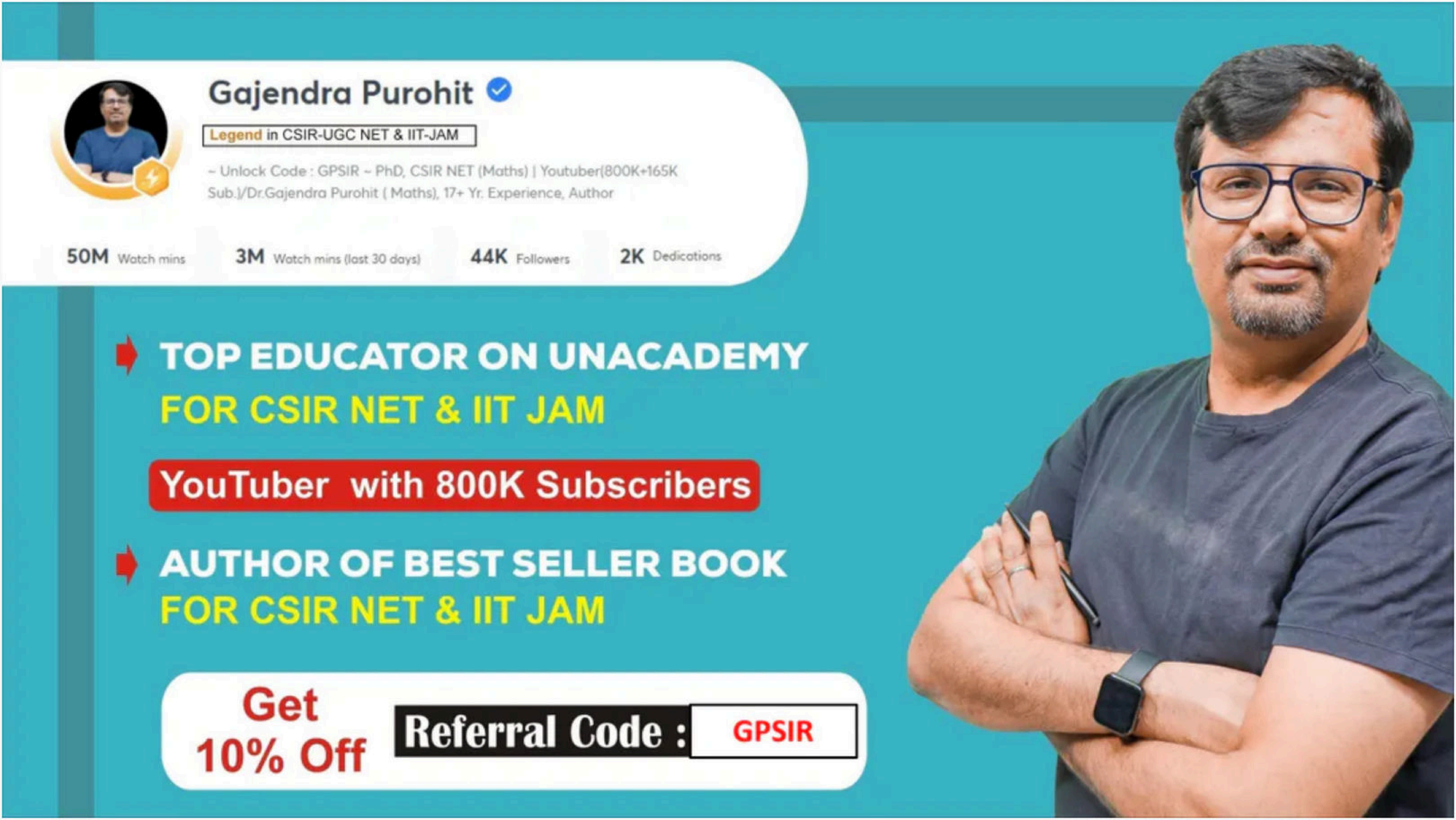
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