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P 5 1

Pre-Leaving Certificate Examination, 2022

Computer Science

Sections A & B

Higher Level

Time: 1 hour, 30 minutes

115 marks

Name:
School:
Address:
Class:
Teacher:

Instructions

There are **three** sections in this examination. Section A and B appear in this booklet. Section C is in a separate booklet that will be provided for the computer-based element.

Section A	Short Answer Questions	Attempt any nine questions All questions carry equal marks	45 marks
Section B	Long Questions	Attempt any two questions All questions carry equal marks	70 marks
Section C	Programming	One question Answer all question parts	80 marks

Calculators may **not** be used during this section.

Write your answers for Section A and Section B in the spaces provided in this booklet. There is space for extra work at the end of the booklet. Label any such extra work clearly with the question number and part.

Section A Short Answer Questions 45 marks

Answer any nine questions.

Question 1

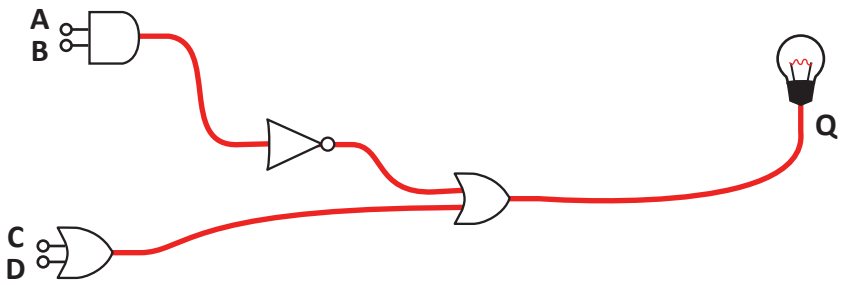
Sketch the Von Neumann architecture of the Central Processing Unit and seperate memory area in the space provided below. Include and label the following components:

- The Arithmetic Logic Unit (ALU)
- Memory Unit
- The Control Unit
- Registers
- Input devices and output devices

Include arrows in your diagram to show the movement of data from one area to another.

Question 2

Simple logic gates can be combined to make more complex circuitry. An example of such a circuitry is shown below:



The inputs are A, B, C and D. The output is Q. Fill in the table below to find the output value for Q.

A	B	C	D	Q
1	0	1	1	
1	0	0	1	
1	1	0	1	
0	1	0	1	
1	0	1	0	

Question 3

People are often surprised to hear that the Internet and the World Wide Web are two different things. The Internet was invented in 1983 using TCP/IP. The World Wide Web was invented in 1989 by Tim Berners-Lee.
Explain the underlined terms in the passage above.

(i) Internet:

(ii) TCP/IP:

(iii) World Wide Web:

Question 4

The Python code below shows a while loop. Examine the code carefully and answer the questions below.

```
1  x = 7
2  while x > 1:                                                    1
3        print("The value of x is: ", x)
4        x = x -1
5        if x == 3:
6           break
7
8  print("End of program")
```

(a) What is the function of the `x = 7` in line 1?

(b) What is the function of the `==` in line 5?

(c) What is the value of x in the second iteration of the while loop?

(d) What is the significance of the `print("The value of x is: ", x)` command being inside the while loop?

(e) Write the expected output for the block of code in the space below.

Question 5

(a) Convert the following hexadecimal number into decimal:

$$\mathbf{5DC_{16}}$$

Please show all your workings.

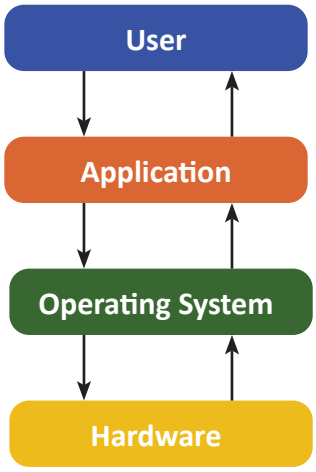
(b) Convert the following binary number into decimal:

$$\mathbf{10010011_{2}}$$

Please show all your workings.

Question 6

This diagram depicts how the various components of a computer interact with each other.



(a) Describe **one** function of an Operating System.

(b) Describe why the user needs computer applications.

(c) The motherboard is an example of a piece of computer hardware. What is the function of a motherboard?

(d) Identify **one** difference between ROM and RAM.

ROM:
RAM:

(e) Explain, giving an example of why it is important for computer applications to be user friendly.

Question 7

Video-sharing websites such as YouTube use databases to store their information and allow their users to query them efficiently. Every video in the YouTube database has a Primary Key.

