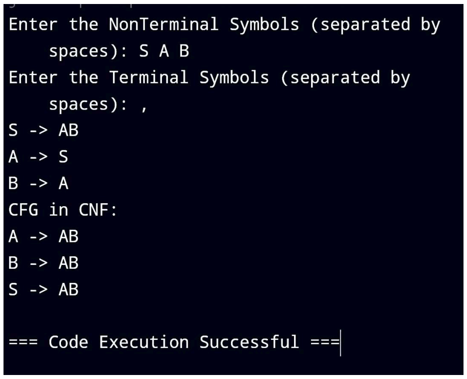
```
import java.util.*;

public class GrammarProcessor {
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);

        // Input Non-Terminal and Terminal Symbols
        System.out.print("Enter the NonTerminal Symbols (separated by spaces): ");
        String[] NT_symbols = scanner.nextLine().split(" ");
        System.out.print("Enter the Terminal Symbols (separated by spaces): ");
        String[] T_symbols = scanner.nextLine().split(" ");
        Set<String> terminals = new HashSet<>(Arrays.asList(T_symbols));

        // Input Productions
        Map<String, List<String>> productions = new HashMap<>();
        for (String nt : NT_symbols) {
            System.out.print(nt + " -> ");
            String[] prodArray = scanner.nextLine().split("/");
            productions.put(nt, new ArrayList<>(Arrays.asList(prodArray)));
        }

        // Eliminate Null Productions
        eliminateNullProductions(productions);

        // Eliminate Unit Productions
        eliminateUnitProductions(productions, terminals);

        // Convert to CNF
        convertToCNF(productions, terminals);

        // Display the final CFG after conversion to CNF
        System.out.println("CFG in CNF:");
        printCFG(productions);

        scanner.close();
    }

    // Function to Eliminate Null Productions
    static void eliminateNullProductions(Map<String, List<String>> productions) {
        Set<String> nullable = new HashSet<>();
        boolean changed;

        // Identify Nullable Symbols
        do {
            changed = false;
            for (Map.Entry<String, List<String>> entry : productions.entrySet()) {
                String nt = entry.getKey();
                List<String> prods = entry.getValue();
                for (String prod : prods) {
                    if (prod.equals("^")) { // Nullable production
                        if (nullable.add(nt)) changed = true;
                        break;
                    }
                    boolean allNullable = true;
                    for (char symbol : prod.toCharArray()) {
                        if (!nullable.contains(String.valueOf(symbol))) {
                            allNullable = false;
                            break;
                        }
                    }
                    if (allNullable && nullable.add(nt)) changed = true;
                }
            }
        } while (changed);

        // Generate New Productions without Nullables
        for (Map.Entry<String, List<String>> entry : productions.entrySet()) {
            String nt = entry.getKey();
            List<String> prods = entry.getValue();
            Set<String> newProds = new HashSet<>();
            for (String prod : prods) {
                if (!prod.equals("^")) {
                    newProds.addAll(generateCombinations(prod, nullable));
                }
            }
            productions.put(nt, new ArrayList<>(newProds));
        }
    }

    // Function to Eliminate Unit Productions
    static void eliminateUnitProductions(Map<String, List<String>> productions, Set<String>
terminals) {
        Map<String, Set<String>> unitProds = new HashMap<>();

        for (String nt : productions.keySet()) {
            unitProds.put(nt, new HashSet<>());
        }
        // Find Unit Productions
        for (String nt : productions.keySet()) {
            for (String prod : productions.get(nt)) {
                if (productions.containsKey(prod) && !terminals.contains(prod)) {
                    unitProds.get(nt).add(prod);
                }
            }
        }

        // Replace Unit Productions with Actual Productions
        for (String nt : unitProds.keySet()) {
            Set<String> newProds = new HashSet<>();
            for (String unit : unitProds.get(nt)) {
                newProds.addAll(productions.get(unit));
            }
            productions.get(nt).removeIf(unitProds.get(nt)::contains);
            productions.get(nt).addAll(newProds);
        }
    }

    // Convert to CNF
    static void convertToCNF(Map<String, List<String>> productions, Set<String> terminals) {
        Map<String, String> nonTerminalMap = new HashMap<>();
        int counter = 1;