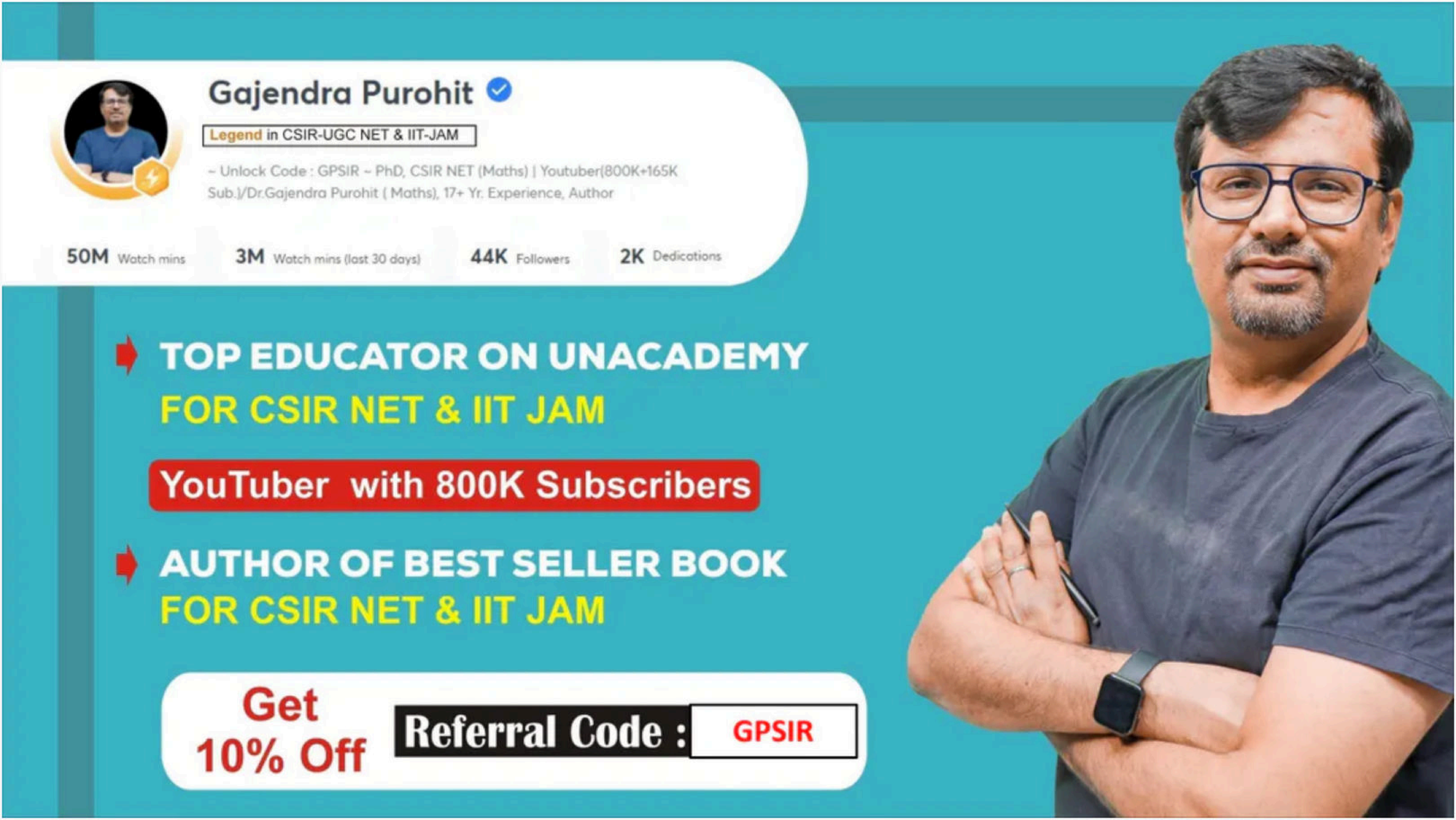

