AH National Qualifications 2022 MODIFIED

X816/77/11 Computing Science

MONDAY, 30 MAY

1:30 PM – 3:30 PM

Total marks — 55

SECTION 1 — Software design and development — 35 marks

Attempt ALL questions.

Attempt EITHER Section 2 OR Section 3

SECTION 2 — Database design and development — 20 marks

SECTION 3 — Web design and development — 20 marks

You may use a calculator.

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.

SQA ©

X816711

SECTION 1 — SOFTWARE DESIGN AND DEVELOPMENT — 35 marks

Attempt ALL questions

1. The following section of pseudocode is included in the design for a program.

```
If head is null
    Create first node
    Set previous pointer of new node = null
    Set next pointer of new node = null
Else
    Create new node
    Set old tail's next pointer = new tail
    Set new tail's previous pointer = old tail
    Set new tail's next pointer = null
End if
```

Name the data structure and operation used in this design. **2**

2. (a) A binary search algorithm is shown below. This algorithm is incomplete.

```
1.  Set low = 0
2.  Set high = number of elements in the list − 1
3.  Set found = false
4.  While ___________________________
5.  Set mid = (low + high) / 2
6.      If target = list[mid] then
7.          Set position = mid
8.          Set found = true
9.      Else if ________________________
10.         Set low = mid + 1
11.     Else
12.         Set high = mid − 1
13.     End if
14. End while
```

Write the conditions needed to complete line 4 and line 9 of the algorithm. **2**

2. (continued)

(b) The contents of an array are shown below.

49366323
35888744
35332982
51087533
35471544
63728272
35395841
35646683
35853694
35676309
35666839

Explain why the binary search algorithm would not return the expected result when applied to the array. **1**

3. An integer array contains the values [12, 7, 4, 5, 13, 6]. The contents of the array are to be sorted into ascending order.

(a) During each iteration of an insertion sort, values in the array are compared and the position of the values may be altered.

Values in array at start of sort [12, 7, 4, 5, 13, 6]
Resultant array after first iteration [7, 12, 4, 5, 13, 6]

Write down the resultant array after the second iteration of the insertion sort has been completed. **1**

(b) During each pass of a bubble sort, values in the array are compared and the position of the values may be altered.

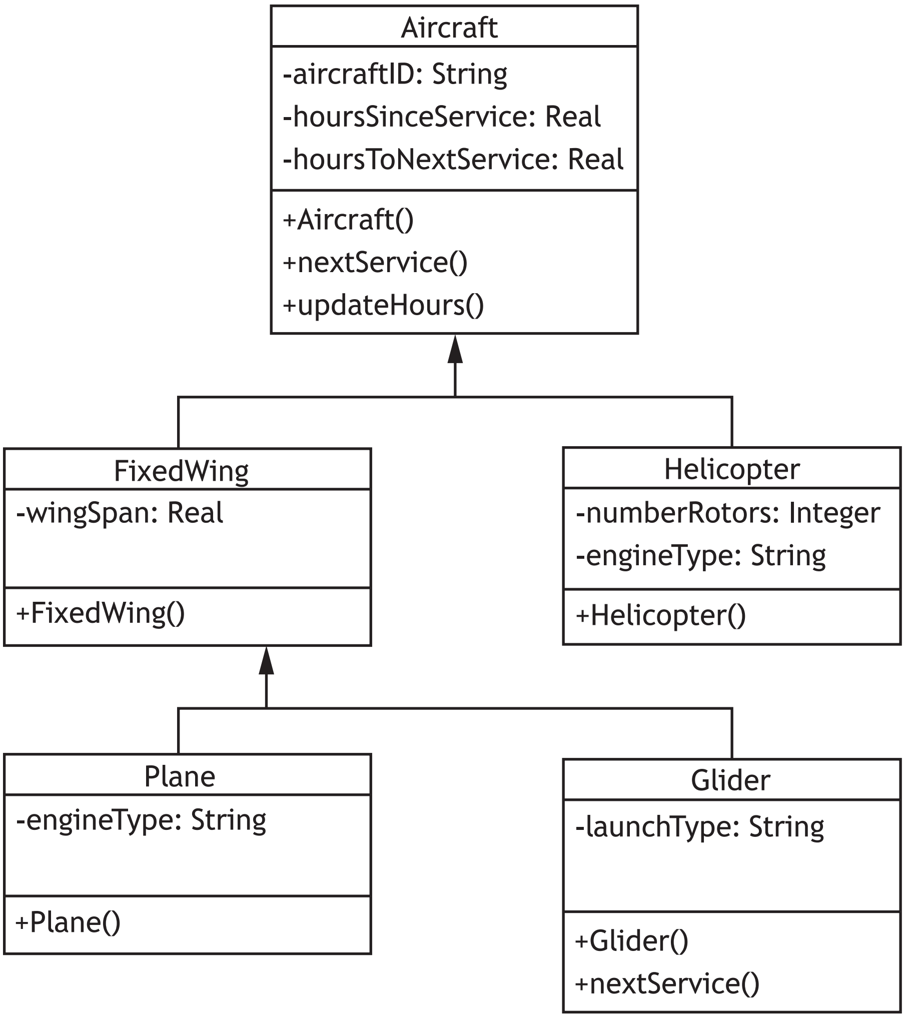
Values in array at start of sort [12, 7, 4, 5, 13, 6]
Resultant array after first pass [7, 4, 5, 12, 6, 13]