(a) Define the underlined term in the above passage.

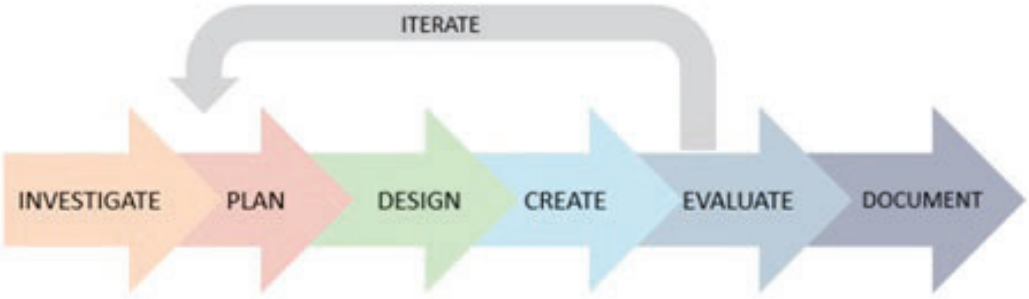
(b) Attributes describe characteristics that define all members of a column in a database. An example of an attribute in terms of YouTube videos would be genre of video (e.g., comedy, instructional or fitness).

As seen in the table below, genre would be represented using a CHAR variable. Fill in the blanks for the other attributes with the type of data best suited to describe them (INT, FLOAT, CHAR, DATE, BOOLEAN)

	Genre	**Video Length**	**Date uploaded**	**Under parental lock?**
Data Type:	CHAR			

5

Question 8



The diagram above identifies some of the main stages of a **software development design process.** Describe briefly what happens at the following stages of the design process:

(a) Investigate stage

(b) Create stage

Question 9

Machine Learning and Artificial Intelligence are becoming rapidly expanding fields in computer science.

(a) Explain what is meant by 'machine learning'.

(b) Give an example of how machine learning can be used in business.

Question 10

Prior to mobile phones becoming common in Ireland, if you needed the telephone number of a person you had to look in a physical phonebook where the names were sorted in alphabetical order according to the first name of the person.
Today, we store the telephone numbers of our contacts in a digital phonebook on our mobile devices. Mobile phones store digital contacts in alphabetical order (A to Z) based on the first name of the contact.

A person wishes to search their digital contacts.

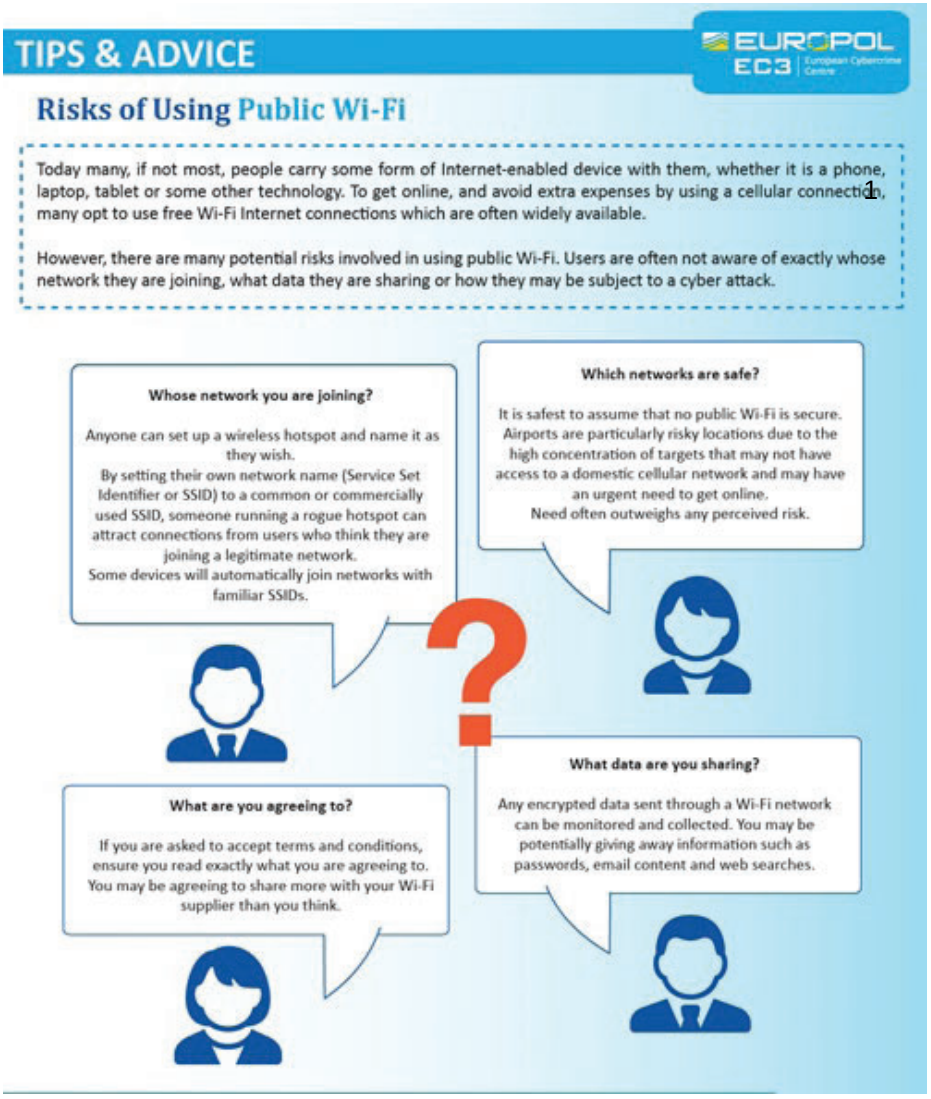
(a) Why is a binary search appropriate for this type of computational task?

