



National
Qualifications
2022-2023

CS(AH)23

Computing Science

Duration 2 hours

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.

Attempt all questions

1. (a) A bubble sort algorithm is shown below. This algorithm is incomplete.

```
1 length = size of list[]
2 repeat
3   set swapped = false
4   for index = 0 to length - 2
5     _____
6     set temp = list[index]
7     set list[index] = list[index + 1]
8     set list[index + 1] = temp
9     set swapped to true
10  end if
11  end for
12  length = length - 1
13  _____
```

Write the pseudocode required for line 5 and line 13 of the algorithm.

2

- (b) The contents of a list to be sorted are shown below.

[12, 7, 4, 5, 13, 6]

Show how the contents of the list would be updated by two passes through the list using the bubble sort algorithm.

You should show the contents of the list after each complete pass.

2

2. A module in a program uses the following data structures and methods.

```

CLASS ListNode is { INTEGER data, INTEGER next }

    CONSTRUCTOR (data) {
        DECLARE THIS.data INITIALLY data
        DECLARE THIS.next INITIALLY NULL
    }

END CLASS

CLASS List is { INTEGER head }

    PROCEDURE process(value) :
        node = ListNode(value)
        IF THIS.head = NULL:
            THIS.head = node
        ELSE
            node.next = THIS.head
            THIS.head = node
        END IF
    END PROCEDURE
...

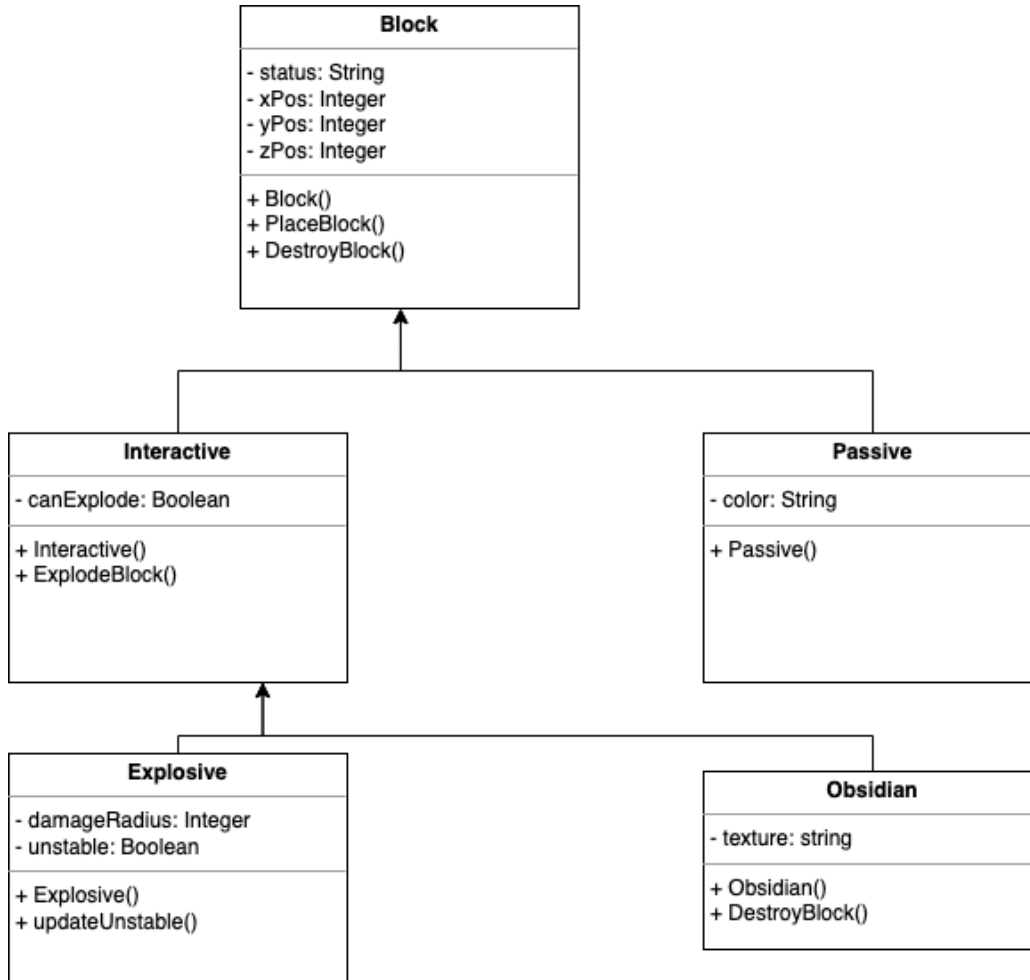
```