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$N = \{1, 2, 3 \ldots\}$

(I) ✓] + Semigroup

(II) ✓

(III) X $0 \notin N$

$(N, +)$ Semi group

$Z = \{\ldots -1, 0, 1, 2 \ldots\}$

(I) ✓] + Semi Group

(II) ✓

(III) ✓ $0 \in Z$

(IV) ✓

$(Z, +)$ Group

(V) abelian

$Q = \{\frac{p}{q}, q \neq 0, p, q \in Z\}$

(I) ✓] + Semi gr

(II) ✓

(III) ✓ abelian

(IV) ✓ $(Q, +)$ Group

(V) ✓

$R = Q \cup Q^c$

(I) ✓] + Semi

(II) ✓

(III) ✓ $(R, +)$ Group

(IV) ✓

(V) ✓ abelian

$N = \{1, 2, 3 \cdots\}$

(I) ✓

(II) ✓

(III) $1 \in N$ ✓

(IV) $2 \in N$ $\frac{1}{2} \notin N$

$(N, \times)$ monoid

$Z = \{\cdots -1, 0, 1, 2 \cdots\}$

(I) ✓

(II) ✓

(III) ✓

(IV) $2 \in Z$, $\frac{1}{2} \notin Z$

$(Z, +)$ monoid

$(Q/\{0\}, \times)$

$Q = \{\frac{p}{q}, q \neq 0 \mid p, q \in Z\}$

(I) ✓

(II) ✓

(III) ✓

(IV) $2 \in Q$ $\frac{1}{2} \in Q$

$(Q^*, \times)$

Group

$R = Q \cup Q^c$

(I) ✓

(II) ✓

(III) ✓

(IV)