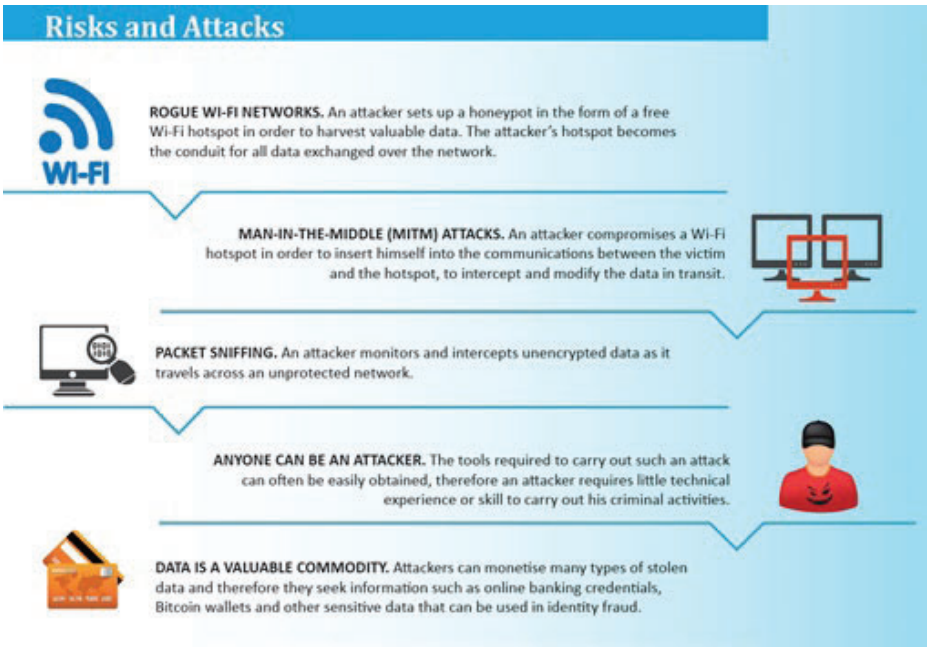
(b) Implement a binary search to find all first names beginning with the letter “D”. Use the alphabet below to show your workings. Make sure you identify the midpoints at each step of the search

A B C D E F G H I K L M N O P Q R S T U V W Y X Z

Question 11

Examine the following poster and answer the questions that follow.





(a) Suggest **two** ways in which you can protect your data from the risks of using public Wi-Fi.

1.
2.

(b) Outline **one** issue that could arise if your data was stolen from a public Wi-Fi network.

Question 12

Pattern recognition and abstraction are two of the four cornerstones of computational thinking.

(a) Define the underlined terms in the context of computational thinking.

(i) Pattern Recognition:

(ii) Abstraction:

(b) Why is abstraction important when designing computational artifacts for the public to use?

Section B — Long Questions — 70 marks

Answer any two questions.

Question 13

(a) **(i)** What is meant if a function is said to be 'recursive'?

(ii) The Python code below shows some code for the Fibonacci sequence; each number is the sum of the two preceding ones, starting from 0 and 1.

The beginning of the sequence is: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, ...

