Markscheme

November 2017

Computer science

Higher level

Paper 1

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Section A

1. *Award up to [2 max].*
    Fixed vocabulary;
    Unambiguous meaning;
    Consistent grammar;
    Consistent syntax;
    Provide a way to define basic data types and operations on those types (ability to write functions/procedures);
    Provide ability of Input and output handling;
    Provide some kind of loop that can be stopped / conditional statement / branching (conditional and unconditional branching);
    It should have variables that reference computer memory, syntax for basic arithmetic and logical
    operations on those memory locations;
    It has to run on/be processed by a computer (*ie* it must have a compiler/interpreter);

    Note: do not accept aspects that address interoperability/portability/standards/ user friendliness   **[2]**

2. (a)   A piece of computer hardware or software that accesses a service made available by a server /
          The role of a client is to access a service made available by a server by sending a request for service;

          Note: the term client is to be understood only from the computing perspective, ie this is not a human.   **[1]**

    (b)   A program/host computer that awaits and fulfills requests from client programs (in the same or other computers) /
          The role of a server is to fulfill requests from client programs (which can reside in the same or in other computers)

          Note: the term server is to be understood only from the computing perspective, ie this is not a human.   **[1]**

3. *Award up to [1 max].*
    Text-to-speech;
    Voice recognition;
    Braille keyboards;
    Touch screen;
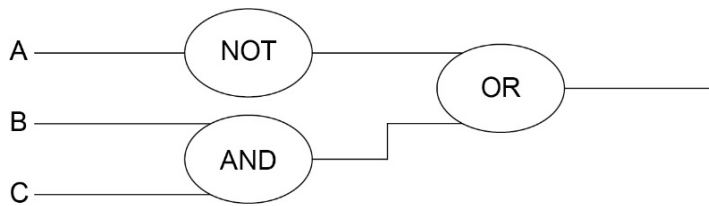   Input from scanner;   **[1]**

4. *Award [1] for all correct input values, [1] for a correct A NOR B column and [1] for a correct (A NOR B) OR A column.*

A	B	A NOR B	(A NOR B) OR A
FALSE	FALSE	TRUE	TRUE
FALSE	TRUE	FALSE	FALSE
TRUE	FALSE	FALSE	TRUE
TRUE	TRUE	FALSE	TRUE

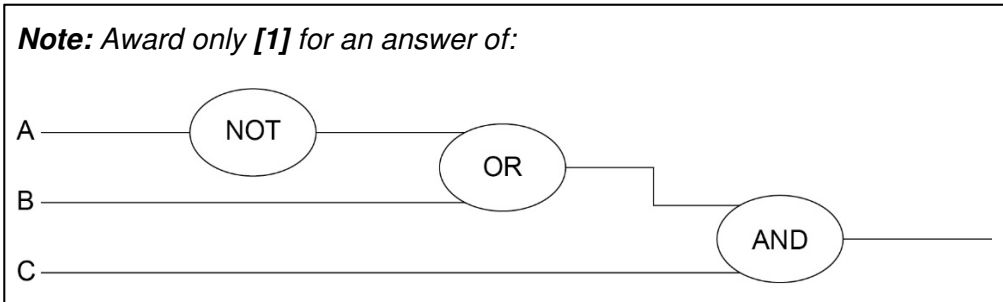**[3]**

5. *Award [1] for each correctly placed gate, up to [3 max].*

[3]

> **Note:** *Award only [1] for an answer of:*
>
>

6. (a) 5;   [1]

(b) *Award up to [3] as follows:*
[3] for fully correct response (sequence of output) "0;2;4";
[2] for response (sequence) "4;2;0" (all elements are correct, but they are in inverse order);
[1] for response "0" (only base case is correct);
OR
"0;2" (incomplete output, but initially correct, and with correct order);
OR
"–2;0;2;4","0;2;4;6" (correct sequence immersed in some unnecessary and incorrect context);

[0] in all other cases (eg responses "2", "4", "2;0", "2;4", "4;2");

0
2
4   [3]

