1. OCR DogCare look after dogs while their owners are at work. They use a program developed in an object-oriented paradigm to store details about each dog.

Each dog is declared by using an instance of the class `Dog`. This has these private attributes:

- `name`
- `breed`
- `height`
- `weight`

The constructor method sets all the attributes to the values passed in as parameters.

Write pseudocode or program code to define the class `Dog`. You should include the attributes and constructor method.

You **do not** need to write the set or get methods.

[5]

2. An embedded system is often a small device that is designed to carry out a limited number of specialised tasks. Professional athletes sometimes wear small embedded systems called fitness trackers in their shirts. These can be used to track their speed, position, heart rate and other performance data during an event. The tracker transmits this data to a pitch-side server which collates the data from all the athletes.

The fitness trackers will send athletes' performance data to a pitch-side server. A program needs to be developed to analyse this data and display the results.

Different words, colours and charts will be displayed to indicate how well athletes are performing.

The program will be used by athletes from different cultures all over the world.

Discuss the layout considerations that the programmer needs to consider when creating the program user interface for different cultures.

You should include the following in your answer:

- layout considerations
- colour considerations
- character set considerations.

[9]

3(a). The Fibonacci sequence is a series of numbers. It starts with the number 0 and then 1. Each number after that is a sum of the two numbers before it.

The first seven numbers in the series are:
0
1
1 (i.e. 1 + 0)
2 (i.e. 1 + 1)
3 (i.e. 1 + 2)
5 (i.e. 2 + 3)
8 (i.e. 3 + 5)

Orla has written some code to show the first five numbers in the Fibonacci sequence (0,1,1,2,3) using the Little Man Computer (LMC) instruction set.

The LMC code that Orla has written contains an error.

```
START       LDA       MAX
            BRZ       END
            LDA       A
            OUT
            ADD       B
            STA       B
            LDA       B
            STA       A
            LDA       MAX
            SUB       ONE
            STA       MAX
            BRA       START
END         HLT
A           DAT       0
B           DAT       1
MAX         DAT       5
ONE         DAT       1
```

i. State the **five** outputs that Orla's code would give.

Output 1 _____

Output 2 _____

Output 3 _____

Output 4 _____

Output 5 _____

[3]

ii. Orla has rewritten her LMC code to fix the error and added an additional `DAT`.

Complete the LMC code to output the first five correct numbers in the Fibonacci sequence (0,1,1,2,3).

```
START               LDA             MAX
                    BRZ             END
                    LDA             A
                    OUT
                    ......................
                    STA             TEMP
                    ......................
                    ADD             B
                    STA             B
                    ......................



                    STA             A
                    LDA             MAX
                    SUB             ONE
                    STA             MAX
                    BRA             START
END                 HLT
A                   DAT             0
B                   DAT             1
 .................  DAT             0
MAX                 DAT             5
ONE                 DAT             1
```

[4]

(b). In Orla's LMC code, she used direct memory addressing.

Give **three** other modes of memory addressing.

1 _____

2 _____

3 _____ **[3]**

(c). Since the development of high level languages, the use of assembly languages has reduced.

Give **two** reasons why in some circumstances programmers will choose to write code in assembly language.

1 _____

_____

2 _____ **[2]**

4(a). A treasure game is being programmed using an object-oriented paradigm.

A class, `Treasure`, is used to store the treasure objects.

The design for the `Treasure` class, its attributes and methods is shown here.

`class: Treasure`

`attributes:`
`private value : integer`
`private level : string`

`methods:`
`new()`
`function getValue()`
`function getLevel()`

i. The constructor method takes a value as an integer, e.g. 100, and a level, e.g. "bronze", as parameters and assigns these to the attributes.

Write pseudocode or program code to declare the class `Treasure`.

You should define the attributes and constructor method in your answer.

You do **not** need to write the get methods.

_____

_____

_____

_____

_____

[5]

ii. The get method `getLevel()` will return the appropriate attribute.

