WMS34

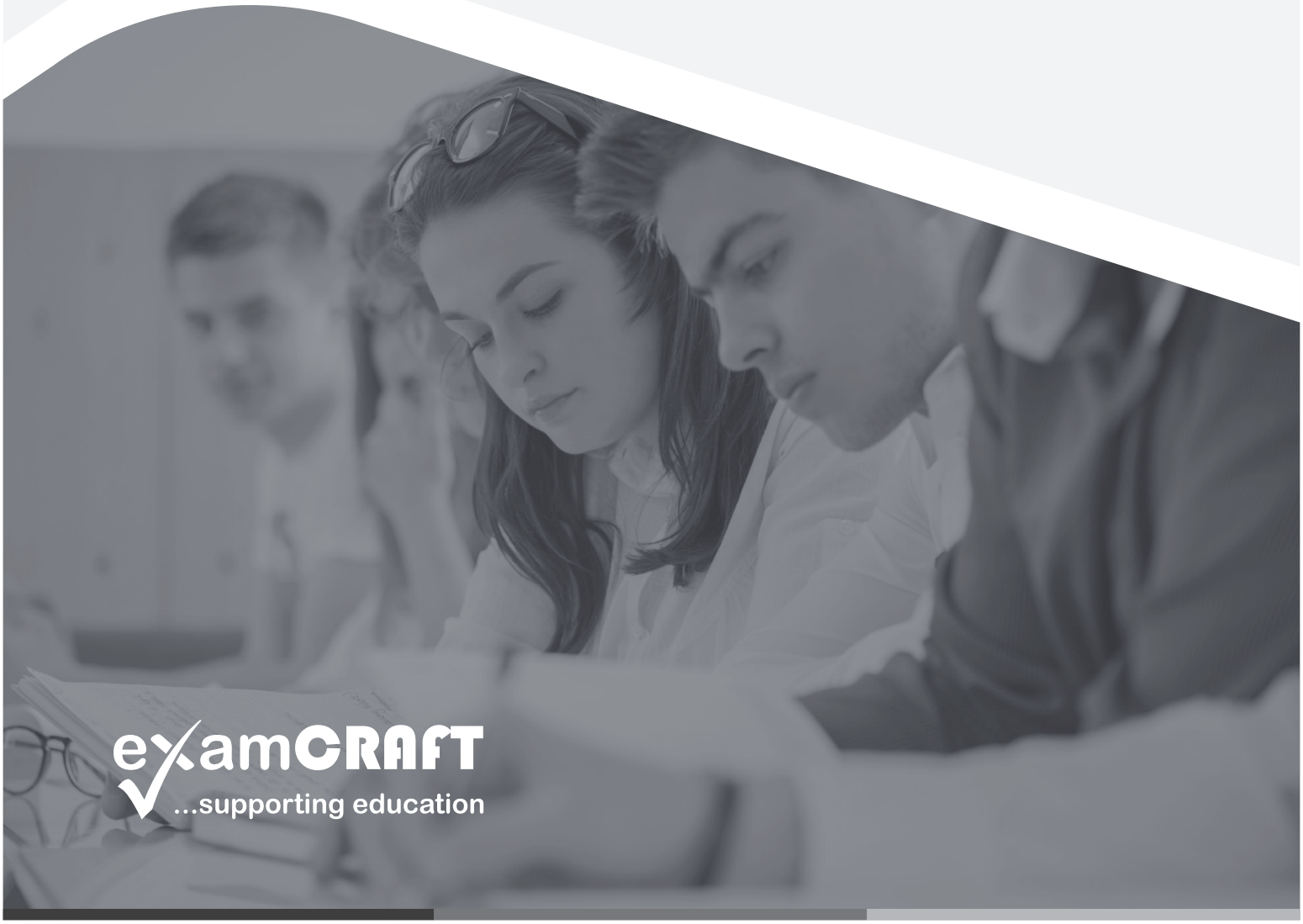
Part of The Examcraft Group

COMPUTER SCIENCE

HIGHER & ORDINARY LEVEL

MARKING SCHEME

Pre-Leaving Certificate Examination 2022



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HIGHER LEVEL

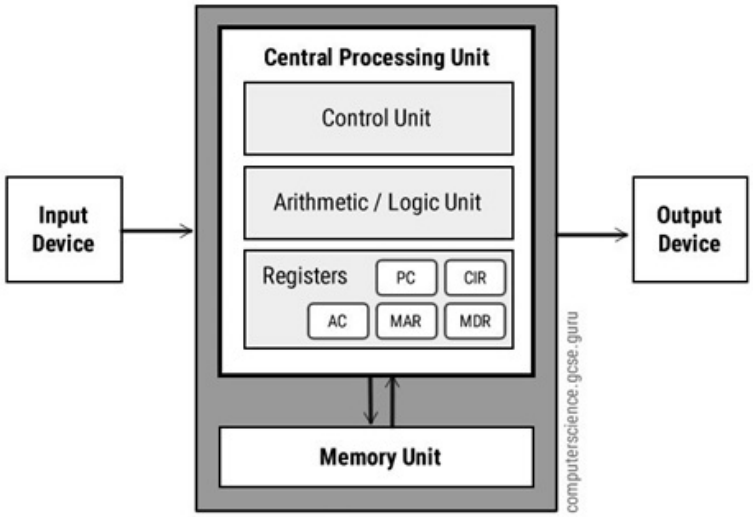
Section A **45 marks**

Answer 9 of the following 12 questions, 5 marks each

Q1. Sketch the Von Neumann architecture of the Central Processing Unit in the space provided below. Include and label the following components:

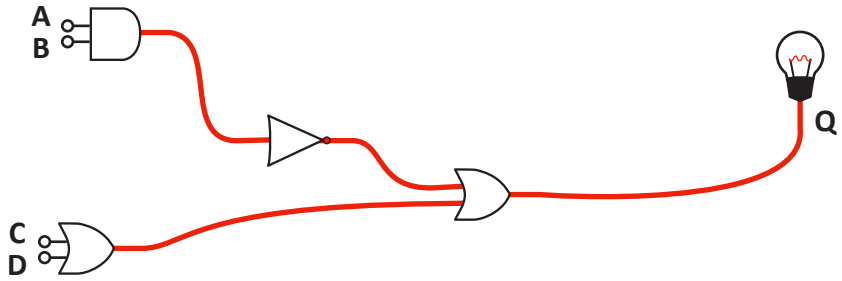
- **The Arithmetic Logic Unit (ALU)**
- **Memory Unit**
- **The Control Unit**
- **Registers**
- **Input devices and output devices**

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



1 mark per correct answer. Must show correct subset structure above.
Deduct 1 mark for each incorrect arrow directions. **5 marks**

Q2 . Simple logic gates can be combined to make more complex circuitry. An example of such a circuitry is shown below:



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

1 mark per correct answer **5 marks**

Q3. 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:** A global network of computers
(ii) **TCP/IP:** Low level protocol – sender breaks messages into packets hands over to IP (for routing) and re-assembles and orders at the destination
(iii) **World Wide Web:** An information distribution service on the internet.