(c) **Example answer 1**
Award marks as follows up to [4 max]. (There are 5 marking points);
Award [1] for determining whether N is odd/even;
Award [1] for correctly initializing and changing the value of the loop controlling variable (K);
Award [1] for the correct condition in the `while` *loop;*
Award [1] for output within the loop for an even N;
Award [1] for output after the loop for an odd N;

```
mystery(N)
   if N mod 2 = 0 then
      K = 0
      loop while K <= N
        output K
        K = K + 2
      end loop
   else
      output N
   end if
end mystery
```

Example answer 2
*Award marks as follows up to **[4 max]**. (There are 5 marking points);*
*Award **[1]** for determining whether N is odd/even;*
*Award **[1]** for correctly initializing and changing the value of the loop controlling variable (K);*
*Award **[1]** for the correct condition in while loop (note K < N);*
*Award **[1]** for output within the loop for an even N;*
*Award **[1]** for outputting N after the loop;*

```
mystery(N)
   K = 0
   loop while (K < N) AND (N mod 2 = 0)
     output K
     K = K + 2
   end loop
   output N
end mystery
```

Note: *No marks for any attempt of program that contains recursive calls.*

Reminder: *in the Spanish version* `mystery()` *is called* `incognita()`.

Remark: *A correct program produces in output numbers in an ascending order, only.*   **[4]**

7. (a) Primary memory / RAM   **[1]**

(b) *Award up to **[2 max]**.*
     Note*: there must be explicit reference to both address and data bus.*

     Example 1
     Buses are used as physical connections to carry information to the CPU;
     The data bus transports data from/to CPU, whereas the address bus the memory address where the data is supposed to go/be;

     Example 2
     Data bus is a physical connection to transport data from-to CPU to be processed;
     Address bus is a physical connection to transport an address of memory storage where data (transported in the data bus) should be read/written;

     Note: *Award **[1]**, for responses that show some understanding of use of buses in CPU, for address location and data transport without using specialist terminology.*   **[2]**

8.   Binary digit;
           (Minimal) unit of storage that can be set to 0 or 1;   **[1]**

9.   *Award up to **[2 max]**.*
           It involves sending sample software to the intended audience;
           (Selected audience does not pay for this software);
           To try/use the software product;
           And give the feedback to the authors (which help in correcting bugs);   **[2]**

Section B

10. (a) Each word in the text file is compared with words in a <u>dictionary</u> (held in memory/online);
If the word is found in the dictionary it is correctly spelt / if the word is not found in the dictionary, spellchecker will recognize that it is incorrectly spelt; **[2]**

(b) *Award **[1]** for stating a problem and **[1]** for an elaboration, up to **[2 max]**.*
Users/employees might be afraid of these changes (for various reasons);
And not willing to help in this change;

Data migration problems;
For example, different file formats so conversion must be performed;

Employee efficiency may drop;
As they learn to use the new system;

Issue of compatibility with legacy software/hardware;
So features of new software/hardware may not work correctly; **[2]**

(c) *Award **[1]** for outlining what is meant by direct changeover, **[1]** for outlining what is meant by phased conversion, and then **[1]** for an advantage or disadvantage **of each**, up to **[4 max]**.*

Example answer
In direct changeover, the old software and hardware is completely replaced, in one move, by the new software and hardware;
Phased conversion involves selecting one section in the office for the direct changeover and other sections will be switched when the first section selected is running satisfactorily. Eventually the whole office has been changed;
A phased conversion is less risky than a direct changeover as any problems that might arise will be isolated in only one section in the office;
Direct changeover means everyone in the organization has same software/hardware and so there are no compatibility issues; **[4]**

(d) *Award **[1 max]**.*
Debugging (**Accept**: white-box testing – *ie* structural testing/flow testing;
black-box testing / requirement testing);
User acceptance testing (alpha-testing) / Beta-testing; **[1]**

(e) *Award **[6 max]** according to the instructions of the closest template of example answer.*
***Remark**: Accept reference to either array MESSAGE or CHARARRAY.*

