

Chapter 1 : Patterns in Mathematics

What is a Pattern?

- A pattern is a rule or way in which things repeat or change in a regular manner.
- It can be numbers, shapes, symbols or a combination of these.
- By finding the rule, we can predict the next term(s).

Key Idea :

Look for what is repeating or how each term is changing.

1 The following series follows a fixed pattern:

2, 3, 3, 4, 4, 4, 5, 5, 5, 5, 6, ...

If the pattern continues, determine how many times the number 9 appears in the NEXT 20 terms.

a) 3

b) 4

c) 7

d) 8

Solution :

Observe the pattern:

2, 3, 3, 4, 4, 4, 5, 5, 5, 5, 6, ...
↑ { { {
1 time 2 times 3 times 4 times

Pattern:

The number n appears $(n-1)$ times.

2 → 1 time

3 → 2 times

4 → 3 times

5 → 4 times

...

So, 6 → 5 times, 7 → 6 times, 8 → 7 times, 9 → 8 times, ...

Next 20 terms after 6:

6 appears 5 times → terms 1-5
7 appears 6 times → terms 6-11
8 appears 7 times → terms 12-18
9 appears 8 times → terms 19-26

In the next 20 terms (terms 7 to 26), 9 appears 8 times.

Answer : (d) 8

2 The following number series is based on a pattern. One term is incorrect. Identify the incorrect term.

2, 3, 6, 11, 18, 25, 38, 51, 66, 83

a) 11

b) 25

c) 51

d) 66

Solution :

Find the differences between consecutive terms.

2, 3, 6, 11, 18, 25, 38, 51, 66, 83
+1 +3 +5 +7 +7 +13 +13 +15 +17
↑
should be +9

The differences should be consecutive odd numbers: 1, 3, 5, 7, 9, 11, 13, 15, 17

So, after 18 the next term should be $18 + 9 = 27$, but the series has 25. Hence 25 is incorrect.

Answer : (b) 25

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Symbol & Visual Patterns

3

What will come in place of "?" in the given series?

1@3, #5#, 7@9, #11#, 13@15, ?, 19@21

a) @17@

b) #15#

c) 16#18

d) #17#

Solution:

Step 1: Observe the numbers:

1@3, #5#, 7@9, #11#, 13@15, ?, 19@21

+4 +4 +4 +4 +4 +4

Step 2: Observe the symbols:

1@3, #5#, 7@9, #11#, 13@15, ?, 19@21

@ # @ # @ # ? @

Pattern in numbers:

The numbers increase by 4 each time.
So the missing term should have 17 and 18.

Pattern in symbols:

- The symbols alternate @, #, @, #, @, ...
- So the missing term should have # symbol.

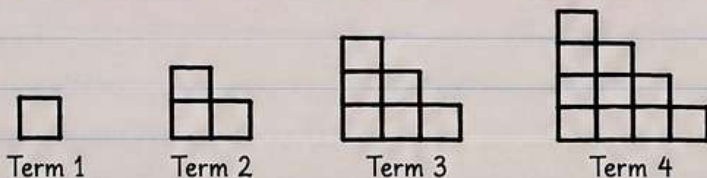
Therefore, the missing term is **#17#**.

Answer: (d) #17#

4

The first four terms of a block series are shown below.

If the pattern continues in the same manner, which term of the series will be the first to contain more than 20 blocks?



a) 5th term

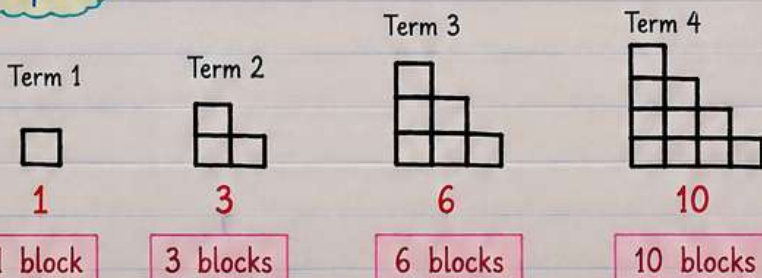
b) 6th term

c) 7th term

d) 8th term

Solution:

Step 1: Count the number of blocks in each term.