First correct-Good description, clear understanding demonstrated	2 marks
Fair description, imited understanding	1 mark
Second correct-Good description, clear understanding demonstrated	2 marks
Fair description, limited understanding	1 mark
Third correct-Good description, clear understanding demonstrated)	1 mark

5 marks

Q4. The Python code below shows a while loop. Examine the code carefully and answer the questions below.

```
1  x = 7
2  while x > 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?** Initialises the x variable — 1 mark
(b) **What is the function of the `==` in line 5?** Equal value comparison operator — 1 mark
(c) **What is the value of x in the second iteration of the while loop?** The value of x is: 6 — 1 mark
(d) **What is the significance of the print(“The value of x is: “, x)command being inside the while loop?** The output will be displayed after each iteration of the while loop — 1 mark
(e) **Write the expected output for the block of code in the space below.** — 1 mark

```
The value of x is:  7
The value of x is:  6
The value of x is:  5
The value of x is:  4
End of program
```

5 marks

Q5. (a) **Convert the following hexadecimal number into decimal:**

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

Please show all your workings.

1500_{10} (subscript not needed)

(b) Convert the following binary number into decimal:

10010011_2

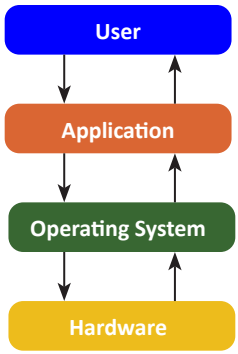
Please show all your workings.

147_{10} (Subscript not needed)

Award 3 marks for the first correct answer. Award 2 marks for incorrect answer but correct workings (with a slip) shown.
Award 2 marks for the second correct answer. Award 1 mark for incorrect answer but correct workings (with a slip) shown.

5 marks

Q6. This diagram depicts how the various components of a computer interact with each other.



(a) Describe one function of an Operating system.
The program that runs on the computer hardware creating information objects, such as files and processes and assures the fair and secure allocation of processor time, access to files, access to devices, and other resources. Good description - clear understanding demonstrated 1 mark

(b) Describe why the user needs computer applications?
A runnable software that provides a specific service.
Good description - clear understandin demonstrated 1 mark

(c) The Motherboard is an example of a piece of computer hardware. What is the function of a Motherboard?
The main circuit board connecting most major components of a computer such as CPU, memory, I/O devices. Good description - clear understanding demonstrated 1 mark

(d) Identify one difference between ROM and RAM.
ROM: Permanently stores instructions on your computer
RAM: Temporary memory of the files you are working on
Or any other valid answer. 1 mark – only awarded if both RAM and ROM correct 1 mark

(e) Explain, giving an example of why it is important for computer applications to be user friendly.
Search features
Deleted files can be recovered.
Any valid answer 1 mark

5 marks

Q7. 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.
A key that uniquely identifies each row of a table in a relational database. 2 marks

(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).

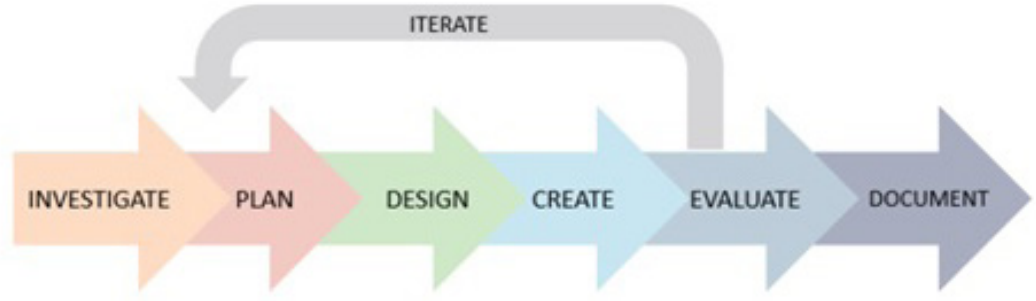
As seen in the table below, Genre would be represented using a CHAR variable. Fill in the blanks for the other attributes with the type of data best suited to describe them (INT, FLOAT, CHAR, DATE, BOOLEAN)

	Genre	Video Length	Date uploaded	Under parental lock?
Data Type:	CHAR	FLOAT	DATE	BOOLEAN

1 mark per correct answer 3 marks

5 marks

Q8.



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

The software engineer develops a hypothesis about the creation of the computing artifact.
The problem is defined and objective set.
Requirements from stakeholders are gathered.
Roles are defined.
Modification of existing artifacts?
Feasibility is completed at this stage: time, resource and financial constraints are explored.
Any explanation that identifies a relevant topic covered at the investigate stage.

(b) Evaluate stage

Established procedures are followed to turn an idea on paper into a real artifact.
Detail is given in the coding section of the artifact.
Prototypes can be created.
Functionality is important.
Any explanation that identifies a relevant topic covered at the create stage.

First correct 3 marks
Second correct 2 marks

