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## Pre-Leaving Certificate Examination, 2023

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# Computer Science

## Marking Scheme

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## Ordinary Level

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Marking schemes for Ordinary and Higher Level exam papers are provided in separate booklets.

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**Pre-Leaving Certificate Examination, 2023**

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## **Computer Science**

### **Ordinary Level**

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#### **Ordinary Level**

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**Pre-Leaving Certificate Examination, 2023**

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## **Computer Science**

### **Ordinary Level**

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### **Explanation**

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#### **Conventions Used**

1. A **dash** – before an answer indicates that the answer is a separate answer, which may be considered as independent of any other suggested answers to the question.
2. A **single forward slash** / before an answer indicates that the answer is synonymous with that which preceded it. Answers separated by a forward slash cannot therefore be taken as different answers.
3. A **double forward slash** // is used to indicate where multiple answers are given but not all are required.
4. **Round brackets** ( ) indicate material which is not considered to be essential in order to gain full marks.
5. ‘etc.’ is used in this marking scheme to indicate that other answers may be acceptable.  
In all other cases, only the answer given or ‘words to that effect’ may be awarded marks.
6. Marks for diagrams are shown as follows (e.g. 5m, 3m, 0m), where 5m indicates the highest possible and 0m the lowest.
7. Answers which are given in this marking scheme should not be considered as the only possible answers that may be accepted. Answers which are synonymous with or equivalent to those in this marking scheme are also acceptable.

#### **Current Marking Scheme**

Assumptions about these marking schemes on the basis of past SEC marking schemes should be avoided. While the underlying assessment principles remain the same, the exact details of the marking of a particular type of question may vary from a similar question asked by the SEC in previous years in accordance with the contribution of that question to the overall examination in the current year. In setting these marking schemes, we have strived to determine how best to ensure the fair and accurate assessment of students’ work and to ensure consistency in the standard of assessment from year to year. Therefore, aspects of the structure, detail and application of the marking schemes for these examinations are subject to change from past SEC marking schemes and from one year to the next without notice.

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Pre-Leaving Certificate Examination, 2023

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## Computer Science

**Ordinary Level  
Marking Scheme (185 marks)**

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**Section A**

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**(45 marks)**

Answer any nine questions.

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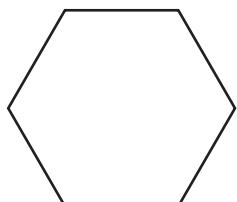
**Question 1**

---

**(5)**

Draw the output of the following piece of Python code. **(5m, 3m, 0m)**

<b>1</b>	import turtle
<b>2</b>	poly=turtle.Turtle()
<b>3</b>	for i in range(6):
<b>4</b>	poly.forward(90)
<b>5</b>	poly.right(60)
<b>6</b>	turtle.done()



\*\* Award 3m for some work of merit.

**Question 2****(5)**

Explain the difference between the World Wide Web and the Internet. **(5m)**

**①    World Wide Web**

Possible points

- a collection of websites. Each website is a collection of web pages. Websites and the pages they are made up of are identified and can be accessed via URLs. Websites are hosted on computers called web servers. These web servers are connected to the internet

**②    Internet**

Possible points

- the connections between networks and devices around the world. Devices are able to communicate with each other through these connections
- the connections between networks. The world wide web is the content that can be accessed on the internet, *etc.*

\*\*    Accept other appropriate answers.

5 marks	**    Very good explanation - clear understanding demonstrated.
3 marks	**    Good explanation - clear information, lacking full understanding.
1 mark	**    Fair explanation - limited understanding.

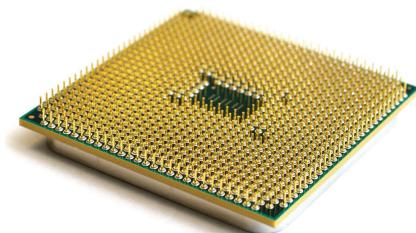
**Question 3**

**(5)**

Identify each of the following computer components. **(2m + 2m + 1m)**



**Component A**



**Component B**



**Component C**

- |             |   |            |
|-------------|---|------------|
| Component A | – | RAM        |
| Component B | – | CPU        |
| Component C | – | hard drive |

**Question 4****(5)**

Write out all the steps in performing a linear search on the following list.  
You are searching for the word “dog”. **(5m)**

Cat	Mouse	Bird	Dog	Killer whale
-----	-------	------	-----	--------------

- Cat ≠ Dog, continue
- Mouse ≠ Dog, continue
- Bird ≠ Dog, continue
- Dog = Dog, stop

5 marks	** Correct answer.
3 marks	** Very good attempt - clear understanding demonstrated.
1 mark	** Fair attempt - limited understanding demonstrated.

**Question 5****(5)**

Give **two** advantages and **one** disadvantage of star topology in computer networks. **(2m + 2m + 1m)**

**①    Advantages**

Any 2:

- easy to manage and maintain the network because each node requires a separate cable //
- easy to locate problems because cable failure only affects a single user //
- easy to extend the network without disturbing the entire network //
- due to hub device, network control and management is much easier // etc.

**②    Disadvantages**

Any 1:

- entire performance of the network depends on the single hub device //
- if the hub device goes down, the entire network will be dead //
- star topology requires more wires compared to ring and bus topologies // etc.

\*\* Accept other appropriate answers.

**Question 6****(5)**

Recent reports suggest that the current shortage of semiconductor chips is to continue until 2024.

Suggest **two** reasons for the current worldwide shortage of semiconductor chips.

- Any 2: **(3m + 2m)**
- distribution chain disruption due to Covid / war //
  - increased demand for GPUs for crypto mining //
  - increased demand for CPUs for smart cars and devices // etc.
- \*\* Accept other appropriate answers.

**Question 7****(5)**

Explain, using an example, how ethical hacking can be of benefit to society. **(5m)**

Possible points

- testing social media systems to ensure accounts are not taken over //
  - testing conferencing software to ensure cameras / chat rooms cannot be taken over / compromised //
  - keeping systems secure, e.g. onboard electronic systems on cars //
  - securing data by identifying potential security issues in a system // etc.
- \*\* Accept other appropriate answers.

5 marks	** Correct answer.
3 marks	** Very good explanation - clear understanding demonstrated.
1 mark	** Fair explanation - limited understanding demonstrated.

**Question 8****(5)**

Describe a simple algorithm for making a slice of toast. **(5m)**

Possible algorithm

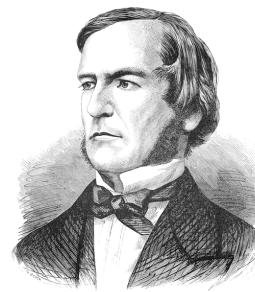
- get bread from cupboard / bread bin
- place toaster on kitchen counter
- put bread in toaster
- set time / temperature on toaster
- turn on toaster
- when toast pops up, remove from toaster
- add butter, etc.

\*\* Accept other appropriate answers.

5 marks	** Correct answer.
3 marks	** Very good algorithm - clear understanding demonstrated.
1 mark	** Fair algorithm - limited understanding demonstrated.

**Question 9****(5)**

Some important people in the field of computer science are named below.

**Satoshi Nakamoto****Ada Lovelace****Alan Turing****George Boole**

Match each person with their accomplishment in the field of computer science by writing their name in the correct space in the table below. **(2m + 1m + 1m + 1m)**

Accomplishment	Person
Invented a system of logic that was used to help develop circuits.	– George Boole
Published the first algorithm intended to be carried out by a machine.	– Ada Lovelace
A pioneer in the development of the blockchain.	– Satoshi Nakamoto
Developed the idea for a test to declare if a computer could pass as a human.	– Alan Turing

**Question 10****(5)**

Describe the difference between alpha testing and beta testing. **(5m)**

**①    Alpha testing**

- a type of acceptance testing; it is performed to identify all possible issues and bugs before releasing the final product to the end users. Alpha testing is carried out by testers who are internal employees of the organisation, *etc.*

**②    Beta testing**

- performed by “real users” of the software application in a “real environment”. It is the final test before shipping a product to the customers. Direct feedback from customers is a major advantage of beta testing. This testing helps to test products in the customer’s environment, *etc.*

\*\* Accept other appropriate answers.

