

CLASS 6

MATHS

NCERT SOLUTIONS

NCERT Solutions for Class 6 Maths Chapter 1: Patterns in Mathematics – Ganita Prakash

Complete NCERT Solutions for Class 6 Maths Chapter 1 "Patterns in Mathematics" (Ganita Prakash) -- a chapter contributed by Fields Medalist Manjul Bhargava, exploring number sequences, shape sequences, and the beautiful relationships between them.

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Complete NCERT Solutions for Class 6 Maths Chapter 1 “Patterns in Mathematics” (Ganita Prakash) — a chapter contributed by Fields Medalist Manjul Bhargava, exploring number sequences, shape sequences, and the beautiful relationships between them.

1.1 What is Mathematics? — Figure It Out (Page 2)

Q1. Can you think of other examples where mathematics helps us in our everyday lives?

Answer: Mathematics helps in managing money and budgeting, cooking and adjusting recipe quantities, estimating travel time and distance, calculating discounts while shopping, and planning schedules.

Q2. How has mathematics helped propel humanity forward?

Answer: Mathematics underlies scientific experiments and discoveries, running economies and elections (counting votes, statistics), designing and building bridges, houses, and other structures, and creating technology such as computers, phones, calendars, and clocks. Nearly every modern invention relies on mathematical principles like measurement, geometry, and logic.

1.2 Patterns in Numbers — Figure It Out (Page 3)

Q1. Can you recognise the pattern in each of the sequences in Table 1?

Answer: Yes — each sequence follows its own clear rule, as shown below.

Q2. Rewrite each sequence, along with the next three numbers, and describe the rule for each.

Answer:

All 1's: 1,1,1,1,1,1,1,... → next: **1, 1, 1**. Rule: every term is 1.

Counting numbers: 1,2,3,4,5,6,7,... → next: **8, 9, 10**. Rule: add 1 each time.

Odd numbers: 1,3,5,7,9,11,13,... → next: **15, 17, 19**. Rule: add 2 each time.

Even numbers: 2,4,6,8,10,12,14,... → next: **16, 18, 20**. Rule: add 2 each time.

Triangular numbers: 1,3,6,10,15,21,28,... → next: **36, 45, 55**. Rule: add the next counting number each time ($28+8=36$, $36+9=45$, $45+10=55$).

Squares: 1,4,9,16,25,36,49,... → next: **64, 81, 100**. Rule: n th term = n^2 ($8^2=64$, $9^2=81$, $10^2=100$).

Cubes: 1,8,27,64,125,216,... → next: **343, 512, 729**. Rule: n th term = n^3 ($7^3=343$, $8^3=512$, $9^3=729$).

Virahanka numbers: 1,2,3,5,8,13,21,... → next: **34, 55, 89**. Rule: each term is the sum of the two before it ($13+21=34$, $21+34=55$, $34+55=89$).

Powers of 2: 1,2,4,8,16,32,64,... → next: **128, 256, 512**. Rule: each term is double the previous one ($2^7=128$, $2^8=256$, $2^9=512$).

Powers of 3: 1, 3, 9, 27, 81, 243, 729, ... → next: **2187, 6561, 19683**. Rule: each term is triple the previous one ($3^7=2187$, $3^8=6561$, $3^9=19683$).

1.3 Visualising Number Sequences — Figure It Out (Pages 5-6)

Q1. Copy the pictorial representations in Table 2 and draw the next picture for each sequence.

Answer: This is a drawing exercise — extend each dot-pattern by one more step, following the same growth rule as the earlier terms.

Q2. Why are 1, 3, 6, 10, 15, ... called triangular numbers? Why are 1, 4, 9, 16, 25, ... called squares? Why are 1, 8, 27, 64, 125, ... called cubes?

Answer: Triangular numbers can be arranged as dots forming a triangle (n th triangular number = $n(n+1)/2$). Square numbers can be arranged as dots forming a perfect square grid (n th square = n^2). Cube numbers can be arranged as unit cubes forming a larger cube (n th cube = n^3).

Q3. 36 is both a triangular number and a square number! Illustrate this, and try representing other numbers pictorially in different ways.

Answer: 36 is the 8th triangular number ($8 \times 9 / 2 = 36$) and also 6^2 (a 6×6 square). Another such number is **1225**, which is the 49th triangular number ($49 \times 50 / 2 = 1225$) **and** the square of 35 ($35 \times 35 = 1225$) — so 1225 can be shown as a square with 35 dots along each side, not 36.

Q4. What would you call this sequence: 1, 7, 19, 37, ...? What is the next number?

Answer: These are **hexagonal numbers**. The differences between terms are 6, 12, 18 (increasing by 6 each time), so the next difference is 24, giving $37 + 24 = 61$.

Q5. Can you think of pictorial ways to visualise powers of 2 and powers of 3?

Answer: Powers of 2 can be shown as repeated doubling (each stage has twice as many dots/branches as the one before, like a branching tree). Powers of 3 can be shown as repeated tripling (each stage has three times as many dots as the one before).

1.4 Relations Among Number Sequences — Figure It Out (Pages 8-9)

Q1. Can you find a pictorial explanation for why adding counting numbers up and down (1, 1+2+1, 1+2+3+2+1, ...) gives square numbers?

Answer: Each such sum forms a square arrangement of dots: $1=1^2$, $1+2+1=4=2^2$, $1+2+3+2+1=9=3^2$, $1+2+3+4+3+2+1=16=4^2$ — verified by direct addition.

Q2. What is the value of $1+2+3+\dots+99+100+99+\dots+3+2+1$?

Answer: Following the same up-and-down pattern, this equals $100^2 = 10,000$.

Q3. What sequence do you get adding the All 1's sequence up? What about adding it up

and down?

