Chapter 14

Arrays: Data Structure & Pre-Release Materials

Arrays

Arrays are data structure used to store multiple data items of same data type under one identifier name.

Arrays are considered to be fixed-length structures of elements of identical data type, accessible by consecutive index (subscript) numbers. It is good practice to explicitly state what the lower bound of the array (i.e. the index of the first element) is because this defaults to either 0 or 1 in different systems. **Generally, a lower bound of 1 will be used**.

Square brackets are used to indicate the array indices.

Each element in the array is identified using its **subscript** or **index number**. The largest and smallest index numbers are called the *upper bound* and *lower bound* of the array.

Example

StudentName[1:30]

For illustration, let's take array declaration to store marks of 10 students.

Marks[1:10]

After storing values in array



As per the above illustration, following are the important points to be considered.

- Index starts with 1.
- Array length is 10 which means it can store 10 elements.
- Each element can be accessed via its index. For example, we can fetch an element at index 6 as 19.

The terms associated with Arrays

Name: The identifier of the array is called Array Name. E.g. StudentName[]

Element: Each data item stored in arrayis called element. Array can store only single types of elements.

Size: The number elements the array can store. E.g. StudentName[1:30] can store 30 names while StudentName[30] can store 31 names as by default it is 0 to 30.

Index: The position of each element is referred as Index Number. Index of Abdullah in array example is 1.

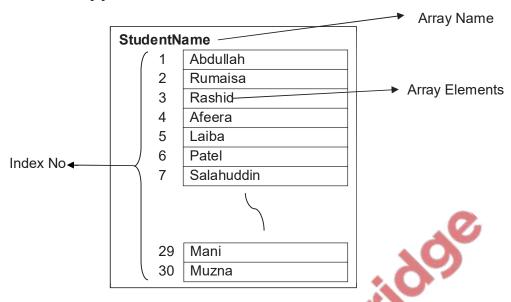
Type: Data type of all elements in a single array have same data types.

Dimension: Dimension is the organisational structure of array. It may be 1D that has single column or 2D that have multiple columns.

Example

DECLARE StudentName[1:30]: STRING

StudentName[1] ← "Abdullah"



Declaring an array

It is important declare the arrays before assigning values in it so that program can reserve that amount of space in its memory; otherwise, there may not be enough space when the program uses the data.

Declaration consists of telling the computer program:

- the identifier name of the array
- the sort of data that is going to be stored in the array, i.e. its data type
- How many items of data are going to be stored, so that it knows how much space to reserve. Different programming languages have different statements for initialising the array but they all do the same thing. In Visual Basic, the statement is:

Dim Name(20) As String

This Dim statement declares:

- the identifier name: Name
- the upper bound: 20
- the data type: String.

The upper bound of 20 specifies that there can be a maximum of 21 data items, since Visual Basic starts with a subscript of zero. We do not have to fill the array; the upper bound of 20 indicates the maximum size.

The array that has been described in one dimension array so far is really only a list of single data items. It is possible to have an array which can be visualised as a two-dimensional table with rows and columns and a data value in each cell.

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Reading data into an array

To assign data values to the elements of the array, we do this with assignment statements such as:

Name(6) = "Patel"

This places the string "Patel" at index position 6 in the array.

Similarly, the following statement places the string "Rashid" at index position 3 in the array. Name(19) = "Mani"

Quick Revision Questions

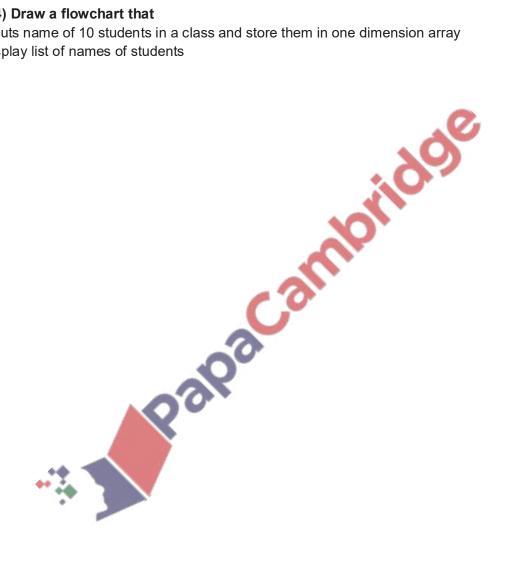
Q 17.1) Explain the following terms regarding arrays: Array:
Size of Array:
Element:
Index:
Dimension:
Q 17.2) Explain with the help of examples when arrays are used in programming.
Q 17.3) Declare arrays to Explain with the help of examples when arrays are used in programming
a) Declare arrays to store name of 30 students

b) Declare arrays to store basic pay of 50 Employees.

