	90 : 60	30	3 : 2
E	60 : 60	60	1 : 1

Images A, C and D have the same simplest form (3 : 2). So, their ratios are proportional.

Images B and E have different simplest forms → not proportional to A, C and D.

Use ':' to show proportional ratios.

Example: $60 : 40 :: 30 : 20$ and $60 : 40 :: 90 : 60$

5. INCREMENTS IN PRODUCTS (USING DISTRIBUTIVITY)

Let the initial two numbers be a and b (product = ab).

Distributive Property

$$a(b + c) = ab + ac$$

$$(a + b)c = ac + bc$$

- 1 If second number b is increased by 1:

$$a(b + 1) = ab + a$$

$$\text{Increase} = a$$

- 2 If first number a is increased by 1:

$$(a + 1)b = ab + b$$

$$\text{Increase} = b$$

- 3 If both a and b are increased by 1:

$$(a + 1)(b + 1) = ab + (a + b + 1)$$

$$\text{Increase} = a + b + 1$$

- 4 If a is increased by 1 and b is decreased by 1:

$$(a + 1)(b - 1) = ab + b - a - 1$$

$$\text{Increase} = b - a - 1$$

General Case

If a is increased by m and b by n :

$$(a + m)(b + n) = ab + mb + an + mn$$

$$\text{Increase} = an + bm + mn$$

(Identity 1)

	b columns	n columns
a rows	ab	an
m rows	mb	mn

Product = sum of products of each term of $(a + m)$ with each term of $(b + n)$.

6. EXPRESSING FRACTIONS AS PERCENTAGES

To express a fraction as a percentage, make the denominator 100.

$$\text{Example: } \frac{3}{4}$$

$$\text{Method 1: } \frac{3}{4} = \frac{3 \times 25}{4 \times 25} = \frac{75}{100} = 75\%$$

$$\text{Method 2: } \frac{3}{4} = \frac{x}{100} \Rightarrow x = \frac{3}{4} \times 100 = 75$$

$$\text{Method 3 (Bar Model):}$$

Multiply $\frac{3}{4}$ of 100 = $\frac{3}{4} \times 100 = 75$

Other Example: $\frac{2}{5}$

$$\text{Method 1: } \frac{2}{5} = \frac{20}{50} = \frac{40}{100} = 40\%$$

$$\text{Method 2: } \frac{2}{5} = \frac{x}{100} \Rightarrow x = \frac{2}{5} \times 100 = 40$$

$$\text{Method 3 (Bar Model):}$$

Multiply $\frac{2}{5}$ of 100 = $\frac{2}{5} \times 100 = 40$



A fraction is of a unit, while a percentage is per 100. So, Fraction → Percentage = $\times 100$.

7. EXPRESSING PERCENTAGES AS FRACTIONS

A percentage $z\%$ is the same as $\frac{z}{100}$.

$$\text{Example: } 24\% = \frac{24}{100}$$

Equivalent forms:

$$\frac{24}{100} = \frac{12}{50} = \frac{6}{25} = \frac{48}{200}$$

In general, $z\%$ can be expressed by any fraction equivalent to $\frac{z}{100}$.

8. WHY USE PERCENTAGES?

- Same information in fractions may not be easy to compare.
- Percentages make comparison quicker and clearer.

Example:

$$\frac{9}{34} = 26.47\% \quad \text{vs} \quad \frac{13}{45} = 28.88\%$$

It is easier to see that 28.88% is larger!



KEY TAKEAWAYS

- ✓ Percent means "out of 100".
- ✓ Fractions ↔ Percentages ($\times 100$ or $\div 100$).
- ✓ Ratios compare two quantities.

- ✓ Ratios in simplest form tell if they are proportional.
- ✓ Same factor change in dimensions ⇒ proportional change.
- ✓ Distributive property helps in understanding change in products.



FRACTIONS IN DISGUISE

Learning Outcomes:

LO1: Converts fractions, decimals and percentages.

LO2: Solves real-life problems involving percentages, discounts, and increases/decreases.

LO3: Interprets percentages as parts of a whole and as comparisons.

Competencies:

C1: Numerical fluency

C2: Quantitative reasoning

C3: Financial literacy

C4: Problem solving

Q.No	Question	LO	Competency
MCQs (One Mark Each)			
1	$\frac{3}{5}$ when expressed as a percent is (a) 60% (b) 6% (c) 600% (d) 0.6%	LO1 LO3	C1
2	$8\frac{3}{4}\%$ when expressed as a fraction is (a) $\frac{7}{80}$ (b) $\frac{35}{100}$ (c) $\frac{35}{4}$ (d) $\frac{35}{40}$	LO1 LO2	C1
3	What percent of 1 day (24 hours) is 72 minutes? (a) 300% (b) 7.2% (c) 33.3% (d) 5%	LO1 LO2	C1 C2
4	An article bought for ₹ 80 was sold for ₹ 90. The gain or loss % is (a) 15% loss (b) 12.5% loss (c) 15% gain (d) 12.5% gain	LO2 LO3	C1 C3 C4
5	The interest on ₹ 5000 for 1 year at 10% per annum without compounding is (a) ₹ 50 (b) ₹ 500 (c) ₹ 60 (d) ₹ 600	LO2 LO3	C1 C3 C4
6	A fraction with its denominator is called a percent (a) 1 (b) 10 (c) 100 (d) 1000	LO1 LO3	C2
7	Arnav has 25 marbles, of which 10 are blue. What percentage of her marbles is blue? (a) 10% (b) 15% (c) 25% (d) 40%	LO1 LO2	C1 C4
8	An item marked at ₹ 9000 is offered in a sale for ₹ 7650. The discount percent is: (a) 5% (b) 15% (c) 55% (d) 85%	LO2 LO3	C1 C3 C4
9	40% of (100 – 20% of 300) is equal to (a) 20 (b) 16 (c) 140 (d) 64	LO1	C1 C2
10	The compound interest on ₹ 5000 at 4% per annum for 2 years compounded annually is: (a) ₹ 5804 (b) ₹ 5708 (c) ₹ 5408 (d) ₹ 5508	LO2 LO3	C1 C3 C4
Short Answer Type (Two Marks Each)			
11	Sudhir obtained 480 marks out of 600 and Manohar got 540 marks out of 750. Whose performance is better?	LO2 LO3	C1 C4
12	Harish saves ₹ 900 out of a total monthly salary of ₹ 14400. Find his percentage of saving.	LO1 LO2	C1 C3 C4

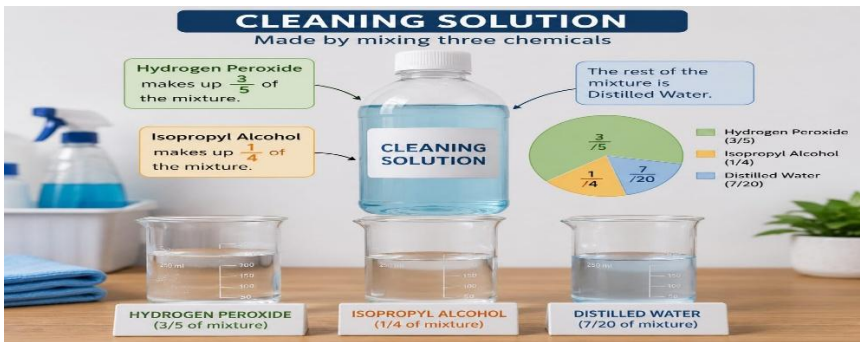
13	Find the value of the following and also draw their bar models: (a) 40% of 240 (b) 75% of 250	LO3	C1 C2
14	Shweta borrowed ₹ 14000 from her friend at 8% per annum without compounded annually. She returned the money along with interest after 2 years. How much money did she pay back?	LO2 LO3	C1 C3 C4
15	The price of a refrigerator which was ₹ 34000 last year increased by 20% this year. What is the price now?	LO2 LO3	C1 C3 C4
16	A cask containing 425 litres, lost 8% by leakage. How many litres were left in the cask?	LO2 LO3	C1 C3 C4
17	The population of country decreases from 150 lakhs to 100 lakhs in 20 years. What is the percentage of decrease?	LO2	C1 C4
18	The percentage of nutrient in a 50 g biscuit packet is shown in the picture. Find out the weight each nutrient makes up in this packet.	LO1 LO2	C1 C2
			
19	The post office offers an interest of 4% p.a. on saving account. How much interest would one get if one invests ₹ 10,000 for 2 years without compounding?	LO2 LO3	C1 C3 C4
20	Find compound interest on ₹ 12,600 for 2 years at 10% per annum compounded annually.	LO2 LO3	C1 C3 C4

Short Answer Type (Three Marks Each)

21	Find the gain or loss%: (i) When a table which costs ₹ 4000 is sold for ₹ 4200. (ii) When a book which costs ₹ 65 and sold for ₹ 60	LO2 LO3	C1 C2 C4
22	The number of employees in a company is 2000. If 40% are females then how many males are there in the company?	LO2	C1 C2 C4
23	A sofa set was bought at ₹ 12,000. Its value depreciated at the rate of 25% per annum. Find its value after two years.	LO2 LO3	C1 C3 C4
24	The price of a head phones is ₹ 1357 including 18% GST, find the price of the article without GST.	LO2 LO3	C1 C3 C4
25	A bacteria culture doubles every 5 hours. If there were 640 bacteria after 30 hours, how many were present initially?	LO2 LO3	C1 C4

Long Answer Type (Five Marks Each)

26	A shopkeeper sold two TV set for ₹ 39600 each. On one he lost 10% while on the other he gained 10%. Find his total gain or loss per cent, in this transaction.	LO1 LO2 LO3	C1 C2 C3 C4
			

27	A Bank in Chintamani, Karnataka, offers an interest of 10% p.a. Compare how much one gets if one deposits ₹ 40,000 for a period of 3 years with compounding and without compounding annually.	LO2 LO3	C1 C2 C3 C4
28	The population of a town increased to 58,320 in 2025 at a rate of 8% per annum. (i) Find the population in 2023. (ii) What will be the population in 2027 if the rate of interest continues?	LO2	C1 C4
Case Study Based			
29	Case Study 1: A chemist is preparing a cleaning solution by mixing three chemicals: Hydrogen Peroxide, Isopropyl Alcohol and Distilled Water. Hydrogen Peroxide makes up $\frac{3}{5}$ of the mixture. Isopropyl Alcohol makes up $\frac{1}{4}$ of the mixture. The rest of the mixture is Distilled Water.  Answer the following questions: (i) What percentage of the mixture is Hydrogen Peroxide? (ii) What percentage of the mixture is Isopropyl Alcohol? (iii) (a) What fraction of the mixture is Distilled Water? Also what percentage of the mixture is Distilled Water? OR (iii) (b) If the total mixture is 2 litres, how many millilitres of each chemical are used?	LO1 LO2	
30	Case Study 2: Electric vehicles are generally considered a more sustainable transport option because they help reduce air pollution, greenhouse gas emissions and fossil-fuel dependence. An EV company sold 5000 vehicles in 2020. Sales pattern: 2021: + 20% 2022: + 25% 2023: + 30% 2024: - 10%  From the above information, answer the following questions: (i) Find number of vehicles sold each year. (ii) find the overall percentage change from 2020 to 2024.	LO1 LO2 LO3	C1 C3 C4

Answers:

Q.	1	2	3	4	5
Ans.	a	a	d	d	b
Q.	6	7	8	9	10
Ans.	c	d	c	b	c
Q.	11	12	13	14	15
Ans.	Sudhir	6.25%	(a) 96 (b) 187.5	₹ 16,240	₹ 40,800
Q.	16	17	18	19	20
Ans.	391 L	$33\frac{1}{3}\%$	Carbohydrates - 30g fat – 10g protein -6g Fibre - 4g	₹ 800	₹ 2646
Q.	21	22	23	24	25
Ans.	(i) 5% gain (ii) 7.69% loss	1200 males	₹ 6750	₹ 1150	10
Q.	26	27	28	29	30
Ans.	1% loss	Diff = ₹ 1240	(i) 50,000 (ii) 68,024 (approx.)	(i) 60% (ii) 25% (iii) (a) 3/20, 15% (iii) (b) 1200mL, 500mL, 300mL	(i) 2021 – 6,000, 2022 – 7,500 2023 – 9,750 024 – 8,775 (ii) 75.50%

Challenging Questions (Stage 1)

Q.1. 11% of which number is 33?

Q.2. By selling a bicycle for ₹ 2024, a shopkeeper loses 12%. If he wishes to make a gain of 12%, what will be the selling price of the bicycle?

Q.3. In an examination, 15% students failed. If 425 students passed the examination, find the number of students who failed.

Q.4. The selling price of 16 articles is equal to the cost of price of 20 articles. Find the gain or loss per cent.

Q.5. The value of an asset increases by r% annually. After 2 years its value becomes 121 % of the original value. Find r?

Challenging Questions (Stage 2)

Q.1. Naresh earns ₹ 50,800 per month. He keeps 50% for household expenses, 15% for his personal expenses, 20% for the education of his children and rest he saves. What amount per month does he save?

Q.2. Find $\frac{30\% \text{ of } 70\% \text{ of } 100\%}{30 \times 700}$

Q.3. Is 20% of a metre longer than 5% of a kilometer?

Q.4. After offering a discount of 40% on the marked price, furnishes obtain a gain of 20%. How much above CP should they mark their MP?

Q.5. An entrepreneur buys machinery for ₹ 12 lakh. Annual maintenance cost is 5% of the purchase value. The machinery generates annual revenue of ₹ 4 lakh for 4 years. Find the net profit or loss.

Challenging Questions (Stage 3)

Q.1. An alloy of copper and zinc contains 45% copper and the rest is zinc. Find the weight of zinc in 2kg of the alloy?

Q.2. A clothing store is offering a special sale on a jacket. First, the store gives a 30% discount on the marked price. During a weekend promotion, an additional 20% discount is given on the reduced price. What single discount is equivalent to these two successive discounts?

Q.3. A shopkeeper purchased 200 bulbs for ₹ 10 each. However, 5 bulbs were fused and had to be thrown away. The remaining were sold at ₹ 12 each. Find the loss or gain per cent.

Q.4. If the breadth of a rectangle is increased by 25% and the area doubles, by what percentage should the length change?

Q.5. A city population grows at a constant rate every year. If the population in 2020 was 8 lakh and in 2025 it became 12.88 lakh, find the annual growth rate.

