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TOTAL MARKS

INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2023

COMPUTER SCIENCE: PAPER II

EXAMINATION NUMBER

Time: 3 hours 150 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 27 pages and an Insert of 2 pages (i–ii). Please check that your question paper is complete.
2. Remove the Insert from the middle of the question paper.
3. Read the questions carefully and make sure that you answer all parts of all the questions.
4. **Answer on the question paper. Please make sure that you write your examination number in the blocks above and on the Insert, and hand both documents in at the end of the examination.**
5. Show all working where applicable.
6. A non-programmable calculator may be used.
7. It is in your own interest to write legibly and present your work neatly.
8. Two blank pages (page 26–27) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the question number of your answer should you use this extra space.

FOR MARKER'S USE ONLY

Question	1	2	3	4	5	6	7	8	9	Total
Marks	6	28	14	18	13	22	11	15	23	150
Marked										
Moderated										

SECTION A SHORT QUESTIONS

QUESTION 1 DEFINITIONS

Give the most appropriate term for each of the following statements:

1.1 A process to ensure that data entered into a database field conforms with the field's criteria.

_____

(1)

1.2 Large volumes of structured and unstructured data that is accumulated from various sources.

_____

(1)

1.3 Translating source code into a separate executable file.

_____

(1)

1.4 A method in the sub-class with the same name and the same parameters as a method in the superclass.

_____

(1)

1.5 A bus that transfers instructions and data between the RAM/cache and the CPU.

_____

(1)

1.6 The interface specification for an SSD that is attached to the PCIe bus.

_____

(1)

6 marks

SECTION B SYSTEM TECHNOLOGIES

QUESTION 2

SCENARIO

Consider the following scenario when answering the rest of the examination paper unless otherwise stated or the questions are of a general nature.

Xavier is a software developer and has been working from home. His company wants all employees to return to working at the office. He loves gaming and has been using the following desktop computer to code programs and play games.

Processor	Intel i9 12th generation 3.2 GHz up to 4.5 GHz 16 × Cores 30 MB cache CPU cooled with fan, heat sink and liquid cooler
RAM	16 GB DDR4 3600 MHz RAM
Motherboard	Intel DDR4 Intel LGA 1700 socket for Intel 12th generation CPUs 2 × DIMM slots 4 × PCIe slots 2 × M.2 slots 4 × SATA ports Supports SATA RAID 0/1/5 4 × USB 3.2 ports 2 × USB 2.0 ports 128 Mb UEFI
Storage	512 MB Solid State Drive connected to a PCIe slot
Graphics	GeForce GT 2 GB DRAM
Connectivity	Ethernet LAN port HDMI port
Operating System	Windows 10

2.1 The processor is an Intel i9 with speeds between 3.2 GHz and 4.5 GHz.

2.1.1 What is the minimum speed of the processor in **megahertz** (**MHz**)? Show your calculations.

(2)

2.1.2 Explain why the speed of the CPU varies from 3.2 GHz to 4.5 GHz.

(2)

2.1.3 Explain why this CPU requires THREE cooling mechanisms: fan, heat sink and liquid cooling.

(2)

2.2 The processor has 16 cores.

2.2.1 If the processor is hyperthreaded, how many logical cores would there be?

(1)

2.2.2 Define the term hyperthreading.

(2)

2.3 The computer has 16 GB DDR4 3600 MHz RAM, and 30 MB cache.

2.3.1 What is the speed of the RAM **megahertz** (**MHz**)?

(1)

2.3.2 Define processor cache.

(2)

2.3.3 When the CPU processes at its minimum speed, it is slower than the RAM. Why is processor cache necessary if the RAM is faster than the CPU? Give TWO reasons for your answer.

Reason 1:

Reason 2:

(2)

2.4 The motherboard supports SATA RAID 0/1/5.

2.4.1 What is RAID? Do not expand the acronym.

(2)

2.4.2 Explain the relevance of the numbers 0/1/5? Provide an example as part of your answer.

Explanation:

Example:

(2)

2.4.3 Xavier would like to include a backup procedure combined with RAID. Define backup.

(2)

2.4.4 Explain why backup and RAID are both necessary to protect data.

(2)

2.4.5 Xavier implements RAID with multiple mechanical hard drives connected to a SATA bus. Give THREE reasons why the overall computer performance will be slower than his current SSD connected to a PCIe bus.