For example:

0+1 = 1

1+1 = 2

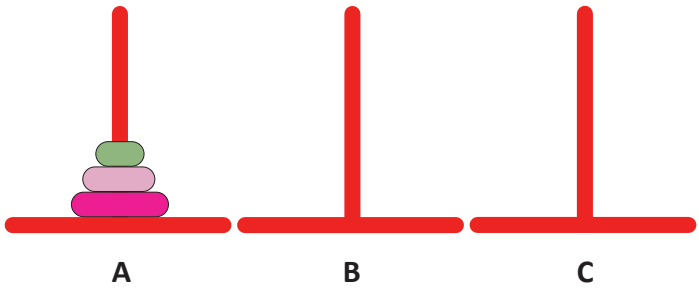
```
number = 14

    def fibonacci (number)
      if number == 0:
        return 0
      if number == 1:
        return 1
      else:
        result = fibonacci(number-1) + fibonacci(number-2)
        return result
    print("The ", number, "th Fibonacci number is: ",fibonacci (number))
```

```
The 14 th Fibonacci number is:377
```

Is the function shown above an example of a recursive function?

Explain your answer.

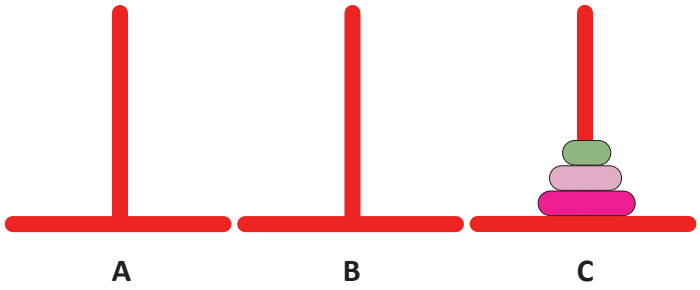
(b) The Towers of Hanoi is a famous Computer Science problem that uses recursion to be solved. The Tower of Hanoi consists of three towers with three disks placed one over the other on Tower A (as seen below).



The objective of the puzzle is to move the stack all the disks from Tower A to Tower C following these rules:

- Only one disk can be moved at a time.
- No disk can be placed on top of a smaller disk.

A solution for the above puzzle is seen below:



(i) If n represents the number of disks on Tower A at the start of the game, one can represent the minimum number of moves to solve the puzzle with the following formula:

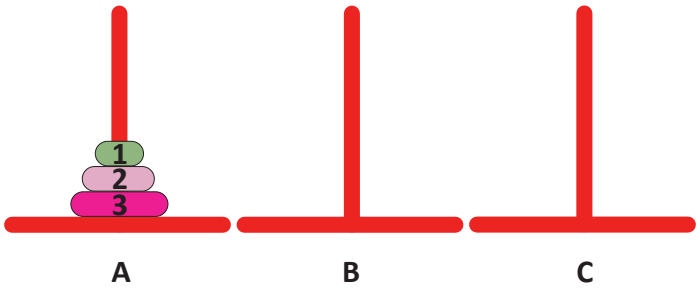
$$2^n - 1$$

Using the above formula, fill in the table below to find the minimum number of moves to solve the Towers of Hanoi for each number of disks on Tower A at start of Game.

Number of Disks on Tower A at start of Game	Minimum number of moves to solve.
3	
4	
5	
6	
7	

(ii) Each of the disks on Tower A has been labelled with a number.

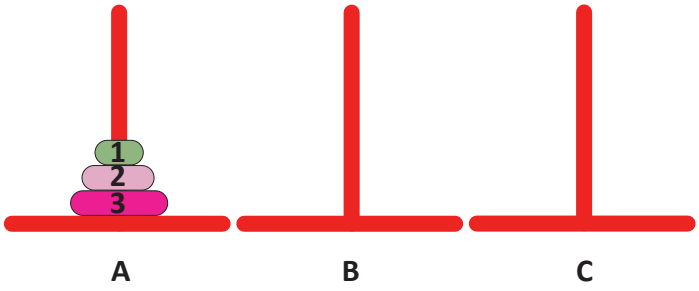
8



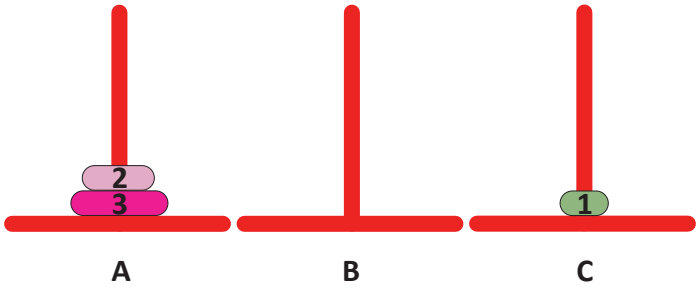
Solve the Tower of Hanoi puzzle above by filling in the table below to record the movements of the disks. Some of it has been completed already for you. 0 represents no disk at that position on the Tower. Use the diagrams of the Towers next to each row for rough work.