Answers (Challenging Questions)

	Q.1	Q.2	Q.3	Q.4	Q.5
Stage 1	300	₹ 2576	75	25% gain	$r = 10$
Stage 2	₹ 7620	0.00001	No	MP should be marked 100% above CP	₹ 1.6 lakh
Stage 3	1.1 kg	44 %	17% gain	60%	10%

2

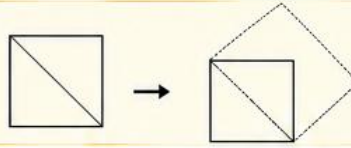
THE BAUDHĀYANA-PYTHAGORAS THEOREM

In this chapter

- Doubling a Square
- Halving a Square
- Hypotenuse of an Isosceles Right Triangle
- Value of $\sqrt{2}$
- Pythagoras Theorem

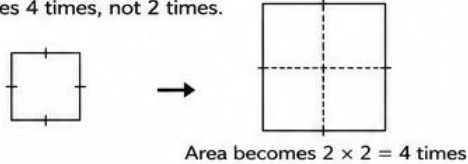
Key Idea (Baudhāyana's Insight)

The diagonal of a square produces a square of double the area of the original square.



1. DOUBLING A SQUARE

- If each side of a square is doubled, the area becomes 4 times, not 2 times.

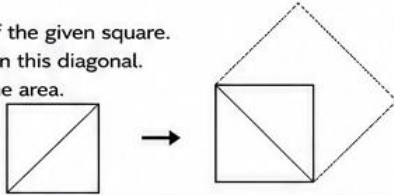


Baudhāyana's Theorem (Śulba-Sūtra, 1.9)

The diagonal of a square produces a square of double the area of the original square.

Construction

Draw the diagonal of the given square. Construct a square on this diagonal. It will have double the area.

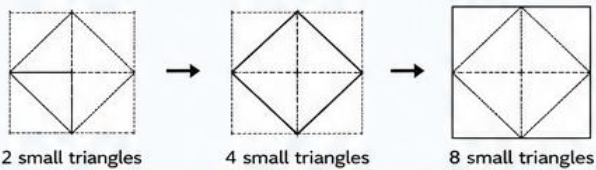


Why does the new square have double the area?

- Draw horizontal and vertical lines through the midpoints of the sides.
- These lines pass through the vertices of the dotted square because the sides of the original square bisect the angles of the new square.
- The original square is made of 2 congruent small triangles; the new square is made of 4 congruent small triangles.
- Hence, $\text{Area}(\text{new square}) = 2 \times \text{Area}(\text{original square})$.

Sequence of Squares

Each square has double the area of the previous one.

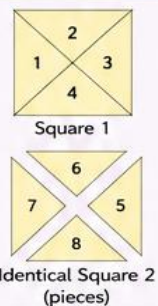


2 small triangles 4 small triangles 8 small triangles

Areas in ratio: 1 : 2 : 4 : 8 : ...

Doubling a Square Using Paper

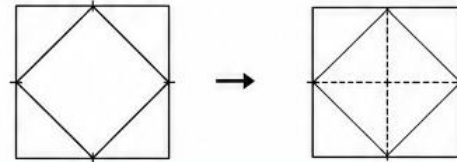
1. Cut two identical squares of paper.
2. In Square 1, draw both diagonals and cut into 4 pieces (1, 2, 3, 4).
3. In identical Square 2, cut along the diagonals to get pieces (5, 6, 7, 8).
4. Place pieces 5, 6, 7, and 8 around Square 1. The outer shape is a square with double the area.



2. HALVING A SQUARE

Construction

Draw a square inside the given square by joining the midpoints of the sides. The inner square has half the area.

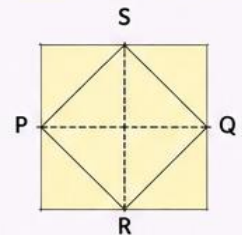


Why does the inner square have half the area?

- The diagonals of the inner square divide the figures into 4 congruent right isosceles triangles.
- The outer square is made of 4 such triangles.
- The inner square is made of 2 such triangles.
- Hence, $\text{Area}(\text{inner square}) = \frac{1}{2} \times \text{Area}(\text{outer square})$.

Halving a Square Using Paper

1. Take a square sheet of paper.
2. Fold it inward so that the crease lines pass through the midpoints of the sides.
3. The inner square PQRS is the required square with half the area.



3. HYPOTENUSE OF AN ISOSCELES RIGHT TRIANGLE

Consider the isosceles right triangle PEAR.

Legs = 1 unit each.

Let $ER = c$ be the hypotenuse.

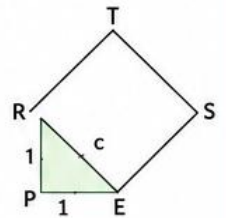
- A square of side 1 is made of two such triangles.
- The square constructed on the diagonal (hypotenuse) has twice the area of the original square.

So, $\text{Area of square REST} = 2 \times \text{Area of square PEAR}$
 $= 2 \times 1 = 2$ sq. units.

But the area of square REST = c^2 .

Therefore, $c^2 = 2 \Rightarrow c = \sqrt{2}$.

Hence, the hypotenuse of an isosceles right triangle with unit legs is $\sqrt{2}$ units.



Value of $\sqrt{2}$ (Decimal Representation)

We know: $1^2 = 1$, $2^2 = 4 \Rightarrow 1 < \sqrt{2} < 2$.

Using the method of closer bounds:

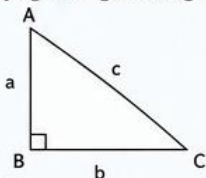
Lower bound (a)		Upper bound (b)	
a	a^2	b	b^2
1.4	1.96	1.5	2.25
1.41	1.9881	1.42	2.0164
1.414	1.999396	1.415	2.002225
1.4142	1.99996164	1.4143	2.00024449

Thus, $\sqrt{2} \approx 1.4142$ (to 4 decimal places).

It is an **irrational number** (non-terminating, non-repeating decimal).

4. PYTHAGORAS THEOREM (THE FINAL THEOREM)

In any right triangle with legs a , b and hypotenuse c (opposite the right angle):



The square of the hypotenuse is equal to the sum of the squares of the other two sides.

$$c^2 = a^2 + b^2$$

Key Definitions

- **Square:** A quadrilateral with all sides equal and all angles 90° .
- **Diagonal of a square:** A line segment joining two opposite vertices.
- **Hypotenuse:** The side opposite to the right angle in a right triangle.
- **East-west line:** A horizontal line.
- **North-south line:** A vertical line.
- **Congruent figures:** Figures that have the same shape and size.

Important Takeaways

- ✓ Diagonal of a square $\rightarrow$ new square with double the area.
- ✓ Connecting midpoints $\rightarrow$ new square with half the area.
- ✓ Hypotenuse of an isosceles right triangle with unit legs = $\sqrt{2}$.
- ✓ $1 < \sqrt{2} < 2$ and $\sqrt{2} \approx 1.4142$.
- ✓ In any right triangle, $c^2 = a^2 + b^2$.

THE BAUDHĀYANA PYTHAGORAS THEOREM

Learning Outcomes:

LO1: Verifies and applies the Pythagorean Theorem in right triangles.

LO2: Finds unknown side lengths.

LO3: Recognizes practical applications in distance and construction. Identifies repeating and growing patterns.

Competencies:

C1: Geometrical reasoning

C2: Logical thinking

C3: Spatial visualization, Observation and identification of patterns

Q.No	Question	LO	Competency
MCQs (One Mark Each)			
1	If a right triangle has sides 6 cm and 8 cm, the hypotenuse is: (a) 9 (b) 10 (c) 12 (d) 14	LO1 LO2	C1 C2
2	Which of the following is a Baudhāyana triple? (a) (4,5,6) (b) (5,12,13) (c) (6,7,8) (d) (8,9,10)	LO3	C2 C3
3	$\sqrt{2}$ lies between: (a) 1 and 1.2 (b) 1.2 and 1.3 (c) 1.4 and 1.5 (d) 1.5 and 1.6	LO3	C2
4	Doubling the side of a square multiplies its area by: (a) 2 (b) 3 (c) 4 (d) 8	LO1 LO2	C1 C2 C3
5	If $c^2=49$ in a right triangle, c equals: (a) 6 (b) 7 (c) 8 (d) 9	LO1 LO2	C1 C2
6	The diagonal of a unit square is: (a) 1 (b) 2 (c) $\sqrt{2}$ (d) $\sqrt{3}$	LO1 LO2	C1 C2
7	A triangle with sides 20,21,29 is: (a) right triangle (b) not right triangle (c) equilateral (d) isosceles	LO1 LO2	C1 C2
8	The square on the hypotenuse has area equal to: (a) difference of areas (b) sum of areas (c) twice area (d) half area	LO1 LO2	C1 C2
9	Half-area square inside a square is formed by joining: (a) corners (b) midpoints (c) diagonals only (d) none	LO2 LO3	C1 C3
10	If area of a square is doubled, side becomes multiplied by: (a) 2 (b) $\sqrt{2}$ (c) 4 (d) $1/2$	LO2 LO3	C1 C2
Short Answer Type (Two Marks Each)			
11	Find the diagonal of a square of side 8 cm.	LO1 LO2	C1 C2
12	Find $\sqrt{72}$ in simplest form.		C2
13	Write two primitive Baudhāyana triples.	LO3	C2 C3
14	State the Baudhāyana–Pythagoras theorem.	LO1	C1
15	Find the diagonal of a square of area 49 cm^2 .	LO1 LO2	C1 C2

16	Find the area difference between squares of sides 9 cm and 5 cm.	LO1 LO3	C1 C2
17	Find the side of a square having double the area of a 4 cm square.	LO1 LO3	C1 C2
18	Find the value of c^2 when $a=11$ and $b=60$.	LO1 LO2	C2 C3
19	Find the area of a square whose side is $\sqrt{18}$ cm.	LO1 LO2	C1 C2
20	Find the area of the square built on the diagonal of a square of side 3 cm.	LO1 LO3	C1 C2
Short Answer Type (Three Marks Each)			
21	Compare the areas of squares on the sides of a 9-12-15 triangle.	LO1 LO3	C2 C3
22	Find the diagonal and area of the square built on it when side is 6 cm.	LO1 LO2	C1 C2
23	Find the side of a square whose area is half of a square of side 14 cm.	LO3	C1 C2
24	A square has area 72 cm^2 . Find its side and diagonal.	LO1 LO3	C1 C2
25	Find the hypotenuse of an isosceles right triangle with equal sides 9 cm.	LO1 LO2	C1 C2
Long Answer Type (Five Marks Each)			
26	A square of side 8 cm is given. Explain how to construct a square with double its area and calculate the new side length.	LO1 LO3	C1 C2
27	A ladder 25 m long reaches a window 24 m above the ground. Find the distance of the ladder's foot from the wall and explain the theorem used.	LO1 LO3	C1 C2 C3
28	A rhombus has diagonals 16 cm and 30 cm. Find its side length using the Baudhāyana–Pythagoras theorem.	LO1 LO3	C1 C2 C3
Case Study Based			
29	A square garden has side 6 m. Students want a new square garden with double the area using the diagonal method. (a) Find the area of the original garden. (b) Find the area of the new garden. (c) Find the side length of the new garden.	LO1 LO2 LO3	C1 C2 C3
30	Two square tiles have sides 3 cm and 4 cm. A designer combines them into a larger square. (a) Find their areas. (b) Find the total area. (c) Find the side of the larger square.	LO1 LO2 LO3	C1 C2 C3

Answers:

Q.	1	2	3	4	5	6	7	8
Ans.	b	b	c	c	b	c	a	c
Q.	9	10	11	12	13	14	15	16
Ans.	(b) midpoints	(b) $\sqrt{2}$	$8\sqrt{2}$	$6\sqrt{2}$	(3,4,5) (5,12,13) etc.	*	$7\sqrt{2}$	56 cm^2
Q.	17	18	19	20	21	22	23	24
Ans.	$4\sqrt{2} \text{ cm}$	61	18 cm^2	18 cm	**	$6\sqrt{2} \text{ cm}, 72 \text{ cm}^2$	$7\sqrt{2} \text{ cm}$	$6\sqrt{2} \text{ cm}, 12 \text{ cm}$
Q.	25	26	27	28	29	30		
Ans.	$9\sqrt{2} \text{ cm}$	$8\sqrt{2} \text{ cm}$	7 m	17 m	$36 \text{ cm}^2, 72 \text{ cm}^2, 6\sqrt{2} \text{ cm}$	$9 \text{ cm}^2, 16 \text{ cm}^2, 25 \text{ cm}^2, 5 \text{ cm}$		

*14. In a right-angled triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the other two sides.

**21. the sum of the areas of the squares on the two shorter sides equals the area of the square on the longest side.

Challenging Questions (Stage 1)

Q.1. A square has side 4 cm. The area of the square on its diagonal is:

(a) 16 (b) 24 (c) 32 (d) 64

Q.2. If the area of a square is doubled, does its perimeter also double? Explain.

Q.3. A square and a rectangle have the same diagonal. Can their areas be equal? Explain.

Q.4. Using the theorem, find the distance between opposite corners of a 24 cm by 7 cm rectangle.

Q.5. A ladder 41 m long rests against a wall. Its foot is 9 m away from the wall. Determine the height reached and explain how the theorem models the situation.

Challenging Questions (Stage 2)

Q.1. A square of area 25 cm^2 has diagonal length:

(a) 5 (b) $5\sqrt{2}$ (c) 10 (d) 25

Q.2. A right triangle has integer sides and hypotenuse 25 cm. Can there be more than one such triangle? Explain.

Q.3. A rectangle has perimeter 34 cm and diagonal 13 cm. Determine its dimensions.

Q.4. Two squares have diagonals in the ratio 3 : 5. Determine the ratio of their areas and explain your reasoning.

Q.5. A designer combines two square tiles of sides 6 cm and 8 cm into one larger square of equal total area. Determine the side length of the new square and explain the geometric principle involved.

Challenging Questions (Stage 3)

Q.1. If $a=b=10$ in an isosceles right triangle, c^2 equals:

(a) 100 (b) 150 (c) 200 (d) 400

Q.2. A square has side 8 cm. Without directly using the formula for the diagonal, explain how the theorem helps determine the diagonal length.

Q.3. A right triangle has sides x , $x+5$ and 25. Determine x .

Q.4. Compare the diagonals of squares having areas 50 cm^2 and 98 cm^2 .

Q.5. A 65 m long rope is tied to the top of a pole and staked to the ground 25 m away from the base of the pole. Find the height of the pole.

Answers (Challenging Questions)

	Q.1	Q.2	Q.3	Q.4	Q.5
Stage 1/Ans	(c) 32	No*	No**	25 cm	40 m
Stage 2/Ans	(b) $5\sqrt{2}$	Yes***	12cm, 5cm	9:25	10 cm
Stage 3/Ans	(c) 200	$8\sqrt{2}$	15	10cm & 14 cm 5:7	60 m

*It becomes only $\sqrt{2}$ times

** Unless the rectangle is a square

*** there are 2 such triangles with sides (7,24,25), (15,20,25)

3

PROPORTIONAL REASONING-2

In This Chapter

- ✓ Proportionality (quick recap)
- ✓ Ratios in maps
- ✓ Ratios with more than 2 terms

Key Idea: When related quantities change by the same factor, we call that relationship a proportional relationship.

