

APOLLO

Computer Science SL Workbook

First assessment 2027

Whole questions arranged by syllabus topic.

Original question and scheme crops preserve source diagrams.

APOLLO

A1 Computer fundamentals

1 questions

APOLLO

Shared case study

Read this source alongside the questions that refer to it.

Computer science

Case study: Preventing network security attacks

Specimen paper

Instructions for candidates

- Case study booklet required for higher level and standard level paper 1 computer science examinations.

Introduction

The integration of technology in healthcare has transformed how medical services are delivered. However, with this increased use of technology, healthcare institutions like private hospitals have become attractive targets for cybercriminals and therefore face significant security challenges that could have devastating impacts. This case study highlights the interventions used to prevent security incidents by one private hospital, TaylorMade Healthcare, and explores some network security practices.

Background

TaylorMade Healthcare uses high-speed internet to operate its network infrastructure, which includes computers, servers, switches, routers, wireless access points, and *firewalls*. These devices and systems are connected internally and to the internet, enabling staff to access medical records, communicate with other users and patients, exchange information, and transfer data. The devices and systems work cohesively and are vital for the hospital's smooth operation, including patient care, data management, and resource handling.

TaylorMade Healthcare stores vast amounts of sensitive data, such as patient health records, financial information, and confidential documents, which it must safeguard to maintain trust and confidence among its patients, staff, and stakeholders.

The hospital's director acknowledges the importance of securing the network and data against risks like *malware* infections, *phishing* attacks, and unauthorized access. The director also knows that it is critical to implement effective security measures to protect the hospital's network infrastructure and data.

Bring-your-own-device (BYOD) policy

TaylorMade Healthcare has adopted a bring-your-own-device (BYOD) policy that permits staff to use personal electronic devices for work tasks. Although a BYOD policy can provide many benefits, such as increased flexibility and convenience, it also has several weaknesses.

Ransomware and rootkit attacks

TaylorMade Healthcare recently suffered a ransomware attack that targeted its network infrastructure. The attack was launched through a phishing email that appeared to be from a trusted source. When an unsuspecting staff member clicked on the link in the email, the ransomware gained access to the hospital's network and quickly spread, encrypting sensitive data and rendering it inaccessible.

The consequences of the attack were severe, leading to significant data loss and system downtime. The ransomware attack encrypted patients' data and prevented staff from accessing patient records for several days. This led to substantial disruptions.

TaylorMade Healthcare's reputation has suffered due to the attack, with patients expressing concern about the security of their data. There was also a significant financial impact, with TaylorMade Healthcare paying the attackers a ransom to regain access to its encrypted data.

Another notable concern is a rootkit attack, which uses malicious software to hide itself within an operating system to gain administrative-level access to the network. Rootkits are notoriously difficult to remove.

Interventions

“Dealing with the ransomware attack was a wake-up call for our entire team,” said Jane Wang, Head of Cybersecurity. “We realized the importance of being proactive and creating a culture of security awareness,” she added, “and we also realized that a comprehensive security strategy is essential for protecting sensitive data and networks.”

Since the attack, TaylorMade Healthcare has identified several measures to prevent future attacks:

- Data backup and *disaster recovery plans*
- *Email filtering*
- *Failover systems*
- Firewall implementation
- Network segmentation and *access control*
- Regular software and security updates
- *Third-party services*
- *User awareness training*

Implementing network segmentation and access control reduced the risk of cyber-attacks and improved the security of TaylorMade Healthcare’s network. These and the other interventions have contributed to reducing the effects of security breaches, ensuring the confidentiality and integrity of sensitive information. These safeguards have also minimized system downtime and strengthened data protection, which is vital for the hospital’s uninterrupted functioning.

Challenges faced

TaylorMade Healthcare’s goal is to build resilience to address the following challenges.

