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18/SCS 01/099

Computer Science

1) $G = (\{S\}, \{a, b\}, S, P)$

with production rules

$S \rightarrow aS / bS / a$

$S \rightarrow a$

$S \rightarrow aS \rightarrow aa$

$S \rightarrow aS \rightarrow abS \rightarrow abaa$

$S \rightarrow bS \rightarrow ba$

$S \rightarrow bS \rightarrow bbS \rightarrow bbba$

$(a^m b^n a^p / m, n \geq 0, p \geq 1)$

ii) $G = (\{S, A, B\}, \{a, b\}, S, P)$

with production rules

$S \rightarrow aAb / aBb / aSb$

$A \rightarrow aA / a$

$B \rightarrow bB / b$

$S \rightarrow aAb \rightarrow aab$

$S \rightarrow aBb \rightarrow abb$

$S \rightarrow aBb \rightarrow abBb \rightarrow abbbb$

$S \rightarrow aSb \rightarrow aaBbb \rightarrow aabbbb$

$S \rightarrow aSb \rightarrow aaBbb \rightarrow aabBbb \rightarrow aabbbbb$

$(a^n b^m / m, n \geq 1)$

iii) $G = (\{S, A, B\}, \{a, b\}, S, P)$

with production rules

$S \rightarrow AS / BS / \lambda$

$A \rightarrow a$

$B \rightarrow b$

$S \rightarrow \lambda$

$S \rightarrow AS \rightarrow aS \rightarrow a\lambda \rightarrow a$

$S \rightarrow AS \rightarrow aS \rightarrow aAS \rightarrow aaS \rightarrow aa\lambda \rightarrow aqa$

$S \rightarrow AS \rightarrow aS \rightarrow aBS \rightarrow abS \rightarrow abBS \rightarrow abbs \rightarrow abbl \rightarrow abb$