Write down the resultant array after the second pass of the bubble sort has been completed. **1**

[Turn over

4. An object-oriented program is written to store and process aircraft details. Different types of aircraft include fixed wing planes, helicopters and gliders. Fixed wing planes and helicopters are serviced every 100 flight hours whereas gliders are serviced every 250 flight hours.

A simplified version of the UML class diagram for the program is shown below.



(a) Describe how inheritance affects the `Plane` class. **2**

(b) Initial values may be set using a constructor method.

(i) Name the constructor method for either of the superclasses shown on the UML class diagram. **1**

(ii) The first line of code in the class declaration for the `Aircraft` class is provided below.

```
CLASS Aircraft IS { STRING aircraftID, REAL
hoursSinceService, REAL hoursToNextService }
```

Using a programming language of your choice, write the equivalent code for the `Helicopter` class. **2**

4. (continued)

(c) The `nextService()` methods of the `Aircraft` and `Glider` classes are shown below.

Aircraft class

```
FUNCTION nextService () RETURNS REAL
   SET THIS.hoursToNextService = 100 – THIS.hoursSinceService
   RETURN THIS.hoursToNextService
END FUNCTION
```

Glider class

```
OVERRIDE FUNCTION nextService () RETURNS REAL
   SET THIS.hoursToNextService = 250 – THIS.hoursSinceService
   RETURN THIS.hoursToNextService
END FUNCTION
```

Using appropriate object-oriented terminology, explain the use made of the `OVERRIDE` statement in the `nextService()` method of the `Glider` class. **2**

(d) A program makes use of the classes in the UML class diagram. Some of the code from this program is shown below.

```
Line 54   DECLARE plane1 INITIALLY Plane ("ABC123", 0.0,
          100.0, 28.9, "jet")
…
…
Line 81   DECLARE fleet AS ARRAY OF Plane INITIALLY [NULL] * 76
Line 82   SET fleet[0] TO plane1
…
…
Line 93   DECLARE numberPlanes INITIALLY countServiceDue(fleet)
Line 94   SEND numberPlanes & " are due a service" TO DISPLAY
```

(i) Using appropriate object-oriented terminology, explain the purpose of Line 54 of this program. **2**

(ii) Using appropriate object-oriented terminology, explain the purpose of Line 81 and Line 82 of this program. **2**

(iii) The `countServiceDue()` function called at Line 93 is used to count the number of planes in the fleet that return a value of no more than 12 when the `nextService()` function is applied.

Using an object-oriented language of your choice, write the code for the `countServiceDue()` function. **3**

[Turn over

5. A new computer game is being developed. During the game, a player must avoid being captured by a group of robots.

The game will be played on a 10 by 10 grid. The player and robots can move horizontally, vertically or diagonally to an adjacent position on the grid. After each player move, the robots will move closer to the player.

A player wins the game when all the robots are destroyed. Robots will be destroyed when two or more robots collide, leaving a pile of rubble in their place. Any robot that collides with a pile of rubble will also be destroyed.

When any robot moves to the same position as the player, the player is captured, and the game is over.

(a) When the game is implemented, a 2-D array of string values is used to store the positions of the player and the robots.

(i) State two additional functional requirements for this game. **2**

(ii) Using a programming language of your choice, write code to declare a 2-D array to represent the game board. **1**

(iii) Using a programming language of your choice, write code to assign the value 'Robot' to **six** random, empty locations on the board. **3**

The grid below represents the contents of the 2-D array at the start of a game.

