MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level
Higher 2

COMPUTING

Paper 1 Written

9569/01

October/November 2022

3 hours

READ THESE INSTRUCTIONS FIRST

An answer booklet will be provided with the question paper. You should follow the instructions on the front cover of the answer booklet. If you need additional answer paper ask the invigilator for a continuation booklet.

Answer **all** questions.
Approved calculators are allowed.

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 **6** printed pages and **2** blank pages.

Singapore Examinations and Assessment Board

Cambridge Assessment International Education

1 A league of cycle clubs has competitive events throughout the year. Each event is scored. The club with the highest score at the end of the year is declared the league champion.

A database is to be used to store the data required about clubs and events.

Each club has a unique club name. The name and email address of the club secretary is stored.

Each event has a unique event number. The date, start time and location of each event is stored.

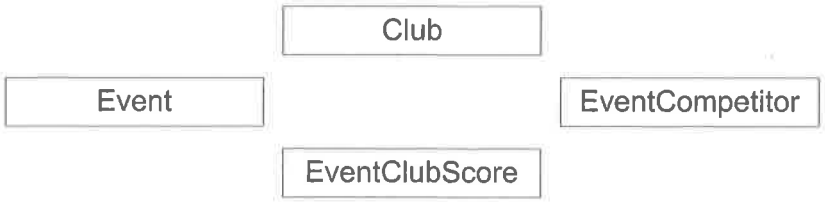
Each event is limited to a maximum of 175 cyclists with a maximum of seven cyclists from any club. When a cyclist enters an event their name and club name are recorded, and they are assigned a unique competitor number in the range 1 to 175 inclusive.

When an event is over, the finishing position and finishing time is stored for each competing cyclist.

The event organiser calculates a score using the positions and times of each cyclist. The score is a value in the range 0 to 25 inclusive and is awarded to each participating club. The club name, the event number and the club score are recorded.

Four entities are to be used to define the data needs of the league. The database has **not** been normalised.

(a) Copy and complete this entity-relationship (ER) diagram by showing **four** many-to-one relationships. When copying the diagram, do **not** rearrange the layout of the four given entities. If needed, your answer may include lines that cross over each other.



[4]

(b) Write table definitions, indicating the primary key, for each of the tables listed below.
Use the format: `TableName (Attribute1, Attribute2, Attribute3, etc.)`

(i) Club [2]

(ii) Event [2]

(iii) EventCompetitor [3]

(iv) EventClubScore [3]

(c) After each event a report is produced displaying, for all competing clubs: the club's name, the club's score for the event, the secretary's name and the secretary's email address.

Write an SQL query that will output the required data for an event with the event number 23. The output must list the clubs in the order of highest score to lowest score. [6]

(d) Normalisation is a process used when designing database tables.

(i) State **two** aims of the normalisation process. [2]

Assume that a table is already in first normal form (1NF).

(ii) State **two** other requirements of a table being in third normal form (3NF). [2]

(e) Identify the most suitable validation technique for an event score. [1]

2 An estate agent maintains a list of apartments for sale or rent. They want to use Object-Oriented Programming (OOP) to model this situation.

For every apartment the following data is recorded:
- the apartment address
- the owner's name, address and email address.

For an apartment that is for sale the following data is recorded:
- the asking price
- the date of sale
- the price paid.

Until an apartment is sold, the date of sale and price paid are left blank.

For a rental apartment the following data is recorded:
- monthly rent
- date when rent is to be paid.

If a rental apartment is vacant, the rent date (date when rent is to be paid) is set to 31/12/2099. When the rent is paid, the rent date is updated.

(a) Explain the difference between a class and an object. [2]

(b) Draw a class diagram for the described situation, showing:
- any derived classes and inheritance from the base class
- the properties needed in the base and any derived classes
- suitable methods, in each class, to support the system.

[8]

It is common for the properties of a class to be private.

(c) Explain an advantage of using private properties. [2]

(d) Explain a benefit of using inheritance to a software developer. [2]

3 Messages are sent across a public network.

(a) State how a message can be made meaningless to anyone other than the intended recipient. [1]

(b) Explain what sending and receiving devices can do to detect any malicious alteration of a message. [4]

Authentication is used in a computing context.