$S \rightarrow BS \rightarrow bS \rightarrow b\lambda \rightarrow b$

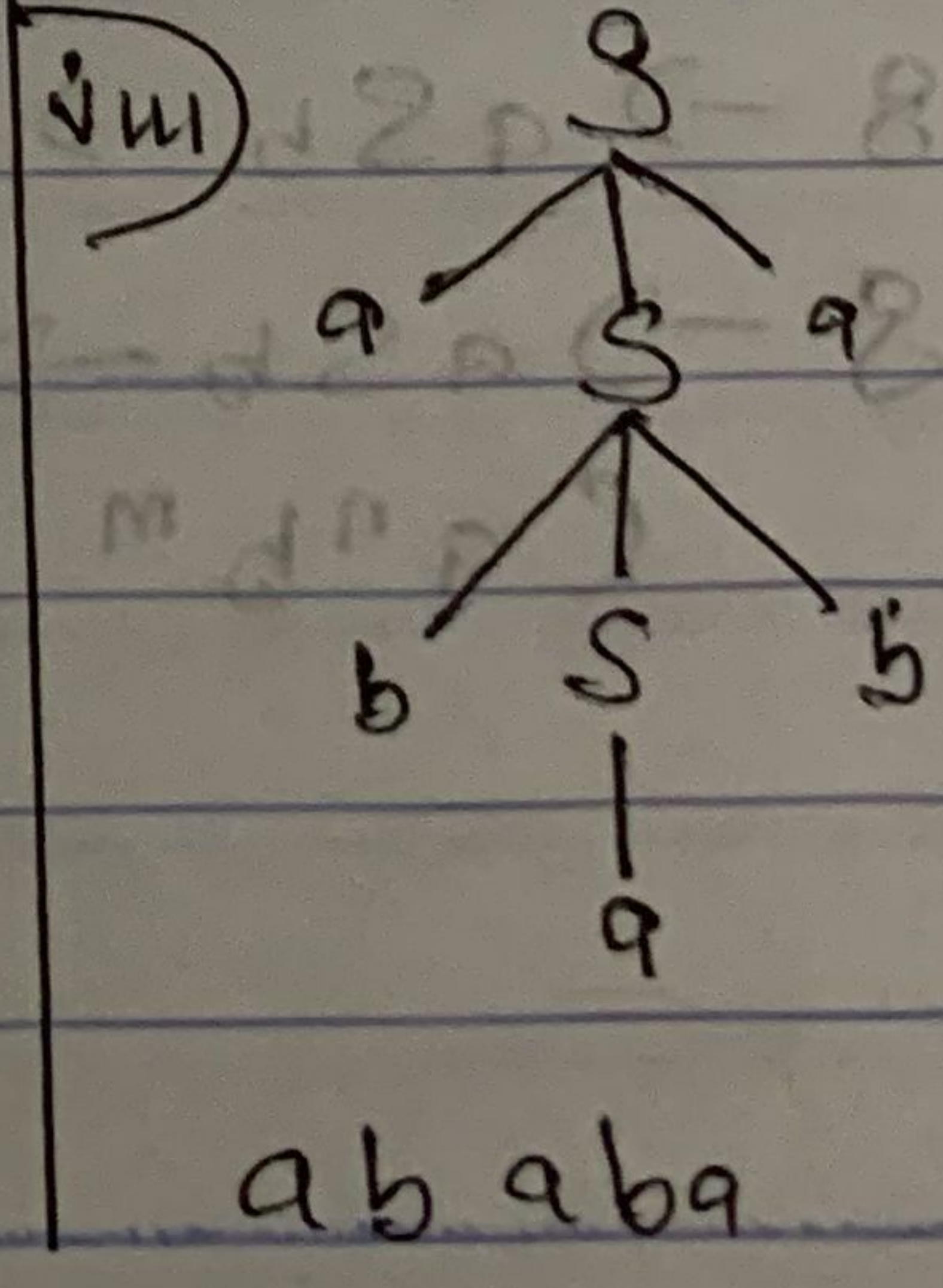
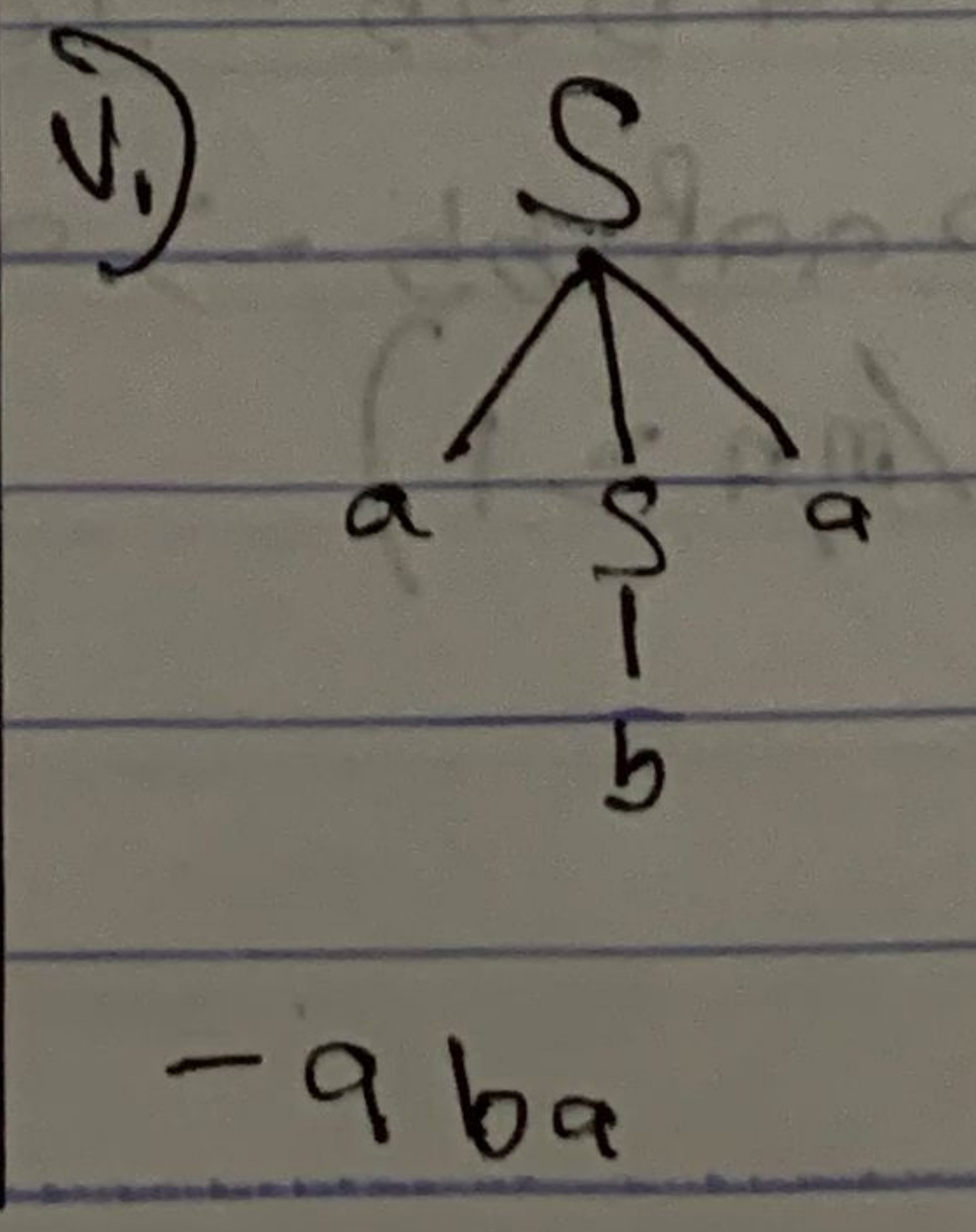
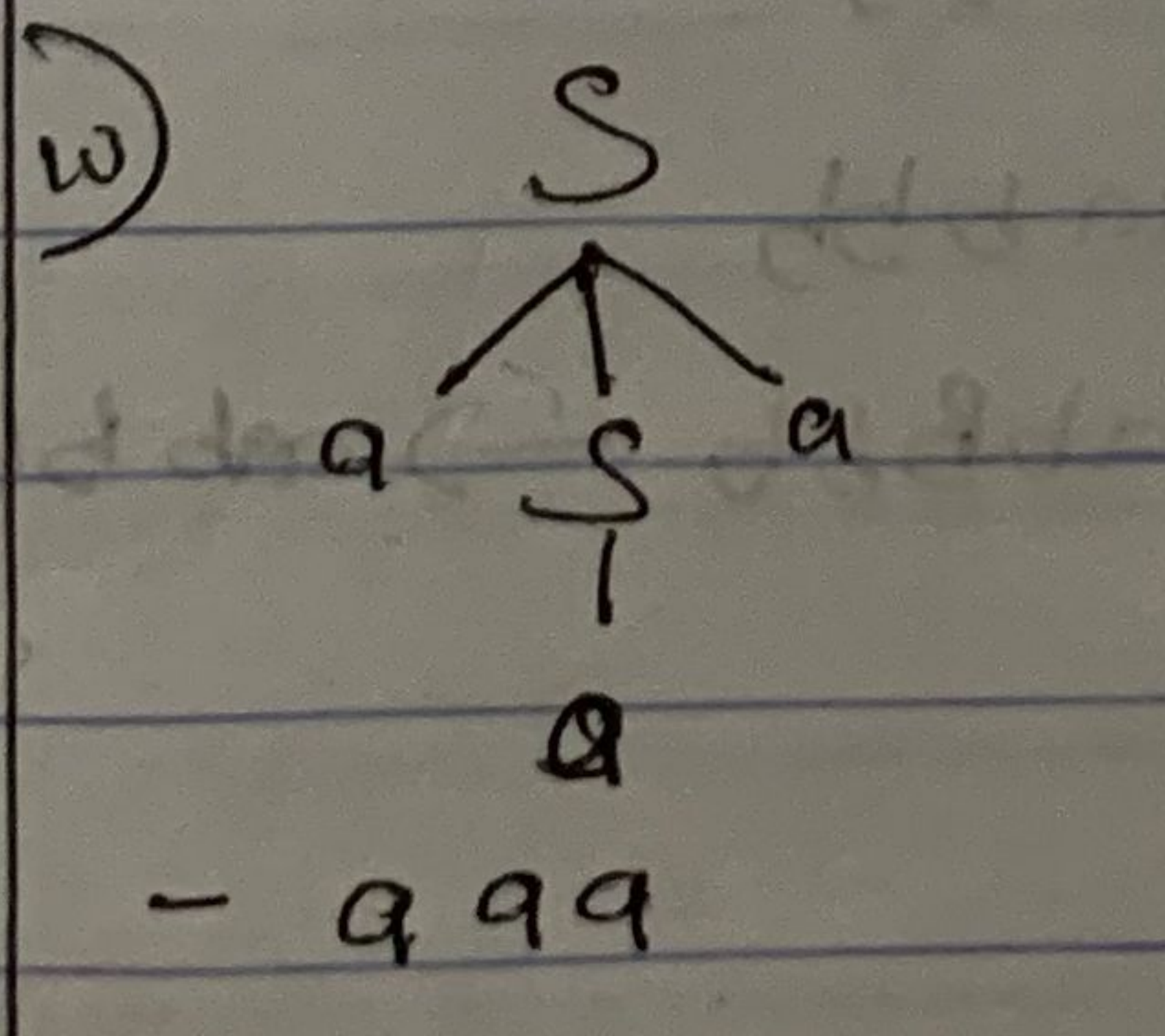
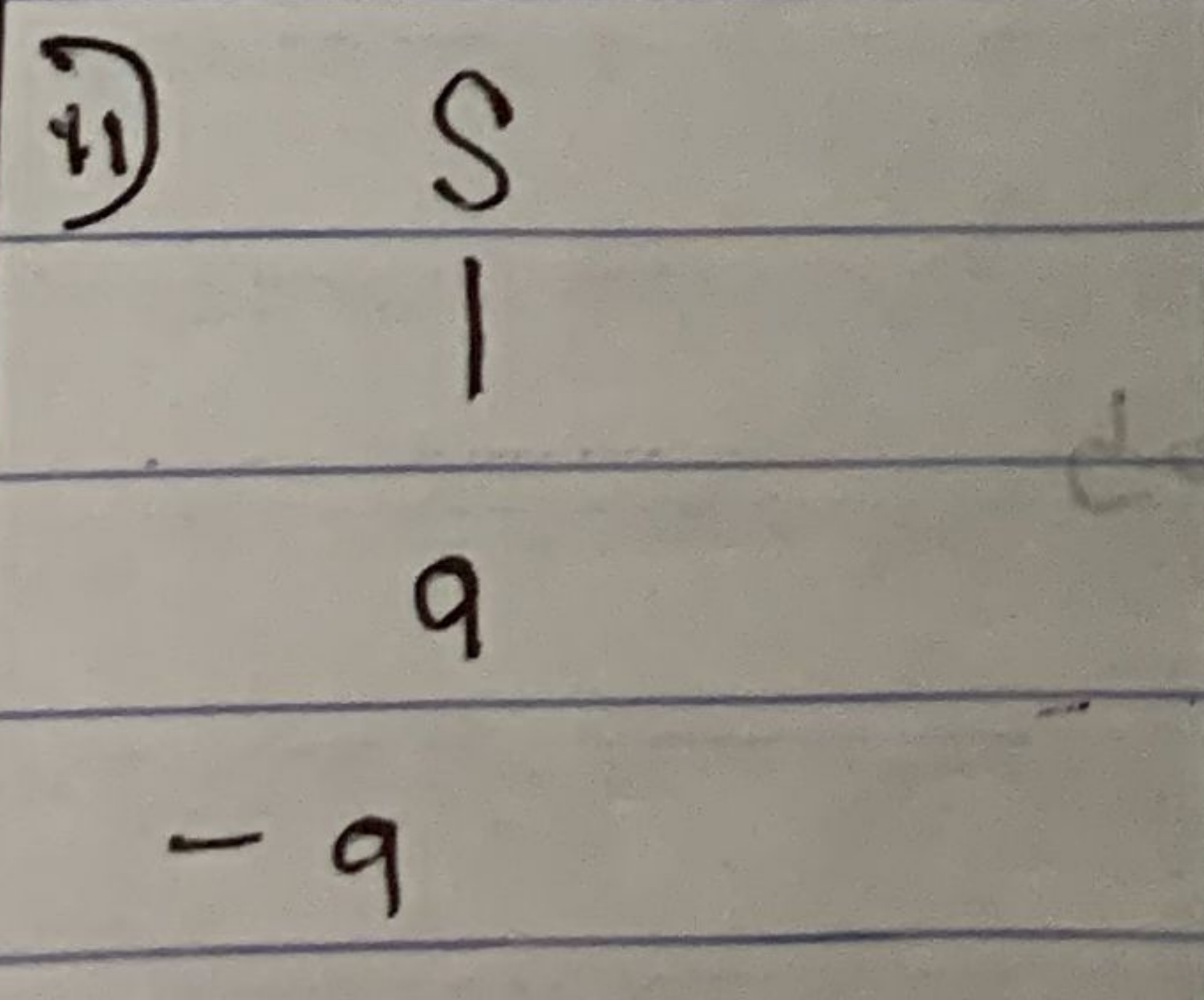