Standard level and higher level:

- Develop strategies to create an awareness of cybersecurity, especially ransomware and rootkit attacks.
- Consider the benefits of a bring-your-own-device (BYOD) policy while preparing for its security weaknesses.

Higher level only:

- Explore the viability of network segmentation and access control.
- Develop procedures to restore operations in case of a breach.

Additional terminology

Access control
Bring your own device (BYOD)
Cybercriminal
Disaster recovery plan
Email filtering
Failover system
Firewall
Malware
Phishing
Ransomware
Rootkit attack
Third-party services
User awareness training

Some companies, products, or individuals named in this case study are fictitious and any similarities with actual entities are purely coincidental.

Section A

Answer **all** questions from this section. Answers must be written within the answer boxes provided.

1. A hospital has an IT team that repairs computer hardware and software.

- (a) (i) Identify the bus that transmits the program counter (PC) contents to the memory address register (MAR). [1]

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- (ii) Outline the function of an accumulator. [2]

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- (b) State the binary equivalent of the hexadecimal number AC. [1]

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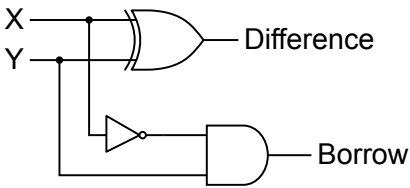
(This question continues on the following page)





(Question 1 continued)

(c) Construct a truth table for the following circuit: [2]



X	Y	Difference	Borrow

The IT team is considering replacing its laptops with ones that use flash memory instead of read-only memory (ROM) for permanent storage of the basic input/output system (BIOS).

(d) Compare and contrast the use of a read-only memory (ROM) chip with flash memory for storing the basic input/output system (BIOS). [3]

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(e) Outline the function of queues in multilevel queue scheduling. [2]

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Turn over

APOLLO

A2 Networks

2 questions

Section A

Answer **all** questions from this section. Answers must be written within the answer boxes provided.

2. A hospital has a local area network (LAN) with a router that uses a fiber-optic cable to connect directly to an internet service provider’s equipment.

(a) List **three** advantages of using a fiber-optic cable instead of a twisted-pair cable. [3]

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(b) Describe the process of packet switching. [4]

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(This question continues on the following page)





(Question 2 continued)

The hospital’s local area network (LAN) is divided into multiple smaller subnetworks, also called subnets.

(c) Explain how subnetting a local area network (LAN) can reduce network congestion. [4]

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Turn over

Section B

Answer the following question, which refers to the case study. Answers must be written within the answer boxes provided.

5. Ransomware and rootkit are types of malware that result in system downtime and data losses.

(a) Outline **one other** potential consequence of a rootkit attack on a hospital. [2]

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(b) Outline **two** ways in which a firewall protects a network system from cybersecurity attacks. [4]

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Turn over

Jane Wang, Head of Cybersecurity at TaylorMade Healthcare, highlighted the importance of being proactive and creating a culture of security awareness.

- [6]

[illegible]

Please **do not** write on this page.

Answers written on this page
will not be marked.



APOLLO

A3 Databases

1 questions

Section A

Answer **all** questions from this section. Answers must be written within the answer boxes provided.

3. A hospital stores patients’ data in a relational database.

(a) Outline **one** benefit of using a relational database. [2]

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(b) Identify **two** scalability issues in a relational database. [2]

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The database view, VISITS, is an extract showing the dates patients visited the hospital for an appointment.

The VisitDate field represents the date of each patient’s appointment.

PatID	PatientName	PatientDOB	DocID	Doctor	VisitDate	Treatment
1	Samuel Moody	2007/06/11	1	Jill Smith	2025/01/11	Bone scan
1	Samuel Moody	2007/06/11	2	Norayr Lomidze	2025/01/12	Physical therapy
2	Lin Kobayashi	1984/02/24	1	Jill Smith	2025/01/12	Physical therapy
3	Yeojoo Kim	1999/08/18	3	Phoebe Drakos	2025/01/13	Radiation therapy
3	Yeojoo Kim	1999/08/18	3	Phoebe Drakos	2025/01/14	Therapy part 1

(This question continues on the following page)



(Question 3 continued)

- (c) Construct an SQL SELECT query to list the names of patients whose treatment includes the word “therapy”.