5 marks

Q9. Machine Learning and Artificial Intelligence are becoming rapidly expanding fields in computer science.

(a) Explain what is meant by machine learning
Programs that can learn from data, recognise patterns and make decisions without human intervention. Good description - clear understanding demonstrated 3 marks

(b) Give an example of how machine learning can be used in business.
Loyalty card coupons Or any other correct answer 2 marks
5 marks

Q10. 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?
The data is in alphabetical order. 1 mark

(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

ABCDEFGHIKLMNOPQRSTUVWYXZ

Step 1: M is middle letter of the alphabet.

Step 2: Focus on the lower half of the alphabet as D would be located there.

Step 3: G is the midpoint of the lower half.

Step 4: Focus on A to G as D would be located there.

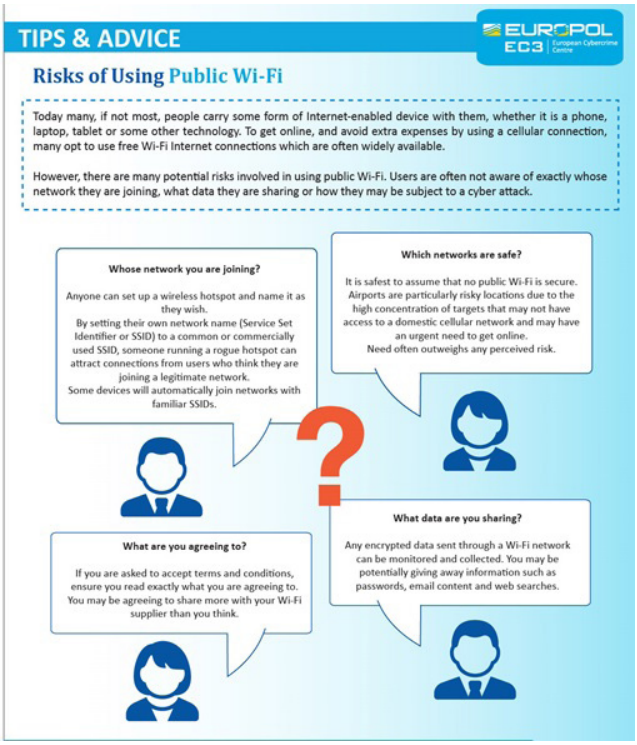
Step 5: C is the midpoint between A and G. Focus on C to G as D would be located there.

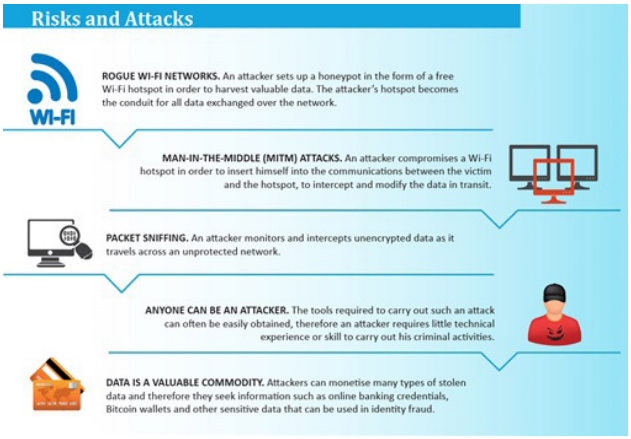
Step 6: E is the midpoint between C and G. Focus on C to E as D would be located there.

Step 7: D found.

Complete answer – allow for visual answer if presented 4 marks
5 marks

Q11. 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. Any correct answer. 1 mark
2. Any correct answer. 1 mark

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

Any correct answer. 3 marks

5 marks

Q12. 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: Finding similarities in decomposed complex problems to help us solve them more easily**.** Good description - clear understanding demonstrated. 2 marks

(ii) Abstraction: Ignoring unimportant details when solving a problem.
Good description - clear understanding demonstrated. 2 marks

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

Hiding processes in the background that the user doesn't need to know in order to use the artifact correctly. Keeps things user-friendly. Or any correct answer. 1 mark

5 marks

Section B - Long Questions 70 Marks

Answer 2 out of the 3 following questions, each question carries 35 marks

Q13. **35 (5, 20, 10) marks**

(a) **5 (2,3) marks**

(i) **What is meant if a function is said to be 'recursive'?** (2 marks)
An algorithm that calls itself from within itself.

(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.** (3 marks)
The beginning of the sequence is: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, ...
For example:
0+1 = 1
1+1 = 2

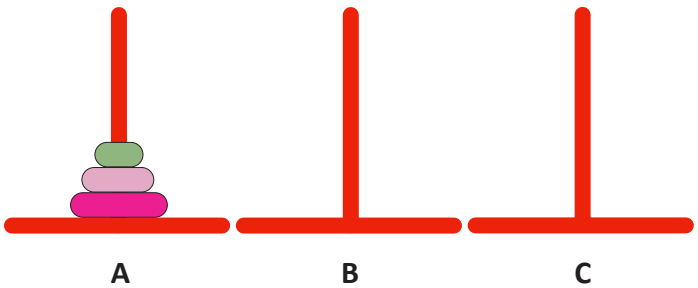
```
1   number = 14
2
3       def fibonacci (number)
4         if number == 0:
5           return 0
6         if number == 1:
7           return 1
8         else:
9           result = fibonacci(number-1) + fibonacci(number-2)
10          return result
11      print("The ", number, "th Fibonacci number is: ",fibonacci (number))
```

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

Is the function shown above an example of a recursive function?
Explain your answer.
Yes, it is recursive. The function Fibonacci is called (twice) within the function itself in line 9.

(b) **20 (10,10) marks**

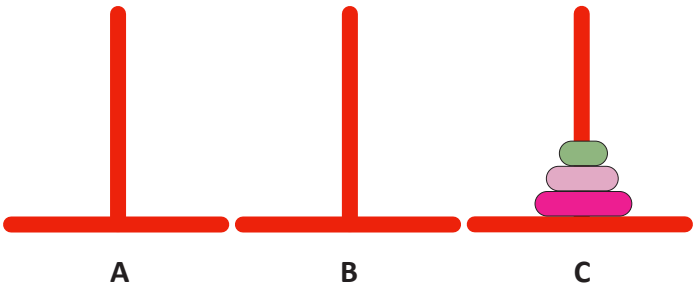
The Towers of Hanoi is a famous Computer Science problem that uses recursion to be solved.
The Tower of Hanoi consists of three towers with 3 disks placed one over the other on Tower A (as seen below).



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 the smaller disk.**

A solution for the above puzzle is seen below:



(i) (10 marks)

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 marks per correct answer

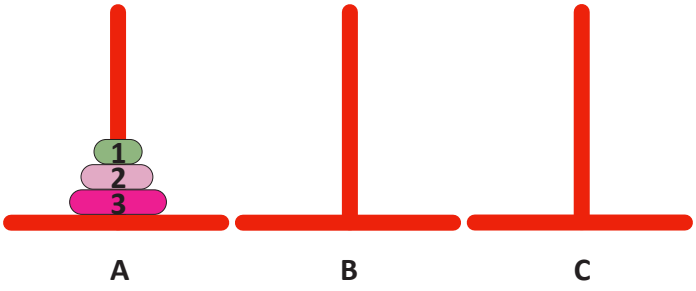
$$2^n - 1$$

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	7
4	15
5	31
6	63
7	127

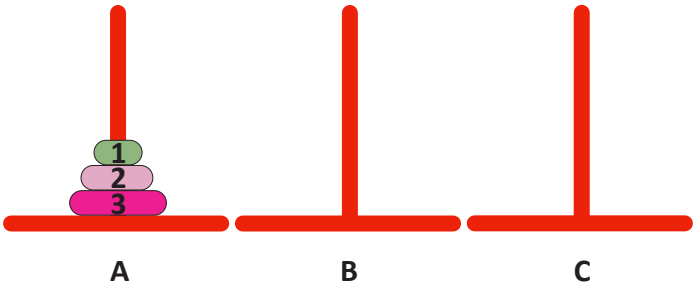
(ii) **Each of the disks on Tower A has been labelled with a number.** (10 marks)

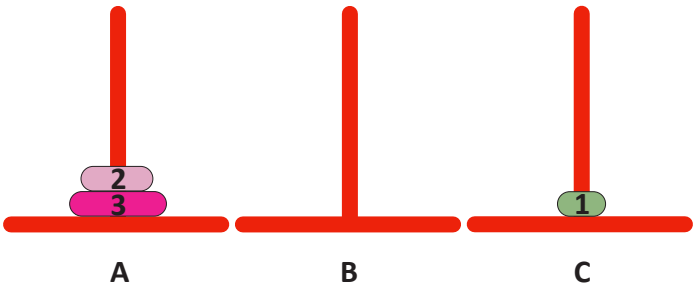
Award 10 marks if solved as below, 6 marks for 4 or more step number done correctly, 4 marks for 1, 2 or 3 step numbers completed correctly, 3 marks if an attempt was made where the student could have solved it using that method if given more time.



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	0 0 3	0 0 2	0 0 1
3	0 0 3	0 1 2	0 0 0
4	0 0 0	0 1 2	0 0 3
5	0 0 1	0 0 2	0 0 3
6	0 0 1	0 0 0	0 2 3
7	0 0 0	0 0 0	1 2 3





(c) Quick sorting is another example of a recursive algorithm. **10(5,3,2) marks**

(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.