1. PROPORTIONALITY—A QUICK RECAP

A proportional relationship between two quantities can be represented using ratios.

Example:

Idli batter: 2 cups rice : 1 cup urad dal $\rightarrow$ 2 : 1

Viswanath mixes 6 cups rice and 3 cups urad dal $\rightarrow$ 6 : 3

Puneet mixes 4 cups rice and 2 cups urad dal $\rightarrow$ 4 : 2

Cross-Multiplication Method

$$\begin{array}{ccc} 6 : 3 & & 4 : 2 \\ & \swarrow \quad \searrow & \\ 6 \times 2 = 12 & \text{and} & 3 \times 4 = 12 \end{array}$$

The products are equal (12). So, the ratios are proportional. (Their idlis will taste the same if all other ingredients are proportional too!)

General Rule (Two Ratios)

Two ratios $a : b$ and $c : d$ are proportional if

$$a \times d = b \times c \quad \text{or} \quad \frac{a}{c} = \frac{b}{d}$$

2. RATIOS IN MAPS

Many maps show a ratio called **Representative Fraction (RF)** (usually in the lower right corner).

RF = 1 : N means 1 unit on the map = N units on the ground (real geographical distance, not road distance).

Example:

RF = 1 : 60,00,000

1 cm on map
= 60,00,000 cm on ground
= 60 km



(Map not to scale)

How to find distance between two cities:

1. Measure the distance between the cities on the map using a ruler.
2. Multiply by the scale (N) to get the actual geographical distance.

Try This!

- Find the distance between Bengaluru and Chennai.
- Find the distance between Mangaluru and Chennai.
- Use different maps (with different scales) and check if you get approximately the same geographical distance.



Note to the Teacher:

Bring maps and atlases to class. Ask students to observe the scale (ratio) on maps. Let them find geographical distances between places of local interest and compare results with peers.



Map Making Activity:

Ask students to draw a sketch of their classroom using a scale (e.g., 1 : 50). Mark positions of objects (desks, board, fans, lights, etc.) using suitable symbols.

3. RATIOS WITH MORE THAN 2 TERMS

Ratios can have more than two terms if the quantities change by the same factor.

Example:

Viswanath's spice mix powder:

8 spoons coriander : 4 red chillies : 2 spoons toor dal : 1 spoon fenugreek (methi) seeds

Ratio = 8 : 4 : 2 : 1 (4 terms)

? Puneet has only 2 red chillies (half of Viswanath's 4 chillies). How much of the other ingredients should he use to make the same spice mix powder?

Since he has half the chillies, he must also take half of all other ingredients.

Puneet's mix: 4 : 2 : 1 : 0.5

(4 spoons coriander, 2 red chillies, 1 spoon toor dal, half spoon fenugreek seeds)

Both ratios are proportional:

$$8 : 4 : 2 : 1 :: 4 : 2 : 1 : 0.5$$

General Rule (Multiple Terms)

If two ratios with the same number of terms are proportional,

$$a : b : c : d :: p : q : r : s$$

then, $\frac{a}{p} = \frac{b}{q} = \frac{c}{r} = \frac{d}{s}$

Example 1: Mixing Paint

Ratio (Red : Blue : White) = 2 : 3 : 5

Yasmin has 10 litres of white paint. How much red and blue paint should she add?

- White corresponds to 5 parts.
- If 5 parts = 10 L $\rightarrow$ 1 part = $10 \div 5 = 2$ L
- Red = 2 parts = $2 \times 2 = 4$ L
- Blue = 3 parts = $3 \times 2 = 6$ L
- Total volume of purple paint = $4 + 6 + 10 = 20$ litres



Example 2: Cement Concrete Mix

Ratio (Cement : Sand : Aggregate) = 1 : 2 : 4

If 7 kg of cement is used, how much sand and aggregate are needed?

- Cement corresponds to 1 part.
- 1 part = 7 kg
- Sand = 2 parts = $2 \times 7 = 14$ kg
- Aggregate = 4 parts = $4 \times 7 = 28$ kg
- Total mix = $7 + 14 + 28 = 49$ kg



KEY DEFINITIONS

- **Ratio:** A way to compare two or more quantities using division ($a : b$ means "a to b").
- **Proportional relationship:** When related quantities change by the same factor.
- **Representative Fraction (RF):** The ratio of a distance on the map to the actual geographical distance on the ground.



IMPORTANT FORMULAS

- Two ratios $a : b$ and $c : d$ are proportional if $\frac{a}{c} \times d = b$ or $\frac{a}{c} = \frac{b}{d}$
- For multiple terms $a : b : c : d :: p : q : r : s \Rightarrow \frac{a}{p} = \frac{b}{q} = \frac{c}{r} = \frac{d}{s}$



KEY TAKEAWAYS

- ✓ Proportionality helps us compare quantities easily.
- ✓ Maps use a ratio (RF) to represent real distances.
- ✓ Ratios can have more than two terms.
- ✓ Keep the same ratio (or scale) to maintain the same relationship.



PROPORTIONAL REASONING-2

Learning Outcomes:

LO1: Solves problems involving direct and inverse proportion.

LO2: Interprets ratios in practical contexts.

LO3: Constructs and reads pie charts.

Competencies:

C1: Data interpretation

C2: Analytical reasoning

C3: Quantitative thinking

Q.No	Question	LO	Competency
MCQs (One Mark Each)			
1	The simplest form of ratio 12 :20:30:40? a)1:2:3:4 b) 2:3:4:5 c) 6:10:15:20 d) 2:5:5:4	LO1	C1 C2
2	Are the ratios 3 : 4 and 72 : 96 proportional? a)Yes b) No c) Cannot say d) May be	LO1	C1 C2
3	The angles of a triangle in 1:2:3.what will be the measurement of the smallest angle? a)25 b) 30 c) 35 d) 45	LO2	C1 C2
4	Vinod made idlis by mixing 6 cups of rice with 3 cups of urad dal, while Puneet wanted to make idlis by mixing 4 cups of rice.How much urad dal he required? so that taste remains the same? a)1cup b)2 cups c)3 cups d)4 cups	LO 2	C2 C3
5	A bus travels with a uniform speed; it covers 480 km in 8 hours.how much time will it take to cover 660 km? a)8 hours b)9 hours c)10 hours d)11 hours	LO3 LO5	C2
6	The ratio of teachers and students in my school and David`s school is the same, there are 5 teachers and 170 students in my school. There are 238 students in David`s school. How many teachers are there in David's school? a)6 b)7 c)8 d)9	LO3	C2 C4
7	If 12 pencils cost ₹60, how much will 10 such pencils cost? a)30 b)40 c)50 d)70	LO3 LO6	C2
8	Ravi makes the powder by grinding 8 spoons of coriander seeds, 4 red chillies, 2 spoons of toor dal, and 1 spoon of fenugreek (methi) seeds. For his spice mix powder, the ratio of coriander seeds to red chillies to toor dal to fenugreek seeds is 8 : 4 : 2 : 1 Find the quantity of red chillies in 30 spoons spice mix powder. a)5 spoons b)6 spoons c)7 spoons d)8 spoons	LO3	C4
9	If 2 workers can move 1500 bricks in a day, how many workers are needed to move 4500 bricks in a day? a)4 d)5 c)6 d)7	LO1 LO5	C2
10	The speed of a cyclist and the time taken to cover a fixed route This is a problem of direct proportion or inverse proportion. a)Inverse b)Direct c)Half Inverse d)Half direct	LO5	C4

Short Answer Type (Two Marks Each)			
11	We can buy 10 special pens for Rs.80. How many rupees do we require to buy 25 pens of the same type?	LO3	C2 C3
12	14 metre cloth is required for 10 pants.How much cloth will be required for 15 pants of the same type?	LO2 LO 3	C2 C4
13	For a particular height and width of a 10 metre long wall needs 5000 bricks. How many bricks will be required for a 15 metre long wall of the same width and height?	LO2 LO3	C1 C2 C3
14	20 workers take 4 days to complete laying a road. How many days will 10 workers take to complete laying the same length of road?	LO2 LO3	C2 C3
15	If the ratio on a map is 1 : 60,00,000, that means a distance of 1 cm on the map is equivalent to a geographical distance of 60,00,000cm. On the same map distance between Delhi and Jaipur is 5.1 cm.Calculate geographical distance between Delhi and Jaipur in kilometres.	LO2 LO3	C2 C3
16	Sonu draws two rectangles on a piece of paper.The length and breadth of rectangle A are 4cm and 6cm, while for rectangle B are 8cm and 16 cm. Are the length and breadth of both rectangles in the same proportion?	LO1	C2
17	Observe the following statements of proportion which one is true. a)4 : 7 :: 12 : 26 b) 8 : 3 :: 24 : 6 c) 7 : 12 :: 12 : 7 d) 21 : 7:: 36 : 12	LO1	C2
18	A packing machine packs 1750 boxes in 25 hours. How much time will it take to pack 3690 boxes?	LO1 LO3	C2 C3
19	Mohan wants to share 361212 marbles to his 3 friends Monu,Sonu Titu in the ratio 1:2:3.How many marbles did Titu get?How many marbles did Sonu get?	LO1 LO2	C1 C2 C3
20	1m cube soil weighs 1800 kg.What will be the weight of 0.512 cm cube?	LO1 LO3	C2
Short Answer Type (Three Marks Each)			
21	Ravi wants a particular shade of purple paint by mixing red, blue, and white paint in the ratio 2 : 3 : 5. If you need 50 ml of purple paint, how many ml of red, blue, and white paint will you mix together?	LO2 LO3	C1 C2 C3
22	Construct a triangle with angles in the ratio 1 : 3 : 5...	LO1	C2
23	A factory requires 42 machines to produce a given number of toys in 63 days. How many machines are required to produce the same number of toys in 54 days?	LO3	C3
24	A car takes 2 hours to reach a destination, travelling at a speed of 60 km/h. How long will the car take if it travels at a speed of 80 km/h?	LO3	C1 C3
25	It takes 6 hours to fill 2 tanks of the same size with a pump. How long will it take to fill 5 such tanks with the same pump?	LO1 LO3	C2 C3
Long Answer Type (Five Marks Each)			
26	A cricket coach schedules practice sessions that include different activities in a specific ratio — time for warm-up/cool-down : time for batting : time for bowling : time for fielding :: 3 : 4 : 3 : 5. If each session is 180 minutes long, how much time is spent on each activity?	LO1 LO2 LO3	C2 C3
27	The perimeter of a triangle is 36 cm.Construct a triangle with side lengths in the ratio 3 : 4 : 5. Is it a scalene,isosceles or equilateral triangle? length of longest side?	LO1 LO2	C1 C2
28	Which of the following pairs of quantities are in inverse proportion?	LO1	C1

	(i) The number of taps filling a water tank and the time taken to fill it. (ii) The number of painters hired and the days needed to paint a wall of fixed size. (iii) The distance a car can travel and the amount of petrol in the tank. (iv) The number of pages in a book and the time required to read it at a fixed reading speed. (v) The length of cloth bought and the price paid at a fixed rate per metre.	LO3	C3
Case Study Based			
29	A group of 450 students were asked to vote for their favourite subjects from the five subjects— English, Hindi , Maths, Science and Social Science. 90 liked English, 50 liked Hindi ,60 liked Maths,150 liked Science and100 liked Social Science.Draw a pie chart to show this information.	LO2 LO3	C1 C2 C3
30	A tank on a building has enough water to supply 200 families living there for 60 days. If 40 more families move in there, how will the water last long? What assumptions do you need to make, to work out this problem? Is it a problem of direct proportion and Inverse proportion?	LO3	C2 C3

ANSWERS

Q.	1	2	3	4	5
Ans.	C	A	B	B	D
Q.	6	7	8	9	10
Ans.	B	C	D	C	A
Q.	11	12	13	14	15
Ans.	200	21 metre	7500	8	306 km
Q.	16	17	18	19	20
Ans.	No	D	41 hours	Titu 180606 sonu120404	921.6kg
Q.	21	22	23	24	25
Ans.	10ml, 15ml, 25ml	angles: 20, 60,100	49	90 min	15 hours
Q.	26	27	28	29	30
Ans.	36,48,36 and 60 minutes	scalene and 15 cm	i)and ii) only	E-72, H-40, M-48, S-120 and for So.sci 80 degree	50 days

Challenging Questions (Stage 1)

1. Divide ₹7,500 into two parts in the ratio 1.5:2.5 : 3.5.

2. 2 pumps can fill a tank in 18 hours. How much time will it take to fill the tank if we add 2 more pumps of the same kind?

Q.3. To make a special shade of purple paint must be mixed in the ratio, Red : Blue : White :: 2 : 3 :

5. What is the quantity of white paint required to make 40 g purple paint?

Q.4. A man distributed some amount to three of his sons in 3:4:3. One of his sons got a maximum amount of Rs 400000. Find the total amount that the man distributed?

Q.5. The ratio of present age of a father and his daughter is 3:1. After 12 years the ratio of their ages would be 11:5. Find the present age of father and his daughter.

Challenging Questions (Stage 2)

Q.1. The mass of equal volumes of silver and water are in the ratio 31 : 2.

If 1 litre of water is 1 kg in mass, what is the mass of 1 litre of silver?

Q.2. If $\frac{a}{2} = \frac{b}{3} = \frac{c}{4} = \frac{d}{5}$. Then find a:b:c:d

Q.3. One acre of land costs ₹18,00,000. What is the cost of 4840 square feet of the same land?

Q.4. A small farmer in Himachal Pradesh sells each 200 g packet of tea for ₹200. A large estate in Meghalaya sells each 1 kg packet of tea for ₹800. Are the weight-to-price ratios in both places proportional? Which tea is more expensive?

Q.5. If 60% of a number is equal to $\frac{4}{5}$ of another number, then find a:b

Challenging Questions (Stage 3)

Q.1. A mixture of 40 kg contains sand and cement in the ratio of 3 : 1. How much cement should be added to the mixture to make the ratio of sand to cement 5 : 2?

Q.2. small pump can fill a tank in 3 hours, while a large pump can fill the same tank in 2 hours. If both pumps are used together, how long will the tank take to fill?

Q.3. Let us try an ancient problem from Lilavati. At that time weights were measured in a unit named palas and niskas was a unit of money. "If $2\frac{1}{2}$ palas of saffron costs $\frac{3}{7}$ niskas, O expert businessman! tell me quickly what quantity of saffron can be bought for 9 niskas?"