A patient’s name should only appear once. [3]

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The database view, VISITS, can be represented by the following notation:

```
VISITS (PatID, PatientName, PatientDOB, DocID, Doctor, VisitDate, Treatment)
```

- (d) Construct the database in third normal form (3NF) for the three entities in the VISITS view extract. [5]

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Turn over

APOLLO

A4 Machine learning

1 questions

Section A

Answer **all** questions from this section. Answers must be written within the answer boxes provided.

4. A hospital uses a supervised learning algorithm for diagnosis.

- (a) Identify **two** factors that might determine the need for an increase in processing power for this supervised learning algorithm. [2]

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An article about algorithmic bias in machine learning appeared in a national newspaper. Some of the hospital’s patients became concerned about the ethics of using supervised learning for diagnosis.

- (b) Outline **one** strategy the hospital could use to address patients’ concerns. [2]

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APOLLO

B1 Computational thinking

2 questions

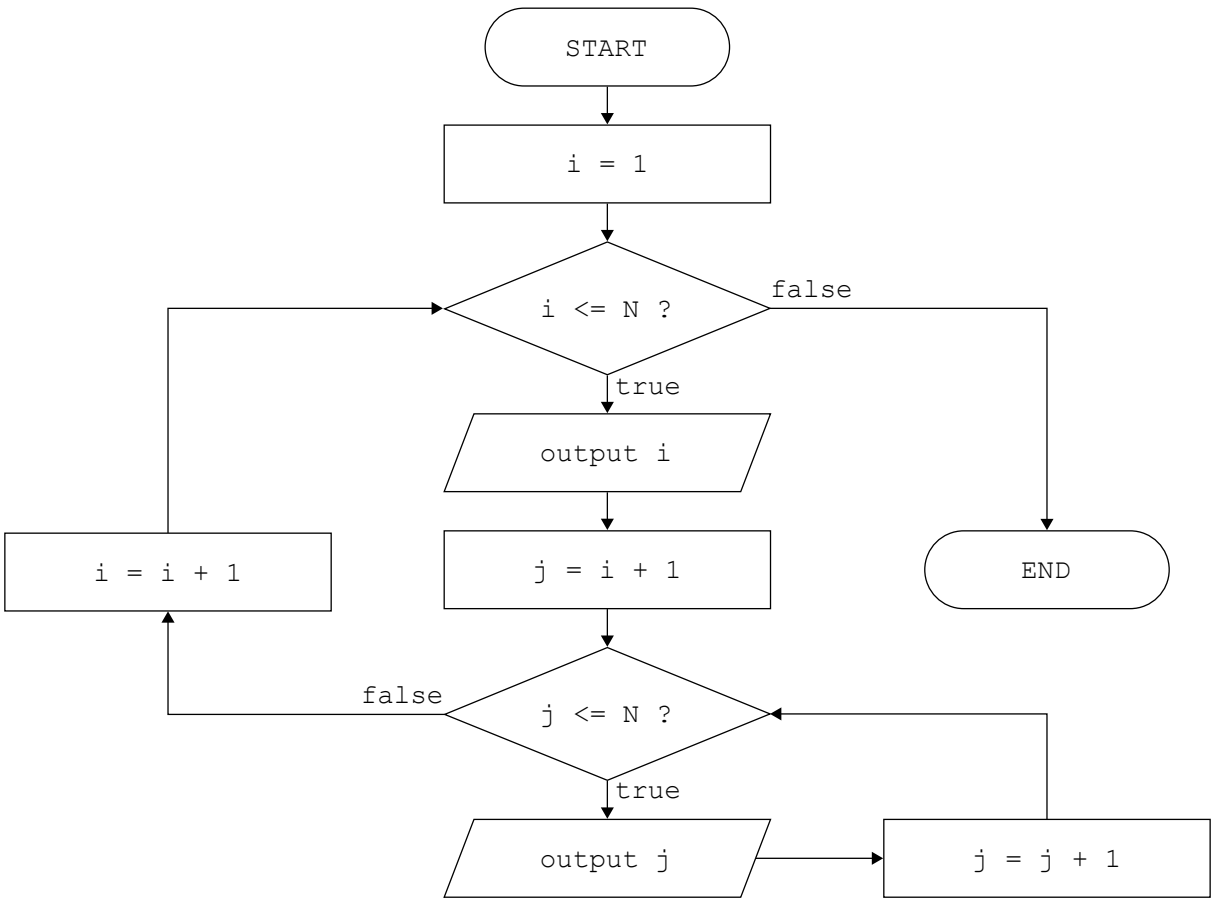
Option A — Java

Answer **all** questions. All code that forms part of your responses must be written in Java.

1. Algorithms can be represented by flowcharts.
- (a) State **one** reason why a flowchart could be used to represent an algorithm.

[1]
- Consider the flowchart shown in **Figure 1**.

Figure 1: Flowchart for an algorithm



- (b) Copy and complete the trace table formed by the processing of this flowchart, where $N = 3$.
- [3]

i	i <= N?	j	j <= N ?	output
1				

(Option A continues on the following page)

— 3 —

(Option A, question 1 continued)

Big O notation is used to indicate the time complexity of an algorithm.