5 marks	**    Correct answer.
3 marks	**    Very good description - clear understanding demonstrated.
1 mark	**    Fair description - limited understanding demonstrated.

**Question 11****(5)**

Outline **three** best practices to follow when creating a secure / strong password.

**Any 3: (2m + 2m + 1m)**

- mix numbers and letters //
- use non-alpha numeric characters //
- use unusual words //
- use at least 8 characters //
- never use common information in a password // *etc.*

\*\* Accept other appropriate answers.

**Question 12****(5)**

Give **one** point in favour of and **one** point against the use of free speech on social media platforms.  
**(3m + 2m)**

**① In favour**Possible points

- free speech is for all - everyone has a voice
  - allows you to anonymously voice an opinion, *etc.*
- \*\* Accept other appropriate answers.

**② Against**Possible points

- people feel they can say anything without considering the consequences
  - rise of misinformation / no fact-checking of information
  - some social media platforms may censor content / opinions / groups
  - posting opinions online could lead to trolling / cyberbullying, *etc.*
- \*\* Accept other appropriate answers.

**Section B****(60)**

Answer any two questions.

**Question 13****(30)**

- (a)** Circle all of the following Boolean expressions that are **true**.

(5)

All correct **(5m)**

**12 > 4 AND 5==5**

**12 >= 4 OR 10!=5**

**NOT(11==3)**

**7 >= 3 AND 91>99**

\*\* Award 2m for 2 correct answers.

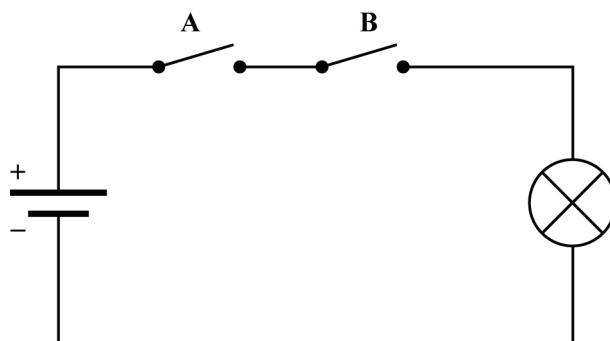
- (b)** Draw a simple circuit diagram, using the components shown below, to demonstrate how an OR logic gate works. **(10m)**

(10)



\*\* Award 8m if parallel circuits shown, but no switches.

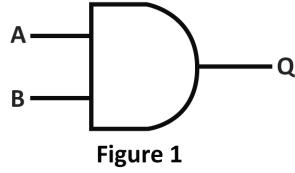
\*\* Award 3m for any correct circuit including a switch.



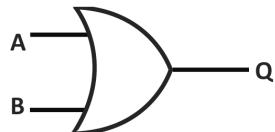
Switch A - Open = '0', Closed = '1'  
 Switch B - Open = '0', Closed = '1'  
 Lamp - On = '1', Off = '0'

**Question 13 (cont'd.)**

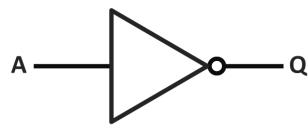
- (c) Match each of the logic gates shown in **Figures 1, 2** and **3** with the correct truth table. (10)

**Figure 1****Truth Table A**

A	Q
0	1
1	0

**Figure 2****Truth Table B**

A	B	Q
0	0	0
1	0	0
0	1	0
1	1	1

**Figure 3****Truth Table C**

A	B	Q
0	0	0
1	0	1
0	1	1
1	1	1

All correct (10m)

- (i) The logic gate in **Figure 1** matches with truth table

\_\_\_\_\_ B \_\_\_\_\_

- (ii) The logic gate in **Figure 2** matches with truth table

\_\_\_\_\_ C \_\_\_\_\_

- (iii) The logic gate in **Figure 3** matches with truth table

\_\_\_\_\_ A \_\_\_\_\_

\*\* Award 5m for any 1 correct.

**Question 13 (cont'd.)**

(d) (i) Identify the electronic component shown in **Figure 4.** (2m) (5)

— transistor

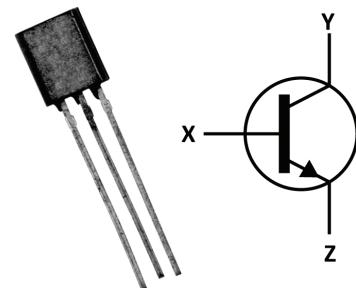
\*\* Accept 'semiconductor'.

(ii) Name the parts labelled **X**, **Y** and **Z**. (3 × 1m)

X — base

Y — collector

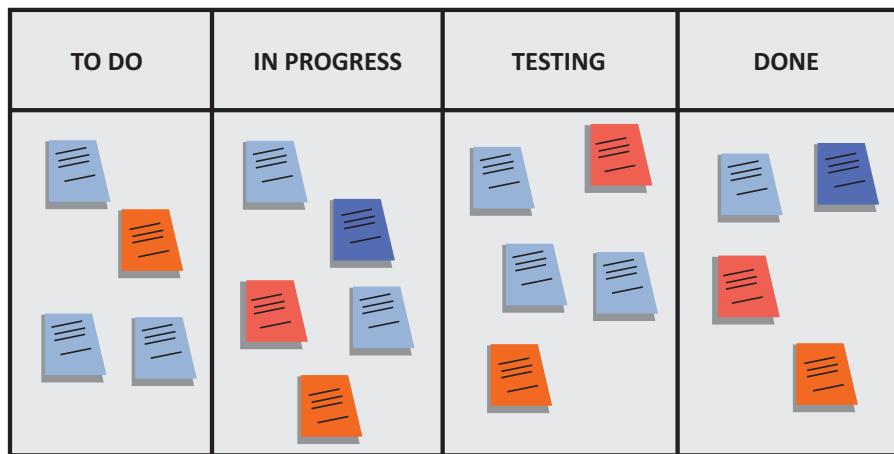
Z — emitter



**Figure 4**

**Question 14****(30)**

Kanban is a popular framework used to implement an agile approach to software development.



- (a)** Outline **two** advantages and **two** disadvantages of an agile approach to software development. (8)

**①** Advantages

Any 2: (2 × 2m)

Possible points

- the customers are satisfied because after every Sprint working feature of the software is delivered to them //
- if the customers have any feedback or want any change in the feature then it can be accommodated in the current release of the product //
- in agile methodology daily interactions are required between the business people and the developers //
- in this methodology attention is paid to the good design of the product //
- changes in the requirements are accepted even in the later stages of the development //
- an agile approach can improve organisational synergy by breaking down organisational barriers and developing a spirit of trust and partnership around organisational goals // etc.

**②** Disadvantages

Any 2: (2 × 2m)

Possible points

- in agile methodology the documentation is limited or, more often, developed ‘just-in-time’ //
- sometimes, in agile methodology the requirement is not very clear, hence it is difficult to predict the expected result //
- in some projects at the start of the software development life cycle it’s difficult to estimate the actual effort required //
- because of the ever-evolving features, there is always a risk of the ever-lasting project //
- for complex projects, the resource requirements and effort are difficult to estimate //
- can be hard for new team members to get up to speed // etc.

\*\* Accept other appropriate answers and material.

**Question 14 (cont'd.)**

- (b)** Describe **three** types of adaptive technology you have come across in your studies.  
Outline how each type you have described has enhanced the user experience.

(12)

Any 3: (3 × 4m)

- large-print books //
- keyboard modifications //
- predictive text / word prediction software //
- computers with voice output //
- touch screens //
- ergonomic mice / keyboards //
- braille embossers //
- light signaller alerts //
- text-to-speech synthesisers //
- onscreen keyboards //
- magnification applications //
- adjustable tables // *etc.*

\*\* Accept other appropriate answers and material.

4 marks	** Valid example and good outline of how it enhanced user experience.
2 marks	** Valid example and fair outline of how it enhanced user experience
1 mark	** Valid example and poor, or no, outline.

- (c) (i)** Explain the concept of user-centered design (UCD). (5m)

(10)

- (user-centered design) is an iterative process in which designers focus on the user and their needs in each phase of the design process, *etc.*

\*\* Accept other appropriate material.

