COMPUTER SCIENCE

HIGHER & ORDINARY LEVEL

MARKING SCHEME

Pre-Leaving Certificate Examination 2023

HIGHER LEVEL

Section A	45 marks

Answer any 9 of 12 questions, 5 marks each

Q1. **Ohm's Law states that a current flowing through a conductor between two points is directly proportional to the voltage applied across the two points.**
In relation to electronics, answer the following questions:

(a) **In terms of an electrical circuit, what is meant by the term voltage?**
Voltage is the pressure from an electrical circuit's power source that pushes charged electrons (current) through an electronic circuit or similar explanation. (2 marks)
Fair description - limited understanding 1 mark

(b) **In terms of an electrical circuit, what is meant by the term current?**
The electric current is the rate of charge flow past a given point in an electronic circuit or similar explanation (2 marks)
Fair description - limited understanding 1 mark

(c) **Identify the electronic device in the image below:** Resistor (1 mark)
5 MARKS

Q2 . **HTTP and URL are key mechanisms used by web browsers when using the world wide web. Explain the underlined terms in the statement above.**

(a) **HTTP:** A protocol used for website servers and browsers to communicate

(b) **URL:** this contains the address of the data requested by the website server

First correct (Good description - clear understanding demonstrated) (3 marks)
Fair description - limited understanding 1 mark
Second correct (Good description - clear understanding demonstrated) (2 marks)
Fair description - limited understanding 1 mark
5 MARKS

Q3. **(a)** **Convert the following binary number into hexadecimal.**
$$10110101_2$$

Please show all your workings.

$B5_{16}$

(b) **Convert the following decimal number into hexadecimal.**
$$79_{10}$$

Please show all your workings.

$4F1_6$

Subscripts not needed for marks

Award **2 marks out of 3 marks** for a slip in the first part attempted.
Award **1 mark out of 2 marks** for a slip in the second part attempted. **5 MARKS**

Q4. **Some Python code is shown below. Examine the code carefully and answer the question that follows.**

```python
import random
import datetime

def func():
    message = "Welcome to my program"
    print (message)
    print("This program will show you the basics of Python!")
    x = datetime.datetime (2020,6,13)
    print (x)
    varl = True
    while varl:
        print("Hello")
        varl = False
    numl = random.randint (2,6)
    num2 = 4.2
    print("This is how you print a variable: ", num2)
    num3 = 2 + 3j
    print (num3)
func()
```
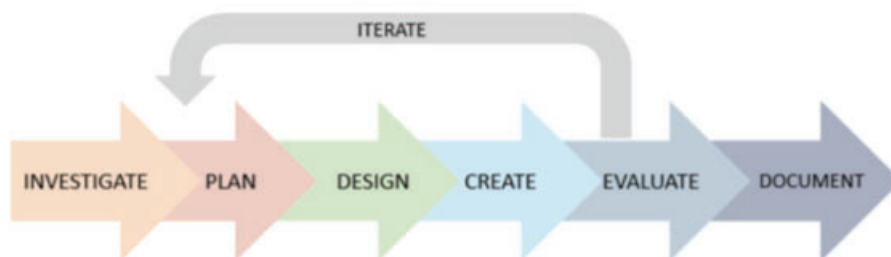
Identify variables for the following datatypes and fill in the table below with the appropriate variable names.

Datatype	Variable name
String	message
Int	num1
Boolean	var1
Date	x
Float	num2

1 mark per correct answer   **5 MARKS**

Q5.

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:

Award **3 marks** for first correct answer and **2 marks** for second correct answer.

(a)   Plan stage
When the project plan is developed that identifies, prioritises, and assigns the tasks and resources required to build the structure for a project, or similar.

(b)   Iterate stage
The iterative stage is when the project progressively gains more complexity and a broader feature set until the final system is complete, or similar.

Award marks for any acceptable answer showing clear understanding of that step
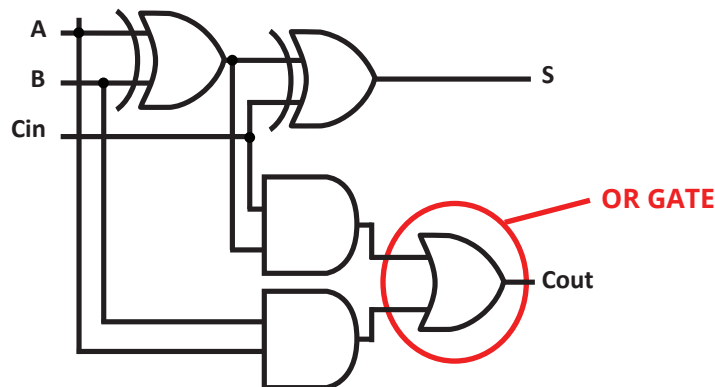3 marks + 2 marks   **5 MARKS**

Q6.   The diagram below shows a Full-Adder. This is an important component of computer circuitry. It is composed of several logic gates combined.
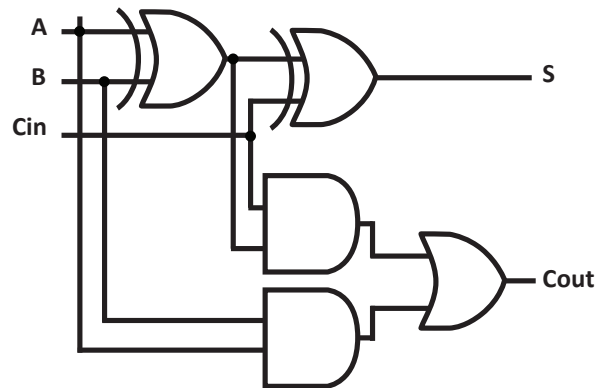
(a)   What is the function of the Full-Adder?
The Full Adder adds two binary bits together (10 + 01, 11 + 00, 01 + 10, etc.); it adds two bits and a carry value, so it adds 3 inputs but gives two outputs, a sum value and a carry value. Or valid answer.   (1 mark)

(b)   Using an appropriate label, label an OR logic gate on the above diagram.

OR GATE

(1 mark)

(c)   Complete the Truth-Table for an OR logic gate.

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

(3 marks) – must get table fully correct for 3 marks
5 MARKS

Q7.   **A coloured pixel is shown below with its associated hexadecimal and binary code:**

Hexadecimal: EC8A33$_{16}$
Binary: 11101100100010100011 0011$_2$

Suggest one reason why it is advantageous to store information about pixel colour in a binary form.

No ambiguity for storing binary data in computers – either ON or OFF
Any valid answer   **5 MARKS**

Q8.

(a)   **Many types of sorting algorithms exist. Each type has their own advantages and**
          disadvantages. One such sorting algorithm is Bubble Sort.   (4 marks)
          Perform a Bubble Sort on the following array of numbers, showing what the array
          looks like after each iteration:

9	4	1	8	6

First iteration

4	9	1	8	6

Second iteration

4	1	9	8	6

Third iteration

4	1	8	9	6

Fourth iteration

4	1	8	6	9

Fifth iteration

1	4	8	6	9

Sorted

1	4	6	8	9

(b)   **What is the time complexity for the worst-case scenario for the above algorithm?**
          $O(n^2)$ (1 mark)

                                                                                           5 MARKS

Q9.

(a) **In relation to computers and webpages, what is your understanding of "Universal Design"?**

Universal Design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation of specialised design, or similar valid answer.

