# Jawahar Navodaya Vidyalaya

SALBANI, MAYURBHANJ, ODISHA

# Exploring Patterns in Square Numbers

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Class :- IX

Section :- 'A'

Roll. no. :- 07

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# Acknowledgement

I would like to express my special thanks of gratitude to my mathematics teacher, Mr. S.N. Das, who gave me this wonderful topic on "Exploring patterns in square numbers". This helped me a lot in doing Research and I came to know about so many new things. I am really thankful to them.

Secondly, I would also like to thanks my parents and friends who provided me with the necessary things for it.

Thank You!

Signature of Student : Bhabani Sankar Sarangi

Signature of Guide teacher:

Overview :-

Students explore patterns in square numbers arranged in different ways. The unit aims to introduce Students to some of basic practices and way of thinking of mathematics as a discipline ; for example , reasoning, conjecturing , proving, problem solving , representing , seeing , and using connections, generalizing , abstracting and Communicating precisely.

Learning objectives :-

(i) observing and coming up with patterns
(ii) Expressing a pattern algebraically
(iii) Extending and verifying a pattern
(iv) visualizing and proving a pattern
(v) Understanding the difference between verification and proof , difference between theorem and conjecture
(vi) Exploring relationships between statements

Materials Required :- Graph paper , Printed number grids.

Prerequisites :- square numbers , Algebraic Identities, Operations on Polynomials

Task 1

The following are the squares of numbers from 1 to 20.

Task 2

It is obvious to see that the numbers with circles appear only in columns I, IV and VIII. There is a regularity in the gaps between the circled numbers, which may not be so obvious.

8. In column I, the gaps increase by 1 row each time, the gaps are as follows : 0, 1, 2.....
9. In column IV, the gaps increase by 4 rows each time, the gaps are as follows : 3, 7, 11....
10. In column VIII, the gaps increase by 4 rows each time, the gaps are as follows : 5, 9, 13....

Some patterns :-

11. The squares of all odd numbers are in column I.
12. The squares of even numbers are in columns IV or VIII.
13. The squares of multiples of 4 are in column VIII.
14. The squares of even numbers that are not multiples of 4 are in column IV.
15. All the squares of numbers of type $8n+1$, $8n+3$, $8n+5$ and $8n+7$ are in the first column, $8n+2$, $8n+6$ are in the fourth column and $8n+4$, and $8n$ are in the eighth column.

Task 2

| I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 |
| 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 |
| 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 |
| 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 |
| 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
| 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 |
| 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 |
| 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 |
| 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 |
| 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 |
| 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 |
| 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 |
| 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 |
| 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 |
| 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 |
| 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 |
| 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 |

| I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|
| 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 |
| 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 |
| 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 |
| 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 |
| 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 |
| 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 |
| 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 |
| 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 |
| 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 |
| 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 |
| 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 |
| 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 |
| 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 |
| 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 |
| 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 |
| 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 |
| 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 |
| 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 |
| 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 |
| 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 |
| 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 |
| 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 |
| 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 |
| 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 |
| 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 |

Task 3A1

(a) 75 being an odd number, $75^2$ will be in the first column and leaves a remainder 1 when divided by 8. (Using statement (11) and its reformulations)

(b) 96 being an even number that is divisible by 4, its square will be in column VIII. (Using Statement (13) and its reformulations)

(c) 122 being an even number that is not divisible by 4, its square will be in column IV. (Using statement (14) and its reformulations)

(d) $100000^2$ – column VIII (using statement (13) and its reformulations)

(e) $12346^2$ – Column IV (using statement (14) and its reformulations)

Task 3A2

The square of $(1234567)^2$ is not in column 5 as we know that the square of all odd numbers will be in column I.

Task 3A3

Proof of some of the patterns from task 1 and 2:

Task 1

Pattern 1 : "The squares of all odd numbers are odd."
Any odd number can be written in the form $2n+1$, where $n$ is a whole number.

$$(2n+1)^2 = 4n^2 + 4n + 1$$
$$= 2(2n^2+2n)+1$$
$$= 2m+1, \quad m = 2n^2+2n \text{ is a whole number.}$$

(Hence proved).

Pattern 2: "The difference between successive square numbers is the sequence of odd number."
Let the 2 numbers be $n$ and $n+1$, where $n$ is a natural number.

$$(n+1)^2 - n^2 = \cancel{n^2} + 2n + 1 - \cancel{n^2}$$
$$= 2n+1$$

$2n+1$ is always an odd number for any natural number, $n$.