	Robot								Robot
							Robot		Robot
				Player					
		Robot							
				Robot					

Movement of the player is controlled using several procedures. Partially completed code for the `moveUp` procedure is shown below.

```
PROCEDURE moveUp()
   <find player row and column>
   IF <the player is not already on the top row> THEN
       <move the player up one row>
   END IF
END PROCEDURE
```

(b) Using a programming language of your choice, write code to implement this procedure. **3**

[Turn over for next question

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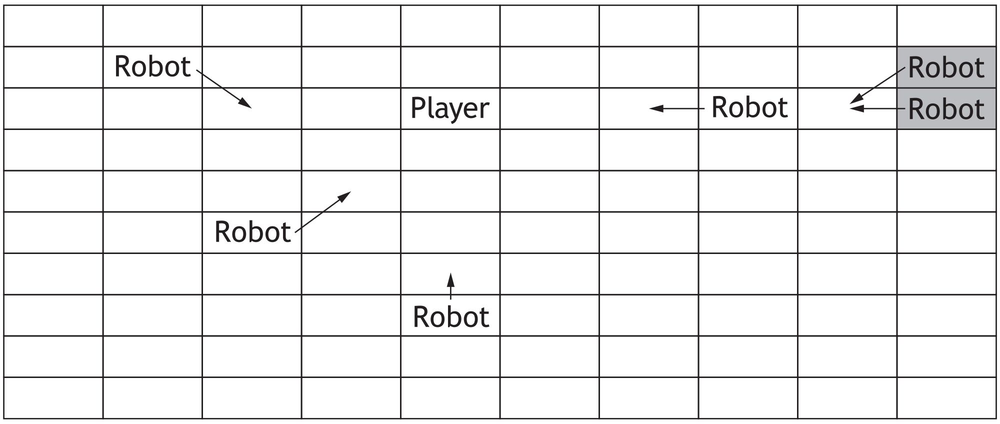
5. (continued)

Whenever a player moves up one row, all the robots will move closer to the player.

The grid below shows the new position of the player after one move, and the existing position of the robots. Each robot will move to the cell indicated by the arrowhead.



The movement of the two robots in the shaded cells will result in a collision. These robots will be destroyed and replaced with a pile of rubble.

The grid below shows the state of the game after all of the robot moves have been completed.

		Robot		Player		Robot		Rubble	
			Robot						
				Robot					

5. (continued)

(c) The procedure `robotMove(robotX,robotY,playerX,playerY)` is used to control the movement of a robot. The parameters identify the current position of the robot and the new position of the player.

This procedure:

- clears the current position of the robot
- assigns the robot to a new position which is closer to player
- checks for a collision between robots which destroys both robots and creates a pile of rubble in their place
- checks for a collision with an existing pile of rubble which destroys the robot
- checks for the robot capturing the player.

Using pseudocode, design the procedure `robotMove`. **5**

[END OF SECTION 1]

[Turn over

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SECTION 2 — DATABASE DESIGN AND DEVELOPMENT — 20 marks

Attempt ALL questions

6. Developers are creating a database to store details of treatments provided at a hospital.

The `Doctor` table of the database contains four required attributes: `doctorID`, `firstName`, `lastName` and `contractType`.

All doctors at the hospital are issued contracts that can be Consultant, Junior or Locum.

The developers use the SQL `CREATE` statement below to create the `Doctor` table.

```
CREATE TABLE Doctor (
   doctorID int NOT NULL AUTO-INCREMENT,
   firstName varchar NOT NULL,
   lastName varchar,
   contractType
);
```

The SQL statement above is not fit for purpose.

Re-write the SQL statement to implement the `Doctor` table correctly. **3**

7. EcoVenture is a walking club. The club website allows registered walkers to record details about walking routes they complete.

Data about the walkers and their completed walking routes is stored in a database with four related tables. The attributes in each table are listed below.

