

Name: _____

Class: _____



JURONG PIONEER JUNIOR COLLEGE

JC2 Preliminary Examination 2026

**COMPUTING
Higher 2**

9569/01

16 September 2026

Paper 1 (Written)

3 hours

Additional materials: 12-page Answer Booklet

Answer **all** the questions.

Approved calculators are allowed.

You are reminded of the need for clear presentation in your answers.

Answer papers will be provided with the question paper.

Write your name and civics class on all the work that you hand in.

Write in **dark blue** or **black pen** on both sides of the paper.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Write your answers to every question **on a fresh page of paper**.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is **100**.

This document consists of **11** printed pages and **1** blank page.

[Turn over

1 JPStream is a hybrid teaching platform used by JPJC. The platform can record students' course enrolment. It can also track students that attend lessons that are conducted on-campus or streamed online. The company maintains **two** types of data storage:

- Relational Database (RDBMS): Stores structured data such as user accounts, courses, class sessions, enrolments, and attendance.
- Non-relational Database (NoSQL DB): Stores unstructured or semi-structured data such as real-time activity logs (e.g. "joined session", "left session", "played video") and device information.

Any student who wishes to use JPStream must register for an account. The company wants to store core data in a relational database with the following requirements:

1. Each student has their student ID and name.
2. Each course has a course ID and name.
3. Session records details of each scheduled live lesson for a course, namely, session ID, course ID, session date, start time, and delivery mode (eg. online or on-campus).
4. Enrolment records details of each student's course enrolment, namely, student ID, course ID, enrolment date, and status (eg. *Active* or *Withdrawn*).
5. Attendance records details of a student's attendance of a session. It includes the time the student joins the session, which will be used to update the punctuality (eg. Present or Late).

- (a) At present, a junior developer has proposed using a single table called `ClassParticipation` to store all information about students, courses, sessions, enrolments, and attendance.

- (i) A table description can be expressed as:

`TableName (Attribute1, Attribute2, Attribute3, ...)`

- The primary key is indicated by underlining one or more attributes.
- Foreign keys are indicated by using a dashed underline.
- An attribute that is both a primary and foreign key will have both solid and dotted lines, ie. Attribute.

[2]

Write the table description for the SINGLE table described above in First Normal Form (1NF).

[2]

- (ii) Explain **one** limitation of using this single 1NF table design and why there is a need to further normalise it into multiple related tables.

[3]

- (iii) Draw an entity-relationship (ER) diagram to show the FIVE tables in Third Normal Form (3NF) and the relationship(s) between them.

- (iv) Write the table descriptions for the FIVE tables in 3NF identified in part (a)

(iii)

[3]

- (b) Using tables created, write SQL statements for the following queries:

- (i) Display the student ID and the total number of lesson sessions attended, for each student who has attended at least one session.

[3]

- (ii) Display the top **three** students who attended the most live lesson sessions, sorted from highest to lowest number of attendances. Show their student ID, name and corresponding attendance count.

[3]

[Turn over

- (c) The real-time activity logs are stored in a NoSQL document database (e.g. MongoDB) using the following document structure:

```
{  
  "studentID": "ST12345",  
  "sessionID": "S67890",  
  "eventType": "JOIN_SESSION",  
  "deviceInfo": { "type": "mobile", "os": "Android" },  
  "networkQuality": "poor",  
  "timestamp": "2025-07-15T13:45:00Z"  
}
```

- (i) Explain **one** advantage of using a NoSQL database instead of a relational database for storing high-volume, high-frequency activity logs like the above. [2]
- (ii) Describe **one** scenario where the relational database design is still preferable for JPStream, even though NoSQL is available. [2]

2 A company is developing a simulation to model a fleet of delivery vehicles.

Vehicles are categorised as Vans, Motorbikes or Bicycles.

