

Name

IBDP Computer Science - HL

Year 12

October, 2023

Instructions

- Answer all questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name at the top of the page.
- Write your answer to each question in the space provided.
- Do not use an erasable pen or correction fluid.
- Calculators must not be used in this paper.

The time available is the entire session.

If you complete the paper before the session ends, you may hand in your paper. After that, you have the option to read a book.

You may not use any technology during the entire session, even after handing in your paper.

There are 70 marks available in this paper.

1

By making direct reference to the technologies used, explain how a virtual private network (VPN) allows a travelling salesperson to connect securely to their company's network.

[4]

2

Construct a truth table for the following Boolean expression.

$(A \text{ AND } B) \text{ NOR } C$

[3]

3

A school uses a local area network (LAN) which connects several computers and a printer to a server and allows access to the internet.

(a) Define the term *server*. [1]

(b) Identify the different clients in this network. [1]

(c) (i) Identify **one** external threat to the security of the school's computer system. [1]

(ii) State **one** way to protect the computer system from the threat identified in part (c)(i). [1]

4

A sub-program `all_even()` accepts a positive integer `N` and outputs `true` if all digits of `N` are even, otherwise it outputs `false`. For example, `all_even(246)` outputs `true` and `all_even(256)` outputs `false`.

The following algorithm is constructed for the sub-program `all_even(N)`.

```
EVEN = true
loop while (N > 0) and (EVEN = true)
    if (N mod 10) mod 2 = 1 then
        EVEN = false
    end if
end loop
output EVEN
```

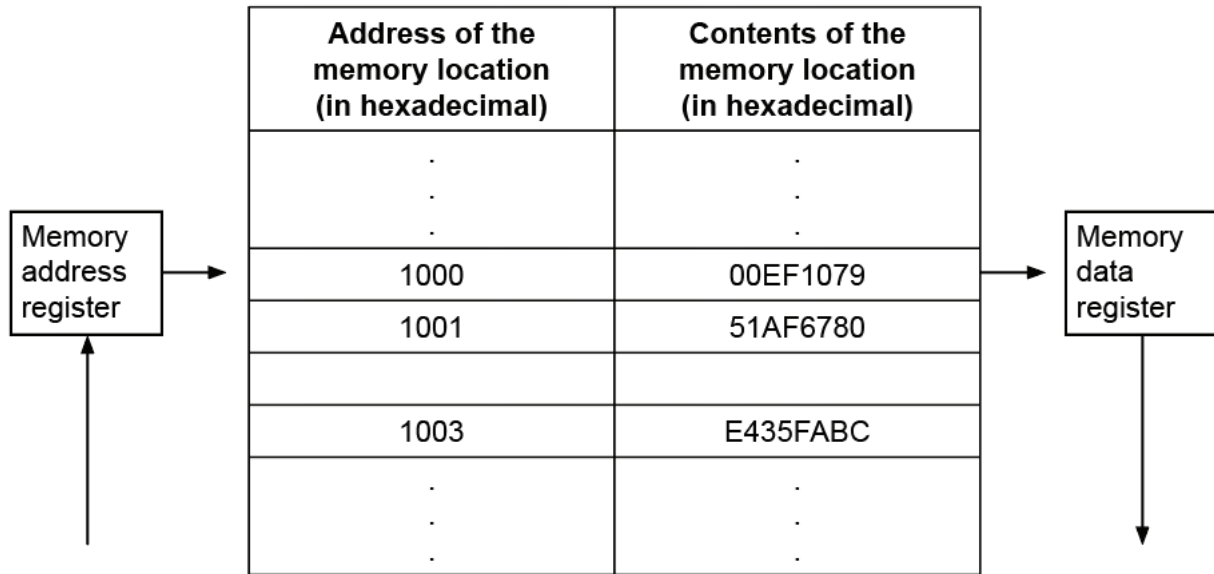
(a) Explain why this algorithm does not obtain the correct result. [2]

(b) Outline what should be changed in the algorithm to obtain the correct result. [3]

5 (a) Draw an annotated diagram showing how an array can be used to store a stack. [2]

(b) Explain how elements in the stack may be reversed using a queue. [4]

The following diagram shows the structure of the random access memory (RAM).



(a) Calculate the number of bits in each memory location. [1]

(b) Calculate the number of bytes in each address. [1]

(c) Outline the function of the:

(i) memory address register [2]

(ii) memory data register. [2]

(d) (i) Identify **two** functions of the operating system. [2]

- (ii) State where the operating system is held when the computer is turned off. [1]

The machine instruction cycle refers to the retrieval of an instruction from the RAM, and subsequently decoding, executing and storing the result.

- (e) (i) Construct a diagram to illustrate the structure of a central processing unit (CPU), clearly showing the flow of data within the CPU. [4]

- (ii) Identify the part of the CPU which performs decoding. [1]

- (iii) Identify the part of the CPU which executes the instruction. [1]

7

A control system is used to control sliding doors which automatically open to allow people in and out of a shop.

(a) (i) Identify **one** type of sensor in this system. [1]

(ii) Identify **one** piece of hardware, other than sensors, that is part of the control system. [1]

(iii) With reference to the role of sensors, outline the sequence of steps within the computer control system that will take place when a person approaches the door. [3]

(b) (i) Define the term *interrupt*. [2]

(ii) Describe a situation in this system where an interrupt would occur. [2]

- (c) Discuss the contribution of computer control systems in industry where they replace human workers.

[6]

8 The table below holds student names and scores, from a class test.

NAME	SCORE
Ann Taylor	10
Boris Penn	18
Ivan Troth	8
Peter Hu	9
Mary Looty	7

- (a) Draw a diagram to show how the data given in the table could be stored in a binary tree in the order of scores. Data should be inserted into the binary tree in the order given in the table (ie data about Ann Taylor is to be inserted first).

[3]

- (b) The same data could be inserted into a singly linked list in descending order of scores. Draw a diagram of this singly linked list.

[3]

- (c) Compare the data structures in part (a) and part (b) in terms of:

- (i) searching

[2]

- (ii) storage requirements.

[2]

9

Consider the following fragment of code that implements the method `result()`, where `x` and `y` are non-negative numbers.

```
public int result(int x, int y)
{
    if (x==0)
    {
        return 0;
    }
    else if (y == 0)
    {
        return 1;
    }
    else
    {
        return (x+y)*result(x, y-1)
    }
}
```

- (a) Trace the method `result(3, 4)` showing the intermediate steps and the final evaluation of this call.

[4]

An electronic amplifier uses a variant of `result()`, to produce distorted special effects whilst a music instrument is being played.

The method `result4()`, with the signature

```
double result4(double x, int y, double z, int v),
```

produces these special effects, taking four non-negative signals in input, and obeying the following specification:

- if the first three inputs (`x`, `y` and `z`) have a combined value that is more than 12 times the value of `v`, then the method behaves as `result(v, y)`
- otherwise, and if the value of `y` is less than half the value of `x`, the method `result4()` is called again, only now with `y` and `v` decremented by 3, unless this would make their values invalid
- if none of these actions are possible, `result4()` behaves as `result(0, 0)`.

- (b) Construct the method `result4()`, according to the given specification.

[4]