- (a) Name the data structure used in the code above. 1
- (b) Name the specific operation shown the code above. 1
- (c) The code above is a module and requires testing.
- Name and describe an appropriate type of testing that could be used to check that the module functions as expected. 2

[Turn over

3. An object-oriented program is written as part of an online game that allows players to place different kinds of blocks on a map to construct buildings or environments. Different types of blocks include interactive, passive, obsidian and explosive. Explosive and interactive blocks can explode and be destroyed. Obsidian blocks cannot be destroyed. If there is an explosion, Obsidian blocks are not destroyed but change texture from “cracked” to “broken” or “broken” to “cracked”.

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



- (a) Describe how inheritance affects the `Explosive` class. 2

- (b) The first line of the code in the class declaration for the `Block` class is provided below:

```
CLASS Block IS { STRING status, INTEGER xPos, INTEGER yPos,
INTEGER zPos }
```

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

- (c) (i) The program uses the following code.

```
DECLARE MyBlock AS Block INITIALLY Block ( "Live", 102, 10, 20 )
```

Using appropriate object-oriented terminology, explain the purpose of this code. 1

3. (c) (continued)

- (ii) A programmer also writes the following line of code for the program.

```
SET MyBlock.zPos TO 999
```

Using appropriate object-oriented terminology, explain why this statement would be invalid.

1

- (d) The
- `DestroyBlock()`
- methods of
- `Block`
- and
- `Obsidian`
- are shown below.

Block class

```
FUNCTION DestroyBlock() RETURNS STRING
  SET THIS.status TO "Destroyed"
  RETURN THIS.status
END FUNCTION
```

Obsidian class

```
OVERRIDE FUNCTION DestroyBlock() RETURNS STRING
  IF THIS.texture TO "cracked" THEN
    SET THIS.texture TO "broken"
  ELSE
    SET THIS.texture TO "cracked"
  END IF
  RETURN status
END FUNCTION
```

Using appropriate object-oriented terminology, explain the use made of the `OVERRIDE` statement in the `DestroyBlock()` method of the `Obsidian` class.

2

- (e) Only explosive blocks have a property of
- `unstable`
- (so may randomly explode if a player is close to them). Explosives are created with a
- `damageRadius`
- of 10 and
- `unstable`
- set to
- `false`
- .

Using a programming language of your choice, write the constructor method for the `Explosive` class.

3

- (f) The online game program makes use of the classes in the UML class diagram. An array,
- `bombwall`
- , is declared.

```
Line 33 DECLARE bombwall AS ARRAY OF Explosive INITIALLY [NULL] * 25
```

Later in the program, this array is filled with 25 objects of the `Explosive` class. Then a function `triggerExplosives` updates the objects in the array, randomly setting the property `unstable` to either `true` or `false` and returns the number set to `true`.

```
Line 97 DECLARE setExplosives INITIALLY triggerExplosives(bombwall[])
```

Using an object-oriented language of your choice, write the code for the `triggerExplosives` function.

3

[Turn over

4. A group of friends play a lottery game. They want a program that will randomly generate 25 lottery entries. Each entry contains six numbers and each of these numbers is from 1 to 59 and no number in an entry can be repeated. An insertion sort should be used to put each lottery entry into ascending order.

The lottery entries will be stored in a 2-D array as shown below. Each row is one lottery entry.

Index	0	1	2	3	4	5
0	12	18	19	32	47	59
1	12	13	47	48	50	58
2	3	7	19	26	32	34
3	9	10	11	21	37	46
4	3	12	15	44	45	54
...
23	1	4	13	28	39	59
24	11	19	25	37	41	46

- (a) When planning to write their program, the friends identify the following tasks to be completed.

3

Task Number	Description	Depends On	Days to Complete
1	Detail Requirements	-	2
2	User Interface Design	1	3
3	Pseudocode Design	1	4
4	Interface Implementation	2	2
5	Writing Code	3	4
6	Integration	4, 5	1
7	Integration Testing	6	2
8	Interface Testing	4	2
9	Final Testing	7, 8	3

Construct a Gantt chart for the program development using the tasks and dependencies above.

