International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

MARKSCHEME

November 2010

COMPUTER SCIENCE

Higher Level

Paper 1

14 pages

*This markscheme is **confidential** and for the exclusive use of examiners in this examination session.*

*It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of IB Cardiff.*

General Marking Instructions

After marking a sufficient number of scripts to become familiar with the markscheme and candidates' responses to all or the majority of questions, Assistant Examiners (AEs) will be contacted by their Team Leader (TL). The purpose of this contact is to discuss the standard of marking, the interpretation of the markscheme and any difficulties with particular questions. It may be necessary to review your initial marking after contacting your TL. **DO NOT BEGIN THE FINAL MARKING OF YOUR SCRIPTS IN RED INK UNTIL YOU RECEIVE NOTIFICATION THAT THE MARKSCHEME IS FINALIZED.** *You will be informed by e-mail, fax or post of modifications to the markscheme and should receive these about one week after the date of the examination. If you have not received them within 10 days you should contact your TL and IB Cardiff. Make an allowance for any difference in time zone before calling.* **AEs WHO DO NOT COMPLY WITH THESE INSTRUCTIONS MAY NOT BE INVITED TO MARK IN FUTURE SESSIONS.**

You should contact the TL whose name appears on your "Allocation of Schools listing" sheet.

Note:
Please use a personal courier service when sending sample materials to TLs unless postal services can be guaranteed. Record the costs on your examiner claim form.

General Marking Instructions

1.   Once markscheme is received mark in pencil until final markscheme is received.

2.   Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.

3.   Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

4.   Sometimes, careful consideration is required to decide whether or not to award a mark. Indeed, another examiner may have arrived at the opposite decision. In these cases write a brief annotation in the **left hand margin** to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking.

5.   Unexplained symbols or personal codes/notations on their own are unacceptable.

6.   Record subtotals (where applicable) in the right-hand margin against the part of the answer to which they refer. Show a mark for each part question (a), (b), *etc.* Do **not** circle sub-totals. Circle the total mark for the question in the right-hand margin opposite the last line of the answer.

7.   Where an answer to a part question is worth no marks, put a zero in the right-hand margin.

8.   **Section A:** Add together the total for the section and write it in the Examiner Column on the cover sheet.
     Section B: Record the mark awarded for each of the six questions answered in the Examiner Column on the cover sheet.
     Total: Add up the marks awarded and enter this in the box marked TOTAL in the Examiner Column on the cover sheet.

9.   After entering the marks on the cover sheet check your addition of all marks to ensure that you have not made an arithmetical error. Check also that you have transferred the marks correctly to the cover sheet. **We have script checking and a note of all clerical errors may be given in feedback to all examiners.**

10. Every page and every question must have an indication that you have marked it. Do this by **writing your initials** on each page where you have made no other mark.

11. A candidate can be penalized if he/she clearly contradicts him/herself within an answer. Once again make a comment to this effect in the left hand margin.

Subject Details: Computer Science HL Paper 1 Markscheme

Mark Allocation

Section A: Candidates are required to answer **all** questions. Total 40 marks.
Section B: Candidates are required to answer **all** questions. Total 60 marks.
               Maximum total = 100 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each statement worth one point has a separate line and the end is signified by means of a semi-colon (;).

- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.

- Words in (…) in the markscheme are not necessary to gain the mark.

- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the markscheme then award the mark.

- Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.

- Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. In this subject effective communication is more important than grammatical accuracy.

- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with "**FT**".

