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Symmetric Group : A collection of all permutations on the set S = {1, 2, 3, ..., n} is define a group under composition of function and denoted by S_n. It is called a symmetric group.

Example : S_1, S_2, S_3, S_4 .... all are symmetric group.

Order of symmetric group : The order of symmetric group S_n is n!.

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$S_3 = \{e\}, \{(12), (13), (23)\}, \{(123), (132)\}$

$o(e) = 1$

$o(ab) = 3$

$o(abc) = 2$

S_3

1+1+1

1+2

3

lcm(1,1,1) = 1

lcm(1,2) = 2

lcm(3) = 3

$$O(1) = \frac{3!}{1^3 \cdot 3!} = 1$$

$$O(2) = \frac{3!}{1 \times 2} = 3$$

$$O(3) = \frac{3!}{3} = 2$$

$o(S_4) = 24$

$1+1+1+1$	e
$1+1+2$	(ab)
$2+2$	$(ab)(cd)$
$1+3$	(abc)
4	$(abcd)$

e	1
(ab)	6
$(ab)(cd)$	3
(abc)	8
$(abcd)$	6

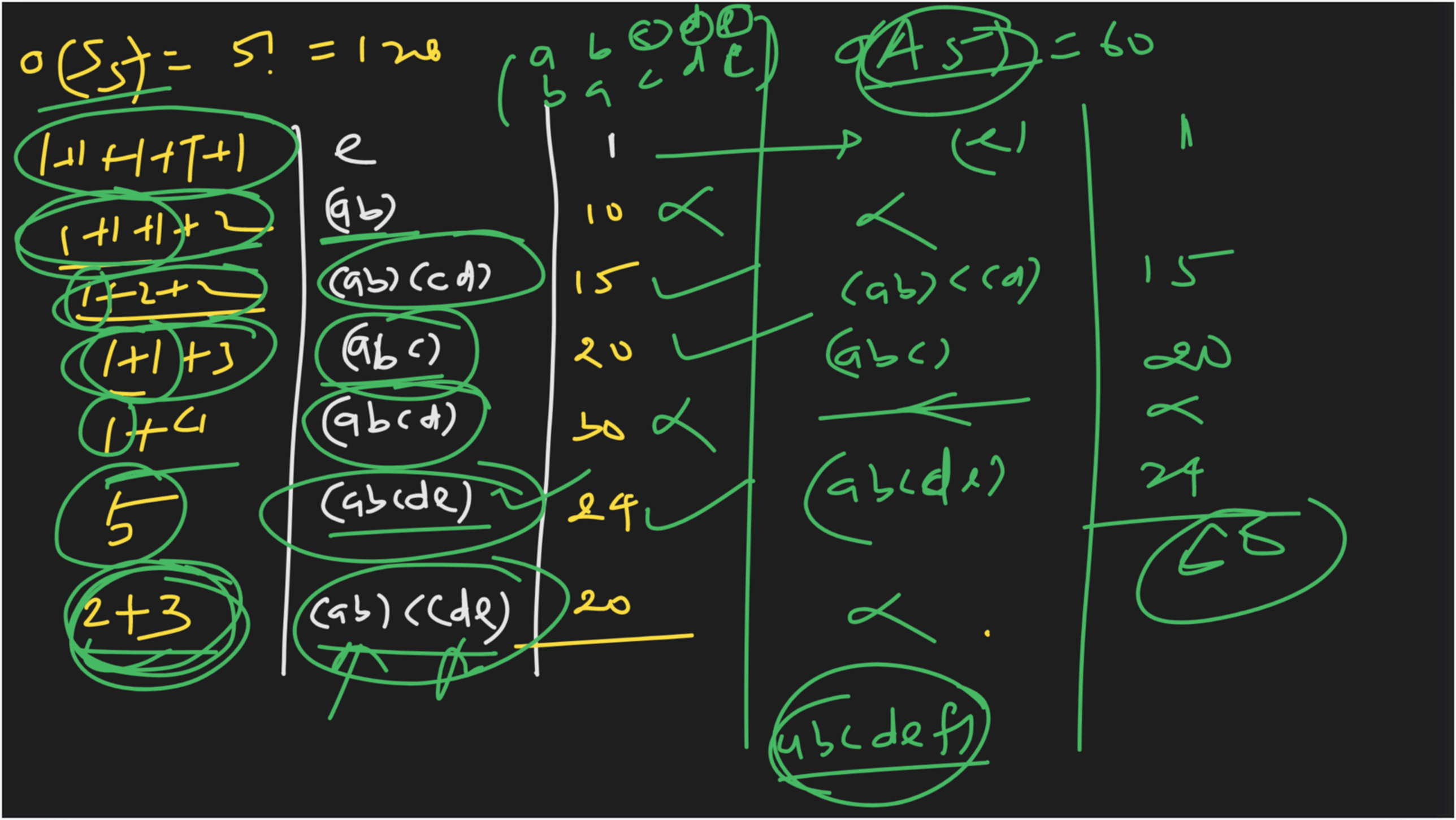
$$o(1) = \frac{4!}{1^4 \cdot 4!} = 1$$

$$o(ab) = \frac{4!}{1^2 \cdot 2! \times 2} = \frac{24}{4} = 6$$

$$o[(ab)(cd)] = \frac{4!}{2^2 \cdot 2!} = \frac{24}{8} = 3$$

$$o(abc) = \frac{4!}{1 \times 3}$$

$$o(abcd) = \frac{4!}{4} = 6$$


o(S5) = 5! = 120
1+1+1+1+1
1+1+1+2
1+2+2
1+1+3
1+4
5
2+3
e
(ab)
(ab)(cd)
(abc)
(abcd)
(ab)(de)
(ab)((de)
10
15
20
30
24
20
A5 = 60
(a1
(ab)((d)
(abc)
(ab(d1)
(ab(def)
1
15
20
24
60

S6

Maximum order element in S6 ?

(a) 9 (b) 10

(c) 6 (d) 5

(2)