(3 marks)

(b) **Suppose you were tasked to build a website for a government department. Name two ways that you could make it accessible to someone with little experience of computers and/or the World Wide Web.**

Two from:
Consistent navigation layout
Feedback on navigation bars, etc.
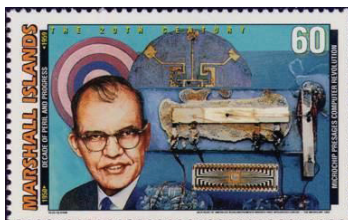Allow for search bars and paths to show pages open
Avoid popups
Allow for use on laptop/ tablet/ phone without loss of clarity
Or any valid answer

(1 mark + 1 mark)

5 MARKS

Q10. **In 1958, Kack Kilby and Robert Noyce independently invented the first Integrated Circuit or "Microchip".**

Pick one other significant historical event in the history of computing and briefly describe it. You should include roughly when it was invented and the impact it had on computing both at the time and subsequent computing technologies.

Any valid answer – year does not need to be exact; a rough time period will suffice. If year/ timeframe is incorrect or not included but the answer is correct, award 4 marks.   **5 MARKS**

Q11. **On the 14th of May 2021, The Health Service Executive (HSE) was subjected to a cyber attack. Read the extract below and answer the questions that follow.**

1. HSE cyber attack and how it may affect you

Our health service was targeted by a criminal cyber attack last year.

The aim of this attack was to disrupt our health services and computer systems, steal data, and demand a ransom for its return.

We have been given a copy of the evidence Gardaí have found of which data has been illegally accessed and copied. This follows a Garda investigation which involved other international police forces.

We are now examining all the affected information. We expect it includes a mix of medical information, personal data, financial information, HSE corporate information, commercial data and general non-personal administrative data.

Personal data means information about individuals, such as names, addresses, contact phone numbers and email addresses. Medical information would include medical records, notes and treatment histories.

Suggest two ways in which the unauthorised release of the stolen data could impact the individuals involved.
Release of sensitive medical records (e.g., genetic information) to insurance companies
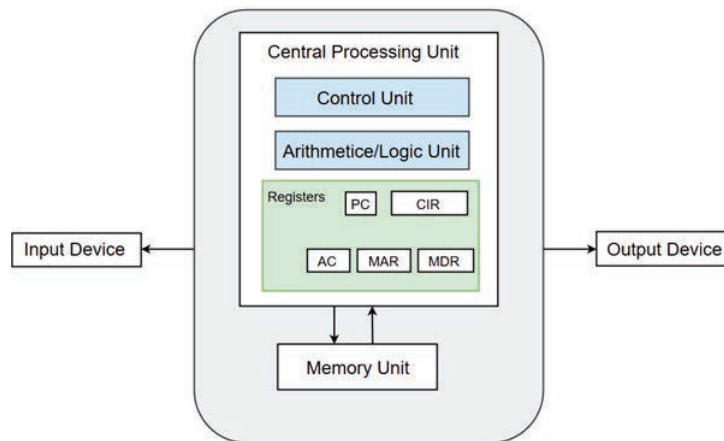Release of Name, Address, PPSN, etc., for identity fraud
Any valid answer
3 marks for first correct answer, 2 marks for second correct answer   **5 MARKS**

Q12. The Von Neumann Architecture and an associated memory unit is shown below:

Von-Neumann Basic Structure:

(a)   What is the function of the Arithmetic Logic Unit (ALU)?
The ALU performs addition, subtraction, multiplication, division and logic operation, or similar understanding demonstrated.   (1 mark)

(b)   Briefly describe the Fetch – Decode – Execute cycle.
The fetch-decode-execute cycle is the sequence of steps that the CPU follows to process instructions.
1. The processor checks the program counter to see which instruction to run next. The program counter gives an address value in memory of where the next instruction is.
2. The processor fetches the instruction value from this memory location. Once the instruction has been fetched, it needs to be decoded and executed.
3. Once this is complete, the processor goes back to the program counter to find the next instruction.
4. This cycle is repeated until the program ends.
Or similar answer presented. Deduct 1 mark per omission of relevant point.   (4 marks)
                                                                                  5 MARKS

Section B - Long Questions   **78 Marks**

Students answer any 2 of the following 3 questions.

Q13.   **39 (10, 18, 11) MARKS**

**(a)**   **10 (5,5) Marks**

<u>Decomposition</u> **and** <u>Algorithms</u> **are two important aspects of Computational Thinking. Explain the underlined terms.**
Decomposition: Breaking a problem up into smaller problems, solving the smaller problems and combining them to solve the whole problem (or similar)   (5 marks)
Algorithms: Breaking a problem up into smaller problems, solving the smaller problems and combining them to solve the whole problem (or similar)   (5 marks)

(b)   **18 Marks**

The Manhattan Tourist Problem is a famous computer science problem.
You are visiting Manhattan in New York City, but you have left all your sightseeing until the trip to the airport!
The object of the challenge is to see as many attractions as possible from your hotel to the airport while travelling south and east only. The numbers along each arrow show the number of attractions on each street.
Complete the given Manhattan Tourist Problem below. Please show your workings.
One (non-optimal) solution to the problem would be: South 1+South 4+South 4+ South 5+East 1+East 3+East 2+East 2 = 22 attractions visited.
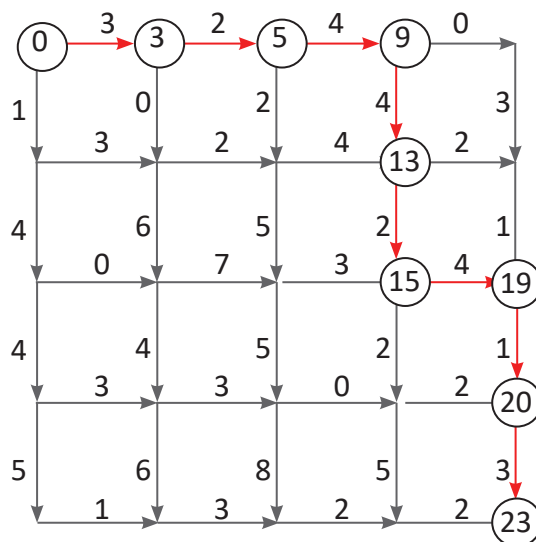
Correct answer – 18 marks
Attempt with mostly the correct path – 12 marks
Attempt with half the correct path – 7 marks
Attempt with less than half the correct path – 5 marks
No attempt – 0 marks

(c)   **11 (6,5) Marks**

<u>Relational Databases </u>are very useful for organisations to keep track of their customer information.

(i)   (6 marks)

Explain what is meant by the underlined term in the above statement.

A relational database is a type of database that stores and provides access to data that is related to one another. Two or more databases are connected using a unique identifier.
Any valid explanation.

(ii)   (5 marks)

Name a primary key a small Manhattan tourism company could use in their relational database.

Customer ID could be used to link two databases that the tourist company has on its customers.
Any valid example

Q14.   **39 (12,17,10) MARKS**

(a)   **(12 marks)**

In relation to computer algorithms, what is meant by a heuristic algorithm?

An algorithm in which accuracy/ precision is sacrificed for speed. It gives an approximate solution rather than the optimal solution. Or a similar explanation.

(b)   **(17 marks)**

A famous problem that can be solved with Heuristics is the Knapsack Problem. A simple Knapsack Problem can be solved by hand. In the Knapsack Problem, you need to pack a set of items into a bag. Each item has a weight (in kg) and value (in euro). The problem is that you can only carry a maximum of 13kg.

You need to choose a combination of the items to maximise the total value (in euro) that you can carry. You can only choose one of each item. You do not necessarily need to reach the limit of 13kg to find the optimal value.