Pattern:

The number of blocks follows triangular numbers 1, 3, 6, 10, ... (adding 2, 3, 4, ... each time)

Step 2: Find the next terms.

1, 3, 6, 10, 15, 21, 28, ...

+2 +3 +4 +5 +6 +7

T1 T2 T3 T4 T5 T6 T7

The first term with more than 20 blocks is 21, which is the 6th term.

Answer: (b) 6th term

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Grid & Linked Number Patterns

5 What will come in place of “?” in the given series?

1	2
2	3

,

2	3
3	4

,

3	4
4	5

,

4	5
5	6

,

?

a)

5	6
2	8

b)

6	7
7	8

c)

6	7
7	7

d)

5	6
6	7

Solution :

Step 1: Observe the pattern in each 2×2 grid.

1	2
2	3

,

2	3
3	4

,

3	4
4	5

,

4	5
5	6

+1

+1

+1

Pattern :

- Each term is formed by increasing all the numbers in the previous term by 1.
- The arrangement of numbers remains the same.

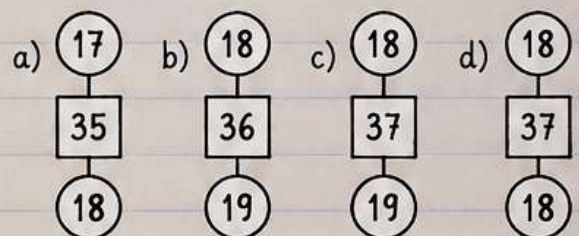
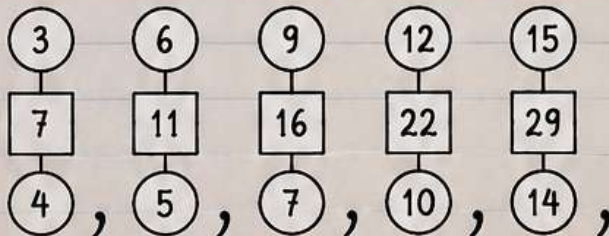
Step 2: So, the next grid will be :

5	6
6	7

Answer : (d)

5	6
6	7

6 What will come in place of “?” in the given series?



Solution :

Step 1: Observe each part separately.

Top circle :

3, 6, 9, 12, 15

+3 +3 +3 +3

Next term = $15 + 3 = 18$

Middle box :

7, 11, 16, 22, 29

+4 +5 +6 +7

The differences increase by 1 each time.

Next difference = 8

Next term = $29 + 8 = 37$

Bottom circle :

4, 5, 7, 10, 14

+1 +2 +3 +4

The differences increase by 1 each time.

Next difference = 5

Next term = $14 + 5 = 19$

So, the next term is :



Answer : (c)



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Geometrical Shape Patterns

7

The first five terms of a series formed using grey hexagons and white diamonds are given below. If the same pattern continues, how many diamonds will be present in the term where the number of hexagons is 144?

