FNG

a) $S \to AB \mid SCB \mid SB \mid bB \mid b$

$A \to aA \mid a \mid cC \mid c$

$B \to bB \mid b$

$C \to cC \mid c$

1° Simp. OK

2° Remoção

$A_1 \to A_2A_3 \mid A_4A_4A_3 \mid A_4A_3 \mid bA_3 \mid b$

$A_2 \to aA_2 \mid a \mid cA_4 \mid c$

$A_3 \to bA_3 \mid b$

$A_4 \to cA_4 \mid c$

↓ 3° $R \leq S$ - OK

↓ Recursão 4°

$A_1 \to A_2A_3 \mid A_2A_3B \mid bA_3B \mid bB \mid A_2A_3C \mid bA_3C \mid bC \mid bA_3 \mid b$

$A_2 \to aA_2 \mid a \mid cA_4 \mid c$

$A_3 \to bA_3 \mid b$

$A_4 \to cA_4 \mid c$

$B \to A_4A_3 \mid A_4A_3B$

$C \to A_3 \mid A_3C$

↓ Terminal 5°

$A_1 \to aA_2A_3 \mid aA_3 \mid cA_4A_3 \mid cA_3 \mid aA_2A_3B \mid aA_3B \mid cA_4A_3B \mid cA_3B \mid bA_3B \mid bB \mid aA_2A_3C \mid aA_3C \mid cA_4A_3C \mid cA_3C \mid bA_3C \mid bC \mid bA_3 \mid b$

$A_2 \to aA_2 \mid a \mid cA_4 \mid c$

$A_3 \to bA_3 \mid b$

$A_4 \to cA_4 \mid c$

$B \to cA_4A_3 \mid cA_3 \mid cA_4A_3B \mid cA_3B$

$C \to bA_3 \mid bA_3C \mid bC \mid b$

$V = \{A_1, A_2, A_3, A_4, B, C\}$

$T = \{a, b, c\}$

$S = A_1$

6° → OK

d) $S \to AB$

$A \to aB$

$B \to bbB \mid b$

1° Simp - OK → 2° Remoção

$A_1 \to A_2A_3$

$A_2 \to aA_3$

$A_3 \to bbA_3 \mid b$

3° $R \leq S$ - OK → 4° Recursão - OK

↓ 5° → Terminal

$A_1 \to aA_3A_3$

$A_2 \to aA_3$

$A_3 \to bbA_3 \mid b$

↓ 6°

$A_1 \to aA_3A_3$

$A_2 \to aA_3$

$A_3 \to bBA_3 \mid b$

$B \to b$

$V = \{A_1, A_2, A_3, B\}$

$T = \{a, b\}$

$S = A_1$

b) $S \to aAd \mid ad \mid Bc$

$A \to Bc$

$B \to Ac \mid a \mid c$

5º Simp-OK → 2º Recursão

$A_1 \to aA_2d \mid ad \mid A_3c$

$A_2 \to A_3c$

$A_3 \to A_2c \mid a \mid c$

↓ 3º $n \leq 5$

$A_1 \to aA_2d \mid ad \mid A_3c$

4º Recursão ← $A_2 \to A_3c$

$A_3 \to A_3cc \mid a \mid c$

$A_1 \to aA_2d \mid ad \mid A_3c$

$A_2 \to A_3c$

$A_3 \to aBc \mid cBc \mid ac \mid cc$

$B \to cc \mid ccB$

↓ 5º → Terminais

D

$A_1 \to aA_3d \mid ad \mid aBc \mid cBc \mid ac \mid cc$

$A_2 \to aBc \mid cBc \mid ac \mid cc$

$A_3 \to aB \mid cB \mid a \mid c$

$B \to cc \mid ccB$

C

$A_1 \to aA_3D \mid aD \mid aBC \mid cBC \mid aC \mid cC$

$A_2 \to aBC \mid cBC \mid aC \mid cC$

$A_3 \to aB \mid cB \mid a \mid c$

$B \to cc \mid ccB$

$C \to c$

$D \to d$

---

c) $S \to ABS \mid BS \mid AS \mid AB \mid aA \mid a \mid aBAb \mid aAb \mid aBb \mid ab$

$A \to aA \mid a$

$B \to aBAb \mid aAb \mid aBb \mid ab$

↓ 2º Recursão ↓ 3º-Simp-OK

$A_1 \to A_2A_3A_1 \mid A_3A_1 \mid A_2A_1 \mid A_2A_3 \mid aA_2 \mid a \mid aA_3Aab \mid aA_2b \mid aA_3b \mid ab$

$A_2 \to aA_2 \mid a$

$A_3 \to aA_3A_2b \mid aA_2b \mid aA_3b \mid ab$ → 3º $n \leq 5$ – OK

↓ 4º Recursão – OK

↓ 5º → Terminais

B

$A_1 \to aA_2A_3A_1 \mid aA_3A_1 \mid aA_3A_2bA_1 \mid aA_2bA_1 \mid aA_3bA_1 \mid abA_1 \mid aA_2A_1 \mid aA_3 \mid aA_2A_3 \mid aA_3$

$A_2 \to aA_2 \mid a$

$A_3 \to aA_3A_2b \mid aA_2b \mid aA_3b \mid ab$

↓ 6º

$A_1 \to aA_2A_3A_1 \mid aA_3A_1 \mid aA_3A_2BA_1 \mid aA_2BA_1 \mid aA_3BA_1 \mid aBA_1 \mid aA_2A_1 \mid aA_3 \mid aA_2A_3 \mid aA_3$