- (b) The program makes use of a 2-D array.

Using a programming language of your choice, write code to declare a 2-D array, called `lottery`, to represent the lottery entries.

1

4. (continued)

(c) The pseudocode design for the program is shown below.

1. Declare lottery 2-D array
2. Declare entryTemp 1-D array
3. For entry from 0 to 24 do
4. randomly generate an entry and store in entryTemp
5. sort entryTemp into ascending order
6. write entryTemp into lottery 2-D array
7. End for

Each time step 4 is completed an array `entryTemp` is filled with randomly generated values.

<code>entryTemp</code>	59	47	32	12	19	18
------------------------	----	----	----	----	----	----

Step 5 uses the insertion sort to put the contents of `entryTemp` into ascending order. Pseudocode for step 5 is show below.

- 5.1 `temp = 0`
- 5.2 `index = 0`
- 5.3 for `i = 1` to `4` do
- 5.4 _____
- 5.6 SET `index` TO `i`
- 5.7 _____
- 5.8 _____
- 5.9 SET `index` TO `index - 1`
- 5.10 END WHILE
- 5.11 _____
- 5.12 END FOR

Write the missing pseudocode for steps 5.4, 5.7, 5.8 and 5.11

4

(d) The procedure `createEntry(entryTemp)` is used to implement line 4 of the design.

This procedure

- Randomly assigns values from 1 to 59 to a variable `temp`.
- Checks `temp` isn't equal to the values already stored in the array `entryTemp`, if it is another value is chosen at random until one is found that isn't in `entryTemp`.
- Writes `temp` to the array `entryTemp`.
- Does this for each cell in the array so that when finished the array is filled with 6 unique values.

Using pseudocode, design the procedure `createEntry`.

5

[END OF SECTION 1]

[Turn over

Section 2 - DATABASE DESIGN AND DEVELOPMENT - 20 marks

Attempt ALL questions

5. The structure of a relational database is shown below.

Team	TeamRegistration	Player
<u>teamID</u> teamName	<u>regID</u> teamID* playerID* mainTeam	<u>playerID</u> playerFirstname playerLastname

Some sample data from the TeamRegistration table is shown below.

regID	teamID	playerID	mainTeam
12082	225	10921	True

The following restrictions apply to the TeamRegistration table.

- A unique regID is automatically generated by the system whenever a new registration is added.
- When a player is added to the Player table, they are automatically assigned a unique playerID.
- When a team is added to the Team table, the team is automatically assigned a unique teamID.
- Each player has a mainTeam which is stored in a varchar attribute TeamRegistration.

Write the SQL statement used to create the structure of the TeamRegistration table. 3

6. A garage uses a database to manage cars, customers, appointments and services. The database allows the garage to set appointments to service the cars of their customers and to record how much the customer is charged.

The attributes of each table are listed below.

Customer	Car	Appointment	Service
<u>customerID</u> custName custMobile custEmail	<u>carReg</u> manufacturer model milage motDue customerID*	<u>carReg*</u> <u>serviceID*</u> apptDate apptTime labourcharge billedHours	<u>serviceID</u> type cost labourHourly

Explain why the Appointment table would benefit from the introduction of a surrogate key. 2

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[Turn over for Question 7

7. Z Cloud is a cloud-based gaming service. A team of developers is creating a database driven website as a core part of the gaming service. The website will allow customers to access and play their games.

Users can play a limited selection of games for free or can complete a registration and pay a subscription for access to all the games available.

- (a) Z Cloud is a new service and the development team want to review issues relating to the ability to stream games over different bandwidths and the quality of the user experience before proceeding to build it.

Name the type of feasibility that the development team are reviewing. Justify your answer.

1

- (b) To gain access to the full game library, a user must register and pay a subscription. When registering users must provide an email address, password and card payment details.