Q.4.The area of Delhi is 1,484 sq. km and the area of Mumbai is 550 sq. km. The population of Delhi is approximately 30 million and that of Mumbai is 20 million people. Which city is more crowded? Why do you say so?

Q.5.The ₹10 coin is an alloy of copper and nickel called ‘cupro-nickel’. Copper and nickel are mixed in a 3 : 1 ratio to get this alloy. The mass of the coin is 7.74 grams. If the cost of copper is ₹906 per kg and the cost of nickel is ₹1,341 per kg, what is the cost of these metals in a ₹10 coin?

Answers (Challenging Questions)

	Q.1	Q.2	Q.3	Q.4	Q.5
Stage 1/Ans	1500,2500,3500	9 hours	20 gram	1000000 Rs	F=54 yrs D= 18 yrs
Stage 2/Ans	15.5 kg	2:3:4:5	200000 rupees	No, Himachal	4:3
Stage 3/Ans	2Kg	72 min	52.5palas	Mumbai	7.85 Rupees

4

EXPLORING SOME GEOMETRIC THEMES

In This Chapter

- ✓ Fractals (self-similar shapes)
- ✓ Visualising Solids in Different Ways



We explore two geometric themes in this chapter:

1. **Fractals** – self-similar shapes that repeat the same pattern at smaller and smaller scales.
2. **Visualising Solids** – understanding the same solid from different views and cross-sections.

1. FRACTALS

Key Idea

A fractal is a shape that shows **self-similarity** – the same or similar pattern appears again and again at smaller and smaller scales.

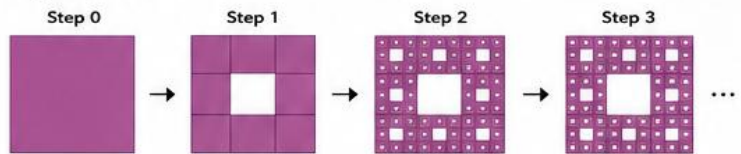
Examples in Nature

Ferns, trees, clouds, coastlines, mountains, lightning and many more.



A. SIERPINSKI CARPET

Start with a square. Divide it into 9 equal squares and remove the central square. Repeat the same process on the remaining 8 squares, and so on.



Number of Squares that Remain (R_n)

Each remaining square produces 8 squares in the next step.

$$R_{n+1} = 8 R_n$$

$$R_0 = 1 \Rightarrow R_n = 8^n$$

Number of Holes (H_n)

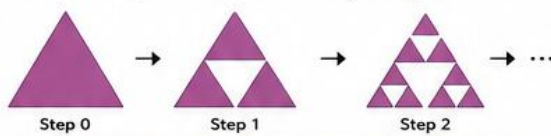
Each remaining square creates a new hole and all previous holes remain.

$$H_{n+1} = H_n + R_n$$

$$H_0 = 0, H_1 = 1, H_2 = 1 + 8, H_3 = 1 + 8 + 8^2, \dots$$

B. SIERPINSKI TRIANGLE (GASKET)

Start with an equilateral triangle. Join midpoints of its sides to form 4 smaller congruent triangles and remove the central one. Repeat on the 3 remaining triangles.



★ Joining the midpoints of an equilateral triangle divides it into 4 identical equilateral triangles. (Hint: Corner triangles are isosceles.)

Figure it Out

1. Draw the first few steps (at least till Step 2).
2. Find the number of holes and triangles that remain at each step.
3. Find the area of the region remaining at the n^{th} step. (Take the starting triangle to have area = 1 sq. unit.)

C. KOCH SNOWFLAKE

Start with an equilateral triangle. Each side is divided into 3 equal parts. On the middle part, an outward equilateral triangle is built and the middle part is removed. Repeat on every side of the new shape, and so on.

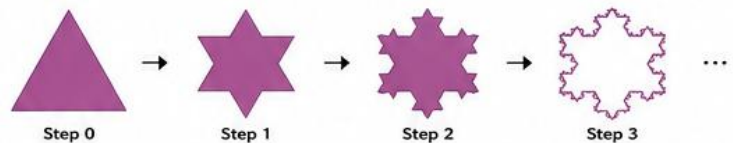


Figure it Out

1. Draw the first few steps (at least till Step 2).
2. Find the number of sides at the n^{th} step.
3. Find the perimeter at the n^{th} step. (Take the starting triangle to have side length = 1 unit.)

FRACTALS IN ART

Fractal patterns have been used in art and architecture for centuries!

- ◆ **Indian temples:** Structures built of smaller copies of the whole form.
- ◆ **African art:** Traditional patterns on textiles (e.g., Nigerian Fulani wedding blankets).
- ◆ **Islamic art:** Intricate repeating fractal-like geometric motifs.



Kandariya Mahadev Temple, Khajuraho, Madhya Pradesh (c. 1025 CE)



Nigerian Fulani Wedding Blanket



Islamic Geometric Motif

2. VISUALISING SOLIDS IN DIFFERENT WAYS

We can look at the same solid in different ways:

A. DIFFERENT VIEWS

A solid looks different from different directions.



Front View



Top View



Side View

B. CROSS-SECTIONS

A slice (cut) of a solid gives a 2D shape.



Cube



Cylinder



Cone



Sphere

C. EXPLORE & SKETCH

- ◆ Think, imagine, cut and draw different views and cross-sections to understand solids better.



KEY DEFINITIONS

- ◆ **Fractal:** A shape that shows self-similarity at different scales.
- ◆ **Self-similarity:** Similar pattern repeats at smaller and smaller sizes.
- ◆ **Square Hole / Triangle Hole:** A part removed at each step in constructing a fractal.
- ◆ **Cross-section:** The 2D shape obtained by slicing a solid with a plane.

IMPORTANT FORMULAS

Sierpinski Carpet

$$R_{n+1} = 8 R_n \Rightarrow R_n = 8^n$$

$$H_{n+1} = H_n + R_n \quad (\text{with } H_0 = 0)$$

Sierpinski Triangle

$$R_{n+1} = 3 R_n \Rightarrow R_n = 3^n$$

$$H_{n+1} = H_n + R_n \quad (\text{with } H_0 = 0)$$

Koch Snowflake (perimeter)

$$P_{n+1} = \frac{4}{3} P_n \Rightarrow P_n = \left(\frac{4}{3}\right)^n P_0$$

KEY TAKEAWAYS

- ✓ Fractals are everywhere – in nature, art and mathematics.
- ✓ They are built using simple rules repeated many times.
- ✓ Counting patterns (squares, triangles, holes, sides) helps us understand fractals.
- ✓ Visualising solids from different views and cross-sections builds spatial understanding.

EXPLORING SOME GEOMETRICAL THEMES

Learning Outcomes

LO1: Identifies and recalls geometric concepts.

LO2: Explains geometric patterns and relationships.

LO3: Constructs and represents geometric figures.

LO4: Analyses patterns, compares geometric structures and draws logical conclusions.

LO5: Applies geometric concepts in real-life situations and creates innovative geometric designs.

Competencies

C1: Knowledge & Understanding

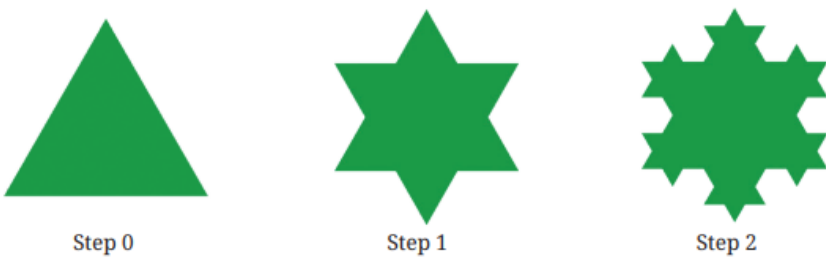
C2: Observation & Identification

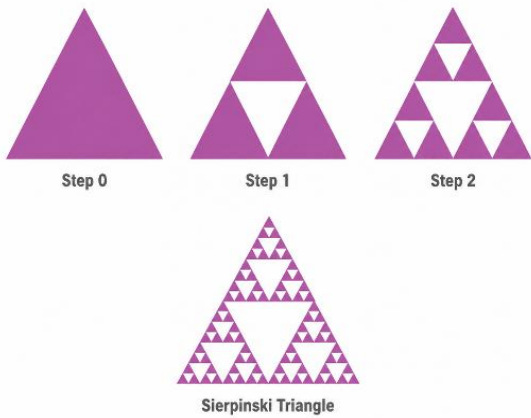
C3: Representation & Construction

C4: Analysis & Reasoning

C5: Application & Creativity

Q.No	Question	LO	Competency
MCQs (One Mark Each)			
1	A fractal is a pattern that: a) Never repeats b) Repeats at different scales c) Has no symmetry d) Is always circular	LO1	C1
2	The Koch Snowflake begins with: a) Square b) Rectangle c) Equilateral Triangle d) Pentagon	LO1	C1
3	The Sierpinski Gasket starts with: a) Circle b) Equilateral Triangle c) Square d) Hexagon	LO1	C1
4	Which property is common to both Koch Snowflake and Sierpinski Gasket? a) Reflection only b) Self-similarity c) Enlargement only d) Translation	LO2	C2
5	Isometric paper is made up of: a) squares b) Rectangles c) Equilateral triangles d) Circles	LO1	C1
6	A net is: a) A graph b) A 2D pattern that folds into a 3D shape c) A polygon d) A tessellation	LO1	C1
7	A square pyramid has: a) 3 triangular faces b) 4 triangular faces c) 5 triangular faces d) 6 triangular faces	LO1	C1
8	Which of the following is NOT a fractal? a) Koch Snowflake b) Sierpinski Gasket c) Fern Leaf d) Rectangle	LO2	C2
9	The perimeter of a Koch Snowflake: a) Decreases b) Remains constant c) Increases d) Becomes zero	LO4	CO4
10	Isometric drawings are used to represent: a) 2D figures only b) 3D objects on paper c) Maps d) Graphs	LO1	CO1
Short Answer Type (Two Marks Each)			
11	Define a fractal.	LO1	C1
12	What is self-similarity?	LO2	CO2

13	Give two examples of fractals found in nature	LO5	CO5
14	What is an isometric drawing?	LO1	CO1
15	Define a net of a solid.	LO3	CO3
16	Draw Stage 1 of a Koch Snowflake	LO3	CO3
17	Draw Stage 1 of a Sierpinski Gasket	LO1	CO1
18	Name the base shape used in constructing a Koch Snowflake.	LO2	CO2
19	Why is isometric paper useful?	LO4	CO4
20	State one similarity and one difference between Koch Snowflake and Sierpinski Gasket	LO4	CO4
Short Answer Type (Three Marks Each)			
21	Explain self-similarity using a fern leaf.	LO3	C3
22	Describe the first two stages in constructing a Koch Snowflake.	LO2	C2
23	Draw a cube using isometric dots	LO2	C2
24	Draw a cube using isometric dots	LO2	C2
25	Describe the first two stages in constructing a Sierpinski Gasket.	LO3	C3
Long Answer Type (Five Marks Each)			
26	Explain the construction of a Koch Snowflake up to Stage 3 with diagrams.	LO3	C3
27	Explain the construction of a Sierpinski Gasket up to Stage 3 with diagrams.	LO3	C3
28	Draw and explain the net of a square pyramid. Identify faces, edges and vertices	LO4	C4
Case Study Based			
29	Study the figure below showing the first three stages of a Koch Snowflake.  Step 0 Step 1 Step 2 i) Which basic shape is used to start the construction of the Koch Snowflake? ii) In Stage 1, each side of the triangle is divided into how many equal parts? iii) What geometric property is observed when the same pattern repeats at every stage? iv) As the stages increase, what happens to the perimeter of the Koch Snowflake?	LO1 LO2 LO3 LO4	C1 C2 C3 C4

30	Study the figure below showing different stages of a Sierpinski Gasket.  Step 0 Step 1 Step 2 Sierpinski Triangle i) Which shape is repeatedly used in constructing the Sierpinski Gasket? ii) In Step 1, how many small triangles remain after removing the central triangle? iii) What is the name of the property in which smaller parts resemble the whole figure? iv) Is the Sierpinski Gasket an example of a fractal? Give Yes/No.	LO1 LO4 LO5	C1 C4 C5
----	---	-------------------	----------------

ANSWERS

Q.	1	2	3	4	5
Ans.	b	c	b	b	c
Q.	6	7	8	9	10
Ans.	b	b	d	c	1b
Q.	29	30			
Ans.	i Equilateral triangle ii Three equal parts Iii Self-similarity Iv The perimeter increases	i Square pyramid ii Four triangular faces iii Five vertices iv Perimeter of base = 24 cm (if side = 6 cm)			

5

TALES BY DOTS AND LINES

This chapter helps us understand how the mean behaves with data.
We use dot plots to visualise and explore important ideas.

In this chapter

- Mean as the 'centre'
- Effect of including / removing values
- Unchanging Mean
- Relatively Unchanged Mean



Scan to learn more!

1. THE BALANCING ACT

Key Idea

The mean (average) is the 'centre' of a collection of data. It balances the data so that the total distance of values on the left equals the total distance of values on the right.

For 2 Numbers

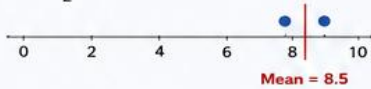
Mean is exactly halfway between the two numbers.

Example:

$$(3, 7) \rightarrow \text{Mean} = \frac{3+7}{2} = 5$$

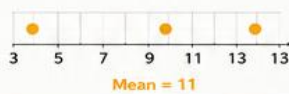
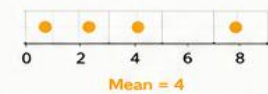
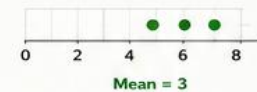
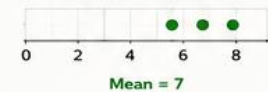


$$(8, 9) \rightarrow \text{Mean} = \frac{8+9}{2} = 8.5$$



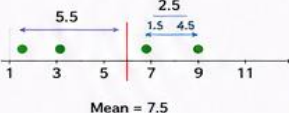
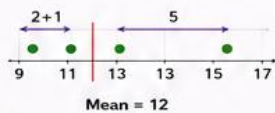
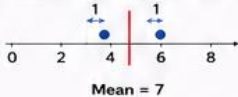
For 3 Numbers

Calculate and mark the mean.



Mean as Balance (Examples)

Sum of distances on LHS = Sum on RHS



Unique Centre

If we move the centre away from the mean, the two sides are no longer balanced.

Collection: 10, 10, 11, 17 (Mean = 12)



Hence, the mean is the **only** centre.

