

RIVER VALLEY HIGH SCHOOL
General Certificate of Education Advanced Level
Higher 2
JC2 Preliminary Examination

COMPUTING

Paper 1

9569/01

18 Sep 2020

3 hours

Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your center number, index number and name on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

If you need additional answer paper ask the invigilator for a continuation booklet.

Answer **all** questions.

Approved calculators are allowed.

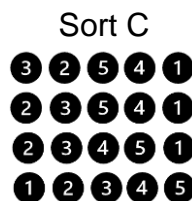
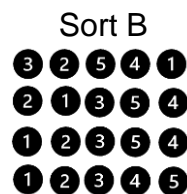
The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 100.

This document consists of **9** printed pages.

Answer **all** questions.

1. The following describes the decision-making process of a man who witnesses offender(s) plucking flowers in a public garden park.
 - If the offender group has more than 3 persons and the park ambassador is within 50 m in radius, the man would seek the ambassador to educate the offender.
 - If the offender group has more than 3 persons and the park ambassador is not within 50 m, the man would walk away quietly only if the offenders are adults.
 - Any other cases, the man would educate the offender(s) gently.
 - a) Create a decision table to show these conditions and actions. [5]
 - b) Simplify your decision table by removing redundancies from the decision table. [2]
2. The diagram below shows how five numbered black balls are sorted using different sorting algorithms A, B C and D.



- a) State the name and the time complexity for each sorting algorithms illustrated above. [4]
- b) Describe a more efficient algorithm to sort the same 5 balls. State the time complexity. [2]

3. The Fisher–Yates shuffle is an algorithm for generating a random permutation of a finite sequence—in plain terms, the algorithm **shuffles** the sequence. The recursive version of the algorithm that shuffles an integer sequence is implemented as follow.

```
import random

def fisher_yates_shuffle(lst, end):
    if end > 0:
        i = random.randint(0, end)
        temp = lst[i]
        lst[i] = lst[end]
        lst[end] = temp
        fisher_yates_shuffle(lst, end - 1)

>>> lst = [1, 2, 3, 4, 5, 6, 7, 8, 9]
>>> fisher_yates_shuffle(lst, len(lst)-1)
[7, 3, 1, 5, 9, 6, 8, 2, 4] #the items are shuffled randomly
```

- a) Write in pseudo-code or in Python, the iterative version of the function `fisher_yates_shuffle`. You can modify the inputs of the function. [4]
- b) Draw a flow chart of the of the iterative version of the function. [4]
- c) The modified version of the shuffle function allows all integers in the sequence with value `-1` not to be affected by the shuffling. For example:

```
>>> lst = [-1, 2, 3, -1, 4, 5, 8, 9, 1, 7, 6, -1]
>>> fisher_yates_shuffle_modified(lst, len(lst)-1)
[-1, 5, 9, -1, 2, 7, 8, 4, 3, 6, 1, -1]
```

Take note that the positions of `-1` are not changed, but the rest of the numbers are shuffled. Below are more examples of the same function call. Also take note that the position(s) of `-1` can anywhere in the sequence.

```
[-1, 1, 5, -1, 2, 9, 3, 7, 6, 4, 8, -1]
[-1, 5, 3, -1, 1, 7, 8, 2, 6, 4, 9, -1]
[-1, 5, 1, -1, 4, 6, 2, 3, 8, 7, 9, -1]
[-1, 9, 4, -1, 1, 5, 8, 3, 7, 6, 2, -1]
[-1, 6, 2, -1, 8, 1, 4, 5, 9, 7, 3, -1]
[-1, 8, 1, -1, 5, 7, 4, 3, 6, 2, 9, -1]
```