The items, weights and values are given below:
Gold Bar (weight 5kg; value €10)
Diamond (weight 3kg, value €20)
Ruby (weight 8kg; value €25)
Coin (weight 4kg, value €8)

Solve the Knapsack Problem with the given bag and items below. You must show that the answer you obtain is the optimal solution for this set of constraints.

| Weight = 5 Kg | Weight = 3 Kg | Weight = 8 Kg | Weight = 4 Kg |
| Value = €10 | Value = €20 | Value = €25 | Value = € 8 |

Maximum Weight = 13 kg

Ruby + Coin = €33
Ruby + Diamond = €45 (Optimal Solution)
Ruby + Gold = €35
Coin + Diamond = €28
Coin + Gold = €18
Diamond + Gold = €30
Gold + Diamond + Coin = €38
17 marks for correct answer proving optimal solution, 8 marks for correct answer without
showing optimal solution, 5 marks for attempt showing logical thinking, e.g., drawing a table)

(10 marks)

(c)   Give two examples of how heuristic algorithms can be used in real-life situations.
Google Maps finding a route between two points   (5 marks)
Playing a computer game against a computer (e.g., chess)   (5 marks)
Any valid answers

Q15.   **39 (8,19,12) MARKS**

(8 marks)

(a)   Many simple electronic components can be combined to create complex circuitry.
State the function of each of the following electronic components:
Resistor: Limits the flow of electric current   (3 marks)
Capacitor: Stores electrical energy   (3 marks)
Transistor: Amplifies, controls or generates electrical signals   (2 marks – only 1 answer needed)

**(b)**   **(19 marks)**

Examples of microcontrollers/microcomputers used to make Embedded Systems that you may have used during your Computer Science Applied Learning Tasks (ALTs) are the Raspberry Pi, Arduino and the Micro: Bit.
These embedded systems can be connected to computers to store data in a database. The diagram below shows a Micro: Bit microcontroller connected to a laptop via a USB cable. The Micro: Bit is using its built-in thermometer to measure the temperature of the air every 5 seconds for 1 minute. These values are being recorded by a Python file.
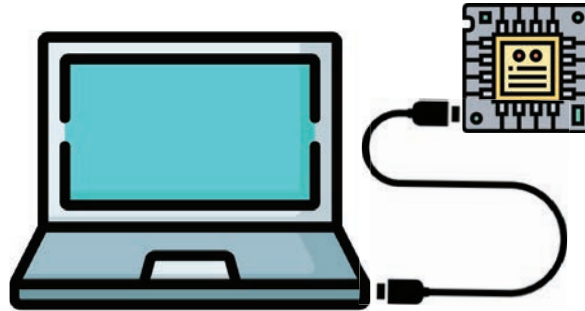
                                                                         (7 marks)

(i)   State one difference between digital and analogue input.
       Digital input is discrete (ON or OFF). Analogue input is continuous.
       Or any valid answer

                                                                         (6 marks)

(ii)   Is temperature an example of continuous or discrete data? Give a reason for your answer.
       Continuous – It can have many different states and fractions of values.

                                                                         (6 marks)

(iii) The raw data collected from the Micro: Bit is shown in the image below:

```
temperature = ["31","30","32","30","29","31","4","28","30","NA","29"]
```

The data as presented above is not suitable for further numerical analysis. State three ways that this data could be prepared or formatted to allow for numerical analysis.
Need to convert strings to integers/ floats as we will be performing numerical analysis
Need to remove any NA values
Need to investigate the extreme outlier of 4 - maybe an error with the Micro: Bit
Only 11 values recorded – investigate what happened
Or any valid answer

2 marks per correct answer - award marks for three correct responses

(12 marks)

(c) **Examples of numerical analysis that could be performed using Python are the mean, median and mode calculations. The image below shows code for each of these calculations but without any meaningful variable names or information. Match each function (`FunctionA`, `FunctionB` and `FunctionC`) with the correct type of numerical analysis in the table below, giving a reason for each choice.**

```python
data = [5, 3, 7, 2, 5]

def FunctionA(data):
    n = len (data)
    data.sort()
    if n % 2 == 0:
        y1 = data[n//2]
        y2 = data[n//2 - 1]
        y3 = (y1 + y2)/2
    else:
        y3 = data[n//2]
    print (y3)
FunctionA (data)

def FucntionB(data):
    data.sort()
    list_1 = []
    i = 0
    while i < len(data) :
        list_1.append(data.count(data[i]))
        i += 1
    di = dict(zip(data,list_1))
    d2={k for (k,v) in d1.items() if v == max(list_1) }
    print (d2)
FunctionB(data)

def FunctionC(data):
    n = len (data)
    x = sum (data)
    y = x/ n
    print(y)
FunctionC(data)
```

Function	Numerical Analysis	Reason
A	Median	Use of indexing of data, sorting data
B	Mode	Counting function, frequency dictionary produced
C	Mean	Use of sum divided by length

4 marks for each correct answer

Only one reason needed for marks
Only award marks for correct matching and reason, not just correct matching. Need only give one reason to award marks.

Section C - Programming   87 MARKS

Students answer all question parts.

Q16. **Note:** solution provided is not exhaustive - award marks for pythonic solution for (a), (b)
and (c)   87 (43, 44) Marks

(a)   **43 Marks**

Many organisations can use programming languages to help speed up processes that
would take much longer by hand. An example would be a government department
responsible for calculating how much tax people pay.
Open the program called Question16_A.py from your device.
Enter your name on line 2.

```python
# Question 16(a)
# Write your name here:


wages = int (input("Please enter your annual wages: "))

cutoff = 36800

def income_tax(wages):




income_tax(wages)
```

This program is designed to calculate how much income tax a person will pay, and the
percentage of their wages lost to tax.

It will ask the user to enter their gross yearly wages, it will check if the gross wages meet
the cut-off value (€36800) for income tax. If it does not meet the cut-off then no income tax
will be paid. If yearly wages <u>does</u> meet the cut-off point, then total income tax will be
applied in the following manner:

- **Wages will be taxed at 20% for the first €36800 earned.**
- **The remaining balance of wages after €36800 will be taxed at 40%.**

Tax-credits are used to reduce the amount of income tax a person pays. They are
subtracted from the total income tax.

Modify the program to do the following:

(i)   The user currently enters their wages as an integer. Modify the program to display
the following formulae:
```
               Net income = Gross wages – total tax
Total tax = (€36800 x 20%) + ((Gross wages - €36800) x 40%) – Tax Credits
```
                                                                         (6 marks)

(ii)   There is a hard-coded variable called "`cutoff`" that has a value of 36800. Create
another hard coded variable called "`tax_credits`" directly above the cutoff variable
that will have a value of 1700.   (6 marks)

(iii) Inside the function "`income_tax`", modify the program so that it displays to the user
if they must pay income tax or not. If the user enters a wage of €36800 or more,
the program displays to the user they must pay income tax; if the user enters a wage
of less than €36800, then the program displays to the user they do not have to pay
any tax. When the program is run, it may look as follows:
                                        (8 marks – allow 5 for just the IF statement)

```
Please enter your annual wages: 35000
You pay no income tax
```

```
Please enter your annual wages: 40000
You will have to pay income tax
```

```
Please enter your annual wages: 36800
You will have to pay income tax
```

(iv) **Currently, the program only tells the user if they do or do not pay income tax. Modify the program so it will:**
  - **calculate the total income tax paid after tax credits have been applied. This should be rounded to 2 decimal places.**
  - **The percentage of total wages lost to income tax (after tax credits have been applied) should also be displayed and rounded to 2 decimal places.**