(c) State the Big O notation for the algorithm shown in **Figure 1**.

[1]

The text file, employees, contains the following information about each employee in a company:

- Surname
- First name
- Role

Each item of data is stored in a new line. Details of the first three employees are shown:

Roberts
John
Sales
Saied
Abdullah
Manager
Sanchez
Pedro
IT manager
...

An algorithm reads the data from the file, employees, line by line. The algorithm writes only the surname of each employee into a new text file, surnames. Both files are currently closed.

(d) Describe the steps that would be followed by this algorithm.

[5]

(Option A continues on page 5)

Turn over



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— 3 —

(Option A, question 1 continued)

Stacks are a data structure frequently used in computer science to represent real-world scenarios.

Table 1 shows the fundamental operations that operate on a stack.

Table 1: Fundamental operations that operate on a stack

<code>push()</code>	Inserts an element onto the top of the stack.
<code>pop()</code>	Removes an element from the top of the stack.
<code>peek()</code>	Returns the top element of the stack without removing it from the stack.
<code>isEmpty()</code>	Returns true if the stack is empty, else it returns false.

(e) Sketch the stack resulting from the following operations.

```
push(1)
push(2)
push(9)
peek()
pop()
push(8)
push(10)
pop()
push(6)
```

You should clearly indicate the top of the stack.

[2]

A new stack has been created and filled with elements.

(f) Using only the stack operations shown in **Table 1**, describe the steps that will locate **and** print only the **first** element that was pushed onto the new stack.

[3]

(Option A continues on the following page)

Turn over



(Option A continued)

Option B — Python

Answer **all** questions. All code that forms part of your responses must be written in Python.

4.

