UNIQUE STUDY POINT

By Sumeet Sahu

www.uniquestudyonline.com

Unique Study Point, Amitesh Nagar, Indore, MP | Contact: 8103405051

Class: VI	**Subject:** Mathematics	**Session:** 2025-26
Chapter: 01 - Patterns in Mathematics	**Time:** 1½ Hours	**Max. Marks:** 40

General Instructions:

1. All questions are compulsory.
2. This question paper contains 20 questions divided into five sections A, B, C, D and E.
3. Section A contains 10 MCQs of 1 mark each.
4. Section B contains 4 questions of 2 marks each.
5. Section C contains 3 questions of 3 marks each.
6. Section D contains 1 question of 5 marks.
7. Section E contains 2 Case Study Based questions of 4 marks each.

SECTION A - Multiple Choice Questions (1 mark each)

1. The sum of first n odd numbers equals:

(a) n

(b) 2n

(c) n^2

(d) 2n-1

2. Which sequence starts at 3 instead of 1?

(a) Square numbers

(b) Regular polygons (number of sides)

(c) Triangular numbers

(d) Powers of 2

3. A polygon with 10 sides is called a:

(a) Nonagon

(b) Decagon

(c) Undecagon

(d) Dodecagon

4. In the Virahānka sequence, the 7th term is:

(a) 13

(b) 21

(c) 34

(d) 55

5. The 5th triangular number is:

(a) 10

(b) 12

(c) 15

(d) 18

6. What is 2^5?

(a) 10

(b) 16

(c) 25

(d) 32

7. Which of the following is the 6th term in the sequence 1, 4, 9, 16, 25, ...?

(a) 30

(b) 32

(c) 36

(d) 42

8. How many lines are in Complete Graph K3?

(a) 2

(b) 3

(c) 4

(d) 6

9. The explanations for why patterns exist in mathematics:

(a) Are not important

(b) Are as important as finding the patterns

(c) Cannot be found

(d) Are easy to understand

10. The number 125 belongs to which sequence?

(a) Square numbers

(b) Triangular numbers

(c) Cube numbers

(d) Hexagonal numbers

SECTION B - Short Answer Questions (2 marks each)

11. Give two examples of how mathematics has helped propel humanity forward in technology or science.

12. What is the relationship between the number of sides and corners in any regular polygon? Why does this relationship exist?

13. Calculate the 6th hexagonal number using the formula: Multiply the corresponding triangular number by 6 and add 1.

14. In the Koch Snowflake sequence, the first shape has 3 line segments. How many line segments does the second shape have? Explain.

SECTION C - Short Answer Questions (3 marks each)

15. Prove using addition that the sum of the first 6 odd numbers equals 6^2. Show all your steps.

16. Complete the following sequences and identify each one:

(a) 1, 8, 27, __, __, 216

(b) 1, 3, __, 10, 15, __

(c) 1, 2, 4, 8, __, __

17. In the Complete Graph sequence K2, K3, K4, K5, ..., verify that the number of lines follows the triangular number pattern by calculating lines for K2, K3, and K4.

SECTION D - Long Answer Question (5 marks)

18.

(a) Calculate the sum: (1×6)+1, (3×6)+1, (6×6)+1, (10×6)+1. What sequence of numbers do you get?

(b) Explain why multiplying triangular numbers by 6 and adding 1 gives hexagonal numbers.

(c) Use this pattern to find the 7th hexagonal number without drawing the hexagon.

SECTION E - Case Study Based Questions (4 marks each)

19.

Case Study 1: Seating Arrangement Pattern

A school auditorium has seats arranged in a triangular pattern. The first row has 1 seat, the second row has 2 seats, the third row has 3 seats, and so on. Additionally, the auditorium also has a square seating section where the first section has 1 seat, the second section has 4 seats (2×2), the third has 9 seats (3×3), and so on.

Based on this case study, answer the following questions:

(i) How many seats are in the first 8 rows of the triangular section combined? (1 mark)

(ii) How many seats are in the 9th square section? (1 mark)

(iii) If the school adds the 8th triangular section and the 8th square section together, how many total seats would that be? Is this number special? (2 marks)

20.