When the program is run, it may look as follows: **(23 marks)**
(23 marks for full correct answer, 18 marks for correct net income tax, correct formatting but not rounded, 18 marks for all correct but no formatting, 15 marks for correct gross income tax (i.e., no tax credits applied), correct rounding and correct formatting, 5 marks for attempted at correct arithmetic).

```
Please enter your annual wages: 35000
You pay no income tax
```

```
Please enter your annual wages: 40000
You will have to pay income tax
Your income tax bill is: € 6940.0
The percentage you lost to tax was: 17.35 %
```

```
Please enter your annual wages: 36800
You will have to pay income tax
Your income tax bill is: € 5660.0
The percentage you lost to tax was: 15.38 %
```

SOLUTION:

```
1   # Question 16(a)
2   # Write your name here:
3
4   wages = int (input("Please enter your annual wages: "))
5   tax_credits = 1700
6
7   cutoft = 36800
8
9   def  income_tax(wages, tax credits,cutoff):
10      print("Welcome to my income tax calculator")
11      if wages < cutoff:
12          print("You pay no income tax")
13      else:
14          print("You will have to pay income tax")
15          income_tax = cutoff*0.2 + (wages - cutoff) * 0.4
16          income_tax_net = income_tax-tax_credits
17          print ("your income tax bill is: €", round (income_tax_net, 2))
18          print("The percentage you lost to tax was: ", round(income_tax_
            net /wages* 100,2), "%")
19  income_tax (wages, tax_credits,cutoff)
```
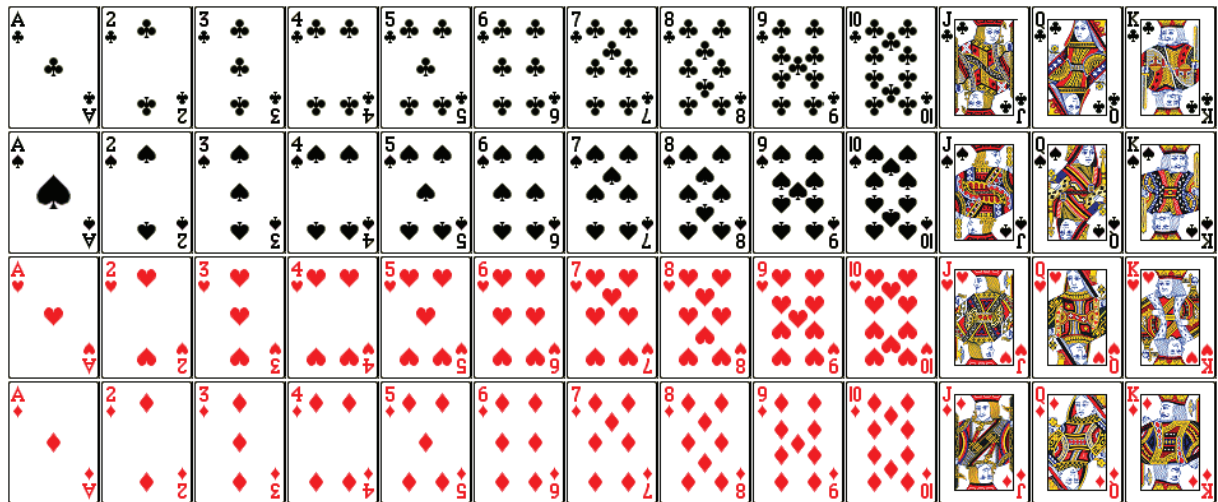
Save and close your file before moving on to the next part.

**(b)**   **44 Marks**

Computer programs can also be used to create simple games. One such simple game is called "High-Card Draw". The player draws a random card from a standard deck of 52 playing cards. The computer also draws a random card from a standard deck of 52 playing cards. A standard 52-card deck can be seen below:

The player's draw and the computer's draw are compared in the following manner: Whoever drew the higher face value (1, 2, 3, 4, 5, 6, 7, 8 9, 10, J, Q, K) wins. If the face-values are the same, then the suits (spades ♠, hearts ♥, diamonds ♦ and clubs ♣) are used to determine the winner in the following manner:

♠   Highest Rank

♥

♦

♣   Lowest Rank
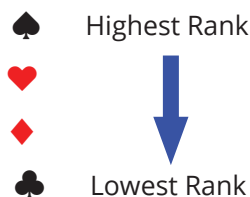
Open the program called Question16_B.py from your device.
Enter your name on line 2.

```
# Question 16(b)
# Enter your name here:


import random

faces = ["1","2","3","4","5","6","7","8","9","10", "11","12","13"]

suits = ["C", "D", "H","S"]

player_face = faces[random.randint (0,12)]
player_suit = suits[random.randint(0,3)]

computer_face = faces [random.randint(0,12)]
computer_suit = suits[random.randint(0,3)]
```

The above program contains two lists, each list is a collection of strings:

> **A list called "**`faces`**" that contains the face values of all the cards in a 52-card deck. Note that A has been replaced by 1, J has been replaced by 11, Q has been replaced by 12 and K has been replaced by 13.**
>
> **It also contains a list called "**`suits`**" that contains the 4 suits of a 52-card deck: "C" for Clubs, "D" for Diamonds, "H" for Hearts and "S" for Spades.**

The program will extract a random face and suit from those lists twice each: one for the player and one for the computer.

Modify the program to do the following:

> **(i)** **Create two new variables: one called "**`player_draw`**". This will be the concatenation of "**`player_face`**" and "**`player_suit`**". The other variable will be called "**`computer_draw`**" and will be the concatenation of "**`computer_face`**" and "**`computer_suit`**". Print these variables to the screen. When the program is run, it may look as follows:**

```
Your draw was:  4S
The computer draw was:  8D
```

> **In this run of the program above, the player drew 4 of Spades and the computer drew 8 of Diamonds.** (8 marks)
>
> (**4 marks** for first correct variable, **4 marks** for second correct variable)

> **(ii)** **Modify the program to include a betting system. Create a new variable called "bet" that will represent an integer value from the user. The user should be prompted to enter the bet after the user draw has been made but before the computer draw.**
>
> **When the program is run, it may look as follows:** (9 marks)
>
> (**5 marks** for integer input, **4 marks** for variable)

```
Your draw was:  3H
Please enter your bet: 6
The computer draw was:  8C
```

> **(iii)** **Using** `int()` **or otherwise, convert the "**`player_face`**" string variable to an integer and store it in a variable called "**`player_face_num`**". Do the same for the "**`computer_face`**" variable and call the new variable "**`computer_face_num`**".** (8 marks)
>
> (4 marks for first variable, 4 marks for the second)

(iv) **Using the "`player_face_num`" and "`computer_face_num`" variables, create a game where the program will check if the player wins, computer wins or if the game ends in a draw based on the card face, they drew. If the player wins, it should multiply their bet by 3 and return how much they won.**   (10 marks)
(6 marks for IF-ELIF-ELSE, 4 marks for betting system)

```
Your draw was:  4H
Please enter your bet: 6
The computer draw was:  6C
You lose!
```

```
Your draw was:  8C
Please enter your bet: 6
The computer draw was:  3C
Well done
You win: € 18
```

```
Your draw was:  2C
Please enter your bet: 6
The computer draw was:  2S
Draw
```

(v) **Currently the game can end in a draw if both the player and computer draw the same face. However, in the real game of high card draw, suits are used to act as a tiebreaker in such scenarios. Modify the program so that the suits will be checked after the faces to determine a winner or if it is indeed a draw. Use the suit ranking image at the start of the question for the ranks. The betting system should be used as before. Hint: A Nested-IF-ELIF-ELSE statement may be useful.**

