

Computer Science HL P1

2010 May

School Level 12th IB Diploma

Programme

Board Exam

International Baccalaureate (IB

Board)

Solved



**COMPUTER SCIENCE
HIGHER LEVEL
PAPER 1**

Thursday 6 May 2010 (afternoon)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Section A: answer all the questions.
- Section B: answer all the questions.

SECTION A

Answer **all** the questions.

1. State **two** items that would be included in a *requirements specification* in addition to inputs and outputs. [2 marks]
2. (a) Calculate $DE + 3C$, giving your answer in hexadecimal. [2 marks]
(b) State the answer to part (a) in binary. [1 mark]
(c) State the error that would occur when this result is stored in an 8 bit register. [1 mark]
3. Outline the function of the *arithmetic and logic unit (ALU)* in the *central processing unit (CPU)*. [2 marks]
4. Compare *magnetic tape* with *flash memory* as media for backing up data. [4 marks]
5. Describe the difference between *private class members* and *public class members*. [2 marks]
6. (a) Outline **one** use of a *macro* within an application. [2 marks]
(b) State **two** advantages of using the macro from part (a). [2 marks]
7. Describe how a *check sum* could ensure data integrity in the transmission of data. [3 marks]
8. Outline **one** advantage of creating a prototype during the design stage of software development. [2 marks]
9. (a) State **two** examples of the use of an *interrupt*. [2 marks]
(b) Outline how the operating system processes an interrupt. [2 marks]
10. Describe the use of *key words* by Internet search engines. [3 marks]

11. (a) (i) Outline the characteristics of *serial transmission*. [2 marks]
(ii) State **one** suitable example of its use. [1 mark]
- (b) (i) Outline the characteristics of *parallel transmission*. [2 marks]
(ii) State **one** suitable example of its use. [1 mark]
12. (a) Define the term *virtual memory*. [2 marks]
(b) Outline the use of virtual memory in the running of a program. [2 marks]



SECTION B

Answer **all** the questions.

13. Software is used to design a road bridge. The software allows the user to simulate small changes to the thickness of the materials used to build the bridge.
- (a) Describe the data type needed to represent the thickness of the materials. [2 marks]

An important factor in bridge safety is the amount of traffic that uses the bridge.

- (b) Outline **one** method for collecting data on the amount of traffic that would be using the bridge. [2 marks]
- (c) Suggest how the results of this data collection would be used to influence the design of the bridge. [4 marks]
- (d) Outline **one** advantage of using a computer and appropriate software to design the bridge. [2 marks]

14. An insurance company has over 50 000 customers, whose details are stored in records within a database. Two of the fields in the customer record are `customer name` and `customer ID`. The records are held in order of `customer ID`.
- (a) Identify the search method used to access the record of a customer when the name is known and state the BigO efficiency of this search. [2 marks]

- (b) Identify the search method that should be used to access the record of a customer when the `customer ID` is known and state the BigO efficiency of this search. [2 marks]

Another field in the customer record is `date payment due`. At the end of each month, the database is searched to find all customers whose payment is due.

- (c) Identify the type of processing used in this search. [1 mark]

The company implements a completely new computer system with a better designed database. This is implemented overnight.

- (d) Discuss the advantages and disadvantages of using a direct changeover method. [5 marks]

15. A washing machine which has several different programs can be set to start working at a specified time. The time to start and the required program are input by a user. The washing machine is controlled by a microprocessor.

- (a) Identify **two** items that would need to be held in read-only memory (ROM). [2 marks]
- (b) Identify **two** items that would need to be held in random access memory (RAM). [2 marks]

The microprocessor controls water input (W), heating (H) and rotation (R). The following table shows the state of these controls for whether or not the washing machine is operating (M).