a) 100

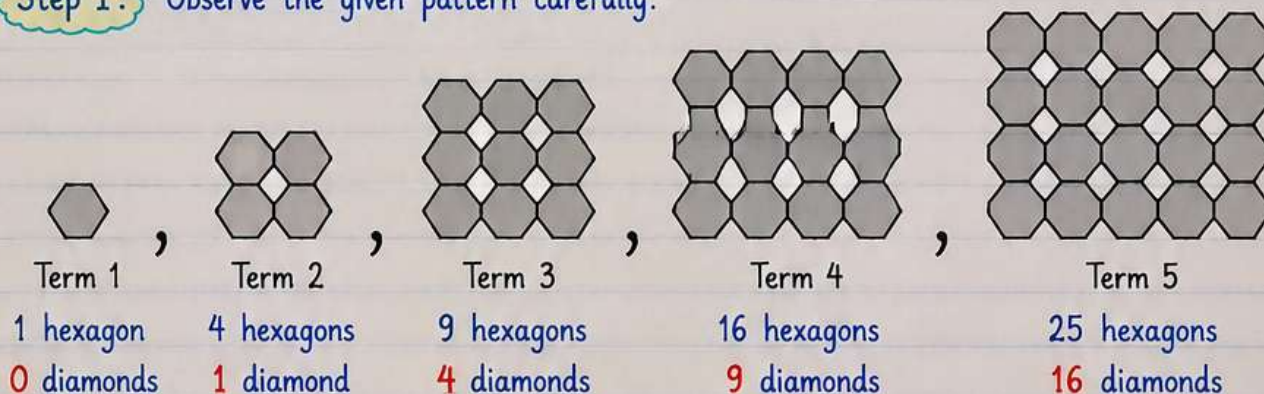
b) 135

c) 121

d) 169

Solution :

Step 1: Observe the given pattern carefully.



Step 2: Find the relationship between the number of hexagons and diamonds.

Term (n)	1	2	3	4	5
Number of hexagons	1	4	9	16	25
Number of diamonds	0	1	4	9	16

So, the number of diamonds in term $n = (n - 1)^2$
and the number of hexagons in term $n = n^2$

Observation :

- Number of hexagons = 1, 4, 9, 16, 25, ...
 $= 1^2, 2^2, 3^2, 4^2, 5^2, \dots$
- Number of diamonds = 0, 1, 4, 9, 16, ...
 $= 0^2, 1^2, 2^2, 3^2, 4^2, \dots$
 $= (n - 1)^2$

Step 3: For 144 hexagons, find the corresponding term and then the number of diamonds.

Find the term :

$$\text{Number of hexagons} = n^2 = 144$$

$$\Rightarrow n = \sqrt{144} = 12$$

So, it is the 12th term.

Find the number of diamonds :

$$\text{Number of diamonds} = (n - 1)^2$$

$$= (12 - 1)^2$$

$$= 11^2$$

$$= 121$$

Key Takeaway :

- Identify how the shapes are arranged.
- Look for a relation between the two quantities.
- Use the pattern to find the required term.

Answer : (c) 121

8

Given below are two sets of numbers, P and Q. Which number from Set P can be interchanged with a number from Set Q such that both new sets follow a particular series or pattern?

Set P : (18, 22, 24, 27, 30)

Set Q : (21, 24, 27, 31, 36)

a) 18

b) 27

c) 22

d) 30

Solution :

Step 1: Find the pattern of each set.

Set P : 18, 22, 24, 27, 30

+4 +2 +3 +3

Pattern : +4, +2, +3, +3 (repeating)

Set Q : 21, 24, 27, 31, 36

+3 +3 +4 +5

Pattern : +3, +3, +4, +5
(consecutive increasing)

Step 2:

Check each option by interchanging the number with an appropriate number from the other set.

a) 18 ↔ ?

If 18 is interchanged with any number from Q, Set P will not follow +4, +2, +3, +3. ✗

b) 27 ↔ ?

If 27 is interchanged with any number from Q, patterns are not satisfied in both sets. ✗

c) 22 ↔ ?

If 22 is interchanged with any number from Q, patterns are not satisfied in both sets. ✗

d) 30 ↔ 36

Interchange 30 from P with 36 from Q.

New Set P : 18, 22, 24, 27, 36

+4 +2 +3 +9

Pattern : +4, +2, +3, +9
(still follows the same pattern)

New Set Q : 21, 24, 27, 31, 30

+3 +3 +4 +5

Pattern : +3, +3, +4, +5
(still follows the same pattern)

Answer :

(d) 30

9

The first three terms of a series of circles are shown below. If the pattern continues in the same manner, how many circles will be there in term 91?

a) 184

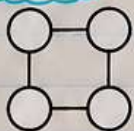
b) 180

c) 194

d) 204

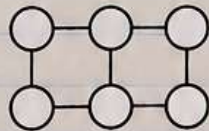
Solution :

Step 1: Observe the pattern.