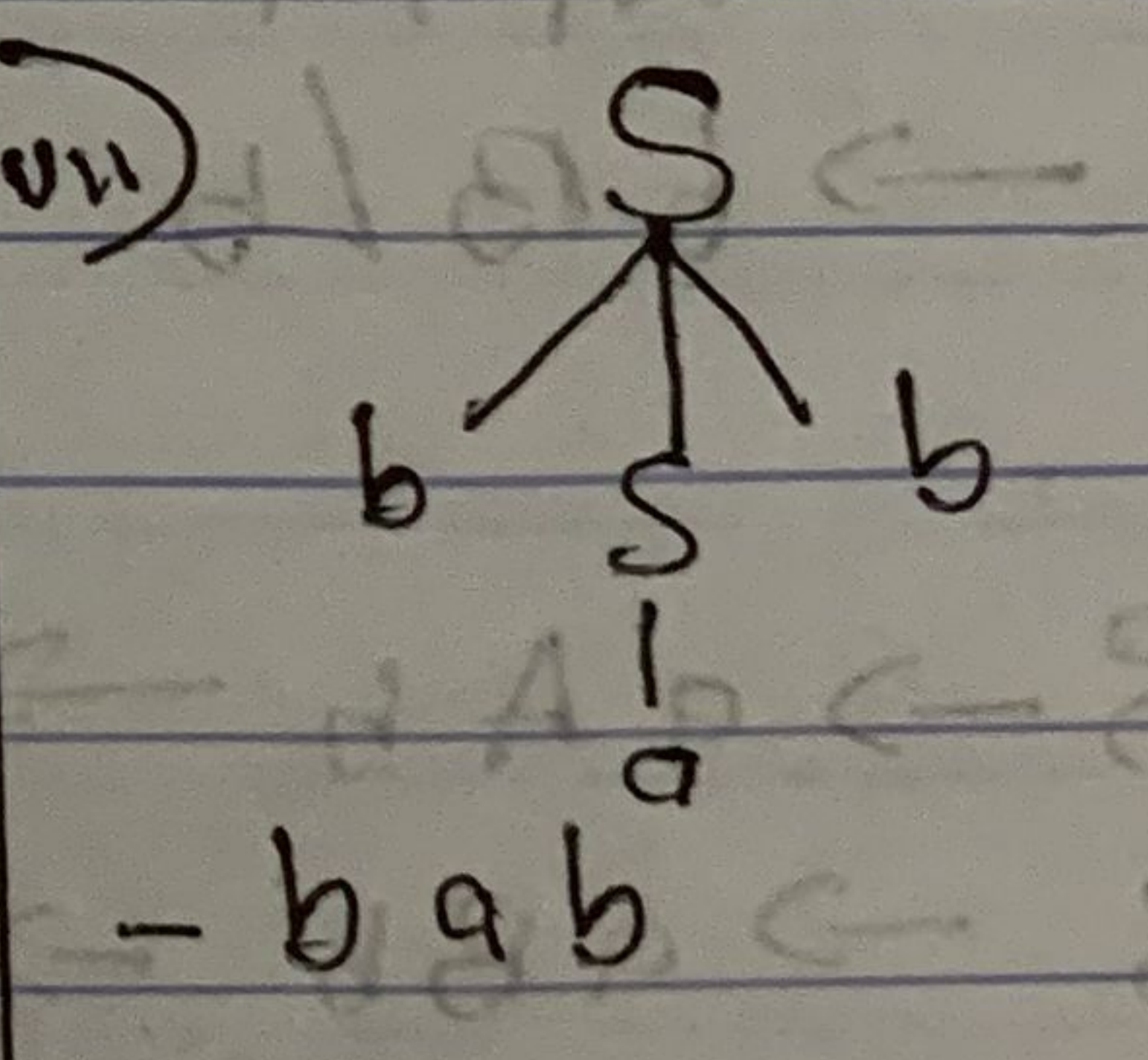
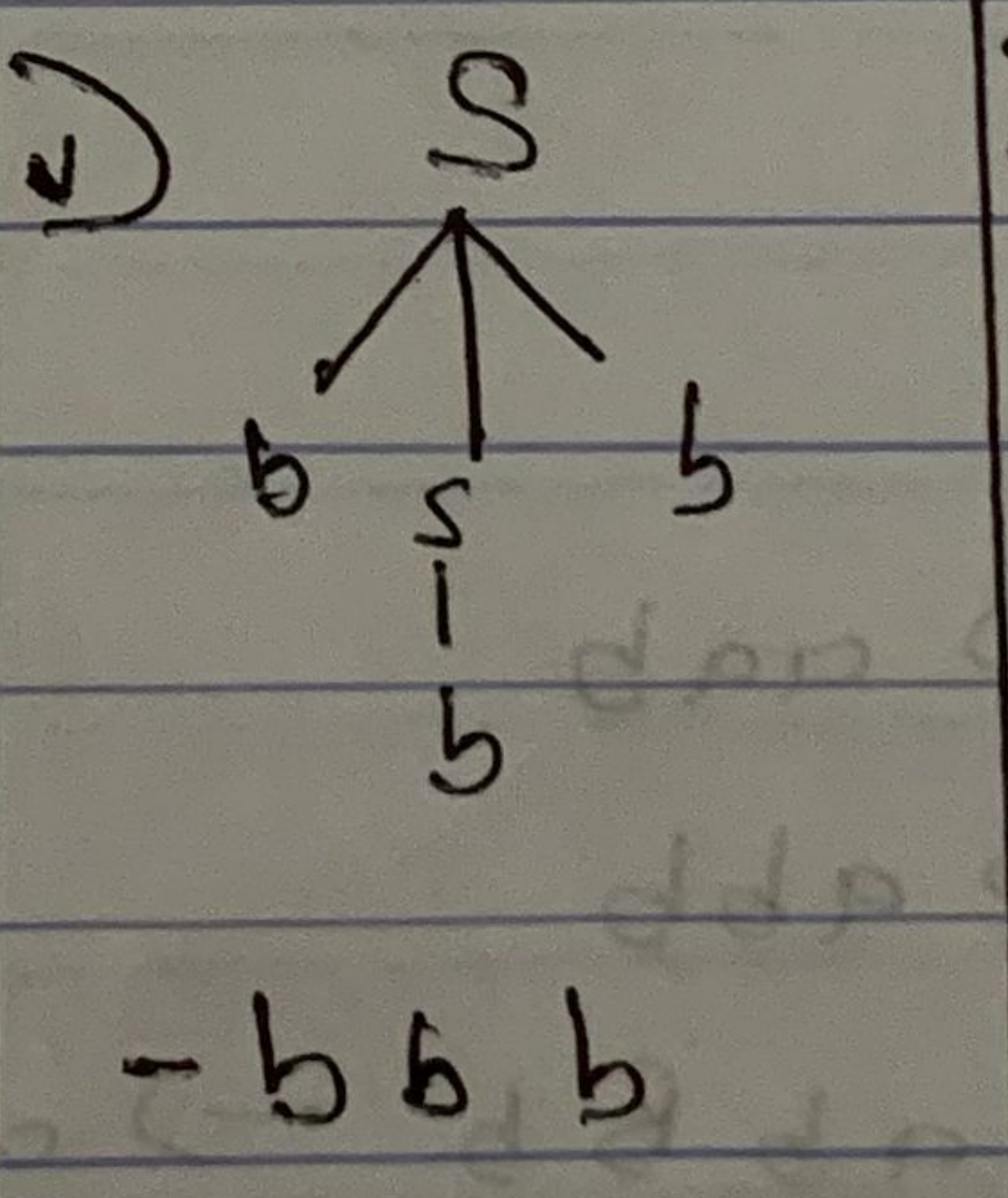
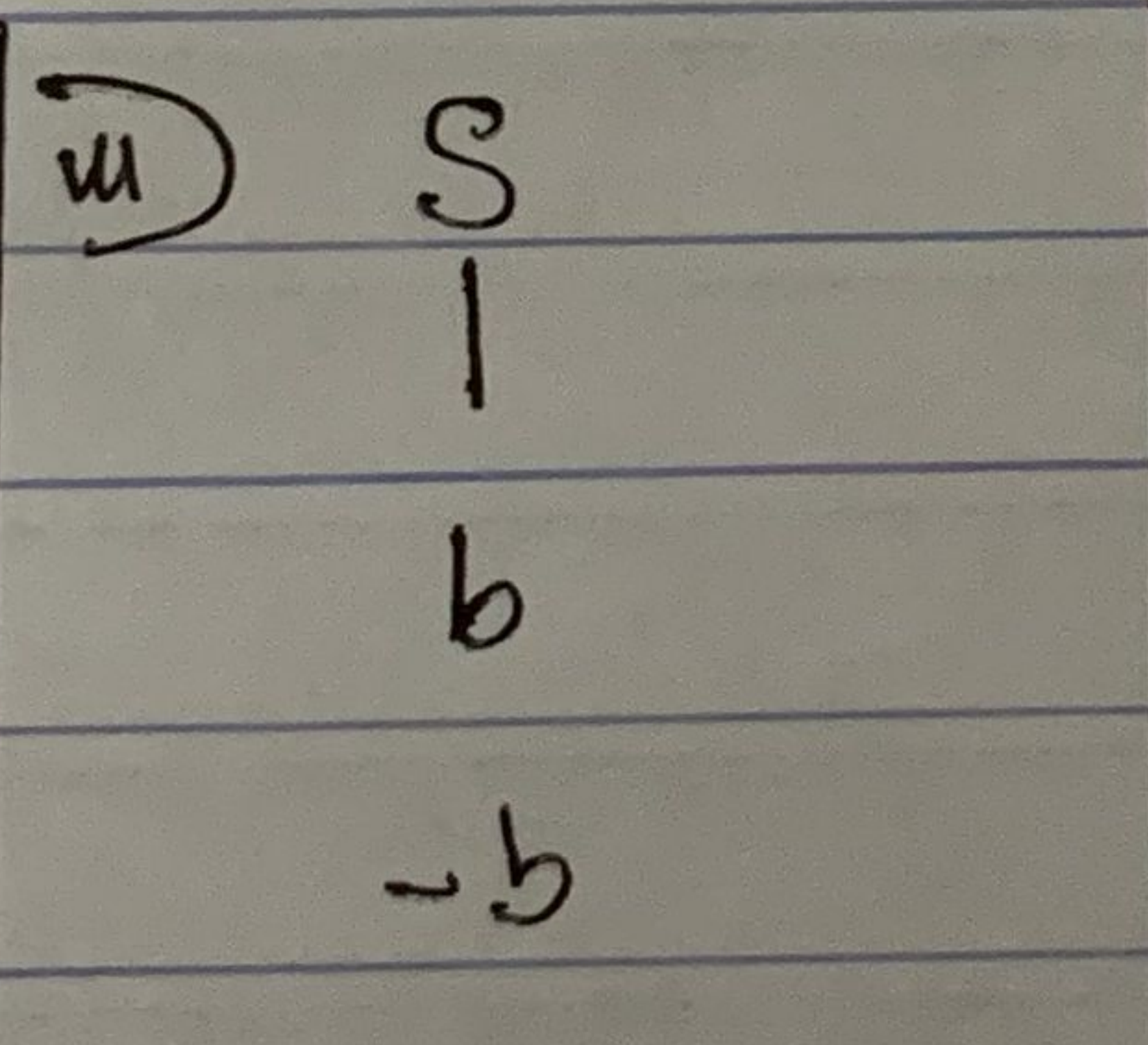
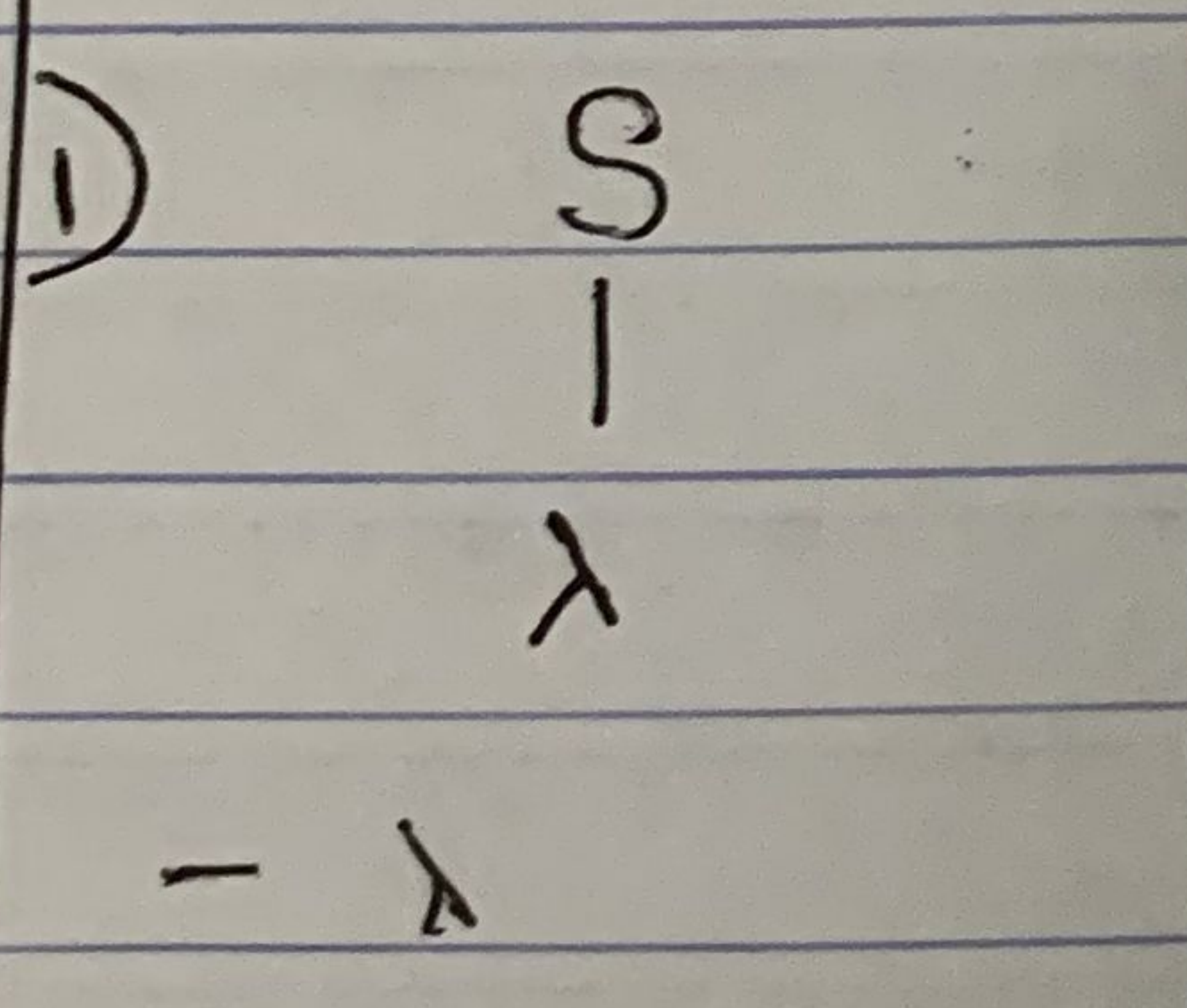
$S \rightarrow BS \rightarrow bS \rightarrow bBS \rightarrow bbS \rightarrow bb\lambda \rightarrow bb$