W	H	R	M
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

- (c) Use the truth table to state the logical conditions that define when the washing machine is operating **and** simplify the expression as far as possible. [3 marks]
- (d) Construct the logical circuit from the simplified expression you obtained in part (c). [3 marks]

16. Study the recursive method below.

```
public int question(int n, int b)
{
    if (n / 10 > 0)
    {
        int y = (n % 10) * b;
        return (y + question(n / 10, b * 2));
    }
    else
        return (n % 10) * b;
}
```

- (a) Identify the terminating condition. [1 mark]
- (b) By showing the result of each recursive call, determine the output of this method when $n = 1011$ and $b = 1$. [5 marks]
- (c) Explain **one** advantage and **one** disadvantage of solving this kind of problem recursively rather than using an iterative method. [4 marks]

17. An online dictionary translates between English and German. When a user knows the German word they can find the English word and when a user knows the English word they can find the German word.

A sample of the word pairs that are stored is as follows:

GERMAN	ENGLISH
Fisch	Fish
Spinat	Spinach
Ei	Egg
Lamm	Lamb
Karotte	Carrot

Assume that these five pairs are input in the order shown.

- (a) Construct the binary tree which stores the above list of pairs in alphabetical order by German word, showing the information which would need to be held at each leaf of the tree. *[4 marks]*

This data could also be represented as a single linked list in alphabetical order by German word.

- (b) (i) Explain **one** advantage of using a binary tree. *[2 marks]*
- (ii) Explain **one** advantage of using a single linked list. *[2 marks]*
- (c) Suggest how this single linked list could be modified to allow translation from English to German as well as from German to English. *[2 marks]*

18. A website allows members to place orders for products. A person may become a member by completing an online form with their details, including payment method, email address and password. To order from the site a member must enter a username and a password.

- (a) Outline the use of *verification* and *validation* in the completion of the membership form. *[2 marks]*
- (b) Outline the way in which encryption should be used in this system. *[3 marks]*
- (c) Explain the role of protocols when a member accesses the site. *[2 marks]*

Two members are logged onto the site at the same time and both want to buy the same product but there is only one left.

Some products are in limited supply and cannot be replaced.

- (d) Outline a way in which the web server could be updated on the number of products in stock. *[1 mark]*
 - (e) Suggest how the web server would avoid the situation of two people buying the last item at the same time. *[2 marks]*
-



MARKSCHEME

May 2010

COMPUTER SCIENCE

Higher Level

Paper 1

15 pages

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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. *Award up to [2 marks max].*
A list of available tools/hardware/software etc.;
Facilities;
Communication;
People available;
Schedule for the next stage;
etc. **[2 marks]**
2. (a) 11A **[2 marks]**
(b) 0001 0001 1010 ; **[1 mark]**
(c) Overflow; **[1 mark]**
3. *Award up to [2 marks max].*
The ALU receives data to be processed;
Performs arithmetical;
And logical operations;
(Uses logic gates) to perform the calculations;
(Uses logic gates) to perform comparisons;
Returns the answer to the accumulator / (output registers); **[2 marks]**
4. *Accept any reasonable answers, given that characteristics evolve rapidly.*
Award up to [2 marks max] for an appropriate application of each with reference to backup.
Example:
Tape could be used for regular backup of large amounts of data, flash memory to back up immediately when needed.

Award up to [2 marks max] for the advantages/disadvantages of each.
Example1:
Flash memory is more portable between machines – tape has large capacity and can be programmed to back up as a batch job.
Example2:
Tape has sequential access (slower), flash memory has direct access (faster).
Example3:
Tape is cheaper per GB but hardware needed is more expensive. **[4 marks]**
5. Private class members can only be accessed from within the class (in which they are defined);
Public class members can be accessed from outside the class; **[2 marks]**