(Hence proved).

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The [illegible] problems [illegible]

Theorem 1:- The squares of all odd numbers are [illegible] of the type [illegible] [illegible] can be obtained in the form [illegible] n is a whole number.

$(2n+1)^2 = 4n^2 + 4n + 1$

$= 4(n^2+n) + 1$

$= 4n(n+1) + 1$

[illegible]

[illegible]

Hence proved

Theorem 2:- The squares of [illegible]

[illegible]

[illegible] n is a whole number

$(4n)^2 = 16n^2$

$= 8(2n^2)$

$= 8m$ [illegible]

Hence proved

Task 2

Pattern 1 : "The squares of all odd numbers are in column I or of the type $8m+1$."

Any odd number can be written in the form $2n+1$, where $n$ is a whole number.

$$(2n+1)^2 = 4n^2 + 4n + 1$$
$$= 4(n^2+n) + 1$$
$$= 4n(n+1) + 1$$

Now $n(n+1)$ is always an even number, because either $n$ is even or $n+1$ is even.

$$(2n+1)^2 = 4n(n+1) + 1 = 8m+1, \text{ where } m = \frac{n(n+1)}{2}$$

(Hence proved)

Pattern 2 : "The squares of multiples of 4 are in column VIII or are multiples of 8"

Any multiple of 4 can be written in the form $4n$, where $n$ is a whole number.

$$(4n)^2 = 16n^2$$
$$= 8(2n^2)$$
$$= 8m, \text{ where } m = 2n^2$$

(Hence proved)

Task 3B

This task is a visualisation of the fact that the difference between squares of consecutive numbers is an odd number.

To build 3 X 3 square on a 2X2 square, the outer edge of orange squares needs to be added. Similarly, to build higher order squares, one should keep on adding the outer edge.

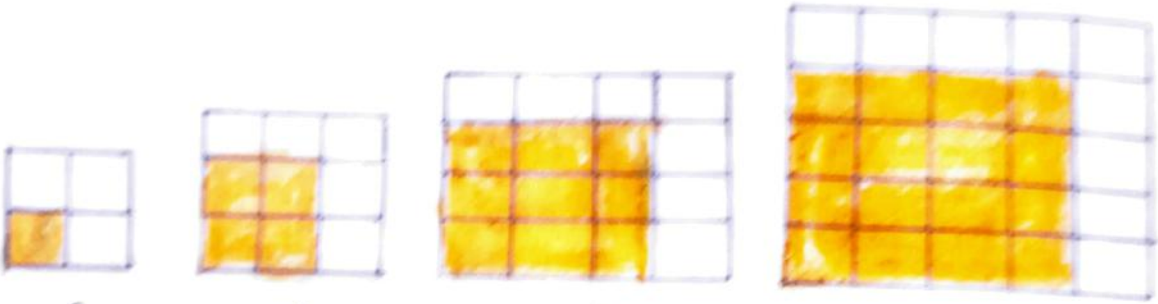
The outer edge that is to be added to a 3X3 square to make it a 4X4 square consists of $3+4=7$ squares.

Similarly, the outer edge that needs to be added to a 4X4 square to make it a 5X5 square consists of $4+5=9$ squares.

In general, the outer edge that needs to be added to a $n \times n$ square to make it an $(n+1)\times(n+1)$ square will have $n+n+1=2n+1$ squares, which is $(n+1)^{th}$ odd number. This could be proved algebraically as well.

The difference between two consecutive squares can be written as $(n+1)^2 - n^2 = 2n+1$

