

2003 SCHOLARSHIP EXAMINATION WRITTEN SECTION

DEPARTMENT	Computer Science
PAPER TITLE	7 th Form School Scholarship
TIME ALLOWED	Two Hours
NUMBER OF QUESTIONS IN PAPER	Eleven
NUMBER OF QUESTIONS TO BE ANSWERED	Eleven
VALUE OF EACH QUESTION	The value of each question is indicated.
GENERAL INSTRUCTIONS	Candidates are to answer ALL question is the Answer Booklet provided.
SPECIAL INSTRUCTIONS	Nil
CALCULATORS PERMITTED	Yes



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TURN OVER

1.
 - (a) Add the two 6-bit binary numbers 101101 and 111000. Show your work, including any carry bits.
 - (b) Computers normally do arithmetic with fixed size numbers (8, 16, 32, or 64 bits). How does this differ from the way we do arithmetic by hand, and why does the difference matter? *[Hint: You should refer to the example in part (a)]*
 - (c) Computers use two's complement form to allow both positive and negative numbers. Why was this particular form a good choice?
(5 marks)

2. Convert 24 (base 10) to
 - (a) binary (base 2)
 - (b) octal (base 8)
 - (c) hexadecimal (base 16)
(5 marks)

3. When I write a program to run on my computer, I don't usually give much thought to other programs that may be running 'at the same time' as my program. Imagine that I am downloading a large file from the Internet 'in the background' while my program runs. Why is it that I don't 'collide' in accessing memory or disk with that program – for example, both running programs deciding to extend files into the same disk segment?
(8 marks)

4. Low level computer languages often complain when we try to perform operations between different kinds of value. For example writing: $23 + "45"$ will give errors in C and Pascal and most Basic systems. Other systems, particularly some of the WWW scripting notations will happily accept such an expression. What is going on here? Your explanation should include: how values are likely to be stored and what has to be done to allow arithmetic to take place.
(8 marks)

5. Year by year, those of us who have worked with computers are amazed by the amount of storage available in new devices. Recently I learned that I could buy a 1GB (gigabyte) 'micro-drive' for my hand held computer. Explain, with examples and in terms that a non-computer literate person could understand, just how much space that is.
(5 marks)

6. When we buy a computer, two things to think about are: the amount of hard disk space; and the amount of main memory? Roughly what values would you expect for each if you were buying a computer today. What is the purpose of each in a computer? Which is the larger and why?
(5 marks)

7. I decided to write a program to display a clock (showing current time of day) on my computer's screen. A rough pseudocode version of the program is as follows:

```
Get the current time from the operating system
and store it in a variable called 'MyTime'
Loop forever doing the following
    Wait for one second
    Add one second to MyTime
    Display the time from 'MyTime' in a large graphic style
End of loop
```

When I tried the program I was disappointed to find that it started well, but didn't keep very accurate time. In fact it lost several minutes a day. I checked the little time display maintained by the operating system in the corner of my screen and found that it kept perfect time. Why did my program lose time? How would you alter the program to fix the problem?

(8 marks)

8. Arithmetic expressions can give different results depending on the order in which operations are performed. For example $4 + 3 * 5$ gives 19 if the multiplication is performed first and 35 with addition first. In programming languages we avoid this uncertainty by having 'rules of precedence' – rules that govern the order in which operations are performed. For a programming language of your choice (please state), outline the precedence rules.

(8 marks)

9. A palindrome is a word or sentence that is the same sequence of letters when read both forward or backward. For example "Able was I ere I saw Elba", is the same in both directions, ignoring spaces and upper/lower case. Another example "Madam I'm Adam".

Assume that strings of characters are stored as:

An array of characters and an integer indicating the number in the array

For example: The string "Demo" could be stored in array A and integer N – (A, N)

A[1] holding 'D', A[2] holding 'e', A[3] holding 'm' and A[4] holding 'o', with N = 4

We will assume that the arrays used are always large enough.

- Given a string held in array A with integer N, such that all punctuation has been removed and all letters are in upper case: Write a code fragment to decide whether the sentence is a palindrome. You may not make a copy of the sentence.
- Write a procedure to copy a string from (A,N) to (B,M) reversing the order of the characters.
- Write a function to compare two strings (A,N) and (B,M), returning true if they are identical, false otherwise.
- Using your procedure and function from steps (b) and (c) write a code fragment to decide if (A,N) holds a palindrome.
- Contrast your code fragments from (a) and (d). What are the advantages and disadvantages of each approach?

(16 marks)

10. This question is about 'if' statements and Boolean expressions.

- (a) A rectangle has been drawn on the screen. Integer variables RX and RY hold the coordinates of the top left pixel of the square. Variables RW and RH hold the exact width and height of the square in pixels. A user makes a mouse click at coordinates MX and MY. Write a Boolean expression to return true if the mouse was clicked on a pixel of the rectangle.
- (b) Two rectangles (R and S) have been drawn on the screen. Variables RX, RY, RW and RH describe one, as above. Variables SX, SY, SW, and SH describe the other. Write a Boolean expression to return true if R completely covers S. (i.e.: no pixel of S is outside R).

[HINT: You may find this easier if you build and use Boolean functions]

- (c) Given two rectangles R and S, write a Boolean expression to return true if there is any overlap (any pixels in common) between R and S. (This is the basic 'collision detection' function used in computer games).

(16 marks)

11. In this question you are asked to design some code fragments to find all distinct words in a large file of English text. For example: the sentence "Every dog will meet another dog every day" contains the distinct words: *every, dog, will, meet, another* and *day*.

- (a) Explain with a diagram how you would store the collection of words (in memory – we are not concerned with writing them to disk).
- (b) Pseudocode a program fragment that reads lines of text from a file (you may assume that words are entirely within lines) and collects words. Do this in reasonable detail, making clear: the processing required to identify words, and the process of deciding whether they are distinct and adding them to the word store.
- (c) Pseudocode a program fragment to list the words in your store.

(16 marks)