Step Number	Tower A	Tower B	Tower C
0	1 2 3	0 0 0	0 0 0
1	0 2 3	0 0 0	0 0 1
2			
3			
4			
5			
6			
7	0 0 0	0 0 0	1 2 3

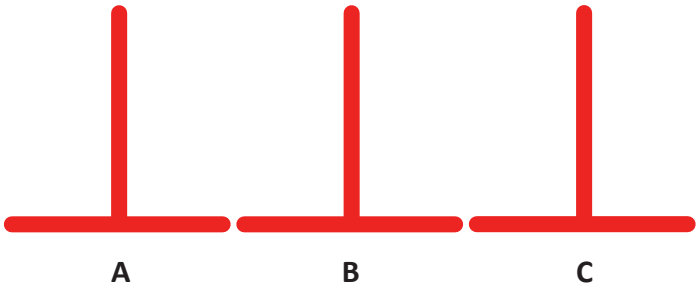
Step Number 0



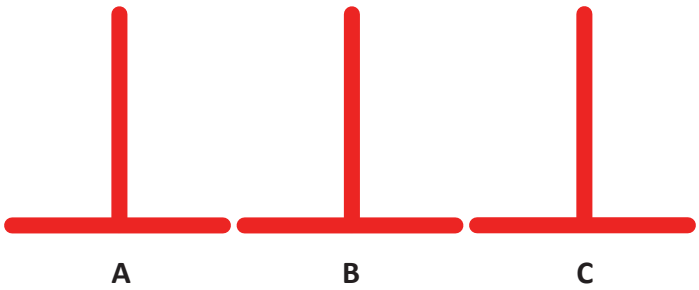
Step Number 1



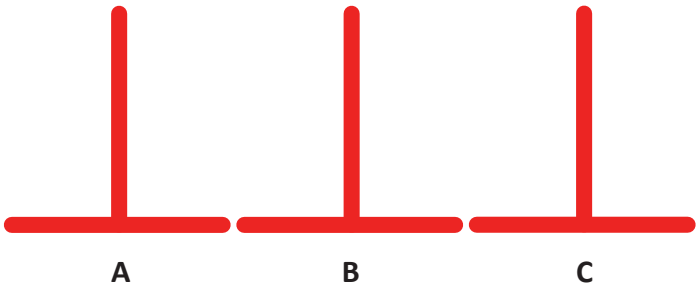
Step Number 2



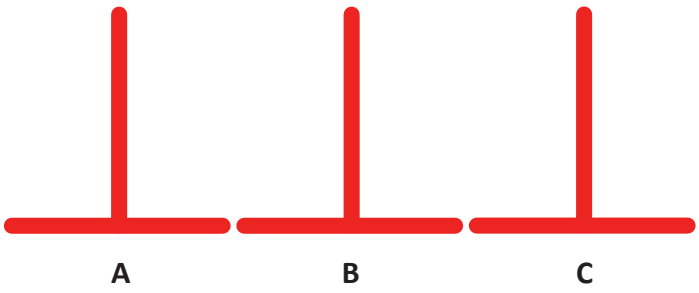
Step Number 3



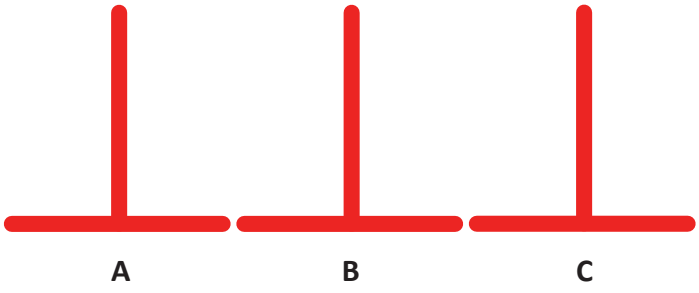
Step Number 4



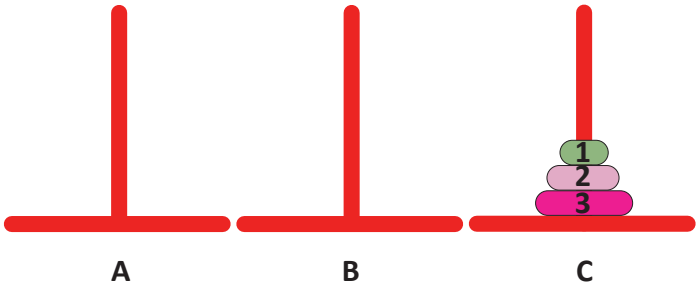
Step Number 5



Step Number 6



Step Number 7



(c) Quick sorting is another example of a recursive algorithm.