For each vehicle, the following items of data are stored:

- a unique registration number
- status (active or inactive)
- distance travelled today, in km (an integer between 0 and 300 inclusive)
- efficiency score (initialised to a random number between 50 and 100 inclusive)

For each van, the additional data item stored is:

- fuel used today, in litres (an integer between 5 and 50 inclusive)

For each motorbike, the additional data item stored is:

- fuel used today, in litres (an integer between 1 and 10 inclusive)

For each bicycle, there is no additional data items stored.

The simulation runs one day at a time. During each day, the efficiency score of a vehicle is recalculated:

- a van's efficiency score decreases by subtracting the fuel used today, multiplied by 2
- a motorbike's efficiency score is modified by adding the distance travelled today and then subtracting the fuel used today, multiplied by 3
- a bicycle's efficiency score increases by 1

If the efficiency score is less than or equal to 0, the vehicle's status is set to inactive (it requires servicing).

Object-oriented programming will be used to model the simulation.

(a) Draw a class diagram that shows the following for the simulation described above:

- the superclass
- any subclasses
- inheritance
- attributes
- appropriate methods

[8]

(b) Define what is meant by instantiation.

[1]

(c) **(i)** Describe encapsulation using an example from the simulation.

[2]

(ii) Describe inheritance using an example from the simulation.

[2]

(iii) Describe polymorphism using an example from the simulation.

[2]

[Turn over

- (d) Copy and complete the table below to give an appropriate example of each type of test data that can be used to test the **input of fuel used today for a van**.

Type of test	Test data
Normal	
Abnormal	
Extreme	

[3]

- (e) State two benefits of using a superclass and inheritance in this simulation, rather than writing three separate, unrelated classes.

[2]

- 3 JP cafe is developing a digital menu system to improve order processing. For each menu item, the system stores the year the item was introduced. The introduction year of a menu item is expected to be from 1990 to 2090.

Range-size mapping is a technique for efficiently storing a value that is known to fall within a fixed range. Instead of storing the value itself, the **offset from the minimum value** is stored (e.g., a year could be stored as year – 1990), so only enough bits to represent the *number of possible values* in the range are needed, rather than enough bits to represent the largest value directly.

That is, you store the **offset from the minimum**:

$$\text{storedValue} = \text{actualValue} - \text{minValue}$$

And recover the original value later using:

$$\text{actualValue} = \text{storedValue} + \text{minValue}$$

- (a) With workings shown clearly, calculate the minimum number of bits needed to effectively represent the given year range. [3]
- (b) During development of the cafe's software, the programmer must convert values between different number bases for the purpose of testing.

With workings shown clearly, convert the following numbers from one base to another:

- (i) 156_{10} to binary, [2]
- (ii) 10010110_2 to denary, [2]
- (iii) 110111001_2 to hexadecimal. [1]

- 4 The notifications of an operating system are managed and stored in a linked list data structure that is implemented using a fixed-size array of list nodes. Each list node consists of:

Field	Meaning
data	notifID (INTEGER), or NULL if empty
next	index location of the succeeding node, or -1 if null.

The linked list `LL` can only store a maximum of 8 list nodes, and it can be represented as such:

index	0	1	2	3	4	5	6	7
data	NULL	7	NULL	14	21	9	NULL	NULL
next	6	5	4	-1	-1	3	7	2

`head = 1`

`nextFree = 0`

It is given that the integer variables `head` and `nextFree` store the index locations of the first node of `LL` and the first node of the free space list respectively.

A freed node's data is not deleted.

- (a) Use the information given above to draw a linked list diagram of `LL` with free space list included. [2]
- (b) A new notification with `notifID = 12` is to be inserted into `LL` so that the linked list remains in ascending order.
- (i) Describe how this new notification can be inserted into the existing linked list `LL` that is given above. [3]
- (ii) Explain **one** advantage a list has over an array in this context. [1]

- 5 A circular queue is used to buffer outgoing string messages, implemented using a fixed-size array `CQ` and two pointers `front` and `rear`. The pointer `front` stores the index location of the first item in `CQ` while `rear` stores the index location of the last item in `CQ`.

