UNIQUE STUDY POINT

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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 sequence 2, 4, 6, 8, 10, ... represents:
(a) Odd numbers
(b) Even numbers
(c) Prime numbers
(d) Square numbers

2. In the sequence of Powers of 3, what comes after 27?
(a) 30
(b) 54
(c) 81
(d) 243

3. The 5th square number is:
(a) 10
(b) 15
(c) 20
(d) 25

4. Which of the following sequences starts with adding numbers up and then down?
(a) 1, 3, 5, 7, ...
(b) 1, 4, 9, 16, ...
(c) 1, 1+2+1, 1+2+3+2+1, ...
(d) 1, 2, 4, 8, ...

5. A hexagon has how many sides?
(a) 5
(b) 6

(c) 7
(d) 8

6. In the Virahānka sequence, each number is formed by:
(a) Adding 2 to the previous number
(b) Multiplying the previous number by 2
(c) Adding the previous two numbers
(d) Squaring the previous number

7. The sum 1 + 3 + 5 + 7 + 9 equals:
(a) 20
(b) 25
(c) 30
(d) 35

8. A regular polygon with 8 sides is called:
(a) Hexagon
(b) Heptagon
(c) Octagon
(d) Nonagon

9. The fourth triangular number is:
(a) 6
(b) 8
(c) 10
(d) 12

10. Mathematics helps in understanding patterns in:
(a) Numbers only
(b) Shapes only
(c) Both numbers and shapes
(d) Neither numbers nor shapes

SECTION B - Short Answer Questions (2 marks each)

11. Write the first five odd numbers and explain how to find the next odd number in the sequence.

12. Draw a pictorial representation of the number 10 as a triangular number using dots.

13. What is the 4th cube number? Show it as a calculation and explain what cubing means.

14. In the sequence of Complete Graphs K2, K3, K4, K5, how many lines are there in K4? Explain the pattern.

SECTION C - Short Answer Questions (3 marks each)

15. What sequence do you get when you add pairs of consecutive triangular numbers? Show this for the first three pairs: (1+3), (3+6), (6+10). What do you notice?

16. Explain with examples why a regular polygon has equal number of sides and corners. Use at least two different polygons in your explanation.

17. Calculate: 1 + 2 + 3 + 2 + 1. Then calculate: 1 + 2 + 3 + 4 + 3 + 2 + 1. What type of numbers do you get and why?

SECTION D - Long Answer Question (5 marks)

18.

(a) Write the sequence you get when you start adding Powers of 2: 1, (1+2), (1+2+4), (1+2+4+8), ... Calculate the first five terms of this sequence.

(b) Now add 1 to each of these numbers. What sequence do you get?

(c) Explain why this pattern occurs. (Hint: Think about how each power of 2 relates to the previous ones)

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

19.

Case Study 1: Patterns in a Flower Garden

Meera is planting flowers in her garden in hexagonal patterns. For each hexagonal arrangement, she places flowers at the vertices (corners) of hexagons of increasing size. The first arrangement has 1 flower at the center, the second has 7 flowers (1 center + 6 around it), the third has 19 flowers, and the pattern continues.

Based on this case study, answer the following questions:

(i) How many flowers are in the fourth hexagonal arrangement? (1 mark)

(ii) What is the difference between consecutive terms in this sequence? (1 mark)

(iii) If Meera multiplies each triangular number (1, 3, 6, 10, 15, ...) by 6 and adds 1, does she get the hexagonal number sequence? Verify for the first three hexagonal numbers. (2 marks)

20.

Case Study 2: Building with Blocks

Amit is stacking square blocks to build towers. For the first tower, he uses 1 block. For the second tower, he stacks layers of 1 and 4 blocks (1+4 = 5 blocks total arranged in a pattern). For the third tower, he uses 1+4+9 = 14 blocks, and so on, adding square numbers.

Based on this case study, answer the following questions:

(i) How many blocks will Amit need for the fourth tower? (1 mark)

(ii) If Amit continues this pattern, how many blocks will be in the fifth tower? (1 mark)

(iii) What is the relationship between this sequence and the square numbers sequence? Explain how adding square numbers creates a new pattern. (2 marks)

DETAILED ANSWER KEY - PAPER 02

SECTION A - Answers to MCQs

1. (b) Even numbers

Even numbers are multiples of 2.

2. (c) 81

Powers of 3: 1, 3, 9, 27, 81. Each is 3 times the previous: 27 × 3 = 81.

3. (d) 25

5th square number = $5^2 = 5 \times 5 = 25$.

4. (c) 1, 1+2+1, 1+2+3+2+1, ...

This sequence adds counting numbers up and then down, giving square numbers.

5. (b) 6

A hexagon has 6 sides and 6 corners.

6. (c) Adding the previous two numbers

In Virahānka sequence: 1, 2, 3, 5, 8, ... where 3=1+2, 5=2+3, 8=3+5.

7. (b) 25

$1 + 3 + 5 + 7 + 9 = 25 = 5^2$.

8. (c) Octagon

An octagon has 8 sides.

9. (c) 10

4th triangular number = 1 + 2 + 3 + 4 = 10.

10. (c) Both numbers and shapes

Mathematics studies patterns in both numbers (number theory) and shapes (geometry).