(i) Using 51 as an initial pivot value, perform a quicksort on the following list of integers. In your answer you should show the state of the list after each pass.

63, 89, 30, 51, 10, 87, 95, 19

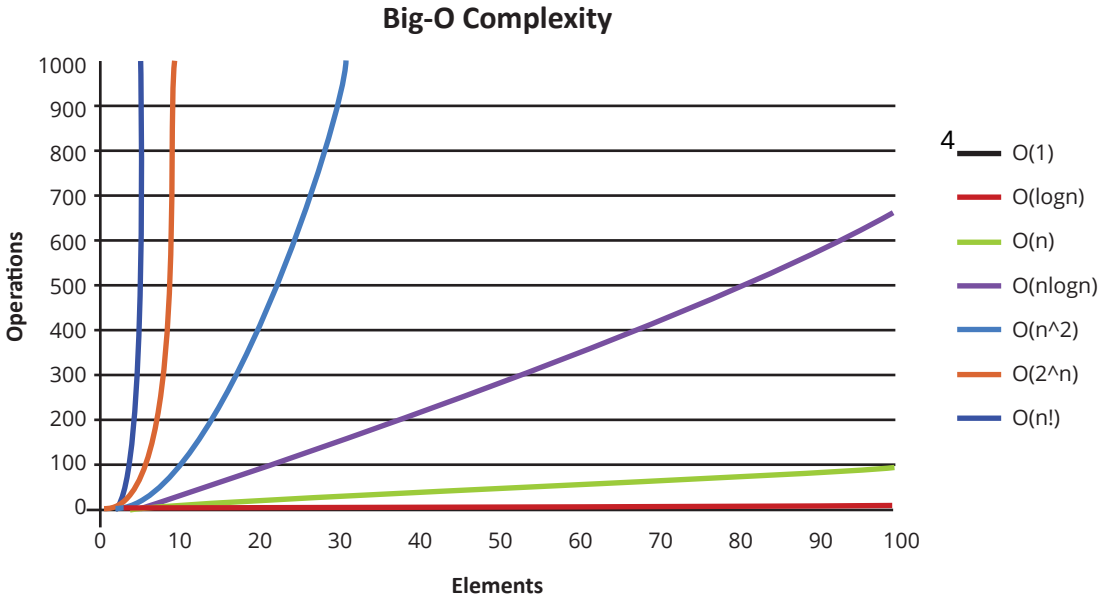
63	89	30	51	10	87	95	19

New pivot value =

New pivot value =

(ii) What is the significance of using 51 as the initial pivot value?

(iii) Which of the following graphs represents the worst-case time complexity for the quicksort?



Question 14

(a) Both hardware and software can be adapted to help people with additional needs use computing technologies.
Give a specific example of hardware and software that can be used for people with additional needs.

Hardware example:
Software example:

(b) The table below shows the ASCII character set. Examine the table and answer the questions that follow.

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACQ	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	SPC	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

(i) How many bits of data are needed for encoding each ASCII character?

(ii) Give **one** limitation of using the ASCII character set as shown above.

(iii) UNICODE was developed after ASCII, what is an advantage of UNICODE over ASCII?

(iv) UTF-8 is an encoding system for UNICODE. What is an advantage of using UTF-8 for encoding characters?

(c) Discuss **two** ethical considerations of a software designer building an app such as the COVID Tracker app used by the Health Service Executive during the COVID-19 outbreak.
According to the HSE:

"The COVID Tracker is a free and easy-to-use mobile phone app that will:

- *Alert you if you have been in close contact with someone who has tested positive for COVID-19 (coronavirus)*
- *Keep other app users safe by alerting them if you test positive for COVID-19.*
- *Give you advice on what to do if you have symptoms".*

Question 15

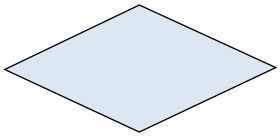
Modules are an important concept in computer programming. A module is a file containing Python definitions and statements that can be imported into another Python script.

(a) **(i)** Name **one** advantage of using modules when creating a software.

(ii) Give **two** examples of pre-defined modules you have used in the Python programming in your course.

1.
2.