1+1+1+1+2

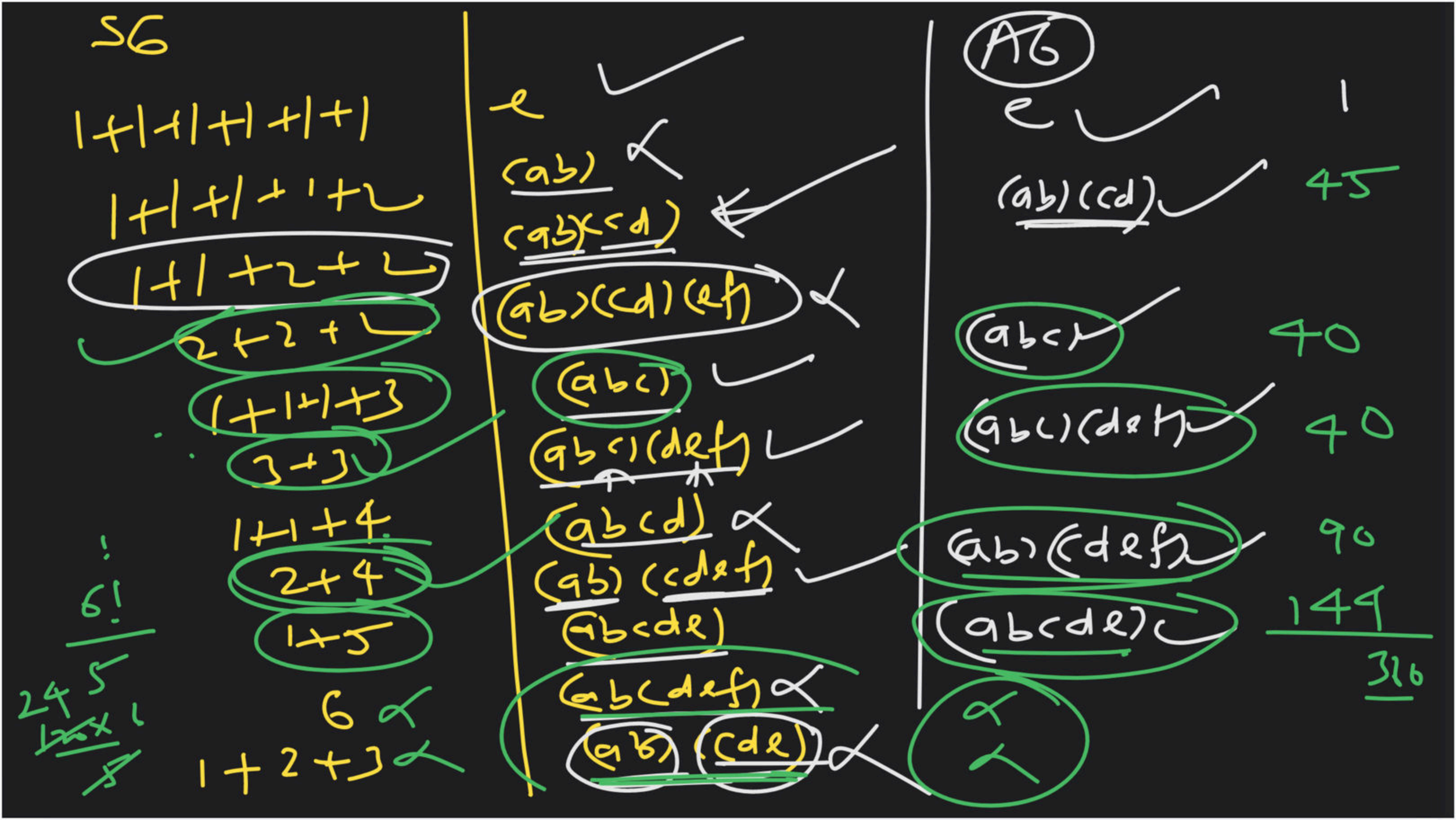
1+1+2=12

2+2+2

$$\frac{6!}{1^4 \cdot 4! \times 2} = \frac{6 \times 5 \times 4!}{4! \times 2} = 15$$

$$\frac{6!}{1^2 \cdot 2! \cdot 2^2 \cdot 2!} = \frac{120 \times 1}{16} = 45$$

$$\frac{6!}{2^3 \cdot 3!} = \frac{120 \times 1}{8 \times 6} = 5$$


SG
1+1+1+1+1+1
1+1+1+1+2
1+1+2+2
2+2+1
1+1+1+3
3+3
1+1+4
2+4
1+5
6
1+2+3
AG
e
(ab)
(ab)(cd)
(ab)(cdef)
(abc)
(abc)(def)
(abcd)
(ab)(cdef)
(abcde)
(abcdef)
(ab)(cde)
1
45
40
40
90
149
316

Note :

Types of permutation in S_3 are I, (ab), (abc)

Types of permutation in S_4 are I, (ab), (abc), (abcd), (ab)(cd)

Type of permutation in S_n are partition of n.

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Note :

(1) The maximum order of elements in S_3 are 3.

(2) The maximum order of elements in S_4 are 4.

(3) The maximum order of elements in S_5 are 6.

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Number of r-cycles in S_n

Number of cycles of length r in S_n are ${}^{n}C_{r}\,(r-1)! = \frac{n!}{r(n-r)!}$.

Number of product of disjoint cycles in S_n

$$= \frac{n!}{\alpha_1^{k_1}.\alpha_2^{k_2}.....\alpha_i^{k_i}.\,k_1!\,k_2!.....k_i!}$$

Where α_i is order of cycle and k_i are repeated number of cycles of order α_i.

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Alternating Group :

The group of all even permutation of S_n under composition of function is called alternating group and denoted by A_n.

Order of alternating group $O(A_n) = \frac{n!}{2}$.

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Q.1. Let S_7 denote the group of permutation of the set { 1 ,2 ,3 ,4 ,5 ,6 ,7}.which of the following is true.

