IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2
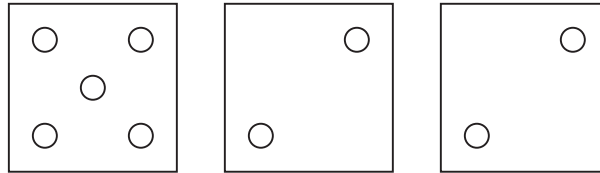
Thursday 16 November 2006 (morning)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

• Do not open this examination paper until instructed to do so.
• Answer all the questions.

*Answer **all** the questions.*

1. A computer program is designed to simulate a dice game. Three dice, with faces from 1-6, are thrown, for example:

One hundred dice throws are simulated and stored in a 2D array of `byte` called `dice`, as follows:

	[0]	[1]	[2]
[0]	6	5	2
[1]	1	2	3
[2]	1	6	6
[3]	2	4	4
	2	4	5

	[0]	[1]	[2]
	5	3	5
	4	3	4
[99]	2	2	2

(a) Explain why `byte` is a suitable data type for this data.   *[2 marks]*

(b) Construct the algorithm for a method to return the total sum of all values in the array.   *[4 marks]*

(This question continues on the following page)

(Question 1 continued)

The following method `getPair(dice, row)` searches a given row for any number that is repeated. If there are no repeats the method returns 0, otherwise the value of the repeated number is returned.

For example, in the given array
`getPair (dice, 0)` returns 0
`getPair (dice, 1)` returns 0
`getPair (dice, 2)` returns 6
`getpair (dice, 99)` returns 2

```java
public byte getPair( byte[][] dice, int row )
{
  if (dice[row][0] == dice[row][1])
  {
    return dice[row][0];
  }
  else if (dice[row][0] == dice[row][2])
  {
    return dice[row][0];
  }
  else if (dice[row][1] == dice[row][2])
  {
    return dice[row][1];
  }
  return 0;
}
```

(c) Construct an algorithm for a method, `evaluate()` which uses `getPair()` to produce the following output: *[4 marks]*

```
result, row 0: 0
result, row 1: 0
result, row 2: 6
```

and so on until

```
result, row 99: 2
```

(This question continues on the following page)

(Question 1 continued)

(d)   The method `getPair()` can return any value from 0 to 6. Construct an algorithm that creates a linked list showing how many times each of these values occurs.

Given the first three rows of the array `dice` shown at the beginning of this question, the list would look like this:

After the fourth row has been examined the list would look like this:

Note that the list is maintained in order of the value field and that each time `getPair()` returns a new value, a new node must be inserted. Use the following node class to create the list:

```
public class DiceNode
{
  private byte value;
  private int frequency;
  private DiceNode next;

  public DiceNode() { }
  public void setValue( byte v ) { this.value = v; }
  public void setFrequency( int f ) { this.frequency = f; }
  public void setNext( DiceNode dn ) { this.next = dn; }
  public byte getValue() { return this.value; }
  public int getFrequency() { return this.frequency; }
  public DiceNode getNext() { return this.next; }
}
```

You may assume that the root of the list has been set to null before your algorithm begins its execution.

```
DiceNode root = null;
```                                                              *[10 marks]*

2.   An ordered binary tree is used to store a sequence of names which are added to the tree as follows:

janice
rifeng
naoko
sonic
jessie

(a)   Draw and label a sketch showing the logical structure of the resulting tree.   *[5 marks]*

A String array `names` of 10 elements is set up to hold the same list of names in order. The order is maintained by keeping track of the end point of the list in an identifier `size` and shuffling down the array until the insertion point is reached:

	[0]	[1]	[2]	[3]	[4]	etc
names						

size = 0, janice added:

	[0]	[1]	[2]	[3]	[4]	etc
names	janice					

size = 1, rifeng added:

	[0]	[1]	[2]	[3]	[4]	etc
names	janice	rifeng				

size = 2, naoko added:

	[0]	[1]	[2]	[3]	[4]	etc
names	janice	naoko	rifeng			

and so on.

(b)   Construct the method `insert(String[] names, String name)` which carries out the procedure as shown above. You may assume there is always space in the array for a name to be added and that the class data member `size` has been initialized to the correct value before the method is called.

Recall that two variables of String type can be compared using `compareTo(String)`; for example:
"tram".compareTo("lily")   will return an integer value >0.   *[8 marks]*

The list is increased to hold 500 names.

(c)   Construct a program fragment to search the array `names` for a given name, using a *binary search*, and to return the position of that name if it is in the array.   *[7 marks]*

3. A text file is used to store a list of unique usernames, names and addresses on a single line, for example some entries might be:

```
richardnz, Richard James, 473 Akoko Street, Karapiro Village
andrewoz, Andrew Melvenn, 34 Victoria Street, Melbourne
elspethit, Elspeth Hawkins, via Verdi 39, Roma
nikkicr, Nikki Usluga, Trg sportova 11, Zagreb
```

(a) Compare **two** ways of outputting the entries in order of username without changing the physical order of entries in the text file. Your answer may consider the use of additional data structures or additional data stored in the existing file. *[6 marks]*

(b) The username must consist of between 6 and 10 lowercase, alphabetical characters only. Outline **three** ways in which methods of the String class could be used in validating a newly created username. *[6 marks]*

(c) Outline how the username could be converted to a file position by use of a hash function and identify any problems this could cause. *[4 marks]*

(d) Identify the characteristics of a data file which holds data as:

   (i)   Fixed length records *[2 marks]*

   (ii) Variable length records *[2 marks]*

This question requires the use of the Case Study.

4. (a) Outline the process involved in a *handshake* between two hardware devices and state why MIDI data does not need to *handshake* the target device. *[3 marks]*

(b) "MIDI takes about 10 Kbytes per minute of performance to store and digital audio takes about 10 Mbytes per minute of performance to store."

Estimate the number of minutes of performance that could be stored in 1 Gbyte:

(i) Using digital audio *[2 marks]*

(ii) Using MIDI *[1 mark]*

You are not expected to calculate the exact values but should show how they would be calculated.

(c) Compare the recording of music using MIDI with the use of digital audio recording. *[6 marks]*

(d) "Daisy chaining" involves one instruction being passed to many devices, serially, to output a variety of sounds. Compare serial with parallel transmission in this situation and outline why serial transmission is acceptable. *[4 marks]*

(e) Identify the parameters which would be sent to a MIDI module to form a note and describe the process that would be applied by the sound module before playing the note. *[6 marks]*

(f) MIDI data can be stored in three formats. A live concert is recorded for broadcast over the Internet. Suggest the best format to use for this and outline why. *[4 marks]*

(g) Discuss any **two** implications of MIDI for intellectual property owners. *[4 marks]*

(h) Outline the purpose of a MIDI controller. *[2 marks]*

(i) Compare the use of circuits to program the sequencer with that of using software. *[4 marks]*

(j) Music can now be generated from the movements of a dancer.

(i) Outline the way in which data can be captured from the dancer's movements to make music. *[2 marks]*

(ii) Discuss **one** implication of making music from movement on the type of music produced. *[2 marks]*