Anonymous users will be allowed to:

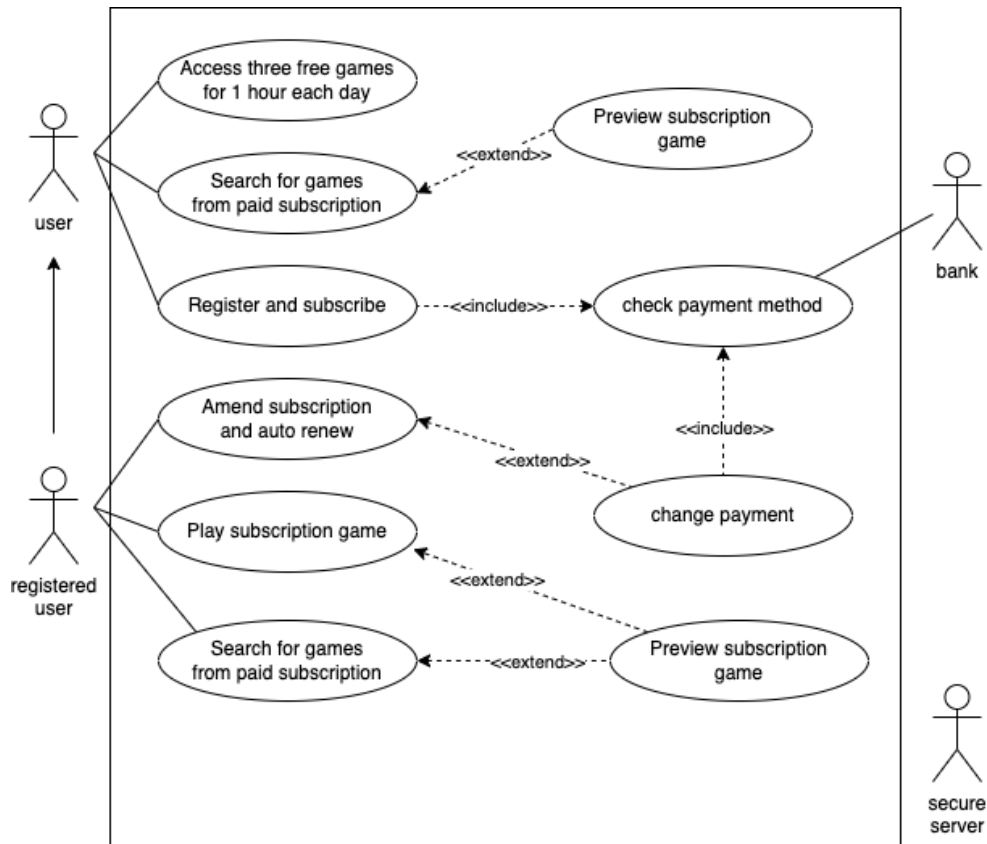
- Access three games with a limit of 1 hour of gameplay each day
- Access to search for games from paid subscription and preview information but cannot play the games
- Register and pay subscription using a secure payment method checked by the user's bank.

A registered user will be allowed to:

- Login to access their account by authenticating with a secure server
- Access all the available games with no limits on gameplay
- Access to search for games from paid subscription, preview and play the games
- Amend subscription information and auto-renew. If payment details change then the secure payment method is again checked by the user's bank.

7 (b) (continued)

A partially complete use case diagram is shown below.



(i) Explain why the relationship between “Search for games from paid subscription” and “Preview subscription game” is extend. 1

(ii) Draw part of the use case diagram that details the login for a registered user. 2

(c) The database driven website for the gaming service makes use of these entities.

- game (gameid, gametitle, rating)
- registeredUser(userID, email, firstname, lastname, password)
- subscription(userID*, startDate, endDate, paymentCard, autorenew)
- gameSession(gameID*, userID*, startDate, startTime, duration)

Once a game has been selected to play, a game session is started with the duration left blank. When the user stops playing the game, the time spent playing the game is calculated and duration is updated. This information is held in the gameSession entity.

Draw an entity-relationship diagram to represent the entities for the gaming service web site. 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.

[Turn Over

7. (continued)

- (d) Once the tables have been created, sample data is stored in the tables for testing.

The SQL query below will be used to display the registeredUsers who played the game "FutureShock" at least twice between 09:00 and 19:00 on 16/05/2023.

```
SELECT firstname, lastname
FROM registeredUser, gameSession, game
WHERE registeredUser.userID = gameSession.userID
AND game.gameID = gameSession.gameID
AND gameTitle = "FutureShock"
AND startDate = '2023-05-16'
AND startTime  '09:00' AND '19:00'
GROUP BY lastname, firstname
 ;
```

State the missing operator and clause labelled A and B.

2

- (e) A query is being designed to list the users, with a current subscription on "2023-02-06", who have played a 5-star rated game.

One possible design for this query is shown below.

