



National
Qualifications
2019

X716/77/11

Computing Science

WEDNESDAY, 22 MAY

9:00 AM – 11:00 AM

Total marks — 60

Attempt ALL questions.

Write your answers clearly in the answer booklet provided. In the answer booklet you must clearly identify the question number you are attempting.

Use **blue** or **black** ink.

Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

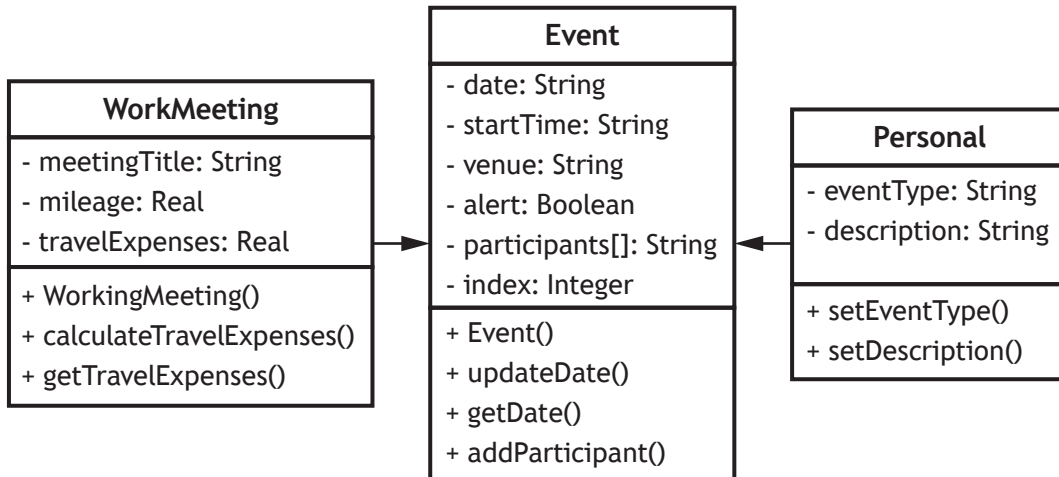


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1. A new time management and planning app called MyBusyLife has been developed using an object-oriented programming language.

A simplified version of the UML class diagram and the code for the `Event` class is shown below.



```

Line 1  CLASS Event IS { STRING date, STRING startTime, STRING venue,
        BOOLEAN alert, ARRAY OF STRING participants, INTEGER index }

Line 2  METHODS
Line 3  CONSTRUCTOR ( STRING date, STRING startTime, STRING venue,
        BOOLEAN alert )
Line 4      DECLARE THIS.date INITIALLY date
Line 5      DECLARE THIS.startTime INITIALLY startTime
Line 6      DECLARE THIS.venue INITIALLY venue
Line 7      DECLARE THIS.alert INITIALLY alert
Line 8      DECLARE THIS.participants INITIALLY [NULL] * 20
Line 9      DECLARE THIS.index INITIALLY 0
Line 10     END CONSTRUCTOR

Line 11     PROCEDURE updateDate(STRING eventDate)
Line 12         SET THIS.date TO eventDate
Line 13     END PROCEDURE

Line 14     FUNCTION getDate() RETURNS STRING
Line 15         RETURN THIS.date
Line 16     END FUNCTION

Line 17     PROCEDURE addParticipant(STRING name)
Line 18         SET THIS.participants[index] TO name
Line 19         SET index TO index + 1
Line 20     END PROCEDURE

Line 21  END CLASS
  
```

1. (continued)

(a) Using a programming language of your choice, write the code equivalent to Line 1 of the `Event` class, for the declaration for the `WorkMeeting` class. 2

(b) Describe the use of the `Constructor` method in the `Event` class. 1

(c) (i) Using appropriate object-oriented terminology, explain the operation and effect of executing the following code. 2

```
DECLARE sales INITIALLY WorkMeeting ( "22/6/19",
    "14:00", "Head Office", false, "June sales meeting",
    12.0, 0.0 )
```

(ii) Explain the effect of executing the following code. 2

```
sales.addParticipant("Chao Li")
```

(iii) The venue for the event called `sales` has been changed.

By referring to the UML class diagram and using appropriate object-oriented terminology, explain why it is not possible to edit the value already assigned to the `venue` property. 2

(d) A user of the app can claim £0.50 from their employer for every mile travelled for work meetings.

(i) The `calculateTravelExpenses()` method will multiply the mileage by £0.50 to calculate the travelling expenses for one meeting.