$A_2 \to aA_2 \mid a$

$A_3 \to aA_3A_2B \mid aA_2B \mid aA_3B \mid aB$

$B \to b$

2) $S \to AbA \mid bA \mid Ab \mid b \mid Aa \mid a$

$A \to Aa \mid a$

$A_1 \to A_2bA_2 \mid bA_2 \mid A_2b \mid b \mid A_2a \mid a$

$A_2 \to aB \mid a$

$B \to a \mid aB$

$A_1 \to aBbA_2 \mid abA_2 \mid bA_2 \mid aBb \mid ab \mid b \mid aBa \mid aa \mid a$

$A_2 \to aB \mid a$

$B \to a \mid aB$

$A_1 \to aBDA_2 \mid aDA_2 \mid bA_2 \mid aBD \mid aD \mid b \mid aBC \mid aC \mid a$

$A_2 \to aB \mid a$

$B \to a \mid aB$

$C \to a \quad D \to b$

1) $S \to AB \mid BCS \mid BS \mid bbB \mid b$

$A \to aA \mid a \mid cC \mid c$

$B \to bbB \mid b$

$C \to cC \mid c$

$A_1 \to aA_2A_3 \mid aA_3 \mid cA_3A_3 \mid cA_3 \mid bbA_3A_4A_3 \mid bA_4A_3 \mid bbA_3 \mid bA_3 \mid b$

$A_2 \to aA_2 \mid a \mid cA_3 \mid c$

$A_3 \to bbA_3 \mid b$

$A_4 \to cA_4 \mid c$

$A_1 \to aA_2A_3 \mid aA_3 \mid cA_3A_3 \mid cA_3 \mid bBA_3A_4A_3 \mid bA_4A_3 \mid bBA_3 \mid bA_3 \mid bBA_3 \mid b$

$A_2 \to aA_2 \mid a \mid cA_3 \mid c$

$A_3 \to bBA_3 \mid b$

$A_4 \to cA_4 \mid c$

$B \to b$

g) $S \to aAd \mid Bc \mid c$

$A \to Bc \mid c$

$B \to Ac$

1º Simp ⇒ OK

2º Rem.

$A_1 \to aA_2d \mid A_3c \mid c$

$A_2 \to A_3c \mid c$

$A_3 \to A_2c$

3º $n \leq 3$

$A_1 \to aA_2d \mid A_3c \mid c$

$A_2 \to A_3c \mid c$

$A_3 \to A_3cc \mid cc$

4ª Recursão

$A_1 \to aA_2d \mid A_3c \mid c$

$A_2 \to A_3c \mid c$

$A_3 \to ccB \mid cc$

$B \to cc \mid ccB$

5ª vez

$A_1 \to aA_2d \mid ccBc \mid ccc \mid c$

$A_2 \to ccBc \mid ccc \mid c$

$A_3 \to ccBc \mid cc$

$B \to cc \mid ccB$

6º

$A_1 \to aA_2D \mid cCBC \mid cCC \mid c$

$A_2 \to cCBC \mid cCC \mid c$

$A_3 \to cCB \mid cC$

$B \to cC \mid cCB$

$C \to c \quad D \to d$

h) $S \to aAd \mid Bc \mid c$

$A \to Bc \mid c$

$B \to Ac \mid SS \mid aAd \mid Bc \mid c$

1º Simp. OK

2º Rem.

$A_1 \to aA_2d \mid A_3c \mid c$

$A_2 \to A_3c \mid c$

$A_3 \to A_2c \mid A_1A_1 \mid aA_2d \mid A_3c \mid c$

3º $n \leq 5$

$A_1 \to aA_2d \mid A_3c \mid c$

$A_2 \to A_3c \mid c$

$A_3 \to A_3cc \mid cc \mid aA_2dA_1 \mid A_3cA_1 \mid cA_1 \mid aA_2d \mid A_3c \mid c$

4º Recursão

$A_1 \to aA_2d \mid A_3c \mid c$

$A_2 \to A_3c \mid c$

$A_3 \to ccB \mid aA_2dA_1B \mid cA_1B \mid aA_2dB \mid cB \mid ccC \mid aA_2dA_1C \mid cA_1C \mid aA_2dC \mid cC \mid ccD \mid aA_2dA_1D \mid cA_1D \mid aA_2dD \mid cD$

$B \to cc \mid ccB \quad C \to cA_1 \mid cA_1C \quad D \to c \mid cD$

5º →

Cont... h) FNG

S → [illegible]

$A_1 \rightarrow aA_2d \mid cCBc \mid aA_2dA_1Bc \mid cA_1Bc \mid aA_2dBc \mid cBc \mid ccCc \mid aA_2dA_1Cc \mid cA_1Cc \mid aA_2dCc \mid cc$
$ccDc \mid aA_2dA_1Dc \mid cA_1Dc \mid aA_2dDc \mid cDc \mid c$

$A_2 \rightarrow ccBc \mid aA_2dA_1Bc \mid cA_1Bc \mid aA_2dBc \mid cBc \mid ccCc \mid aA_2dA_1Cc \mid cA_1Cc \mid aA_1Cc \mid$
$aA_2dCc \mid cCc \mid ccDc \mid aA_2dA_1Dc \mid cA_1Dc \mid aA_2dDc \mid cD$

$A_3 \rightarrow ccB \mid aA_2dA_1Bc \mid cA_1Bc \mid aA_1dBc \mid cBc \mid ccC \mid aA_2dA_1C \mid cA_1C \mid aA_2dC \mid cC$
$ccD \mid aA_2dA_1D \mid cA_1D \mid aA_2dD \mid cD$

$B \rightarrow cc \mid ccB$; $C \rightarrow cA_1 \mid cA_1C$ $D \rightarrow c \mid cD$