Reason 1:

Reason 2:

Reason 3:

(3)

2.5 The motherboard has 128 Mb UEFI firmware.

2.5.1 What is the purpose of this component?

(1)

2.5.2 UEFI is an upgrade to which older firmware?

_____

(1)

2.5.3 What data is needed by UEFI to perform its function?

_____

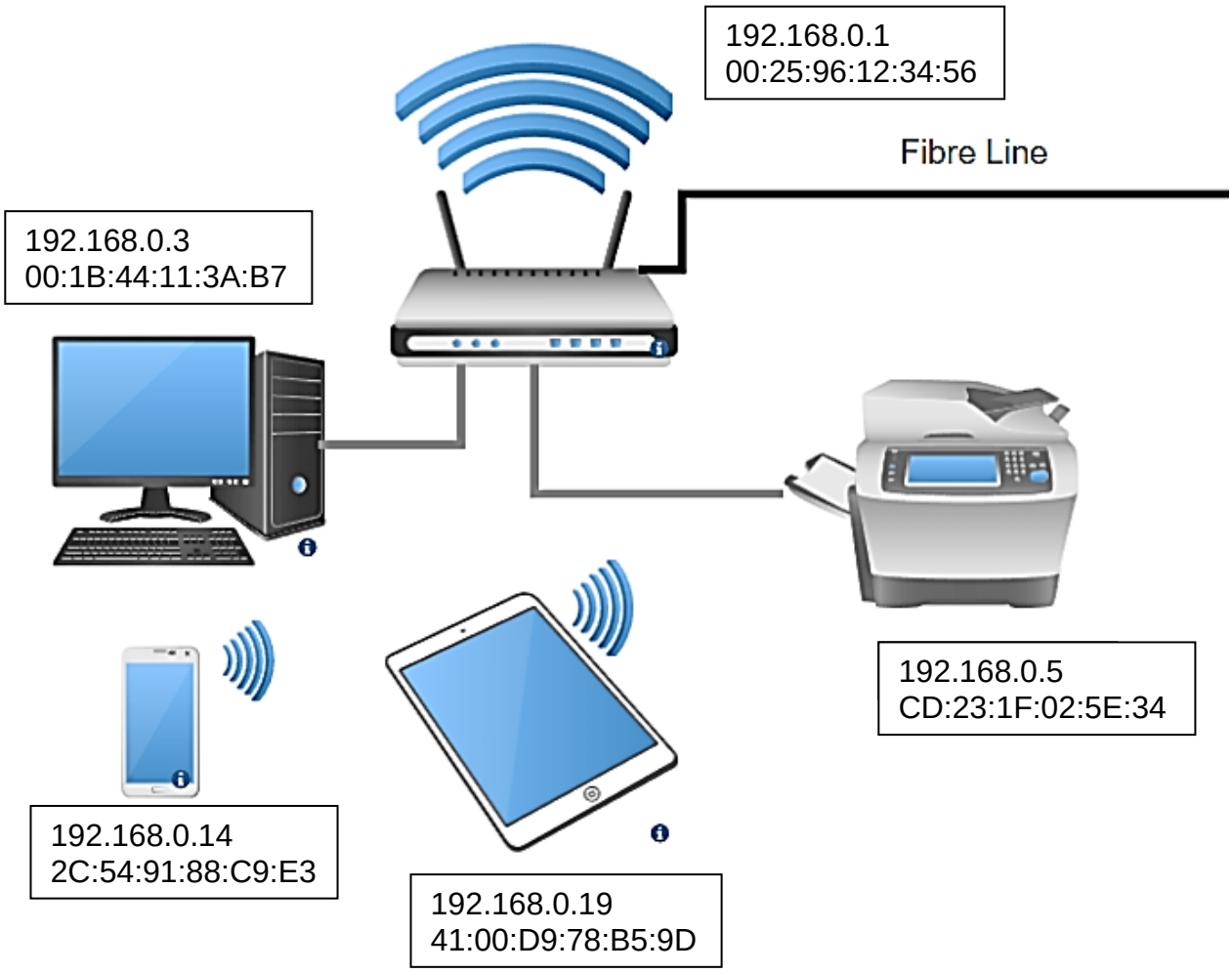
(1)