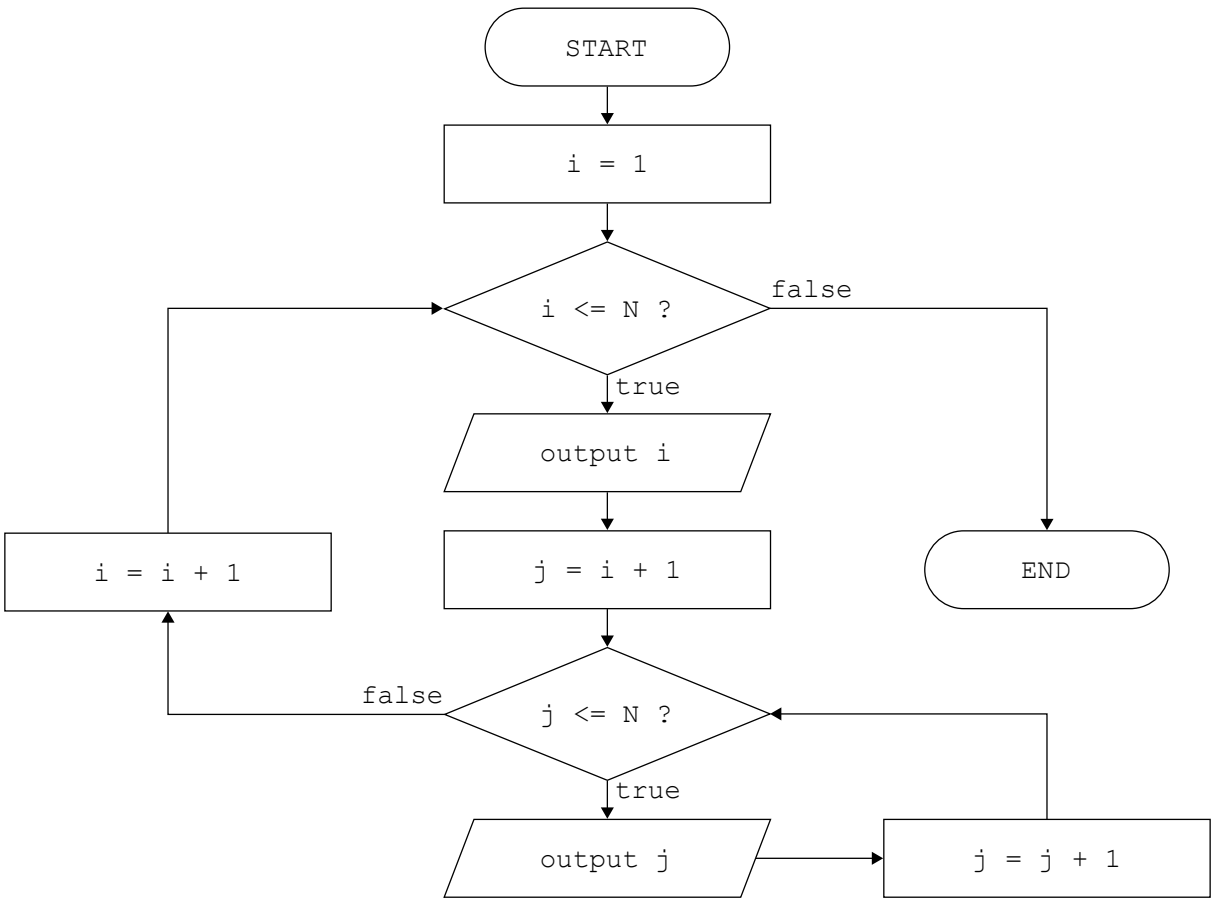
Algorithms can be represented by flowcharts.
- (a)

State **one** reason why a flowchart could be used to represent an algorithm.

[1]

Consider the flowchart shown in **Figure 2**.

Figure 2: Flowchart for an algorithm



- (b)

Copy and complete the trace table formed by the processing of this flowchart, where $N = 3$.

[3]

i	i <= N?	j	j <= N ?	output
1				

(Option B continues on the following page)

(Option B, question 4 continued)

Big O notation is used to indicate the time complexity of an algorithm.

(c) State the Big O notation for the algorithm shown in **Figure 2**.

[1]

The text file, employees, contains the following information about each employee in a company:

- Surname
- First name
- Role

Each item of data is stored in a new line. Details of the first three employees are shown:

```
Roberts
John
Sales
Saied
Abdullah
Manager
Sanchez
Pedro
IT manager
...
```

An algorithm reads the data from the file, employees, line by line. The algorithm writes only the surname of each employee into a new text file, surnames. Both files are currently closed.