Example answers 1, 2, 3 and 4
*Award marks as follows up to **[6 max]**.*
*Award **[1]** for correctly initializing and changing indexes in MESSAGE (variable K);*
*Award **[1]** for comparing CH with the character at position K in MESSAGE;*
*Award **[1]** for terminating the while loop when there are no more characters to check (Accept 19 instead of len(MESSAGE));*
*Award **[1]** for terminating the loop when CH is found in MESSAGE;*
*Award **[1]** for correctly <u>returned</u> value of POS when CH <u>does not</u> appear in MESSAGE. (**Note:** output not accepted);*
*Award **[1]** for correct assignment (or value) of POS when CH appears in MESSAGE;*

Example answer 1
```
POS = -1
FOUND = false
K = 0
loop while (K < len(MESSAGE)) AND (NOT FOUND)
    if MESSAGE[K] = CH then
         FOUND = true
         POS = K
    end if
    K = K + 1
end loop
return POS
```

Example answer 2
```
POS = -1
FOUND = false
K = 0
loop while (FOUND = false) OR (K < len(MESSAGE) //this order!
    if MESSAGE[K] = CH then
         FOUND = true
         POS = K
    end if
    K = K + 1
end loop
return POS
```

Example answer 3
```
K = 0
loop while (MESSAGE[K]! = CH) AND (K < len(MESSAGE))
    K = K + 1
end loop
if len(MESSAGE) = K then
    POS = -1
else
    POS = K
end if
return POS
```

Example answer 4
```
K = 0
loop while (MESSAGE[K]! = CH) OR (K < len(MESSAGE))
    K = K + 1
end loop
if K = len(MESSAGE) then
    POS = -1
else
    POS = K
end if
return POS
```

Example answer 5 (for-loop, decrementing the index)
*Award up to **[5 max]** for an answer with a `for` loop (as there are no marks awarded for efficiency);*
*Award **[1]** for starting from the **last** index of MESSAGE;*
*Award **[1]** for ending at the first index of MESSAGE;*
*Award **[1]** for comparing CH with the character at position K in MESSAGE;*
*Award **[1]** for correct defined/returned value of POS when CH does not appear in MESSAGE;*
*Award **[1]** for correct assignment of POS when CH appears in MESSAGE;*

```
POS = -1
loop for K from len(MESSAGE)-1 to 0
  if MESSAGE(K) = CH then
    POS = K
  end if
end loop
return POS
```

Note: *Attempts of solutions that use an <u>incremental for-loop</u>, starting from the first index of the array, necessarily require the presence of a temporary variable to store the index!;*
*If none is present, then it is likely to be an incorrect attempt to the question (NAQ): award **[3 max]**;*   **[6]**

11. (a) *Award up to **[1 max]**.*
Wireless router/modem;
Access points;
Switch;
Wireless repeater/extender/booster;   **[1]**

(b) *Award **[1]** for identifying a disadvantage and **[1]** for an expansion, for **two** disadvantages up to **[4 max]**.*

Data transfer will decrease (compared with a wired LAN);
Because the number of computers using the network increases;
(and because) WLAN has lower bandwidth than a wired LAN;

Less data security;
As devices from outside the school can access the network/intercept transmissions;

More easily open to misuse;
As teacher/administrator cannot directly monitor a specific student/teacher/ machine;

Intermittent connectivity due to physical barriers (walls);
Results in low transfer/speed and may hinder operations.

Note: *Accept any reasonable points, provided they are appropriately elaborated.*   **[4]**

(c)   Award up to *[3 max]*.
        Give each user appropriate login details/passwords;
        Different access rights for students, teachers, school administrators (file-level and
        share-level security);
        All passwords and files /disk should be encrypted;
        Use the latest WiFi protocol/WPA2;
        Require MAC address authentication;
        Password protect the documents;

        Note: *the focus of the question is on protection of confidential data
        (Firewalls not accepted)*   **[3]**