$(R^*, \times)$

$\boxed{\times}$

aberian / commutative

$a \times b = 1$

$b = 1/a$

Closure $\forall\, a, b \in S$

$a \times b \in S$

$\forall\, a, b \in S$

$a \times b = b \times S$

Associative $\forall\, a, b, c \in S$

$a \times (b \times c) = (a \times b) \times c$

$2 \times \frac{1}{2} = 1$

identity $\forall\, a \in S\ \exists\, e \in S$

$3 \times \frac{1}{3} = 1$

s.t. $a \times e = e \times a = a$

$a \times e = a$

$4 \times 1/4 = 1$

$e = 1$

Inverse $\forall\, a \in S\ \exists\, b \in S,\ \underline{a \neq 0}$

$a \times b = e$

modulo $+$

$G = (Z_4, +_4)$, $Z_4 = \{0, 1, 2, 3\}$

$o(4) = 4$

$+_4$	0	1	2	3
$e = 0$	0	1	2	3
1	1	2	3	0
2	2	3	0	1
3	3	0	1	2

I closure

II ✓

III identity $- 0 = 0$

order of group

$o(G) = 4$

order of element

$o(0) = 1$

$o(1) = 4$

$o(2) = 2$

$o(3) = 4$

$1 = 1$
$1+1 = 2$
$1+1+1 = 3$
$1+1+1+1 = 0$

~~$2 = 2$~~
~~$2+2 = 0$~~
~~$2+2+2 = 2$~~
~~$2+2+2+2 = 0$~~

$3 = 3$
$3+3 = 2$
$3+3+3 = 1$
$3+3+3+3 = 0$

$\mathbb{Z}_{10}$

1

2

5

10

$1, 3, 7, 9$

$\phi(1) = 1$

$\phi(2) = 1$

$\phi(5) = 5 - 5^0 = 4$

$\phi(10) = \phi(5 \times 2) = \phi(5) \times \phi(2)$

$= 4 \times 1 = 4$

$\phi(100)$

$(\mathbb{Z}_{100}, +, \times)$

$\phi(100)$

$\phi(2^2 \times 5^2) = \phi(2^2)\,\phi(5^2)$

$= (2^2 - 2)(5^2 - 5)$

$= 2 \times 20 = 40$

$\langle \mathbb{Z}_5, +_5 \rangle$

I

II

III $e = 0$

IV

$0^{-1} = 0$

$1^{-1} = 4$

$2^{-1} = 3$

$3^{-1} = 2$

$4^{-1} = 1$

V

$\phi(0) = 4$

1, 2, 3, 4

$o(1) = 5$

$o(2) = 5$

$o(3) = 5$

$o(4) = 5$

+	0	1	2	3	4
e = 0	0	1	2	3	4
1	1	2	3	4	0
2	2	3	4	0	1
3	3	4	0	1	2
4	4	0	1	2	3

$(\mathbb{Z}_4, \times_4) = \{0, 1, 2, 3\}$

(I) ✓

(II) ✓

(III) $e = 1$

(IV) $1^{-1} = 1$

2^{-1} ✗

$\boxed{3^{-1} = 3}$

$\times_4$	0	1	2	3
0	0	0	0	0
$e=1$	0	1	2	3
2	0	2	0	2
3	0	3	2	1

$U(4) = \{1, 3\}$

$U(10)$

1 3 7 9

$(\mathbb{Z}_5, \times_5)$

(I) ✓

(II) ✓

(III) $e = 1$

(IV) $1^{-1} = 1$

$2^{-1} = 3$

$3^{-1} = 2$

$4^{-1} = 4$

(V) Abelian

$\times_5$	0	1	2	3	4
0	0	0	0	0	0
$e=1$	0	1	2	3	4
2	0	2	4	1	3
3	0	3	1	4	2
4	0	4	3	2	1

$U(5) = \{1, 2, 3, 4\}$

$\phi(10) = \phi(2)\,\phi(5)$

$= 1 \times 4$

$= 4$

$U(10) = \{1, 3, 7, 9\} = \langle$

$\times_{10}$	1	3	7	9
$e = 1$	1	3	7	9
3	3	9	1	7
7	7	1	9	3
9	9	7	3	1

$o(G) = 4$

$o(1) = 1$

$o(3) = 4$

$o(7) = 4$

$o(9) = 2$

$U(8) = \{1, 3, 5, 7\}$

$o(G) = 4$

$\times_8$	1	3	5	7
$e = 1$	1	3	5	7
3	3	1	7	5
5	5	7	1	3
7	7	5	3	1

abelian

$o(1) = 1$

$o(3) = 2$

$o(5) = 2$

$o(7) = 2$

$3^2 = 1$

$5^2 = 1$

$7^2 = 1$

$\langle \{1, -1, i, -i\}, \times \rangle$

(i) ✓

(ii) ✓

(iii) $e = 1$

(iv) $1^{-1} = 1$

$(-1)^{-1} = -1$

$(i)^{-1} = -i$

$(-i)^{-1} = i$

$\times$	1	-1	i	$-i$
$e = 1$	1	-1	i	$-i$
-1	-1	1	$-i$	i
i	i	$-i$	-1	1
$-i$	$-i$	$+i$	1	-1

Closure Prop

$\oplus$ $\forall\ a, b \in S$
$a + b \in S$

$\otimes$ $a, b \in S$
$a * b \in S$

Associative $a + (b + c) = (a + b) + c$

identity $\forall\ a \in S\ \exists\ e \in S$
$a + e = e + a = a$
$e = 0$

Inverse $\forall\ a \in S\ \exists\ b \in S$
$a + b = e \quad a + b = 0$
$b = -a$

$a \in S$
$-a \in S$

abelian (commutative)
$\forall\ a, b \in S$
$a * b = b * a$
$a + b = b + a$

$U(12) = \{1, 5, 7, 11\}$

$5^{-1} = 5$

$7^{-1} = 7$

$11^{-1} = 11$

T F

$\times_{12}$	1	5	7	11
1	1	5	7	11
5	5	1	11	7
7	7	11	1	5
11	11	7	5	1

Definition $\Rightarrow$ A non-empty set G with binary composition $\star$ is said to be group if it satisfy following property

A. Closure property $\Rightarrow a \star b \in G$, $\forall$ a, b $\in G$

B. Associative prop. $\Rightarrow a \star (b \star c) = (a \star b) \star c$

$$\forall\, a, b, c \in G$$

C. Identify exist $\Rightarrow a \star e = e \star a = a$

$$\forall\, a \in G$$

D. Inverse exist $\Rightarrow \exists\, b \in G$

$$a \star b = b \star a = e \quad ; \forall\, a \in G$$

The fact that $(G, \star)$ is a group

Ex. 1 (z, +), (Q , +), (R, +), (C, +)

Ex. 2 ($R^\star$, ×), ($Q^\star$, ×)

Where $R^\star$ = R- {o} & $Q^\star$ = Q – {o}

Ex. 3 (Z_m, $\oplus_m$)

Where Z_m = {0, 1, 2… m-1}

Cyclic group : A group G is called cyclic if ∃ a ∈G s.t.