Route	**Walker**	**Hill**	**Walk**
routeID	walkerID	hillID	walkerID*
routeName	walkerName	hillName	routeID*
routeLength	walkerExperience	hillType	walkDate
routeDifficulty	walkerDOB	hillHeight	walkStartTime
hillID*			walkDistance
			walkEndTime
			walkDifficulty

Explain why the `Walk` table would benefit from the introduction of a surrogate key. **2**

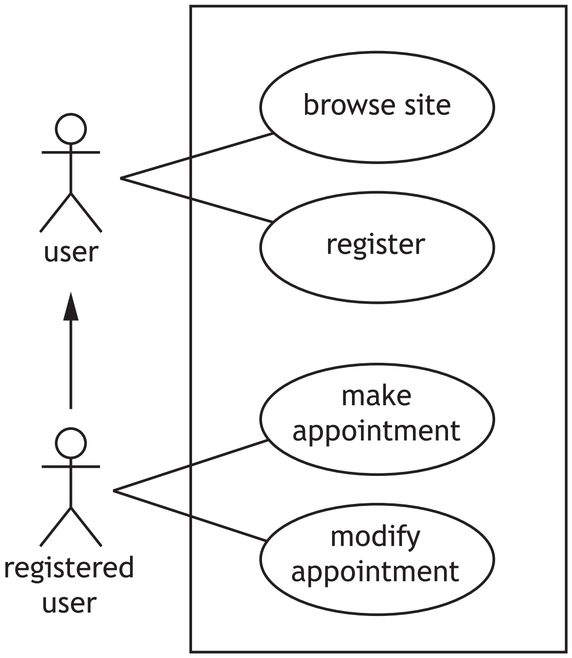
[Turn over

8. Hair by Harvey is a hair salon. A team of developers is creating a database-driven website to allow customers to book appointments for treatments at the salon. **MARKS**

(a) Part of the booking process requires a new customer to register before making an appointment. When registering, customers must provide their full name and contact telephone number.

(i) Name the type of feasibility study that is highlighted in the requirements for this part of the booking system. Justify your answer. **1**

(ii) Part of the use case diagram for the website is shown.



Describe the relationship between the actors in this diagram. **1**

(b) The attributes in each of the four entities required in the booking system are listed below.

Customer (cLastName, cFirstName, contactNumber, <u>customerID</u>)

Appointment (<u>appDate</u>, <u>appTime</u>, <u>customerID</u>*, stylistID*, treatmentID*)

Stylist (<u>stylistID</u>, sLastName, sFirstName, ratePerHour)

Treatment (<u>treatmentID</u>, description, price)

When making an appointment, a customer must select the type of treatment required but can choose a particular stylist or leave the attribute `stylistID` in the entity `Appointment` blank for the details to be assigned later.

Draw an entity-relationship diagram to represent the tables in the booking system. You should indicate:

- the name of each entity and relationship
- whether each entity is strong or weak
- whether relationship participation is mandatory or optional
- the cardinality of each relationship. **4**

8. (continued)

(c) Once the tables have been created correctly, sample test data is stored in the tables.

The incomplete SQL query shown below will be used to display the full name of all the stylists who have provided at least three hair colouring treatments in the months of April and May 2022.

```
SELECT sLastName, sFirstName
FROM Appointment, Treatment, Stylist
WHERE description = "Hair colouring"
AND appDate [        A        ] '2022-04-01' AND '2022-05-31'
AND Appointment.stylistID = Stylist.stylistID
AND Appointment.treatmentID = Treatment.treatmentID
GROUP BY sLastName, sFirstName
[              B              ] ;
```

State the missing operator and clause labelled **A** and **B**. **2**

(d) A query to list the customers who are due to be treated by the stylists with `stylistID` 2, 5 or 7 is being designed.

One possible design of this query is shown.

<table>
<tr><td>Fields(s)/ calculations</td><td colspan="4">Customer last name, customer first name, contact number</td></tr>
<tr><td>Table(s) quer(-ies)</td><td colspan="4">Customer</td></tr>
<tr><td rowspan="3">Search criteria</td><td rowspan="3">C</td><td rowspan="3">Inner query</td><td>Fields(s)/ calculations</td><td>customerID</td></tr>
<tr><td>Table(s)</td><td>Appointment</td></tr>
<tr><td>Search criteria</td><td>D</td></tr>
</table>

(i) State the missing search criteria labelled **C**. **1**

(ii) The missing search criteria labelled **D** applies to a subquery.

Describe how the logical operator `IN` could be used in the implementation of the search criteria for the subquery. **1**

8. (continued)

(e) Test data in the `Customer` and `Appointment` tables is shown below.