Pa	age 205
c)	Declare arrays to input and store status of 50 employee that they are permanent or not.

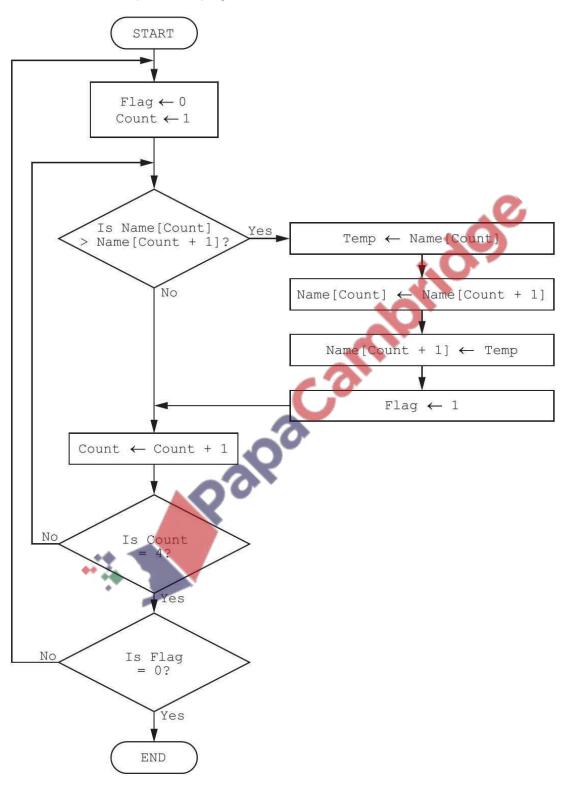
Q 17.4) Draw a flowchart that

- > Inputs name of 10 students in a class and store them in one dimension array
- > Display list of names of students



Past paper flowchart for same type of question in Winter 2017 P21 Q5

The flowchart below represents a program routine.



(a) The array used in the flowchart contains the following data:

|--|

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Jamal	Amir	Eve	Tara

Complete the trace table using the data given in the array.

[5]

Flag	Count	Name[1]	Name[2]	Name[3]	Name[4]	Temp
		Jamal	Amir	Eve	Tara	
					. (2
			4			
				,		

(b) Describe what the algorithm represented by the flowor	hart is doing.
	[2]

NEXT

Q 17.5Summer 2018 P21

3 The global trade item number (GTIN-8) barcode has seven digits and a check digit. This pseudocode algorithm inputs seven digits and calculates the eighth digit, then outputs theGTIN-8.

DIV(X,Y), finds the number of divides in division for example DIV(23,10) is 2. MOD(X,Y), finds the remainder in division for example MOD(23,10) is 3.

```
FOR Count ← 1 TO 7
   INPUT Number
   Digit(Count) ← Number
NEXT
Sum \leftarrow (Digit(1)+Digit(3)+Digit(5)+Digit(7))*3+Digit(2)+Digit(4)+Digit(6)
IF MOD(Sum, 10) <> 0
   THEN Digit(8) \leftarrow DIV(Sum,10)*10 + 10 - Sum
                                              pridoe
   ELSE Digit(8) \leftarrow 0
ENDIF
OUTPUT "GTIN-8"
FOR Count ← 1 TO 8
   OUTPUT Digit (Count)
```

(a) Complete the trace table for the input data: 5, 7, 0, 1, 2, 3

[5]

					4	4			
Digit (1)	Digit (2)	Digit (3)	Digit (4)	Digit (5)	Digit (6)	Digit (7)	Digit (8)	Sum	OUTPUT
Complete the trace table for the input data: 4, 3, 1, 0, 2, 3, 1									
Digit	Digit	Digit	Digit	Digit	Digit	Digit	Digit	Sum	OUTPUT
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Sum	OUIPUI
			0						

b) Explain how you would change the algorithm to input eight digits (seven digits and the check	-
ligit) and output if the check digit entered is correct or not.	
[31

Q 17.6) An algorithm to reset the contents of the array Coins after each sale is shown below. Ther e are 10 different coins. This algorithm contains a logic error.