5 marks	** Good explanation of the concept of user-centered design.
3 marks	** Fair explanation of the concept of user-centered design.
1 mark	** Poor explanation of the concept of user-centered design.

- (ii)** Explain why **Figure 5** is an example of bad user-centered design. (5m)

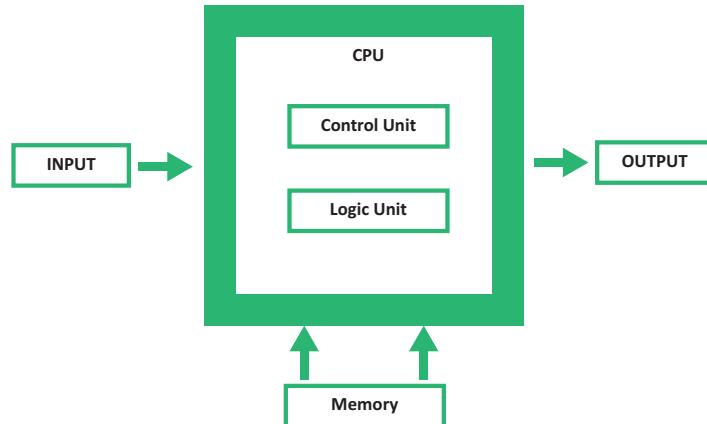
- the sign on the door says ‘pull’, but there is no handle, *etc.*

\*\* Accept other appropriate material.

**Figure 5**

**Question 15****(30)**

John von Neumann conceived a fundamental idea that serves all modern computers – that a computer's program and the data that it processes do not have to be fed into the computer while it is working but can be kept in the computer's memory. This idea is generally referred to as the *stored-program computer*.



**(a)** Explain the role of each of the following in a computer: (5)

**(i)** Arithmetic logic unit (ALU). (2m)

- a component that performs arithmetic and logical calculations, *etc.*
- \*\* Accept other appropriate material.

**(ii)** Bus. (3m)

- the wires through which data travels from one part of the CPU to another or from one part of the motherboard to another, *etc.*
- \*\* Award 1m if only wires are mentioned.
- \*\* Accept other appropriate material.

**Question 15 (cont'd.)**

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- (b) The logic gates in the CPU use binary numbers to perform calculations. (5)  
Convert the denary number  $267_{10}$  to a binary number. (5m)

– 100001011

\*\* Award 3m for attempt to use powers of 2 or to divide by 2.

- (c) Hexadecimal (or hex) is a base 16 system used to simplify how binary is represented.  
A hex digit can be any of the following 16 digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. (10)

- (i) Convert the binary number  $100110011110_2$  to a hexadecimal number. (5m)

– 99E

\*\* Award 3m for splitting into nibbles or finding the denary number.

\*\* Award 1m for any attempt to use 16 or a power of 6.

- (ii) Give **two** uses for hexadecimal numbers in computing.

Any 2: (3m + 2m)

- colour references //
- assembly language programs //
- error messages //
- cryptocurrency addresses // etc.

\*\* Accept other appropriate answers.

**Question 15 (cont'd.)**

---

(d) (i) The use of memory is key to the efficiency of a computer system. (10)

Give **one** advantage and **one** disadvantage of using a solid-state drive (SSD) over a hard disk drive (HDD). (**3m + 2m**)

\*\* Expect 1 advantage and 1 disadvantage for full marks.

**①** Advantage

- Any 1:  
– faster //  
– more robust //  
– safe from magnetic damage // etc.

**②** Disadvantage

- Any 1:  
– expensive //  
– smaller capacity //  
– data degrades quicker // etc.

\*\* Accept other appropriate answers.

(ii) Data centres may account for 30% of Ireland's electricity use by 2030.

Suggest **two** reasons why data centres require large amounts of energy to run.

Any 2: (**3m + 2m**)

- servers require energy to keep running 24 hours a day, all year round //  
– data centres need to be kept cool to prevent servers from overheating // etc.

\*\* Accept other appropriate answers.

Answer all question parts.

**Question 16****(80)**

**(a) Possible solution**

<pre> <b>1</b> # Question 16(a) <b>2</b> # Name and School: <b>3</b> <b>4</b> flight_num=input("Enter your flight number:   ") <b>5</b> destination=input("Enter your destination:   ") <b>6</b> num_ppl=int(input("Enter the number of people in the travel group:   ")) <b>7</b> child=int(input("Enter the number of children in the travel group:   ")) <b>8</b> print("Your flight number is",flight_num,"\\nYou are travelling to",destination,"\\nThere are 7 people flying.") <b>9</b> print("The total cost of your flight is:\\u20ac",num_ppl*520) <b>10</b> <b>11</b> if flight_num=="EI121"or flight_num=="ei121": <b>12</b>     print("The total cost of your flight is:\\u20ac",num_ppl*520-(50*child)) <b>13</b> else: <b>14</b>     print("The total cost of your flight is:\\u20ac",num_ppl*400-(50*child)) <b>15</b> </pre>	# (i)&(ii) # (i)&(ii) # (i)&(ii) # (iv) # (ii) # (iii) # (i) # (iv)&(v) # (iv)& # (vi) # (iv) # (iv) & # (vii)
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**Question 16 (cont'd.)**

- (a) Open the program called **Question16\_A.py** from your device.  
The source code is shown and described briefly below.

Before making any changes, you should save your working copy of the file using the format **StudentNameQuestion16\_A.py**. For example, you would save the file as **PatMurphyQuestion16\_A.py** if your name was Pat Murphy.

Enter your Name and School in the space provided on **line 2** in your Python file.

```

1 # Question 16(a)
2 # Name and School:
3
4 flight_num = "EI121"
5 destination = "Orlando"
6 num_ppl = 7

```

The program above is for a booking system for an airline. The aim of the program is to confirm flight details and cost for a group travelling to Orlando. The user will choose a flight and confirm the destination and the number of people (including children) travelling in the group. The program will output a message confirming the flight details and cost for the travel group.

Make the following changes to the program:

- (i) Amend the program to allow the variables **flight\_num** and **destination** to accept any string and to allow the variable **num\_ppl** to accept an integer value. (5m) (5)

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

```

Enter your flight number: EI121
Enter your destination: Orlando
Enter the number of people in the travel group: 7

```

5 marks	** Correct response. Correct implementation using solution above or similar.
3 marks	** Some use of input.
1 mark	** Any valid attempt.

**Question 16 (cont'd.)**

(a) (cont'd.)

- (ii) Amend the program so that it prints the values of the three variables in part (i).

When the program is run the output may now look as follows: **(10m)**

(10)

```
Enter your flight number: EI121
Enter your destination: Orlando
Enter the number of people in the travel group: 7
Your flight number is EI121
You are travelling to Orlando
There are 7 people in the travel group
```

10 marks	** Correct response. Correct implementation using solution above or similar.
8 marks	** Evidence of use of special characters.
5 marks	** Uses print more than once but gets it right.
3 marks	** Any valid attempt.

- (iii) The price of a return flight to Orlando is €520. Adjust the code so it calculates the total cost of the flights. (Hint: use the unicode \u20ac to create a euro symbol.)

When the program is run the output may now look as follows: **(15m)**

(15)

```
Enter your flight number: EI121
Enter your destination: Orlando
Enter the number of people in the travel group: 7
Your flight number is EI121
You are travelling to Orlando
There are 7 people in the travel group
The total cost of your flights is €3640
```

15 marks	** Correct response. Correct implementation using solution above or similar.
10 marks	** Correct formula and output but no euro symbol.
8 marks	** Some attempt to create formula.
5 marks	** Any valid attempt.

**Question 16 (cont'd.)**

(a) (cont'd.)

- (iv) The airline offers a second flight, EI125, to Orlando. This flight is cheaper, at €400, but involves a stopover, making the journey longer. Adjust the code so that when you enter either flight number it will calculate the correct fare for your group.

When the program is run the output may now look as follows: **(10m)**

(10)

```
Enter your flight number: EI125
Enter your destination: Orlando
Enter the number of people in the travel group: 7
Your flight number is EI125
You are travelling to Orlando
There are 7 people in the travel group
The total cost of your flights is €2800
```

10 marks	** Correct response. Correct implementation using solution above or similar.
8 marks	** Some evidence of use of conditional.
5 marks	** Some attempt to use blunt force inputs, etc.
3 marks	** Any valid attempt.