SECTION A   *Total: [40 marks]*

1.   (a)   The process of replacing the old computer system by the new one / creating the
           new computer system;
           In the series of stages: analysis, design, development, implementation, maintenance;   *[2 marks]*

     (b)   Analysis;   *[1 mark]*

2.   *Award [1 mark] for each of the following items in a labelled diagram, up to
     [4 marks max]*.
     Control unit (CU);
     Arithmetic and Logic Unit (ALU);
     Buses;
     Primary memory;   *[4 marks]*

3.   *Award [1 mark] for each labelled symbol, up to [5 marks max]*.
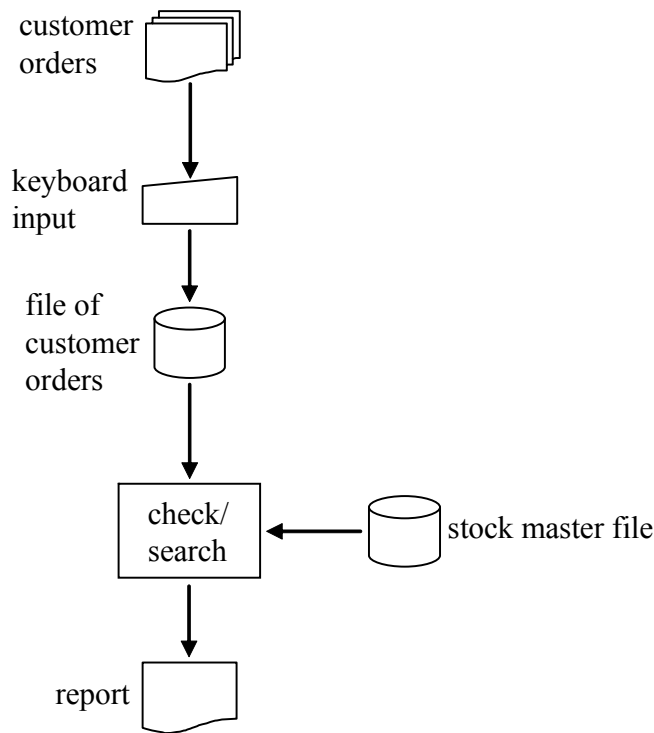
                                                                                                     [5 marks]

4.   Any example of using a device/computer for accessing information;
     From some other computer to which it is connected;   *[2 marks]*

5.   *Award up to [2 marks max]*.
     Word length;
     Bus size;
     Frequency;
     Number of cores;
     Cache size.

                                                                                                     [2 marks]

6. (a) *Award [1 mark] for whole part, [1 mark] for fraction part.*
$10100.1_{(2)}$ *[2 marks]*

(b) $A9_{(16)}$;   *[1 mark]*

7. (a) *Award up to [1 mark max].*
Greater range of numbers;
Better accuracy;
Accept answers for whole and fractional numbers.   *[1 mark]*

(b) *Award up to [1 mark max].*
No rounding/truncation errors;
Faster processing;
Accept answers for whole and fractional numbers.   *[1 mark]*

8. (a) Accumulator / special purpose register;   *[1 mark]*

(b) The result of the operation;
The value to be stored in the memory location is too large/larger than the
largest value that can be stored in this memory location;   *[2 marks]*

9. *Award up to [2 marks max].*
File manager;
Data compressor;
(Anti)virus software;
Defragmentation software;
Credit any acceptable alternatives.   *[2 marks]*

10. (a) $O(\log_2 n)$ / $O(\log n)$ / $O(\ln n)$;   *[1 mark]*

(b) $O(n^2)$;   *[1 mark]*

11. (a) *Award up to [1 mark max]*.
Source documents, data in a form of prepared source documents;
Data capture, data at source produced in machine sensible form (*e.g.* digital
photos, or temperature/humidity readings);   *[1 mark]*

(b) Data can be transferred from the field to the central computer by using
telecommunication facilities;
Accept any appropriate example.   *[1 mark]*

(c) *Example answer:*
Data verification is a method of checking/ensuring that data at the source is the
same as inputted data;
Usually the user is involved, for example asked to retype data;
Data validation is performed by the software;
Checking the range, whether the type of data is correct *etc.*;   *[4 marks]*

12. *Example answers:*
Encapsulation is the process of describing a class or object;
By hiding all details of how it was written/constructed;

Combination of private data and public methods;
That form an object/a single program unit;   *[2 marks]*