(d)   Set of rules for data transmission;   **[1]**

(e)   *Award up to **[6]** as follows:*

        *Award up to **[3 max]** for a general description of how data is transferred by
        packet switching. (**[1 max]** if this general description is very simplistic and refers
        to just the Header/Data/Trailer already shown in the question paper).*

        *Award up to **[3 max]** for added detail that references the contents of the given
        data packet in the answer.*

        Example of general description
        Data is organized in specially formatted units (data packets) which are routed
        from source to destination using network switches and routers;

        Network switches and routers determine how best to transfer the packet between
        a number of intermediate devices (routers and switches) on the path to its
        destination (rather than flowing directly over a single wire on the path to its
        destination);

        Data packets are reassembled at the destination;

        Example of referencing content
        Addresses have to be in a standard format so that each switch/routing station
        recognizes the address;
        Address of sender identifies the sending computer, so that any packets not
        received can be re-requested;
        Address of receiver identifies intended recipient so it can be forwarded on
        correctly;
        The **protocol** used must be identified so that the correct rules are followed;
        Size of packet / size of fields in packet – All packets/fields must have the same
        size so that the data can be reassembled;
        Sequence number so that packets can be reassembled in correct order;
        Transmission codes to show whether the data packet is transmitted or
        re-transmitted;
        Control bits, to maintain the integrity of the data by ensuring that the data
        received is the same as the data sent;
        Error checking code – when an error is detected, an algorithm either corrects
        the error or requests that the packet is resent;   **[6]**

12. (a) *Award up to [2 max].*
*([1] for each of the **two** benefits).*

Digital cameras are relatively cheap;
Robust;
No need for AD conversion;
Generally very high quality pictures (useful to prevent malpractice);
Generally quick;

Example answer 1
No need for conversion because image is in digital format;
Thousands/millions of photos of eyes could be taken before needing replacement;

Example answer 2
It is directly connected to a microprocessor for image comparison;
It could be fitted (purchased), with a macro lens so that a close up scan of the
Iris is possible; **[2]**

(b) *Award up to [2 max].*

Processor compares the inputted image/pattern with the images stored in memory;

If a match is found, it sends a signal to unlock doors /
(if match is not found, it sends error message/the doors remain locked); **[2]**

(c) Output transducer is a device (an actuator) which converts;
an electrical signal into physical quantity (a physical action);

Output transducer is a device which converts energy from one physical form to
another;
eg electrical energy (signal) into electro-mechanical or kinetic energy / to produce
action (lock/unlock door);

Note: *Award one mark only for an answer that just says that the output
transducer can be used to lock/unlock doors.* **[2]**

(d) *Award [1] for the meaning of centrally controlled system;*
[1] for the meaning of a distributed system, and;
[up to 2 max] for an expansion/comparison addressing both kind of systems
[up to 4 max];

Example answer
A centrally controlled system involves a central computer which controls all
labs/doors;
A distributed system can have only a dedicated microprocessor with memory to
control one of the labs/doors;

A centrally controlled system is more versatile;
Could be used in solving other business tasks (accept specific examples);
Can unlock all doors easily during an emergency;
Access rights can be updated easily;
Data is stored centrally and therefore easier to update;
A failure in a central system would affect all doors;

A distributed system can be programmed with ad hoc OS depending on the technologies used;
It may be practical choice when dealing with legacy systems/ specific devices/ old infrastructure/while updating the facilities;
It contributes a higher sense of partition of the physical space (territory) to groups / individuals;
Data are stored locally, so there is local consistency (and smaller size mean easier to manage);
Changes to data may be done locally, and if some data are common in two or more different
systems, global inconsistencies across different systems may be introduced; **[4]**

(e) *Award **[2 max]**.*
Memory management;
Resource allocation / Resource and Hardware management (printer, disk drives, *etc.*);
Booting / bootstrapping;
Loading and execute / provide service for applications software;
Disk/File system management;
Data security;
Provides a user interface to other levels of the machine;
etc. **[2]**

(f) *Award **[1]** for choosing "interrupt", **[1]** for explaining "interrupts" and **[1]** for justifying the choice in this context, up to **[3 max]**.*