- (v) Some people will mistakenly use lowercase ‘ei’ instead of uppercase ‘EI’ when entering their flight number. Adjust the code to cope with this possible error.

When the program is run the output may now look as follows: **(5m)**

(5)

```
Enter your flight number: ei121
Enter your destination: Orlando
Enter the number of people in the travel group: 7
Your flight number is ei121
You are travelling to Orlando
There are 7 people in the travel group
The total cost of your flights is €3640
```

5 marks	** Correct response. Correct implementation using solution above or similar.
3 marks	** Some change made.
1 mark	** Any valid attempt.

**Question 16 (cont'd.)**

(a) (cont'd.)

- (vi) The airline offers a discount of €50 per child on flights to Orlando.

There are 3 children travelling in the group of 7. Adjust the code to allow you to enter the number of children and output the price based on these details.

When the program is run the output may now look as follows: **(15m)**

(15)

```
Enter your flight number: EI121
Enter your destination: Orlando
Enter the number of people in the travel group: 7
Enter the number of children in the travel group: 3
Your flight number is EI121
You are travelling to Orlando
There are 7 people in the travel group
The total cost of your flights is €3490
```

15 marks	** Correct response. Correct implementation using solution above or similar.
10 marks	** Evidence of formula to adjust the price.
8 marks	** Combines both inputs into one print.
5 marks	** Adds new input.
3 marks	** Any valid attempt.

Save your file using the format **StudentNameQuestion16\_A.py**. For example, you would save the file as **PatMurphyQuestion16\_A.py** if your name was Pat Murphy.

**Question 16 (cont'd.)**

(b) Possible solution

```
1 # Question 16 (b)
2 # Name and School:
3
4 count=0
5 direct=[]
6 indirect=[]
7 while count!=5:
8     flight_number=int(input("Please enter a flight number: EI"))
9     if flight_number%2==0:
10         direct.append(flight_number)
11     elif flight_number%5==0:
12         indirect.append(flight_number)
13     count+=1
14 for i in direct:
15     print("EI",i,"is a direct flight")
16 for j in indirect:
17     print("EI",j,"is an indirect flight")
18
```

**Question 16 (cont'd.)**

- (b) Open the program called **Question16\_B.py** from your device. (20)

<b>1</b>	# Question 16 (b)
<b>2</b>	# Name and School:
<b>3</b>	
<b>4</b>	flight_number =

Before making any changes, you should save your working copy of the file using the format **StudentNameQuestion16\_B.py**. For example, you would save the file as **PatMurphyQuestion16\_B.py** if your name was Pat Murphy.

Enter your Name and School in the space provided on **line 2** in your Python file.

You can fly direct (non-stop) or indirect (with a stopover) to Orlando.

Flights that end with the number 2 fly direct.

Flights that end with the number 5 fly indirect.

The flight numbers are: 122, 125, 132, 135, 155.

Adjust the code so that when you input each of these numbers they are sorted into direct or indirect flights. **(20m)**

20 marks	** Correct response. Correct implementation using solution above or similar.
15 marks	** Uses both loops and conditionals.
8 marks	** Use of conditional or mod 2, mod 5.
5 marks	** Any attempt to create input or loop.
3 marks	** Any valid attempt.

Save your file using the format **StudentNameQuestion16\_B.py**. For example, you would save the file as **PatMurphyQuestion16\_A.py** if your name was Pat Murphy.

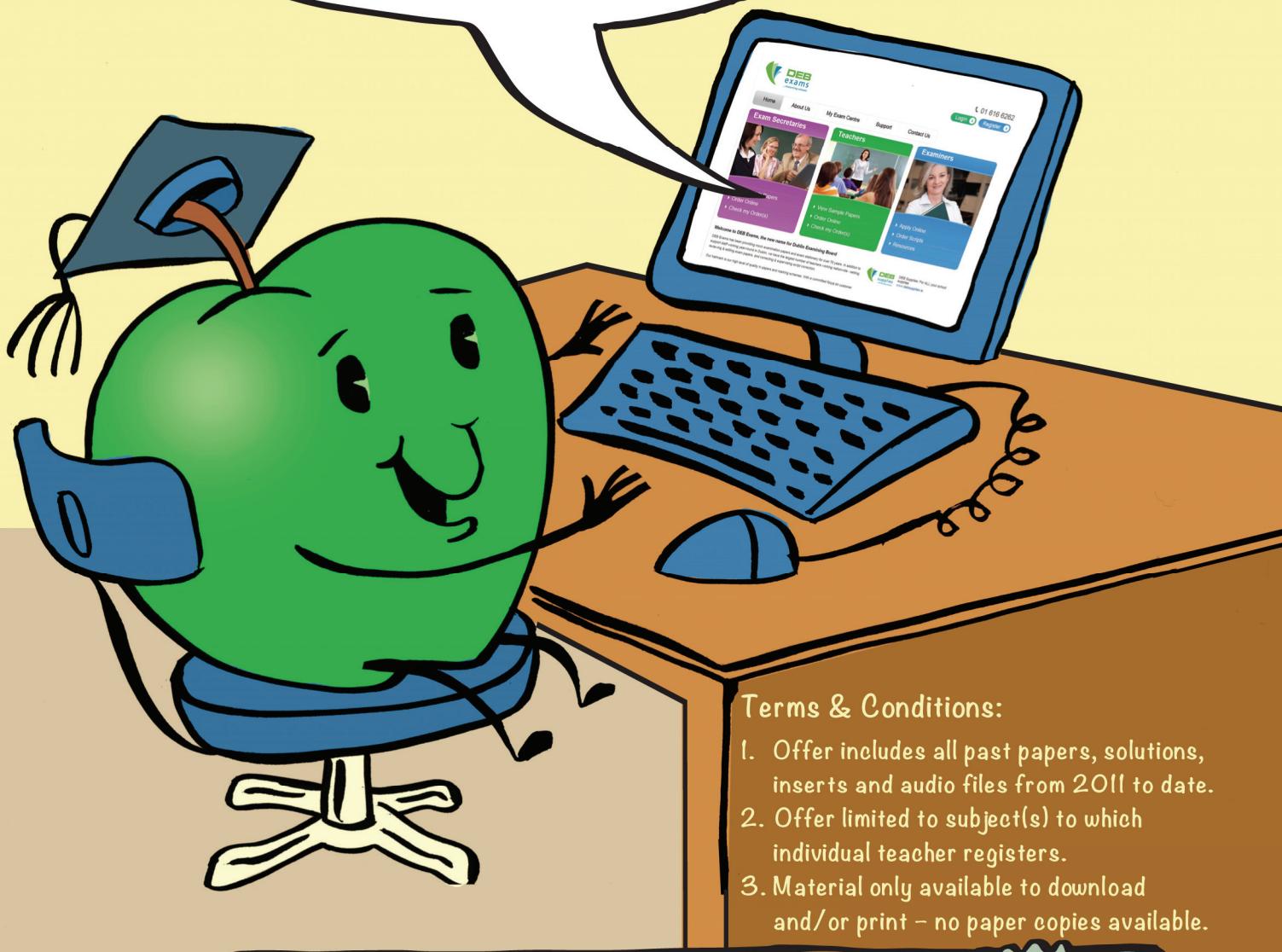
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## Pre-Leaving Certificate Examination, 2023

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# Computer Science

## Marking Scheme

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## Higher Level

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# **Computer Science**

## **Marking Scheme**

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### **Higher Level**

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Pre-Leaving Certificate Examination, 2023

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## Computer Science

### Higher Level

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**Pre-Leaving Certificate Examination, 2023**

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## **Computer Science**

### **Higher Level**

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### **Explanation**

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#### **Conventions Used**

1. A **dash** – before an answer indicates that the answer is a separate answer, which may be considered as independent of any other suggested answers to the question.
2. A **single forward slash** / before an answer indicates that the answer is synonymous with that which preceded it. Answers separated by a forward slash cannot therefore be taken as different answers.
3. A **double forward slash** // is used to indicate where multiple answers are given but not all are required.
4. **Round brackets** ( ) indicate material which is not considered to be essential in order to gain full marks.
5. ‘etc.’ is used in this marking scheme to indicate that other answers may be acceptable. In all other cases, only the answer given or ‘words to that effect’ may be awarded marks.
6. Marks for diagrams are shown as follows (e.g. 5m, 3m, 0m), where 5m indicates the highest possible and 0m the lowest.
7. Answers which are given in this marking scheme should not be considered as the only possible answers that may be accepted. Answers which are synonymous with or equivalent to those in this marking scheme are also acceptable.