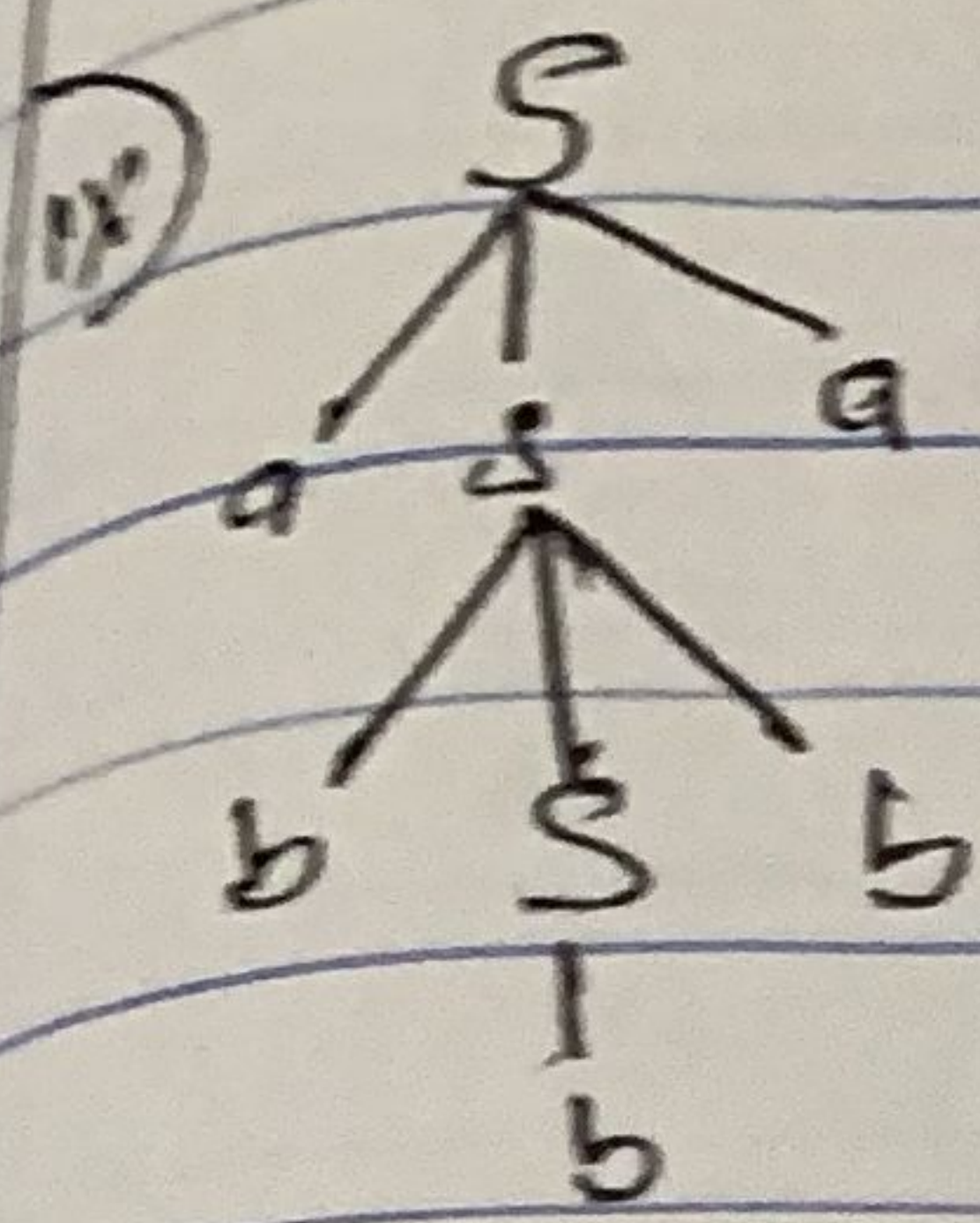
$S \rightarrow BS \rightarrow bS \rightarrow bAS \rightarrow baS \rightarrow ba\lambda \rightarrow ba$

