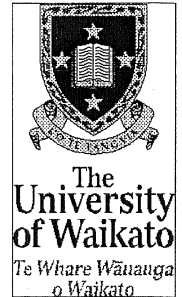


2011 SCHOLARSHIP EXAMINATION

WRITTEN SECTION



DEPARTMENT	Computer Science
COURSE TITLE	Year 13 Scholarship
TIME ALLOWED	Two Hours
NUMBER OF QUESTIONS IN PAPER	Fifteen
NUMBER OF QUESTIONS TO BE ANSWERED	Fifteen
VALUE OF EACH QUESTION	The value of each question is indicated.
GENERAL INSTRUCTIONS	Candidates are to answer ALL questions in the answer booklet provided
SPECIAL INSTRUCTIONS	None
CALCULATORS PERMITTED	Yes

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Section A
Computing Concepts

1. Explain how we can use an 8 bit binary number to store both positive and negative values. What are the largest (most positive) and smallest (most negative) values that can be stored.

(5 marks)
2. Add the eight bit binary numbers 01111111 and 00000001. Show your work, including carry bits.

(5 marks)
3. A friend complains to you that a recently purchased piece of software refused to run on his computer, giving an error message stating that there was not enough primary memory. However he continues, "There should be lots of memory. I just added a huge new disk drive". How would you explain to him that computers have different kinds of storage for different purposes and why his disk drive does not solve the 'memory' problem?

(5 marks)
4. Our ordinary form of decimal arithmetic cannot exactly represent some fractions. For example $1/3$ can be approximated as 0.333 or 0.333333. We can make the approximation as accurate as we like, but we cannot write down $1/3$ exactly as a decimal value. Interestingly binary computer arithmetic cannot exactly represent $1/10$. Explain.

(5 marks)
5. A modern computer usually has between 1 and 8 processors, two being the most common number. A computer with two processors can do two things at once. However we don't seem to be limited to running two tasks at a time. We might be downloading a file, listening to music and playing a game all at the same time. In fact that is possible when our machine has only a single processor. Discuss.

(5 marks)
6. Much of the information we download from the internet is compressed. For example picture information is often downloaded in PNG format. I have a picture of a jellyfish with 1024 by 768 pixels in 24 bit colour (8 bits each of red, green and blue) on my computer. Uncompressed it requires approximately 2.36MB of storage. The PNG compression method reduces its storage requirement to 1.53MB, a saving of about 35%, without losing any information. An acquaintance suggested that we could use the compression method again and reduce the PNG file by a further 35%. Why is this idea incorrect?

(5 marks)
7. Computers can perform certain kinds of calculations very much faster than people can. However, there are things that people do, and consider easy, that computers can only be programmed to do with great difficulty. Give an example of a task that is easy for a person and difficult for a computer. Discuss.

(5 marks)

CONTINUED

Section B
Programming

Note 1: In answering questions 8 – 14 you may find that the question wording does not always fully explain what your program fragment should do in all situations. Where this is the case you should describe the problem, choose and implement a solution.

Note 2: You are expected to write solutions in this section using basic coding constructs – loops, if statements and arrays. In some cases it might be possible to use a library function to solve the problem. You should not do that.

8. Write instructions to multiply together the numbers from 1 to 10. (6 marks)

9. Write a fragment of code that takes a string (array of characters) of length N and replaces all lower case letter a's with uppercase A's. (6 marks)

10. Write a fragment of code to search through an integer array A of length N, to see if a particular value V occurs in the array. If the value occurs your program should display 'Yes', otherwise 'No'. *Note: If the value V occurs more than once in the array, your program should display 'Yes' only once.* (6 marks)

11. Write a fragment of code to display a 9 by 9 times table, where all the numbers are found by multiplying the number at the top of the column by the number at the left of their row.

```
1  2  3  4  5  6  7  8  9
2  4  6  8 10 12 14 16 18
3  6  9 12 15 18 21 24 27
.  .  .
9 18 27 36 45 54 63 72 81
```

(6 marks)

12. Write a fragment of code that takes an integer and displays it as a string using the word form of each digit. For example 123 should be displayed as "one two three" and 0 should be displayed as "zero". You may assume that the integer value you start with is positive.

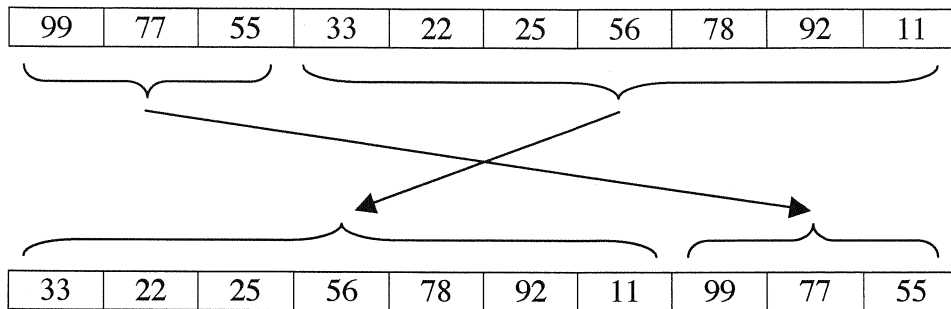
(6 marks)

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13. Write a fragment of code that takes a string and calculates the number of separate words in the string. For example: “the quick brown fox jumped” has 5 words and “never say never” has 3. You may assume that words are separated by space characters and that there is no punctuation.

(6 marks)

14. Consider an array of integers of size N. It is necessary to swap the first M values in the array with the remainder, for some $M < N$. For example if N is 10 and M is 3 the problem might look like this.



It would be easy to do this if we had enough memory to make a copy of one of the two areas of the array. However this is not the case. Can you find a way of swapping the data without using any additional array or file storage – ie: just by moving individual values around. (You can use a variables to hold single values.)

(6 marks)

Problem Solving

15. Consider the following code fragment.

```
1   p = a[0];
2   i = 0;
3   j = N - 1;
4
5   while (i < j)
6   {
7       while (i < j && a[j] < p)
8       {
9           j = j - 1;
10      }
11
12      if (i < j)
13      {
14          a[i] = a[j];
15          i = i + 1;
16      }
17
18      while (i < j && a[i] > p)
19      {
20          i = i + 1;
21      }
22
23      if (i < j)
24      {
25          a[j] = a[i];
26          j = j - 1;
27      }
28  }
29
30  a[i] = p;
```

where 'a' is an array of integers and 'p', 'i', and 'j' are integer variables. The array has N elements that are accessed as a[0], a[1], ..., a[N-1]. The '&&' symbol on lines 7 and 18 is the Boolean AND operator.

(a) Describe what happens if the fragment is run with N = 10, and the 10 elements of the array 'a' hold values 12, 4, 8, 16, 2, 15, 5, 19, 14 and 5 respectively. Your answer should show clearly the final values of the variables and the content of the array.

(7 marks)

(b) What would have happened if the value of a[0] had been 20 at the start, and everything else exactly as it was for part (a)?

(4 marks)

(Question 15 – continued on next page)

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- (c) Explain in words what this code fragment achieves? (4 marks)
- (d) What is the total number of times that a value is stored into the array as the fragment runs (ie: total number of times one of lines 14, 25 or 30 is executed)? (4 marks)
- (e) If N had been 20, what would have been your answer to part (d)? Would your answer have depended on the values in the array? (2 marks)
- (f) Write down a formula or otherwise provide an explanation of the number of times a value is stored into the array for arbitrary N . (2 marks)