#### **Current Marking Scheme**

Assumptions about these marking schemes on the basis of past SEC marking schemes should be avoided. While the underlying assessment principles remain the same, the exact details of the marking of a particular type of question may vary from a similar question asked by the SEC in previous years in accordance with the contribution of that question to the overall examination in the current year. In setting these marking schemes, we have strived to determine how best to ensure the fair and accurate assessment of students' work and to ensure consistency in the standard of assessment from year to year. Therefore, aspects of the structure, detail and application of the marking schemes for these examinations are subject to change from past SEC marking schemes and from one year to the next without notice.

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**Pre-Leaving Certificate Examination, 2023**

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## **Computer Science**

### **Higher Level Marking Scheme (185 marks)**

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**Section A**

---

**(45 marks)**

Answer any nine questions.

---

**Question 1**

---

**(5)**

What is heuristics in relation to machine learning? **(5m)**

- heuristics is used in machine learning (ML) and artificial intelligence (AI) when it is impractical to solve a particular problem with a step-by-step algorithm. Because a heuristic approach emphasises speed over accuracy, it is often combined with optimisation algorithms to improve results, *etc.*
- \*\* Accept other appropriate material.

5 marks	** Correct answer.
3 marks	** Very good explanation - clear understanding demonstrated.
1 mark	** Fair explanation - limited understanding.

---

**Question 2**

---

**(5)**

A selection of types of memory used in computing is given below.

List A	Secondary Storage → Main Memory → Cache Memory → CPU Registers
List B	CPU Registers → Cache Memory → Secondary Storage → Main Memory
List C	CPU Registers → Cache Memory → Main Memory → Secondary Storage
List D	Cache Memory → CPU Registers → Main Memory → Secondary Storage

Select the list that places the memory types in the correct order in terms of capacity, from biggest to smallest. **(5m)**

- list A

**Question 3****(5)**

The term “Turing-complete” refers to any device that can emulate a Turing machine.

Briefly explain the concept of a Turing machine. **(5m)**

- a Turing machine consists of the following components:
  - a limited set of states
  - an infinite tape with storage and read/write device
  - a definition or function, *etc.*
- \*\* Accept other appropriate material.
- \*\* Accept a well-labelled diagram.

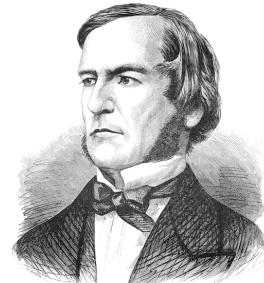


5 marks	** Very good explanation - two or more points of information given.
3 marks	** Good explanation - at least one point of information given.
1 mark	** Fair explanation - limited understanding demonstrated.

**Question 4****(5)**

Explain the importance of George Boole to computer science. **(5m)**

- proposed a concept which became known as Boolean logic. Boolean logic is a logic theory that acts as the basis of modern computers and other digital devices. It is centred around three simple words, “Or”, “And” and “Not”, known as Boolean operators, *etc.*
- \*\* Accept other appropriate material.



5 marks	** Correct answer.
3 marks	** Very good explanation - clear understanding demonstrated.
1 mark	** Fair explanation - limited understanding demonstrated.

**Question 5****(5)**

Describe doping in the context of semiconductor production. **(5m)**

- doping is the intentional introduction of impurities into an intrinsic semiconductor for the purpose of modulating its electrical, optical and structural properties. The doped material is referred to as an extrinsic semiconductor, *etc.*
- \*\* Accept other appropriate material.

5 marks	** Correct answer.
3 marks	** Very good description - clear understanding demonstrated.
1 mark	** Fair description - limited understanding demonstrated.

**Question 6****(5)**

Outline **two** potential advantages and **two** potential disadvantages of facial recognition technology.  
**(2m + 1m + 1m + 1m)**

**① Potential advantages**

- Any 2:
- helps to catch criminals //
  - helps to find missing people //
  - helps advertisers personalise on-street advertising / can improve shopping experience //
  - strengthens security measures, *e.g.* at airports //
  - reduces the number of touchpoints //
  - can help to improve medical treatment // *etc.*

\*\* Accept other appropriate answers.

**② Potential disadvantages**

- Any 2:
- privacy issues //
  - profiling issues //
  - data vulnerabilities //
  - issues with state control //
  - imperfect technology //
  - technology can be fooled // *etc.*

\*\* Accept other appropriate answers.

**Question 7****(5)**

Explain the difference between white box testing and black box testing. **(5m)**

**①** White box testing

- checks the internal functioning of the system. In this method, testing is based on coverage of code statements, branches, paths or conditions. The white box testing method assumes that the path of the logic in a unit or program is known and that the tester is familiar with how to read and interpret code

**②** Black box testing

- only considers the external behaviour of the system; a tester does not have any information about the internal workings of the software system / the internal workings of the software are not taken into account, etc.

\*\* Accept other appropriate material.

5 marks	** Correct answer.
3 marks	** Very good explanation - clear understanding demonstrated.
1 mark	** Fair explanation - limited understanding demonstrated.

**Question 8****(5)**

State **three** IT security measures that a company should implement before allowing its employees to work from home.

Any 3: **(2m + 2m + 1m)**

Possible points

- set up a virtual private network (VPN) //
- password security //
- home Wi-Fi security //
- cover webcam / camera when not in use //
- two-factor identification //
- distribute work devices to all remote workers //
- ensure software is regularly updated // etc.

\*\* Accept other appropriate answers.

**Question 9****(5)**

Explain how the modulo operator in Python allows one to develop a program to test for divisibility. **(5m)**

- modulo arithmetic divides one number into another and allows a remainder to be produced. If one number is divisible by another, the remainder is zero, *etc.*
- \*\* Accept other appropriate material.

5 marks	** Correct answer.
3 marks	** Very good explanation - clear understanding demonstrated.
1 mark	** Fair explanation - limited understanding demonstrated.

**Question 10****(5)**

Outline why a graphics processing unit (GPU) is preferred to a central processing unit (CPU) when mining cryptocurrencies. **(5m)**

- the hash rate is much higher due to the need for GPUs to digitally render graphics using complicated equations. This is perfect for the calculations necessary to mine certain popular blockchain coins, *etc.*
- \*\* Accept other appropriate material.

5 marks	** Correct answer.
3 marks	** Very good explanation - clear understanding demonstrated.
1 mark	** Fair explanation - limited understanding demonstrated.

**Question 11****(5)**

What do each of the following acronyms stand for?

**(a) ASCII. (1m)**

- American Standard Code for Information Interchange

**(b) BIOS. (1m)**

- Basic Input (/) Output System

**(c) MAR. (1m)**

- Memory Address Register

**(d) USB. (1m)**

- Universal Serial Bus

**(e) WLAN. (1m)**

- Wireless Local Area Network

**Question 12****(5)**

Explain the importance of the half-adder in logic gate circuitry. **(5m)**

- it allows for the addition of two bits and the sum and carry function can take place, *etc.*
- \*\* Accept other appropriate material.

5 marks	** Correct answer.
3 marks	** Very good explanation - clear understanding demonstrated.
1 mark	** Fair explanation - limited understanding demonstrated.

**Section B****(60)**

Answer any two questions.

**Question 13****(30)**

VPNs are fast becoming a necessary tool for streaming and browsing online.

(10)

**(a)** What do the letters VPN stand for? **(5m)**

- virtual private network
- \*\* All words correct for full marks.

**(b)** Outline **two** advantages and **two** disadvantages of VPNs. **(2m + 1m + 1m + 1m)**

**①** Advantages

Any 2:

- can bypass geo-locking to access content //
- online privacy / anonymity //
- free from censorship //
- safer torrenting //
- network scalability //
- can save money on region-based ecommerce // etc.