ii) $G = (\{S\}, \{a, b\}, S, P)$

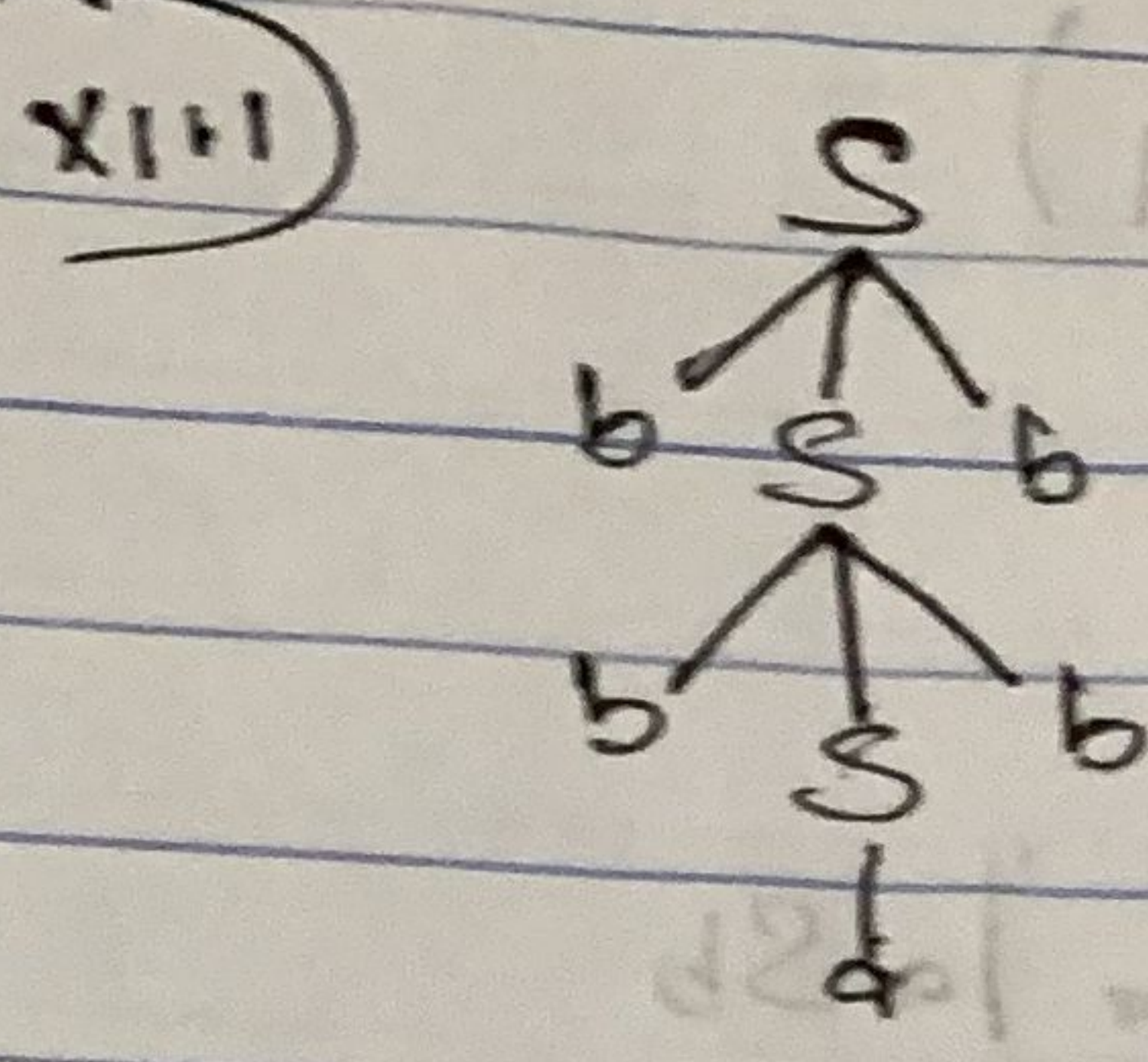
with production rules

$S \rightarrow aSa / bSb / a / b / \lambda$

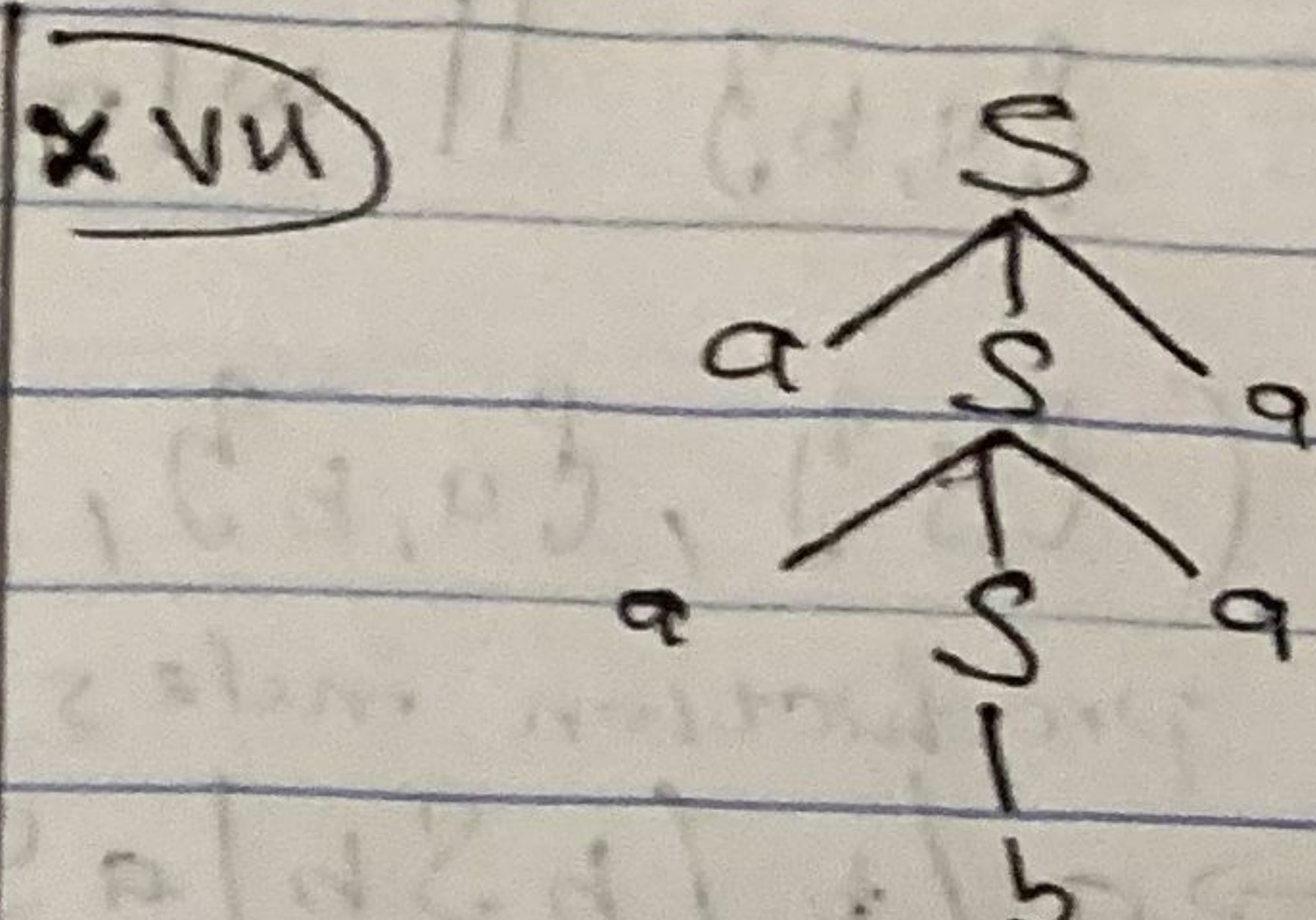