Example answer:
Interrupt;
A signal sent from an input device to a computer causes the processor, and the main program that operates the computer (the operating system), to stop and figure out what to do next;
Interrupt is better in this situation because it does not waste central computer's time (other tasks could be performed);
(example of emergency – it must give quick response);

Note: *Award **[1 max]** for an answer of "polling", but only if reasonably justified.*

Polling – the continuous checking of all input devices by processor to see what state they are in/to see whether they are still connected/want to communicate;
So a faulty device that is polled will not reply; **[3]**

13. (a) *Award up to [2 max].*
Each node contains data and also a link to other nodes;
Links between nodes are implemented by pointers (a pointer references a
location in memory or holds a memory address);
List size is not fixed / predetermined; **[2]**

(b) *Award up to [6 max] as follows. (There are 7 marking points)*
[1] create new node;
[1] instantiation of values and pointers in new node;
[1] state where the search starts from;
[1] how to detect position for insertion;
[1] update pointers in new node;
[1] update pointers from the node at the insertion point, to the new node;
[1] update external pointers;
Remark: *Some answers may just use illustrations alone, or very minimal explanations: see note below;*

Create a new node (with pointer NEWNODE) with data field Primrose and two
pointer fields (next and previous), to be inserted;

Perform a linear search, either from the beginning or end of the list (using
pointers FIRST and LAST, on the alphabetically order list;

The location/position of insertion, is found by comparing nodes (Primrose to be
inserted after Lavender, LOCATION points to Lavender) (**Accept** any description
to that effect);

(At the end of this phase, the situation looks as in **Figure 1**)

Figure 1
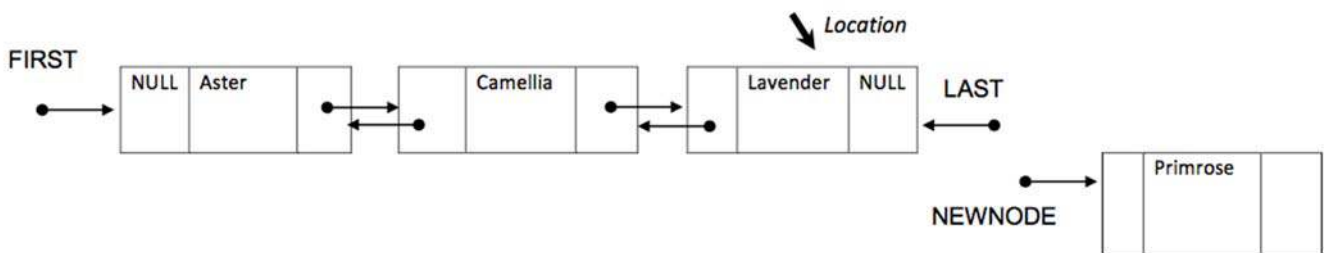
Then, continue by setting the "next" field/pointer in the newly created node to
NULL;

Set the "previous" pointer in the newly created node to the current LAST / to point
to Lavender/ to point to the node detected by LOCATION;

Change/Set/Update the Lavender's "next" pointer to point to the new node / to
link with the NEWNODE pointer (delete NULL in the field and link to the existing
NEWNODE pointer);

Update the LAST pointer to point to the newly created node;

Eventually the final doubly linked list looks like this (**Figure 2**);