Field(s)/ calculations	registeredUser.userID, registeredUser.firstname, registeredUser.lastname			
Table(s) Quer(-ies)	registeredUser, gameSession, game			
Search criteria	game.rating = 5 AND	Inner query	Field(s)/ calculations	userID
	<input type="text" value="C"/>		Table(s)	subscription
			Search criteria	<input type="text" value="D"/>
Group by	registeredUser.userID			

- (i) State the missing search criteria labelled C.

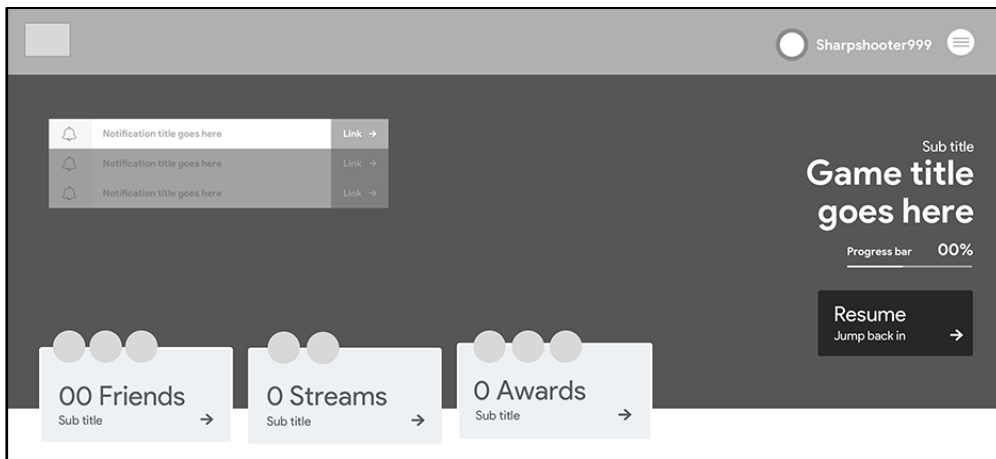
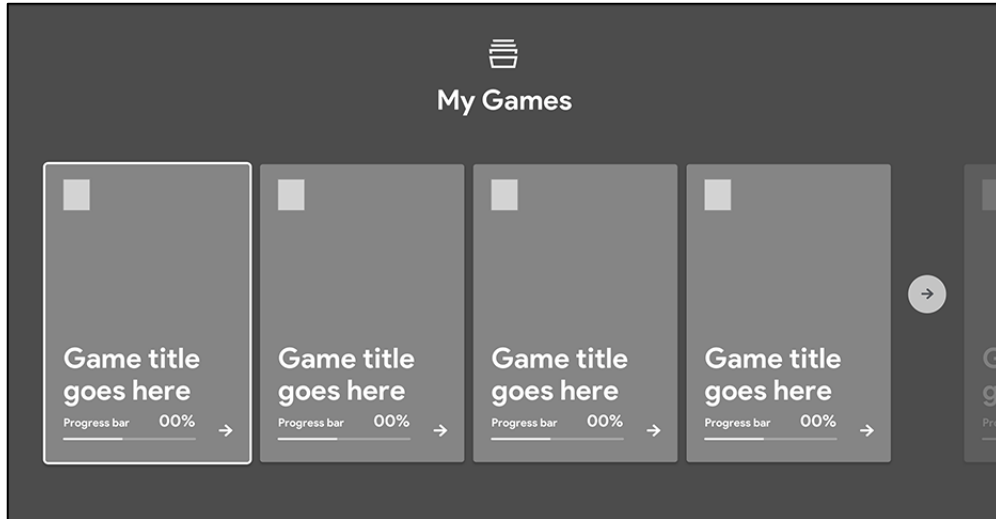
1

- (ii) State the missing search criteria labelled D.


1

7. (continued)

- (f) During the development, Megan, a gamer and a key target audience for the service, works with Fatima, one of the developers. Megan views the following designs while working with Fatima.



- (i) Name and describe the type of testing that Megan and Fatima are doing. 2
- (ii) During End User Testing, Fatima makes use of this document.