28 marks

SECTION C NETWORKING

QUESTION 3

Xavier has a fibre-cabled Internet connection connected to a Wi-Fi home router. His desktop and printer are connected to the router using UTP cables. His smartphone and tablet connect to the router wirelessly.



3.1 The Wi-Fi home router functions as a multipurpose device.

3.1.1 What is the primary function of a router?

(2)

3.1.2 Explain why the Wi-Fi home router also acts as a switch in this scenario.

(2)

3.2 Each device has an IP address and a MAC address.

3.2.1 What is a MAC address?

(2)

3.2.2 Xavier checks the IP addresses of each device and notices that the IP addresses of the tablet and smartphone have changed. What protocol would be responsible for allocating IP addresses?

(1)

3.2.3 Name the protocol for mapping the IP addresses of each device to its MAC address.

(1)

3.2.4 Each IP address starts with 198.68.0, indicating the devices are on the same local area network.

(a) What is the maximum number of devices that can be connected if all devices are prefixed with 198.68.0?

(1)

(b) Explain your answer.

(2)

3.3 Xavier sends a document to the printer from his desktop.

3.3.1 How will the data be sent?

Select the correct answer:

Packet ☐ Frame ☐

(1)

3.3.2 Write down the Destination IP address and the Destination MAC address used for data sent from the desktop to the printer as it leaves the desktop.

Destination IP address: _____

Destination MAC address: _____

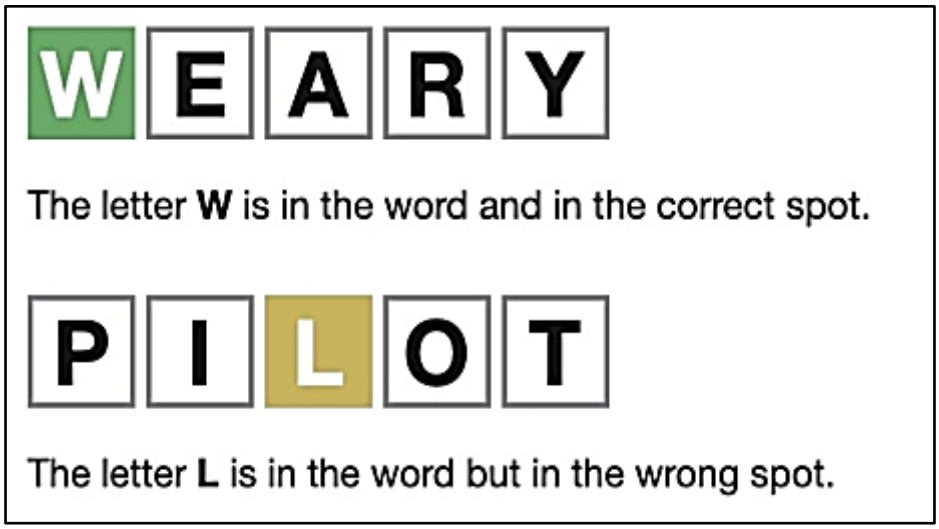
(2)
[14]

QUESTION 4

Xavier's company is looking to create an online game similar to Wordle. Read the article below and answer the questions that follow:

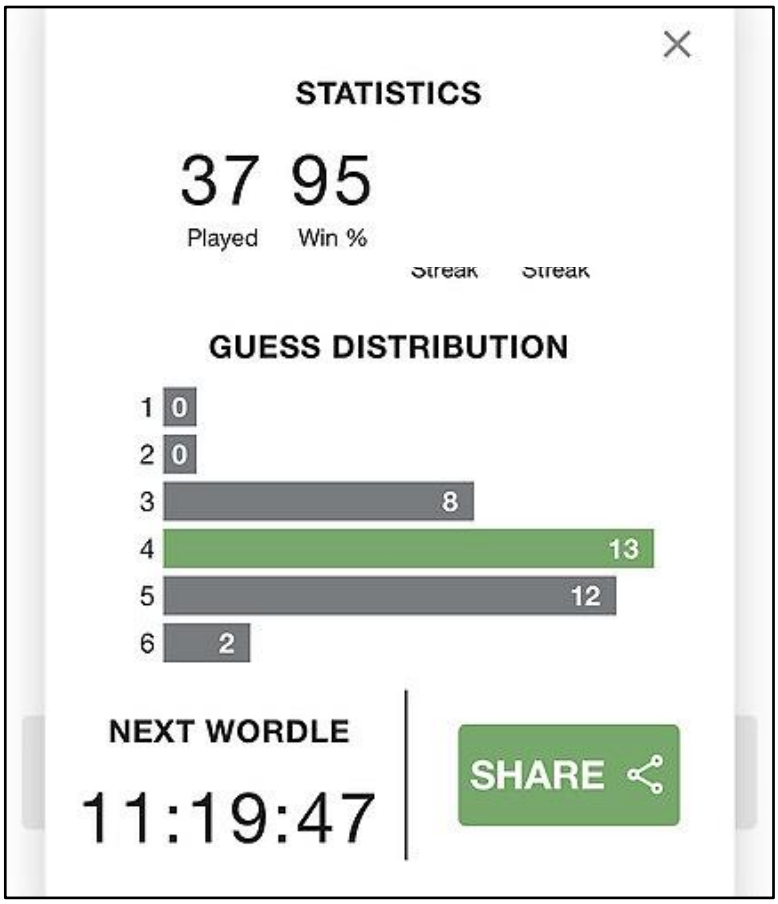
Wordle is a New York Times-owned game played daily using a web browser. Players must guess a mystery five-letter word, known as the 'wordle' in six attempts.

If a user's chosen word has any letters in the correct position, the letter's background changes to green. The background changes to yellow if the letter is in the incorrect position. Otherwise, the background is white.



[Source: <https://i.inews.co.uk/content/uploads/2022/01/PRI_217279117-640x360.jpg>]

After each game, the user is shown a summary of their statistics which can be shared on social media apps.



[Source: <https://forum.quartertothree.com/uploads/default/optimized/3X/a/a/aab800d085ee0896ec94447444238c7fbd1a1634_2_431x500.jpeg]>

In the above screen, the user has played 37 times and guessed the correct word 95% of the 37 times. On average, it takes 4 attempts to guess the correct word.

The game does not require a user to log on, and if the user starts the game and returns to it later the same day, their previous guesses will be recorded. Each day the user's attempts are cleared to start afresh with a new word. The game will initially remain free to new and existing users, but fans are concerned that the game may be placed behind a paywall.

As the game operates entirely using **client-side** code run in the browser, some players have downloaded the webpage for offline use due to fears that the New York Times Company would modify the game undesirably.

[Adapted from: <https://inews.co.uk/news/technology/wordle-what-how-play-word-game-free-online-rules-explained-1383747>, <https://en.wikipedia.org/wiki/Wordle> (Accessed 7 April 2022)]

4.1 The article mentions client-side scripting.

4.1.1 Define **server**-side scripting.

(2)

4.1.2 Explain why Wordle can be executed using client-side scripting, assuming the word of the day is included in the HTML code sent to the user.

(2)

4.1.3 Xavier tests out the game and plays it for 20 days in a row. He plays the game on either his desktop or smartphone. He notices that his statistics are different for each device. His desktop shows the statistics of 13 games played, and his smartphone shows the statistics of the remaining 7 games played.

Give TWO possible reasons why his statistics are different for each device.