5 marks - award 3 marks if wrong pivot values selected. 5 marks

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

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

New pivot value =

19	10	30	51	63	89	87	95

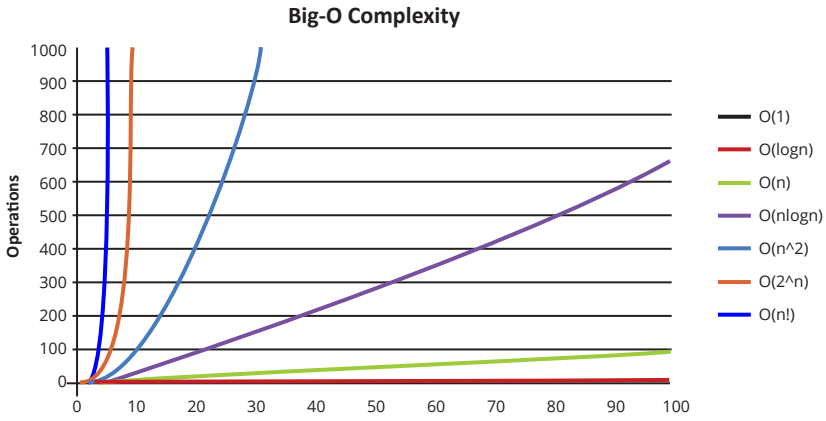
New pivot value =

10	19	30	51	63	89	87	95

10	19	30	51	63	87	89	95

(ii) What is the significance of using 51 as the initial pivot value? 3 marks
51 is roughly the median value of the dataset.

(iii) Which of the following graphs represents the worst-case time complexity for the quicksort? 2 marks



$O(n^2)$

Q14. **35 (6,14,15) marks**

(a) Both hardware and software can be adapted to help people with additional needs use computing technologies. **6 marks**
Give a specific example of hardware and software that can be used for people with additional needs.

Hardware example: (Braille Keyboard - 3 marks for any correct example)
Software example: (JAWS reading software - 3 marks for any correct example)

(b) The table below shows the ASCII character set. Examine the table and answer the questions that follow. **14 (3,3,5,3) marks**

	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? 3 marks

8 bits

(ii) Give one limitation of using the ASCII character set as shown above. 3 marks

Can only be used for the English language character set (or any other valid reason).

(iii) UNICODE was developed after ASCII, what is an advantage of UNICODE over ASCII? 5 marks

Any one correct answer: Cross-platform, universal, can be used for any language character set or any valid reason.

(iv) UTF-8 is an encoding system for UNICODE. What is an advantage of using UTF-8 for encoding characters? 3 marks

Less memory/storage required compared to UNICODE or any valid reason.

(c) Discuss 2 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: At least 3 considerations needed and briefly explained – 5 marks each.
2/5 marks for naming, 3/5 for describing. **15 marks**

"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".**

Any valid answer e.g., keeping user data safe, tracking a person's movement, privacy etc.

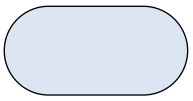
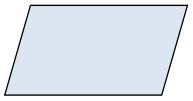
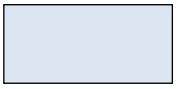
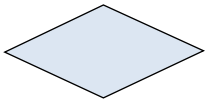
Q15. **35 (9,10,16) marks**

(a) **Modules are an important concept in computer programming. A module is a file containing Python definitions and statements.** **9 marks**

(i) **Name 1 advantage of using modules when creating a software.**
1. Allows for logical organisation of code or any valid reason. 3 marks

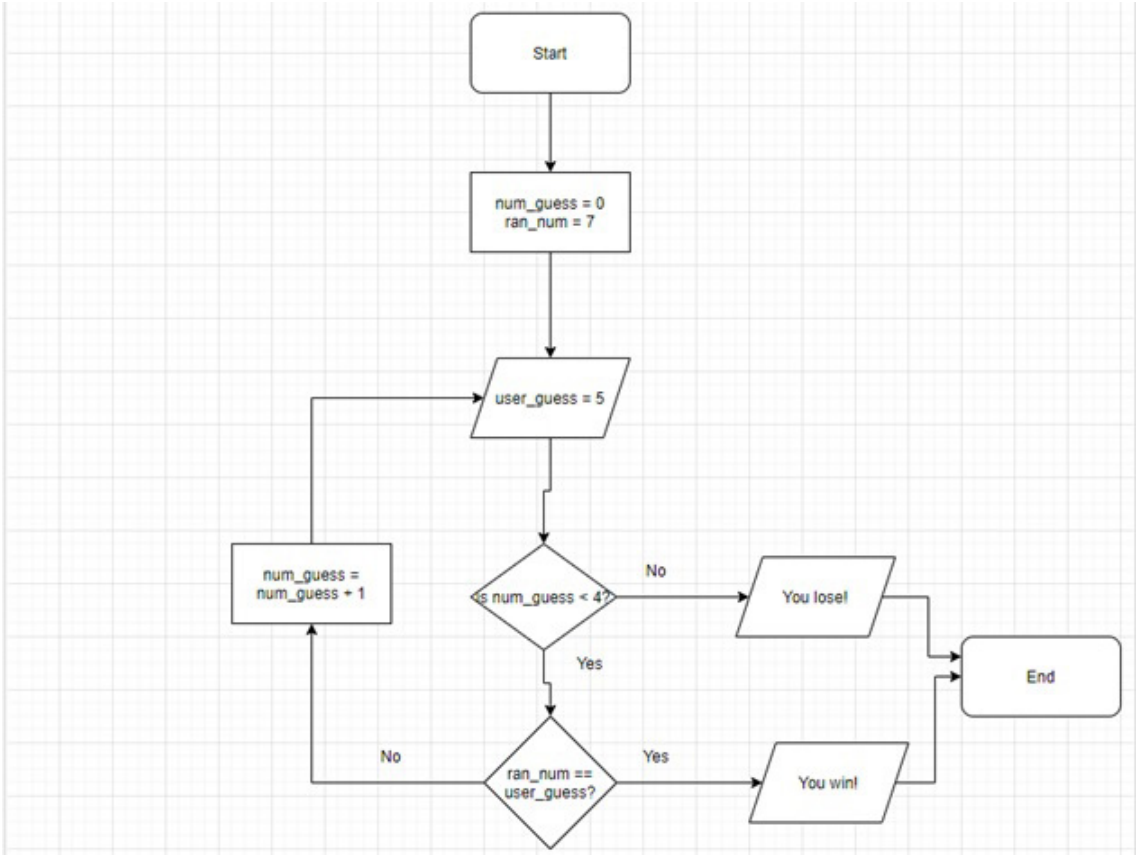
(ii) **Give 2 examples of pre-defined modules used in the Python programming language. (6 marks total)**
1. Random or any valid answer. 3 marks
2. Math or any valid answer. 3 marks

(b) **Flowcharts and pseudocode are useful tools to visualise how computer programs operate.** **10 Marks**

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.** 10 marks
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.**

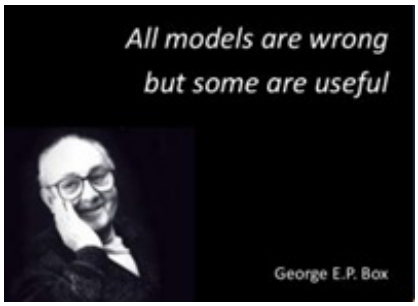


10 marks for fully correct answer or like above.
7 marks for 1 missing or incorrect element
5 marks for 2 missing or incorrect elements
3 marks for 3 missing or incorrect elements
0 marks for 4 or more missing or incorrect elements

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

16 (6,8,1,1) marks

(i) Discuss one way that models and simulations are useful and one way that models and simulation are imitated in computer programming. 6 (3,3)



Useful: speed, flexibility etc. or any valid answer. 3 marks

Limitations: not all factors in an experiment can be described using an algorithm or any valid answer. 3 marks

(ii) The Python code below shows code for a coin flipping simulation however, there are 8 mistakes in the code that will cause an error to appear when the code is ran. 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")
```

```
1   import random
2
3   results = []
4
5   for throws in range(1000): #no :
6     ran num = random.ranint(1,10) #no_ #randint not ranint
7     if ran_num >= 1 and <= 5: #no ran_num <=5
8       result.append(“H”) #should be results, not result
9     elif ran_num > 5 and ran_num <= 10 : #no ident for elif
10      results.append(“T”)
11  print(“The number of heads thrown was: “, results.count(“h”)) #capital H
12  print(“The number of tails thrown was: “, results.count(“T”) #) missing
```