        // Replace long productions with non-terminals
        for (Map.Entry<String, List<String>> entry : productions.entrySet()) {
            String nt = entry.getKey();
            List<String> prods = entry.getValue();
            List<String> newProds = new ArrayList<>();
            for (String prod : prods) {
                if (prod.length() > 2) {
                    StringBuilder newProd = new StringBuilder();
                    for (int i = 0; i < prod.length(); i += 2) {
                        String part = (i + 1 < prod.length()) ? prod.substring(i, i + 2) : prod.substring(i, i +
1);
                        if (part.length() == 2) {
                            String newNonTerminal = "X" + counter++;
                            nonTerminalMap.put(newNonTerminal, part);
                            newProd.append(newNonTerminal);
                        } else {
                            newProd.append(part);
                        }
                    }
                    newProds.add(newProd.toString());
                } else {
                    newProds.add(prod);
                }
            }
            productions.put(nt, new ArrayList<>(new HashSet<>(newProds)));
        }

        // Replace terminals with non-terminals
        for (Map.Entry<String, List<String>> entry : productions.entrySet()) {
            String nt = entry.getKey();
            List<String> prods = entry.getValue();
            List<String> newProds = new ArrayList<>();
            for (String prod : prods) {
                StringBuilder newProd = new StringBuilder();
                for (char c : prod.toCharArray()) {
                    if (terminals.contains(String.valueOf(c))) {
                        String newNonTerminal = "X" + counter++;
                        nonTerminalMap.put(newNonTerminal, String.valueOf(c));
                        newProd.append(newNonTerminal);
                    } else {
                        newProd.append(c);
                    }
                }
                newProds.add(newProd.toString());
            }
            productions.put(nt, new ArrayList<>(new HashSet<>(newProds)));
        }

        // Add new non-terminals to productions
        for (Map.Entry<String, String> entry : nonTerminalMap.entrySet()) {
            String nt = entry.getKey();
            String prod = entry.getValue();
            productions.putIfAbsent(nt, new ArrayList<>(Arrays.asList(prod)));
        }
    }

    // Generate Combinations by Eliminating Nullable Symbols
    private static Set<String> generateCombinations(String prod, Set<String> nullable) {
        Set<String> combinations = new HashSet<>();
        List<Integer> positions = new ArrayList<>();
        for (int i = 0; i < prod.length(); i++) {
            if (nullable.contains(String.valueOf(prod.charAt(i)))) {
                positions.add(i);
            }
        }
        int n = positions.size();
        for (int i = 0; i < (1 << n); i++) {
            StringBuilder sb = new StringBuilder(prod);
            for (int j = 0; j < n; j++) {
                if ((i & (1 << j)) != 0) {
                    sb.setCharAt(positions.get(j), '^');
                }
            }
            combinations.add(sb.toString().replace("^", ""));
        }
        return combinations;
    }

    // Function to Print CFG
    static void printCFG(Map<String, List<String>> productions) {
        for (Map.Entry<String, List<String>> entry : productions.entrySet()) {
            String nt = entry.getKey();
            List<String> prods = entry.getValue();
            System.out.print(nt + " -> ");
            System.out.println(String.join(" / ", prods));
        }
    }
}
```

Output



```
Enter the NonTerminal Symbols (separated by
    spaces): S A B
Enter the Terminal Symbols (separated by
    spaces): ,
S -> AB
A -> S
B -> A
CFG in CNF:
A -> AB
B -> AB
S -> AB

=== Code Execution Successful ===
```

CONCLUSION:

Through this experiment, I gained a deeper understanding of how to eliminate null and unit production from the given grammar. Also I can identify nullable variables and derivables by applying rules. After eliminating null and unit production, we have to convert into standard Chomsky Normal Form.