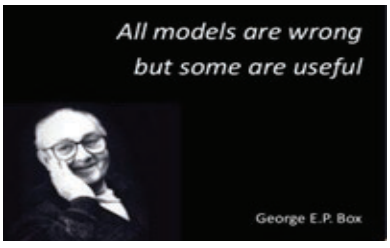
(b) Flowcharts and pseudocode are useful tools to visualise how computer programs operate.

Symbol	Name	Function
	Start/end	An oval represents a start or end point
	Arrows	A line is a connector that shows relationships between the representative shapes
	Input/Output	A parallelogram represents input or output
	Process	A rectangle represents a process
	Decision	A diamond indicates a decision

(i) A software engineer wishes to create a program that will play a game of "Snap" with the user. Using the flowchart symbols above create a flowchart for the following task.

- It will generate a random number between 1 and 10.
- It will then ask the user to take a guess what that number is.
- If the user guesses correctly, it will display an appropriate message and end the program.
- If the user guesses incorrectly, it will display an appropriate message; ask the user to guess again and repeat.
- The user has a total of 3 attempts to guess the correct number. After the 3 incorrect guesses, the program should end.

(c) Modelling and simulation are important aspects of computer programming.



(i) Discuss **one** way that models and simulations are useful and **one** way that models and simulation are imitated in computer programming.

(ii) The Python code below shows code for a coin flipping simulation however, there are eight mistakes in the code that will cause an error to appear when the code is run. Examine the code carefully and re-write the code error free.

```
1   import random
2
3   results = []
4
5
6   for throws in range(1000)
7     ran num = random.ranint(1,10)
8     if ran_num >= 1 and <= 5:
9       result.append("H")
10  elif ran_num > 5 and ran_num <= 10
11      results.append("T")
12  print("The number of heads thrown was: ", results.count("h"))
13  print("The number of tails thrown was: ", results.count("T")
```

(iii) What change in the output would you expect to see if the number of iterations of the for loop was decreased to 10?

(iv) What change in the output would you expect to see if the number of iterations of the for loop was increased to 10000?

Acknowledgements

Q2. Source: https://logic.ly/

Q6. Source: https://www.javatpoint.com/history-of-operating-system

Q11.Source: https://www.europol.europa.eu/activities-services/public-awareness-and-prevention-guides/risks-of-using-public-wi-fi

Q13. Source: https://www.hackerearth.com/practice/notes/sorting-and-searching-algorithms-time-complexities-cheat-sheet/

Q14. Source: http://www.stat.ucla.edu/~dinov/courses_students.dir/PIC10B_CPP_Summer01.dir/PIC10B_CPP_Summer01.dir/ASCII_table.htm

P 5 2

Pre-Leaving Certificate Examination, 2022

Computer Science

Section C

Higher Level

Time: 1 hour

80 marks

Instructions

There is one section of the examination paper in this booklet.

Section C	Programming	One question Answer all questions	80 marks

Answer all parts of the question on your digital device.

Calculators may be used during this section of the examination.

Ensure that you save your work regularly and when you complete each question part.

Save your files using the naming structure described at the beginning of each question part.

If you are unable to get some code to work correctly, you can comment out the code so that you can proceed. The code that has been commented out will be reviewed by the examiner.

Rough work pages are provided at the end of this booklet. Please note that this work will **not** be reviewed by an examiner.

At the end of the examination it is your responiibilty to ensure that you have saved all of your files onto your external media.

Section C Programming 80 marks

Answer all question parts.

Question 16

We can use the random library when building computer programs to build basic games. Many computer games use random features to keep gameplay fresh and exciting.

(a) Open the program called **Question16_A.py** from your device.
Enter your name on **line 2**.

```
1  # Question 16(a)
2  # Student name:
3  import random
4  your_name = input("Please enter your name: ")
5  lucky_number = 5
6  computer_die_roll = random.randint(1,6)
7  print("The computer rolled: ", computer_die_roll)
```

This program is designed to roll a six-sided dice and display the result, the user will then take a guess at what number the computer will roll. The objective of the game is for the user to correctly guess what number the computer will roll on its dice. The user has a variable called `lucky_number` whose value is 5.
A sample run of the program is displayed below – the user enters their name and the computer's dice roll is displayed.

```
Please enter your name: John
The computer rolled: 3
```

Modify the program to do the following:

(i) Insert a comment to say "initialize computer number" in the appropriate location in the program to show where the computer generates it's dice score.

(ii) Currently in the program the value of the variable **`lucky_number`** is hard-coded to 5. Modify the program so that it prompts the user to enter a value for **`lucky_number`**. The value should be converted to an integer.