8 mistakes above, 1 mark each (see comments for each answer) 8 marks

(iii) What change in the output would you expect to see if the number of iterations of the for loop was decreased to 10? 1 mark

Bigger chance of more of a disparity between the number of Heads and Tails seen at the end of the program. Less repetitions of a simulation means less accurate results (or similar).

(iv) What change in the output would you expect to see if the number of iterations of the for loop was increased to 10000? 1 mark

Bigger chance of less of a disparity between the number of Heads and Tails seen at the end of the program. More repetitions of a simulation means more accurate results (or similar).

Section C - Programming 80 Marks

Answer all parts, 50 marks for part (a), 30 marks for part (b)

NB: The solutions presented here are only exemplars of possible solutions. Award marks if question answered fully in Pythonic manner (e.g., meaningful and explicit variable names, simple being preferred to complex, complex being preferred to complicated, flat better than overly nested, readability is important etc)

Q16. **80 (50,30) marks**

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 online 2. **50 (6,10,12,7,15)marks**

```
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 die 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 die 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 die score. **6 marks**
5 marks for correct location only, see line 9 in solution below.

(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. **10 marks**
7 marks for the integer input (statement from computer does not have to match exactly but must be appropriate), see line 7 in solution below, 3 marks for correctly for matching the print statement in line 10 in solution below - accept any correct formatting.

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 computers die roll value. **12 marks**

Print statement from computer does not have to match exactly but must be appropriate, see line 6 in solution below.

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. **7 marks**

For the function name – see line 4 below, 2 marks for the print statement - see line 5 below.)

```
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 die roll of the computer and see did the user guess the correct number. Extend the program that it displays if the user guessed the correct number, guessed too low or too high. **15 marks**

See lines 11 to 16 below. 7 marks if student did not use 3 branches in IF/ELIF/ELSE statement, 5 marks if no output statements. 5 marks if wrong relational operators were used or if an assignment statement (=) was used instead of ==

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!
```

```
# Question 16(a)
# Student name:
import random
def dice_game():
  print ("welcome to my dice game!!")
  your_name = input("Please enter your name: ")
  lucky_number = int(input("Please pick a number between 1 and 6: "))
  print(your_name," 's lucky number was : ", lucky_number)
  computer_die_roll = random.randint(1,6) #initialize computer number
  print("The computer rolled: ", computer_die_roll)
  if lucky number -- computer_die_roll:
    print("You guessed correct, well done!")
  elif lucky number < computer_die_roll:
    print("You guessed too low!")
  else:
    print("You guessed too high!")

dice_game()
```

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

(b) Open the program called Question16_B.py from your device. 30 (8,10,12) marks

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 display 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.

```
#Question 16 (b)
#Student name:
import random
ticket = []

user_number = int(input ("Please pick a number between 1 and 10: "))
ticket.append(user_number)
user_number = int(input("Please pick a number between 1 and 10: "))
ticket.append(user_number)
user_number = int(input ("Please pick a number between 1 and 10: ))
ticket.append (user_number)

print ("Your ticket is: ", ticket)
print ("The draw will start now, good luck!")
drum = [1,2,3,4,5,6,7,8,9,10]
result = []
def lotto (ticket):
        for times in range (3):
          draw - drum (random.randint (0,len (drum))-1]
          result.append (draw)
     print("The draw was: ", result)

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) The code in line 6, line 7, line 8, line 9, line 10 and line 11 is repetitive. Modify the code so that the user input code only appears once in the script, but the user is still asked for 3 numbers. 8 marks

(8 marks for using a loop see lines 6 – 8 below)

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

(ii) Using a list function or otherwise, modify the code above that 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: 10 marks

7 marks for correct use of IF/ELIF/ELSE combination see lines 19 to 22 below,
5 marks for use of sorted() function or otherwise)

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!
```

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

(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 a list function or otherwise, modify the code so that each number picked from the drum is unique for the draw list. **12 marks**

8 marks for drum list entering or being placed into lotto function as an argument (see line 14 below) and 4 marks for drum.remove() function (or otherwise) – (see line 17below)

```
# Question 16(b)
# Student name:
import random
ticket = [] #empty list for the user to srore their lotto picks

for pick in range(3):
   user_number = int(input("Please pick a number between 1 and 10: "))
   ticket.append(user_number)

print("You ticket is: ",ticket)
print("The draw will start now, good luck!")
drum = [1,2,3,4,5,6,7,8,9,10]
result = []
def lotto(ticket,drum):
     for times in range(3):
       draw = drum [random.randint(0, len(drum))-1]
       result.append(draw)
       drum.remove(draw)
     print("The draw was: ", result)
     if sorted(result) == sorted(ticket):
       print("You win!")
     elif sorted(result) != sorted(ticket):
       print("You lose!")
lotto(ticket,drum)
```

Save your file.

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

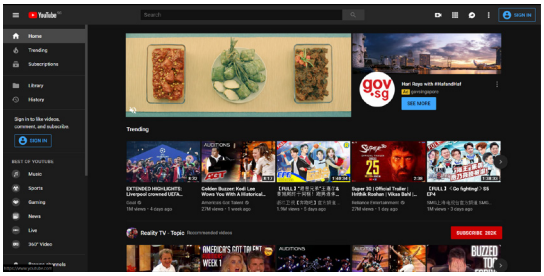
Ordinary Level

Section A - Short Answer Questions 45 Marks

Answer any 9 of 12 questions. All questions carry 5 marks.

Q1. (a) Answer the following question by putting a tick (✓) in the relevant box. Tick one box only. 2 marks

The image below shows the homepage of YouTube.



Which computer language are webpages primarily written in?

Hypertext Markup Language (HTML)	☑
Python	☐
JavaScript	☐
Structured Query Language	☐

(b) The above image shows the user using YouTube in the "Dark Mode" setting. Suggest a reason why using "dark mode" might be better for the user than using the normal "Light Mode". 3 marks

Ergonomics – helps reduce eye fatigue by changing the contrast of the background and the icons *(any valid answer)*

5 marks

Q2. The truth tables for some logic gates are given below. Match the completed truth tables with the correct logic gate by filling the in table below:

Truth Table	Logic Gate
A	AND
B	OR
C	NOT

5 marks

2 marks for first correct answer

2 marks for second correct answer

1 mark for third correct answer

A

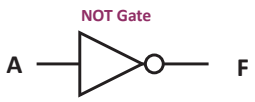
Input		Output
A	B	F
0	C	0
0	1	0
1	C	0
1	1	1

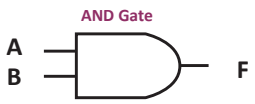
B

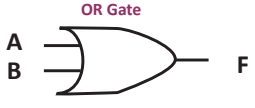
Input		Output
A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

C

Input	Output
A	F
0	1
1	0







Q3. Convert the decimal number 5610 to a binary number. **5 marks**

111000_2 *(Subscript not needed for full marks)*

Q4. The diagram below shows a person using a computer game controller. Identify one part of the controller that uses digital input. Identify another part of the controller that uses analogue input. Explain your answer in each case.

Digital Input: Coloured button(s), start button, D Pad arrows (accept any correct terminology) or any correct answer. Explanation: Buttons are either on/off (accept correct explanation)

Analogue Input: (Trigger buttons, D-Stick (accept joystick or any correct terminology) or any correct answer. Explanation: Trigger buttons/ D-stick input can be varied over time (accept any correct explanation)

3 marks for first correct answer (correct explanation must be given).
2 marks for second correct answer (correct explanation must be given).

5 marks

Q5. Operating Systems such as Windows, Mac and UNIX offer both Graphical User Interfaces (GUIs) (Figure 1) and Command Line Interfaces (CLIs) (Figure 2). GUIs and CLIs also exist in some games such as Minecraft.

Figure 1 Figure 2

(i) Explain one reason why a user would choose to use a GUI over a CLI
Visual interface makes it more accessible for beginners/ casual users.
User-Friendly
Lower barrier to entry
Any valid answer

(ii) Explain one reason why a user would choose a CLI over a GUI.
Automation
Faster performance as only keys needed.
Lower system resources
Any valid answer

3 marks for first correct answer
2 marks for second correct answer

5 marks

Q6. Some Python code is shown below. The code could be used as part of an ATM when a person withdraws money from their account. Examine the code carefully and answer the questions that follow.