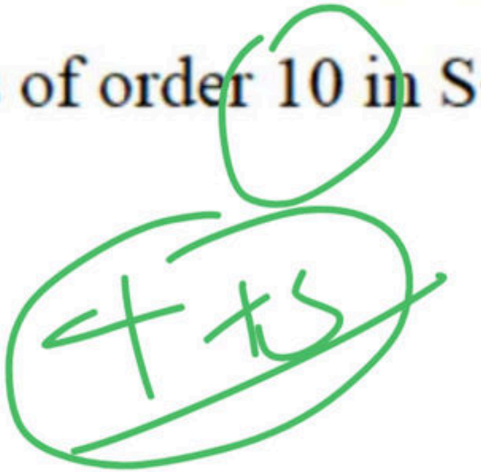
CSIR NET JUNE 2018

(a) There are no elements of order 6 in S_7

(b) There are no elements of order 7 in S_7

(c) There are no elements of order 8 in S_7

(d) There are no elements of order 10 in S_7



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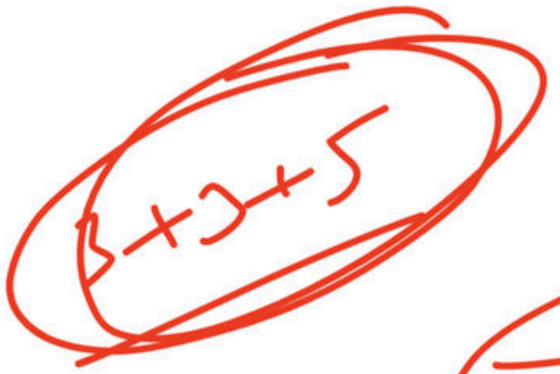
Q.2. Which of the following numbers can be orders of permutation σ of 11 symbols such that σ does not fix any symbol **CSIR NET DEC. 2011**

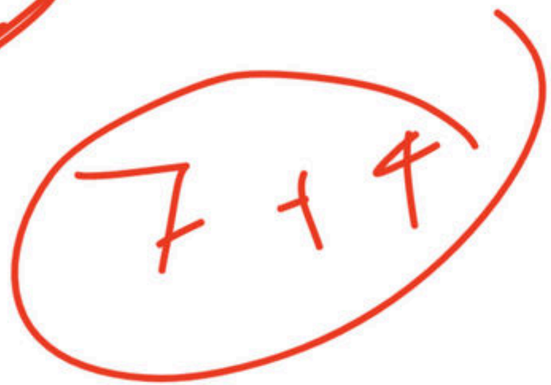
(a) 18

(b) 30

(c) 15

(d) 28





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Q.3. The number of elements in the set $\{x \in S_3 : x^4 = e\}$ is

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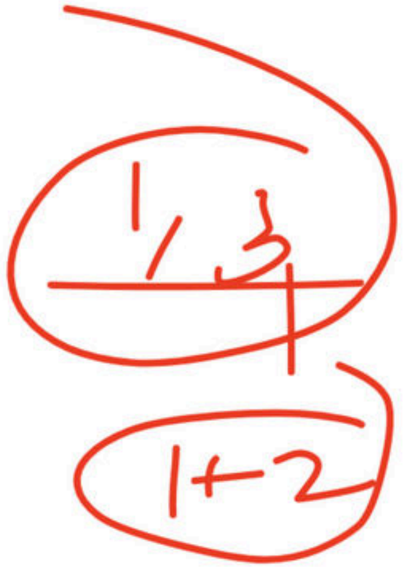
(a) 1 (b) 2 (c) 3

(d) 4



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Q.4. The order of elements (123)(245)(456) in the group S_6 is **IIT - JAM-2018**