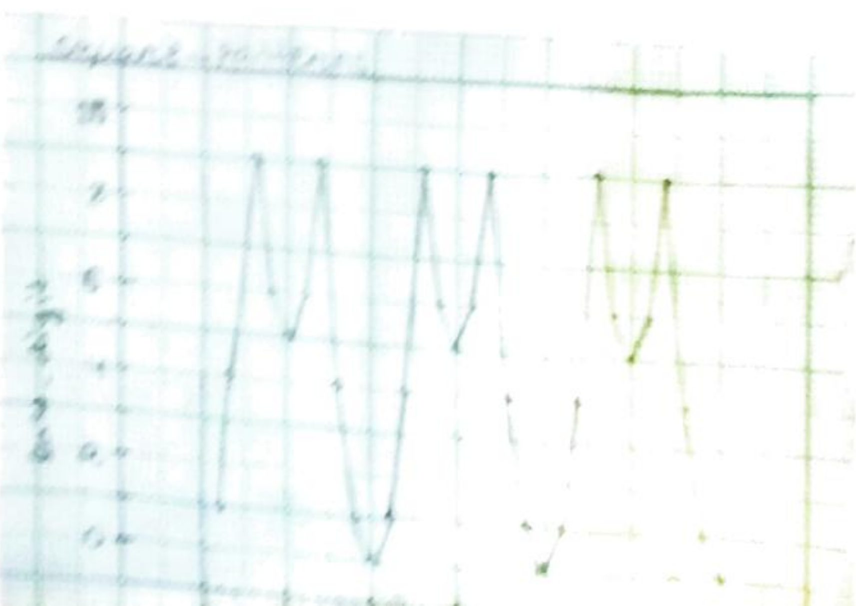
## Task 38



2 3 4 5

$1+3=4$ $4+5=9$ $9+7=16$ $16+9=25$

## Task 36



sk 3C1

he graph helps to see the repeating pattern and e symmetry. Notice the repeating pattern and the mmetry about the lines at $x$ = multiples of 5.

sk 3C2

he units digit of any number is the remainder tained on dividing the number by 10.
y number can be written in the form $10n+K$

$(0n+K)^2 = 100n^2 + 20nK + K^2$
e units digit of $100n^2 + 20nK$ is 0 as it is a ultiple of 10.
, the units digit of $100n^2 + 20nK + K^2$ is the same the last digit of $K^2$.
he units digit of $K^2$ and $(10n+K)^2$ are identical.
hus, there is a repeating pattern.

te :- The repeating unit is symmetric about multiples of 5, which means that the last digits of $5n+K$ and $5n-K$ are the same. This can be proved as follows.

$(5n+K)^2 = 25n^2 + 10K + K^2$
$5n-K)^2 = 25n^2 - 10K + K^2$
$(5n+K)^2 - (5n-K)^2 = 10K$
the difference between these two numbers is $10K$, hich has a zero at the units place and therefore

Task 3C.3

| I | II | III | IV | V | VI | VII | VIII | IX | X |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 |
| 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 |
| 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 |
| 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |

they both have the same units digit.
Also, the last digit of $K^2$ and $(10n - K)^2$ are identical.

Task 3C3

Task 2 was based on the remainders that a perfect square would leave when divided by 8, whereas Task 3C was about the remainders that a perfect square would leave when divided by 10. Both are essentially similar.

The remainder when divided by 10 happens to be the last digit as well.

Task 3C4

When a perfect square is divided by 3 one cannot get a remainder of 2.

Task 4

Multiple reasons / arguments may be articulated, for example -

(a) The last digits of a perfect square follow the pattern 1, 4, 9, 6, 5, 6, 9, 4, 1, 0. The digit 2, the last digit does not belong to this pattern. Therefore, it is not a perfect square.

(b) A perfect square leaves a remainder 1, 4 or 0 when divided by 8. 122 leaves a remainder of 2 and therefore it is not a perfect square.

(c) $11^2$ is 121, $12^2$ is 144. So, all numbers between these two numbers will have their square roots between 11 and 12 and are therefore not perfect squares.

But, these arguments may not work for some numbers 356 has the last digit 6 and leaves a remainder 4 when divided by 8. So, arguments of the form (a) and (b) will not work in this case. However, an argument can be built up along the lines of (c). Other reasons like

(d) A perfect square leaves a remainder 1 or 0 when divided by 3, but 356 leaves a remainder 2. Hence it is not a perfect square can also come up.

(e) A perfect square if it has the units digit 0, must have the hundreds digit 0 as well. This is not the case with 340 and therefore it is not a perfect square.

The number 425 is in column I, but not a perfect square. There are many more numbers in column I which are not perfect squares.