Write the method `getLevel()` using either pseudocode or program code.

[2]

iii. Describe the object-oriented programming technique being used in part **9(b)(ii)**.

[2]

(b). Describe **two** benefits of using an object-oriented paradigm rather than a procedural paradigm.

1

2 _____

_____

_____

[4]

5. Describe **two** differences between assembly language and high-level languages.

Difference 1 _____

_____

_____

_____

Difference 2 _____

_____

_____

[4]

6. A program is written using an object-oriented programming paradigm and uses a class called `video` to organise videos that are streamed to customers.

The class `video` has these attributes:

- name
- number of views
- star rating.

The constructor method will set the name attribute to the name that is passed in as a parameter. The constructor will also initially set the number of views to 0 and the star rating to 3.

i. Write program code or pseudocode to declare the class `video` and initialise the required attributes as private.

You should include **both** the attribute definitions and the constructor method in your answer.

_____

_____

_____

_____

_____

_____

_____

[7]

ii. A public method called `updateviews()` will update the number of views after a video has been viewed. This method is defined inside the `video` class.

Write program code or pseudocode for the method `updateviews()` to increase the number of views by one.

[2]

7. Fig. 1 shows assembly code written using the Little Man Computer (LMC). The program calculates and outputs the total amount that is donated to a charity in any particular day.
Depending on the amount, an additional bonus may be added to each amount donated.

```
start      INP
           STA donation
           SUB hundred
           BRP bonus
nobonus    LDA total
           ADD donation
           STA total
           OUT
           BRA start
bonus      LDA total
           ADD donation
           ADD twenty
           STA total
           OUT
           BRA start
hundred    DAT 100
twenty     DAT 20
donation   DAT 0
total      DAT 0
```

Fig. 1

i. The program shown in **Fig. 1** is run **once** using **three** different inputs. Therefore, while the program is running once, it will output the updated total three times.

Give the total values that are output when the values **10**, **50** and **120** are input into this program.

Output for 10 _____

Output for 50 _____

Output for 120 _____

[3]

ii. Write LMC code that will reset the value of the memory location labelled `total` to zero and then stop the program.

_____

_____

_____

_____

_____

_____

_____

[4]

iii. This program is run on a processor that allows pipelining.

Define the term 'pipelining'.

_____

_____

_____

_____

_____

[3]

iv. Explain **one** benefit to a charity of using a processor that allows pipelining.

_____

_____

_____

[2]

8.

An object-oriented system is implemented to organize a company's information about staff attendance. Classes, objects, methods and attributes are used in this system.

i. State the meaning of each of the following terms:

Object _____

_____

Method _____

_____

Attribute _____

_____

[3]

ii. Each worker has a name and an attendance figure which can be between 0 and 100.

Write a definition for a fully encapsulated worker class, providing both get and set methods for all attributes. You do **not** have to write code for the constructor method.

[5]

9(a). * In assembly language, different modes of addressing memory can be used.

Discuss the different modes used. You should include:

- How the operand value is determined
- What an operand of `27` would refer to in that mode
- The reasons for requiring multiple modes of addressing **[12]**

(b). A program written using the Little Man Computer instruction set is shown in **Fig. 1**.

```
         INP
         STA  numone
         INP
         STA  numtwo
main     LDA  numone
         SUB  numtwo
         BRP  pos
notpos   LDA  count
         OUT
         LDA  numone
         OUT
         HLT
pos      STA  numone
         LDA  count
         ADD  one
         STA  count
         BRA  main
numone   DAT
numtwo   DAT
one      DAT  1
count    DAT  0
```

