8 **(a)** State **two** factors that may affect the performance of a sorting algorithm.

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.....

.....

..... [2]

(b) The given algorithm is a simple bubble sort that arranges a set of scores stored in a one-dimensional array into **descending** order, and orders the corresponding students' names stored into a two-dimensional array in the same order as the scores. All the arrays are indexed from 1.

The contents of both arrays after sorting are shown.

	Score
1	98
2	97
...	
248	5
249	3

	Name	
	1	**2**
1	Smithfield	Tom
2	Johnson	Jane
...		
248	Peters	Jade
249	Allen	John

```
YearSize ← 249
Flag ← TRUE
WHILE Flag = TRUE
    Flag ← FALSE
    FOR Student ← 1 TO YearSize - 1
        IF Score[Student] < Score[Student + 1] THEN
           Temp1 ← Score[Student]
           Temp2 ← Name[Student,1]
           Temp3 ← Name[Student,2]
           Score[Student] ← Score[Student + 1]
           Name[Student,1] ← Name[Student + 1,1]
           Name[Student,2] ← Name[Student + 1,2]
           Score[Student + 1] ← Temp1
           Name[Student + 1,1] ← Temp2
           Name[Student + 1,2] ← Temp3
           Flag ← TRUE
        ENDIF
    NEXT Student
ENDWHILE
```

Write an algorithm, using pseudocode, that will perform the same task using an insertion sort.

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..... [6]

10 **(a)** State **three** essential features of **recursion**.

1 .....

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2 .....

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3 .....

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[3]

(b) Explain the reasons why a stack is a suitable Abstract Data Type (ADT) to implement recursion.

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.....

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..... [3]

(c) Identify **two** ADTs other than a stack.

1 .....

2 .....

[2]

(d) The function `StackFull()` checks whether a stack is full.

The function uses the variable `TopOfStack` to represent the pointer to the most recent position used on the stack, and the variable `Max` to represent the maximum size of the stack. Assume `TopOfStack` and `Max` are global variables.

```
FUNCTION StackFull() RETURNS BOOLEAN
    IF TopOfStack = Max THEN
       RETURN TRUE
    ELSE
       RETURN FALSE
    ENDIF
ENDFUNCTION
```

An algorithm `AddInteger` is required to add a new integer data element to a stack.

The stack is implemented as an array `ArrayStack`.

The function `AddInteger()` calls `StackFull()` and returns an appropriate message.

Complete the pseudocode for the function `AddInteger()`.

```
FUNCTION AddInteger(NewInteger : INTEGER) RETURNS STRING
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
ENDFUNCTION
```

[5]

12 **(a)** The array `Names[0:99]` is in alphabetical order.

Complete this pseudocode binary search algorithm.

```
Lower ← 0

.....
Mid ← 0
Exit ← FALSE
OUTPUT "Enter the name to be found "
INPUT Target
REPEAT

  ..... THEN

     OUTPUT Target, " does not exist"
     Exit ← TRUE
  ENDIF
  Mid ← Lower + (Upper - Lower + 1) DIV 2
  IF Names[Mid] < Target THEN

     Lower ← .....
  ENDIF
  IF Names[Mid] > Target THEN

     .....
  ENDIF

  ..... THEN
     OUTPUT Target, " was found at location ", Mid
     Exit ← TRUE
  ENDIF

.....
```

[6]

(b) Big O notation is used to classify efficiency of algorithms.

The Big O notation for time complexity in a binary search is O(log n).

(i) State the Big O notation for time complexity of a linear search.

..... [1]

(ii) Describe the meaning of O(log n) as it applies to a binary search algorithm.

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..... [2]