Task 3C4

| I | II | III |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | 9 |
| 10 | 11 | 12 |
| 13 | 14 | 15 |
| 16 | 17 | 18 |
| 19 | 20 | 21 |
| 22 | 23 | 24 |
| 25 | 26 | 27 |
| 28 | 29 | 30 |
| 31 | 32 | 33 |
| 34 | 35 | 36 |
| 37 | 38 | 39 |
| 40 | 41 | 42 |
| 43 | 44 | 45 |
| 46 | 47 | 48 |
| 49 | 50 | 51 |
| 52 | 53 | 54 |
| 55 | 56 | 57 |
| 58 | 59 | 60 |

| I | II | III |
|---|---|---|
| 61 | 62 | 63 |
| 64 | 65 | 66 |
| 67 | 68 | 69 |
| 70 | 71 | 72 |
| 73 | 74 | 75 |
| 76 | 77 | 78 |
| 79 | 80 | 81 |
| 82 | 83 | 84 |
| 85 | 86 | 87 |
| 88 | 89 | 90 |
| 91 | 92 | 93 |
| 94 | 95 | 96 |
| 97 | 98 | 99 |
| 100 | 101 | 102 |
| 103 | 104 | 105 |
| 106 | 107 | 108 |
| 109 | 110 | 111 |
| 112 | 113 | 114 |
| 115 | 116 | 117 |
| 118 | 119 | 120 |

| I | II | III |
|---|---|---|
| 121 | 122 | 123 |
| 124 | 125 | 126 |
| 127 | 128 | 129 |
| 130 | 131 | 132 |
| 133 | 134 | 135 |
| 136 | 137 | 138 |
| 139 | 140 | 141 |
| 142 | 143 | 144 |
| 145 | 146 | 147 |
| 148 | 149 | 150 |
| 151 | 152 | 153 |
| 154 | 155 | 156 |
| 157 | 158 | 159 |
| 160 | 161 | 162 |
| 163 | 164 | 165 |
| 166 | 167 | 168 |
| 169 | 170 | 171 |
| 172 | 173 | 174 |
| 175 | 176 | 177 |
| 178 | 179 | 180 |

| I | II | III |
|---|---|---|
| 181 | 182 | 183 |
| 184 | 185 | 186 |
| 187 | 188 | 189 |
| 190 | 191 | 192 |
| 193 | 194 | 195 |
| 196 | 197 | 198 |
| 199 | 200 | 201 |
| 202 | 203 | 204 |
| 205 | 206 | 207 |
| 208 | 209 | 210 |
| 211 | 212 | 213 |
| 214 | 215 | 216 |
| 217 | 218 | 219 |
| 220 | 221 | 222 |
| 223 | 224 | 225 |
| 226 | 227 | 228 |
| 229 | 230 | 231 |
| 232 | 233 | 234 |
| 235 | 236 | 237 |
| 238 | 239 | 240 |

using the language of mathematics, last digit being one of 1, 4, 9, 6, 5 or 0, or leaving remainders 0, 1 or 4 when divided by 8 are necessary conditions for a number to be a square.

consider the number 1000 :
It has the last digit 0, digit in the hundreds place is also 0, leaves a remainder 0 when divided by 8, 1 when divided by 3 and yet is not a perfect square.

References :-

https://nrich.maths.org/7117
https://nrich.maths.org/2280
https://nrich.maths.org/4350

Page No.
Date.

# Exploring Patterns in Square numbers

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Subject :- Mathematics

Experiment Name : Exploring Patterns In Square numbers

Page No.

Task -1 :-

| Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Square | 1 | 4 | 9 | 16 | 25 | 36 | 49 | 64 | 81 | 100 | 121 | 144 | 169 | 196 | 225 | 256 | 289 | 324 | 361 | 400 |

The squares of numbers from 1 to 20, We observe that, (With odd no.s)

→ (1+3)1 = 4 = Square of 2 ($\because$ 1<2<3)
→ (3+5)2 = 16 = Square of 4 ($\because$ 3<4<5)
→ (5+7)3 = 36 = Square of 6 ($\because$ 5<6<7)
→ (7+9) 4 = 64 = Square of 8 ($\because$ 7<8<9)
----------------------------------- etc.

Like this, we can calculated. So, ~~In~~ we observed this pattern.

Task -2 :-

| I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|
| 1 | — | — | 4 | — | — | — | 16 |
| 9 | — | — | 36 | — | — | — | 64 |
| 25 | — | — | 100 | — | — | — | 144 |
| 49 | — | — | 196 | — | — | — | 256 |
| 81 | — | — | 324 | — | — | — | 400 |
| 121 | — | — | | — | — | — | |
| 169 | — | — | | — | — | — | |
| 225 | — | — | | — | — | — | |

NOTE

Teacher's Signature & Date : ...............................