\*\* Accept other appropriate answers.

**②** Disadvantages

Any 2:

- illegal use //
- decreased online performance / slow connection speeds //
- VPN service uses your bandwidth //
- not 100% safe //
- extra cost //
- VPN blocking software exists //
- may have dropped connection // etc.

\*\* Accept other appropriate answers.

**Question 13 (cont'd.)**

**(b)** Complete the table below to give the name and/or function of the network protocols. (4 × 2m) (8)

Network Protocol	Function
(i) TCP	– sets rules for how devices connect to network / splits data into packets, <i>etc.</i>
(ii) IP	Responsible for directing data packets across a network.
(iii) FTP	– used to access, edit and move files on other devices, <i>etc.</i>
(iv) POP3	Used to retrieve emails from a server; once the user downloads an email, the server deletes its copy.

**(c) (i)** What is the function of a domain name server (DNS)? (3m) (6)

- a DNS translates the website's domain name into its IP address / stores domain names of websites in a directory, *etc.*
- \*\* Accept other appropriate material.

**(ii)** Why do devices need MAC addresses to connect to the internet? (3m)

- MAC addresses are used to identify a device on a network. A MAC address is the final destination of a data request, *etc.*
- \*\* Accept other appropriate material.

**Question 13 (cont'd.)**

---

- (d) Outline **two** advantages and **one** disadvantage to an organisation of connecting its servers in a full mesh network instead of a star network. (6)

**① Possible advantages of a mesh network**

- Any 2: **(2 × 2m)**
- connecting in a mesh builds in redundancy, so if there is a failure, it allows other routes to connect the servers. This means the network can still operate fully and all the computers have access to the servers //
  - if used as part of a WLAN, it can remove Wi-Fi blackspots //
  - easy to add range by connecting nodes to gateways // etc.
- \*\* Accept other appropriate answers.

**② Possible disadvantages of a mesh network**

- Any 1: **(2m)**
- some connections would always be more redundant as a mesh finds the most optimised route //
  - adding extra servers to a mesh can be more complicated because they need to be connected to all other servers // etc.
- \*\* Accept other appropriate answers.

**Question 14****(30)**

- (a)** A washing machine will be allowed to start (washStart) only if all of the following conditions are met:

- The real variable weight is greater than 2□6 and less than 8□5 kg.
- The Boolean variable doorLocked is true.

Write an algorithm that checks these conditions before allowing the washing machine to start. (You can use pseudocode or any suitable language.)



(9)

Appropriate selection statement **(3m)**

A Boolean condition that checks each of the conditions **(3m)**

Allowing the washing machine to start if conditions met **(3m)**

Possible algorithm

- check door and weight  
if weight >2.6 and <8.5 AND doorLocked==True then  
    washStart=True  
    else  
    washStart=False.
- \*\* Accept other appropriate answers and material.

- (b)** Jim has written the function rollTwo( $n$ ), which simulates the outcome of two random rolls on an  $n$ -sided dice, returning the results as a list, e.g. rollTwo(6) might return [6,2].

(6)

Jim declared a local variable inside the function.

Explain **two** reasons why it is considered good practice to use local variables when coding.

**Any 2: (2 × 3m)**

- they can only be changed and accessed from inside the declared function. Prevents accidentally affecting other parts of the program //
- a local variable is invisible outside the function, meaning you can use the same variable name more than once //
- you decrease the dependencies between your components, *i.e.* you decrease the complexity of your code //
- offers a guarantee that the values of variables will remain intact while the task is running //
- local variables are deleted as soon as any function is over and release the memory space which they occupied, *etc.*

\*\* Accept other appropriate answers.

**Question 14 (cont'd.)**

- (c) Six athletes compete in the long jump.

The best jump taken by each athlete is listed below.



5□32 m

5□50 m

5□39 m

6□50 m

6□28 m

6□14 m

Show the stages of a bubble sort algorithm to list these jumps in ascending order.

(15)

Fully correct showing at least four swaps (15m)

Any three swaps shown (10m)

Any two swaps shown (8m)

Any valid attempt (4m)

5□32m	5.50 m	5.39 m	6.50 m	6.28 m	6.14 m
5.32 m	5.39 m	5.50 m	6.50 m	6.28 m	6.14 m
5.32 m	5.39 m	5.50 m	6.50 m	6.28 m	6.14 m
5.32 m	5.39 m	5.50 m	6.28 m	6.50 m	6.14 m
5.32 m	5.39 m	5.50 m	6.28 m	6.14 m	6.50 m
5.32 m	5.39 m	5.50 m	6.28 m	6.14 m	6.50 m
5.32 m	5.39 m	5.50 m	6.28 m	6.14 m	6.50 m
5.32 m	5.39 m	5.50 m	6.28 m	6.14 m	6.50 m
5.32 m	5.39 m	5.50 m	6.14 m	6.28 m	6.50 m

**Question 15****(30)**

In cryptography, a Caesar cipher is one of the simplest and most widely known encryption techniques. It is a type of substitution cipher in which each letter in the plaintext is replaced by a letter some fixed number of positions down the alphabet

It can be represented in modulo arithmetic as:

$$D_n(x) = (x - n) \bmod 26$$

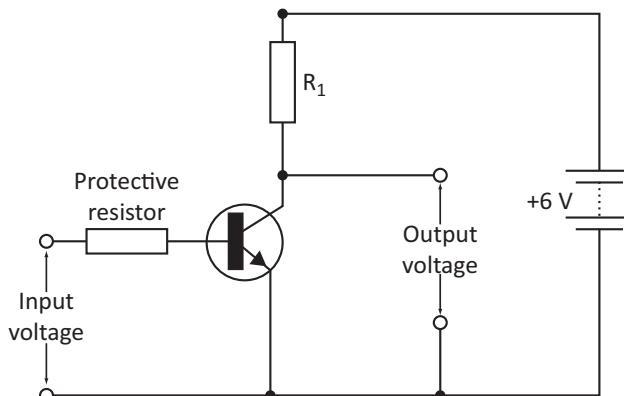
where  $x$  is the letter to be encrypted and  $n$  is a value between 0 and 25

- (a)** Decode the following message, which has been encrypted using the cipher  $n = 7$ . **(5m)** (5)

**Ulclay aybza h jvtwbaly fvb jhuuva aoyvd vba aol dpukvd**

- Never trust a computer you cannot throw out the window
- \*\* All words correct for full marks.

- (b)** A diagram of a voltage inverter circuit is shown below.



Explain how the diode in this circuit allows it to function as a primitive NOT gate.

(Hint: refer to the voltages across the diode in your answer.) **(10m)** (10)

- when the input voltage is 6 V this causes the voltage across the base of the diode to be high and the emitter of the diode has a low voltage
- when the input voltage is 0 V this causes the voltage across the base to be low and the emitter of the diode has a high voltage, etc.
- \*\* Accept other appropriate material.

10 marks	** Fully correct explanation.
8 marks	** Good explanation.
6 marks	** Fair explanation.
2 marks	** Any valid attempt.

**Question 15 (cont'd.)**

- (c) Use logic to decode the following statement and complete the truth table below.  
The first cell has been completed for you.

(10)

**Mary is not Seán's sister and Seán is not Maura's brother,  
therefore Mary is Maura's sister**

Fully correct (10m)

8 or more correct (5m)

3 or more correct (3m)

Mary is Sean's sister	Sean is Maura's brother	Mary is Maura's sister
NO	NO	NO
NO	YES	NO
YES	NO	NO
YES	YES	YES

**Question 15 (cont'd.)**

- (d) Logic is a way of taking two facts and making a third fact that is guaranteed to be true.  
 Liam and Fiona each made two statements and drew a conclusion from them as shown below.

	<b>Liam</b>	<b>Fiona</b>
<b>Statement 1</b>	"Tonight is a school night".	"I didn't stay up late last night".
<b>Statement 2</b>	"You can't stay up late on a school night".	"You can't stay up late on a school night".
<b>Conclusion</b>	"Therefore, you can't stay up late tonight".	"Therefore, last night was a school night".

Who has made an invalid conclusion, Liam or Fiona? (5m)

(5)

- Fiona

Give a reason for your answer.