6. (a) *Award [1 mark] for suitable macro and [1 mark] for appropriate package up to [2 marks max].*
Example:
A macro to clear/update entries in a spreadsheet;
A macro to type a name using a hotkey in a word processor;
Creating a circle for a given radius in a graphics package; *[2 marks]*
- (b) *Award [1 mark] for each suitable advantage.*
Example:
Saves time as code does not have to be reproduced;
Portability – can be used again (sometimes across different applications);
Adaptability – can easily be changed to suit needs; *[2 marks]*
7. *Award up to [3 marks max].*
Checksum is computed from data;
Groups of bits are added before transmission and the sum appended to the group;
When the data is received the actual sum is compared with the check sum;
If the two are the same it is assumed that the data has not been corrupted;
Otherwise a re-send would be requested; *[3 marks]*
8. *Award up to [2 marks max].*
Saves time for the programmer in the long term as an interface is created which may not be accepted;
Early feedback from user could save later changes which could be difficult/time consuming;
More user/programmer interaction – increases the programmers understanding of the problem; *[2 marks]*
9. (a) *Award [1 mark] for each appropriate use of an interrupt up to [2 marks max].*
Example:
Interrupt used to indicate that a client wants access to the server (in a multi access system);
A peripheral needs serving (load CD, printer etc.);
Software application reports an error;
Power problem alert (battery low, blackout etc.); *[2 marks]*
- (b) *Award up to [2 marks max].*
Operating system is alerted that a service is needed (i.e. flag set);
Depending on the priority;
Current processing is suspended;
Stack used to store current state;
Service dealt with and processing resumed; *[2 marks]*
10. *Award up to [3 marks max].*
Search engine accesses a list of URLs;
Indexed by key words;
List of addresses under these key words returned;
Accept reference to importance of key words in the ordering of the returned websites; *[3 marks]*

11. *Accept points in (i) that are given in (ii) for both (a) and (b).*
- (a) (i) Serial transmission receives/sends data bit by bit, sequentially;
Is suitable for long distance cables as data is less likely to corrupt on one line; **[2 marks]**
- (ii) Connecting computers in a LAN; **[1 mark]**
- (b) (i) Parallel transmission receives/sends data more than 1 (normally 8) bits at a time, in parallel;
Is suitable for short distance since data on parallel line can get "out of sync" in long distance; **[2 marks]**
- (ii) *Award [1 mark max].*
Transmission within the CPU;
Transmission within the computer/from printer to computer; **[1 mark]**
12. (a) Virtual memory is a way of appearing to extend primary memory;
By using part of secondary memory in the same way as primary memory; **[2 marks]**
- (b) Part of the program (or data) is held on hard disk;
Called in (by paging) when needed; **[2 marks]**

SECTION B

Total: [60 marks]

13. (a) Data type for the thickness would need to be floating point (double);
Small changes would need to be recorded; **[2 marks]**

- (b) *Award [1 mark] for suitable method and [1 mark] for an elaboration up to [2 marks max].*

Example:

Use sensors on current routes (that could be replaced by the road bridge);
To count the amount of traffic which might use the bridge;
At different times of the day;

Example:

Use questionnaires/interviews at different points on the route;
At different times of the day;
To find out how many vehicles would use the bridge instead of the current routes; **[2 marks]**

- (c) *Award up to [4 marks max].*
Simulate normal and extreme traffic flow;
Increase amount of traffic until bridge not stable;
Or amount of traffic impossible;
Repeat with different thicknesses;
To obtain suitable thickness; **[4 marks]**

- (d) *Award [1 mark] for an advantage and [1 mark] for an elaboration up to [2 marks max].*

Example:

Saves cost;
Since once the software and hardware are bought they can be used for many different projects whereas a physical model would have to be built each time;

Example:

More accurate;
As many more factors can be taken into account and smaller changes can be made; **[2 marks]**

Total: [10 marks]

14. (a) Sequential / linear search (on key – customer name);
O(n);
Award FT mark for correct efficiency. **[2 marks]**
- (b) Binary search (on key – customer ID);
O(log n);
Award FT mark for correct efficiency. **[2 marks]**
- (c) Batch processing; **[1 mark]**
- (d) *Award [3 marks max] for advantages elaborated and [3 marks max] for disadvantages elaborated up to [5 marks max].*

Example advantages:

There is no extra cost;
Benefits can be gained immediately;
Since new system is better than the old;

Example disadvantages:

Staff re-training will be more lengthy/difficult/in advance/not on the system;
As they will need to be capable of using the system immediately without training;
If there is an unsuspected bug in the new system;
There is not a second system to fall back on/disastrous for the company;

Accept answers which give valid advantages or disadvantages to changing the system when it is not being used. **[5 marks]**

Total: [10 marks]

15. (a) Held in ROM;
 Award [1 mark] for any reasonable data that would be in ROM.
 Example:
 Instructions to be activated for each separate program;
 Start up instructions;
 Instructions to take information from sensors; [2 marks]

- (b) Held in RAM;
 Award [1 mark] for any reasonable data that would be in RAM.
 Example:
 Time to start set by user;
 Settings input by user;
 Current state of variables; [2 marks]

- (c) Award [3 marks] if correct answer arrived at even without working. Otherwise award [1 mark] for each correct step ([2 marks max] if incorrect answer).