o (a) = o (G) and such type of a is called generator of G

Ex. Let G = (Z_4, $\oplus_4$)

O (G) = 4

and o (1) = o (3) = 4

so G is cyclic & 1, 3 are two generator

Trick $\Rightarrow$ Number of generator in cyclic group of order m is ϕ (m)

Where ϕ (m) is

If $m = a^p b^q$

Then $\phi (m) = m\left(1-\frac{1}{a}\right)\left(1-\frac{1}{b}\right)$

Ex. Let $G = (Z_4, \oplus_4)$ then Number of generator in G are ϕ (4)

ie. $\phi (4) = \phi (2^2) = 4\left(1-\frac{1}{2}\right) = 4 \times \frac{1}{2} = 2$

Q1. The number of generator at Additive group Z_{36} is equal to

(A) 6 (B) 12

(C) 18 (D) 36

Q2. The number of generator of $(Z_{100}, \oplus_{100})$ is

(A) 40 (B) 9

(C) 41 (D) 100

Trick : Let a be an element of a group G then $O(a) | O(G)$

Ex. $G = (Z_4, \oplus_4)$

$G = \{(0, 1, 2, 3), \oplus_4\}$

Here $o(0) = 1$, $o(1) = 4$, $o(2) = 2$

& $o(3) = 4$

here Number of element of order 4 are $\phi(4) = \phi(2^2) = 2$

& Number of element of order 2 are $\phi(2) = 1$

Trick$\rightarrow$ Number of elements of order 'd' in $(Z_m, \oplus_m)$ are ϕ (d) where $d|m$

Q3. WOTF is possible order of element in $(z_{100}, \oplus_{100})$

(A) 40 (B) 20

(C) 50 (D) 21

Q4. WOTF is/ are not possible order of element of group of order 10

(A) 2 (B) 6

(C) 1 (D) 7

Q5 Number of elements of order 8 in cyclic group are

(A) 6 (B) 4

(C) 2 (D) 8

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Q6. Number of elements of order 15 in cyclic group

(A) 5 (B) 3

(C) 8 (D) Not

★ Let G be a non-abelian group & $o(G) = p.q$ $(p < q)$

& p & q are prime Then

(a) Number of elements of order q are $q - 1$
(b) Number of elements of order p are $(p-1)q$

Q7. Let G be a non- abelian group of order 55 then number of element of order 5 & number of element of order 11 are

(A) (2, 3) (B) (44, 10)

(C) (4, 11) (D) Not

Q8. Let G be a non-abelian group of order 21 s.t. p & q are number of element of order 3 & order 7 respectively then p + q are

(A) 3 (B) 14

(C) 6 (D) 20

Q9. Let G be a non-abelian group of order 69, s.t. p & q are number of element of order 23 & 69 then $|q - p|$ is

(A) 22 (B) -22

(C) 69 (D) -69

★ Let G be a group of order p^2 where p is prime.

then G must be abelian group.