When the program is run the output may look as follows:

```
Please enter your name: John
Please select a lucky number between 1 and 6: 4
The computer rolled: 1
```

(iii) Modify the program to display the user's lucky number before the computer's dice roll value. When the program is run, the output may look as follows:

```
Please enter your name: John
Please select a lucky number between 1 and 6: 4
John's lucky number was: 4
The computer rolled: 3
```

(iv) Incorporate the following function definition into your program and insert a line so that the function is called before the user enters any data. All your code should be incorporated into this **`dice_game()`** function.

```
def dice_game():
  print ("welcome to my dice game!!")
```

(v) As the program is now, it doesn't play a game between the user and the computer. A more meaningful output would be to compare the **`lucky_number`** of the user and the dice roll of the computer and see if the user guessed the correct number. Extend the program so that it displays if the user guessed the correct number, guessed too low or too high.

When the program is run the output may look as follows:

```
Welcome to my dice game!!
Please enter your name: John
Please select a lucky number between 1 and 6: 5
John's lucky number was: 5
The computer rolled: 2
You guessed too high!
```

```
Welcome to my dice game!!
Please enter your name: John
Please select a lucky number between 1 and 6: 2
John's lucky number was: 2
The computer rolled: 6
You guessed too low!
```

```
Welcome to my dice game!!
Please enter your name: John
Please select a lucky number between 1 and 6: 4
John's lucky number was: 4
The computer rolled: 4
You guessed correct, well done!
```

Save and close your file before moving on to the next part.

(b) Open the program called **Question16_B.py** from your device.
Another type of game that can be created using the random library in Python is a basic lotto game.

This program is designed to simulate a basic lottery game although some features are missing; the user picks 3 numbers to put on their ticket. The computer then randomly picks 3 numbers from a list of 10 numbers and displays the result.
A sample run of the program is displayed below – the user picks their numbers, and the computer takes random numbers from the drum list. Examine the code carefully and answer the questions below.

```
1   #Question 16 (b)
2   #Student name:
3   import random
4   ticket = []
5
6   user_number = int(input ("Please pick a number between 1 and 10: "))
7   ticket.append(user_number)
8   user_number = int(input("Please pick a number between 1 and 10: "))
9   ticket.append(user_number)
10  user_number = int(input ("Please pick a number between 1 and 10: ))
11  ticket.append (user_number)
12
13  print ("Your ticket is: ", ticket)
14  print ("The draw will start now, good luck!")
15  drum = [1,2,3,4,5,6,7,8,9,10]
16  result = []
17  def lotto (ticket):
18          for times in range (3):
19            draw = drum [random.randint (0,len (drum))-1]
20            result.append (draw)
21       print("The draw was: ", result)
22
23  lotto (ticket)
```

```
Please pick a number between 1 and 10: 4
Please pick a number between 1 and 10: 7
Please pick a number between 1 and 10: 2
Your ticket is: [4, 7, 2]
The draw will start now, good luck!
The draw was: [10, 10, 7]
```

(i) Modify the code so the line asking the user for their input is only used once but repeated 3 times to allow the user to enter their 3 numbers.

(ii) Using one of pythons inbuilt methods, functios or otherwise, modify the code above so that it will check if the ticket matches the result of the lotto (i.e., that the 3 numbers in each list are the same).
Note: The order that the user picks their numbers and the order in which numbers are drawn out of the drum does not matter, if they are the same, the user will win.
An appropriate message should be displayed in either scenario as below:

```
Please pick a number between 1 and 10: 2
Please pick a number between 1 and 10: 5
Please pick a number between 1 and 10: 3
Your ticket is: [2, 5, 3]
The draw will start now, good luck!
The draw was: [7, 9, 10]
You lose!
```

```
Please pick a number between 1 and 10: 4
Please pick a number between 1 and 10: 2
Please pick a number between 1 and 10: 7
Your ticket is: [4, 2, 7]
The draw will start now, good luck!
The draw was: [7, 4, 2]
You win!
```

(iii) Currently, it is possible for the computer to draw duplicates from the drum as shown below:

```
Please pick a number between 1 and 10: 4
Please pick a number between 1 and 10: 7
Please pick a number between 1 and 10: 2
Your ticket is: [4, 7, 2]
The draw will start now, good luck!
The draw was: [10, 10, 7]
```

This is not realistic as lotto games usually have only one copy of each number in the drum. Using one of pythons inbuilt methods, functios or otherwise, modify the code so that each number picked from the drum is unique for the draw list.

Save your file.

Ensure that you have saved and closed all files before you finish the examination.

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