(a) 1 (b) 2

(c) 4 (d) 6

(1234)(57)

lcm(4,2) = 4

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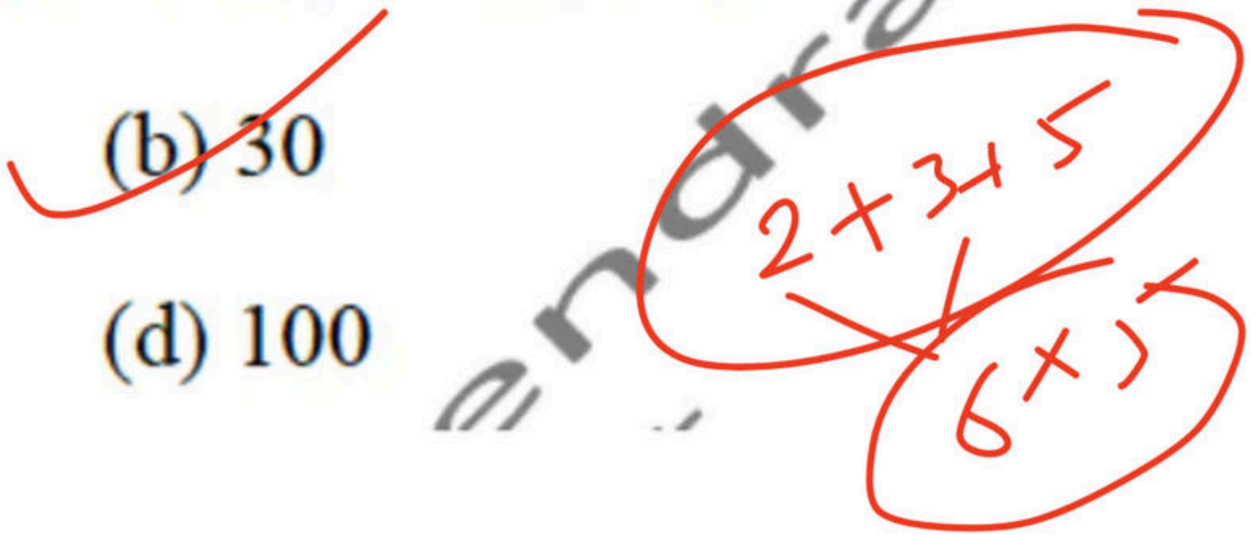
Q.5. The maximum order of a permutation σ in the symmetric group S_{10} is **IIT - JAM 2017**

(a) 10 (b) 30

(c) 5 (d) 100



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Q.6. Number of elements of order 4 in $Z_4 \times S_4$ are

(a) 30 (b) 24

(c) 25 (d) Not exist

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Q.7. Let σ be an element of permutation group S_5. Then the maximum possible order of σ is **IIT - JAM 2016**

(a) 5 (b) 6

(c) 10 (d) 15

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Q.7. Let A_6 be the group of even permutation of 6 distinct symbols, then the number of elements of order 6 in A_6 are **IIT - JAM-2018**

(a) 0 (b) 1

(c) 3 (d) 6

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Q.8. If $\alpha = (1\ 3)(2\ 5\ 4)$ in the symmetric group S_5, then α^{65} equals **IIT - JAM 2011**

(a) $(1\ 3)(2\ 5\ 4)$

(b) $(1\ 2)(3\ 4\ 5)$

(c) $(3\ 2)(1\ 5\ 4)$

(d) $(3\ 1)(2\ 4\ 5)$

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Q.9. The number of elements of S_5 (the symmetric group of 5 letters) which are their own inverses equals

IIT - JAM 2010

(a) 10 (b) 11

(c) 25 (d) 26

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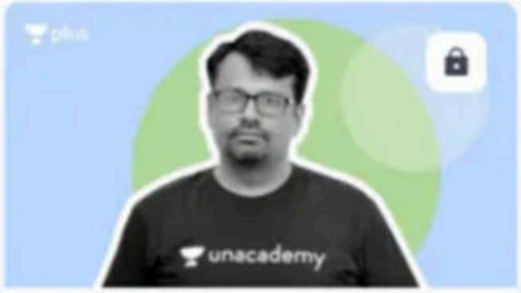

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Educator highlights

- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
- PhD, NET | Plus Educator For CSIR NET | Youtuber (260K+Subs.) | Director Pacific Science College |
- Lives in **Udaipur, Rajasthan, India**
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