Ex. Group of order 4 is always abelian

Q10. WOTF possible order of group s.t. group is abelian

(A) 6 (B) 8

(C) 9 (D) 25


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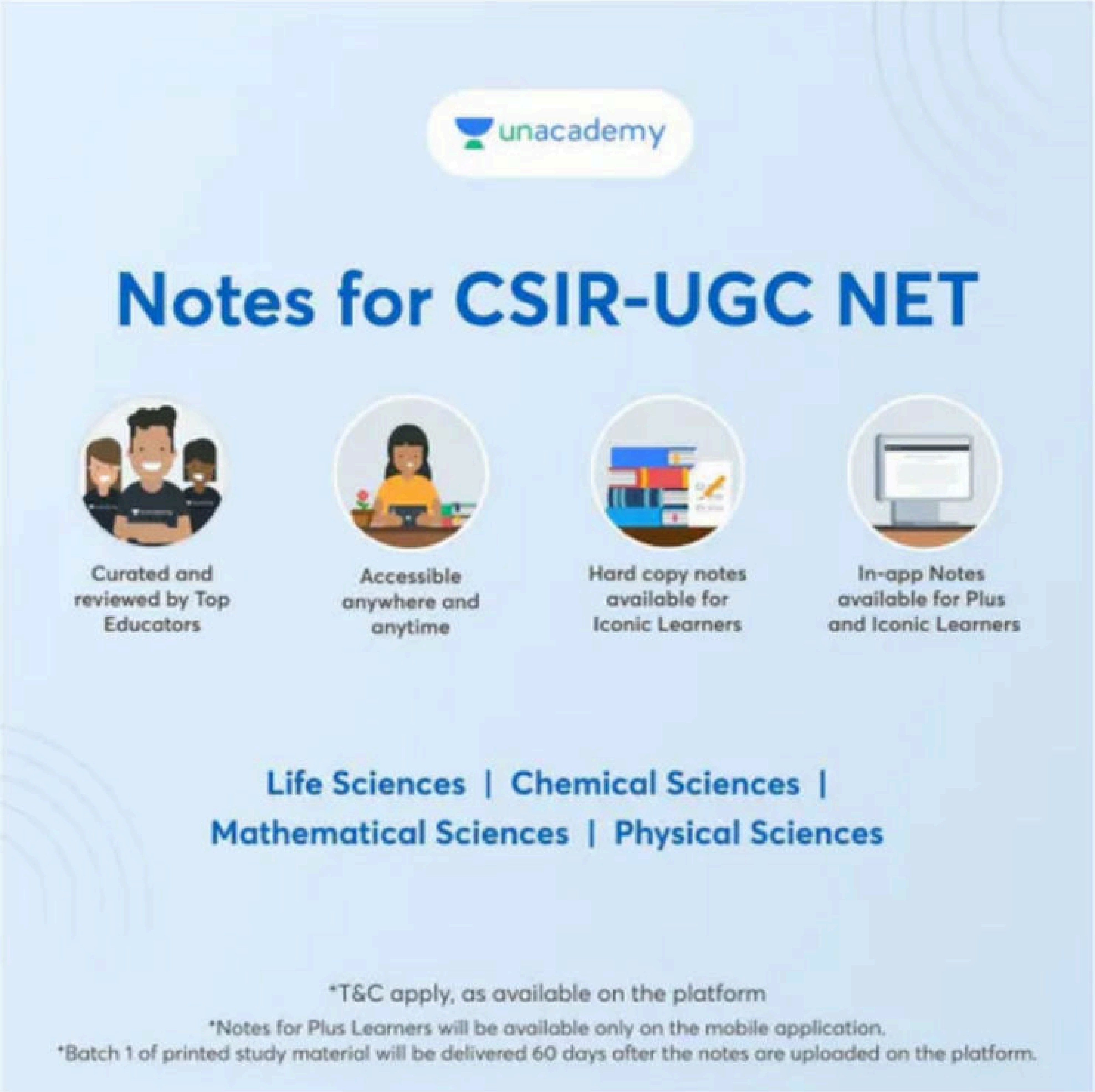
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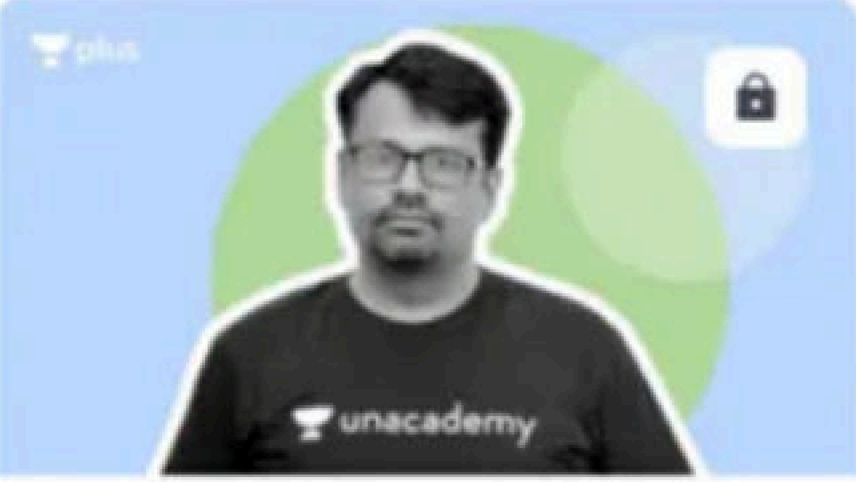