EITHER

$$\begin{aligned}
 M &= W' \cdot H \cdot R' + W' \cdot H \cdot R + W \cdot H' \cdot R + W \cdot H \cdot R \\
 &= W' (H \cdot R' + H \cdot R) + W \cdot R (H + H') \\
 &= W' \cdot H + W \cdot R
 \end{aligned}$$

OR

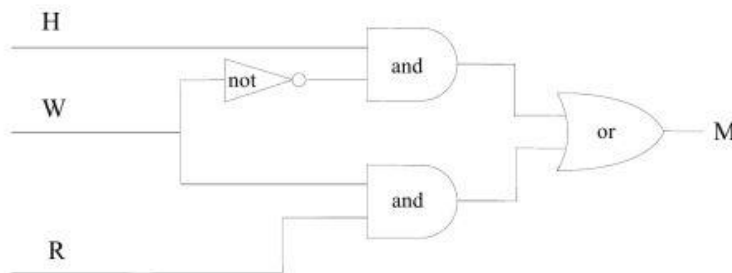
$$\begin{aligned}
 M &= \bar{W} \cdot H \cdot \bar{R} + \bar{W} \cdot H \cdot R + W \cdot \bar{H} \cdot R + W \cdot H \cdot R \\
 &= W (H \cdot \bar{R} + H \cdot R) + W \cdot R (H + \bar{H}) \\
 &= \bar{W} \cdot H + W \cdot R
 \end{aligned}$$

OR

$$\begin{aligned}
 M &= (\text{not}W \text{ and } H \text{ and not}R) \text{ or } (\text{not}W \text{ and } H \text{ and } R) \text{ or } (W \text{ and not}H \text{ and } R) \\
 &\quad \text{or } (W \text{ and } H \text{ and } R) \\
 &= \text{not}W(H \text{ and not}R \text{ or } H \text{ and } R) \text{ or } W \text{ and } R(H \text{ or not}H) \\
 &= (\text{not}W \text{ and } H) \text{ or } (W \text{ and } R)
 \end{aligned}$$

[3 marks]

- (d) Award [1 mark] for each correct entry into each correct gate [3 marks max].
 Allow follow through – i.e. if only two gates then [2 marks max].



[3 marks]

Total: [10 marks]

16. (a) Award [1 mark max].

When

```

n / 10 ≤ 0;
NOT (n / 10 > 0);
(n / 10 > 0) == false;

```

[1 mark]

(b) There are many different ways of tracing a recursive algorithm. Accept any method but award marks as follows:

[1 mark] for each correct call (i.e. n and b correct) to question up to [4 marks max].

[1 mark] for returning and adding to the final return of 11.

Award up to [2 marks max] for a consistent error which demonstrates understanding of recursion.

Example:

n	n / 10 > 0	b	y	return
1011	True	1	1	8+0+2+1=11
101	True	2	2	8+0+2=10
10	True	4	0	8+0=8
1	False	8		8

Example:

Entering question with n = 1011; b = 1

n / 10 > 0 is true

y = 1

Entering question with n = 101; b = 2

n / 10 > 0 is true

y = 2

Entering question with n = 10; b = 4

n / 10 > 0 is true

y = 0

Entering question with n = 1; b = 8

n / 10 > 0 is false

Returning with 8

Returning with 0 + 8 = 8

Returning with 2 + 8 = 10

Returning with 1 + 10 = 11

Result = 11

Example:

n y question

1011 1 (1011, 1)

101 2 (101, 2)

10 0 (10, 4)

1 8 (1, 8)

Returned 1+2+0+8=11

[5 marks]

continued ...