Figure 2
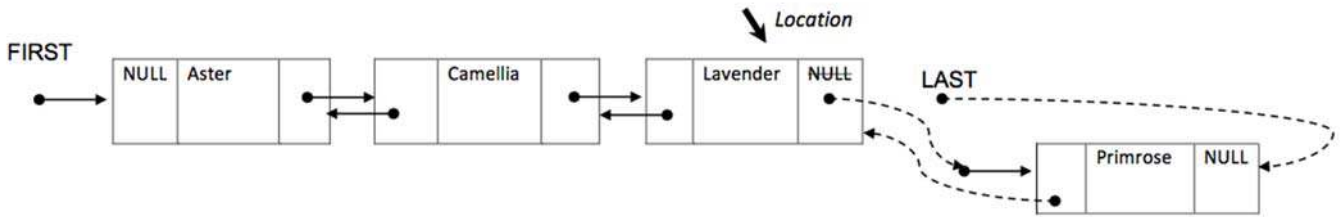
*Note: Award **[4 max]** for responses that return one or more drawings without any explanation at all, for evidence of these features:*
[1] *Evidence of creation of an initial new node for Primrose out of the list;*
[1] *The order of nodes Aster/Camellia/Lavender/Primrose is eventually correct;*
[1] *The two unidirectional links between Lavender and Primrose are (eventually) correctly displayed, from-to the appropriate fields;*
[1] *LAST points correctly to the appropriate field in the new node Primrose, **and** NULL fills the last field of the new node;* **[6]**

(c)   *Award **[1]** for each one in the correct order.*
Apple;
Broom;
Camellia;
Day Lily;

Note: Solution for the Spanish version (in this order):
Aster; Camelia; Lavanda; Lirio; **[4]**

(d)   *Award marks as follows up to **[3 max]**.*

Example answer 1
Create an empty stack (FLOFRU);
pop all elements from FRUITS and **push** them onto FLOFRU;
Then **pop** all elements from FLOWERS and **push** them onto FLOFRU;

Example answer 2
Create an empty stack (FLOFRU);
While FRUITS is not empty
        pop an element from FRUITS and **push** it onto FLOFRU;
While FLOWERS is not empty
        pop an element from FLOWERS and **push** it onto FLOFRU;

*Note: Award **[2 max]** for generic descriptions that do not use appropriate terminology on data structures and their operations.* **[3]**

14. (a)   36;   **[1]**

(b)   7;   **[1]**

(c)   *Award marks as follows up to **[6 max]**. (There are 7 marking points)*
*Award **[1]** for initialization and correct changes of K (index/position in arrays*
VALUES and COL);
*Award **[1]** for initialization and correct changes of COUNT (counts non-zero*
elements);
*Award **[1]** for correct conditions in "row" loop;*
*Award **[1]** for correct conditions in "column" loop;*
*Award **[1]** for placing non-zero element at correct position in array VALUES;*
*Award **[1]** for placing the "column" index of the non-zero element at correct*
position in array COL;
*Award **[1]** for placing COUNT at correct position in array ROWC;*

```
COUNT = 0
K = 0
loop for I from 0 to 5
   loop for J from 0 to 5
     if MAT[I][J]! = 0 then
        VALUES[K] = MAT[I][J]
        COL[K] = J
        K = K + 1
        COUNT = COUNT + 1
     end if
   end loop
   ROWC[I] = COUNT
end loop
```
                                                                                                      [6]

(d)   *Award up to **[2 max]**.*

   Example answer 1
   Array COL should be <u>searched</u> for (value) C;
   If (value) C is <u>not found </u>in array COL then this column (the column whose index in
   BIGMAT is C) holds only zeros;

   Example answer 2
   If the number of <u>occurrences</u> of (value) C in array COL;
   <u>Equals zero</u> then this column holds only zeros;

   ***Example answer 3**: Award **[1 only]**.*
   If COL[C] = COL[C-1], then the column with index C in BIGMAT contains no
   non-zero-elements;
   (Accept words to that effect: "if the difference between COL[C] and COL[C-1] is
   zero, then...");   **[2]**

(e)   1;   **[1]**

(f) (i) 5;   **[1]**

(ii) *Award marks as follows up to **[3 max]**.*
*Award **[1]** for realizing that the range should be determined differently for*
the first row (when row index R is 0) OR correct range when row index is 0;
*Award **[1]** for correct first index in range (when row index R is not 0);*
*Award **[1]** for correct last index in range;*

If row index R is equal to 0 then the range is from 0 to ROWC[0]−1 ;
If row index R is not equal to 0 then the range is from ROWC[R−1];
To ROWC[R]−1;

Note: *Award **[2 max]** for a correct calculation of the indexes, but no*
unifying expression showing how they have been calculated is given).   **[3]**