(c) Describe **two** situations where authentication is important. For each situation, state how it can be achieved. [4]

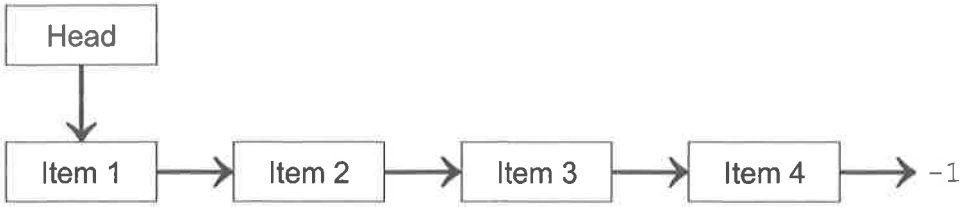
4 A program needs a structure to store ordered data. Data items are added and removed from the structure during the execution of the program. The programmer is considering using either a fixed-capacity array or a linked list to hold the ordered data items.

(a) State **two** advantages of using a fixed-capacity array over a linked list to store the ordered items. [2]

(b) State **two** advantages of using a linked list over a fixed-capacity array to store the ordered items. [2]

(c) A linked list can be represented as a number of nodes each containing an item of data and a pointer to the next node. A pointer `Head` indicates the location of the first node.

A value of `-1` in `Head` indicates an empty list; a value of `-1` in a pointer indicates the final node.



Function `Z` is written to operate on a linked list `LL`. The function has a single integer parameter, `CurrentPointer`. The function returns an integer.

```
01  FUNCTION Z(CurrentPointer) RETURNS INTEGER
02       IF CurrentPointer = -1 THEN
03            RETURN 0
04       ELSE
05            CurrentPointer = LL(CurrentPointer).Pointer
06            RETURN 1 + Z(CurrentPointer)
07       ENDIF
08  ENDFUNCTION
```

(i) State what line `06` indicates about function `Z` [1]

(ii) State what lines `02` and `03` represent. [1]

(iii) State the purpose of function `Z` [1]

(d) Using pseudo-code write a function, of the same type as function `Z`, to reverse the order of the data items in the linked list `LL`. You can assume that `Head` points to the first item in the current list. [5]

(e) It is common to sort items in a fixed-capacity array.
Explain why a merge sort may be faster than a quicksort in this situation. [2]

5 A programmer is writing code for a system to control an elevator. The programming language used allows the use of dynamic memory allocation.

The following algorithm describes what is to happen after a floor button in the elevator has been pressed:

```
Get some memory that will be used to store the chosen floor number
Store the chosen floor number into the memory
Is the elevator already at the chosen floor?
  Yes:
    Finished
  No:
    Close the doors
    Move to the required floor
    Open the doors
    Release the memory used to store the floor number
```

You may assume that only one button press is processed at a time.

The programmer believes that they have thoroughly tested the complete system and finds it to operate exactly as expected.

After many months in operation the elevator ceases to operate. The engineer called to investigate the fault switches off the power to the elevator and control system, finds no obvious problem, switches the power back on and finds that the elevator operates correctly. Several months later the elevator ceases to operate again.

(a) Explain how a mistake in the algorithm is causing the recurring problem. [3]

(b) Explain how the algorithm should be changed to prevent the problem recurring. [2]

(c) Suggest **two** reasons why the mistake was **not** identified during testing. [2]

6 Every night a business backs up all its data. From time to time the data that is infrequently accessed is archived.

(a) **(i)** Describe the purpose of creating a backup. [2]

(ii) Describe the purpose of archiving. [2]

(b) Explain why backup copies of the data should be stored off-site. [2]

(c) Describe the consequences of the business **not** backing up the data. [3]

7 **(a)** Data transmitted across the internet is divided into sequentially numbered packets.

(i) Explain why transmitted data is divided into packets. [2]

(ii) Explain why the packets are sequentially numbered. [2]

(iii) State **two** items, other than the packet number, that are stored in the packet header. [2]

(b) Explain why protocols are required to enable reliable communication over the internet. [2]

(c) A router is a device that allows the connection of a LAN to the internet.

Explain how the router directs arriving data packets to the correct device on the LAN. [2]

(d) A firewall is often placed between a LAN and the internet.

Explain how a firewall can provide security to the LAN. [2]

8 A hash function and associated hash table are commonly used when finding storage space for a new record and searching for a specific record within a data set.

(a) Explain the advantage a hash table search might have over a linear search and a binary search when searching for a specific record. Refer to time complexity in your answer. [3]

(b) Explain the meaning of a collision in the context of a hash table search. [2]

(c) Describe **one** method that can be used to handle the consequence of a collision. [2]

(d) A hashing algorithm is used to calculate the index of a hash table from a record key. Give **three** features of an effective hashing algorithm. [3]

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