Case Study 2: Fibonacci in Nature

The Virahānka sequence (also known as Fibonacci sequence) appears in nature in many ways - in the spiral patterns of shells, the arrangement of sunflower seeds, and the branching of trees. In this sequence: 1, 2, 3, 5, 8, 13, 21, 34, ..., each number is the sum of the previous two.

Based on this case study, answer the following questions:

(i) What is the 10th term in the Virahānka sequence? (1 mark)

(ii) If you add the first 5 terms of this sequence, what do you get? (1 mark)

(iii) There is an interesting relationship: When you add up Virahānka numbers 1+2+3+5+8, you get 19, and the next Virahānka number after 8 is 13. What do you notice about 19 compared to 21 (which is 8+13)? Can you verify if the sum of first n Virahānka numbers is always related to the (n+2)th term? (2 marks)

DETAILED ANSWER KEY - PAPER 04

SECTION A - Answers to MCQs

1. (c) n^2

The sum of first n odd numbers equals n^2. For example: $1+3+5+7=16=4^2$.

2. (b) Regular polygons (number of sides)

Regular polygons start from triangle (3 sides), then quadrilateral (4 sides), etc.

3. (b) Decagon

A decagon has 10 sides and 10 corners.

4. (b) 21

Sequence: 1, 2, 3, 5, 8, 13, 21. Each term = sum of previous two.

5. (c) 15

5th triangular number = 1+2+3+4+5 = 15.

6. (d) 32

$2^5 = 2\times2\times2\times2\times2 = 32$.

7. (c) 36

6th square number = $6^2 = 36$.

8. (b) 3

K3 has 3 vertices, each connected to the other 2: 3 lines total (triangular number).

9. (b) Are as important as finding the patterns

Understanding why patterns exist is crucial for applying them beyond their original context.

10. (c) Cube numbers

$125 = 5^3 = 5\times5\times5$.

SECTION B - Answers to Short Answer Questions

11.

Example 1: Understanding patterns in the motion of celestial bodies led to the development of the theory of gravitation, which helped humanity launch satellites and send rockets to the Moon and Mars.

Example 2: Understanding patterns in genomes (using mathematical analysis) has helped in diagnosing and curing diseases, advancing medical science significantly.

Other examples include: building bridges and complex structures, developing computers and mobile phones, creating weather prediction systems, etc.

12.

Relationship: In any regular polygon, the number of sides always equals the number of corners (vertices).

Why: A polygon is formed by connecting points (corners) with straight line segments (sides). Each side connects exactly two corners, and each corner is where exactly two sides meet. In a closed polygon, this creates a one-to-one correspondence between sides and corners, making their counts equal.

13.

First, find the 6th triangular number:

$T_6 = 1 + 2 + 3 + 4 + 5 + 6 = 21$

Now apply the formula:

6th Hexagonal number = $(T_6 \times 6) + 1$

$= (21 \times 6) + 1$

$= 126 + 1$

$= 127$

14.

In Koch Snowflake sequence:

First shape: 3 line segments (an equilateral triangle)

Second shape: 12 line segments

Explanation: Each line segment is replaced by a "speed bump" pattern that uses 4 line segments instead of 1. So 3 line segments become $3 \times 4 = 12$ line segments.

The pattern is: 3, 12, 48, ... (multiply by 4 each time, or $3\times4^{n-1}$)

SECTION C - Answers to Short Answer Questions

15.

First 6 odd numbers: 1, 3, 5, 7, 9, 11

Step-by-step addition:

$1 = 1$

$1 + 3 = 4$

$4 + 5 = 9$

$9 + 7 = 16$

$16 + 9 = 25$

$25 + 11 = 36$

Therefore: $1 + 3 + 5 + 7 + 9 + 11 = 36$

Verification: $6^2 = 6 \times 6 = 36$ ✓

This proves that the sum of the first 6 odd numbers equals 6^2.