- Fiona's conclusion is a logical fallacy because there are lots of reasons not to stay up late, not just on school nights. So you can't be sure about last night. Note this is still a fallacy even if it turns out that last night was a school night; Fiona's conclusion might be true, but you can't guarantee it from her statements 1 and 2, etc.

\*\* Accept other appropriate answers.

5 marks	** Correct statement identified and fully valid reason given.
3 marks	** Correct statement identified but no clear reason given.
1 mark	** Correct statement identified but no reason of any merit given.

## Section C

## Programming

(80 marks)

Answer all question parts.

## Question 16

(80)

**(a) Possible solution**

```
1 # Question 16(a)
2 # Name and School:
3
4 cardNum=72008282828210
5 #print("Welcome to CardCheck. Enter your card
6 number:",cardNum) # (i)
7 cardNum1=int(input("Welcome to CardCheck. Enter your card
8 number:")) # (iii)
9 date=int(input("Enter the card expiry date e.g. 11/26 should
10 be entered as 1126: "))
11 length=16 # (iv)
12 attempt=0 # (iv)
13 y=len(str(cardNum1)) # (iv)
14
15
16 if y==length: # (iv)
17     while (cardNum >= 10): # (ii)
18         cardNum = cardNum//10 # (ii)
19
20     if cardNum==7: # (ii)
21         print("This is a ZincCard" ) # (ii)
22     else: # (ii)
23         print("This is a WinCard" ) # (ii)
24 elif y!=length: # (iv)
25     while y!=length and attempt < 2: # (iv)
26         attempt = attempt + 1 # (iv)
27         cardNum=int(input("That is incorrect, please try
28 again:")) # (iv)
29         if len(str(cardNum)) == length: # (iv)
30             print("That is correct") # (iv)
31
32
33         while (cardNum >= 10): # (ii)
34             cardNum = cardNum//10 # (ii)
```

**Question 16 (cont'd.)**

(a) Possible solution (cont'd.)

30	<code>if cardNum==7:</code>	# (ii)
31	<code>    print("This is a ZincCard")</code>	# (ii)
32	<code>else:</code>	# (ii)
33	<code>    print("This is a WinCard")</code>	# (ii)
34	<code>    break</code>	# (iv)
35	<code>elif attempt == 2:</code>	# (iv)
36	<code>    print("Number of attempts exceeded")</code>	# (iv)
37	<code>cvv=0</code>	
38	<code>while date:</code>	
39	<code>    cvv += date % 10</code>	
40	<code>    date //= 10</code>	
41	<code>print("CVV number: ",((int(str(cardNum1)[:2]))*cvv) -</code>	
42	<code>(int(str(cardNum1)[9])))</code>	
43	<code>print("Card number:",(str(cardNum1)[:4])," -</code>	
	<code>" ,(str(cardNum1)[4:8])," - ,(str(cardNum1)[8:12])," -</code>	
	<code>" ,(str(cardNum1)[12:16])," and it is valid")</code>	

**Question 16 (cont'd.)**

- (a) Open the program called **Question16\_A.py** from your device.

Before making any changes, you should save your working copy of the file using the format **StudentNameQuestion16\_A.py**. For example, you would save the file as **PatMurphyQuestion16\_A.py** if your name was Pat Murphy.

Enter your Name and School in the space provided on **line 2** in your Python file.

Validating credit cards is an important tool for FinTech companies. Shown below are credit cards offered by two fictional companies, ZincCard and WinCard:



```

1 # Question 16 (a)
2 # Name and School:
3
4 cardNum=7200828282828210
5
6 print(cardNum)

```

Make the following changes to the program:

- (i) Amend the file so that the output reads as follows: **(5m)**

Welcome to CardCheck. Enter your card number:  
7200828282828210

5 marks	** Correct response. Correct implementation using solution above or similar.
3 marks	** Some use of print or brackets, <i>etc.</i>
1 mark	** Any valid attempt.

**Question 16 (cont'd.)**

(a) (cont'd.)

- (ii) ZincCard numbers begin with a 7 and WinCard numbers begin with an 8.  
Modify the program so that it detects whether the card number is for a ZincCard or a WinCard. (You can use 72008282828210 to validate that it is a ZincCard.)

When the program is run the output may now look as follows: **(10m)**

(10)

```
Welcome to CardCheck. Enter your card number:  
72008282828210  
This is a ZincCard
```

10 marks	** Correct response. Correct implementation using solution above or similar.
8 marks	** Evidence of use of conditionals but with syntax error or similar.
5 marks	** Some attempt to use conditional or similar.
3 marks	** Any valid attempt.

- (iii) Amend the file so that it can accept any ZincCard or WinCard number. **(5m)**

(5)

5 marks	** Correct response. Correct implementation.
3 marks	** Some use of input or int or str, etc.
1 mark	** Any valid attempt.

**Question 16 (cont'd.)**

(a) (cont'd.)

- (iv) Both credit cards use a 16-digit number. Modify the program to check that the length of the card number is correct. If it isn't, the program should prompt the user to re-enter the card number. If the user's **initial input and two other attempts** fail, the user is "blocked" and the program stops.

When the program is run the output may now look as follows: **(15m)**

(15)

```
Welcome to CardCheck. Enter your card number: 8
That is incorrect, please try again: 7
That is incorrect, please try again: 7200828282828210
That is correct
This is a ZincCard
```

15 marks	** Correct response. Correct implementation using solution above or similar.
10 marks	** Evidence of use of loops or similar with slight errors.
8 marks	** Evidence of use of loops or a counter.
5 marks	** Some attempt to use conditional or similar, <i>etc.</i>
3 marks	** Any valid attempt.

- (v) For extra security, a card verification value (CVV) 3-digit number is used in conjunction with the 16-digit number and the expiry date of the card.

To generate a unique CVV

- Add up the digits in the card expiry date, e.g.  $04/25 = 0 + 4 + 2 + 5 = 11$
- Multiply this by the first 2 digits in the card number, e.g. for ZincCard = 72
- Subtract the 10th digit of the card, e.g. for ZincCard = 2
- e.g.  $11 \times 72 - 2 = 790$

Modify the program so that it outputs the correct CVV for the relevant card number.

When the program is run the output may now look as follows: **(10m)**

(10)

```
Welcome to CardCheck. Enter your card number:
7200828282828210
Enter the card expiry date e.g. 11/26 should be entered
as 1126: 0425
This is a ZincCard
CVV number: 790
```

10 marks	** Correct response. Correct implementation using solution above or similar.
8 marks	** Evidence of use of loops and lists with slight errors.
5 marks	** Some attempt to use to use loop or create a formula.
3 marks	** Any valid attempt.

**Question 16 (cont'd.)****(a) (cont'd.)**

- (vi)** Place a single comment in your code where you have had to use any Boolean notation. **(5m)** (5)

5 marks	** Correct response. Correct implementation in any incidence where a conditional is used.
---------	---

- (vii)** Modify the program so that the output looks as follows: **(10m)** (10)

```
Welcome to CardCheck. Enter your card number:  
8549018035096133  
Enter the card expiry date e.g. 11/26 should be entered  
as 1126: 0324  
This is a WinCard  
CVV number: 760  
Card number: 8549-0180-3509-6133 and it is valid
```

10 marks	** Correct response. Correct implementation using solution above or similar.
8 marks	** Evidence of use print statement and slicing.
5 marks	** Some attempt to slice string.
3 marks	** Any valid attempt.

Save your file using the format **StudentNameQuestion16\_A.py**. For example, you would save the file as **PatMurphyQuestion16\_A.py** if your name was Pat Murphy.

**Question 16 (cont'd.)**

(b) Possible solution

```

1 # Question 16(b)
2 # Name and School:
3
4 cardNum=8549018035096133
5
6
7 cardNum2=[int(x) for x in str(cardNum)]
8 checkdigit=cardNum2.pop()
9 cardNum2.reverse()
10 processed_digits=[]
11 odd_index=[]
12 even_index=[]
13
14 count = 0
15 count2=0
16 for i in cardNum2:
17     if count % 2 == 1:
18         odd_index.append(i)
19     count += 1
20 for j in cardNum2:
21     if count2%2 == 0:
22         even_index.append(j)
23     count2 += 1
24 for k in even_index:
25     k=(k*2)
26     if k >9:
27         k=k-9
28     processed_digits.append(k)
29 Valid_num=checkdigit+sum(odd_index)+sum(processed_digits)
30 if Valid_num%2==0:
31     print(cardNum, "is a valid credit card")
32 else:
33     print(cardNum, "is not a valid credit card")
34

```

**Question 16 (cont'd.)**

- (b) Open the program called **Question16\_B.py** from your device.