	<p>Name: Jeremy Smith <i>Retired, 65 years old, London, England</i></p> <p>His Needs: Wants to be able to play games at his leisure and has a slow internet connection so does not want to download things.</p>
	<p>Frustrations: Just wants to play games and does not want to wait for technology. Limited tech knowledge so needs an intuitive interface and help centre.</p>

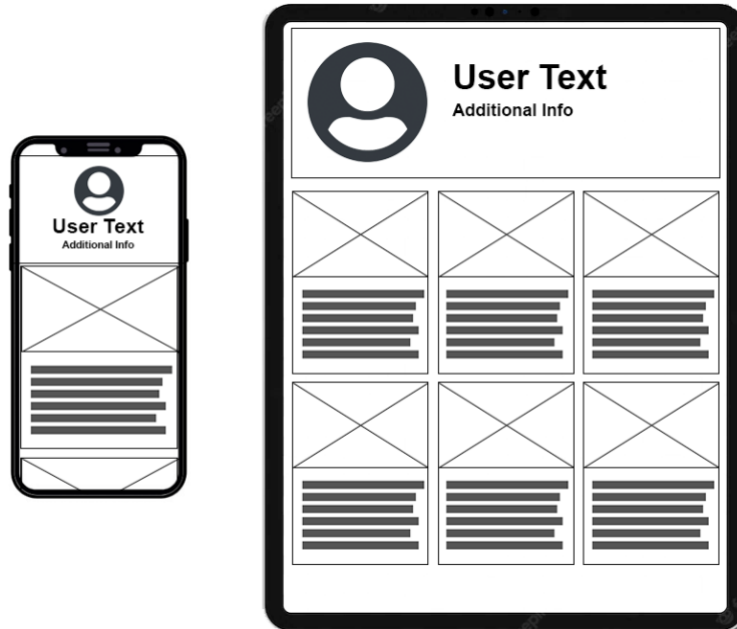
Name this document and explain how it is used as part of end user testing. 1

[END OF SECTION 2]

SECTION 3 - WEB DESIGN AND DEVELOPMENT - 20 marks

Attempt ALL questions

8. Wireframes are used in the design of a website.



Explain the purpose of the following code.

```
.grid {
  float:left;
  width: 33%;
}
@media screen and (max-width: 480px) {
  .grid {
    width: 100%;
  }
}
```

2

9. A website uses PHP to create a user tracking system. The code below is used in a page.

```
$_SESSION["pathway"] = "home->sales->dresses";
```

Explain the use of session variables and the code required to begin and end these sessions.

3

10. Z Cloud is a cloud-based gaming service. A team of developers is creating a database driven website as a core part of the gaming service. The website will allow customers to access and play their games.

Users can play a limited selection of games for free or can complete a registration and pay a subscription for access to all the games available.

- (a) Z Cloud is a new service and the development team want to review issues relating to the delivery of the service and the quality of the user experience before preceding to build it.

Name the type of feasibility that the development team are reviewing. Justify your answer.

1

- (b) To gain access to the full game library, a user must register and pay a subscription. When registering users must provide an email address, password and card payment details.

Anonymous users will be allowed to:

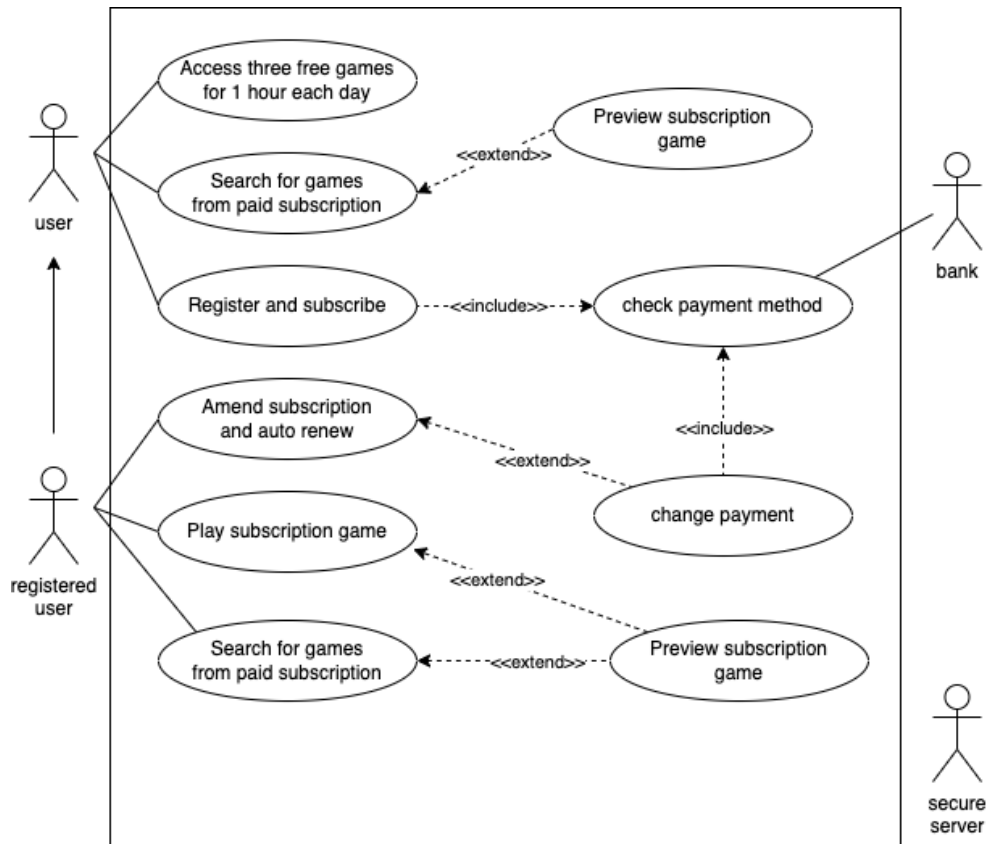
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10. (b) (continued)