SECTION B - Answers to Short Answer Questions

11.

First five odd numbers: 1, 3, 5, 7, 9

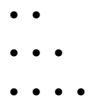
To find the next odd number, add 2 to the current odd number.

Example: 9 + 2 = 11 (next odd number)

Pattern: Each odd number is 2 more than the previous odd number.

12.

Pictorial representation of 10 as a triangular number:



This shows: 1 + 2 + 3 + 4 = 10 dots arranged in a triangle with 4 rows.

13.

The 4th cube number = $4^3 = 4 \times 4 \times 4 = 64$

Cubing means multiplying a number by itself three times.

Example: 4 cubed = 4 × 4 × 4

This represents the number of unit cubes in a 4×4×4 cube.

14.

In K4 (Complete Graph with 4 vertices), there are 6 lines.

Pattern: In a complete graph Kn, each vertex connects to every other vertex.

For K4: Each of 4 vertices connects to 3 others, giving 4×3=12 connections, but each line is counted twice.

So, number of lines = 12 ÷ 2 = 6

Sequence: K2=1, K3=3, K4=6, K5=10 (triangular numbers!)

SECTION C - Answers to Short Answer Questions

15.

Adding pairs of consecutive triangular numbers:

$1 + 3 = 4 = 2^2$

$3 + 6 = 9 = 3^2$

$6 + 10 = 16 = 4^2$

Observation: We get the sequence of square numbers!

When we add two consecutive triangular numbers, we always get a square number. This is because two triangular arrangements can be combined to form a rectangular (or square) arrangement.

16.

In any regular polygon, the number of sides always equals the number of corners.

Example 1 - Pentagon: Has 5 sides and 5 corners

Example 2 - Octagon: Has 8 sides and 8 corners

Reason: A polygon is formed by connecting points (corners) with straight line segments (sides). Each corner is where two sides meet, and each side connects two corners. In a closed figure, every corner must be connected, so the number of sides must equal the number of corners.

17.

Calculation 1: $1 + 2 + 3 + 2 + 1 = 9 = 3^2$

Calculation 2: $1 + 2 + 3 + 4 + 3 + 2 + 1 = 16 = 4^2$

We get square numbers!

Reason: When we add counting numbers "up and down" (1, 1+2+1, 1+2+3+2+1, ...), we are essentially doubling the triangular arrangement and adding them together, which forms a square. This is another beautiful way that square numbers appear in nature.

SECTION D - Answer to Long Answer Question

18.

(a) Sequence when adding Powers of 2:

1st term: 1

2nd term: 1 + 2 = 3

3rd term: 1 + 2 + 4 = 7

4th term: 1 + 2 + 4 + 8 = 15

5th term: 1 + 2 + 4 + 8 + 16 = 31

Sequence: 1, 3, 7, 15, 31

(b) After adding 1 to each number:

1+1=2, 3+1=4, 7+1=8, 15+1=16, 31+1=32

New sequence: 2, 4, 8, 16, 32

This is the Powers of 2 sequence (shifted)!

(c) Explanation:

Each power of 2 equals the sum of all previous powers of 2 plus 1.

For example: $1 + 2 + 4 + 8 = 15$, and $15 + 1 = 16 = 2^4$ (the next power of 2)

This happens because in binary representation, adding all powers of 2 up to 2^{n-1} gives $2^n - 1$. Adding 1 more gives exactly 2^n.

SECTION E - Answers to Case Study Based Questions

19.

(i) Fourth hexagonal arrangement:

The hexagonal sequence is: 1, 7, 19, 37, ...

The differences are: 6, 12, 18, ... (multiples of 6)

Fourth hexagonal number = 37 + 24 = 61 flowers

(ii) Differences between consecutive terms:

7 - 1 = 6

19 - 7 = 12

37 - 19 = 18

The differences are 6, 12, 18, ... (multiples of 6 increasing by 6 each time)

(iii) Verification:

Triangular numbers: 1, 3, 6, 10, 15, ...

For 1st hexagonal: $(1 \times 6) + 1 = 7$ ✓

For 2nd hexagonal: $(3 \times 6) + 1 = 19$ ✓

For 3rd hexagonal: $(6 \times 6) + 1 = 37$ ✓

Yes, the formula works! Hexagonal numbers can be generated by the formula: $H_n = (T_n \times 6) + 1$, where T_n is the nth triangular number.

20.

(i) Blocks needed for fourth tower:

$1 + 4 + 9 + 16 = 30$ blocks

(ii) Blocks in fifth tower:

$1 + 4 + 9 + 16 + 25 = 55$ blocks

(iii) Relationship and pattern:

The sequence 1, 5, 14, 30, 55, ... is formed by adding consecutive square numbers.

Relationship: Each term represents the cumulative sum of square numbers:

$T_1 = 1^2 = 1$

$T_2 = 1^2 + 2^2 = 1 + 4 = 5$

$T_3 = 1^2 + 2^2 + 3^2 = 1 + 4 + 9 = 14$

$T_4 = 1^2 + 2^2 + 3^2 + 4^2 = 1 + 4 + 9 + 16 = 30$

This creates a new pattern called "square pyramidal numbers," which represent the total number of objects when building a pyramid with square layers of increasing size.