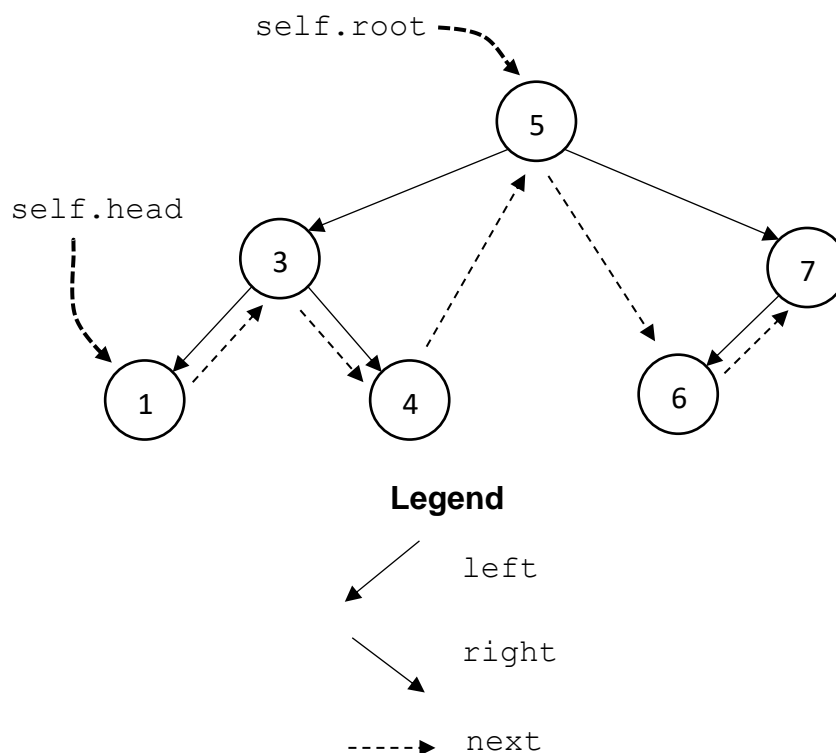
Write in pseudo-code or in Python, the modified version of the function `fisher_yates_shuffle_modified`. You can assume that the number sequence does not contain consecutive `-1`s. [4]

4. A new user-defined data structure has both the characteristics of a sorted linked list and a binary search tree. The data structure is designed to store integers only. It is implemented using the class `myNode` and `myDataStructure`.

```
class myNode:
    def __init__(self, data):
        self.data = data # the node data
        self.left = None # Pointer to the left child
        self.right = None # Pointer to the right child
        self.next = None # Pointer to the next node in
                          # the sorted linked list

class myDataStructure:
    def __init__(self):
        self.root = None # Pointer to the root of BST
        self.head = None # Pointer to sorted linked list
```

The diagram below illustrates the content of the data structure when integers 5, 3, 1, 7, 6 and 4 are inserted in the same order in it.



The class functions of class `myDataStructure` is given below in Python. Study them carefully and answer question **4a** to **4c**.

```
def func1(self, newNode):
    def helper(currNode, node):
        if currNode == None:
            return node
        else:
            if currNode.data > node.data:
                node.next = currNode
                return node
            else:
                currNode.next = helper(currNode.next, node)
                return currNode

    if self.head:
        self.head = helper(self.head, newNode)
    else:
        self.head = newNode

def func2(self, node):
    def helper(root, node):
        if root.data > node.data:
            if root.left == None:
                root.left = node
            else:
                helper(root.left, node)
        else:
            if root.right == None:
                root.right = node
            else:
                helper(root.right, node)
    if self.root:
        helper(self.root, node)
    else:
        self.root = node

def func3(self, data):
    node = myNode(data)
    self.func1(node)
    self.func2(node)

def func4(self):
    def helper(node):
        if node:
            print(node.data)
            helper(node.left)
            helper(node.right)
    helper(self.root)
```

```

def func5(self):
    def helper(node):
        if node:
            print(node.data)
            helper(node.next)
    helper(self.head)

def func6(self):
    def helper(currNode):
        if not currNode.left:
            return currNode
        else:
            return helper(currNode.left)
    return helper(self.root)

def func7(self):
    def helper(currNode):
        if not currNode.right:
            return currNode
        else:
            return helper(currNode.right)
    return helper(self.root)

```

- a) Explain the purpose of **func1** to **func7** in class `myDataStructure`. [7]
 - b) Describe how you can improve the time complexity of **func1**. [2]
 - c) Describe how you can improve the time complexity of **func6**. [1]
5. The following questions are related to computer network.
- a) What does protocol define in computer networks? [3]
 - b) Explain the importance of protocol in computer network. [2]
 - c) Explain the TCP/IP model and the function of each layer with examples. [5]
6. The following questions are not related to each other.
- a) Suggest 4 ways to protect data at rest? [2]
 - b) What is the difference between back up and archive? [1]
 - c) What is the advantage of version control in software development? [2]

7. A clinic currently stores the patient records in flat files. These files contain information including personal particulars of patients, their treatment and prescription records etc.

Using examples from the clinic's flat files to illustrate your answers.

- a) Explain how data redundancy could arise. [2]
- b) Explain why data privacy could be a concern for flat file systems. [2]

Below is an example of the patient treatment record of the clinic.