```
1  balance = 1000
2  print("Your current balance is: ", balance, "euro")
3  withdrawal = float(input("How much would you like to withdraw?:"))
4  balance = 1000 - withdrawal
5  print("Your new balance is: ",round(balance,2), "euro")
```

(i) In line 3, the `withdrawal` variable is a float. What is a floating-point number? 3 marks

Floating point numbers are used to represent real numbers (accept decimal numbers).

(ii) If the value of the withdrawal variable was 350, what would the value of the balance variable be when the program finished? 1 mark

650

(iii) Suggest a reason why using a float input is more appropriate than an integer in this program. 1 mark

The user can withdraw coins from their account if they wish, integers would not allow this. Money can be in decimals. *(any correct explanation)*

5 marks

Q7. Describe one precaution someone should take when using the internet to keep their personal information safe.

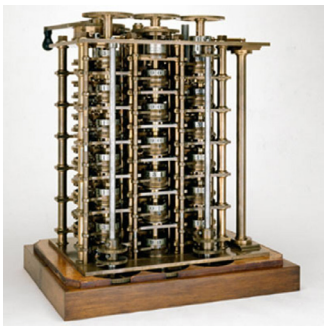
- Be careful who you share your personal details with.
- Keep your social media accounts on a private setting.
- Use secure payment services such as PayPal.
- Don't download/ open material from an untrusted or unknown source.
- Any correct answer.

5 marks

Q8. The history of computing has been constantly changing for over 200 years. Put these events in the history of computing in the correct order, starting from the oldest (i.e., the one that happened first)

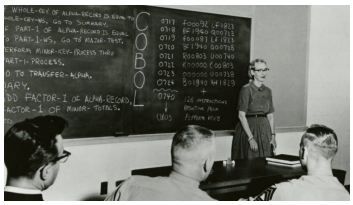
A The World Wide Web is invented in CERN, Switzerland.

B Charles Babbage invents his Analytical Steam Engine for mathematical calculations.



C Apple releases the iPad.

D Grace Hopper creates the first computing language, COBOL.



E Paul Allen and Bill Gates found Microsoft.

	Event
Oldest	B
	D
	E
	A
Newest	C

5 marks for all 5 correct
4 marks for 3 correct
2 marks for 1 correct

5 marks

Q9. You are part of a software development team. You have been asked by a veterinary surgery to create a database for their customers and their pets.
Using the table below, identify the type of data (Character, Integer, Float, Date or Boolean) for each column.

Customer name	Pet Name	Pet Age (Years)	Last Visit	Pet neutered?
Character	Character	Integer	Date	Boolean

1 mark for each

5 marks

Q10. The diagram below shows some readable/writable CDs and a USB Stick.

(i) Which of these storage devices would be most suitable to store a large video clip on?
USB stick 2 marks

(ii) Give a reason for your answer.
Generally, USB Sticks have a larger capacity; they are more durable than CDs; they are easier to transport; the stored data is less likely to degrade over the same time period or any valid answer 3 marks

5 marks

Q11. Hardware is physical equipment that allows for the computer and human to interact. The table below has 6 pieces of computer hardware, state if each one is input or output. The first has been completed for you.

Hardware	Input or Output
Mouse	Input
Speaker	Output
Printer	Output
Scanner	Input
Keyboard	Input
Microphone	Input

1 for each correct answer. **5 marks**

Q12. Machine learning and artificial intelligence have helped revolutionise many areas of society.

(i) Identify one area that has been impacted by machine learning/ artificial intelligence.
2 marks

Any valid answer

(ii) State 1 ethical concern of using machine learning/ artificial intelligence in the area you identified in part (i).
3 marks

Any valid concern - must match with part (i) for marks to be awarded.

5 marks

Section B - Long Questions — 70 Marks

Any two of the following three questions, each question has 35 marks.

Q13. **35 (4,21,10) marks**

Computational thinking or "thinking like a computer" is a very important skill in computer science that can also be applied to real-life situations as well. There are 4 cornerstones of Computational Thinking:

- **Algorithms**
- **Pattern Recognition**
- **Abstraction**
- **Decomposition**

By using some (or all) of these skills, problems that seem difficult at the beginning can be solved with relative ease.

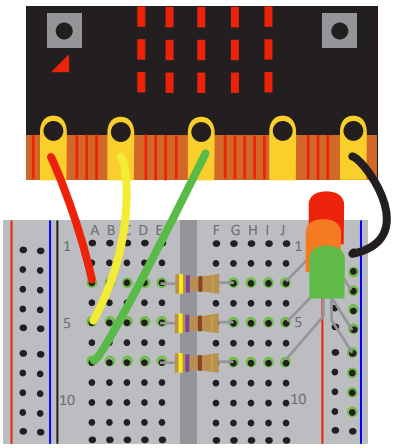
(a) (i) Match each term associated with computational thinking with the sentence that best describes it under the table.

Aspect of Computational Thinking	Description
Algorithms	D
Pattern Recognition	A
Abstraction	C
Decomposition	B

A: Finding the similarities among simpler, smaller problems that can help us solve more complex problems more efficiently.
B: Breaking a big problem up into smaller, more manageable parts.
C: Ignoring parts or areas of problems that do not matter, removing unimportant details from a problem.
D: Using a series of logical steps when solving a problem.

1 mark per correct answer **4 marks**

(b) The image below shows an image of an embedded system (A Micro Bit) connected to a breadboard with LEDs.
The Micro Bit is connected to a RED LED, a GREEN LED and an ORANGE LED.



The LEDs are programmed to turn on and off using timers from when the Micro Bit program starts. The pattern of the LEDs turning off and on is seen below:

The RED LED Sequence: 1 minute ON, 2 minutes OFF, then repeat.

The GREEN LED Sequence: 2 minutes ON, 2 minutes OFF, then repeat.

The ORANGE LED Sequence: 1 minute ON, 1 minute OFF, then repeat.

The Micro Bit will display a message of the overall colour depending which light(s) are turned on. The table below shows the combinations of LEDs and the message from the Micro Bit showing the overall colour.

RED LED	GREEN LED	ORANGE LED	OVERALL COLOUR
OFF	OFF	OFF	**NONE**
ON	OFF	OFF	**RED**
ON	ON	OFF	**YELLOW**
ON	ON	ON	**PURPLE**
OFF	ON	ON	**BROWN**
OFF	OFF	ON	**ORANGE**
OFF	ON	OFF	**GREEN**
ON	OFF	ON	**TANGERINE**

(i) Using the table below, what will the overall colour be in the 9th minute after the Micro Bit starts? The first minute has been completed for you.

Minute Number	RED LED	GREEN LED	ORANGE LED	Overall Colour
1	ON	ON	ON	Purple
2	OFF	ON	OFF	
3	OFF	OFF	ON	
4	ON	ON	OFF	
5	OFF	ON	ON	
6	OFF	OFF	OFF	
7	ON	ON	ON	
8	OFF	ON	OFF	
9	OFF	OFF	ON	Brown