When the program is run, it may look as follows:
(5 marks for nested IF-ELIF – ELSE, 3 marks for betting system)   (9 marks)

```
Your draw was:  6H
Please enter your bet: 6
The computer draw was:  6H
Draw
Draw
```

```
Your draw was:  4H
Please enter your bet: 6
The computer draw was:  4D
Well done
You win: € 18
```

```
Your draw was:  4C
Please enter your bet: 6
The computer draw was:  4H
You lose
```

SOLUTION:

```python
# Question 16(b)
# Write your name here:
import random
faces = ["1","2","3","4","5","6","7","8","9","10", "11","12","13"]
suits = ["C", "D", "H","S"]
player_face = faces (random.randint(0,12)]
player_suit = suits[random.randint(0,3)]
player_draw = player_face+player_suit
print("Your draw was: ",player_draw)
bet = int(input("Please enter your bet: "))
computer_face = faces [random.randint(0,12)]
computer_suit = suits[random.randint(0,3)]
computer_draw = computer_face+computer_suit
print("The computer draw was: ", computer_draw)
player_face_num = int(player_face)
computer_face_num = int(computer_face)

if player_face_num > computer_face_num:
    print("Well done")
    print("You win: €", bet*3)
elif player_face_num < computer_face_num:
    print("You lose!")
else:
    if player_suit == "C" and computer_suit != "C":
        print("You lose")
    elif player_suit == "S" and computer_suit != "S":
        print("Well done")
        print("You win: €", bet*3)
    elif player_suit == computer_suit:
        print("Draw")
    elif player_suit == "D" and computer_suit == "H":
        print("You lose")
    elif player_suit == "H" and computer_suit == "C":
        print("Well done")
        print("You win: €", bet*3)
    elif player_suit == "H" and computer_suit == "D":
        print("Well done")
        print("You win: €", bet*3)
```

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

Ordinary Level

Section A - Short Answer Questions   **45 MARKS**

Answer any 9 of the 12 questions, 5 marks per question

Q1.   **Two types of primary memory are RAM and ROM.**

(i)   **Give one difference between RAM and ROM:** RAM is temporary that stores information on the files you are working on currently. ROM is permanent memory that stores instructions for your computer.   (3 marks)
Accept any valid answer. Must give a comparison of the two types of memory to award marks.

(ii)   **Give an example of a device that could be used as Secondary Memory in a computer.**
Solid State Drives (SSDs), USBs, CDs etc   (2 marks for any 1 valid answer)
                                                                                        5 MARKS

Q2.   **Program tracing is an important aspect of coding; it allows the programmer/ user to track the values of variables throughout the code. A piece of Python code is shown below. Examine the code and answer the questions that follow.**

```
1   x = 5
2   y = 4
3   y = x - 2
4   x = y + 3
5   print("The value of x is: ",x)
6   print("The value of y is: ",y)
```

(i)   **What will the final value of the variable x be when the code is run?**
6

(ii)   **What will the final value of the variable y be when the code is run?**
3

3 marks for the first correct answer
2 marks for the second correct answer
Allow for: "The value of x is: 6"
"The value of y is: 3"   **5 MARKS**

Q3. The decimal (or Base 10) number system is the number system most used by humans today. Computers use another number system such as the binary number system (Base 2).

(i) **Convert the following binary number to its decimal equivalent. Please show all your workings**

$$10110010_2$$

178_{10}

(ii) **Convert the following decimal number to its binary equivalent.**

$$99_{10}$$

1100011_2

Award **3 marks** for first correct answer and **2 marks** for second correct answer.
Award **2 marks** for first attempt with a slip. Award **1 mark** for second attempt with a slip.
Subscripts not needed for full marks.   **5 MARKS**

Q4. **Sorting and Searching are two key algorithm types in Computer Science. Perform a Simple Sort on the data array below starting with the smallest number. An empty array has been provided. Indicate at each step of the algorithm which number you have selected as the new minimum from the original array**

Original array:

3	5	1	2	4

New minimum: 1

1				

New minimum: 2

1	2			

New minimum:

1	2	3		

New minimum:

1	2	3	4	

New minimum:

1	2	3	4	5

Award **1 mark** per correct row   **5 MARKS**

Q5. **Binary Digits (commonly known as "Bits") can have a value of either 1 or 0. Answer the questions below:**

   (i) **How many bits are in a byte?** (2 marks)

   8

   (ii) **Which is a bigger file, a 1 Megabyte file or a 1 Gigabyte file?** (2 marks)

   Gigabyte

   (iii) **There are 1000 metres in 1 kilometre and 1000 grams in a kilogram. Why are there 1024 bytes in a kilobyte and not 1000 kilobytes?** (1 mark)

   1000 is not divisible by 8, 1024 is the nearest number above 1000 that is divisible by 8. The memory must be divisible by 8 – as there are 8 bits in a byte. Or any valid description

5 MARKS

Q6.
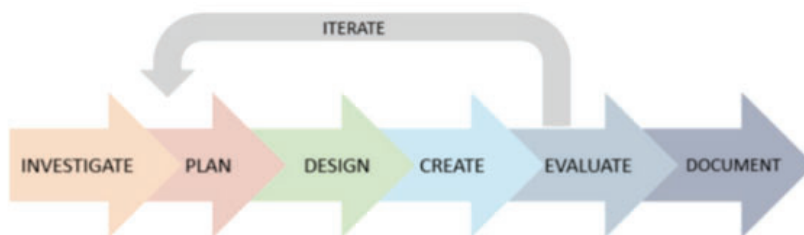
The diagram above identifies some of the main stages of a software development design process. Describe briefly what happens at the following stages of the design process:

   (i) **Create stage**

   Different modules or designs will be integrated together to create the artefact, or any valid explanation.

   (ii) **Evaluate stage**

   The artefact will be reviewed by the software developer(s). It will be reflected upon and ideas for additions or improvements will be suggested, or any valid explanation.

   3 marks for the first correct answer
   2 marks for the second correct answer   **5 MARKS**

Q7. **Turtle graphics are ways of creating simple pictures in a Python program. Give it the command `turtle.forward(50)`, and it moves 50 pixels in the direction it is facing, drawing a line as it moves. The turtle starts facing to the right (→).**
   Give it the command `turtle.left(90)`, and it rotates in-place 90 degrees to the left. Code and the resulting shape for a square is shown below:

```
import turtle
turtle.forward (50)
turtle.left (90)
turtle.forward (50)
turtle.left (90)
turtle.forward (50)
turtle.left (90)
turtle.forward (50)
turtle.left (90)
```
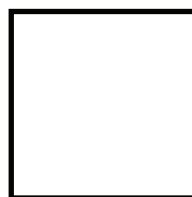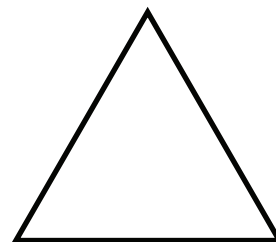
Match the following blocks of code with the correct shape made. (3 marks)

Code A

```
import turtle
turtle.forward (100)
turtle.left (72)
turtle.forward (100)
turtle.left (72)
turtle.forward (100)
turtle.left (72)
turtle.forward (100)
turtle.left (72)
```
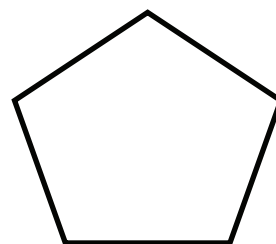
Triangle

Code B

```
import turtle
turtle.forward (100)
turtle.left (90)
turtle.forward (50)
turtle.left (90)
turtle.forward (100)
turtle.left (90)
turtle.forward (50)
turtle.left (90)
```

Pentagon

Code C

```
import turtle
turtle.forward (100)
turtle.left (120)
turtle.forward (100)
turtle.left (120)
turtle.forward (100)
turtle.left (120)
```

Rectangle

Code	Shape
A	Pentagon
B	Rectangle
C	Triangle

2 marks for first correct answer, **2 marks** for second correct answer, **1 mark** for final correct answer

5 MARKS

Q8. The image below shows a man in a self-driving car. Self-driving cars are example of machine learning and artificial intelligence.