3. UNCHANGING MEAN

- It is possible to include or remove values without changing the mean.
- Some possibilities:

Add one value = mean
(10 added to data with mean 10)

Remove one value = mean
(any one 10 removed)

Add two below & one above
(e.g., 8, 8 and 12)

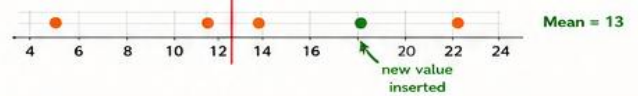
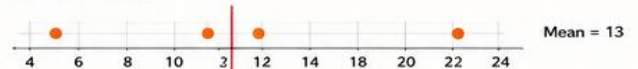


Similarly: add two above & one below.
There are many such combinations!

2. EFFECT OF INCLUDING / REMOVING VALUES

Including a New Value

- If a new value greater than the mean is added, the mean increases.

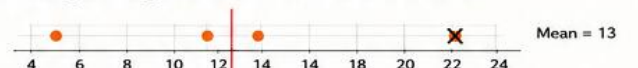


- If a new value smaller than the mean is added, the mean decreases.



Removing a Value

- Removing a value greater than the mean → mean decreases.

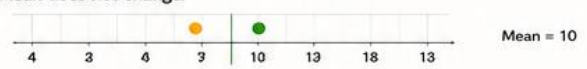


- Removing a value smaller than the mean → mean increases.



Adding / Removing a Value Equal to the Mean

- Mean does not change.



Fair-Share Interpretation

- Think of sharing equally (fairly) among all values.
- If one value is larger than the mean, others must share more to keep it fair.
- If one value is smaller, others share less.

Math Talk

4. RELATIVELY UNCHANGED MEAN

If every value in the collection is:

1. Increased (or decreased) by a fixed number k
→ Mean also increases (or decreases) by k .
Example: Add 10 to every value → Mean increases by 10.
Subtract 1 from every value → Mean decreases by 1.
2. Multiplied by a fixed number k
→ Mean is also multiplied by k .
Example: Double every value → Mean doubles.

Algebraic Rule

- Let values be $x_1, x_2, \dots, x_n$ with mean $a = \frac{x_1 + x_2 + \dots + x_n}{n}$
- Add k to every value:
New mean = $a + k$
- Subtract k from every value:
New mean = $a - k$
- Multiply every value by k :
New mean = ka

KEY DEFINITIONS

- **Mean (Average):** Sum of all values divided by the number of values.
- **Centre (Balance Point):** A value where the sum of distances of data on the left equals the sum on the right.
- **Dot Plot:** A way to display data using dots on a number line.



IMPORTANT FORMULAS

- Mean: $\bar{x} = \frac{x_1 + x_2 + \dots + x_n}{n}$
- When each value changes:
Add $k \rightarrow \text{Mean} = \bar{x} + k$
Subtract $k \rightarrow \text{Mean} = \bar{x} - k$
Multiply by $k \rightarrow \text{Mean} = k\bar{x}$



KEY TAKEAWAYS

- ✓ Mean is the centre that balances data.
- ✓ Adding values greater than the mean increases it; smaller values decrease it.
- ✓ Removing works in the opposite way.
- ✓ Adding/removing a value equal to the mean does not change it.
- ✓ Mean changes predictably when all values change together.



TALES BY DOTS AND LINES

Learning Outcomes:

LO1: Revisiting mean and median -and seeing how the mean behaves like a perfect balance point on a number line.

LO2: Exploring what happen to mean and median when values added, removed, or changed and proving it with algebra.

LO3: Using frequency tables to find the average family size -without writing every value out individually.

LO4: Using digital tools like Google Sheets or Excel to quickly compute sums and averages for datasets.

LO5: Reading and creating line graphs and infographics to spot trends, patterns, and stories hidden in data.

Competencies:

C1: Mathematical Reasoning: The ability to visualize and analyze data distributions ,rather than blindly memorizing, calculations, formulas.

C2: Analytical thinking : Evaluating how adding or removing specific values (such as extremely high or low number)impacts the overall average of the data set

C3: Data Visualization :Learning how to plot data using dot plot and lines to identify trends ,changes over time , and data distributions.

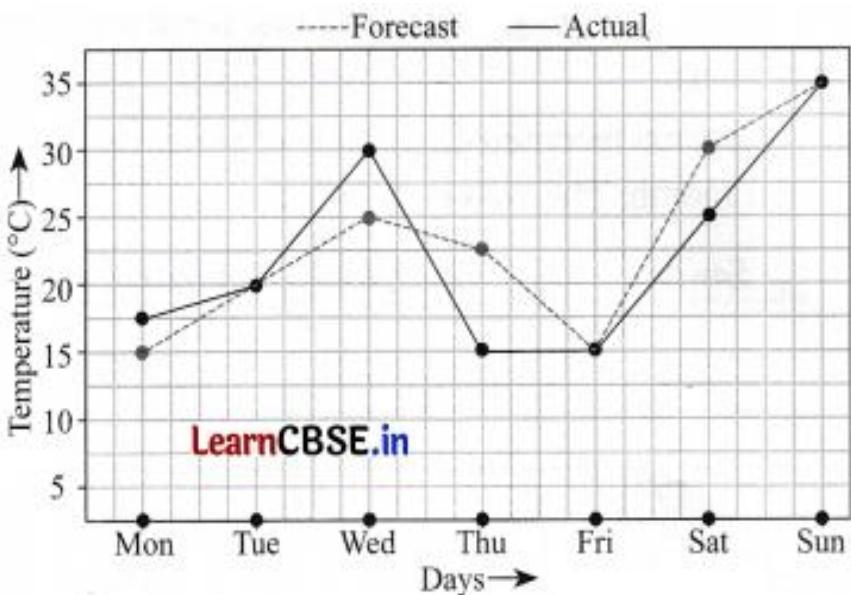
C4: Graphical Interpretation: Building the ability to read, interpret, and extract insights from line graphs.

Q. No	Question	LO	Competency
MCQs (One Mark Each)			
1.	Which term is called the ‘center of the data set’? (a) Dot plot (b) Mean (c) Median (d) Range	LO1	C1
2.	The median of the numbers 3, 6, 9, 12, and 15 is: (a) 6 (b) 9 (c) 12 (d) 15	LO1	C1
3.	The median of the data 12, 15, x, 20, 25, 30 is 17.5. The value of x is (a) 15 (b) 17.5 (c) 18 (d) 20	LO2	C2
4.	If every value in a data set is multiplied by 3, what happens to the mean? (a) The mean becomes three times the original mean (b) The mean increases by 3 (c) The mean is unchanged (d) The mean decreases by 3	LO2	C2
5.	Which type of graph is best suited to display and compare data that changes continuously over time? A) Bar graph	LO5	C4

	B) Line graph C) Pie chart D) Dot plot		
6.	If 1 is added to every student's recorded height in a class, how will it affect the average (mean) height of the class? A) The average will increase by 1 B) The average will decrease by 1 C) The average will not change D) The average will multiply by the number of students	LO2	C2
7.	1. For a dot plot of any two numbers, the arithmetic mean is always located: A) Closer to the smaller number B) Closer to the larger number C) Exactly halfway between the two numbers D) At the median of the two numbers [1]	LO1	C3
8	A line graph is used to show (a) Shapes (b) Areas (c) Pictures (d) Continuous change over time	LO5	C4
9	Which spreadsheet function is used to find the mean of data in cells A1 to A5? (a) = SUM (A1 : A5) (b) = MEDIAN (A1 : A5) (c) = AVERAGE (A1 : A5) (d) = COUNT (A1 : A5)	LO4	C1
10.	In a spreadsheet, the values in cells A1 to A10 represent the marks of students. Which formula will give the difference between the highest and lowest marks? (a) = MAX (A1 : A10) + MIN(A1 : A10) (b) = MAX (A1 : A10) – MIN (A1 : A10) (c) = AVERAGE (A1 : A10) (d) = COUNT (A1 : A10)	LO4	C2
2 Marks Questions			
11.	The mean of 6 numbers is 15. If one number is removed from the collection, the mean of the remaining numbers drops to 14. Find the value of the removed number.	LO2	C2
12.	Q12. A farmer calculates the average harvest per tree as 25.6 coconuts across 15 trees. His son reviews the ledger and finds that one tree's count was mistakenly recorded as 3 more than its actual value. Find the corrected average.	LO2	C2
13.	The median of observations 11, 12, 14, 18, $x + 2$, 22, 23, 25 and 61 arranged in ascending order is 21. Find the value of x ?	LO2	C1

14.	The mean of 100 observations was calculated as 40. It was found later that one of the observations was misread as 83, instead of 53. Find the correct mean?	LO2	C2
15.	The daily earnings (in ₹) of 9 workers in a factory are 8, 16, 19, 16, 8, 16, 19, 8 and 19. what will be the median wage?	LO1	C1
16	Find the Mean of the first 50 multiples of 4.	LO1	C1
17	Find the median of 8, 10, 19, 23, 26, 34, 40, 41, 41, 48, 51, 55, 70, 84, 91, 92.	LO1	C1
18	The mean of the numbers 8, 13, 10, 4, 5, 20, y, 10 is 10.375. Find the value of y.	LO2	C1
19	Check whether each of the statements below is true. Justify your reasoning. Use algebra, if necessary, to justify. (i) The average of two even numbers is even. (ii) The average of any two multiples of 5 will be a multiple of 5.	LO2	C1
20	The weights of 10 wrestlers are 42, 40, 39, 33, 48, 38, 42, 35, 32 and w. Their mean weight is 39.2 kg. Find the value of w and show the steps.	LO2	C1

3 MARKS QUESTIONS

21	The following graph shows the temperature forecast and the actual temperature for each day of a week.  (a) What was the maximum forecast temperature during the week? (b) What was the minimum actual temperature during the week? (c) On which day did the actual temperature differ the most from the forecast temperature?	LO5	C4
----	---	-----	----

22	The marks obtained by four students in a test are 24, 32, 28, and 36. Find the mean. How will the mean change if a student scoring 40 marks is included? Represent all the values on the dot slot after adding the new value.	LO2	C3																		
23	The average (mean) temperature in a city over 5 days was 28°C. The temperatures for 4 of the days were 25°C, 30°C, 26°C, and 32°C. What was the temperature on the 5th day?	LO2	C1																		
24	The table below shows the annual rainfall (in cm) recorded in two cities, P and Q, over a period of five years. <table><tr><th>Year</th><th>City P</th><th>City Q</th></tr><tr><td>2019</td><td>80</td><td>65</td></tr><tr><td>2020</td><td>85</td><td>70</td></tr><tr><td>2021</td><td>90</td><td>78</td></tr><tr><td>2022</td><td>88</td><td>75</td></tr><tr><td>2023</td><td>95</td><td>82</td></tr></table> Visualise this data on a line graph. What does the overall trend of rainfall in city Q show?	Year	City P	City Q	2019	80	65	2020	85	70	2021	90	78	2022	88	75	2023	95	82	LO5	C3
Year	City P	City Q																			
2019	80	65																			
2020	85	70																			
2021	90	78																			
2022	88	75																			
2023	95	82																			
25	The mean of the following data is 14. Find the value of k. <table><tr><td>x</td><td>5</td><td>10</td><td>15</td><td>20</td><td>25</td></tr><tr><td>f</td><td>7</td><td>k</td><td>8</td><td>4</td><td>5</td></tr></table>	x	5	10	15	20	25	f	7	k	8	4	5	LO3	C1						
x	5	10	15	20	25																
f	7	k	8	4	5																

5 Marks Questions

26	The following table shows the distance travelled (in km) by Car A and Car B in different 5 hours. <table><tr><td>Time(Hrs)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Car A</td><td>20</td><td>40</td><td>60</td><td>60</td><td>80</td></tr><tr><td>Car B</td><td>15</td><td>30</td><td>45</td><td>65</td><td>85</td></tr></table> (i) Draw a distance-time line graph for both cars on the same graph. (ii) During which hour was Car A at rest? (iii) Which car travelled more distance in total? (iv) At which hour did Car B overtake Car A?	Time(Hrs)	1	2	3	4	5	Car A	20	40	60	60	80	Car B	15	30	45	65	85	LO5	C4		
Time(Hrs)	1	2	3	4	5																		
Car A	20	40	60	60	80																		
Car B	15	30	45	65	85																		
27	Obtain the median for the following frequency distribution. <table><tr><td>x</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>y</td><td>8</td><td>10</td><td>11</td><td>16</td><td>20</td><td>25</td><td>15</td><td>9</td><td>6</td></tr></table>	x	1	2	3	4	5	6	7	8	9	y	8	10	11	16	20	25	15	9	6	LO3	C1
x	1	2	3	4	5	6	7	8	9														
y	8	10	11	16	20	25	15	9	6														

28	A dart-throwing competition was organized in a school. The number of throws participants took to hit the bull's eye (the center of circle) is given in the table below. Describe the data maximum, mean, and median. 	LO3	C2																						
<table><tr><td>No. of trials</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr><tr><td>No. of students</td><td>1</td><td>0</td><td>0</td><td>1</td><td>4</td><td>9</td><td>12</td><td>15</td><td>10</td><td>10</td></tr></table>				No. of trials	1	2	3	4	5	6	7	8	9	10	No. of students	1	0	0	1	4	9	12	15	10	10
No. of trials	1	2	3	4	5	6	7	8	9	10															
No. of students	1	0	0	1	4	9	12	15	10	10															

Case Study Based Questions

29	Mohit is making a multidisciplinary project on the topic population. His mathematics teacher asks him to compare the population of three cities from the year 2015 to 2020 and to visualize the data on a line graph. Mohit draws a line graph which shows the population (in thousands) of City A, City B, and City C from the year 2015 to 2020.  By making use of this graph help him to find the answers of following questions - Which city had the highest population in 2020? - Which city showed the fastest growth during the given period? - In which year did city B's population cross 450 thousand? - Compare the population growth of city C from 2015 to 2020. - What does the overall trend of the graph indicate?	LO5	C4
----	--	-----	----

30	Mrs. Anita, a mathematics teacher of Grade 8, conducted a unit test for her class. After correcting the answer sheets, she listed the marks (out of 50) scored by 11 students. 12,18, 20, 24, 26, 28, 30, 32, 35, 38, 47 She calculated the mean of the marks and found it to be 28. However, some students felt that the average score did not truly represent the performance of the class because one student scored much higher than the rest. Mrs. Anita decided to analyze the data further using the median and by examining, how the mean changes, when values are added or removed. On the basis of the above information, answer the following questions. (a) Find the median of the given marks and compare it with the mean. (b) If the highest score (47) is removed, state whether the mean will increase, decrease or remain the same. Justify your answer. (c) If a new student joins the class and scores 28 marks, what will be the new mean of the data? Explain your answer. (d) What do you observe about the mean when a value equal to the current mean is added to the data set?	LO2	C2
----	--	-----	----

ANSWERS

Q	1	2	3	4
Ans	b	b	a	a
Q	5	6	7	8
Ans	b	a	c	d
Q	9	10	11	12
Ans	c	b	20	25.4
Q	13	14	15	16
Ans	19	39.7	16	102
Q	17	18	19	20
Ans	41	13	(i) True (ii) True	43
Q	21	22	23	24
Ans	(a) 35°C (b) 15°C. (c) Thursday.	Mean 30 The mean increases as the newly added value is greater than the original mean.	27°C	(a) Draw line graph (b) The rainfall in city Q shows an overall increasing trend with a slight decrease in 2022.
Q	25	26	27	28
Ans	K=6	(i) self (ii) during the 4th hour (between 3 and 4 hours). (iii) Car B (iv) 4th hour	Median = 5	Minimum number of trials is 1. The Maximum number of trials is 10. Mean 7.6 trials Median = average of 31th and 32th terms
Q	29	30		
Ans	(i) City A (ii) City A (iii) In the year 2018. (iv) population of all three cities increased over time.	(a) Median = 28; it is almost equal to the mean (28.18). (b) Mean decreases to 26.3 when 47 is removed. (c) New mean = 28.17 (approximately). (d) Adding a value equal to the mean leaves the mean unchanged.		