Customer			
cLastName	**cFirstName**	**contactNumber**	**customerID**
Smith	John	01632774488	1
Ali	Muhammad	01632776655	2
McMillan	Arthur	07709223344	3
Doherty	Lesley	07141189100	4

Appointment				
appDate	**appTime**	**customerID**	**stylistID**	**treatmentID**
2022-01-10	09:00:00	1		1
2022-31-12	09:00:00	2	1	1
2022-02-01	16:00:00	2	2	1
2022-01-10	14:00:00	1	3	2

The test plan for the database includes the following query.

Query	**Expected output**

`SELECT cFirstName, cLastName`
`FROM Customer, Appointment`
`WHERE Customer.customerID =`
`Appointment.customerID`
`AND stylistID NOT LIKE "*";`	

State the expected output of this query and explain your answer. **2**

8. (continued)

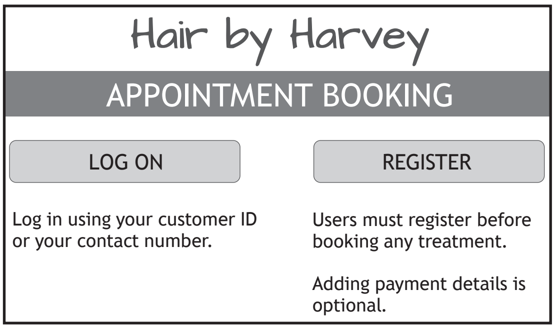
(f) Once developed, all aspects of the website will be tested.

The test plan for the completed website includes the persona and test case described below.

Persona	**Test Case**
Lesley is a 27-year-old who likes to make regular bookings to have her hair coloured every 12 weeks.	Log on to the system using customer ID 4. Make a booking for a hair colouring treatment on 22nd July 2022 and a follow-up booking 12 weeks later.

Some screen shots resulting from this section of testing are shown below.

introductory screen



Hair by Harvey

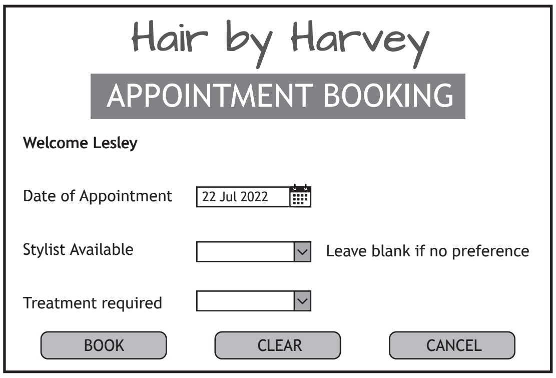
APPOINTMENT BOOKING

Log in using your customer ID or your contact number.

Users must register before booking any treatment.

Adding payment details is optional.

appointment date



Hair by Harvey

APPOINTMENT BOOKING

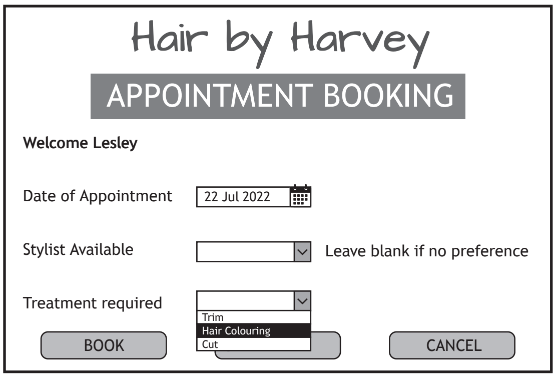
Welcome Lesley

Date of Appointment: 22 Jul 2022

Stylist Available: Leave blank if no preference

Treatment required:

treatment



Hair by Harvey

APPOINTMENT BOOKING

Welcome Lesley

Date of Appointment: 22 Jul 2022

Stylist Available: Leave blank if no preference

Treatment required: Hair Colouring

(i) Name and describe the type of testing illustrated above. **2**

(ii) Explain whether the solution shown is fit for purpose. **1**

[END OF SECTION 2]

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SECTION 3 — WEB DESIGN AND DEVELOPMENT — 20 marks

Attempt ALL questions

9. EcoVenture is a walking club. The club website allows registered walkers to record details about walking routes they complete.