(a) **Suggest one issue with the technology associated with self-driving cars presently.**

(3 marks)

Sensors not being "good" enough to detect/ discern objects in front of the car
Sensors not being able to "see" far enough down the road
Any valid answer

(b) **Identify two other examples of machine learning and artificial intelligence and briefly explain how they are involved in improving society.**

(2 marks) – 1 mark per correct response

Students must provide a valid explanation to be awarded marks

5 MARKS

Q9. The American Standard Code for Information Interchange (ASCII) was a common method of encoding used in the sending and receiving of messages. It was invented in 1981 and could encode 127 different characters using the Binary number system. The ASCII standard character table is shown below.

ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol
0	0	NUL	16	10	DLE	32	20	(space)	48	30	0
1	1	SOH	17	11	DC1	33	21	!	49	31	1
2	2	STX	18	12	DC2	34	22	"	50	32	2
3	3	ETX	19	13	DC3	35	23	#	51	33	3
4	4	EOT	20	14	DC4	36	24	$	52	34	4
5	5	ENQ	21	15	NAK	37	25	%	53	35	5
6	6	ACK	22	16	SYN	38	26	&	54	36	6
7	7	BEL	23	17	ETB	39	27	'	55	37	7
8	8	BS	24	18	CAN	40	28	(	56	38	8
9	9	TAB	25	19	EM	41	29	)	57	39	9
10	A	LF	26	1A	SUB	42	2A	*	58	3A	:
11	B	VT	27	1B	ESC	43	2B	+	59	3B	;
12	C	FF	28	1C	FS	44	2C	,	60	3C	<
13	D	CR	29	1D	GS	45	2D	-	61	3D	=
14	E	SO	30	1E	RS	46	2E	.	62	3E	>
15	F	SI	31	1F	US	47	2F	/	63	3F	?

ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol
64	40	@	80	50	P	96	60	`	112	70	p
65	41	A	81	51	Q	97	61	a	113	71	q
66	42	B	82	52	R	98	62	b	114	72	r
67	43	C	83	53	S	99	63	c	115	73	s
68	44	D	84	54	T	100	64	d	116	74	t
69	45	E	85	55	U	101	65	e	117	75	u
70	46	F	86	56	V	102	66	f	118	76	v
71	47	G	87	57	W	103	67	g	119	77	w
72	48	H	88	58	X	104	68	h	120	78	x
73	49	I	89	59	Y	105	69	i	121	79	y
74	4A	J	90	5A	Z	106	6A	j	122	7A	z
75	4B	K	91	5B	[	107	6B	k	123	7B	{
76	4C	L	92	5C	\	108	6C	l	124	7C		
77	4D	M	93	5D	]	109	6D	m	125	7D	}
78	4E	N	94	5E	^	110	6E	n	126	7E	~
79	4F	O	95	5F	_	111	6F	o	127	7F	

(a)   **Suggest one limitation of the ASCII system when sending information internationally in 1981.** (3 marks)

Only the English-language character set was encoded for in the ASCII system and was only used in certain countries.

(b)   **What character encoding format was developed to overcome the limitation you identified in part (a)? Explain how this newer method of character encoding overcame this limitation.** (2 marks)
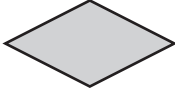
The development of UNICODE allowed for an increased character set and was universally adopted.
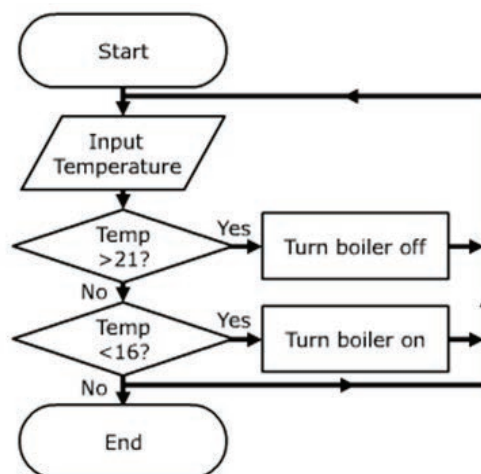
5 MARKS

Q10. **Flowcharts can be useful when showing the functionality of a piece of hardware or software. For example, when using a microcontroller (such as a BBC Micro: Bit, Raspberry Pi or Arduino) you can use a flowchart to describe how it can be used to build a home heating system.**
Using the flowchart symbols below, sketch a flowchart that will describe the following home heating system:

•   **The temperature is detected by the thermometer of the Embedded System**

•   **If the temperature is greater than 21 degrees Celsius, turn off the boiler**

•   **If the temperature is less than 16 degrees Celsius, turn on the boiler**

•   **This process should keep on going forever.**

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

Award **5 marks** for: Start, End, 2 Decisions, 1 input, 2 processes and the loop arrows

Award **4 marks** for missing 1 item

Award **3 marks** for missing 2 items

Award **2 marks** for missing 3 items

Award **1 mark** for missing 4 items

Award **0 marks** for 5 or more missing items   **5 MARKS**

Q11. **Computing technologies (both hardware and software) need to be produced for people with a disability. Examine the image below and answer the questions that follow.**

(a)   **Identify one way in which the above keyboard is adapted for people with a disability.**

(2 marks)

The font is bigger
Or
The keys are bigger
Or
The colours are inverted on the keys
This helps people with reduced eyesight

(b)   **Voice-controlled person assistants such as Apple's Siri or Google's Google Assistant are common on handheld devices. Suggest one way in which this software could be used to help someone with special needs use the device.**   (3 marks)

Any valid answer

5 MARKS

Q12. **The image below shows a person playing a computer game. The computer game uses both the Random-Access Memory (RAM) and the Read-Only Memory (ROM) of the computer.**

(a) **While the user is playing the computer game, is the game using Random-Access Memory or Read-Only Memory to display the graphics and generate the sound? Give a reason for your answer.**

Random-Access Memory. RAM is used for what the computer is doing now. Or explained correctly.

(b) **When the user saves the game before turning the computer off, is the user using Random-Access Memory or Read-Only Memory to save the game?**
Give a reason for your answer.

Read-Only Memory. ROM is used for permanently saving a game or a file on the computer. Or explained correctly.

3 marks for first correct answer
2 marks for second correct answer
Explanation must be correct to award marks, do not award marks for just RAM and ROM alone.

5 MARKS

Section B - Long Questions	78 Marks

Students answer any 2 of the 3 questions.

Q13.   39 (7, 20, 12) MARKS

(a)   Minesweeper is a game where mines are hidden in a grid of squares. Safe squares have numbers telling you how many mines touch the square.

Minesweeper is a popular game that you can use computational thinking to solve.

The rules of minesweeper are as follows:

•   A square with a number cannot contain a mine
•   Each number describes the number of mines touching that square (with either a side or a corner touching). These mines can touch vertically, horizontally or diagonally
•   No square contains more than one mine

An example of a completed Minesweeper problem would be:

1	2	
1		2
1	1	1

1	2	Mine
1	Mine	2
1	1	1

Find exactly five mines in the grid below.