13. (a) *Award up to [1 mark max]*.
I/O interrupts;
Program checks interrupts (caused by run-time errors);
External interrupts (expiring of time, signal received from another process);
Malfunctioning hardware interrupts;
etc.   *[1 mark]*

(b) *Award [1 mark] for each step in correct order, up to [3 marks max]*.
Fetch;
Decode;
Execute;
Store;   *[3 marks]*

SECTION B   *Total: [60 marks]*

14. (a) *Award [1 mark] for the name, [1 mark] for the example, up to [4 marks max].*
Syntax errors;
Any example such as mistyping, omitting symbols;
Run-time errors;
Any example such as division by 0, out of bounds error, attempting to read
from a closed/missing file;
Logic errors;
Examples like using incorrect formula to calculate the area of a circle;   *[4 marks]*

(b) *Award [1 mark] for the name, [1 mark] for the description, up to [6 marks max].*
Editor;
The software that enables programmers to enter/modify source code;
Translators (compiler/interpreter);
The software that translates source code into machine/object code;
Linker/linkage editor;
Software that puts appropriate machine addresses in all external calls, links all
modules;
Loader;
Software that takes appropriate machine code and loads instructions into their
specified storage locations;
Debugger;
Software that helps programmers to find logic errors;
etc.

*Note: If only an IDE that includes many (if not all) of the software programs
listed above without stating them, award also [1 mark] for the name and
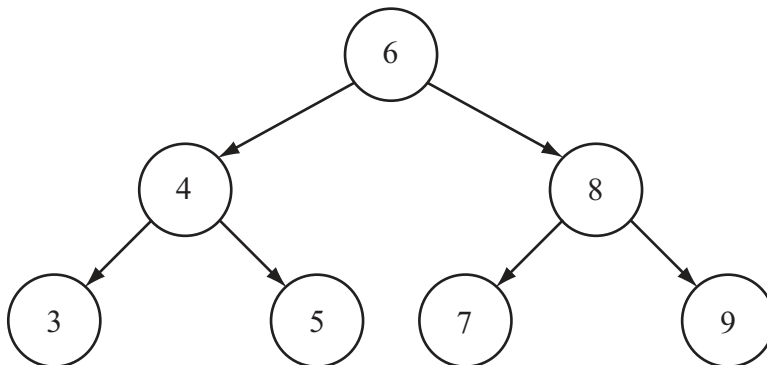[1 mark] for a description.*   *[6 marks]*

Total: [10 marks]

15. (a) *Award marks as follows up to [3 marks max].*
Award [1 mark] for root.
Award [1 mark] for left subtree.
Award [1 mark] for right subtree.

*(Award [2 marks] for the correct mirror image, and follow through marks in
part (b).)*   *[3 marks]*

continued ...

Question 15 continued

(b)   *Award [2 marks] for correct sequence, [1 mark] for minor error.*
         6 4 3 5 8 7 9   *[2 marks]*

(c)   In-order traversal;   *[1 mark]*

(d)   *Award up to [4 marks max].*
         For the list of n items;
         The optimum efficiency of searching the BST is $O(\log_2 n)$;
         When input is ordered then the BST will have n levels;
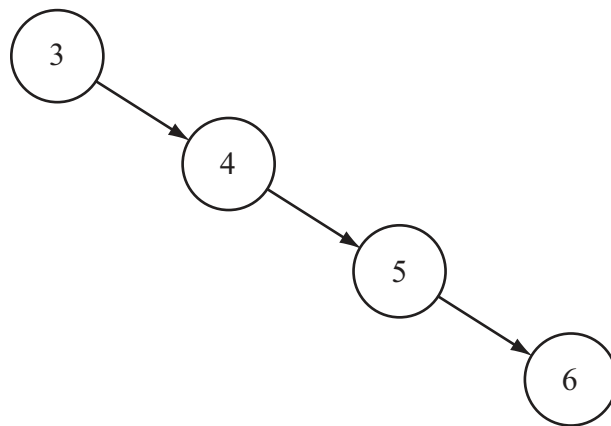   And searching efficiency is $O(n)$;
         Same as efficiency of searching a linked list;

