

Answer *THREE* questions, including question 1 or question 2 (or both).

1. a. Design and implement a C++ function called `permutation` which takes two strings and returns 1 if the second is a permutation of the first and 0 otherwise.

Note that one string is a permutation of another if they contain exactly the same characters, but possibly in a different order. For example ‘examination’ is a permutation of ‘minaextanio’, ‘ionexanitam’, and many other strings. It is not however a permutation of ‘examine’, ‘examination’ *etc.*

You may use the function `strlen` but you may not assume that any other functions are available. Your answer should include a full design, and properly commented C++.

[28 marks]

- b. Briefly explain, giving examples where necessary, how you would test the function implemented in the first part of the question.

[5 marks]

[Total 33 marks]

TURN OVER

2. This question involves producing a C++ class to represent simple railway timetables. A timetable is a finite collection of towns/cities, referred to as ‘stops’, each having a corresponding time of arrival. For example,

Stop number 1	Glasgow	6-04
Stop number 2	Nottingham	9-37
Stop number 3	Crewe	10-15
Stop number 4	London	13-45
Stop number 5	Brighton	15-15

There must be no limit on the number of stops on the route, or on the length of a place name. Times must always be stored as a correct value—for example a time of 29-87 should not be allowed—but you do not have to ensure that times are in ascending order along the route.

Design and implement a C++ class called `Timetable`. The class should have a constructor and a destructor, and the following member functions:

1. `set_stop` should take a stop number and a place name, and set the specified stop name accordingly, if the stop exists.
2. `set_time` should take a stop number and a time, and set the specified stop time accordingly, if the stop exists.
3. `insert_stop` should take a stop number, name and time and insert a new stop in the timetable as specified, re-arranging the timetable as necessary to make room. Note that when used correctly this member function must increase the number of stops by 1.

Your class should make correct use of `new` and `delete` to ensure that exactly the right quantity of memory is used at all times to store the relevant information. You may make use of the usual functions `strlen` and `strcpy` but you may not assume that any other functions are available.

[Total 33 marks]

CONTINUED

3. Write an essay on the subject of the linked list data structure in C++. Your answer should include illustrative examples written in C++.

[Total 33 marks]

TURN OVER

4. a. Briefly summarize the advantages and disadvantages of the use of recursion in C++ programming.

[3 marks]

- b. Consider the following C++ function. It is assumed that arrays passed to the function are of equal length, and contain positive integers with the exception of their final elements, which will always be -1 .

```
int function (int * a1, int * a2)
{
    if (a1[0] == -1)
        return 1;
    else
    {
        int temp = a1[0] + a2[0];
        a1++;
        a2++;
        return temp * function(a1,a2);
    }
}
```

Explain what this function does, and how it works. Illustrate your answer by explaining what happens when the function is called using the following:

```
int array1 [] = {2, 2, 2, -1};
int array2 [] = {1, 3, 6, -1};
cout << function(array1, array2) << endl;
```

[12 marks]

- c. Explain in detail, including a pseudo-code description, the operation of the Insertion Sort algorithm.

[6 marks]

CONTINUED

- d. Explain in detail, including a pseudo-code description, the operation of the Merge-sort algorithm. Illustrate your answer using the example of sorting the sequence of numbers 100, 3, -5, 5, 8, 20, 15, 13, 50 into ascending order.

[12 marks]

[Total 33 marks]

5. a. Briefly describe each of the following features of C++ and explain how they are used, including examples of C++ code where necessary: private members of a class, destructors, operator overloading, friends, inheritance.

[25 marks]

- b. Give a detailed explanation of why it may be necessary for a C++ class to possess a copy constructor, and why the parameter of a copy constructor must be passed by reference.

[8 marks]

[Total 33 marks]

END OF PAPER