Brown (15 marks total – 15 marks for correct answer, 10 marks for wrong answer with detailed workings, 5 marks for wrong answer with some workings, 2 marks for using some pattern without finding the correct answer. 15 marks

(ii) Is the LED system above an example of a digital or analogue output? Give one reason for your answer. 3 marks

Digital (1 mark). LED is either in OFF or ON state (2 marks)

(iii) Which component of Computational Thinking (Algorithms, Pattern Recognition, Abstraction or Decomposition) would you say is the most useful in solving the above problem? Give a reason for your answer. 3 marks

Pattern recognition (1 mark). Due to repetitive nature of LEDs, you can predict future states. (2 marks)

Any valid answer with valid explanation award full marks if the component and reason are consistent.

(c) Computational Thinking can be used to solve problems or complete tasks outside of computer science. Pick one aspect of computational thinking (Algorithms, Pattern Recognition, Abstraction or Decomposition). Explain one way in which that aspect can be applied to an everyday problem or task e.g. applying Decomposition to a jogsaw puzzle.

Any valid example (3 marks)

Appropriate description of the example (7 marks) **10 marks**

Q14. Embedded Systems such as the Micro Bit, Raspberry Pi or the Arduino form part of one of the Applied Learning Tasks (ALTs) that you performed during your Computer Science course. **35 (10,15,10) marks**

(a) Embedded Systems usually have a processing unit and memory. **10 (6,4) marks**

(i) What is the function of the Central Processing Unit (CPU) in a computer? 6 marks

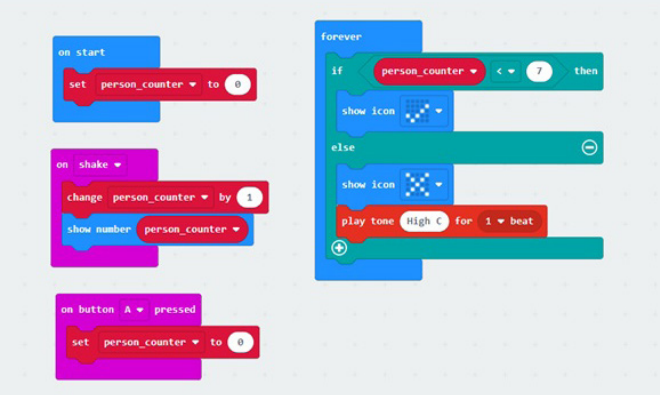
Brain of the computer – performs arithmetic, logic, controls input and output of the computer.

(ii) Name 2 types of memory that computers can have. 4 marks

RAM *(or an appropriate description of RAM)* **2 marks**

ROM *(or an appropriate description of ROM)* **2 marks**

(b) The image below shows code that could be used to program a Micro Bit embedded system. The Micro Bit (with a buzzer) is attached to an anti-viral hand sanitiser at the entrance to a room, every time the hand sanitiser dispenser is pressed, the Micro Bit will shake. Examine the code carefully below and answer the questions that follow. **15 marks**



(i) Is the on shake a digital input or analogue input?

Analogue 2 marks

(ii) What is the initial value of the variable person_counter?

0 2 marks

(iii) What happens when the value of person_counter becomes 8 or higher?
X symbol appears (1 mark)
High C tone played for 1 beat (accept noise made) 2 marks

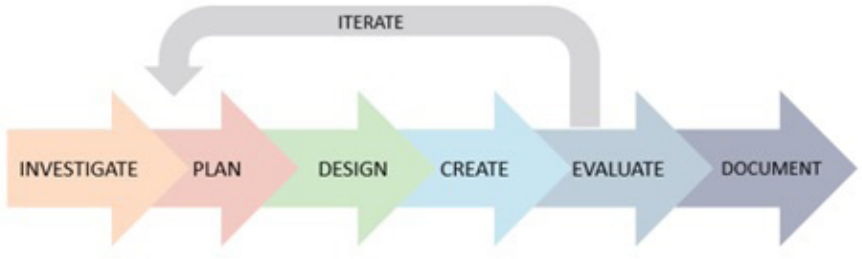
(iv) What is the purpose of the on button A pressed input?
Resets the person_counter variable to 0 2 marks

(v) Briefly describe how you could modify the code and/or Micro Bit accessories to improve the functionality of this embedded system.
Attach LEDs to the Micro Bit (green when less than 8 people in the room, red when more than 7 people in the room)
Any valid answer 7 marks

(c) Embedded Systems play an important role in our daily lives. Give two examples of that embedded system used in society. **10 marks**
Fire/ smoke alarms
Microwaves
Central Heating Systems
Calculators
Digital watches
Any valid answer

5 marks for the first correct answer, 5 marks for the second correct answer.

Q15. Following a design process when creating a computational artifact is important. **35 (12,15,8) marks**

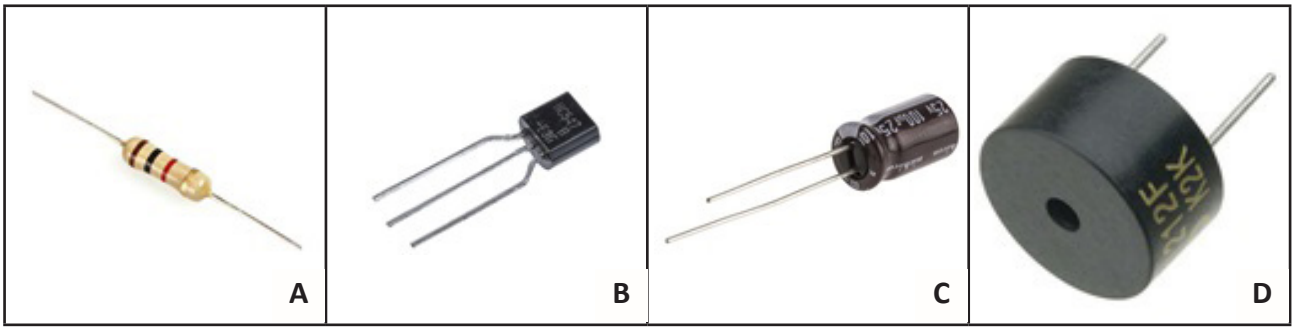


(a) The diagram above outlines the stages involved in a typical design process. Describe the following stages in the process: **12 marks**

(i) Iteration 6 marks
The artifact is improved upon after each cycle of the design process until it is ready to be used. The process is modified to suit the individual project being completed. *Any valid answer*

(ii) Document 6 marks
Explain the functionality of the artifact. Unify information about the artifact. Allow for discussion and feedback between producers and stakeholders. Any valid answer.

(b) Many electronic devices were created using the design process above. Match each image with its corresponding term in the table below. Match the function of each item. Give an example of a device where each item could be used. 15 marks



Term	Image	Function
Buzzer	D	Produces an audio signal after receiving an electric current.
Capacitor	C	Stores electrical energy.
Resistor	A	Limits the flow of electrical current.
Transistor	B	Produces an audio signal after receiving an electric current.

Limits the flow of electrical current.
Produces an audio signal after receiving an electric current.
Stores electrical energy.
Controls the flow of electrical energy.

5 marks for Image column – 2 marks for first correct answer, 2 marks for second correct answer, 1 mark for last correct answer.
10 marks for Function column – 4 marks for first correct answer, 4 marks for second correct answer, 2 marks for final correct answer.

(c) Describe one environmental issue with the production and use of electronic devices such as the above. 8 marks

Landfill sites becoming fuller and fuller; heavy metals entering the food chain causing poisoning etc (3 marks for naming an issue, 5 marks for describing the issue)

Section C - Programming 80 Marks

Answer all parts, 50 marks for part (a), 30 marks for part (b)

NB: The solutions presented here are only exemplars of possible solutions. Award marks if question answered fully in Pythonic manner (e.g., meaningful and explicit variable names, simple being preferred to complex, complex being preferred to complicated, flat better than overly nested, readability is important etc)

Q16 **50 marks**

(a) **50 (8,8,12,8,10,4) marks**

Open the program called Question16_A.py from your device.
Enter your name in the space provided on line 2.

This is a simple program that can find the perimeter and area of a quadrilateral. When this program is run, it prompts the user to select either perimeter or area. The user enters the letter "p" if they wish to find the perimeter or enters the letter "a" if they wish to find the area.

