Greibach Normal Form (GNF)
Convert the following grammar G into GNF

$S \rightarrow XA \,|BB$

$B \rightarrow b \,|SB$

$X \rightarrow b$

$A \rightarrow a$

1.   Rewrite G in Chomsky Normal Form (CNF)

      3   It is already in CNF

2.   Re-label the variables

      S with A_1
      X with A_2
      A with A_3
      B with A_4

      $A_1 \rightarrow A_2 \, A_3 \,|A_4 \; A_4$
      $A_4 \rightarrow b \,|A_1 \; A_4$
      $A_2 \rightarrow b$
      $A_3 \rightarrow a$

3.   Identify all productions which do not conform to any of the types listed below

      $A_i \rightarrow A_j \; x_k \quad j > i$
      $Z_i \rightarrow A_v \; x_k \quad j \leq n$
      $A_i \rightarrow a \; x_k$
      $x_k \in V^*$ (i.e. x_k is some string of zero or more variables)
      $a \in T$ (i.e. 'a' is a single terminal)

4. $A_4 \rightarrow A_1 \; A_4$ .... *identified*

5. $A_4 \rightarrow A_1 \; A_4 \,|b$
      To eliminate A_1 we'll use the substitution rule
      Substituting for $A_1 \rightarrow A_2 \, A_3 \,|A_4 \, A_4$

$$A_4 \rightarrow A_2 \, A_3 \, A_4 \,\big|\, A_4 \, A_4 \, A_4 \big| b$$

The above two productions still do not conform to any of the types in step 3.
Substituting for $A_2 \rightarrow b$

$$A_4 \rightarrow b \, A_3 \, A_4 \,\big|\, A_4 \, A_4 \, A_4 \,\big| b$$

Now we have to remove left recursive production $A_4 \rightarrow A_4 \, A_4 \, A_4$

$$A_4 \rightarrow b \, A_3 \, A_4 \,\big|\, b \,\big|\, b A_3 \, A_4 \, Z \,\big|\, bZ$$
$$Z \rightarrow A_4 A_4 \,\big|\, A_4 \, A_4 \, Z$$

6. At this stage our grammar now looks like

$$A_1 \rightarrow A_2 A_3 \,\big|\, A_4 A_4$$
$$A_4 \rightarrow b A_3 \, A_4 \,\big|\, b \,\big|\, b \, A_3 A_4 Z \,\big|\, bZ$$
$$Z \rightarrow A_4 A_4 \,\big|\, A_4 \, A_4 \, Z$$
$$A_2 \rightarrow b$$
$$A_3 \rightarrow a$$

All rules now conform to one of the types in step 3.
But the grammar is still not in Greibach Normal Form!

7. All productions for A_2, A_3 and A_4 are in GNF

for $A_1 \rightarrow A_2 \, A_3 \,\big|\, A_4 \, A_4$

Substitute for $A_2 \,\&\, A_4$ to convert it to GNF
$$A_1 \rightarrow bA_3 \,\big|\, bA_3 \, A_4 \, A_4 \,\big|\, bA_4 \,\big|\, bA_3 \, A_4 \, ZA_4 \,\big|\, bZA_4$$

for $Z \rightarrow A_4 \, A_4 \,\big|\, A_4 A_4 \, Z$

Substitute for A_4 to convert it to GNF
$$Z \rightarrow bA_3 A_4 A_4 \,\big|\, bA_4 \,\big|\, bA_3 \, A_4 \, ZA_4 \,\big|\, bZA_4 \,\big|\, bA_3 A_4 A_4 Z \,\big|\, bA_4 Z \,\big|\, bA_3 A_4 ZA_4 Z \,\big|\, bZA_4 Z$$

8. Finally the Grammar in GNF is

$$A_1 \rightarrow bA_3 \,\big|\, bA_3 A_4 A_4 \,\big|\, bA_4 \,\big|\, bA_3 A_4 ZA_4 \,\big|\, bZA_4$$
$$A_4 \rightarrow bA_3 A_4 \,\big|\, b \,\big|\, bA_3 A_4 Z \,\big|\, bZ$$
$$Z \rightarrow bA_3 A_4 A_4 \,\big|\, bA_4 \,\big|\, bA_3 A_4 ZA_4 \,\big|\, bZA_4 \,\big|\, bA_3 A_4 A_4 Z \,\big|\, bA_4 Z \,\big|\, bA_3 A_4 ZA_4 Z \,\big|\, bZA_4 Z$$
$$A_2 \rightarrow b$$
$$A_3 \rightarrow a$$