READ THESE INSTRUCTIONS FIRST

Candidates should use this material in preparation for the examination. Candidates should attempt the practical programming tasks using their chosen high-level, procedural programming language.
This material is intended to be read by teachers and candidates prior to the June 2015 examination for 9608 Paper 4.

**Reminders**
The syllabus states:

- there will be questions on the examination paper which do not relate to this pre-release material
- you must choose a high-level programming language from this list:
  - Visual Basic (Console Mode)
  - Python
  - Pascal / Delphi (Console Mode)

The practical skills covered in Paper 2 are a precursor to those required in Paper 4. It is therefore recommended that the high-level programming language chosen for this paper is the same as that for Paper 2. This allows for sufficient expertise to be acquired with the opportunity for extensive practice.

Questions on the examination paper may ask the candidate to write:

- structured English
- pseudocode
- program code

A program flowchart should be considered as an alternative to pseudocode for the documenting of an algorithm design.

Candidates should be confident with:

- the presentation of an algorithm using either a program flowchart or pseudocode
- the production of a program flowchart from given pseudocode (or the reverse)
TASK 1

A linked list Abstract Data Type (ADT) has these associated operations:

- create linked list
- add item to linked list
- remove item from linked list

The linked list ADT consists of a linked list of nodes. Each node consists of data and a pointer to the next node.

TASK 1.1

Consider the use of a linked list to store names in alphabetical order.

The following sequence of operations is carried out:

CreateLinkedList
AddName("Nabila")
AddName("Jack")
AddName("Kerrie")
AddName("Sara")
RemoveName("Kerrie")
AddName("Zac")

Add appropriate labels to the diagram to show the final state of the linked list. Use the space on the left as a workspace. Show your final answer in the node shapes on the right:
**TASK 1.2**
The linked list is to be implemented as an array of records, where each record represents a node.

The `CreateLinkedList` operation links all nodes to form the free list and initialises the `HeadPointer` and `FreePointer`.

Complete the diagram to show the values of all pointers after the `CreateLinkedList` operation has been carried out.

Key focus: Implementation of linked lists using an array of records

<table>
<thead>
<tr>
<th>NameList</th>
<th>HeadPointer</th>
<th>Name</th>
<th>Pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>[1]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[2]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[3]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[4]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[5]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[6]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>...</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[49]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[50]</td>
<td></td>
</tr>
</tbody>
</table>

Write **pseudocode** for the `CreateLinkedList` operation.

Write **program code** from your pseudocode design.
TASK 1.3
Complete the diagram to show the values of all pointers after the following operations have been carried out:

AddName("Nabila")
AddName("Jack")
AddName("Kerrie")
AddName("Sara")
RemoveName("Kerrie")
AddName("Zac")
TASK 1.4
Complete the identifier table for the pseudocode given below.

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Array to store node data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name to be added</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pointer to next free node in array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pointer to first node in list</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pointer to current node</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pointer to previous node</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pointer to new node</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

01 PROCEDURE AddName(NewName)
02 // New name placed in node at head of free list
03   NameList[FreePointer].Name ← NewName
04   NewNodePointer ← FreePointer
05   FreePointer ← NameList[FreePointer].Pointer
06
07 // initialise current pointer to start of list
08   CurrentPointer ← HeadPointer
09
10 // check that it is not the special case of adding to empty list
11   IF HeadPointer > 0
12 // loop to locate position of new name
13 // saves current pointer and then updates current pointer
14     WHILE NameList[CurrentPointer].Name < NewName
15       PreviousPointer ← CurrentPointer
16       CurrentPointer ← NameList[CurrentPointer].Pointer
17   ENDWHILE
18
19 // check to see whether new name is first in linked list
20   IF CurrentPointer = HeadPointer
21     THEN
22       NameList[NewNodePointer].Pointer ← HeadPointer
23       HeadPointer ← NewNodePointer
24   ELSE
25     NameList[NewNodePointer].Pointer ← NameList[PreviousPointer].Pointer
26     NameList[PreviousPointer].Pointer ← NewNodePointer
27   ENDIF
28 ENDPROCEDURE
TASK 1.5
Write program code for the pseudocode given in Task 1.4.

TASK 1.6
The structured English algorithm for the operation to remove a name from the linked list is as follows:

If list is not empty
  Find the name to be removed
  If it is the first name in the linked list
    Adjust the head pointer
  If it is not the first name in the linked list
    Adjust pointers to exclude the name to be removed from the list
  Link released node into free list

TASK 1.6.1
Write the algorithm, as a procedure in pseudocode, from the structured English given above.

TASK 1.6.2
Write program code from your pseudocode design.

TASK 1.6.3
Test your program code for creating a linked list, adding and removing names, using the data given in Task 1.3.

Suggested extension task
Queues, stacks, binary trees and dictionaries can be implemented as linked lists of nodes.

Design pseudocode and write program code for these data structures.
TASK 2

A vehicle hire company has cars and trucks for hire.

The unique registration and the engine size (in litres, to the nearest 0.1 of a litre) are stored for all vehicles.

Data stored about cars also include the hire charge per day (in $) and the number of passengers allowed.

Data stored about trucks also include the hire charge per hour (in $) and the maximum payload (in kg).

Object-oriented software is to be written to process data about vehicles hired, including calculating the hire fee.

The superclass (also known as base class or parent class) Vehicle is designed.

Two subclasses (also known as derived classes or child classes) have been identified:

- Car
- Truck

Key focus: Object-oriented programming

TASK 2.1
Complete the inheritance diagram.
**TASK 2.2**
Complete the **class diagram** showing the appropriate properties and methods.

```

                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................

Constructor()
                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................
                      ........................................

Note: a constructor is a method that creates a new instance of a class and initialises it.

**TASK 2.3**
Write **program code** for the class definitions. Make use of polymorphism and inheritance where appropriate.

**TASK 2.4**
Write **program code** to create a new instance of Car.

**Suggested extension task**
Write **program code** to display the properties of the object you created in Task 2.4.
TASK 3

An intruder detection system is inactive when the power is switched off. The system is activated when the power is switched on. When the system senses an intruder the alarm bell rings. A reset button is pressed to turn the alarm bell off and return the system to the active state.

The transition from one state to another is as shown in the state transition table below.

<table>
<thead>
<tr>
<th>Current state</th>
<th>Event</th>
<th>Next state</th>
</tr>
</thead>
<tbody>
<tr>
<td>System inactive</td>
<td>Switch power on</td>
<td>System active</td>
</tr>
<tr>
<td>System active</td>
<td>Senses intruder</td>
<td>Alarm bell rings</td>
</tr>
<tr>
<td>System active</td>
<td>Switch power off</td>
<td>System inactive</td>
</tr>
<tr>
<td>Alarm bell rings</td>
<td>Press reset button</td>
<td>System active</td>
</tr>
<tr>
<td>Alarm bell rings</td>
<td>Switch power off</td>
<td>System inactive</td>
</tr>
</tbody>
</table>

Complete the diagram.

**Key focus: State transition diagrams**