Challenging Questions (Stage 1)

1. The mean of 5 numbers is 20. If four numbers are 12, 18, 25, 30 then find the fifth number.
2. The mean of a dataset (8, 3, 10, 13, 4, 6, 7, 7, 8, 8, 5) is 6.5. If every value in this dataset is increased by 10, explain logically what the new mean will be without calculating the sum of the new dataset.
3. A company advertises: "Average salary of employees is ₹60,000." The salaries are: ₹20,000, ₹22,000, ₹25,000, ₹28,000, ₹30,000, ₹35,000, ₹2,60,000. Would you use the mean or median to understand what a typical employee earns?
4. The mean of a dataset is 20. Every value in the dataset is multiplied by 3, and then 5 is added to each resulting value. Determine the new mean of the dataset and explain the mathematical rule used to arrive at your answer.
5. The mean of 10 numbers is 50. Later it is discovered that one number was recorded as 90 instead of 60. Find the correct mean.

Challenging Questions (Stage 2)

1. The mean of 5 observations is 15. If three new observations (10, 15, and 20) are added to the dataset, calculate the new mean. What does this indicate about adding data values that are equivalent to the mean?
2. A class has 15 students with a mean score of 40. A new student joins the class. After joining, the mean becomes 42. Find the new student's score.
3. A farmer calculates the average harvest per tree as 25.6 coconuts across 15 trees. Later, it is discovered that one tree's harvest count was recorded as 3 coconuts more than the actual number. What is the correct average harvest per tree?
4. Priya tracks the number of flowers bloomed in her garden. She calculates an average of 18 flowers per plant across 12 plants. Later, she finds that one plant's count was recorded 2 more than the actual. What is the correct average of flowers per plant?
5. A teacher measures the heights of 25 students. She finds the average (mean) height to be 150.5 cm. Later, she realizes she recorded one student's height as 132 cm instead of their actual height of 122 cm. Calculate the correct average height of the students.

Challenging Questions (Stage 3)

1. In a class, the average weight of 8 students is 39.2 kg. The weights of 7 students are 42, 40, 39, 33, 48, and 38 kg, and 42 kg. Find the weight of the 8th student.
2. A dataset has 5 values: 8, 12, x , 18, 22. If the mean of this dataset is 15, a student claims that removing the value of x will increase the overall mean. Is this claim correct? Show your working to justify your answer.
3. The following observations have been arranged in ascending order. If the median of the data is 63, find the value of x : 29, 32, 48, 50, x , $x + 2$, 72, 78, 84, 95.
4. A school cricket team plays 10 matches. The mean(average)score of their matches is 50 runs, and the median (middle score) is 48 runs. Later, the coach finds two mistakes in the scorebook. One score of 29 runs was actually 92 runs (a typing error) The score of a new 11th match was completely forgotten and left out. Let's call this missing score X When the coach fixes these mistakes and adds the 11th match. The new mean jumps up by 12 runs (it becomes 62 runs) The median stays exactly the same at 48 runs. Find the value of the missing score X .
5. Construct a set of 7 numbers whose: Mean = 20, Median = 25.

Answers (Challenging Questions)

	Q.1	Q.2	Q.3	Q.4	Q.5
Stage 1	15	16.5	Median	65	47
Stage 2	15	72	25.4	17.83	150.1
Stage 3	31.6	The claim is incorrect	62	$X=119$	One possible set of 7 numbers is: 10, 15, 15, 25, 25, 25, 25.

6

ALGEBRA PLAY

We use algebra to understand number tricks, create new tricks, and explore patterns in number pyramids.

In this chapter

- Algebra tricks & puzzles
- Thinking/about 'Think of a Number' tricks
- Number pyramids



Scan to learn more!

1. THE BALANCING ACT

Key Idea

The mean (average) is the 'centre' of the data. It balances the total distance of values on the left and right.

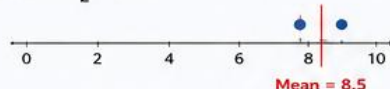
For 2 Numbers

Mean is exactly halfway between the two numbers.

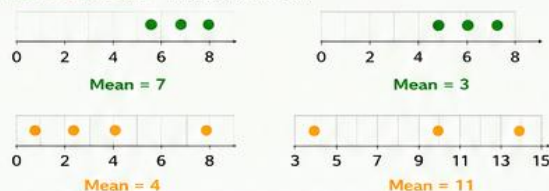
$$(3, 7) \rightarrow \text{Mean} = \frac{3+7}{2} = 5$$



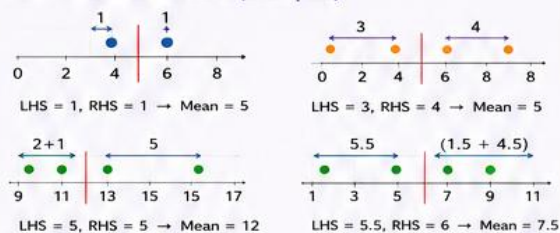
$$(8, 9) \rightarrow \text{Mean} = \frac{8+9}{2} = 8.5$$



For 3 Numbers – Mark the mean.

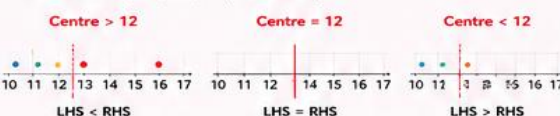


How Mean is the Centre (Examples)



Unique Centre

For the data 10, 10, 11, 17 (mean = 12)



Hence, the mean is the **only** centre.

4. HOW MEAN CHANGES

Add a value > mean	Mean increases.	
Add a value < mean	Mean decreases.	
Remove a value > mean	Mean decreases.	
Remove a value < mean	Mean increases.	
Add or remove value = mean	Mean does not change.	

Relatively Unchanged Mean

If every value changes by the same amount:

- Add k to every value $\rightarrow$ Mean increases by k .
- Subtract k from every value $\rightarrow$ Mean decreases by k .
- Multiply every value by $k \rightarrow$ Mean becomes k times.
- Divide every value by $k \rightarrow$ Mean becomes $\frac{1}{k}$ times.

Math Talk

2. THINKING ABOUT 'THINK OF A NUMBER' TRICKS

(A) Always 2 Trick

- Think of a number.
- Double it.
- Add four.
- Divide by two.
- Subtract the original number.

Algebraic Explanation

- x
- $2x$
- $2x + 4$
- $x + 2$
- $x + 2 - x = 2$

No matter what the starting number is, the result is always 2.

(B) Date Trick

- Think of a date (DD/MM).
- Multiply the month by 5.
- Add 6.
- Multiply by 4.
- Add 9.
- Multiply by 5.
- Add the day.

Algebraic Explanation

Let month = M , day = D

- $5M$
- $5M + 6$
- $20M + 24$
- $20M + 33$
- $100M + 165$
- $100M + 165 + D$

Final answer = $100M + 165 + D$

- Subtract 165 from final answer $\rightarrow 100M + D$
- Last two digits $\rightarrow D$ (day)
- Remaining digits $\rightarrow M$ (month)
- Example: $291 - 165 = 126 \rightarrow M = 1, D = 26 \rightarrow 26^{\text{th}}$ January

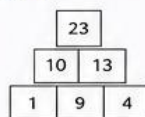
Explore & Create

- Try other dates and find the pattern.
- Change the steps (add, subtract, multiply etc.) to make new tricks.
- You can also aim for a fixed final answer like 3, 5, 10 and so on.

3. NUMBER PYRAMIDS

Rule: Each number is the sum of the two numbers directly below it.

Example



How to Fill?

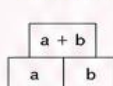
- To find a missing number, subtract the known number from the number above it.

Example:

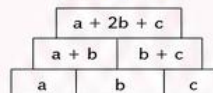


General Pattern

2-row pyramid



3-row pyramid



Observation

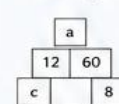
The top number = a weighted sum of the bottom row. (Middle numbers act as coefficients 1, 2, 1.)

Figure it Out

1. Fill the pyramids.



2. Given pyramid:



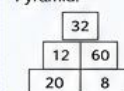
$$\begin{aligned} a + 12 &= 60 \\ 12 + c &= a \\ c + 8 &= 60 \end{aligned}$$

$$\Rightarrow c = 20, a = 32$$

3. Without building, find top number for given bottom row.

$$\begin{aligned} \text{Bottom row: } 4, 13, 8, 7, 11 &\rightarrow \text{Top} = 4 + 3 \times 13 + 3 \times 8 + 3 \times 7 + 11 = 84 \\ \text{Bottom row: } 8, 19, 21, 13, 7, 18 &\rightarrow \text{Top} = 8 + 2 \times 19 + 2 \times 21 + 2 \times 13 + 2 \times 7 + 18 = 146 \end{aligned}$$

(Coefficients: 1, 2, 2, ..., 2, 1)



KEY DEFINITIONS

- Mean (Average):** Sum of all values divided by the number of values.
- Centre (Balance Point):** Value where the sum of distances on the left equals the sum on the right.
- Dot Plot:** Data shown as dots on a number line.
- Number Pyramid:** Each number is the sum of the two numbers below it.

IMPORTANT FORMULAS

- Mean: $\bar{x} = \frac{x_1 + x_2 + \dots + x_n}{n}$
- After adding k : New mean = $\bar{x} + k$
- After subtracting k : New mean = $\bar{x} - k$
- After multiplying by k : New mean = $k\bar{x}$
- After dividing by k : New mean = $\frac{\bar{x}}{k}$

KEY TAKEAWAYS

- ✓ The mean balances data.
- ✓ Including/removing values changes the mean predictably.
- ✓ Algebra helps us understand tricks and invent new ones.
- ✓ In number pyramids, the top number is a weighted sum of the bottom row.
- ✓ Patterns in numbers can be explored and explained systematically.

ALGEBRA PLAY

Learning Outcomes

- LO1: Apply algebraic expressions to analyse mathematical tricks and puzzles.
 LO2: Solve logical and numerical problems using algebraic reasoning.
 LO3: Identify patterns and relationships in number pyramids, grids and number games.
 LO4: Use algebra to justify mathematical statements and verify results.
 LO5: Develop higher-order thinking, reasoning and problem-solving skills.

Competencies

- C1: Conceptual Understanding
 C2: Algebraic Reasoning
 C3: Critical Thinking
 C4: Problem Solving
 C5: Mathematical Communication

Q.No	Question	LO	Competency
MCQs (One Mark Each)			
1	A student thinks of a number x , triples it, adds 12 and divides the result by 3. Which expression is obtained before subtracting the original number? A. $x + 12$ B. $x + 4$ C. $3x + 4$ D. $x + 3$	LO1	C2
2	A number pyramid has bottom numbers 6, 9 and 4. What is the topmost number? A. 22 B. 28 C. 25 D. 30	LO2	C4
3	If the top row of a three-level number pyramid is represented by $a + 2b + c$, the coefficient of b is: A. 1 B. 2 C. 3 D. 4	LO3	C1
4	A 2×2 calendar block has top-left number n . The sum of the four numbers is: A. $4n + 8$ B. $4n + 16$ C. $2n + 16$ D. $4n + 14$	LO3	C2
5	To obtain the greatest product using three different digits, the largest digit should generally be used as the: A. Tens digit B. Ones digit C. Multiplier D. Smallest digit	LO4	C3
6	The difference between a two-digit number and its reverse is always divisible by: A. 7 B. 9 C. 10 D. 12	LO4	C2
7	Which branch of mathematics helps explain why number tricks always work? A. Geometry B. Algebra C. Data Handling D. Mensuration	LO1	C1
8	In a number pyramid, every box depends directly on: A. The top number B. The two boxes below it C. The left box only D. The right box only	LO2	C3
9	A mathematical trick gives the same answer for every starting number because the: A. Numbers are equal B. Variable gets eliminated C. Number becomes zero D. Operation changes	LO5	C2
10	Which of the following best develops algebraic thinking? A. Copying formulas B. Explaining why a trick works C. Learning tables D. Drawing figures	LO5	C5

Short Answer Type (Two Marks Each)

11	A student creates this trick: Think of a number $\rightarrow$ Multiply by 4 $\rightarrow$ Add 20 $\rightarrow$ Divide by 4 $\rightarrow$ Subtract the original number. Predict the final answer without choosing any number. Justify your answer algebraically.	LO1	C2
12	The bottom row of a number pyramid is 7, x, 9 and the top number is 34. Find the value of x.	LO2	C4
13	A number is multiplied by 4 and then 7 is added. The result is 39. Find the number.	LO1	C3
14	A 2×2 calendar block has a total sum of 100. Find the four numbers in the block using algebra.	LO3	C2
15	Form the greatest possible product using the digits 2, 6 and 8 (use each digit only once). Explain your choice in one or two steps.	LO4	C3
16	A two-digit number is represented by $10a + b$. Write the algebraic expression for the number obtained after reversing its digits.	LO2	C1
17	In an algebra grid, $\star + \blacktriangle = 24$ and $\blacktriangle = 9$. Find the value of $\star$. Then verify your answer.	LO2	C4
18	The perimeter of a rectangle is 74 cm. Its length is 9 cm more than its breadth. Find its dimensions.	LO5	C5
19	The difference between two consecutive odd numbers is always 2. If their sum is 84, find the numbers.	LO5	C5
20	A student claims that arranging the remaining digits in decreasing order always helps in obtaining the greatest product when the largest digit is used as the multiplier. Verify the claim using the digits 4, 5 and 9.	LO4	C3