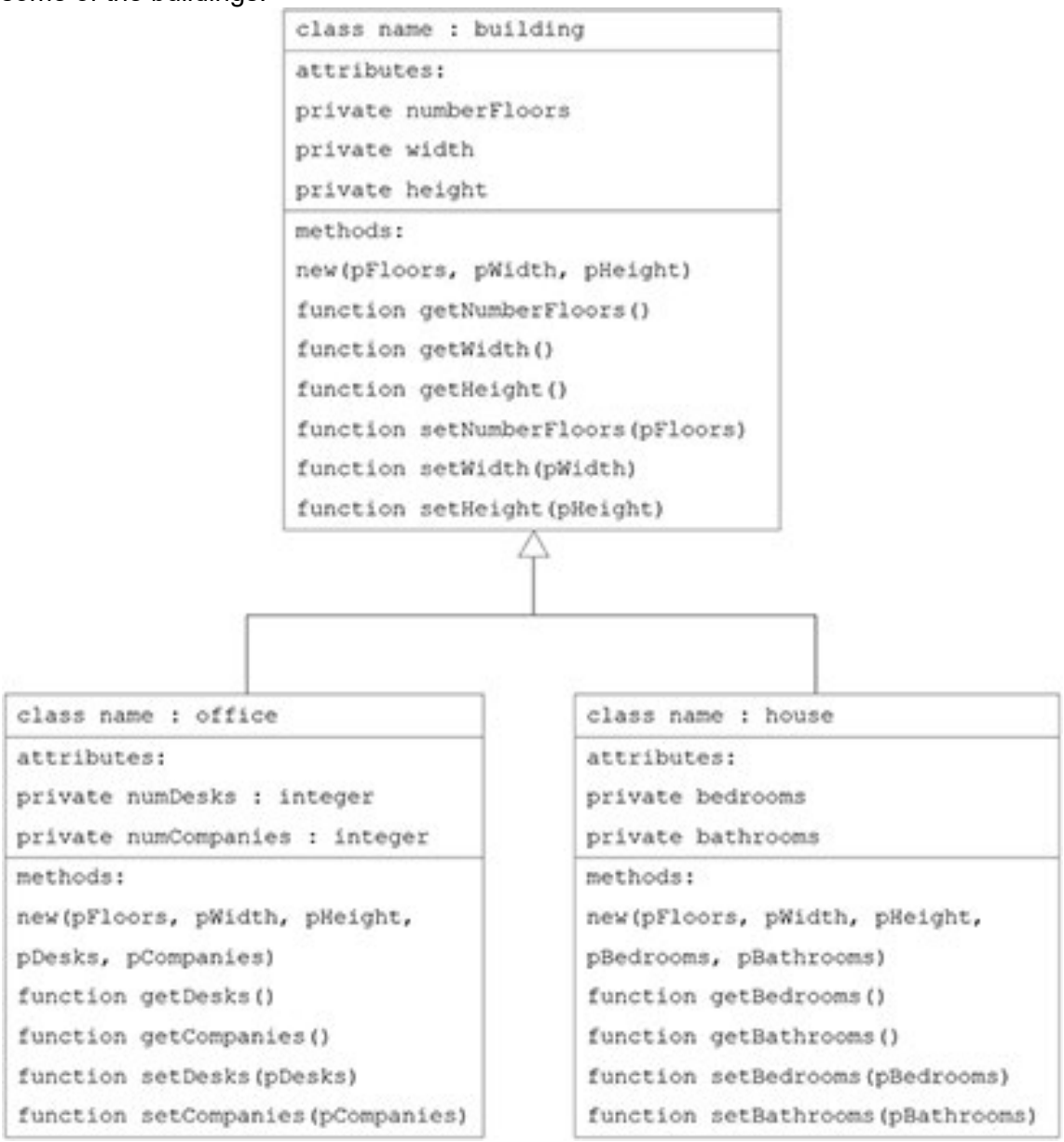
Fig. 1

Complete the table below to show the output(s) from this program given the inputs.

Inputs	Output(s)
12, 5	
18, 2	
16, 4	
3, 7	

[4]

10(a). Christoff is writing a program to simulate a city using object-oriented programming. He is designing classes to store different types of buildings and their location on the road. He has created the following plan for some of the buildings:



The classes `office` and `house` inherit from `building`.