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- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
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GROUP OF ORDER 1 TO 12

Q.1. Let G be a group of order 12 then which of the following is true

(a) G is always abelian group

(b) G has always an element of order 6

(c) G has always an elements of order 3

(d) None of these

Q.2. Which of the following is true

(a) G is always abelian group if $O(G) < 6$

(b) G is always cyclic group if $O(G) < 6$

(c) $\exists$ a group of order 9 which is non - abelian

(d) None of these

Q.3. Let G be a group of order 8 then which of the following is always true

(a) G is always abelian

(b) G is always non – abelian group

(c) G has an elements of order 8

(d) None of these

Q.4. Which of the following is true

(a) G is always abelian group if O(G) = 12

(b) G is always cyclic group if O(G) = 11

(c) Every elements of order 11 in G if O(G) = 11

(d) None of these

Result :

(1) If $O(G) = pq$ where $p < q$

(i) If $p \nmid q - 1$ then G is cyclic

(ii) If $p \mid q - 1$ then G may not be abelain group

(2) If G is non – abelian group of order pq where $p < q$ then

(i) G has an elements of order q are $q - 1$

(ii) G has an elements of order p are $q(p - 1)$

(3) If G is abelian group of order pq then G is cyclic group

Q.5. If G is abelian group then Which of the following is true

(a) G is always cyclic group if $O(G) = 14$

(b) G is always cyclic group if $O(G) = 12$

(c) G is always cyclic group if $O(G) = 20$

(d) G is always cyclic group if $O(G) = 21$

Q.6. Which of the following is cyclic group

(a) $O(G) = 14$

(b) if $O(G) = 77$

(c) if $O(G) = 35$

(d) if $O(G) = 21$

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★ Let G be a non-abelian group & $o(G) = p.q$ $(p < q)$

& p & q are prime Then

(a) Number of elements of order q are $q - 1$
(b) Number of elements of order p are $(p-1)q$

Q7. Let G be a non- abelian group of order 55 then number of element of order 5 & number of element of order 11 are

(A) (2, 3)
(B) (44, 10)
(C) (4, 11)
(D) Not

Q8. Let G be a non-abelian group of order 21 s.t. p & q are number of element of order 3 & order 7 respectively then p + q are

(A) 3 (B) 14

(C) 6 (D) 20

Q9. Let G be a non-abelian group of order 69, s.t. p & q are number of element of order 23 & 69 then $|q - p|$ is

(A) 22 (B) -22

(C) 69 (D) -69

★ Let G be a group of order p^2 where p is prime.

then G must be abelian group.

Ex. Group of order 4 is always abelian

Q10. WOTF possible order of group s.t. group is abelian

(A) 6 (B) 8

(C) 9 (D) 25


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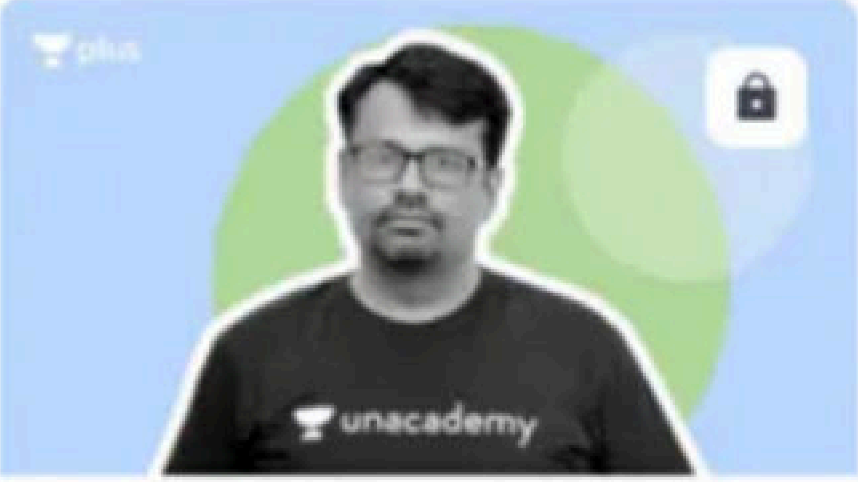

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- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
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- Lives in **Udaipur, Rajasthan, India**
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