0		3	M
		M	M
2	M	4	
	M		

7 marks for correct answer
5 marks for 4 correct mines
3 marks for 3 correct mines
2 mark for 2 correct mines
1 mark for 2 correct mines

7 marks

(b)   **The river-crossing problem is a famous computational thinking problem.**
Imagine you are a farmer and you have bought three items in a market: a wolf, a cabbage
and a sheep.
On your way home, you must cross a river using a boat.
The issue is that the boat can only carry you plus one item you bought at a time.
You cannot leave the sheep and the wolf alone together as the wolf will eat the sheep.
You cannot leave the sheep and the cabbage alone as the sheep will eat the cabbage.

Write down the steps you must take in order to successfully bring all three items across
the river intact.
Bring sheep across first
Then go back
Bring wolf across
Bring sheep back with you
Bring cabbage across
Go back for sheep
Bring sheep across

20 marks for correct answer. **10 marks** for half correct answer. **5 marks** for a logical attempt,
3 marks for the beginnings of attempt or a sketch of arrows.

20 marks

(c)   **There are four aspects of computational thinking: Pattern Recognition, Algorithms,**
Abstraction and Decomposition. In your opinion which one of the four aspects of
computational thinking would be most suited to solve the river-crossing problem?
Algorithms: Following a set of instructions to solve a problem in a finite number of steps.
Award marks for any response with valid explanation

12 marks

Q14.   **39 (19, 20) MARKS**

(a)   Numerical analysis can be used to summarise a large collection of data. Match each type
of numerical analysis with the description of it by filling in the table below. The first one
has been completed for you.

Type of numerical analysis	Description
Mean	D
Median	**A**
Mode	**B**
Range	**C**

Description
A: The middle value of a sorted dataset
B: The value or values that occurs most frequently in a dataset
C: The largest value minus the smallest value
D: The average of a dataset
6 marks for first correct answer
6 marks for second correct answer
6 marks for third correct answer
1 marks for final correct answer

19 marks

(b)   Data visualisation is an important aspect of data analysis. It allows for quick and easy
interpretation of data collected. There are several different types of graphs that can be
generated using code to display data as shown in the image below:
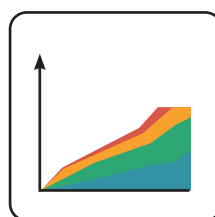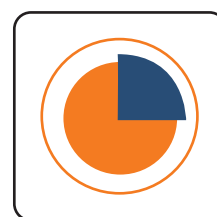

Bar Chart   Histogram   Scatter Plot   Area Plot   Pie Chart

Using the data examples given below, match that example with an appropriate type of
graph. You can only use each type of graph once in your answer.

Data example	Type of graph
Exam results of a student	**Bar chart OR Histogram**
Temperature recorded over several hours	**Scatter plot**
Monthly expenditure of a household budget	**Pie chart**
The ages of a group of people	**Histogram OR Bar chart**

Each type of chart can only be used once.
5 marks for the first correct answer
5 marks for the second correct answer
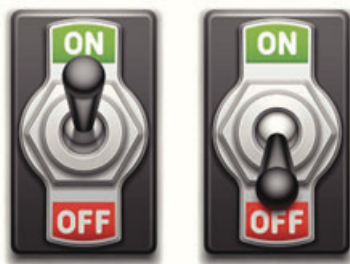**5 marks** for the third correct answer
5 marks for the last correct answer

20 marks

Q15.　　　　　　　　　　　　　　　　　　　**39 (8, 12, 19) MARKS**

(a)　The basis of the binary system in early computers was physical switches that were either ON or OFF.

Combinations of these switches were used to program these early computers.
Give two reasons why it is important that data storage and transmission uses the binary system in computers.
No possibility of interference
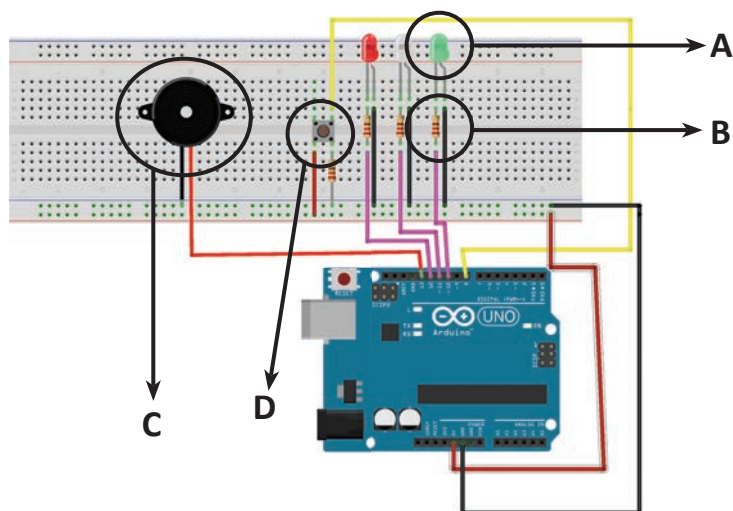The presence or absence of voltage can be described using ON/ OFF in transistors
Or any valid answer
4 marks for the first correct answer
4 marks for the second correct answer　　　　　　　　　　　　　　　　**8 marks**

(b)　The diagram below shows an Arduino Embedded System connected to various electronic components. Examine the diagram and answer the questions that follow.

(i)　**Identify the component labeled "A"**
An LED.　　　　　　　　　　　　　　　　　　　　　　　　　　　　　(3 marks)

(ii)　**Identify the component labeled "B"**
A Resistor.　　　　　　　　　　　　　　　　　　　　　　　　　　　(3 marks)

(iii)　**Component "C" is a buzzer. Is this an example of an analogue output or digital output? Explain your answer**
Analogue. It has variable voltage which gives a variable output (or explained).
1 mark for correct answer. 2 marks for correct description.　　　　　　　(3 marks)

(iii)　**Component "D" is a button. Is this an example of digital input or analogue input? Explain your answer**
Digital. It is either ON or OFF. (or explained).
1 mark for correct answer. 2 marks for correct description.　　　　　　　(3 marks)
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　12 marks

(c)   Important building blocks of computers and electronic circuitry are Logic Gates. There are three main types of Logic Gates: AND Gates, OR Gates and NOT Gates.
The AND and OR Gates have two inputs (A and B) and one output (C). The NOT Gate has one input and one output. The output of each gate depends on the input(s) given.

19 marks

(i)   Complete the Truth Tables for each type of gate given below.

AND Gate Truth Table

A	B	C
0	0	**0**
0	1	**0**
1	0	**0**
1	1	**1**

OR Gate Truth Table

A	B	C
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**1**

NOT Gate Truth Table
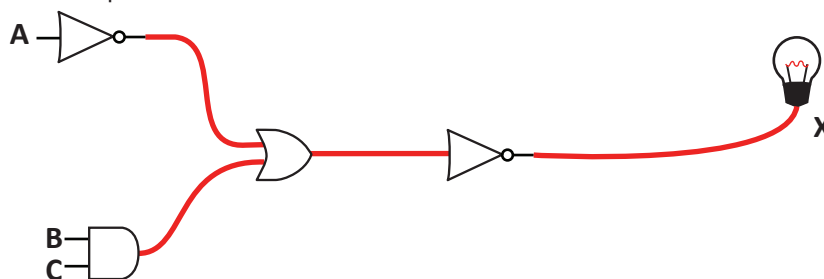
A	C
1	**0**
0	**1**

1 mark per correct answer   (10 marks)

(ii)   The diagram below shows some logic gates connected. The three initial inputs are A, B and C. The final output is X.