A partially complete use case diagram is shown below.



- (i) Explain why the relationship between “Search for games from paid subscription” and “Preview subscription game” is extend. 1
 - (ii) Draw part of the use case diagram that details the login for a registered user. 2
- (c) The PHP script `userLogin.php` is used to verify a user’s login credentials. The script also forms a connection with the secure server to access the database. The script:
- Assigns the connection details to server-side variables
 - Creates a connection call `$conn` with the database server

Write the PHP code required to complete these two tasks. Your code will make use of the following access details.

```

servername = "sql.local"
username = "webclient"
Password = "Play1927"
Database = "ZCloud"
    
```

2

10. (continued)

- (d) The database table `game` is used to store details of games available in the service. Some sample data from this table is shown below.

game			
gameID	gameTitle	genre	rating
12	High School Simulator	Simulation	2
27	FutureShock	Shooter	4
45	Star Trip	RTS	3

A query is used to display details of games of the "Action" genre that have a rating of 5.

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

Line 84 `$qstring = "SELECT gameTitle, rating FROM game WHERE genre = "Action" AND rating = 5;`

Line 85 `//run query and store data in $gamedata`

Line 86 `$gamedata =`

A

Line 87 `//check there is data to display`

Line 88 `If (`

B

`) > 0 {`

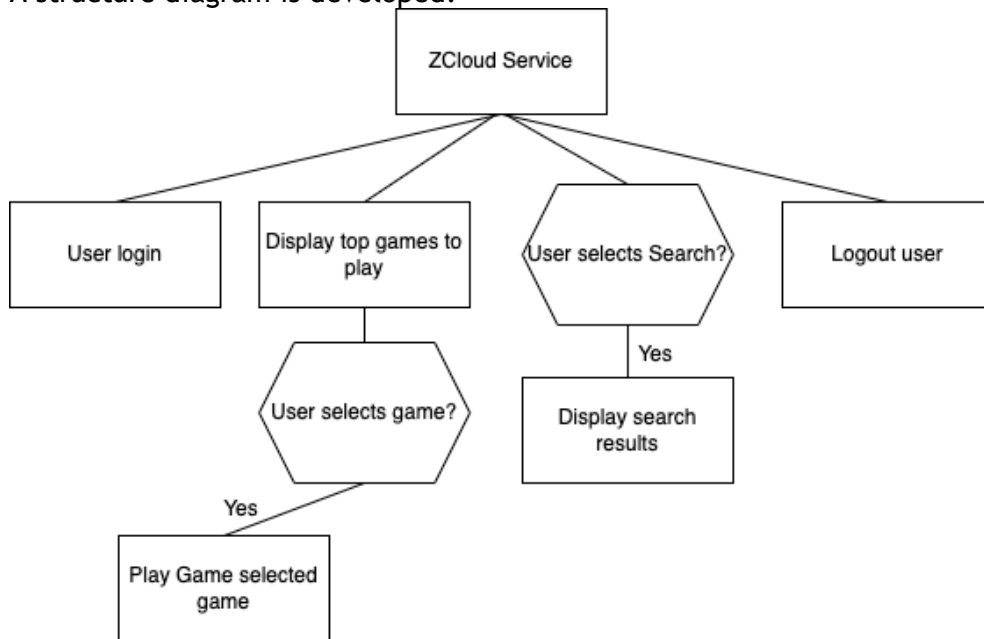
Line 89 `//code to display data`

- (i) Write the PHP code needed to complete A (line 86). 2
- (ii) Write the PHP code needed to complete B (line 88). 2

10. (continued)

- (e) A user should be able to:
- log into the service, and then repeatably:
 - select a game from those listed on the website to play, or
 - search for a specific game
 - play the game and, when done,
 - be able to select or search another game or log out.