Before making any changes, you should save your working copy of the file using the format **StudentNameQuestion16\_B.py**. For example, you would save the file as **PatMurphyQuestion16\_B.py** if your name was Pat Murphy.

Enter your Name and School in the space provided on **line 2** in your Python file.

The Luhn algorithm, also known as the **modulus 10** or **mod 10** algorithm, is a simple checksum formula used to validate a variety of identification numbers, such as credit card numbers.

Steps in the Luhn algorithm:

1. Remove the last digit from the card number. This number is called the checking digit and will be used at step 4.
2. Reverse the order of the remaining digits.
3. For this sequence of reversed digits, take the digits at **each of the even indices** (0, 2, 4, 6, etc.) and double them. If a result is greater than 9, subtract 9 from that number.
4. Add together all of the results and add the checking digit removed at step 1.
5. If the result is divisible by 10, the number is a valid card number. If is not, the card number is not valid.

Here is an example using WinCard number 8549018035096133:

1.	<table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>8</td><td>5</td><td>4</td><td>9</td><td>0</td><td>1</td><td>8</td><td>0</td><td>3</td><td>5</td><td>0</td><td>9</td><td>6</td><td>1</td><td>3</td><td>X</td></tr></table>	8	5	4	9	0	1	8	0	3	5	0	9	6	1	3	X																																
8	5	4	9	0	1	8	0	3	5	0	9	6	1	3	X																																		
2.	<table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>3</td><td>1</td><td>6</td><td>9</td><td>0</td><td>5</td><td>3</td><td>0</td><td>8</td><td>1</td><td>0</td><td>9</td><td>4</td><td>5</td><td>8</td><td>X</td></tr></table>	3	1	6	9	0	5	3	0	8	1	0	9	4	5	8	X																																
3	1	6	9	0	5	3	0	8	1	0	9	4	5	8	X																																		
3.	<table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>3</td><td>1</td><td>6</td><td>9</td><td>0</td><td>5</td><td>3</td><td>0</td><td>8</td><td>1</td><td>0</td><td>9</td><td>4</td><td>5</td><td>8</td><td>X</td></tr> <tr><td>↓</td><td></td><td>↓</td><td>↓</td><td>↓</td><td>↓</td><td></td><td>↓</td><td>↓</td><td>↓</td><td>↓</td><td>↓</td><td>↓</td><td>↓</td><td>↓</td><td>X</td></tr> <tr><td>6</td><td></td><td>12-9</td><td></td><td>0</td><td></td><td>6</td><td></td><td>16-9</td><td></td><td>0</td><td></td><td>8</td><td></td><td>16-9</td><td></td></tr></table>	3	1	6	9	0	5	3	0	8	1	0	9	4	5	8	X	↓		↓	↓	↓	↓		↓	↓	↓	↓	↓	↓	↓	↓	X	6		12-9		0		6		16-9		0		8		16-9	
3	1	6	9	0	5	3	0	8	1	0	9	4	5	8	X																																		
↓		↓	↓	↓	↓		↓	↓	↓	↓	↓	↓	↓	↓	X																																		
6		12-9		0		6		16-9		0		8		16-9																																			
4.	$6 + 1 + 3 + 9 + 0 + 5 + 6 + 0 + 7 + 1 + 0 + 9 + 8 + 5 + 7 + 3 = 70$																																																
5.	$70 \div 10 = 7$ so this card is valid.																																																

Write a program that validates either of the credit card numbers used in **question 16(a)**. (20m)

(20)

20 marks	** Correct response. Correct implementation using solution above or similar.
15 marks	** Uses both loops and conditionals.
8 marks	** Use of conditional or mod 2, mod 5.
5 marks	** Any attempt to create input or loop.
3 marks	** Any valid attempt.

Save your file using the format **StudentNameQuestion16\_B.py**. For example, you would save the file as **PatMurphyQuestion16\_B.py** if your name was Pat Murphy.

Notes:

Notes:

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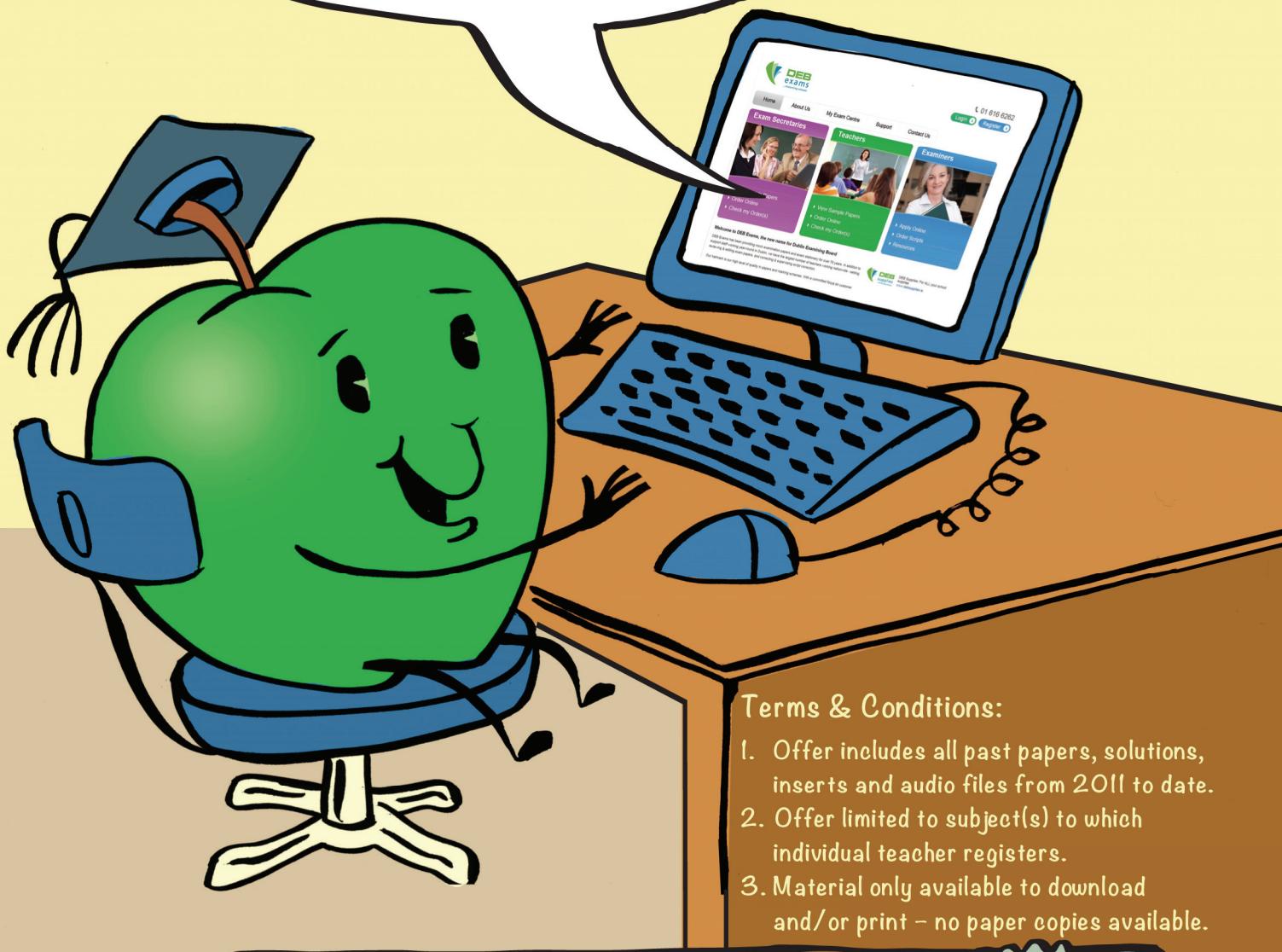
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