```
1   # Question 16(a)
2   # Student name:
3
4   length = 6
5   width = 4
6
7
8   choice = input("Do you want to find the (perimeter or (a)rea? ")
9
10  if choice == "p":
11    print(length + length + width + width)
12  elif choice == "a":
13    print(length*width)
```

(i) **Modify the program to output a message to the user describing what the program does. This message should be displayed at the start of the program.**
See line 5 below. **8 marks**
When the program is run the output may look as follows:

```
This program can find the perimeter or area of a quadrilateral
Do you want to find the (p)erimeter or (a)rea? p
20
```

(ii) **Modify the program to prompt the userr to enter their name when the program starts.**

A suitable variable should be used to store the name. The program should output a suitable massge using the user name when the program ends. **8 marks**
5 marks for variable created. 3 marks for input command used correctly,
2 marks for wrong locations of username input and output (see lines 8 and 15 below)
When the program is run the output may look as follows:

```
This program can find the perimeter or area of a quadrilateral
Please enter your user name: John
Do you want to find the (p) erimeter or (a) rea? a
24
Thank you for using the program John
```

(iii) Currently the variables length and width are hard coded to the values of 6 and 4 respectively. Modify the code so that the user will be asked to enter the values as floating-point numbers for these variables. 12 marks

6 marks for length input command. 6 marks for width input command (see lines 6 and 7 below). Award 2/4 marks for integer input command)

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

```
This program can find the perimeter or area of a quadrilateral
Please enter the length: 7.5
Please enter the width: 4.7
Please enter your user name: John
Do you want to find the (p) erimeter or (a) rea? a
35.25
Thank you for using the program John
```

(iv) Modify the code so that the output of both the area and perimeter will be rounded to 2 decimal places. 8 marks

5 marks for round command used. 3 marks for 2 decimal places (see lines 12 and 14 below).

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

```
This program can find the perimeter or area of a quadrilateral
Please enter the length: 7.52367
Please enter the width: 4.457249
Please enter your user name: John
Do you want to find the (p) erimeter or (a) rea? a
33.53
Thank you for using the program John
```

(v) Modify the program so that when the program is run the output will be more informative to the user. 10 marks

4 marks for length output formatting. 4 marks for width output formatting (see lines 12 and 14 below).

The output will look as follows:

```
This program can find the perimeter or area of a quadrilateral Q
Please enter the length: 7.532
Please enter the width: 4.674
Please enter your user name: John
Do you want to find the (p) erimeter or (a) rea? p
A quadrilateral with a length of 7.532 and a width of 4.674 h
as a perimiter of: 24.41
Thank you for using the program John
```

```
This program can find the perimeter or area of a quadrilateral Q
Please enter the length: 7.542
Please enter the width: 4.876
Please enter your user name: John
Do you want to find the (p) erimeter or (a)rea? a
A quadrilateral with a length of 7.542 and a width of 4.876 h
as an area of: 36.77
Thank you for using the program John
```

(vi) **In the perimeter calculator part of the code, change the code so that instead of Perimter = length + length + width + width, the perimeter will be found using the formula, Perimiter = (lengthX 2) + (widthX2). You can test the functionality of your code by using the data in the following table.** **4 marks**
Award 4 marks for correct formula for perimeter (seeline 12 below).

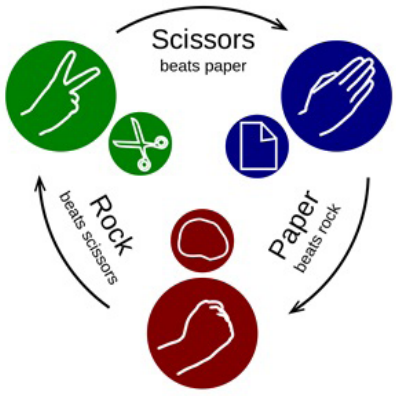
Length	Width	Perimeter	Area
3.7	7.4	22.2	27.38
2.6	10.5	27.3	26.7
8.8	11.4	100.32	40.4

```
1  # Question 16(a)
2  # Student name:
3
4
5  print("This program can find the perimeter or area of a quadrilateral")
6  length = float (input("Please enter the length: "))
7  width = Float (input("Please enter the width: "))
8  username = input("Please enter your user name: ")
9  choice = inpet("Do you want to find the (p) erimeter or (a) rea? ")
10 print
11 choice = "p":
12 print("A quadrilateral with a length of length," and a width of ",width, "has a perimiter of: ", (round((2*length) + (2*width), 2)))
13 elif choice == "a":
14 print("A quadrilateral with a length of ", length," and a width of ",width, "has an area of: ", (round(length*width, 2)))
15 print("Thank you for using the program", username)
```

(b) **30 (15,15) marks**

Open the program called Question16_B.py from your device.
Enter your name in the space provided online 2.

In this code, the player will play a game of rock, paper, scissors against the computer. The rules of the game are described below:



If both the player and computer pick the same, the game ends in draw.

```
1  # Question 16(b)
2  # Student name:
3
4  import random
5
6  computer_options = ["rock", "paper", "scissors"]
7
8
9  computer_choice = computer_options (random.randint(0,2)]
```

(i) Modify the program so: 15 marks

- **The user should be prompted to enter their choice of rock, paper or scissors when the program starts.** 5 marks
- **A suitable variable should be used to store the user input.** 4 marks
- **The user's choice should be printed out with an appropriate message.** 3 marks
  2 marks *for printing the choice, 1 for printing appropriate message)*
- **The computer's choice should be printed out with an appropriate message.** 3 marks
  2 marks *for printing the choice, 1 for printing appropriate message)*

(Seelines 8, 13 and 14 below)

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

```
Enter rock, paper or scissors: rock
Player chose: rock
Computer chose: paper
```

(ii) Modify the program so that it will tell the user who won the game. Use the rules of the game above to help. 15 marks

5 marks for "Draw" scenario (Lines 17 and 18)
6 marks for the 3 "Computer Wins" scenario (Lines 19 to 24)
4 marks for the "Player Wins" Scenario (Lines 25 and 26)
Award all marks if student codes in all possible combinations of player-computer outcomes if they use IF-ELIF-ELSE.

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

```
Enter rock, paper or scissors: rock
Player chose: rock
Computer chose: paper
Computer wins
```

```
Enter rock, paper or scissors: paper
Player chose: paper
Computer chose: rock
Player wins
```

```
Enter rock, paper or scissors: paper
Player chose: paper
Computer chose: paper
Draw!
```

```
# Question 16 (b)
# Student Name:

import random

computer_options = (“rock”, “paper”,”scissors”]

user_choice = input (“Enter rock, paper or scissors: “)
computer_choice = computer_options[random.randint(0,2)]



print(“Player chose: “,user_choice)
print (“Computer chose: “, computer_choice)


if user_choice == computer_choice:
  print(“Draw!”)
elif user_choice == “rock” and computer_choice == “paper”:
  print(“Computer wins”)
elif user_choice == “paper” and computer_choice == “scissors”:
  print(“Computer wins”)
elif user_choice == “scissors” and computer_choice == “rock”:
  print(“Computer wins”)
else:
  print(“Player wins!”)
```

Save your file.

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

NOTES

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