Describe what is meant by inheritance with reference to these classes.

[2]

(b). Part of the declaration for the class `building` is shown.

Complete the pseudocode declaration by filling in the missing statements.

```
class building
    private numberFloors
    private width
    private ……
    public procedure new(pFloors, pWidth, pHeight)
       numberFloors = ……
       width = pWidth
       height = pHeight
    endprocedure
    public function getNumberFloors()
       return ……
    endfunction
    public function setNumberFloors(pFloors)
       /sets the value of numberFloors when the parameter is >= 1
       /returns true if numberFloors is successfully changed,
       /returns false otherwise
       if pFloors >= 1 then
         numberFloors = ……
         return true
       else
         return ……
       endif
    endfunction
endclass
```

[5]

(c). Write program code or pseudocode to declare the class house.
Define the attributes and constructor method in your answer. You do **not** need to write the get or set methods.

[6]

(d). Christoff develops a new class to store the houses in one road. His class design is shown:

class : houseRoad
attributes: private buildings(100) /array of class house private numberBuildings /records the number /of houses currently stored in the array /buildings
methods: new(building) function getBuilding(buildingNum) procedure newbuilding(pBuilding)

The method `newbuilding()` takes a new building as a parameter, and stores this in the next free space in the array `buildings`.

Write pseudocode or program code for the method `newbuilding()`.

[4]

(e). Christoff wants to create a new `house` called `houseOne`. It has the properties: 2 floors, 8(m) width, 10(m) height, 3 bedrooms and 2 bathrooms.

The house is located on a road with the identifier `limeAvenue` of type `houseRoad`, `houseOne` is the first house in this road.

Write pseudocode or program code to declare the house `houseOne`, road `limeAvenue` and assign `houseOne` to the first array position in the road.

[4]

(f). The method `new` is used to denote the constructor for each class.

State the purpose of the constructor.

[1]

11. The pseudocode function `binarySearch()` performs a binary search on the array `dataArray` that is passed as a parameter. The function returns the array index of `searchValue` within the array, and `-1` if it is not in the array.

The pseudocode binary search algorithm is incomplete.

i. Complete the algorithm by filling in the missing statements.

```
function binarySearch(dataArray:byref, upperbound, lowerbound, ……)
  while true
    middle = lowerbound + ((upperbound - lowerbound) ……)
    if upperbound < lowerbound then
      return ……
    else
      if dataArray[middle] < searchValue then
        lowerbound = ……
      elseif dataArray[middle] > searchValue then
        upperbound = ……
      else
        return ……
      endif
    endif
  endwhile
endfunction
```

[6]

ii. The algorithm uses a while loop.

State a different type of loop that could be used instead of the while loop in the given algorithm.

---**[1]**

12(a). A supermarket uses an object-oriented approach to organise items that it offers for sale. Part of the class definition for the `ItemForSale` class is shown below.

```
class ItemForSale
      public itemName
      public price
      public discount

      …

endclass
```

The `discount` attribute represents a percentage discount on the price. The discount can be between 0 and 50 (inclusive). All new items for sale initially have a discount value of 0.

i. Write the constructor method for the `ItemForSale` class.

---**[4]**

ii. Write a line of code to create an object of type `ItemForSale` called `mushypeas` that has a name of "mushy peas" and a price of £0.89

---**[3]**

iii. Write the `calculatePrice()` method, which applies the percentage discount to the price and returns the new value.

[3]

(b). The supermarket has previously had issues with discounts being set as values above 50.

Explain how encapsulation could be applied to the `ItemForSale` class to stop this problem from occurring.

You are **not** expected to write any code in your answer to this question.

[3]

(c). Some items in the supermarket are only available through home delivery. These items are the same as `ItemsForSale` with the following exceptions:

- the supermarket also stores the location of the stock
- the percentage discount allowed is up to 75 rather than the standard 50.