Given the following combinations of inputs, give the outputs of X.

A	B	C	X
1	0	0	
1	1	1	

5 marks for first correct answer
4 marks for second correct answer   (9 marks)

Section C - Programming   **87 Marks**

Students answer all question parts.

Q16 **Note:** solution provided is not exhaustive - award marks for pythonic solution for (a), and
(b)   **87 (44, 43) Marks**

(a)   Computer programs can be used to make simple tools. One such tool is a calculator.
Open the program called Question16_A.py from your device.
Enter your name in the space provided on line 2.
The program asks the user if they wish to add or subtract. If the user enters "a" then the
program will add the numbers and if "s" is entered by the user, it will subtract the first
number from the second. It prints the results of the calculations to the screen.   **44 Marks**

```
#Question 16(a)
#Write your name here:
option = input("Would you like to (a)dd or (s)ubtract?")
num1 = int(input("Please enter your first number: "))
num2 = int(input("Please enter your second number: "))
if option == "a":
    print (num1 + num2)
if option == "s":
    print (num1 - num2)
```

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

```
Would you like to (a)dd or (s)ubtract? a
Please enter your first number: 12
Please enter your second number: 7
19
```

```
Would you like to (a)dd or (s)ubtract? s
Please enter your first number: 12
Please enter your second number: 7
5
```

Modify the program to do the following:
(i)   **Increase the number of operations the calculator can perform by including a**
multiplication and division option.
When the program is run the output may now look as follows: (15 marks)
8 marks for new IF-ELSE branches + 4 marks for multiplication operator and 3 marks for
division operation

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? m
Please enter your first number: 12
Please enter your second number: 7
84
```

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? d
Please enter your first number: 12
Please enter your second number: 7
1.7142857142857142
```

(ii)   **At present, the program can only take in integers. Modify the program so the user**
will be able to enter floating-point numbers.
When the program is run the output may now look as follows: (10 marks)

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? m
Please enter your first number: 5.5
Please enter your second number: 6.2
34.1
```

(iii) **The outputs are not very informative as the program is written currently. Modify the program so that the outputs will be more informative as shown below:** (12 marks)
3 marks per correct format, allow for * symbol in place of "x" for multiplication

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? a
Please enter your first number: 5.5
Please enter your second number: 6.1
5.5 + 6.1 = 11.6
```

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? s
Please enter your first number: 5.5
Please enter your second number: 6.1
5.5 - 6.1 = -0.5999999999999996
```

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? m
Please enter your first number: 5.5
Please enter your second number: 6.1
5.5 x 6.1 = 33.55
```

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? d
Please enter your first number: 5.5
Please enter your second number: 6.1
5.5 / 6.1 = 0.9016393442622951
```

(iv) **In the above output, some of the decimal places are quite long and unnecessary. Modify the code so that all answers will be rounded to 2 decimal places. When the program is run the output may now look as follows:** (7 marks)
3 marks for first correct rounding, 2 marks for second, 1 mark for third rounding and 1 mark for last correct rounding.

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? s
Please enter your first number: 5.5
Please enter your second number: 6.1
5.5 - 6.1 = -0.6
```

```
Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide? d
Please enter your first number: 5.5
Please enter your second number: 6.1
5.5 / 6.1 = 0.9
```

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

SOLUTION:

```
#Question 16(a)
#Write your name here:
option = input("Would you like to (a)dd, (s)ubtract, (m)ultiply or (d)ivide?")
num1 = int(input("Please enter your first number: "))
num2 = int(input("Please enter your second number: "))
if option == "a":
    print (num1, " + " num2, "=" round (num1 + num2, 2))
if option == "s":
    print (num1, " - " num2, "=" round (num1 - num2, 2))
if option == "m":
    print (num1, " x " num2, "=" round (num1 * num2, 2))
if option == "d":
    print (num1, " / " num2, "=" round (num1 / num2, 2))
```

(b)   **43 Marks**

Computer programs can also be used to make games. In this program, the user will play a simple word-guessing game with the computer.

Open the program called Question16_B.py from your device.
Enter your name in the space provided on Line 2.
The program contains a list of words. The program will extract a random word from the list and store it in a variable called "random_word".

```
#Question 16(b)
#Write your name here:
import random
words = ["cat", "mat", "can", "man", "pool","tool", "mule","pat","tan", "rule"]
print("The list of words is: ", words)
random_word = words (random.randint(0,len(words)-1)]
```

Modify the program to do the following:

(i)   **Print the length of the variable random_word.**
         When the program is run the output may now look as follows: (8 marks)
         4 marks for length and **4 marks** for formatting

```
The length of the word is: 3
```

(ii)   **Print the first character in the random_word variable.**   (11 marks)
         When the program is run the output may now look as follows:
         6 marks for first character and **5 marks** for formatting

```
The length of the word is: 3
The first letter in the word is: C
```

(iii) **Allow the user to make a guess at what the word is. This should be stored in an appropriately labelled variable.**
         When the program is run the output may now look as follows: (9 marks)
         5 marks for input, **4 marks** for meaningful variable

```
The length of the word is: 3
The first letter in the word is: C
Please guess what the word is:
```

(iv) **If the user guesses correctly, display an appropriate message. If the user guesses incorrectly, display an appropriate message and allow the user to make 2 more guesses at the word. If the user guesses correctly at any point, an appropriate message should be displayed. If the user does not guess the correct word after 3 guesses, an appropriate message should be displayed and the user should be told what the word was. Hint: a loop may be useful**

When the program is run, it may look as follows: (15 marks)
5 marks for IF statement, 5 **marks** for ELSE statement, **1 mark** for correct guess formatting, **2 marks** for incorrect guess formatting, **2 marks** for correct use of loops

```
The list of words is: ['cat', 'mat', 'can', 'man', 'pool', 'tool', 'mule', 'pat',
'tan', 'rule']
The length of the word is: 4
The first letter in the word is: p
Please guess what the word is: mat
You guessed incorrectly, try again
Please guess what the word is: pat
You guessed incorrectly, try again
Please guess what the word is: man
You guessed incorrectly, try again
The word was: pool
```

```
The list of words is: ['cat', 'mat', 'can', 'man', 'pool', 'tool', 'mule', 'pat',
'tan', 'rule']
The length of the word is: 3
The first letter in the word is: m
Please guess what the word is: man
You guessed incorrectly, try again
Please guess what the word is: mat
Well done!
The word was: mat
```

```
The list of words is: ['cat', 'mat', 'can', 'man', 'pool', 'tool', 'mule', 'pat',
'tan', 'rule']
The length of the word is: 4
The first letter in the word is: t
Please guess what the word is: tool
Well done!
The word was: tool
```

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

SOLUTION:

```
1    #Question 16(b)
2    #Write your name here:
3    import random
4    words = ["cat", "mat", "can", "man", "pool","tool", "mule","pat","tan", "rule"]
5    print("The list of words is: ", words)
6    random_word = words (random.randint(0,len(words)-1]
7    print("The length of the word is: ", len(random_word))
8    print("The first letter in the word is: ", random_word[0])
9    for times in range(3):
10       guess = input ("Please guess what the word is: ")
11       if guess == random_word:
12           print("Well done!")
13           break
14       else:
15           print("You guessed incorrectly, try again")
16       print("The word was: ", random_word)
```

Examcraft Group

Examcraft

89F Lagan Road,
Dublin Industrial Estate,
Dublin 11

T: 01 808 1494

F: 01 836 2739

E: info@examcraft.ie

W: www.examcraft.ie