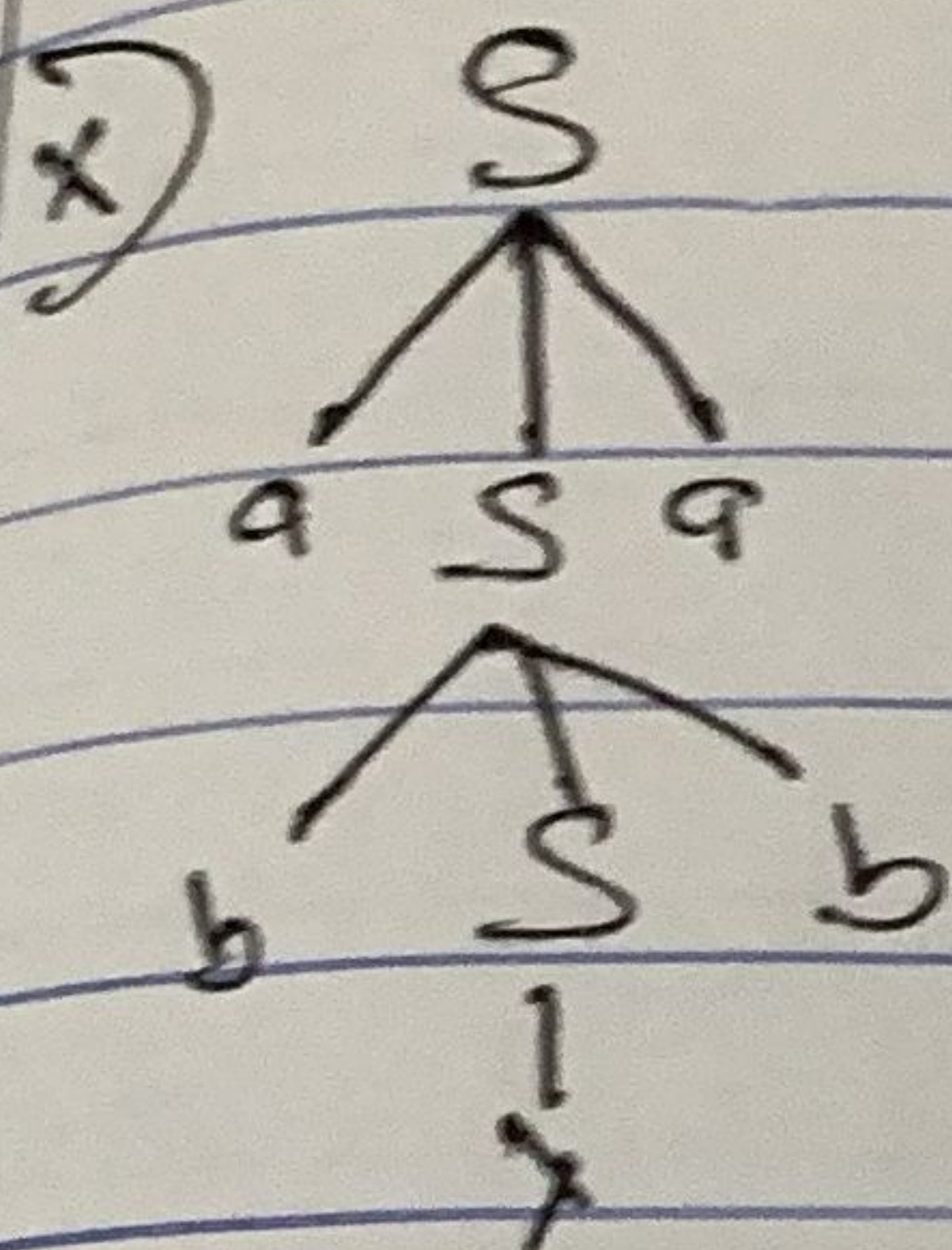
- abbbba



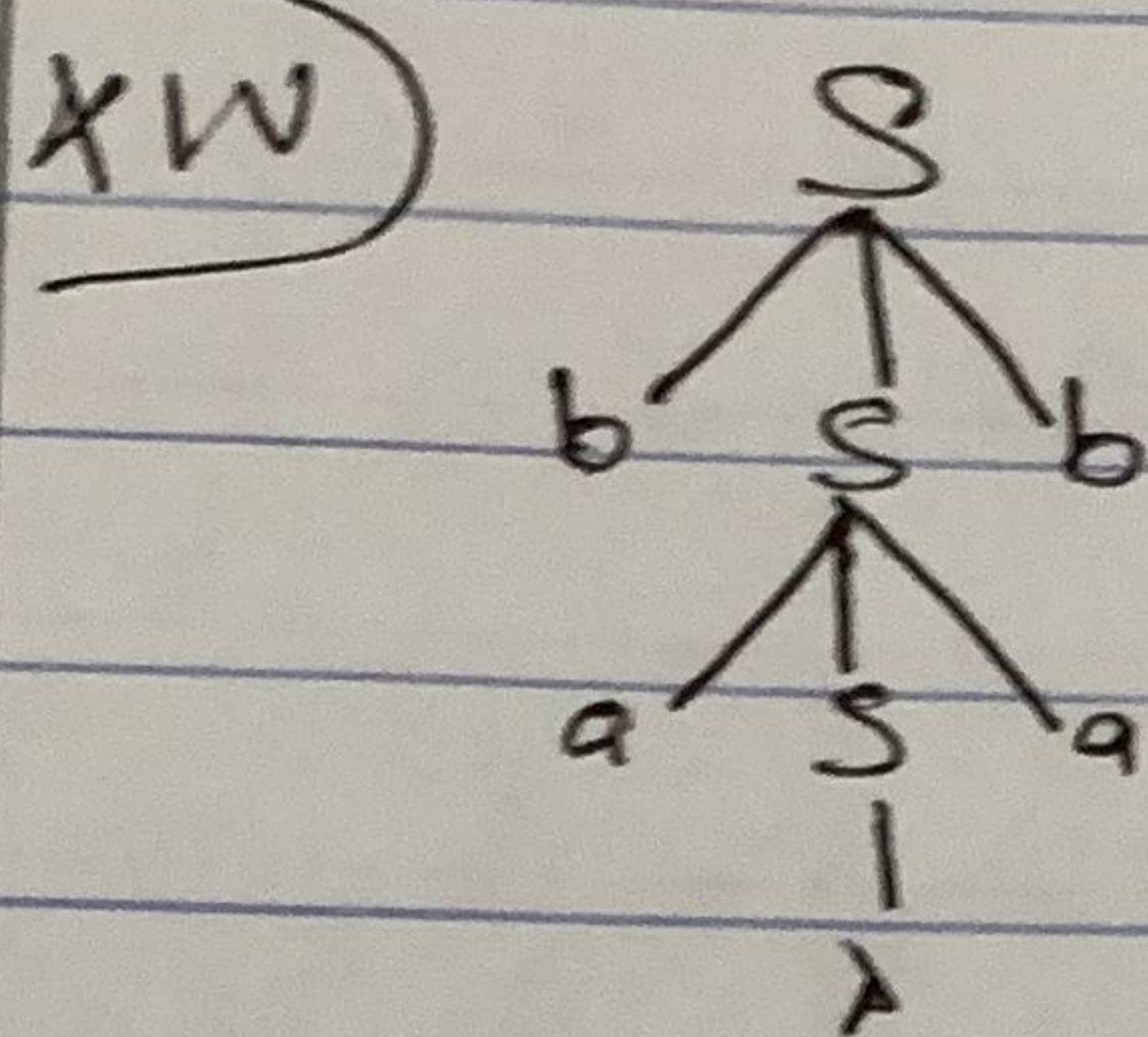
- bbab



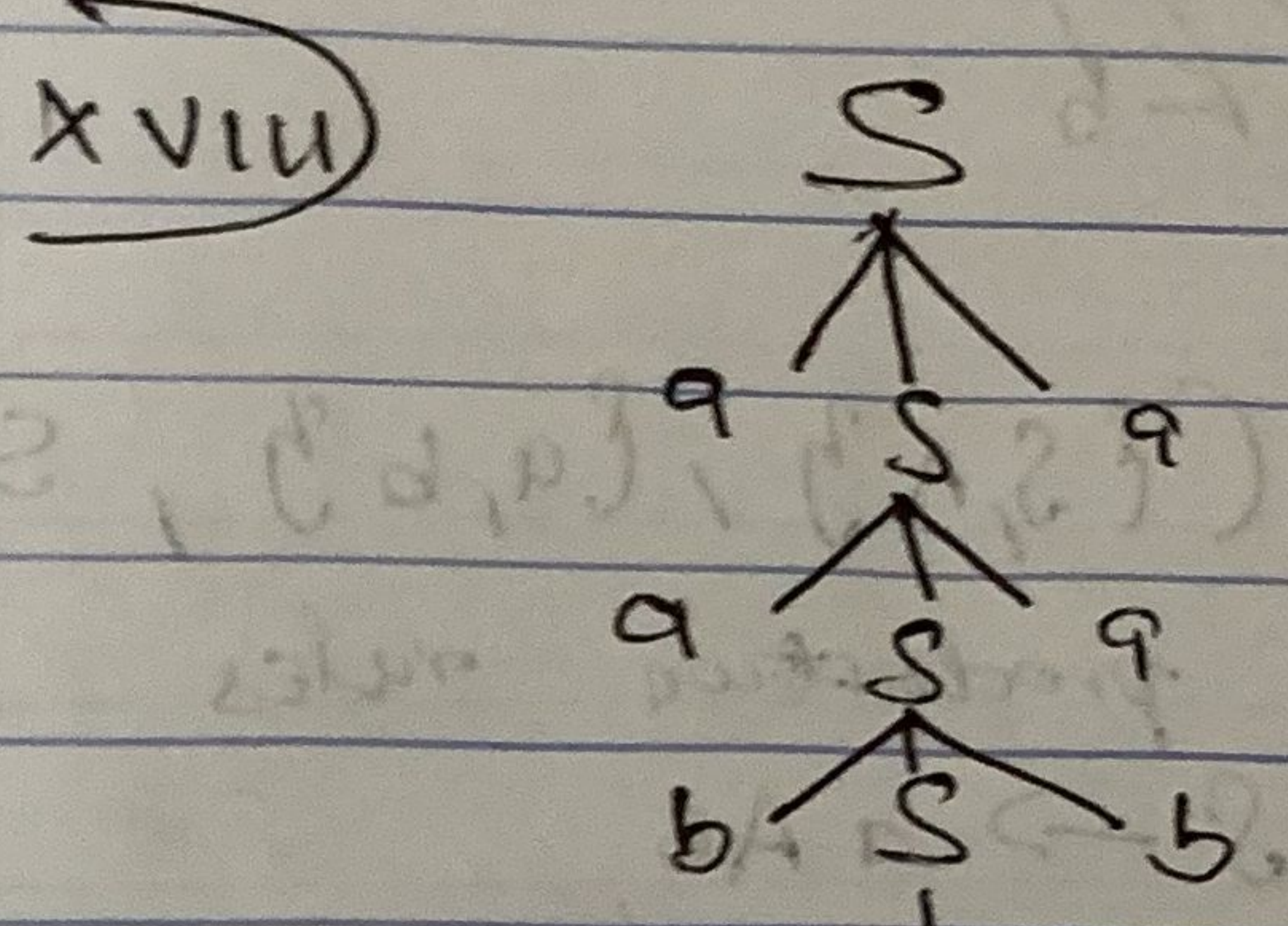
- aabaa



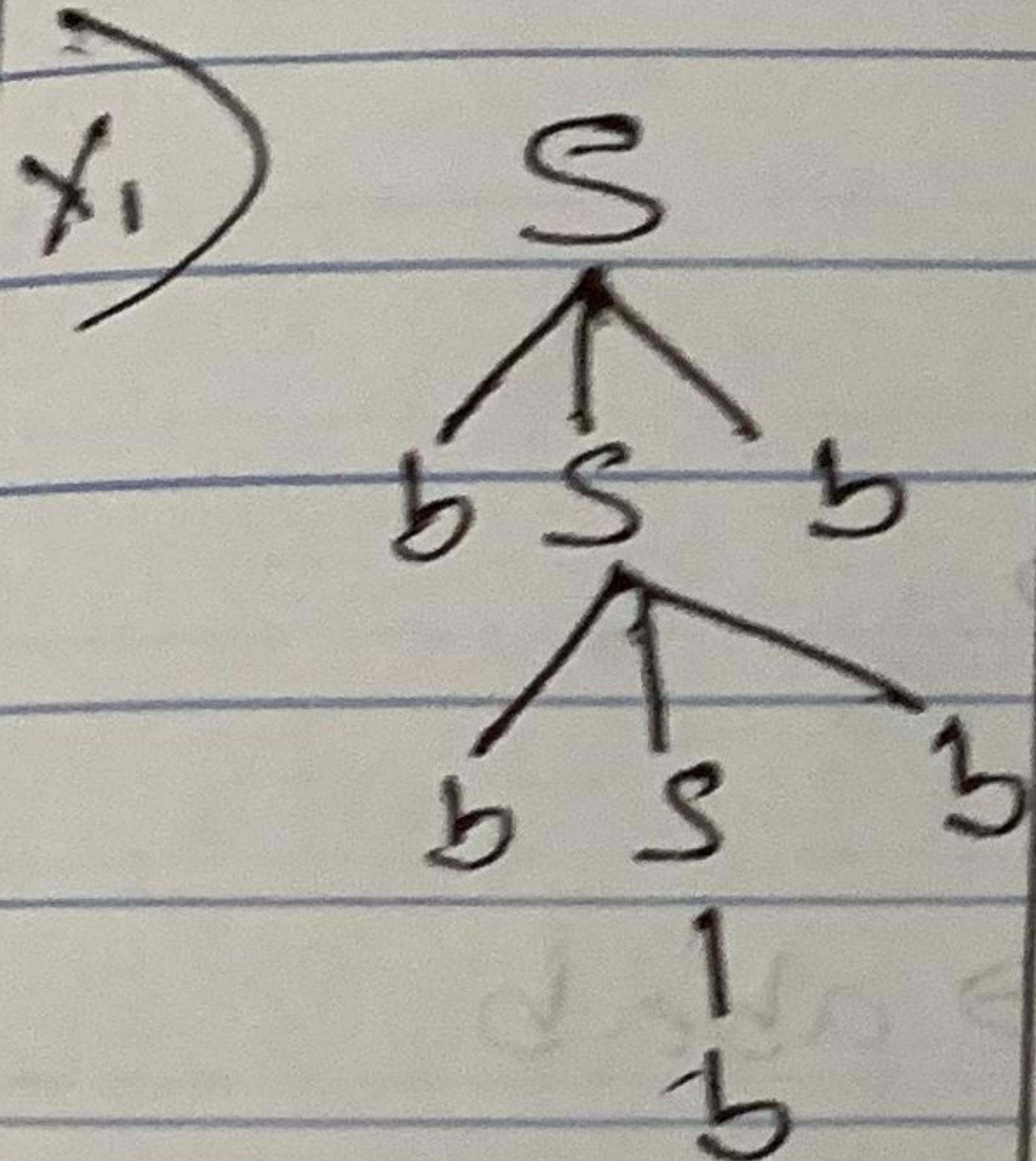