The `calculateTravelExpenses()` method makes use of a procedure.

```
Line 21 PROCEDURE calculateTravelExpenses()
Line 22
Line 23 END PROCEDURE
```

Using a programming language of your choice, write the code for Line 22 of the `calculateTravelExpenses()` method. 1

(ii) The following line of code creates an array of 100 meetings.

```
DECLARE myMeetings2019 AS ARRAY OF WorkMeeting
INITIALLY <array of 100 WorkMeeting objects>
```

Travel expenses can be claimed at the end of every month.

Using a programming language of your choice, write the code used to calculate the total travel expenses for all meetings stored in the `myMeetings2019` array that took place in April 2019. 3

(e) Increased popularity of the `MyBusyLife` app means more servers are needed to store and process users' data.

Describe two environmental implications of this increased popularity. 2

[Turn over

2. An ice cream company offers tours of its production facility.
- (a) Tours can be booked using the online form shown below.

Tour Booking Form

Full Name*:

Contact Number*:

Date of tour*:

Time*:

09:00am
10:00am
11:00am
12:00pm

** identifies a field which must be completed*

The first three lines of HTML code used to generate the form are shown below.

Line 1 `<h2>Tour Booking Form</h2>`

Line 2 `<form _____ >`

Line 3 `Full Name*:<input type="text" name="fullName" required>`

Once completed, the form data will be submitted securely to the server-side script called `form1.php`.

Complete Line 2 of the HTML code used to create this form.

2

- (b) A relational database is used to store details of tours and tour guides.

The SQL code used to create the `Guide` table is shown below.

```
CREATE TABLE Guide(
    guideID int NOT NULL PRIMARY KEY,
    lastName varchar(20) NOT NULL,
    firstName varchar(20) NOT NULL
);
```

The data submitted by the HTML form is stored in a second table called `Tour`. This table has a field called `tourID` which uses auto increment.

The relationship between the `Tour` and `Guide` tables is shown below.



Write the SQL code to create the `Tour` table.

3

2. (continued)

(c) The managing director wants to know the largest number of tours completed by any of the tour guides on 16/04/2019.

(i) Write the SQL statement to display the number of tours each tour guide completed on 16/04/2019. 2

(ii) Write the SQL statement, using your answer from (c)(i), to display the largest number of tours completed. 2

(d) When a request for a tour is received, the date and time selected is checked against existing tours.

The algorithm used to check the available date and time is shown below.

1. assign full name submitted to \$fullname
2. assign contact number submitted to \$contact
3. assign date submitted to \$date
4. assign time submitted to \$time
5. select a tour guide and assign ID to \$guideID
6. assign connection details (server = ice1, username = u1, password = p1, database = facilityTour)
7. connect to secure database
8. if requested date and time is available
9. add tour details to Tour table
10. else
11. display message indicating different date/time must be selected.
12. end if

(i) Write the server-side script required to implement Line 6 and Line 7 of the algorithm. 2

(ii) Write the server-side script required to implement Line 9 of the algorithm. 3

(e) The number of tours is lower than the management of the company would like. They consider using social media and online marketing to improve this.

Describe one legal concern management may have in using these approaches. 1

[Turn over

3. The Perfect Towel Company sells a range of towels. The company needs new software to keep track of stock.

The details stored about each towel include

- towel ID
- type
- price
- quantity in stock.

Two prototypes of the solution are developed.

- (a) The first prototype uses four 1-D arrays called `towelID`, `type`, `price` and `quantity`.

- (i) An insertion sort is used to arrange the towel data in ascending order of `towelID`.

The values currently stored in the `towelID` array are shown below.

index	0	1	2	3	4
value	B224	F127	F411	B432	H121

Explain how the insertion sort algorithm would be used to place the towel with `towelID` B432 in the correct position in the `towelID` array.

You should assume that the corresponding values in the `type`, `price` and `quantity` arrays will be sorted accordingly.

3

- (ii) The binary search algorithm is used to determine whether a particular `towelID` is in stock.

1. set `startPointer` to 0
2. set `endPointer` to index of (last element in `towelID` array) - 1
3. set `found` to false
4. enter `towelIDtoFind`
5. repeat
6. set `middle` to $(\text{startPointer} + \text{endPointer})/2$
7. make comparisons and update pointers
8. until `startPointer > endPointer` or `found = true`
9. if `found = true` then
10. check stock level
11. else
12. display not found
13. end if

Use pseudocode to refine step 7 of the algorithm.