Question 16 continued

- (c) *Award [2 marks] for an advantage explained and [2 marks] for a disadvantage explained.*

Advantage:

- Less code to write;
- Less repetition than in iteration methods;

Disadvantage:

- More complicated to code;
- Slower Execution;
- Can use more memory when executed;

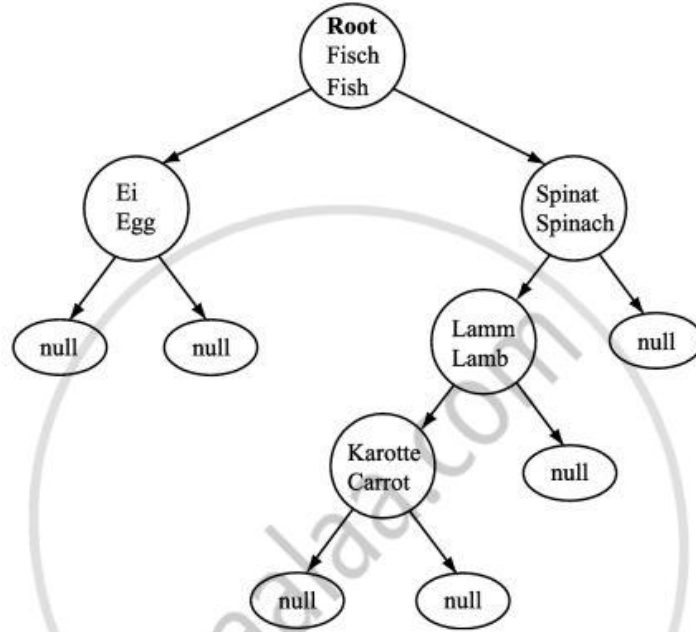
[4 marks]

Total: [10 marks]



17. (a) *Award marks as follows up to [4 marks max].
Award [1 mark] for correct root (the word "Root" does not have to appear).
Award [2 marks] for correct order (allow mirror image).
(Award [1 mark] if there is no more than one mistake.)
(Award [1 mark] if there is only the German word.)
Award [1 mark] for correct null pointers.*

[4 marks]



- (b) (i) *Award [1 mark] for a suitable advantage and [1 mark] for an elaboration up to [2 marks max].
Example:
A binary tree is quick to search;
Especially if it is well balanced as the number of comparisons is small;* **[2 marks]**
- (ii) *Award [1 mark] for a suitable advantage and [1 mark] for an elaboration up to [2 marks max].
Example:
A single linked list is efficient in adding and deleting items;
As only the pointers have to be readjusted;* **[2 marks]**
- (c) *Award [1 mark] for a suitable suggestion and [1 mark] for an elaboration up to [2 marks max].
Example:
A second set of pointers could be introduced to give English alphabetical order;
Head (root) pointer would point to the first word in English and the tail would be after the last word in alphabetical order;
Doubly linked list with two external pointers;
First to give German and second to give English alphabetical order;* **[2 marks]**

Total: [10 marks]

18. (a) **Verification:** The potential member will have to type in their password twice and it will be checked against the first one;
Validation: The format of payment details/personal details will be checked against the expected format and rejected if they are not of the correct format; [2 marks]
- (b) *Award up to [3 marks max].*
When member first applies the payment method;
The personal details should be encrypted;
Each time the member logs in, user name and password should be encrypted;
For transmission between member computer and server (accept this once anywhere); [3 marks]
- (c) *Award up to [2 marks max].*
The protocols are an agreed way/set of rules for communicating when transferring data;
Protocol ensures that the data is accepted and understood by the receiver;
Packets of data include information to get from sender to receiver;
Each packet will contain destination/number in packet;
Protocols ensure that machines with different platforms can communicate; [2 marks]
- (d) Each time an order is confirmed/article bought the number in stock is reduced by one; [1 mark]
- (e) *Award up to [2 marks max].*
When a member makes an enquiry (if stock is low);
That item is made unavailable/blocked to others;
If bought the item is then unavailable until restocked or removed from site;
If not bought it is unblocked;
- Accept also*
A system that does not block but halts a member in the process of buying;
To say that it is no longer available if another member has bought in the meantime; [2 marks]

Total: [10 marks]