Here we observed that,

i) In 1st column

The square of 1, 3, 5, 7, 9, 11, 13, 15, 17, 19 ----
are present.

ii) Then there is not any square no.
in 2nd & 3rd column.

iii) In 4th column

The square of 2, 6, 10, 14 -----
are present.
$$\begin{array}{cccc} 2 & 6 & 10 & 14 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ (2\times\underline{1}) & (2\times\underline{3}) & (2\times\underline{5}) & (2\times\underline{7}) \end{array}$$

iv) Then, again there is not any square no.
in 5th, 6th & 7th column.

v) In 8th column

The square of 4, 8, 12, 16, 20
are present.
$$\begin{array}{ccccc} 4 & 8 & 12 & 16 & 20 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ (4\times1) & (4\times2) & (4\times3) & (4\times4) & (4\times5) \end{array}$$

So, here we observed this pattern.

## Task 3A1:-

(a) $75^2$ → It is present in 1st column.
(b) $96^2$ → It is present in 8th column.
(c) $122^2$ → It is present in 8th Column.
(d) $100000^2$ → It is present in 4th column.
(e) $12346^2$ → It is present in 4th column.

## Task-3A2

No, it is not possible that $(1234567)^2$ is in Column-5. Because as we see & concluded that there is not any square number present in Column-5.

## Task-3A3

From task-1 & task-2 we proved that,

i) From 1 to any number, we can find a pattern like this:-

No. → 1 2 3 4 5 6 7 8 9

Sq. no. → 4 16 36 64

$[(3+1)\times 1]$ $[(3+5)\times 2]$ $[(5+7)\times 3]$ $[(7+9)\times 4]$

ii) In 1st column, there is the number 1, 3, 5, 7, 9, 11, 13, 15, 17, 19 ----'s square no.s are present.

iii) In 4th column we observed the square of $(2\times1)=2$, $(2\times3)=6$, $(2\times5)=10$, $(2\times7)=14$ are present.

iv) In 8th column, we observed the pattern that the square of $(4\times1)=4$, $(4\times2)=8$, $(4\times3)=12$, $(4\times4)=16$, $(4\times5)=20$ are present.

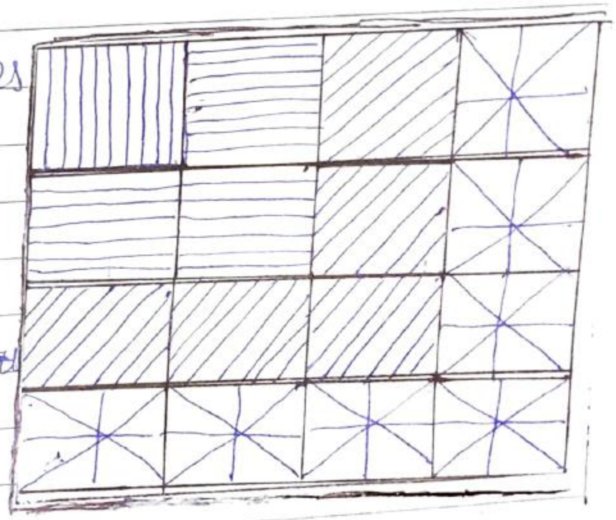
Task 3B :-

⇒ Here is one square.

⇒ We can add 3 more squares to make $2\times2$ square.

⇒ Now we can ~~mad~~ make $3\times3$ square by adding 5 squares more to $2\times2$ ~~squ~~ square.

⇒ Now we can make $4\times4$ square by adding 7 squares more.



* Yes, this pattern is related to the 1st pattern

1 2 3 4 5 6 7

$2\times2$ $4\times4$ $6\times6$

Task - 3(2) :-

| Numbers | Square numbers : |
| --- | --- |
| 1 | 1 |
| 2 | 4 |
| 3 | 9 |
| 4 | 16 |
| 5 | 25 |
| 6 | 36 |
| 7 | 49 |
| 8 | 64 |
| 9 | 81 |
| 10 | 100 |
| 11 | 121 |
| 12 | 144 |
| 13 | 169 |
| 14 | 196 |
| 15 | 225 |
| 16 | 256 |
| 17 | 289 |
| 18 | 324 |
| 19 | 361 |
| 20 | 400 |

1, 4, 9, 6, 5, 6, 9, 4, 1, 0

1, 4, 9, 6, 5, 6, 9, 4, 1, 0

⇒ Yes, here we proved that the last digits 1, 4, 9, 6, 5, 6, 9, 4, 1, 0 repeats.