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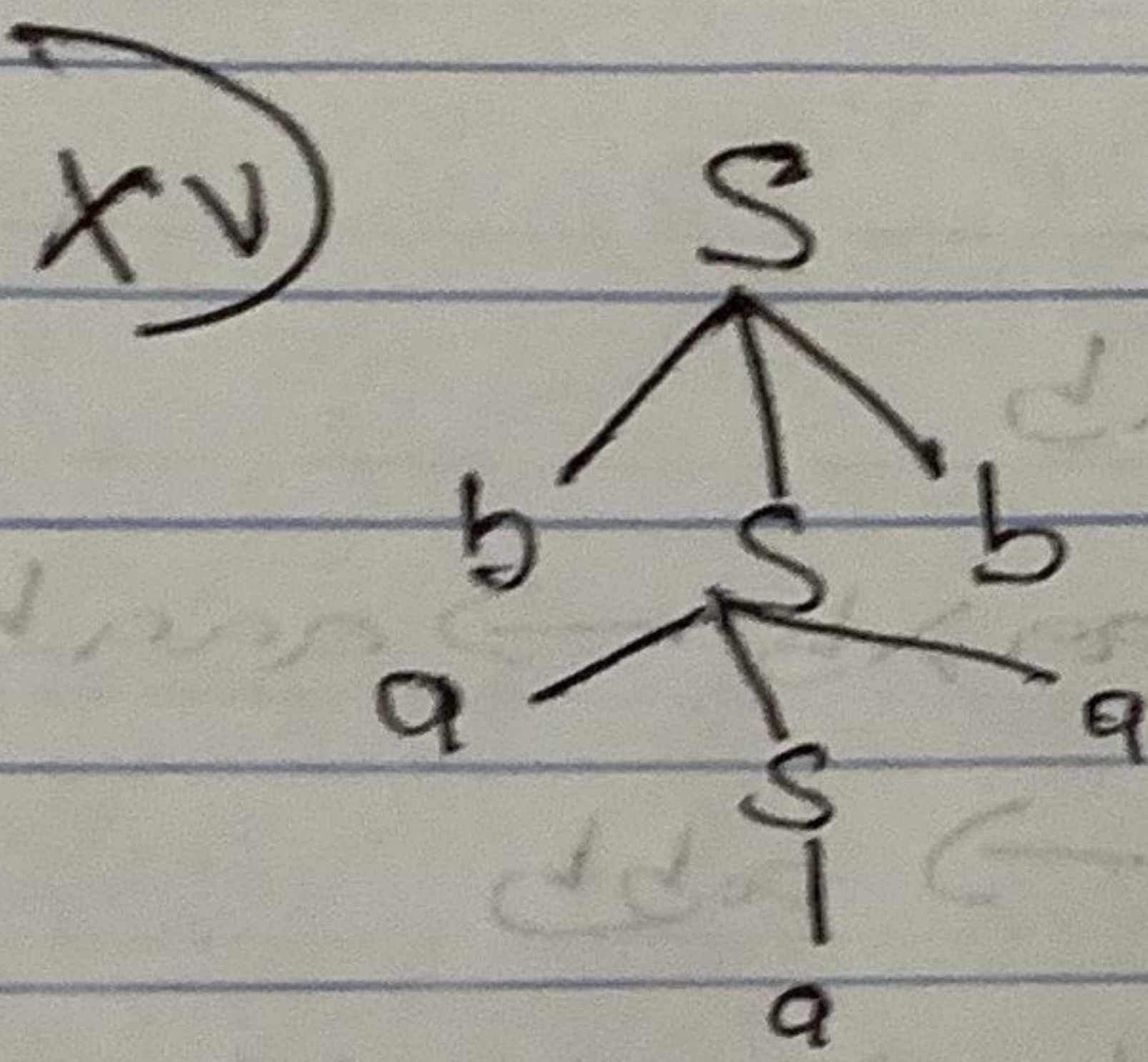
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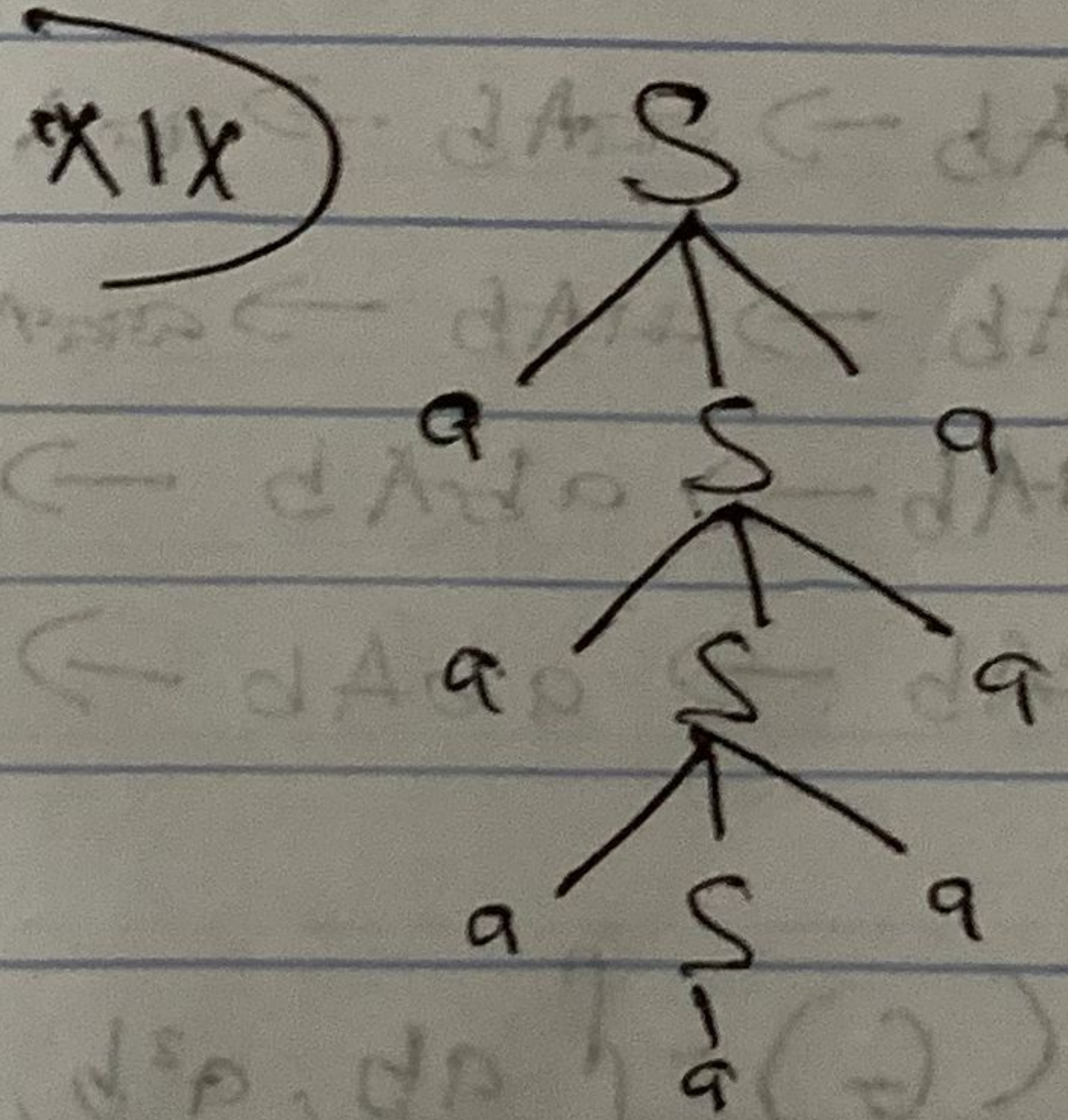
- aababaa