Data about the walkers and their completed walking routes is stored in an online database. The `Walker` table has four attributes listed below:

```
Walker ( walkerID, walkerName, walkerExperience, walkerDOB )
```

During processing, the details stored in the `Walker` table have been retrieved and stored temporarily in a PHP variable called `$tableData`. An extract from the PHP for this process is shown below.

```
…
Line 44     echo "<table border = "2">
              <tr>
                 <th>Walker ID</th>
                 <th>Walker Name</th>
              </tr>";
Line 45     while ($walker = mysqli_fetch_array($tableData))
Line 46     {
Line 47        // display walker details in HTML table
Line 48        echo _________________________________________;
Line 49     }
Line 50     echo "</table>";
…
```

Write the PHP statement used in Line 48 to display the details of the walkers. **2**

10. Explain the use of `session_start()` and `session_destroy()` functions when using PHP to create a login system for a website. **3**

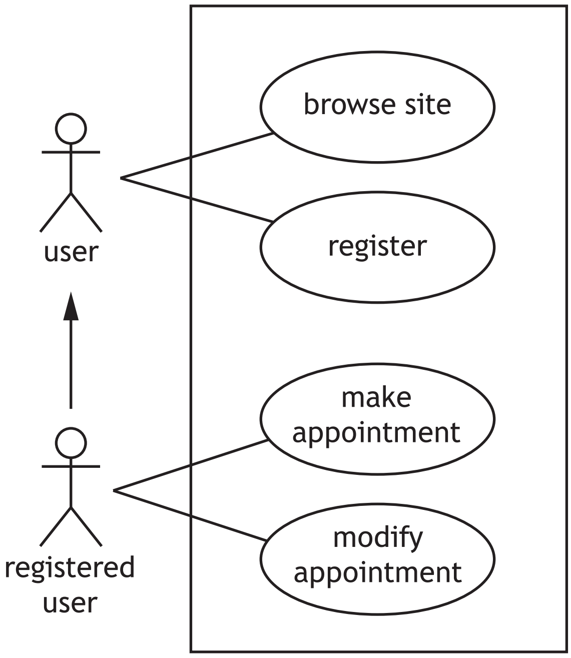
[Turn over

11. Hair by Harvey is a hair salon. A team of developers is creating a database-driven website to allow customers to book appointments for treatments at the salon.

(a) Part of the booking process requires a new customer to register before making an appointment. When registering, customers must provide their full name and contact telephone number.

(i) Name the type of feasibility study that is highlighted in the requirements for this part of the booking system. Justify your answer. **1**

(ii) Part of the use case diagram is shown.



Describe the relationship between the actors in the diagram. **1**

(b) Customers who want to modify an existing appointment must enter the `appointmentID` in a HTML form.

The code for this HTML form is shown below.

```
Line 1    <form action = "modifyAppt.php" method = "GET">
Line 2    Appointment ID: <input type="text" name="apptID" />
Line 3    <input type="submit" value="Modify Appointment">
Line 4    </form >
```

Write the PHP code for the file `modifyAppt.php` to assign the form data to suitable server-side variables. **2**

11. (continued)

(c) The website connects to an external database server using the following credentials.

➢ Username:	Harvey
➢ Password:	£dxG67*
➢ Server:	db.hbh.com
➢ Database:	hairbyharvey

Write the PHP code used to establish a connection with the database server using a variable called `$conn`. **2**

(d) The database table called `Stylist` is used to store details of all stylists who work in the salon. Sample data from the `Stylist` table is shown below.

Stylist			
stylistID	**sFirstName**	**sLastName**	**ratePerHour**
1	Harry	McCann	14.25
2	Tina	Reid	15.00
3	Jeremy	Gerrard	14.50
...	...	...	...

A query is used to display the full name of all stylists who earn at least £14.50 per hour.

The incomplete PHP code used to execute this query and display the results is shown below.

```
Line 1    $sql = "SELECT sFirstName, sLastName FROM Stylist
          WHERE ratePerHour >= 14.50";
Line 2    // execute query and store results in $result
Line 3    $result = ________________________________ ;
Line 4    // check query has returned at least one row of data
Line 5    if ( ________________________________ > 0 {
Line 6        // process each row of data
...
```

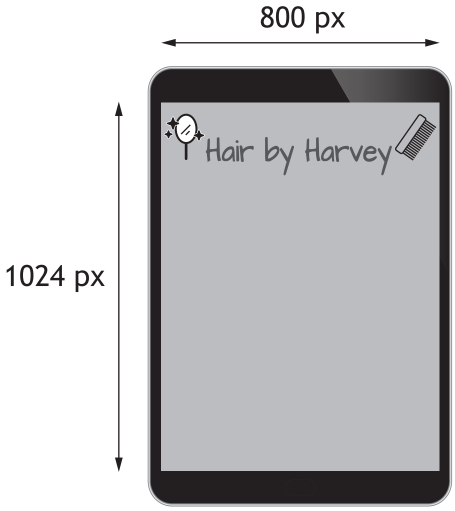
Write the PHP code needed to complete Line 3 and Line 5. **4**