(d) Describe the steps that would be followed by this algorithm.

[5]

(Option B continues on page 15)

Turn over

— IT —

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(Option B, question 4 continued)

Stacks are a data structure frequently used in computer science to represent real-world scenarios.

Table 3 shows the fundamental operations that operate on a stack.

Table 3: Fundamental operations that operate on a stack

<code>push()</code>	Inserts an element onto the top of the stack.
<code>pop()</code>	Removes an element from the top of the stack.
<code>peek()</code>	Returns the top element of the stack without removing it from the stack.
<code>isEmpty()</code>	Returns true if the stack is empty, else it returns false.

(e) Sketch the stack resulting from the following operations.

```
push(1)
push(2)
push(9)
peek()
pop()
push(8)
push(10)
pop()
push(6)
```

You should clearly indicate the top of the stack. [2]

A new stack has been created and filled with elements.

(f) Using only the stack operations shown in **Table 3**, describe the steps that will locate **and** print only the **first** element that was pushed onto the new stack. [3]

(Option B continues on the following page)

(Option B continued)

APOLLO

B2 Programming

2 questions

Option A — Java

Answer **all** questions. All code that forms part of your responses must be written in Java.

2. A theatre stores the names and email addresses of its clients in two separate one-dimensional (1D) arrays, where each client's name and email address have corresponding indices. The two arrays are shown in **Table 2**.

Table 2: Name and email arrays

Name array		Email array	
Index	Name	Index	Email address
0	Maria Gonzalez	0	magonzalez24@example.net
1	Olga Sarkozky	1	osarkozky12@one2seven.org
2	Julia Brown	2	jbrown23@example.com
3	...	3	...

- (a) Explain why arrays have been chosen to hold this data instead of separate variables. [3]

A method has been constructed that will change each name so that the surname appears before the first name. For example, "Maria Gonzalez" will become "Gonzalez Maria".

- (b) Describe the steps involved in this method.

Assume that there is only one space between each first name and surname. [4]

Consider the following two-dimensional (2D) array, `MAT`.

```
int[][] MAT = {{2, 7, 1}, {8, 9, 0}}
```

- (c) State the code that will identify the data item 0 in `MAT`. [1]

(Option A continues on the following page)

— , —

(Option A, question 2 continued)

The following code operates on `MAT`:

```
int[][] MAT = {{2, 7, 1}, {8, 9, 0}};
int a = 0;
int b = 0;
for (int row = 0; row < 2; row++)
{
    for (int col = 0; col < 3; col++)
    {
        a = a + 1;
        int item = MAT[row][col];
        if (item%2 != 0)
            b = b + item;
    }
}
System.out.println ("The value of a is : " + a);
System.out.println ("The value of b is : " + b);
```

(d) State the output from this code.

[2]

The theatre employs a 2D array to indicate the status of each seat for a performance. `true` indicates that the seat has been sold for that performance. `false` indicates that it has not been sold.

The 2D array `seats` is used to represent the seating plan in the theatre. The array contains 40 rows and 30 columns.

For example, `seats[2][3] = false` shows that the seat in row 2, column 3 of the 2D array, `seats`, has not been sold.

After each performance, the sales data is analysed with a program that uses the method `least()`. This accepts the 2D array `seats` and outputs the row for which the lowest number of seats were sold.

(e) Construct the method `least()`.

Assume only one row matches this condition.

[5]

(Option A continues on the following page)

Turn over



(Option A continued)

Option B — Python

Answer **all** questions. All code that forms part of your responses must be written in Python.

5. A theatre stores the names and email addresses of its clients in two separate one-dimensional (1D) lists, where each client’s name and email address have corresponding indices. The two lists are shown in **Table 4**.