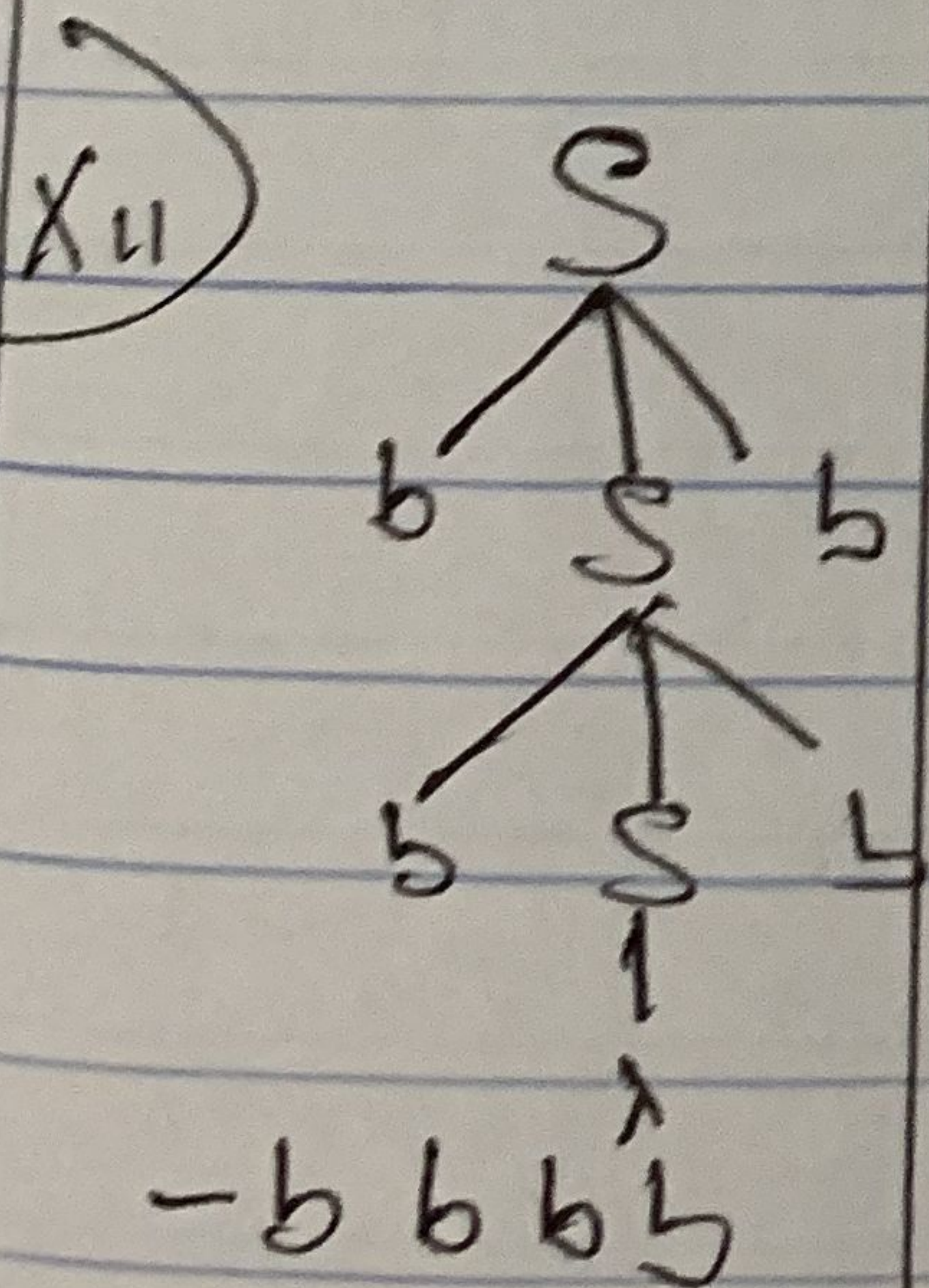
- bbbbbb



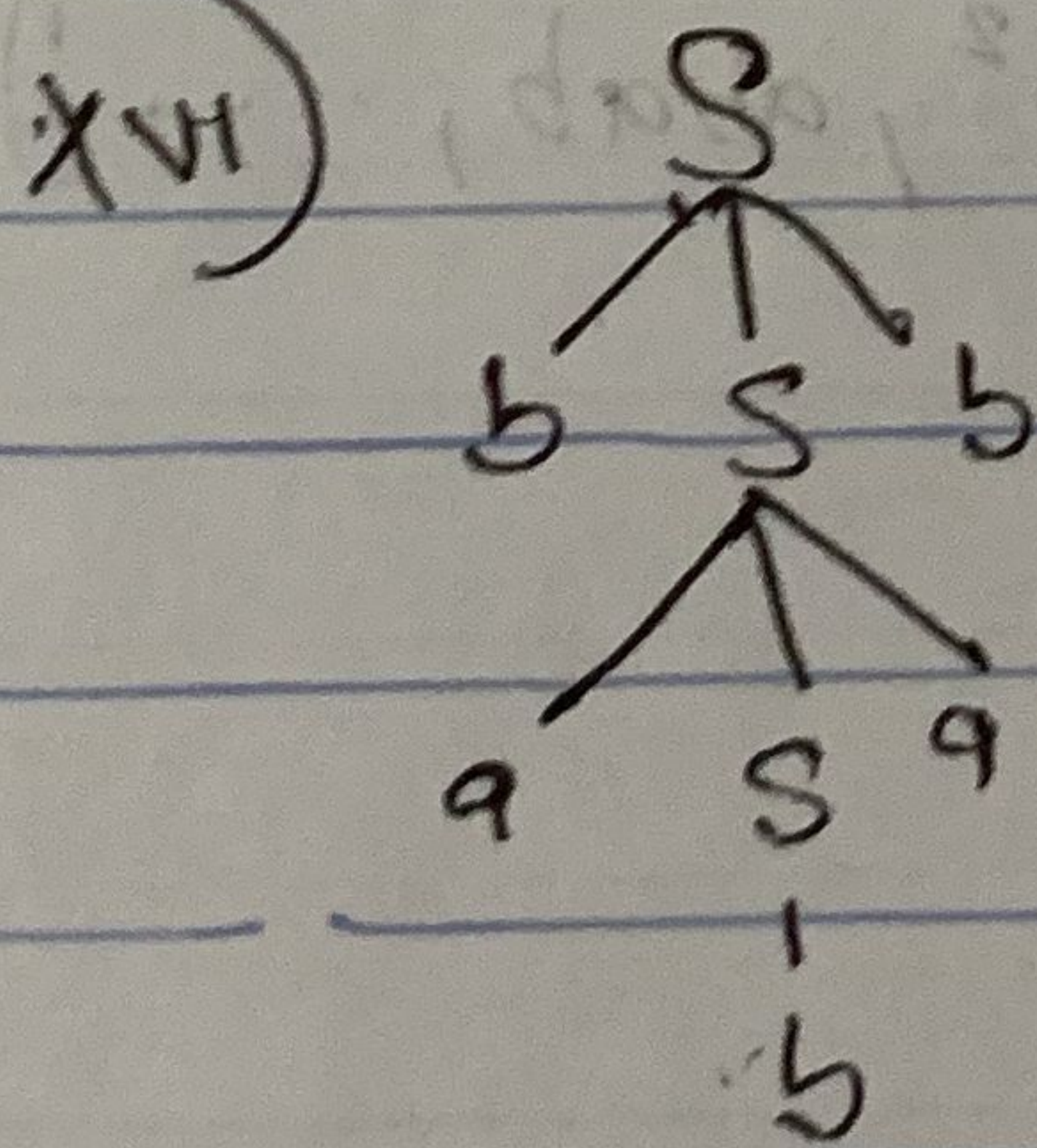
- baaba



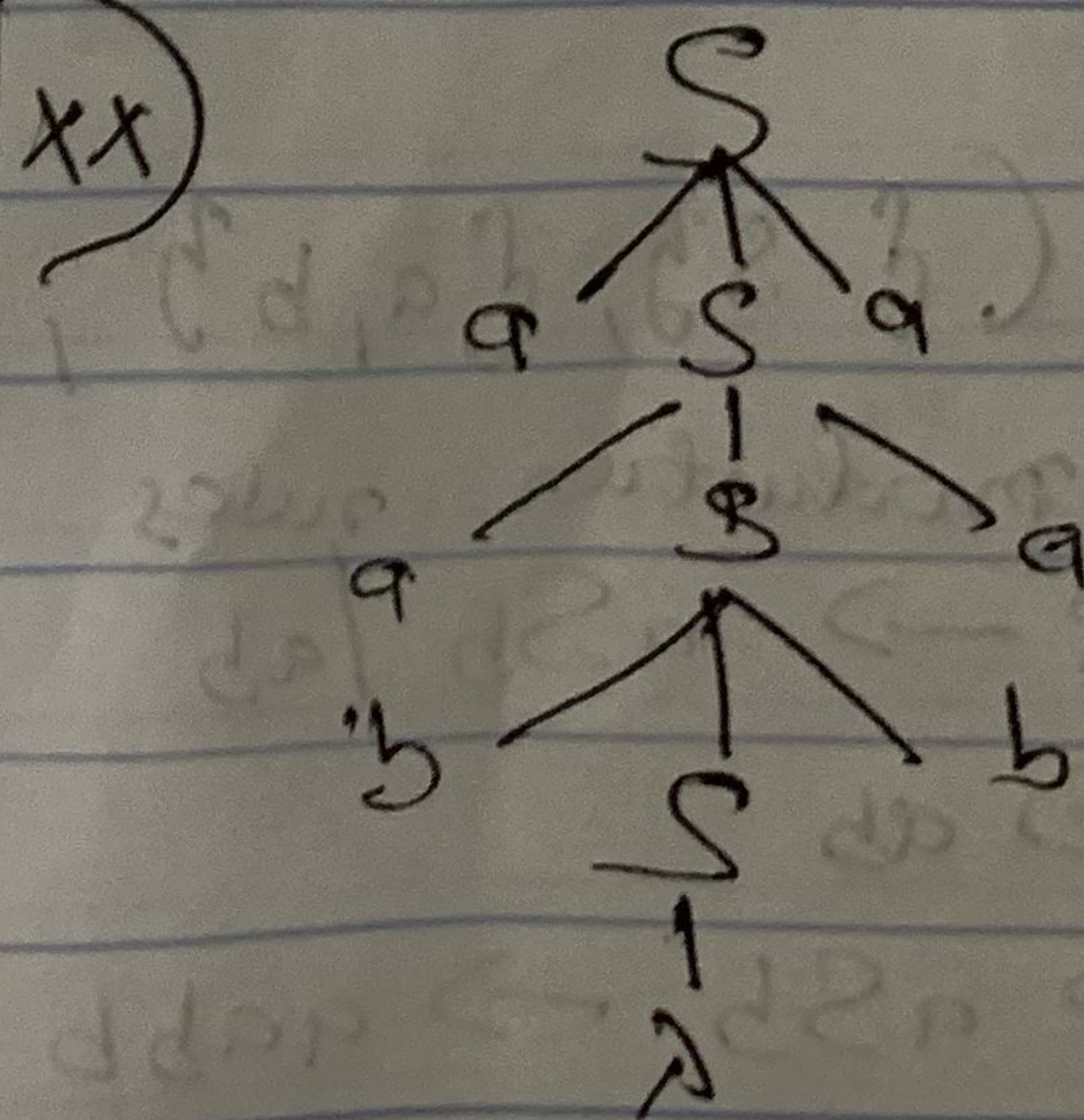
- aaaaaaaaa



- bbbba



- babab



- aabbaa

3 $(w \in \{a,b\} \mid w \pmod 2 = 1)$

$$G = (\{S\}, \{a,b\}, S, P)$$

with production rules

$$S \rightarrow a \mid b \mid bSb \mid aSa \mid bSa \mid aSb$$

$$S \rightarrow a$$

$$S \rightarrow b$$

4 $G = (\{S,A\}, \{a,b\}, S, P)$

with production rules

$$S \rightarrow aAb$$

$$A \rightarrow aA \mid bA \mid \lambda$$

$$S \rightarrow aAb \rightarrow a\lambda b \rightarrow ab$$

$$S \rightarrow aAb \rightarrow aAb \rightarrow aa\lambda b \rightarrow aab$$

$$S \rightarrow aAb \rightarrow aAb \rightarrow aAb \rightarrow aaaSb \rightarrow aaaSb$$

$$S \rightarrow aAb \rightarrow abAb \rightarrow ab\lambda b \rightarrow abb$$

$$S \rightarrow aAb \rightarrow abAb \rightarrow abaAb \rightarrow abaa\lambda b \rightarrow abaaab$$

$$L(G) = \{ab, a^2b, a^3b, ab^2, abab, \dots\}$$

ii) $G = (\{S\}, \{a,b\}, S, P)$

with production rules

$$S \rightarrow aSb \mid ab$$

$$S \rightarrow ab$$

$$S \rightarrow aSb \rightarrow aabb$$

$$L(G) = \{ab, a^2b^2, a^3b^3\} = \{a^m b^m \mid m \geq 1\}$$

$$iii) G = (\{S, A\}, \{a, b, c\}, S, P)$$

with production rules

$$S \rightarrow aSc / aAc$$

$$A \rightarrow aAb / ab$$

$$S \rightarrow aAbc \rightarrow aabc$$

$$S \rightarrow aSc \rightarrow aaAcc \rightarrow aaabcc$$

$$S \rightarrow aAc \rightarrow aaAbc \rightarrow aaabbc$$

$$S \rightarrow aSc \rightarrow aaSc \rightarrow aaaAcc \rightarrow aaaaAbcc \rightarrow aaaaa bbcc$$

$$L(G) = \{a^2bc, a^3bc^2, a^2b^2c, a^5b^2c^2, \dots\}$$

$$= \{a^n b^m c^p \mid n, m, p \geq 1\}$$

$$iv) G = (\{S, A, B\}, \{a, b\}, S, P)$$

with production rules

$$S \rightarrow AB$$

$$B \rightarrow bB / b$$

$$A \rightarrow aA / a$$

$$S \rightarrow AB \rightarrow aB \rightarrow ab$$

$$S \rightarrow AB \rightarrow aAB \rightarrow aAbB \rightarrow aabB \rightarrow aabb$$

$$L(G) = \{ab, a^2b^2, a^3b^3, \dots\}$$

$$= \{a^n b^n \mid n > 0\}$$