Patient Treatment Record					
Record No:	RN001223	Date:	20200623	Time:	1430
Patient Information					
Patient ID:	P0002141	Name:	Xiao Ming	Gender:	Male
Contact:	92315482	Email:	xiao_ming@gmail.com		
Treatment Details					
Observations: Diarrhoea, slight headache ...					
Fever:	Yes/No	Blood Pressure:		High/Normal/Low	
Medicine Prescriptions					
Name	Instruction		Unit Price	Quantity	Subtotal
Panadol	After meals, 3 times/day		\$ 0.80	18	\$ 14.40
Loperamide	Before meals, 3 times/day		\$ 1.50	12	\$ 18.00
...
Total:				...	

To make things easier, you may assume that Subtotal and Total are calculated on the spot. Hence, there is no need to store these data into the database.

- c) You are required to design a relational database solution for the clinic. Identify the tables that will give a normalized solution. Show the process of normalization. [6]
- d) Based on your solution in (c), draw a fully labelled ER diagram to show how the entities are related. [3]

The following table is generated for the sales history of a medicine

Medicine Name:	Panadol	Date:	20200623
TreatmentRecord	Unit Price	Quantity	Subtotal
RN001223	\$ 0.80	18	\$ 14.40
RN001225	\$ 0.80	10	\$ 8.00
...

- e) To create the report, `MedicineName` and `Date` are used. Name other tables and fields that the database uses to produce this report. [4]

The clinic requested to include the data of patient's Medical Certificate (MC) to be included into the database too. Each time a patient visits the clinic, he may get an MC according to the doctor's advice. Each MC should contain the information of the starting date, and no. of days which the patient is deemed as unfit for duty.

- f)** Explain how this would affect the current database tables and the ER diagram. [3]

With the covid-19 situation, additional information of patients needed to be stored. The clinic also plans to expand the amount of digitalized data such as particulars of doctor and nurses, and pharmaceutical information of the medicines etc.

- g)** Compare based on the advantages and disadvantages of relational and non-relational databases, state and explain which database model you would choose to suit the needs of the clinic. [4]
- h)** The clinic would like to design a web application for patients to book their appointment slots online. State two features which may be designed to help the user to input data correctly and accurately. Give an example of data which would be input using each feature. [4]
- i)** To make the website more appealing, the front-end designer downloaded a professional looking bootstrap template. Explain why this could potentially violates the copyright law and suggest one possible alternative solution. [3]
- j)** A pharmaceutical company offers you an attractive amount for allowing them to access your database, so that they could better analyze and understand the needs of the patients. Refer to the Software Engineering Code of Ethics and Professional Practice, state and explain your course of action in response to such request. [2]

8. [Context of this question is a continuation of Qn 7]

An intern has written an erroneous procedure which aims to calculate the total for all the medicines prescribed. The argument `arr` contains an array of tuples. Each tuple stores information according to the following format:

```
(name: str, instructions: str, unit_price: float, quantity: int)
```

You may assume arrays and tuples in the following procedures follows 0-index.

```
01 PROCEDURE CAL_TOTAL(arr: ARRAY OF TUPLES):
02     DECLARE total: FLOAT
03     total = 0.0
04     FOR i in RANGE(LENGTH(arr)):
05         DECLARE sub_total: INT
06         sub_total = unit_price ** quantity
07         total += sub_total
08     END FOR
09 ND PROCEDURE
```

- a) By using the above code to illustrate your answer, explain the definition of the following types of program errors and suggest possible ways to fix the error:

[6]

- (i) Syntax Error
- (ii) Runtime Error
- (iii) Logic Error

- b) Suggest two useful debugging methods for the intern.

[2]

You are to implement an Object-Oriented solution to store information of medicines. Each medicine should have its **name**, **instruction**, **unit price** and **stock** stored. In addition, some medicine requires additional information:

For **liquid medicines**, the **volume** of liquid contained in each packaging needs to be stored.

For **injection medicines**, the **location** of injection needs to be stored.

- c) Draw a class diagram, with base class `Medicine`, showing:

- appropriate sub-classes
- inheritance
- the properties required
- appropriate methods, including **constructor** methods, and at least **one** pair of '**get**' and '**set**' methods for one of the properties.

[5]

- d) Using the above example, explain the meaning of the term **Polymorphism**.

[2]

- e) Using the above example, explain the meaning of the term **Inheritance**.

[2]

End of paper