Table 4: Name and email lists

Name list		Email list	
Index	Name	Index	Email address
0	Maria Gonzalez	0	magonzalez24@example.net
1	Olga Sarkozky	1	osarkozky12@one2seven.org
2	Julia Brown	2	jbrown23@example.com
3	...	3	...

- (a) Explain why lists have been chosen to hold this data instead of separate variables. [3]

A function has been constructed that will change each name so that the surname appears before the first name. For example, “Maria Gonzalez” will become “Gonzalez Maria”.

- (b) Describe the steps involved in this function.

Assume that there is only one space between each first name and surname. [4]

Consider the following two-dimensional (2D) list, `MAT`.

```

MAT = [[2, 7, 1],
       [8, 9, 0]]

```

- (c) State the code that will identify the data item 0 in `MAT`. [1]

(Option B continues on the following page)

— 11 —

(Option B, question 5 continued)

The following code operates on `MAT`:

```
a = 0
b = 0
for row in range (0, 2):
    for col in range (0, 3):
        a = a + 1
        item = MAT[row][col]
        if item%2 != 0:
            b = b + item
print ('The value of a is : ',a)
print ('The value of b is : ',b)
```

(d) State the output from this code.

[2]

The theatre employs a 2D list to indicate the status of each seat for a performance. `True` indicates that the seat has been sold for that performance. `False` indicates that it has not been sold.

The 2D list `seats` is used to represent the seating plan in the theatre. The list contains 40 rows and 30 columns.

For example, `seats[2][3] = False` shows that the seat in row 2, column 3 of the 2D list, `seats`, has not been sold.

After each performance, the sales data is analysed.

One program uses the function `least()`. This accepts the 2D list `seats` and outputs the row for which the lowest number of seats were sold.

(e) Construct the function `least()`.

Assume only one row matches this condition.

[5]

(Option B continues on the following page)

Turn over

— 10 —

(Option B continued)

APOLLO

B3 Object-oriented programming

2 questions

Option A — Java

Answer **all** questions. All code that forms part of your responses must be written in Java.

3. A company employs a number of salespeople to sell its goods.

Details of the sales made by each employee for a year are stored in the `SalesPerson` object for that employee.

At the end of each month, the total sales for each employee are added to the array `sales` in the `SalesPerson` object. At the end of the year, the array will contain 12 entries, one for each month of the year.

Bonuses are paid to employees at the end of each year.

The `SalesPerson` class is partially shown:

```
public class SalesPerson
{
    static int bonus1 = ... ;           // value to be added
    static int bonus2 = ... ;           // value to be added
    private String id;                  // unique id for each employee
    double[] sales = new double[12];    // sales figures for each month in a year

    public SalesPerson(String id)
    {
        this.id = id;
    }

    public String getId() // returns employee's id
    {
        return this.id;
    }

    public double calculateTotal() // returns the total sales figure for
the year
    {
        // code missing
    }

    public double calculateHighest() // returns highest monthly total in
the year
    {
        // code missing
    }

    public void addSales(...) // adds the sales for a month to the sales array
    {
        // code missing
    }
}
```

(Option A continues on the following page)

— 3 —

(Option A, question 3 continued)

The driver code can be used to instantiate new `SalesPerson` objects. For example:

```
SalesPerson employee1 = new SalesPerson ("A6457098");
```

- (a) List the operations that would be carried out by the constructor when this line of code is run.

[4]

An object can have different types of attributes.

- (b) Outline **one** difference in the way in which the `bonus1` and `id` attributes are applied in the `SalesPerson` class.

[2]

The variable `id` has been identified as being a private attribute of the class.

- (c) Outline **two** consequences of declaring an attribute as private.

[2]

At the end of each month, the `SalesPerson` method, `addSales()`, adds the total sales for that month to the sales array for each employee.

The parameters passed to this method are the total sales for that month and the number representing that month, where 0 corresponds to January.

For example:

```
employee1.addSales(30000,2); // this adds 30000 to the sales array for  
the month of March for employee1.
```

- (d) Construct the method `addSales()`.