A freed node's data is not deleted.

The following is the pseudocode to implement and initialise an empty circular queue `CQ`:

```

DECLARE CQ : ARRAY[0:3] of STRING
CQ[0] ← NULL
CQ[1] ← NULL
CQ[2] ← NULL
CQ[3] ← NULL
front ← -1
rear ← -1

```

- (a) Write down a pseudocode for the procedure `enqueue(msg: STRING)` that takes in `msg` as the value of the outgoing string message. Your pseudocode should be able to appropriately handle cases when `CQ` is empty or full. [4]

After creating an empty `CQ` and assigning it with `NULL` values, the lines of codes below were run in the given sequence starting from the top to the bottom:

```

enqueue("Gaia")
enqueue("Annie")
dequeue()
enqueue("Carrie")
enqueue("Hollie")
dequeue()

```

- (b) With an appropriate diagram, draw the final state of the circular queue `CQ` and its pointers `front` and `rear` clearly indicated after all the lines of codes above were executed. [2]
- (c) State **one** real-life application that make use of circular queue in their implementations. [1]

[Turn over

- 6 JP supermarket chain uses automated self-checkout kiosks. Every product has a unique 12-character alphanumeric product code (e.g., "34XK92LM02BN").

To speed up price lookups during scanning, each kiosk stores product codes and their respective prices in a fixed-size hash table.

- (a) Explain why an array data structure is preferred to a list data structure when implementing a fixed-size hash table. [2]
- (b) Explain the purpose of a hash function used in the context of a hash table. [2]
- (c) Linear probing is a collision handling technique that can be used on a hash table.
 - (i) Describe how a collision can occur. [1]
 - (ii) Explain how linear probing can be used to handle a collision. [2]

- 7 JP Motors is a car dealership that maintains a sorted list of recently launched cars that are identified by their engine capacities (cc). The engine capacities of the **five** different cars are stored in a python list shown below:

2200	1600	3000	1800	2500
------	------	------	------	------

Insertion sort will be used to sort the python list in ascending order of the cars' engine capacities.

- (a) Describe the algorithm of an insertion sort. [4]
- (b) Copy and complete the table to show the state of the list at the end of each pass of the insertion sort.

	list				
Pass	2200	1600	3000	1800	2500
1					
2					
3					
4					

- (c) State the worst-case time complexity for insertion sort. [1]
- (d) State and describe the condition where the insertion sort algorithm is preferred over quick sort algorithms. [2]

- 8 A company has recently moved into a new office. It has 80 desktop computers, 20 laptops, several wireless access points, a file server, and a router connected to the Internet. Employees access company files, browse the Internet, and work remotely from home.
- (a) Describe **three** functions of a router in the company's network. [3]
 - (b) One employee receives an email claiming to be from the company's bank asking them to click a link and enter their username and password.
 - (i) Identify the type of cyberattack. [1]
 - (ii) State and describe **one** measure the employee or company can take to reduce the risk of this attack from succeeding. [2]
 - (c) Encryption is one method that can be used to maintain the confidentiality and integrity of data.
 - (i) State what is meant by a private key. [2]
 - (ii) Describe how asymmetric encryption prevents eavesdropping. [2]
 - (iii) Explain how digital signature can be used to verify the integrity of a message when it is received. [4]
 - (d) The company restaurant has a native application for customers to make order using their mobile phones.
Identify and describe **two** benefits of developing a native application. [4]
- A computing student develops a mobile application for a school event. The app collects users' names, mobile numbers, email addresses and photographs during registration. The student also shares part of the data collected with a third-party company to advertise products without informing the users.
- (e) State **two** ways in which the student has failed to comply with the Personal Data Protection Act (PDPA). Explain your answers. [4]

END OF PAPER

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