16.

(a) 1, 8, 27, **64**, **125**, 216

This is the **cube numbers** sequence: $1^3, 2^3, 3^3, 4^3, 5^3, 6^3$

(b) 1, 3, **6**, 10, 15, **21**

This is the **triangular numbers** sequence

(c) 1, 2, 4, 8, **16**, **32**

This is the **Powers of 2** sequence: $2^0, 2^1, 2^2, 2^3, 2^4, 2^5$

17.

K2 (2 vertices):

Connects 2 points with 1 line

Number of lines = 1 (which is the 1st triangular number)

K3 (3 vertices):

Each of 3 vertices connects to 2 others: 3×2 = 6 connections

But each line counted twice, so: 6 ÷ 2 = 3 lines

Number of lines = 3 = 1+2 (which is the 2nd triangular number)

K4 (4 vertices):

Each of 4 vertices connects to 3 others: 4×3 = 12 connections

Each line counted twice, so: 12 ÷ 2 = 6 lines

Number of lines = 6 = 1+2+3 (which is the 3rd triangular number)

Verification: The pattern 1, 3, 6, 10, ... is indeed the triangular number sequence! ✓

SECTION D - Answer to Long Answer Question

18.

(a) Calculating the expressions:

(1 × 6) + 1 = 6 + 1 = 7

(3 × 6) + 1 = 18 + 1 = 19

(6 × 6) + 1 = 36 + 1 = 37

(10 × 6) + 1 = 60 + 1 = 61

Sequence obtained: 7, 19, 37, 61 (These are hexagonal numbers!)

(b) Explanation:

Triangular numbers represent dots arranged in a triangular pattern. A hexagonal number can be visualized as one central dot surrounded by hexagonal layers.

Each hexagonal layer has 6 sides, and the number of dots on each side corresponds to the position in the sequence. When we multiply a triangular number by 6, we're essentially creating 6 triangular arrangements radiating from a center. Adding 1 accounts for the central dot.

Mathematically: $H_n = (T_n \times 6) + 1$, where H_n is the nth hexagonal number and T_n is the nth triangular number.

(c) Finding the 7th hexagonal number:

Step 1: Find T_7 = 1 + 2 + 3 + 4 + 5 + 6 + 7 = 28

Step 2: Apply formula: H_7 = (28 × 6) + 1

= 168 + 1

= 169

Answer: The 7th hexagonal number is 169.

SECTION E - Answers to Case Study Based Questions

19.

(i) Seats in first 8 rows of triangular section:

This is the 8th triangular number:

T_8 = 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 = 36 seats

(ii) Seats in 9th square section:

9th square number = 9^2 = 81 seats

(iii) Total seats combining both:

8th triangular section = 36 seats

8th square section = 8^2 = 64 seats

Total = 36 + 64 = 100 seats

Is this special? Yes! 100 = 10^2

This demonstrates the beautiful relationship: $T_8 + S_8 = 36 + 64 = 100 = 10^2$

In general, the nth triangular number plus the nth square number has interesting properties in number patterns.

20.

(i) 10th term in Virahānka sequence:

Sequence: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89

10th term = 89

(Finding it: 34+55=89)

(ii) Sum of first 5 terms:

1 + 2 + 3 + 5 + 8 = 19

(iii) Relationship analysis:

Sum of first 5 terms = 19

The 7th Virahānka term = 21

Notice: 19 is very close to 21, differing by 2

Actually, 19 + 2 = 21, and 2 is the 3rd term in the sequence!

Verification with more terms:

Sum of first 6 terms: 1+2+3+5+8+13 = 32

8th Virahānka term = 34

Difference = 34 - 32 = 2

Pattern discovered: The sum of the first n Virahānka numbers equals the (n+2)th Virahānka number minus 2!

Or: $F_1 + F_2 + ... + F_n = F(n+2) - 2$

This is a beautiful property of the Virahānka/Fibonacci sequence!

Made with ❤ by Sumeet Sahu

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Website: uniquestudyonline.com