University of Toronto
Faculty of Applied Science and Engineering

FINAL EXAMINATION, December 2001
First Year - Program 5

CSC181F Introduction to Computer Programming

Examiner - D.B. Wortman

Open books and notes. Non programmable calculators permitted.
Write all answers in the examination book.
ANSWER ALL QUESTIONS. **7 questions**, 150 marks total. $2\frac{1}{2}$ hours (150 minutes).
WRITE LEGIBLY; unreadable answers can not be marked.
Clearly state any assumptions you've made in answering the questions in the exam book.

DON'T PANIC **KEEP COOL** **DON'T PANIC**

Some Possibly Useful Data Structures

```
/* singly linked lists */
typedef struct listNode * listPtr ;
struct listNode {
    int value ;
    /* link to next node */
    listPtr next ;
} ;
typedef struct listNode LISTNODE ;
#define LNODESIZE ( sizeof( LISTNODE ) )
```

```
/* binary trees */
typedef struct treeNode * treePtr ;
struct treeNode {
    int value ;
    /* left and right branches */
    treePtr left, right ;
} ;
typedef struct treeNode TREENODE ;
#define TNODESIZE ( sizeof( TREENODE ) )
```

1a. [1 mark] Write your name LEGIBLY on the front cover of all your exam books.
1b. [1 mark] Write your student number LEGIBLY on the front cover of all your exam books.

2. [20 marks]Let B be the *transpose* of the square matrix A (i.e. $B_{j,i} = A_{i,j}$). Write a C function with the header

```
void transpose( double ** A , double ** B , int N ) ;
```

This function computes the transpose of the square matrix A and stores it in the matrix B. You may assume without checking that the parameters A and B are both square matrices of size N x N. Write your function using **only** pointers. Do **not** use subscripts to access A and B.

3. [32 marks] Write efficient C++ functions to overload the == and < operators to provide an ordering relationship for the sparseVectors from Assignment 5. Describe the data structure that you use to represent sparse vectors. If the sparse vectors being compared are of unequal length then the shorter vector is (conceptually) filled out with zeros to the length of the longer vector.
Let A and B be sparse vectors with elements A_i and B_j

A and B are equal iff $\forall\, i\, A_i = B_i$

A is less than B iff $\exists\, k\ such\ that\ A_k < B_k\ and\ \forall\, i\ (i < k) \Rightarrow (A_i = B_i)$

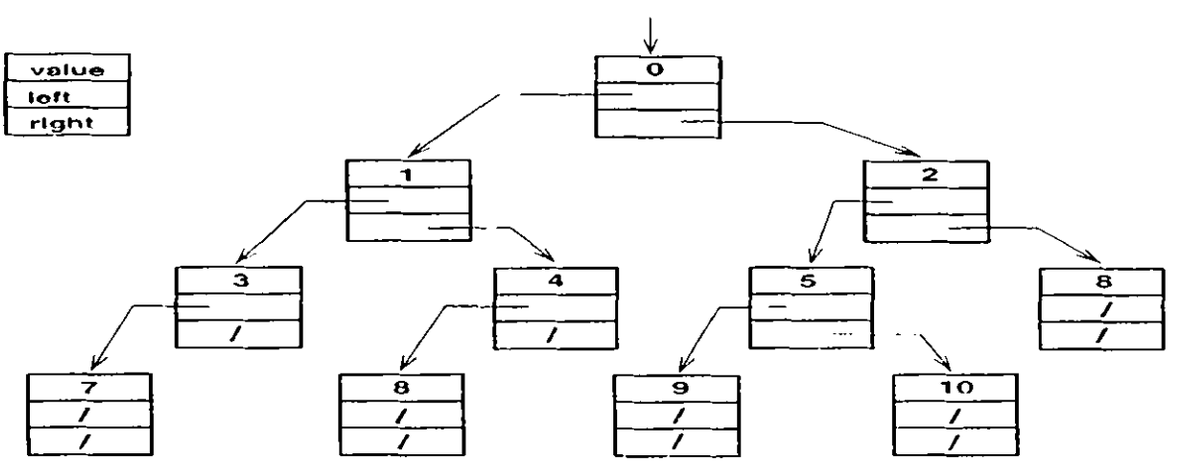
4a. [8 marks]Write four test cases to thoroughly test the == operator for sparse vectors from the previous question.