         Example answer: (Please note that candidates may use any input list)

         When n = 4 and input items are: 3, 4, 5, 6;
         Then the resulting BST will have 4 (n = 4) levels / will not have the left subtree /
         will look as follows:
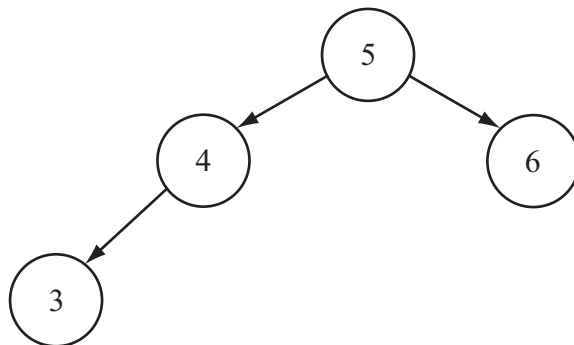

                                                                                                         [1 mark]

         And searching has same efficiency as searching a linked list;   *[1 mark]*

         The efficiency is $O(n)$;   *[1 mark]*

         If the items were not inputted in order, for example the input list is 5, 4, 6, 3
         then the resulting BST would look as follows:

         And efficiency will be $O(\log_2 n)$;   *[1 mark]*

                                                                                                         Total: [10 marks]

16. (a) *Award up to [2 marks max].*
Each user should have a personal password;
Passwords should be regularly changed;
Each computer should have access rights depending on its location;
Computers should not be unattended;   *[2 marks]*

   (b) All data files should be backed up;
Backing up need to be performed daily/weekly;
In a case of corruption the most recent back up of the master file is loaded;
And updated using a file of all updates/changes/transactions that have occurred
from the last back-up;   *[4 marks]*

   (c) *Award up to [4 marks max].*
Each user should have appropriate access rights;
Passwords should be encrypted;
File systems should be encrypted;
Administrator should record who has logged on from which computer and for
how long;
Administrator should record how many times a wrong password was typed in;   *[4 marks]*

Total: [10 marks]

17. (a) (i) A process that calls itself;   *[1 mark]*

(ii) **Advantages**
Award [1 mark] for advantage, [1 mark] for description.

Example answers:
Some problems have natural recursive solution;
For example tree traversals, tower of Hanoi;

Shorter for programmers to write;
For example short recursive tree traversal compared to long, complicated
iterative traversal;

Disadvantages
Award [1 mark] for disadvantage, [1 mark] for description.

Example answers:
Non-recursive solution could be more efficient;
In terms of time and space;

If recursion repeats too long, stack overflow can crash the program;
Too many parameters and return addresses to be pushed onto the stack;   *[4 marks]*

(b) (i) `w = mystery(2, 3) = 0`   *[1 mark]*

(ii) `w = mystery(2, 2) = 1 + mystery(0, 2) = 1 + 0 = 1`   *[1 mark]*

(iii) `w = mystery(7, 3) = 1 + mystery(4, 3)`
`    = 1 + 1 + mystery(1, 3) = 1 + 1 + 0 = 2`   *[1 mark]*

(c) *Award up to [2 marks max].*
Accepts two integers (n and m);
Calculates;
And returns;
The result in integer division n / m;   *[2 marks]*

Total: [10 marks]

18. (a) *Award **[3 marks]** for the correct table.*
*Award **[2 marks]** for 6 or 7 correct rows.*
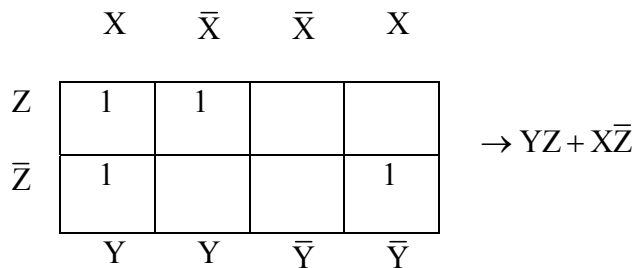*Award **[1 mark]** for 4 or 5 correct rows.*

