Program the following 13 functions in LISP. Make sure you test them thoroughly. Sample data will be mailed to you. Turn in a listing of your program and the results of applying the test data.

1. Given two sets of atoms \( x \) and \( y \) represented as lists, write functions \( \text{union}[x, y] \), \( \text{intersection}[x, y] \) and \( \text{set_difference}[x, y] \), for their union \( x \cup y \), intersection \( x \cap y \), and set difference \( u \setminus y \), respectively. Use the function \( \text{member}[n, x] \) defined below, which may also be written as \( n \in x \):

\[
\text{member}(x, u) = \begin{cases} 
\text{nil} & \text{if null } u \\
\text{else if } \text{car } u \text{ eq } x \text{ then } \text{t} \\
\text{else } \text{member}(x, \text{cdr } u) 
\end{cases}
\]

For example, \((A \ B \ C) \cup (B \ C \ D) = (A \ B \ C \ D)\), \((A \ B \ C) \cap (B \ C \ D) = (B \ C)\), and \((A \ B \ C) \setminus (B \ C \ D) = (A)\).

Pay attention to getting correct the trivial (i.e., base) cases in which some of the arguments are \text{nil}. In general, it is important to understand clearly the trivial cases of functions.

2. Given an integer \( n \) and a list \( l \) of integers sorted in increasing order, write a function \( \text{merge}[n, l] \) which inserts \( n \) in its proper place in \( l \). For example, \( \text{merge}[3, '(2 \ 4)] = (2 \ 3 \ 4)\), and \( \text{merge}[3, '(2 \ 3)] = (2 \ 3 \ 3)\).

3. Given two sets of atoms \( x \) and \( y \) represented as ordered lists containing no duplicates, write functions \( \text{union}[x, y] \), \( \text{intersection}[x, y] \) and \( \text{set_difference}[x, y] \) giving the union, intersection, and set difference, respectively, of \( x \) and \( y \); the result is wanted as an ordered list.

Note that computing these functions of unordered lists takes a number of comparisons proportional to the square of the number of elements of a typical list, while for ordered lists, the number of comparisons is proportional to the number of elements.

4. Using \text{merge}, write a function named \( \text{sort}[l] \) that transforms an unordered list \( l \) into an ordered list. Your algorithm should repeatedly invoke the \( \text{merge} \) function starting with an empty list, thereby running in \( O(n^2) \) time for a list of \( n \) elements.

5. Write a predicate \( \text{occur}[a, s] \) to indicate whether an atom \( a \) occurs in a given s-expression \( s \), e.g., \( \text{occur}[B, '(A \ B) \ . \ C)] = \text{t} \).

6. Write a function \( \text{num_occur}[a, s] \) that indicates how many times an atom \( a \) occurs in an s-expression \( s \), e.g., \( \text{num_occur}[B, '(A \ B) \ . \ C)] = 1 \).

7. Write a function \( \text{nodups}[s] \) to make a list without duplications of the atoms occurring in an s-expression \( s \), e.g., \( \text{nodups}[''((A \ . \ B) \ . \ (C \ . \ A))] = (A \ B \ C)\).

8. Write a function \( \text{multiplicity}[s] \) that indicates which atoms occur more than once in an s-expression \( s \). The result should be in the form of a list of pairs (i.e., an assoc-list), where each pair consists of the atom that occurs more than once and its multiplicity, e.g., \( \text{multiplicity}[''((A \ . \ B) \ . \ (C \ . \ A))] = ((A \ . \ 2))\).
9. Write a predicate \texttt{multi\_occur\_sexpr[x, y]} that indicates whether or not an s-expression x has more than one occurrence of an s-expression y as a sub-expression, e.g., \texttt{multi\_occur\_sexpr[\texttt{((A . B) . (C . (A . B)))}, (A . B)] = t.}