Explain how inheritance can be used to implement the above requirements.

[4]

13. The Little Man Computer (LMC) instruction set can be used to write programs using assembly language.

Fig. 3 shows assembly code written using the LMC instruction set.

```
          INP
          STA X
          SUB Y
          BRP jump
          LDA X
          STA Z
          HLT
jump      LDA Y
          STA Z
          HLT
X         DAT 0
Y         DAT 5
Z         DAT 0
```

Fig. 3

i. Tick **one** box to indicate the programming construct that is **not** used in **Fig. 3**.

Sequence ☐

Selection ☐

Iteration ☐

[1]

ii. When the program is run, 7 is input by the user.

State the value that will be in the memory location `Z` when the program has run with this input.

_____ **[1]**

iii. Write an equivalent version of the LMC assembly code shown in **Fig. 3** for a procedural programming language.

You should write your code using pseudocode or program code.

[4]

14(a). A printer buffer is a storage area that holds the data, known as jobs, that are to be printed by a printer.

A simulation of the printer buffer uses a queue data structure to store jobs that are waiting to be printed. The queue is not circular.

The printer buffer is represented as a zero-indexed 1D array with the identifier `buffer`.

Fig. 2 shows the current contents of the queue `buffer` and its pointers.

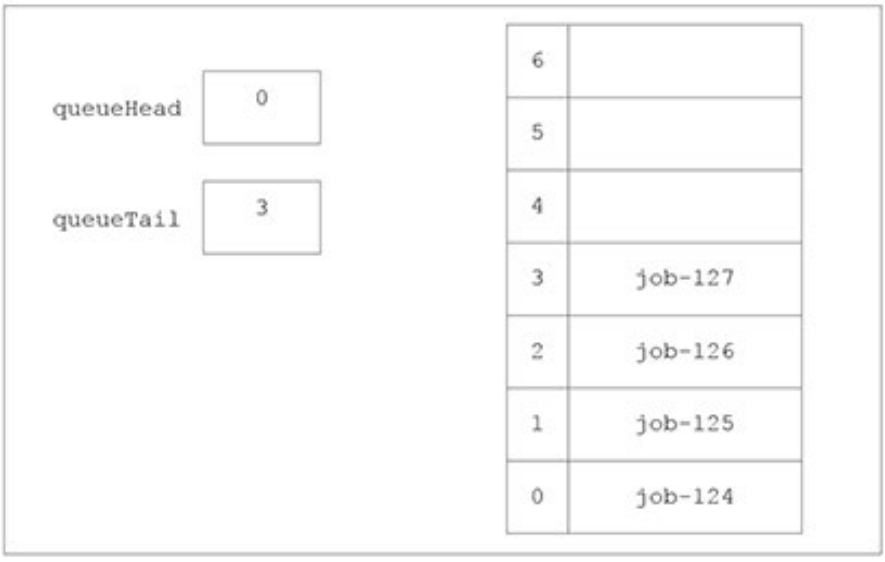


Fig. 2

State the purpose of the pointers `queueHead` and `queueTail`.

`queueHead` _____

_____

`queueTail` _____

_____

[2]

(b). The function `dequeue` outputs and removes the next data item in the queue.

The procedure `enqueue` adds the job passed as a parameter to the queue.

Show the final contents of the queue and pointer values after the following instructions have been run on the queue `buffer` shown in **Fig. 2**.