A structure diagram is developed.

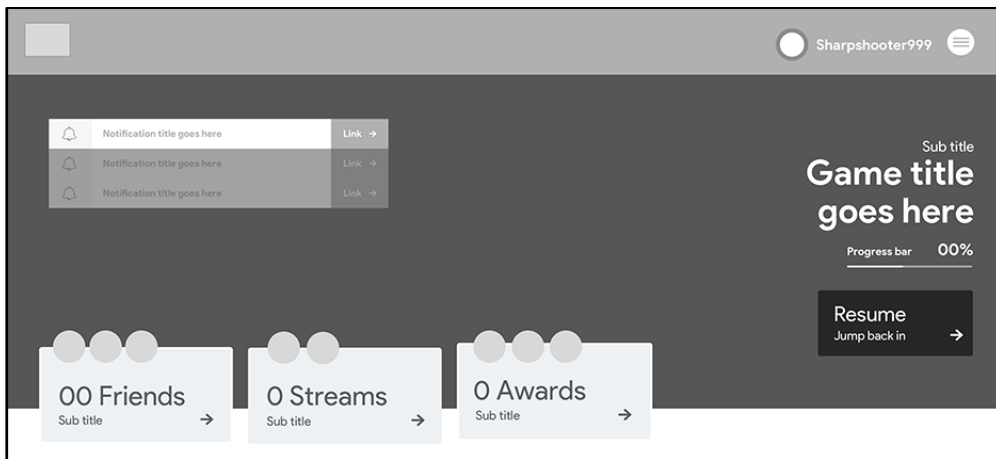
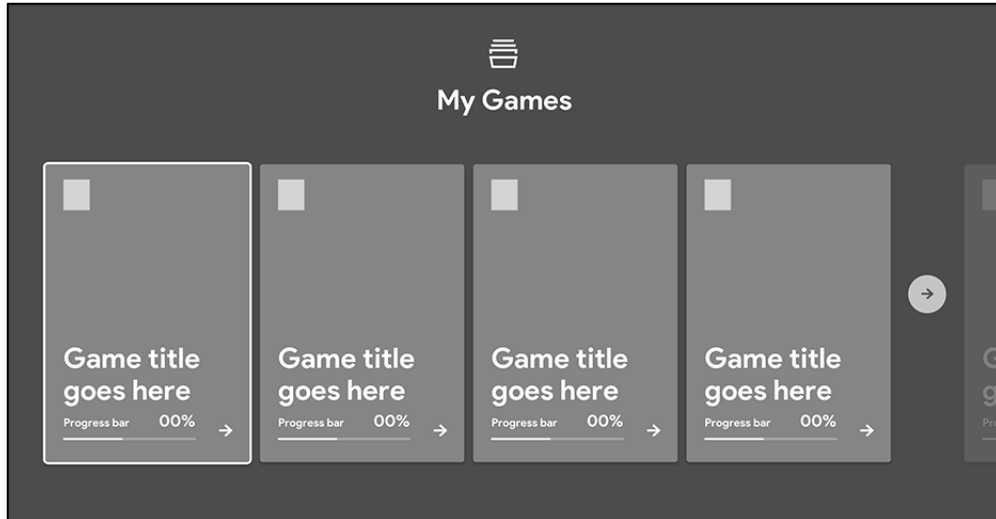


Explain why this structure diagram is not fit for purpose.

2

10. (continued)

- (f) During the development, Megan, a gamer and a key target audience for the service, works with Fatima, one of the developers. Megan views the following designs while working with Fatima.



- (i) Name and describe the type of testing that Megan and Fatima are doing. 2
- (ii) During End User Testing, Fatima makes use of this document.

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Name this document and explain how it is used as part of end user testing. 1

[END OF SECTION 3]

[END OF QUESTION PAPER]

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