4b. [12 marks]Write six test cases to thoroughly test the < operator for sparse vectors from the previous question.

5. [20 marks] Using the definitions for binary trees given at the start of this exam what is the printed output from the function.

```
void twisted( treePtr inTree ) {
    if ( inTree )
        if ( inTree-> right ) {
            twisted( inTree-> right-> left ) ;
            printf("%d \n", inTree-> value );
            twisted( inTree-> left ) ;
            printf("%d \n", inTree-> right-> value );
            twisted( inTree-> right-> right );
        } else {
            printf("%d \n", inTree-> value );
            twisted( inTree-> left );
        }
}
```

When it is applied to the tree shown below?



6. [30 marks] A table of atomic weights for some elements is given below

Al	26.98	Sb	121.75	S	32.06	Ba	137.34
Br	79.91	Ca	40.08	C	12.01	Cl	35.45
Cu	63.54	H	1.008	I	126.9	Fe	55.84
Pb	207.21	Mg	24.31	N	14.01	O	16.00

Assume that chemical formulae are written as a list of atom names followed by a count of the number of atoms in parentheses. The parenthesized count can be omitted in which case a count of one is assumed. Examples

Formula	Written as	Formula	Written as	Formula	Written as
H_2O	H(2)O	C_2H_5OH	C(2)H(5)OH	H_2SO_4	H(2)SO(4)
$COCl_2$	COCl(2)	$Ca_4Al_2Fe_2O_{10}$	Ca(4)Al(2)Fe(2)O(10)	$PbC_4H_6O_4$	PbC(4)H(6)O(4)

Write a C function with the header

float molecularWeight(**const char** * formula) ;

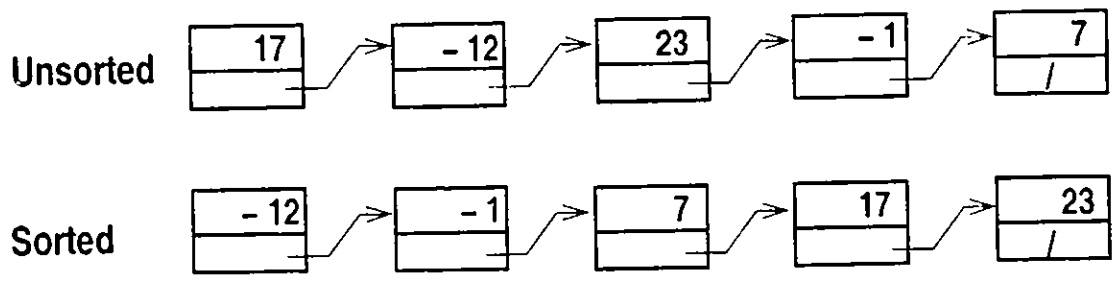
Where *formula* is a *correctly formed* chemical formula as described above (i.e. you do NOT have to error check the formula). This function processes the formula and calculates the molecular weight (i.e. the sum of the atomic weight of the atoms) of the compound represented by the formula. You may assume that the formula contains only the atoms listed above.

Gift: if you use a table to hold the elements and weights, you do not have to write out the entire table in your answer as long at is clear how the table is constructed.

7. [25 marks] Assume singly linked lists are built using the data structure given at the start of this exam. Write a C function with the header

listPtr sortList(**const** listPtr inlist) ;

This function sorts the nodes in its argument *inList* into ascending order and returns a pointer to the sorted list. It should not modify inList. Example:



1c. [1 mark] Write the number of books you used on the front cover of the first exam book.