3

3. (a) (continued)

- (iii) A function called `calc()` is to be applied to the `quantity` array.
The values stored in the `quantity` array are shown below.

index	0	1	2	3	4
value	134	14	13	111	34

The code for function `calc()` is shown below.

```

FUNCTION calc(ARRAY OF INTEGER q, INTEGER n) RETURNS INTEGER
  IF n <= 0 THEN
    RETURN 0
  ELSE
    RETURN calc(q, n-1) + q[n-1]
  END IF
END FUNCTION
    
```

- (A) Name the computational construct used in function `calc()`. 1

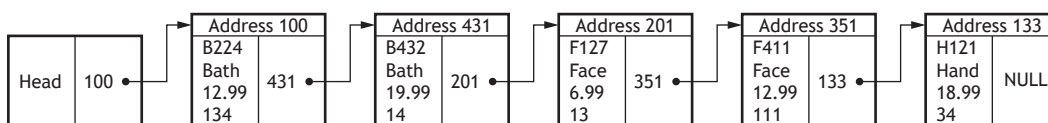
- (B) The function is called using the following statement:

```
SET x TO calc(quantity, 3)
```

With reference to the function code above, explain how the value 161 is assigned to the variable `x`. 2

- (b) The ID for any towel to be restocked will be added to a queue data structure.
Use pseudocode to design an algorithm used to add an item to the queue. 3

- (c) The second prototype uses a linked list as shown below.



A new towel ("H128", "Hand", 4.99, 200) is added at address 147.

Describe the changes that will be made to the linked list when this new towel is added. 2

- (d) Once fully developed, the new software will undergo beta testing.
Describe what is involved in beta testing the software. 1

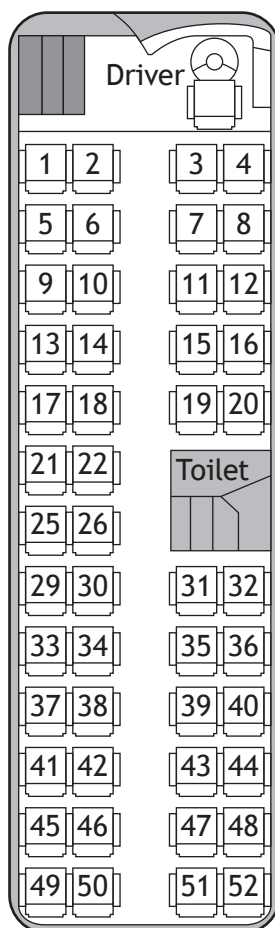
[Turn over

4. A coach company runs a daily journey from Edinburgh to London. Users of the company website can check seat availability, book a seat and make payments online. Registered users can login to edit or cancel a booking.

(a) With reference to the information above, draw a use case diagram to represent the requirements of the online booking system.

3

(b) The layout of the coach's seats is shown below.



Booking management software is being developed to store seats sold for each journey.

The software will store the following information for each seat.

Details stored	Sample data
customer's name	John
contact phone number	01313321249
the cost of the seat	45.00
whether or not the seat has been sold	TRUE

4. (b) (continued)

- (i) Using a programming language of your choice, define a record structure to store a seat's information. 1
- (ii) Using a programming language of your choice, declare a 2-D array called `seatingPlan` to store each seat from the coach layout on *page 8*. 1
- (c) Each seat is assigned the initial values “Empty”, “Null”, 0.0 and false. Note that seats 23, 24, 27 and 28 have been replaced by a toilet so they should be declared with the initial values “Toilet”, “Null”, 0.0 and true.
- Use pseudocode to design a sub-routine to initialise the variable `seatingPlan` with the appropriate values. 3
- (d) When checking seat availability, the cost of the first available seat is displayed before the user chooses whether to book the seat.
- The seats are allocated sequentially (from seat 1 on row 1) on a first-come, first-served basis, with a total of 48 seats available.
- Seat prices are shown in the table below.

Seats 1 to 20 in rows 1 to 5	Seats 21 to 44 in rows 6 to 11	Seats 45 to 52 in rows 12 and 13
£22.50	£45.00	£75.00

Using pseudocode, or a programming language of your choice, write a sub-routine to

- check for the first available seat in the `seatingPlan` array
- display ‘No Availability’ or the cost of first available seat, as appropriate
- ask the user if they wish to book the seat
- add the appropriate information to this seat record, if the user chooses to proceed.

Note any assumptions you make. 5

- (e) The company considers incorporating concurrent programming techniques into its booking management software.
- Describe one problem that could arise in this situation from the use of multiple threads. 1
- (f) The company wants to make the booking management software available as a mobile app.
- Name and describe the type of maintenance that would be required. 1

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