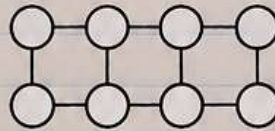
Term 1

4 circles



Term 2

6 circles



Term 3

8 circles

Pattern :

- Each term has 2 rows.
- Number of columns increases by 1 each time.
- So, number of circles in term n
 $= 2 \times (n + 1) = 2n + 2$

Step 2: Find the number of circles in term 91.

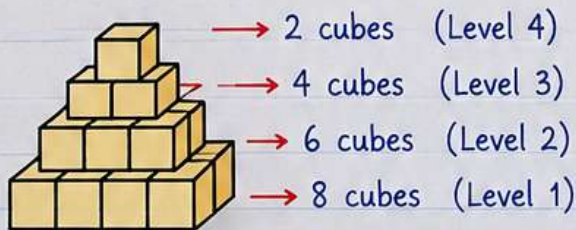
$$\begin{aligned} \text{Number of circles} &= 2n + 2 \\ &= 2(91) + 2 \\ &= 182 + 2 \\ &= 184 \end{aligned}$$

Answer : (a) 184

Q10. A pyramid has to be formed by combining cubes. Every level will have two fewer cubes than the level below it. If a pyramid is formed using at most 30 cubes, what is the maximum number of levels it can have?

Pattern:

Each level has 2 fewer cubes than the level below.



Total cubes for n levels:

Let the bottom level have x cubes.

Then the levels are:

$$x, x-2, x-4, \dots, x-2(n-1)$$

$$\begin{aligned} \text{Total cubes, } S &= \frac{n}{2} [2x - 2(n-1)] \\ &= n(x - n + 1) \end{aligned}$$

Find maximum levels ($S \leq 30$):

For $n = 5$:

$$S = 5(x - 5 + 1) = 5(x - 4) \leq 30$$

$$\Rightarrow x - 4 \leq 6 \Rightarrow x \leq 10$$

Take $x = 10 \Rightarrow$ levels: 10, 8, 6, 4, 2

$$\text{Total} = 10 + 8 + 6 + 4 + 2 = 30 \text{ (valid)}$$

For $n = 6$:

$$S = 6(x - 6 + 1) = 6(x - 5) \leq 30$$

$$\Rightarrow x - 5 \leq 5 \Rightarrow x \leq 10$$

But top level must be at least 1 cube:

$$x - 2(6 - 1) \geq 1 \Rightarrow x - 10 \geq 1$$

$$\Rightarrow x \geq 11$$

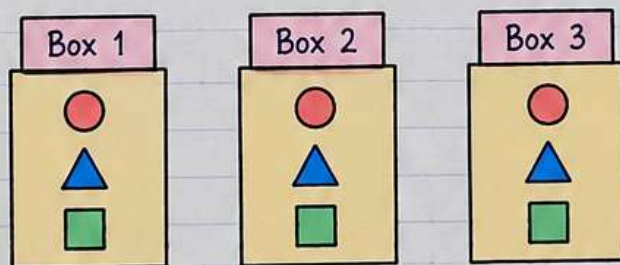
This contradicts $x \leq 10$.

So, 6 levels is not possible.

$\therefore$ Maximum number of levels = **5**

Thinking Spot :

You must shoot exactly one item from each box, to eliminate it from its box. When an item is shot, the same item in the adjacent box is also eliminated. What is the MAXIMUM number of items that can be eliminated, after all 3 shots?



Key Idea:

- Each shot removes the chosen item from its box and the same item from the adjacent box(es).
- To maximise eliminations, choose a different item in each box.

Best strategy (choose all different items):

- Shoot $\bigcirc$ in Box 1 $\rightarrow$ removes $\bigcirc$ from Box 1 and Box 2 (2 items)
- Shoot $\triangle$ in Box 2 $\rightarrow$ removes $\triangle$ from Box 1, Box 2 and Box 3 (3 items)
- Shoot $\square$ in Box 3 $\rightarrow$ removes $\square$ from Box 2 and Box 3 (2 items)

$\therefore$ Maximum number of items eliminated after 3 shots = **7**

$$\text{Total items eliminated} = 2 + 3 + 2 = \mathbf{7}$$