Reason 1:

Reason 2:

(2)

4.2 The URL for the Wordle game is https://www.nytimes.com/games/wordle/index.html.

4.2.1 Websites that start with "https" use SSL. Define Secure Socket Layer (SSL).

(2)

4.2.2 Give ONE reason why the Wordle site would need to be secure if users are not required to log on.

(1)

4.3 The article mentions that players are concerned that the game may be limited to New York Times subscribers and will only be available behind a paywall.

4.3.1 Would the Wordle site form part of the dark web if it was only available behind a paywall?

Select the correct answer:

Yes ☐ No ☐

(1)

4.3.2 Give TWO reasons for your answer.

Reason 1:

Reason 2:

(2)

4.4 Xavier installed a Virtual Private Network (VPN) on his desktop.

4.4.1 Define a VPN.

(2)

4.4.2 Do you think his previous Wordle statistics would be removed once the VPN is installed?

Select the correct answer:

Yes ☐ No ☐

(1)

4.4.3 Give ONE reason for your answer.

_____

_____

(1)

4.4.4 Explain why a VPN is not the same as remote access.

_____

_____

_____

_____

(2)
[18]

32 marks

SECTION D SOCIAL IMPLICATIONS

QUESTION 5

5.1 Xavier's company is considering creating a similar online game to Wordle but with additional features.

5.1.1 Would you consider this illegal if Xavier developed his own source code for the solution?

Select the correct answer:

Yes ☐ No ☐

(1)

5.1.2 Explain your answer in 5.1.1

_____

_____

_____

_____

(2)

5.2 Users can share their Wordle results on social media. Some Twitter[1] users have been annoyed with the flood of tweets from users bragging about their Wordle results. Recently Twitter blocked a user account that automatically responded to a tweet with the next day's answer.

[Source: <https://pbs.twimg.com/media/FJ4gK0mXIAkUfJq?format=jpg&name=small>]

[1] Twitter is a social media app where user's can post limited text messages, images or videos called 'tweets'. These posts can be liked, replied to or shared. Twitter recently changed its name to X.

5.2.1 Define the term information overload.

(2)

5.2.2 Give TWO strategies a Twitter user could use to manage information overload without deleting their Twitter account?

Strategy 1:

Strategy 2:

(2)

5.2.3 Give TWO reasons why Twitter blocked this user's account when many other users tweet controversial or offensive material?

Reason 1:

Reason 2:

(2)

5.3 Give ONE example of how Wordle could be used for educational purposes.

(2)

5.4 Some users struggle to differentiate between the green and yellow colours used to indicate correctly placed letters and letters in the incorrect position.

5.4.1 Give TWO user interface changes to help users who cannot see the difference between green and yellow.

Change 1:

Change 2:

(2)
[13]

13 marks

SECTION E DATA AND INFORMATION MANAGEMENT AND SOLUTION DEVELOPMENT

QUESTION 6

Xavier considers the design of a backend class that will reside on the Wordle server and the frontend class that will reside on the user's computer.

The frontend class will store the user's IP address, the date and time the game started, the time the game ended, the number of attempts the user took for the day and the total number of days the user has played the game.

He decides to create a class called **UserWordle**.

UserWordle Class

- IPaddress : string – stores the IP address of the user's computer
- startTime : DateTime – record the starting date and time for the game
- endTme : Time – record the time it took to complete the game
- numAttempts : integer – the number of tries the user took for the day
- totalDays : integer – the total number of days the user has played the game

6.1 Explain why the **totalDays** field should be static in this scenario.

(2)

6.2 Explain why the **totalDays** field should be private in this scenario.

(2)

6.3 6.3.1 Complete the class diagram for the **UserWordle** class using the fields on the previous page and the following methods.

Methods

- Parameterised constructor method accepting the following parameters: **inIP** (string), **inS** (DateTime), **inE** (Time), **inNA** (integer);
- Accessor methods for the **IPAddress,** and **totalDays** fields;
- Mutator methods for the **startTime** field, which will accept a parameter **inST** (DateTime) and **endTime** field, which will accept the parameter **inE** (Time);
- A **toString()** method to concatenate the fields of the **Event** object into a string object.