Answer: Adding up (1, 1+1, 1+1+1, ...) gives the **counting numbers** (1, 2, 3, 4, ...). Adding up and down (1; 1+1+1; 1+1+1+1+1; ...) gives the **odd numbers** (1, 3, 5, 7, ...), since each level has one more pair of 1's than the last.

Q4. What sequence do you get adding the counting numbers up?

Answer: $1=1$, $1+2=3$, $1+2+3=6$, $1+2+3+4=10$, $1+2+3+4+5=15$,... — this gives the **triangular numbers**.

Q5. What happens when you add up pairs of consecutive triangular numbers?

Answer: You get square numbers: $1+3=4=2^2$, $3+6=9=3^2$, $6+10=16=4^2$, $10+15=25=5^2$.

Q6. What happens when you add up powers of 2 starting with 1? Now add 1 to each answer.

Answer: Cumulative sums: 1, $1+2=3$, $1+2+4=7$, $1+2+4+8=15$, $1+2+4+8+16=31$. Adding 1 to each gives 2, 4, 8, 16, 32 — **powers of 2 again** (since the sum of the first n powers of 2, starting from 1, is always one less than the next power of 2).

Q7. What happens when you multiply the triangular numbers by 6 and add 1?

Answer: $6(1)+1=7$, $6(3)+1=19$, $6(6)+1=37$, $6(10)+1=61$, $6(15)+1=91$ — this gives the **hexagonal numbers**.

Q8. What happens when you add up hexagonal numbers?

Answer: $1=1^3$, $1+7=8=2^3$, $1+7+19=27=3^3$, $1+7+19+37=64=4^3$, $1+7+19+37+61=125=5^3$ — this gives the **cube numbers**.

Q9. Find your own patterns or relations among the sequences in Table 1.

Answer: One elegant example: the sum of the first n cubes always equals the square of the n th triangular number (this is known as Nicomachus's theorem). Check: $1^3=1^2=1$; $1^3+2^3=1+8=9=(1+2)^2=3^2$; $1^3+2^3+3^3=1+8+27=36=(1+2+3)^2=6^2$; $1^3+2^3+3^3+4^3=1+8+27+64=100=(1+2+3+4)^2=10^2$.

1.5 Patterns in Shapes — Figure It Out (Page 11)

Q1. Can you recognise the pattern in each of the sequences in Table 3 (regular polygons, complete graphs, stacked squares, stacked triangles, Koch snowflake)?

Answer:

Regular polygons: each shape has one more side than the last (triangle=3, quadrilateral=4, pentagon=5, hexagon=6, ...).

Complete graphs: starting from 2 points joined by 1 line, each new graph adds one more point connected to every existing point. The number of connecting lines for n points is $\frac{n(n-1)}{2}$, giving 1, 3, 6, 10, 15, ... for $n=2,3,4,5,6$ — the triangular numbers.

Stacked squares: an $n \times n$ grid of unit squares gives 1, 4, 9, 16, ... little squares — the square numbers.

Stacked triangles: built from rows of 1, 3, 5, 7, ... little triangles, giving totals of 1, 4, 9, 16, 25, ... — also

the square numbers (since the sum of the first n odd numbers is n^2).

Koch snowflake: each straight segment is replaced with a smaller “bump” of 4 segments at every step, so the total number of segments multiplies by 4 each time.

Q2. Redraw each sequence, draw the next shape, and describe the rule.

Answer: Following the rules above: the next regular polygon would have one more side than the previous one; the next complete graph adds one more connected point; the next stacked-squares shape would be a 6×6 grid = 36 squares; the next stacked-triangles shape would total $1+3+5+7+9+11 = 36$ triangles; the next Koch snowflake iteration multiplies the segment count by 4 again.

1.6 Relation to Number Sequences — Figure It Out (Pages 11-12)

Q1. Count the sides in each Regular Polygon shape. Which sequence? What about corners?

Answer: Sides: 3, 4, 5, 6, 7, ... (counting numbers from 3). Corners: the exact same sequence, because every polygon has the same number of corners (vertices) as it has sides.

Q2. Count the lines in each Complete Graph shape. Which sequence?

Answer: 1, 3, 6, 10, 15, ... — the **triangular numbers**. For n points, the number of connecting lines is $n(n-1)/2$: for 2 points $\rightarrow$ 1 line, 3 points $\rightarrow$ 3 lines, 4 points $\rightarrow$ 6 lines, 5 points $\rightarrow$ 10 lines, 6 points $\rightarrow$ 15 lines.

Q3. Count the little squares in each Stacked Squares shape. Which sequence?

Answer: 1, 4, 9, 16, ... — the **square numbers**, since an $n \times n$ grid always has n^2 unit squares.

Q4. Count the little triangles in each Stacked Triangles shape. Which sequence?

Answer: 1, 4, 9, 16, 25, ... — the **square numbers**. Adding the triangles row by row: $1=1$, $1+3=4$, $1+3+5=9$, $1+3+5+7=16$ (each row adds the next odd number, and the sum of the first n odd numbers is always n^2).

Q5. Count the total line segments in each Koch snowflake shape. Which sequence?

Answer: 3, 12, 48, 192, ... — each term is **4 times** the previous one (starting from a triangle's 3 sides): $3 \times 4^0=3$, $3 \times 4^1=12$, $3 \times 4^2=48$, $3 \times 4^3=192$.

More Patterns to Explore

Sum of the first n odd numbers = n^2 : $1=1^2$, $1+3=4=2^2$, $1+3+5=9=3^2$, $1+3+5+7=16=4^2$, $1+3+5+7+9=25=5^2$, $1+3+5+7+9+11=36=6^2$. Following this pattern, the sum of the first 10 odd numbers is $10^2=100$, and the sum of the first 100 odd numbers is $100^2=10,000$.

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