Short Answer Type (Three Marks Each)

21	A student designs this trick: Think of a number $\rightarrow$ Multiply by 5 $\rightarrow$ Add 15 $\rightarrow$ Divide by 5 $\rightarrow$ Subtract the original number. Prove algebraically that the final answer is always the same.	LO1	C2
22	The bottom row of a number pyramid is x, 8, 5. If the top number is 35, find x and complete the pyramid.	LO2	C4
23	The cost of 5 pens and 3 pencils is ₹81. If each pencil costs ₹7, find the cost of one pen.	LO3	C3
24	Show algebraically that the difference between any two-digit number and its reverse is always divisible by 9.	LO4	C2
25	Using the digits 4, 6 and 8, verify algebraically why the largest digit should be used as the multiplier to obtain the greatest product.	LO4	C3

Long Answer Type (Five Marks Each)

26	A fruit seller spends ₹1200 as a fixed daily expense and ₹18 on each fruit basket. If he sells each basket for ₹30, how many baskets must he sell to earn a profit of ₹600? Form an algebraic equation and solve it.	LO4	C4
27	A father is 4 times as old as his son. After 8 years, the father will be twice the son's age. Find their present ages using algebra.	LO4	C4
28	Decode the puzzle and find the final value. $\begin{array}{c} \blacktriangle + \blacktriangle + \blacktriangle = 6 \\ \blacktriangle + \blacktriangle + \bullet = 13 \\ \blacklozenge + \blacklozenge + \bullet = 17 \\ \blacklozenge \blacklozenge + \blacktriangle \times \bullet \bullet = ? \end{array}$	LO5	C5

Case Study Based

29	Aarav created a number pyramid in which each box is the sum of the two boxes below it. The bottom row is 8, x, 6 and the top number is 38. Answer the following: (a) Form an algebraic equation for the top number. (b) Find the value of x. (c) Complete the pyramid. (d) State one rule of a number pyramid.	LO2, LO3	C2, C4
30	Mehak chooses a 2×2 block from a calendar. She tells her friend that the sum of the four numbers is 124. Answer the following: (a) Let the top-left number be x. Write the algebraic expression for the sum. (b) Find the value of x. (c) Write the four numbers in the block. (d) Explain why this method works for every calendar.	LO3, LO4	C2, C5

ANSWERS

Q.	1	2	3	4	5
Ans.	B	B	B	B	C
Q.	6	7	8	9	10
Ans.	B	B	B	B	B
Q.	11	12	13	14	15
Ans.	5	9	8	21, 22, 28, 29	496
Q.	16	17	18	19	20
Ans.	$10b + a$	$\star = 15$	L- 23cm, B- 14cm	41, 43	486
Q.	21	22	23	24	25
Ans.	Final answer is always 3	$x = 7$; Middle row = 15, 13; Top = 28	₹12	Difference = $9(a - b)$ or $9(b - a)$ hence divisible by 9	Greatest product = 512
Q.	26	27	28	29	30
Ans.	150 baskets	Father = 32 years, Son = 8 years	44	(a) $8 + 2x + 6 = 38$ (b) $x = 12$ (c) Middle row = 20, 18; Top = 38 (d) Each upper box is the sum of the two boxes below it.	(a) $4x + 16 = 124$ (b) $x = 27$ (c) 27, 28, 34, 35 (d) Calendar numbers differ by 1 horizontally and 7 vertically, so the algebraic relation remains fixed.

Challenging Questions (Stage 1)

1. The sum of two consecutive even numbers is 66. Find the numbers.
2. The bottom row of a number pyramid is 5, x, 8. If the top number is 31, find x without constructing the entire pyramid.
3. A 2×2 calendar block has a sum of 84. Find the four numbers.
4. Arrange the digits 2, 5 and 8 to obtain the greatest possible product. Explain your reasoning.
5. A two-digit number and its reverse differ by 45. Write one possible pair of numbers and verify the divisibility property.

Challenging Questions (Stage 2)

1. Three times a number decreased by 5 is equal to twice the number increased by 7. Find the number.
2. The bottom row of a four-level number pyramid is 4, x, 7, 9. If the top number is 58, determine the value of x.
3. A 2×2 calendar block has a sum of 156. Without trial and error, determine all four numbers using algebra.

4. Four different digits 3, 5, 7, 9 are to be arranged to form a three-digit number $\times$ one-digit number. Find the arrangement that gives the greatest product and justify your answer.
5. A two-digit number has digits differing by 5. When the digits are reversed and the smaller number is subtracted from the larger one, what is the result?

Challenging Questions (Stage 3)

1. The present age of a father is three times the age of his son. After 8 years, the father will be 44 years old. Find their present ages.
2. A number pyramid has bottom numbers a, b, c, d, e. Derive a general algebraic expression for the topmost number in terms of a, b, c, d and e.
3. The sum of three consecutive integers is 99. Find the integers.
4. A shopkeeper has a fixed daily expense of ₹1800 and spends ₹35 on each item sold. He wants a profit of ₹1500 by selling the items at ₹65 each. Form an algebraic equation and determine the minimum number of items he should sell.
5. A number is increased by 25%. The new number is 100. Find the original number using an equation.

Answer (Challenging Questions)

	1	2	3	4	5
Stage 1	32, 34	$x = 9$	17, 18, 24, 25	$52 \times 8 =$ 416	Example: 81 and 36 (difference = 45, divisible by 9)
Stage 2	12	$x = 2$	35, 36, 42, 43	$753 \times 9 =$ 6777	45
Stage 3	36,12	Top $= a + 4b + 6c + 4d + e$	32,33, 34	165 items	80

7

AREA

Algebra helps us explore patterns, solve puzzles and create tricks. In this chapter we use it to understand areas and number pyramids.

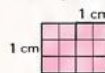
In This Chapter

- ✓ Area of rectangles and squares
- ✓ Why perimeter is not a measure of area
- ✓ Finding missing lengths and areas
- ✓ Area around shapes (paths)
- ✓ Number pyramids



Key Idea

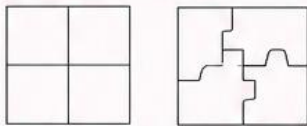
Area is the amount of surface enclosed by a shape. We measure it using unit squares.



Area of 1 square = 1 sq. cm
Area of N squares = N sq. cm or $N \text{ cm}^2$

1. RECTANGLES AND SQUARES

- Many ways to divide a square into 4 equal parts!



- Area can change shape but remains the same.

Area of a Rectangle

Area = length $\times$ width
(or length $\times$ breadth)

Units: sq. unit (or unit)

Example:



Area of a Triangle

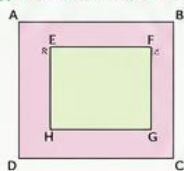
- A diagonal of a rectangle divides it into two congruent triangles.
- Area of each triangle = $\frac{1}{2} \times \text{length} \times \text{width}$

Example: $\frac{1}{2} \times 7 \times 4 = 14 \text{ sq. cm}$



4. AREAS AROUND SHAPES (PATHS)

(i) Path around a rectangular park

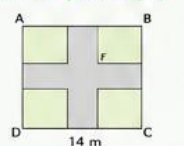


Two ways to find area of the path

Method 1:
Area(Path) = Area(ABCD) - Area(EFGH)

Method 2:
If width of path = x ,
Outer: length = L , breadth = B
Inner: length = $(L - 2x)$, breadth = $(B - 2x)$

(ii) Cross path in a plot



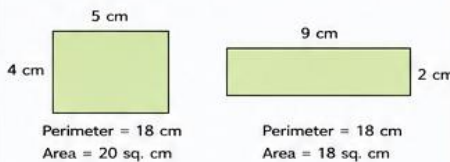
Break the path into rectangles.

If vertical width = x ,
horizontal width = y .

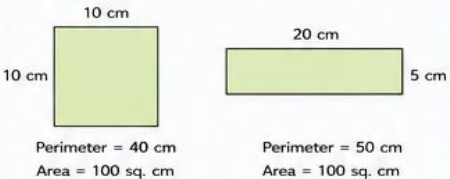
Area(Path) = $14x + 12y - xy$
(subtract the overlap xy counted twice)

2. WHY PERIMETER IS NOT A MEASURE OF AREA

- Same perimeter, different areas:



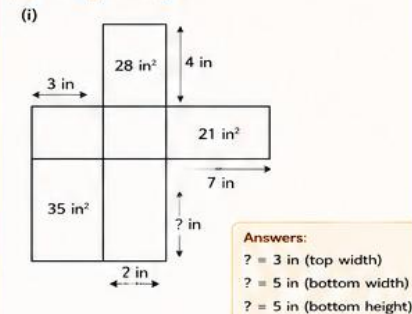
- Larger perimeter, smaller area:



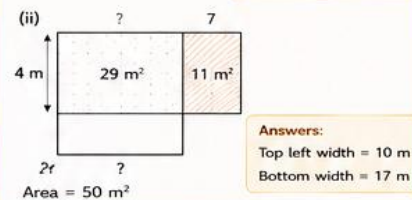
Hence, perimeter does not tell us the area.
Area depends on how much surface is enclosed inside the boundary.

3. FIGURE IT OUT

(a) Missing Sidelengths



Answers:
? = 3 in (top width)
? = 5 in (bottom width)
? = 5 in (bottom height)

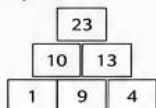


Answers:
Top left width = 10 m
Bottom width = 17 m

5. NUMBER PYRAMIDS

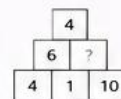
Rule: Each number is the sum of the two numbers directly below it.

Example



How to Fill?

- Work from bottom to top to find known numbers.
- Work from top to bottom to find missing numbers by subtraction.



? = 6 - 4 = 2
(top - left bottom)

General Pattern

For bottom row: a, b, c

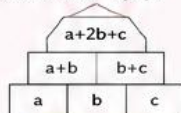
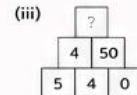
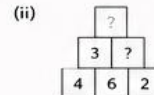
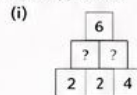


Figure it Out!

1. Fill the pyramids.



Write expression for top of a 4-row pyramid in terms of bottom row a, b, c, d .

Top = $a + 3b + 3c + d$ (Coefficients: 1, 3, 3, 1)

6. HOW THE MEAN CHANGES

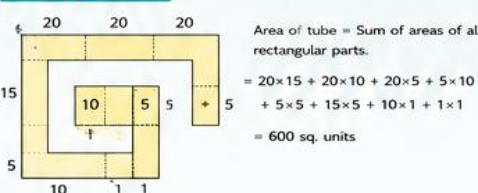
Operation on data	Effect on mean	Example (mean = 10)
Add a value $>$ mean	Mean increases	Add 20 $\rightarrow$ mean $>$ 10
Add a value $<$ mean	Mean decreases	Add 2 $\rightarrow$ mean $<$ 10
Remove a value $>$ mean	Mean decreases	Remove 20 $\rightarrow$ mean $<$ 10
Remove a value $<$ mean	Mean increases	Remove 2 $\rightarrow$ mean $>$ 10
Add or remove value = mean	Mean unchanged	Add or remove 10 $\rightarrow$ mean = 10

Relatively Unchanged Mean

- Add k to every value $\rightarrow$ mean increases by k .
- Subtract k from every value $\rightarrow$ mean decreases by k .
- Multiply every value by $k \rightarrow$ mean becomes k times.
- Divide every value by $k \rightarrow$ mean becomes $\frac{1}{k}$ times.

Math Talk

7. SPIRAL TUBE



Area of tube = Sum of areas of all rectangular parts.
 $= 20 \times 15 + 20 \times 10 + 20 \times 5 + 5 \times 10$
 $+ 5 \times 5 + 15 \times 5 + 10 \times 1 + 1 \times 1$
 $= 600 \text{ sq. units}$

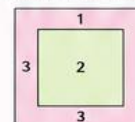
Straight tube with same area

If width = 5, then required length = $600 \div 5 = 120$ units.

8. MORE EXPLORATIONS

1. Doubling the side of a square:

- Region 1 (outer square) $\rightarrow$ 4 times area
- Region 2 (inner square) $\rightarrow$ 4 times area
- Region 3 (frame) $\rightarrow$ 4 times area



2. Rearranging 4 equal parts:

- Cut square into 4 equal parts.
- Rearrange to get a larger square with a square hole in the centre.



KEY DEFINITIONS

- **Area:** The amount of surface enclosed by a shape, measured in square units.
- **Perimeter:** The total length of the boundary of a shape.
- **Unit Square:** A square with side 1 unit (area = 1 sq. unit).

IMPORTANT FORMULAS

- Area of rectangle = length $\times$ width
- Area of square = side $\times$ side = side²
- Area of triangle (from rectangle) = $\frac{1}{2} \times \text{length} \times \text{width}$
- Path around rectangle (method 1):
Area = Outer rectangle - Inner rectangle
- Path (cross) in a plot: Area = $14x + 12y - xy$
(x = vertical width, y = horizontal width)

KEY TAKEAWAYS

- ✓ We measure area using unit squares.
- ✓ Perimeter cannot determine area.
- ✓ Algebra helps us find unknown lengths and areas.
- ✓ In number pyramids, each number is the sum of the two below.
- ✓ Mean changes in predictable ways with operations on data.
- ✓ Patterns in numbers can be explored using algebra.

AREA

Learning Outcomes:

LO1: Distinguishing Area from Perimeter

LO2: transforming geometric shapes without altering their total area.

LO3: calculation of the areas of fundamental geometric shapes—including triangles, parallelograms, rhombuses, and trapeziums.