Experiment Name : Page No.

## Task-3C3 :-

| I | II | III | IV | V | VI | VII | VIII | IX | X |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 |
| 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 |
| 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 |
| 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |

If, a perfect square is divided by 10, then the decimal is lying before 1, 4, 9, 6, 5, 6; & the remainder should be zero.

Ex. → $\frac{25}{10} = 2.5$ & remainder = 0.

## Task - 3 (4) :-

* If the numbers are written in a 3-column grid then the all square numbers are lying on 1st column & 3rd column only.

* It doesn't lie on II column.

| I | II | III |
|---|---|---|
| 1 | - | 9 |
| 4 | - | 36 |
| 16 | - | |
| 25 | - | |
| 49 | - | |

| I | II | III |
|---|---|---|
| 64 | - | 81 |
| 100 | - | |

| I | II | III |
|---|---|---|
| 121 | - | 144 |
| 169 | - | |

| I | II | III |
|---|---|---|
| 169 | - | 225 |

Task - 3(5 :-

| I | II | III | IV |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | 32 |
| 33 | 34 | 35 | 36 |
| 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 |
| 45 | 46 | 47 | 48 |
| 49 | 50 | 51 | 52 |
| 53 | 54 | 55 | 56 |
| 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 |
| 65 | 66 | 67 | 68 |
| 69 | 70 | 71 | 72 |
| 73 | 74 | 75 | 76 |
| 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 |
| 85 | 86 | 87 | 88 |
| 89 | 90 | 91 | 92 |

| I | II | III | IV |
|---|---|---|---|
| 93 | 94 | 95 | 96 |
| 97 | 98 | 99 | 100 |
| 101 | 102 | 103 | 104 |
| 105 | 106 | 107 | 108 |
| 109 | 110 | 111 | 112 |
| 113 | 114 | 115 | 116 |
| 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 |
| 125 | 126 | 127 | 128 |
| 129 | 130 | 131 | 132 |
| 133 | 134 | 135 | 136 |
| 137 | 138 | 139 | 140 |
| 141 | 142 | 143 | 144 |
| 145 | 146 | 147 | 148 |
| 149 | 150 | 151 | 152 |
| 153 | 154 | 155 | 156 |
| 157 | 158 | 159 | 160 |
| 161 | 162 | 163 | 164 |
| 165 | 166 | 167 | 168 |
| 169 | 170 | 171 | 172 |
| 173 | 174 | 175 | 176 |
| 177 | 178 | 179 | 180 |
| 181 | 182 | 183 | 184 |

Experiment Name :



* The square numbers are lying on the 1st and 4th column.

Task - 3(b) :-

Yes, I can make such grids with other number of columns. Yes, I can predict where the square numbers would be with such grids.

Task - 4 :-

(i) (a) 122, (b) 356, (c) 340, (d) 12356 & (e) 425 are not perfect square numbers because,

(a)
$$\begin{array}{r|l} 2 & 122 \\ \hline & 61 \end{array}$$

(b)
$$\begin{array}{r|l} 2 & 356 \\ \hline 2 & 178 \\ \hline & 89 \end{array}$$

(c)
$$\begin{array}{r|l} 2 & 340 \\ \hline 2 & 170 \\ \hline 5 & 85 \\ \hline & 17 \end{array}$$

(d) ~~122~~
$$\begin{array}{r|l} 2 & 12356 \\ \hline 2 & 6178 \\ \hline & 3089 \end{array}$$

(e)
$$\begin{array}{r|l} 5 & 425 \\ \hline 5 & 85 \\ \hline & 17 \end{array}$$

By Prime factorisation method it can't be pairs. Therefore, they are not ~~to~~ perfect square number.

(ii) (a) An example which is not a perfect square & :- whose units digit is 0, leaves remainder 4 when divided by 8 is $\boxed{20}$.

(b) Whose unit digit is 6, leaves a remainder 4 when divided by 8 and leaves a remainder 1 when divided by 3 is $\boxed{66}$.

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Topic : Exploring patterns in square numbers

# Jawahar Navodaya Vidyalaya

SALBANI, MAYURBHANJ, ODISHA

# Exploring Patterns in Square Numbers

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