REPEAT Coins(i) = 0	
i = i + 1 UNTIL i = 10	
(i) State what is meant by a logic error.	
	 [1]
(ii) Explain why the algorithm above contains a logic error.	
[2	 2]
(i) •The program is written to do something other than what the programmer intended	
(ii) It will only reset the first 9 elements / will not resetthe 10th element After setting Coins(9) = 0, i will become 10 and the loop will stop It should be UNTIL i > 10 / or other working correction	
Q 17.8Summer 2015 P22 5 (a) Write an algorithm, using pseudo code and a FOR TO NEXT loop structure, to input	
1000 numbers into an array.	
	•••
	2]
(b) Rewrite your algorithm using another loop structure.	
	4]

Page | 209 i = 1

<u>Examiner's comments on Question 5</u>
(a) Most candidates attempted the loop structure, better candidates also showed the skill of being able to use the loop counter as the array index. Some candidates misread the question and incorrectly provided program code rather than pseudo code.

⁽b) Better candidates correctly used REPEAT ... UNTIL or WHILE ... DO ... ENDWHILE structures.

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The most challenging aspect was the correct management of the loop counter.

Q 17.9Summer 2016 P22

Constant	A collection of related data
Data structure	Description
Draw a line to connect each data structur	re to the correct description.
Q 17.10Winter 2017 P22 3 The following diagram shows four data	structures and four descriptions. [3]
	[3]
•	
range.	output an error message if the number is outside this
(c) Write an algorithm, using pseudocode	e, to input a number between 0 and 100 inclusive. The
	[1]
useu.	Cio
(b) Identify, using pseudocode, another leaved.	pop structure that the algorithm in part (a) could have
	[2]
INPUT Name[l] NEXT I	
5 (a) Describe the purpose of each state FORI← 1 to 300	ment in this algorithm.
F (a) Describe the number of each state	anaut in this almonithms
	[2]
Data structure	
	e a patient's temperature every hour for a day. State the eto use and give the reason for your choice.

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	A value that can change whilst a program is
Array	running
Table	A value that never changes whilst a program is
	running
Variable	A series of elements of the same data type
A restaurant table will have its data stor	red in its own booking record. Alessio decides to use an
array of records.	
	ay TableBookingsfor the 12 table records.
Programming language	A Prince of the Control of the Contr
Code	[1]
Summer 2016 P21 &P23	
(ii) The swimming club has 50 member	rs.
State the data structure that would be n	nost suitable to use and give a reason for your choice.
Data structure	
Reason	
	[2]
*** 3 8.0	

Practice Questions

Q 1a) Declare an array called Marks whose index values ranges from 0 to 999 and whose element type is integer
[1]
b) Initialise the array declared in part a, all values in the array should be equals to 0.
[2]
Q 2) Consider the following code:
DECLARE NextChar[1:30] : CHAR
Write a code to store the letter 'A' at 1st and 'Z' at 26th location of the Array.
Q3a) Write a pseudo code that uses an array to store marks of 10 students of a class. Enter marks
of each student. After input all the marks output the list of marks.
*
[4]

b) Calculate the average marks of the class by traversing the array.

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[3
c) Output the smallest and the greatest marks of the class by traversing the array.
<u> </u>
[3
d) Create a second array to input and store name of students of the class. Output the list of name of students and their marks by traversing the two arrays. At the end of list print average marks of
the class.
[4]

Q 4a) Write a program to input name and telephone of your friends in two one dimension arrays. Each array can store up to 5 elements.

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[3]
b) Write a program that inputs the name of your friend search in the array and output telephone number.
[3]
c) After the user selects a name, give him option to display and change the telephone number in the array. After change of telephone number, output the entire list.
O. E. John works in a supermarket where he is given a task to find which item has the highest pri
t t. C. Labor transca un a atro-amegantes trobana ha ca aitrana a baale ba binal trobiala ibana ha a bla a lainha ab mir

- Q 5) John works in a supermarket, where he is given a task to find which item has the highest pric e and which item has the lowest price. There are 900 items in the supermarket.
 - a. Declare suitable arrays to store name and price of each product.
 - b. In put price of each product with its name.

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	C.	Output the number of items which have a price greater than 100and number of items which
		have price less than 50.
•	d.	Output the highest and the lowest price.
	••••	
		.0.
		*O**
		[4]
		a Pacaini.