LO4: Polygon Deconstruction (Learners find the area of any irregular or complex polygon by systematically decomposing (splitting) it into simpler components like triangles and rectangles)

Competencies:

C1: Critical thinking

C2: Spatial Reasoning & Visualization

C3: Mathematical Modelling and Problem Solving

C4: Conceptual Understanding

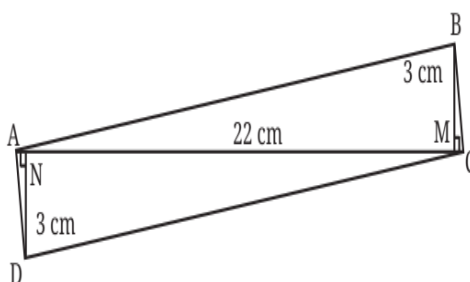
Q.No	Question	LO	Competency
MCQs (One Mark Each)			
1	The area of a square is 64 sq units. What is the perimeter of the square? (a) 16 units (b) 24 units (c) 32 units (d) 64 units	LO1	C1, C4
2	A triangle and a rectangle have the same base and height. The area of the triangle is 30 sq units. What is the area of the rectangle? (a) 15 sq units (b) 30 sq units (c) 45 sq units (d) 60 sq units	LO3	C4
3	A triangular region is formed by joining diagonal points of three identical squares, the area of the triangle depends mainly on (a) perimeter of the square (b) sidelength of the square (c) shape of the triangle only (d) position of the square	LO2	C2
4	If the side of a square is doubled, its area becomes (a) doubled (b) tripled (c) four times (d) eight times	LO2	C1
5	Which of the following statements is true? (a) Regions with larger perimeter always have larger area. (b) Regions with same area have same perimeter. (c) Regions with equal perimeter can have different areas. (d) Area and perimeter are always proportional.	LO1	C1

6	One diagonal of a rhombus is 24 cm. If its area is 120 sq cm, find the length of the other diagonal. (a) 10 cm (b) 5 cm (c) 20 cm (d) 15 cm	LO3	C3
7	The area of a trapezium is 180 sq cm and its height is 9 cm. If the two parallel sides differ by 4 cm, find the length of the smaller parallel side. (a) 18 cm (b) 22 cm (c) 20 cm (d) 16 cm	LO3	C3
8	A regular polygon can be divided into a central rectangle and two congruent trapeziums on either side. What is the total area if the rectangle has dimensions 10 cm $\times$ 4 cm and each trapezium has parallel sides of 10 cm and 4 cm with a height of 3 cm? (a) 82 sq cm (b) 61 sq cm (c) 124 sq cm (d) 72 sq cm	LO4	C2
9	The floor of a community hall requires 2000 repeating rhombus-shaped tiles. Each tile has diagonals measuring 40 cm and 25 cm. Find the total cost of polishing the floor at the rate of Rs 5 per sq m. (a) Rs 500 (b) Rs 5000 (c) Rs 1000 (d) Rs 250	LO3	C3
10	If the area of a general quadrilateral is 420 sq cm and its long main diagonal is 28 cm, what is the sum of the two perpendicular offsets dropped from the remaining opposite vertices? (a) 30 cm (b) 15 cm (c) 60 cm (d) 25 cm	LO4	C3
Short Answer Type (Two Marks Each)			
11	A rectangular garden is 18 m long and 12 m wide. Find its area.	LO3	C4
12	A square playground has a side of 16 m. Find its area.	LO3	C4
13	Find the area of a triangle whose base is 14 cm and height is 9 cm.	LO3	C4
14	A parallelogram has a base of 15 cm and a corresponding height of 8 cm. Find its area.	LO3	C4
15	Find the area of a rhombus whose diagonals are 18 cm and 24 cm.	LO3	C4
16	A trapezium has parallel sides measuring 10 cm and 16 cm, and its height is 7 cm. Find its area.	LO3	C4
17	A rectangular park measures 30 m $\times$ 20 m. A path of uniform width is made inside the park, leaving an inner rectangle of 24 m $\times$ 14 m. Find the area of the path.	LO4	C3

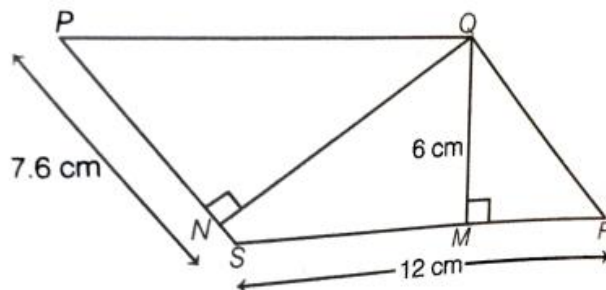
18	A triangular field has a base of 25 m and an area of 200 m^2 . Find its height.	LO3	C3
19	A rectangular sheet of paper measures $24 \text{ cm} \times 18 \text{ cm}$. A square of side 6 cm is cut from one corner. Find the remaining area of the sheet.	LO4	C2
20	A polygon is divided into three triangles having areas 18 cm^2 , 25 cm^2 , and 32 cm^2 . Find the total area of the polygon	LO4	C2

Short Answer Type (Three Marks Each)

21	The area of a trapezium is 1584 cm^2 and the distance between its parallel sides is 36 cm. If one of the parallel sides is 48 cm, find the length of the other parallel side	LO3	C3
22	The diagonals of a rhombus are in the ratio 3 : 4. If its area is 2400 m^2 , find the lengths of both diagonals.	LO3	C3
23	Find the area of the quadrilateral ABCD given that $AC = 22 \text{ cm}$, $BM = 3 \text{ cm}$, $DN = 3 \text{ cm}$, BM is perpendicular to AC , and DN is perpendicular to AC .	LO4	C2

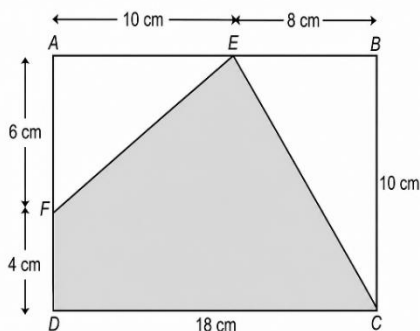


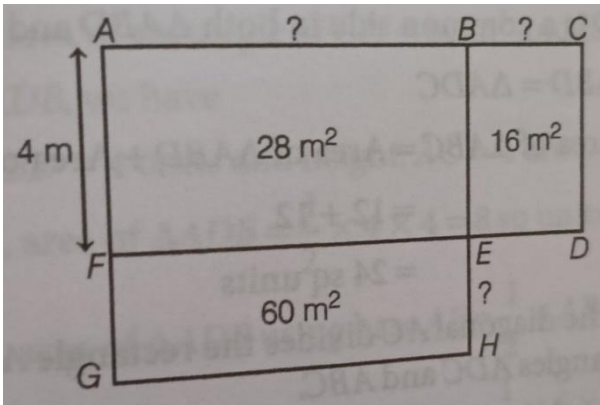
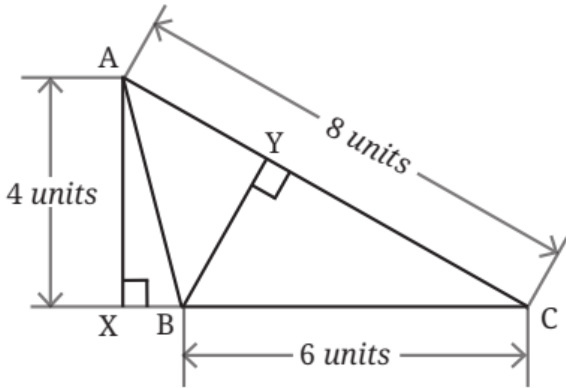
24	The area of a trapezium-shaped field is 10500 m^2 . One parallel side is double the other. The perpendicular distance between them is 100 m. Find the lengths of both parallel sides.	LO3	C3
25	Find QN.	LO3	C2



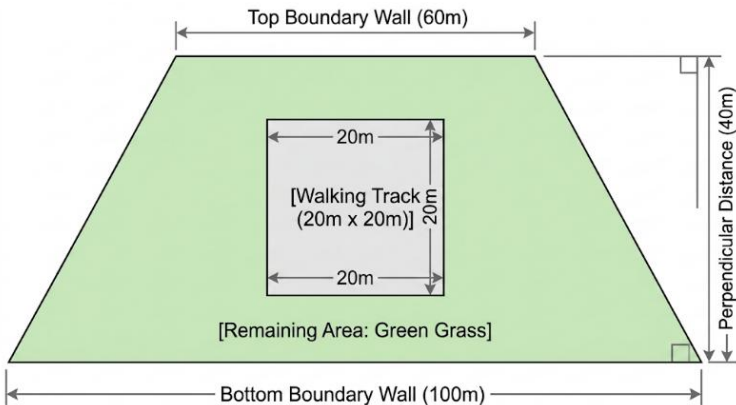
Long Answer Type (Five Marks Each)

26	Find the area of the shaded region given that ABCD is a rectangle	LO4	C2
----	---	-----	----



27	Identify the missing side lengths 	LO2	C2
28	Find the length of the altitude BY 	LO3	C3

Case Study Based

29	Design of a Modern School Park The management of PM SHRI School decided to renovate a vacant plot inside the school campus into an eco-friendly student park. The structural layout of the park is planned in the shape of a large trapezium. 	LO3, LO4	C3,C4
----	--	-------------	-------

	The two parallel boundary walls of the park measure 60m and 100m respectively. The perpendicular distance between these two parallel boundaries is 40m. Inside this park, a central square walking track of side 20m is developed using red bricks, while the remaining part of the plot is covered with green grass. Based on the above information, answer the following questions: 1. What is the total area of the trapezium-shaped school park plot? (1 Mark) 2. Find the area of the plot that is covered with green grass. (1 Mark) 3. If the cost of laying bricks on the walking track is Rs 25 per m^2. find the total budget required for the walking track. (2 Mark)		
30	Designing Decorative Flooring Tiles An architectural firm is designing a grand assembly floor using specialized geometric tiles. Each individual tile is crafted in the shape of a rhombus. The lengths of the two diagonals of each tile are 30cm and 40 cm The entire assembly floor requires exactly 1500 of these identical repeating tiles to completely cover the surface without any gaps or overlaps. Based on the above information, answer the following questions: 1. Find the surface area covered by a single rhombus-shaped tile in cm^2. 1 mark 2. What is the total surface area of the assembly floor in square meters (m^2) 2 Marks 3. If a decorative boundary border is to be placed around one tile, find the perimeter of a single tile. 1 Marks	LO1, LO3	C1,C3,C4

ANSWERS

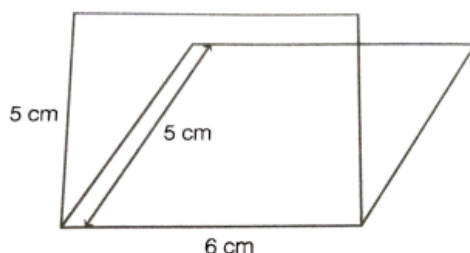
Q.	1	2	3	4	5
Ans.	c	d	b	c	c
Q.	6	7	8	9	10
Ans.	a	a	a	a	a
Q.	11	12	13	14	15
Ans.	216 m ²	256 m ²	63 cm ²	120	216cm ²
Q.	16	17	18	19	20
Ans.	91 cm ²	264 m ²	16 m	396 cm ²	75 cm ²
Q.	21	22	23	24	25
Ans.	40 cm	60m and 80m	66 cm ²	70 m and 140 m	9.47 cm
Q.	26	27	28	29	30
Ans.	110 cm ²	AB= 7cm BC = 4cm EH=15cm	BY = 3 units	1)3,200 m ² 2)2,800 m ² 3. Rs 10,000	1)600 cm ² 2) 90 m ² 3.) 100 cm

Challenging Questions (Stage 1)

- 1.A trapezium has parallel sides 36 cm and 54 cm. Its area is 810 cm². Find its height. If a square of side 9 cm is cut from it, find the remaining area.
- 2.A rhombus has diagonals 24 cm and 18 cm. Find its area. If each side is bordered with ribbon, find its perimeter.
- 3.A triangle and a parallelogram have equal areas. The triangle has base 20 m and height 12 m. Find the height of the parallelogram whose base is 15 m.
- 4.A quadrilateral is divided by a diagonal of 16 cm. The perpendicular distances from the other two vertices are 8 cm and 10 cm. Find its area.
- 5.A rectangular park 28 m × 20 m has a semicircular flower bed on one shorter side. Find the total area (Take $\pi = 22/7$).

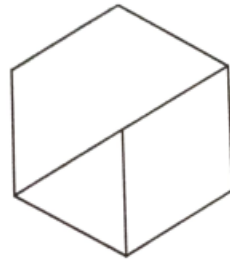
Challenging Questions (Stage 2)

- 1.A trapezium has area 1840 m². The parallel sides are in the ratio 3:5 and differ by 20 m. Find the sides and height.
- 2.The diagonals of a rhombus are in the ratio 5:12. Its area is 1350 cm². Find the perimeter.
- 3.A triangular field and a trapezium have equal areas. Determine the missing height of the trapezium.
- 4.A composite figure consists of a rectangle and two congruent triangles. Find the total area from the given dimensions.
- 5.Consider a rectangle and a parallelogram of the same side lengths 6cm and 5 cm . which has the greater area

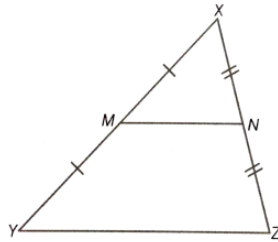


Challenging Questions (Stage 3)

1. A regular hexagon is divided into a trapezium, an equilateral triangle and a rhombus as shown in a figure. Find ratio of their areas



2. If M and N are the mid-points of XY and XZ, what fraction of the area of $\triangle XYZ$ is the area of $\triangle XMN$?



3. The diagonals of a rhombus-shaped decorative tile are in the ratio 3:4. A designer decides to increase the shorter diagonal by 10 cm and decrease the longer diagonal by 10 cm to form a new quadrilateral.

(a) If the area of the original tile was 2400 cm^2 , find the side length and perimeter of the original rhombus.

(b) What geometric shape is formed after modifying the diagonals? Calculate the change in total surface area.

4. A rectangular sports ground inside a school measures $120 \text{ m} \times 80 \text{ m}$. Cross-paths of width 5 m run through the center (parallel to length and breadth). Four congruent quadrant-shaped flower beds of radius 14 m are at the inner corners.

(a) Find the total area covered by the gravel cross-paths.

(b) Calculate the remaining area of the field left as open green grass. (Take $\pi = 22/7$)

5. A trapezium plot has parallel sides in the ratio 4:7. The height is half the length of the shorter parallel side.

(a) If turfing the plot at Rs 15 per m^2 costs Rs 49,500, determine the lengths of the parallel sides and height.

(b) If height doubles while parallel sides remain constant, how does the cost change? Find the ratio.

Answer (Challenging Questions)

	1	2	3	4	5
Stage 1	height=18cm Remaining Area = 729 cm ²	Area = 216 cm ² Perimeter =60cm	height = 8 m	144 cm ²	Total Area 717.14 m ²
Stage 2	Sides= 30 m and 50 m h = 46 m	26x, 174.41 cm	$h = (b_t \times h_t) \div (a + b)$	Total Area = (L×B) + (b×h)	Rectangle has greater area
Stage 3	3:1:2	area of $\triangle XMN$ = $\frac{1}{4}$ area of $\triangle XYZ$	a)Side = 50 cm. Perimeter = 200 cm. b)Square Change in Area = 50 cm ² (Increase)	a)Total Track Area = 975 m ² Remaining Grass Area = 8,009 m ²	a)Height = 34.64 m b) ratio of the original cost to the new cost is 1:2