UserWordle
Fields:
Methods:

(10)

6.3.2 Why is a mutator method unnecessary to increment the static **totalDays** field?

(1)

6.4 The data for the user with IP address 123.234.54.6, start date and time 24-06-2023 13:12:34, end time 14:02:32 and number of attempts 6, is stored in a JSON file.

6.4.1 Show how the data will be stored for this user.

(6)

6.4.2 Explain ONE advantage of a JSON file.

(1)
[22]

QUESTION 7

Xavier is developing an online game similar to Wordle, where a word is randomly chosen daily from a list of words. In this case, the word will be between 4 to 7 characters. The user can try to guess the word, but they only have 8 guesses. Xavier has designed an algorithm to test the user's word against the word chosen by the computer.
NOTE: In pseudocode, all strings are numbered from 0.

```
method testWord (userWord : string) : string
begin
1       for i ← 0 to number of letters in userWord – 1 inc by 1
        begin
2               lett ← letter at position i in userWord
3               pos = position of lett in word (-1 is assigned if lett is not in word)
4               if pos = i
                begin
5                       correctLett ← correctLett + lett
6               else if pos >= 0
7                       wrongPlace ← wrongPlace + lett
8               else notInWord ← notInWord + lett
                endif
        endfor
        return temp
end method
```

Assume that the random word stored in the variable **word** is 'happy' and the user's guess is 'ship' in the parameter **userWord**.

7.1 Complete the trace table on page i of the Insert. (9)

7.2 Explain why the output is incorrect.

_____

_____

_____

_____

(2)
[11]

QUESTION 8

8.1 Xavier designs a table with sample data to store the user's statistics and data related to the generated word. The table is shown on page ii of the Insert.

8.1.1 Define atomic data.

(2)

8.1.2 Explain why a field storing the date and time is atomic data.

(1)

8.1.3 Xavier split up the field to store the starting time and date into two separate fields. Explain why this is necessary to normalise the table.

(2)

8.2 Normalise the table to third normal form using the **IPAddress** and **Date** fields as a composite primary key. Write your solution as a set of relations with the primary key underlined.

(10)
[15]

48 marks

SECTION F DATA REPRESENTATION LOGIC GATES AND BOOLEAN ALGEBRA

QUESTION 9

9.1 Draw the logic circuit diagram of F(A,B) = ((A.B)' + (A' + B)')'

(6)

9.2 Using Boolean algebra, show that F(A,B) = ((A.B)' + (A' + B)')' = AB

(6)

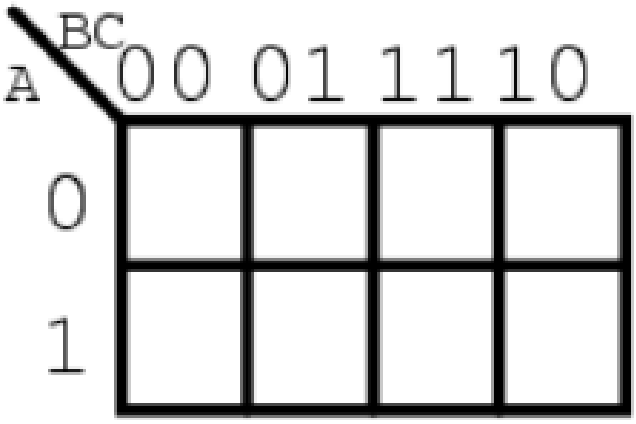
9.3 Using the partially completed truth table below, prove that ((A.B)' + (A' + B)')' = AB

A	**B**	**((A.B)' + (A' + B)')' WORKINGS**	**((A.B)' + (A' + B)')'**	**AB**
0	0		0	0
0	1		0	0
1	0		0	0
1	1		1	1

(6)

9.4 Use the Karnaugh map below to simplify the function. Write the simplified function in the block below the Karnaugh map.

F(A,B,C) = A'BC' + A'BC + ABC' + ABC



[Source: <https://fra221a1240.files.wordpress.com/2015/08/43.png>]

F(A,B,C) =

(5)
[23]

23 marks

Total: 150 marks

ADDITIONAL SPACE (ALL QUESTIONS)

REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.