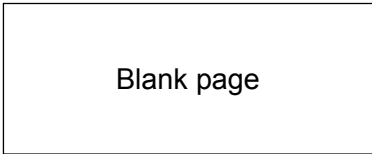
[2]

The `SalesPerson` method `calculateHighest()` returns the highest monthly sales figure by that employee during the year.

- (e) Construct the method `calculateHighest()`.

[5]

(Option A continues on page 11)**Turn over**



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(Option A, question 3 continued)

The company has 10 employees. An array, `employee`, of size 10 holds `SalesPerson` objects, one for each employee.

End-of-year bonuses, shown in the `SalesPerson` class, are calculated for each employee as follows:

- `bonus1` is paid if the total sales for the year are more than 300 000.
- `bonus2` is paid if the sales for any one month are more than 20 000.

The driver code includes the method `calculateBonus()`.

For each employee, this method:

- calculates the bonuses
- outputs their employee ID and their total bonus.

(f) Construct the method `calculateBonus()`.

Use any of the methods listed in the `SalesPerson` class.

[5]

End of Option A

Turn over

Option B — Python

Answer **all** questions. All code that forms part of your responses must be written in Python.

6. A company employs a number of salespeople to sell its goods.

Details of the sales made by each employee for a year are stored in the `SalesPerson` object for that employee.

At the end of each month, the total sales for each employee are added to the list `self._sales` in the `SalesPerson` object. At the end of the year, the list will contain 12 entries, one for each month of the year.

Bonuses are paid to employees at the end of each year.

The `SalesPerson` class is partially shown:

```
class SalesPerson():

    bonus1 = ...          # value to be added
    bonus2 = ...          # value to be added

    def __init__(self, id):
        self.__id = id    # employee id
        self.__sales = [] # holds the monthly sales figures

    def get_id(self):      # returns employee's id
        return self.__id

    def calculate_total(...): # returns the total sales figure for the year
        # code missing

    def calculate_highest(...): # returns highest monthly total in the year
        # code missing

    def add_sales(...):      # adds the sales for a month to the sales list
        # code missing
```

(Option B continues on the following page)

(Option B, question 6 continued)

The driver code can be used to instantiate new `SalesPerson` objects. For example:

```
employee1 = SalesPerson ("A6457098")
```

- (a) List the operations that would be carried out by the constructor when this line of code is run. [4]

An object can have different types of attributes.

- (b) Outline **one** difference in the way in which the `bonus1` and `self._id` attributes are applied in the `SalesPerson` class. [2]

The underscore character in `self._id = id` identifies the variable as being a private attribute of the class.

- (c) Outline **two** consequences of declaring an attribute as private. [2]

At the end of each month, the `SalesPerson` method, `add_sales()`, adds the total sales for that month to the sales list for each employee.

For example:

```
employee1.add_sales(30000) # this adds 30000 to the sales list
for employee1.
```

- (d) Construct the method `add_sales()`. [2]

The `SalesPerson` method `calculate_highest()` returns the highest monthly sales figure by that employee during the year.

- (e) Construct the method `calculate_highest()`.

The `max()` function must not be used. [5]

(Option B continues on page 21)

Turn over

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— 41 —

(Option B, question 6 continued)

The company has 10 employees. A list, `employee`, of size 10 holds `SalesPerson` objects, one for each employee.

End-of-year bonuses, shown in the `SalesPerson` class, are calculated for each employee as follows:

- `bonus1` is paid if the total sales for the year are more than 300 000.
- `bonus2` is paid if the sales for any one month are more than 20 000.

The driver code includes the function `calculate_bonus()`.

For each employee, this function:

- calculates the bonuses
- outputs their employee ID and their total bonus.

(f) Construct the function `def calculate_bonus()`.

Use any of the methods listed in the `SalesPerson` class.

[5]

End of Option B