[Turn over

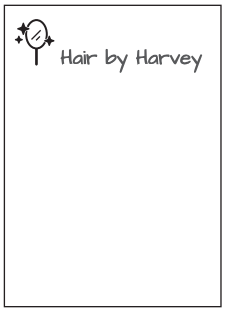
11. (continued)

(e) The website will be used to output data to tablets and A4 paper. The planned layout for both forms of output media is shown below.

planned layout of tablet output



planned layout of A4 paper output



The CSS used to create the tablet layout is shown below.

```
@media screen and (max-width:800px) {
    body { background-color: light-grey }
    .mirrorImg { width: 200px; height: 200px }
    .combImg { width: 200px; height: 200px }
    .heading { font-family: Arabic; font-size: 32px }
}
```

Describe how the CSS could be adapted to produce the layout for paper output. **2**

11. (continued)

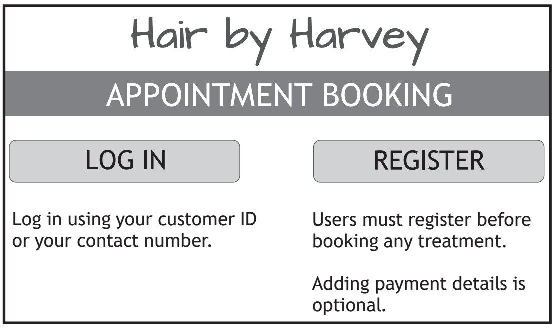
(f) Once developed, all aspects of the website will be tested.

The test plan for the completed website includes the persona and test case described below.

Persona	**Test Case**
Lesley is a 27-year-old who likes to make regular bookings to have her hair coloured every 12 weeks.	Log on to the system using customer ID 4. Make a booking for a hair colouring treatment on 22nd July 2022 and a follow-up booking 12 weeks later.

Some screen shots resulting from this section of testing are shown below.

introductory screen



Hair by Harvey

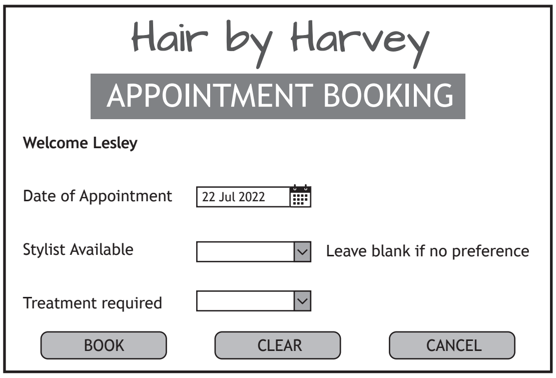
APPOINTMENT BOOKING

Log in using your customer ID or your contact number.

Users must register before booking any treatment.

Adding payment details is optional.

appointment date



Hair by Harvey

APPOINTMENT BOOKING

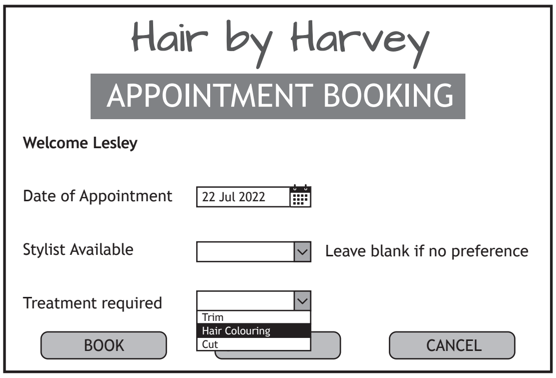
Welcome Lesley

Date of Appointment: 22 Jul 2022

Stylist Available: Leave blank if no preference

Treatment required:

treatment



Hair by Harvey

APPOINTMENT BOOKING

Welcome Lesley

Date of Appointment: 22 Jul 2022

Stylist Available: Leave blank if no preference

Treatment required: Hair Colouring

(i) Name and describe the type of testing illustrated above. **2**

(ii) Explain whether the solution shown is fit for purpose. **1**

[END OF SECTION 3]

[END OF QUESTION PAPER]

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