Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4095209132

COMPUTER SCIENCE **9608/43**

Paper 4 Further Problem-solving and Programming Skills **October/November 2015**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **16** printed pages.

CAMBRIDGE International Examinations

[Turn over

Throughout the paper you will be asked to write either **pseudocode** or **program code**.

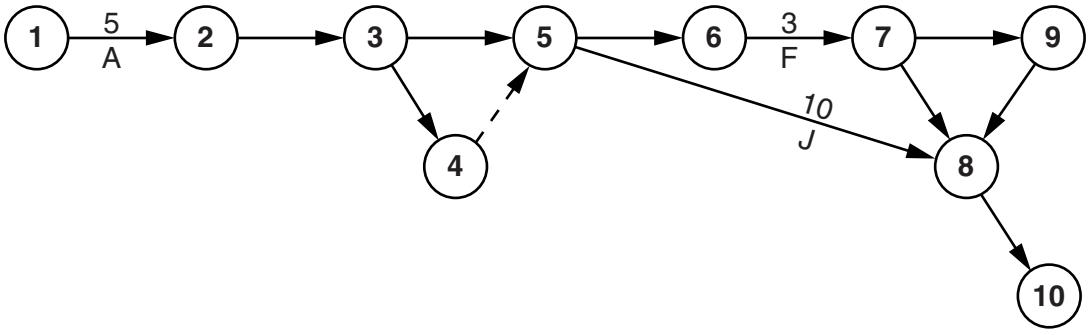
Complete the statement to indicate which high-level programming language you will use.

Programming language .....

1 A large software house has been asked to supply a computerised solution for a business. The project manager has drawn up a list of activities and their likely duration.

Activity	Description	Weeks to complete
A	Write requirement specification	5
B	Produce program design	5
C	Write module code	15
D	Module testing	10
E	Integration testing	5
F	Alpha testing	3
G	Install software and acceptance testing	5
H	Write end user training guide	5
J	Write technical documentation	10
K	End user training	4
L	Sign off final system	1

(a) The project manager decides to construct a Program Evaluation Review Technique (PERT) chart from this data.



(i) Complete the PERT chart. [7]

(ii) State the critical path.

.....[2]

(iii) Calculate the minimum number of weeks for the completion of this solution.

.....[1]

(b) For activity J:

(i) State the earliest start time.

Week number .....[1]

(ii) State the latest start time.

Week number .....[1]

(c) Give a reason why the project manager used a PERT chart.

.....

.....[1]

2 A declarative programming language is used to represent the following facts and rules:

```
01  male(ali).
02  male(raul).
03  male(ahmed).
04  male(philippe).
05  female(meena).
06  female(aisha).
07  female(gina).
08  parent(ali, raul).
09  parent(meena, raul).
10  parent(ali, ahmed).
11  parent(meena, ahmed).
12  parent(ali, aisha).
13  parent(meena, aisha).
14  father(A, B) IF male(A) AND parent(A, B).
```

These clauses have the following meaning:

Clause	Explanation
01	Ali is male
05	Meena is female
08	Ali is a parent of Raul
14	A is the father of B if A is male and A is a parent of B

(a) More facts are to be included.

Philippe and Gina are the parents of Meena.

Write the additional clauses to record this.

15 .....

16 .....[2]

(b) Using the variable P, the goal

```
parent(P, raul)
```

returns

```
P =  ali, meena
```

Write the result returned by the goal

```
parent(ali, C)
```

C = ...[2]

(c) Use the variable `F` to write the goal to find the father of Ahmed.

.....[1]

(d) Write the rule to show that `X` is the mother of `Y`.

```
mother(X, Y)

IF .....

..... [2]
```

(e) `W` is a grandparent of `Z` if `W` is a parent of one of `Z`'s parents.
Complete the following rule:

```
grandparent(W, Z)

IF .....

.....

.....[2]
```

(f) Complete the rule to show that `G` is a grandfather of `K`.

```
grandfather(G, K)

IF .....

.....

.....[2]
```

3 A lending library stocks two types of item for loan: books and CDs.

All stock items have a title, the date the item was acquired and whether the item is currently out on loan.

Books have an author and ISBN. CDs have an artist and play time in minutes.

The library needs a program to process data about the stock items. The program will use an object-oriented programming language.

(a) Complete the class diagram showing the appropriate properties and methods.

StockItem
Title: STRING ....
ShowTitle() ....

Book
Author: STRING ....
Constructor() ShowAuthor() ....

CD
....
....