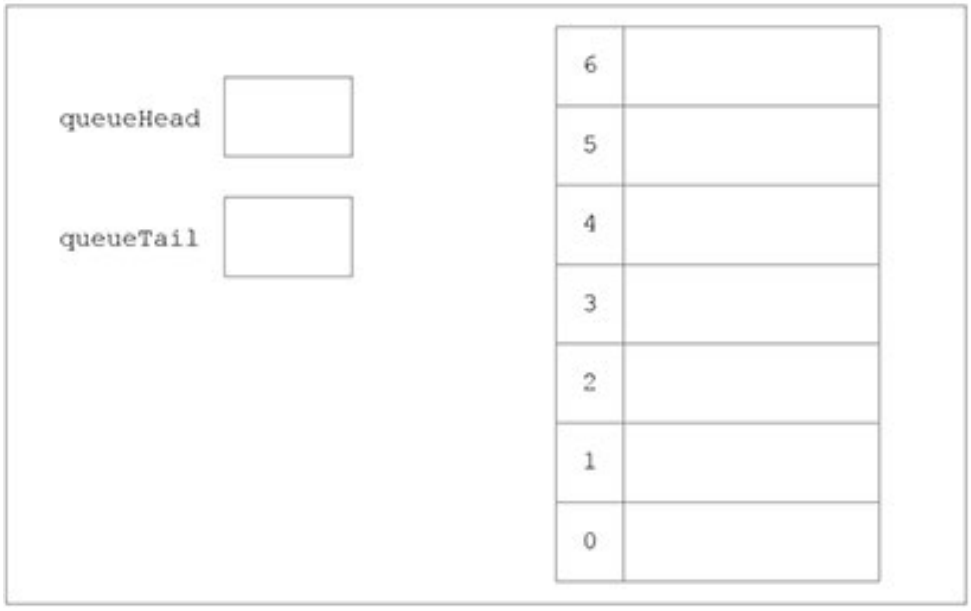
```
dequeue()

dequeue()

enqueue(job-128)

dequeue()

enqueue(job-129)
```



[5]

(c). The array, `buffer` and pointer values are declared with global scope.

i. The function `dequeue` returns `null` if the array is empty, and the contents of the next element if not empty. The queue is not circular.

Write an algorithm, using pseudocode or program code, for the function `dequeue()`.

[5]

ii. The function `enqueue` returns -1 if there is no space at the end of the queue to add data, and returns 1 if the parameter was added to `buffer`. The array `buffer` contains a maximum of 100 elements.

Write an algorithm, using pseudocode or program code, for the function `enqueue()`.

[6]

iii. In the main program of the simulation the user is asked whether they want to add an item to the queue or remove an item.

If they choose to add an item they have to input the job name, and the function `enqueue` is called.

If they choose to remove an item, the function `dequeue` is called and the job name is output.

Appropriate messages are output if either action cannot be run because the queue is either empty or full.

Write, using pseudocode or program code, an algorithm for the main program of the simulation.

[8]

(d). The queue is changed to make it a circular queue.

Describe how the functions `enqueue` and `dequeue` will need to be changed to allow `buffer` to work as a circular queue.

[3]

(e). Some print jobs can have different priorities. The higher the priority the sooner the job needs to be printed.

Describe how the program could be changed to deal with different priorities.

[3]

15. Two people play a counting game. The rules of the game are as follows:

- The first player starts at 1
- Each player may choose one, two or three numbers on their turn and the numbers must be in ascending order
- Players take it in turns to choose
- The player who chooses “15” loses the game.

For example, if the first player chooses three numbers (1, 2, 3) then the second player could choose one number (4), two numbers (4, 5) or three numbers (4, 5, 6). The first player then takes another go.

Write an algorithm using pseudocode that allows two players to play this game. The algorithm should:

- Alternate between player 1 and player 2
- Ask the player how many numbers they would like to choose, ensuring that this is between 1 and 3
- Display the numbers that the player has chosen
- Display a suitable message to say which player has won once the number 15 has been displayed.

[8]

16. * Procedural programming and object-oriented programming are two paradigms commonly used by programmers when developing computer games.

Discuss the advantages of using object-oriented programming over procedural programming when developing computer games. You should refer to inheritance, encapsulation and polymorphism in your answer.

[12]

END OF QUESTION PAPER