X	Y	Z	OUT
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

***Note:** When awarding marks be aware of the alternative solution. Given the nature of the question, it is quicker to complete the table in two parts – Z=0 and Z=1 – which is unconventional but a possible correct solution.* **[3 marks]**

(b) (i) *Award up to **[2 marks max]**, **[1 mark]** for minor error.*
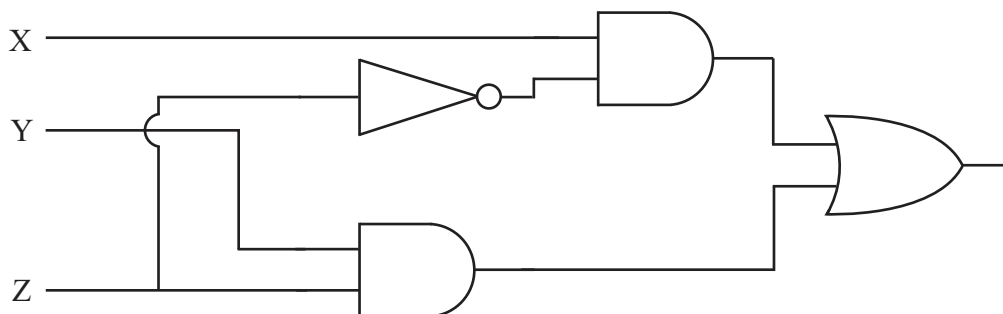$OUT = \bar{X}YZ + X\bar{Y}\bar{Z} + XY\bar{Z} + XYZ$ **[2 marks]**

(ii) $\bar{X}YZ + X\bar{Y}\bar{Z} + XY\bar{Z} + XYZ = (\bar{X} + X)YZ + X\bar{Z}(\bar{Y} + Y)$
$= YZ + X\bar{Z}$

OR

	X	$\bar{X}$	$\bar{X}$	X	
Z	1	1			
$\bar{Z}$	1			1	$\rightarrow YZ + X\bar{Z}$
	Y	Y	$\bar{Y}$	$\bar{Y}$	

[2 marks]

(c) *Award **[1 mark]** for each correct gate, up to **[3 marks max]**.*

[3 marks]

Total: [10 marks]

19. (a) *Award [1 mark] for each correct column, up to [3 marks max].*

N = 8

c	c % 2 == 0	c < 8	p	s	output
1	F	T	1	0	
2	T	T	1	2	
3	F	T	3	2	
4	T	T	3	6	
5	F	T	15	6	
6	T	T	15	12	
7	F	T	105	12	
8		F			s = 12 p = 105

[3 marks]

(b) Calculates and outputs the sum of all even numbers;
The product of all odd numbers in the range 1 to (n – 1);   *[2 marks]*

(c) *Award [2 marks] for three correct bold lines.*
Award [1 mark] for two correct bold lines.

```
int n = 8;
int p = 1;
int s = 0;
int c = 1;
while (c < n)
{
   if (c % 2 == 0)
   { s = s + c; }
   else
   { p = p * c; }
   c = c + 1;
}
output("s = " + s);
output("p = " + p);
```

Note: Be aware the alternative of
     `c = 0;` *before the loop*
     `while (c < n – 1)`
     `c = c + 1;` *before if.*   *[2 marks]*

(d) *Award up to [2 marks max] for calculation of number of times operation is executed, award [1 mark] for BigO notation.*
Loop executes $n-1$ times;
There are $(n-1)+(n-1)$ additions;
$n-1$ multiplications;
$n-1$ division by 2;
$(n-1)+(n-1)$ comparison;
$(n-1)+(n-1)+3$ assignments

In BigO notation the efficiency is O(n)   *[3 marks]*

Total: [10 marks]