[7]

(b) Write **program code**

(i) for the class definition for the superclass `StockItem`.

Programming language .....

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.....[3]

(ii) for the class definition for the subclass `Book`.

Programming language .....

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.....[3]

(iii) to create a new instance of `Book` with:

- identifier `NewBook`
- title “Computers”
- author A.Nyone
- ISBN 099111
- acquired on 12/11/2001
- not out on loan

Programming language .....

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.....[3]

Question 4 begins on page 10.

4 A binary tree Abstract Data Type (ADT) has these associated operations:

- create the tree (`CreateTree`)
- add an item to tree (`Add`)
- output items in ascending order (`TraverseTree`)

(a) Show the final state of the binary tree after the following operations are carried out.

```
CreateTree
Add("Dodi")
Add("Farai")
Add("Elli")
Add("George")
Add("Ben")
Add("Celine")
Add("Ali")
```

[4]

(b) The binary tree ADT is to be implemented as an array of nodes. Each node consists of data and two pointers.

Using pseudocode, a record type, `Node`, is declared as follows:

```
TYPE Node
   DECLARE Name : STRING
   DECLARE LeftPointer : INTEGER
   DECLARE RightPointer : INTEGER
ENDTYPE
```

The statement

```
DECLARE Tree : ARRAY[1:10] OF Node
```

reserves space for 10 nodes in array `Tree`.

The `CreateTree` operation links all nodes into a linked list of free nodes. It also initialises the `RootPointer` and `FreePointer`.

Show the contents of the `Tree` array and the values of the two pointers, `RootPointer` and `FreePointer`, after the operations given in **part (a)** have been carried out.

`RootPointer`

		Tree		
		Name	LeftPointer	RightPointer
	[1]			
	[2]			
	[3]			
	[4]			
	[5]			
	[6]			
	[7]			
	[8]			
	[9]			
	[10]			

`FreePointer`

[7]

(c) A programmer needs an algorithm for outputting items in ascending order. To design this, the programmer writes a recursive procedure in pseudocode.

(i) Complete the pseudocode:

```
01 PROCEDURE TraverseTree(BYVALUE Root: INTEGER)
02    IF Tree[Root].LeftPointer .....
03       THEN
04          TraverseTree(.....)
05    ENDIF
06    OUTPUT .....Name
07    IF .....<> 0
08       THEN
09          TraverseTree(.....)
10    ENDIF
11 ENDPROCEDURE
```

[5]

(ii) Explain what is meant by a recursive procedure. Give a line number from the code above that shows procedure `TraverseTree` is recursive.

.....

.....

.....

Line number .....[2]

(iii) Write the pseudocode call required to output all names stored in `Tree`.

.....

.....[1]

Question 5 begins on page 14.

5 Data about sports club members are stored in a random file of records.

- The key field of a member record is the member ID (range 1000 to 9999).
- Other member data are stored.
- A hashing function is used to calculate a record address.
- The random file initially consists of dummy records.
- Dummy records are shown by member ID set to 0.

```
FUNCTION Hash(MemberID : INTEGER) RETURNS INTEGER

   Address ← MemberID MOD 100

   RETURN Address

ENDFUNCTION
```

(a) New members with the following member IDs have joined the sports club:

1001, 3005, 4096, 2098, 7002

Indicate where each record should be stored by deleting the zero and writing the member ID in the correct cell.

MembershipFile

Address	MemberID	Other member data
0	0	
1	0	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	0	
:		
:		
96	0	
97	0	
98	0	
99	0	

[2]

(b) (i) The program stores a new member's data in the record variable `NewMember`. The field `MemberID` stores the member ID.

Complete the pseudocode:

```
10 // generate record address
20 NewAddress ← .....
30 // move pointer to the disk address for the record
40 SEEK .....
50 PUTRECORD "MembershipFile", .....
```

[4]

(ii) Before records can be saved to the file `MembershipFile`, the file needs to be opened.

Complete the pseudocode.

```
01 TRY
02    OPENFILE ..... FOR RANDOM
03 EXCEPT
04    .....
05 ENDTRY
```

[2]

(iii) A record with member ID 9001 is to be stored.

Explain the problem that occurs when this record is saved.

.....

.....

.....

.....[2]

(iv) Describe a method, without changing the function `Hash`, to handle the problem identified in **part (b)(iii)**.

.....

.....

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.....[2]

(v) Write **pseudocode** to implement the method you described in **part (b)(iv)**.

Choose line numbers to indicate where your pseudocode should be inserted in the pseudocode of **part (b)(i)**.

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.....[4]