Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

COMPUTING **9691/33**

Paper 3 **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 on all the work you hand in.
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.

1 Customers purchase products by placing an order on a company's website.

- Each customer has recorded:
  - customer ID
  - name
  - city

- Each product has recorded:
  - product ID
  - description
  - retail price

- Each order has recorded:
  - customer ID
  - product ID
  - order date
  - order dispatched? (TRUE/FALSE)
  - dispatch date

An order is always for one product only.
Each product can be purchased by a number of different customers.
The customer may order the same product many times.

Over a period of time, customers will place many orders.
A customer never places more than one order on any one day.

The data are to be stored in a relational database.

(a) A first attempt at the database design produced the following single table `CUSTOMER`.

Table: `CUSTOMER`

CustomerID	**CustomerName**	**City**	**OrderDate**	**ProductID**
043	Wilber	London	10-09-15	678
			21-09-15	883
			28-10-15	883
928	Said	Manchester	09-05-15	241
			18-07-15	906
493	Tasha	Glasgow	11-09-15	005
351	Ahmed	Liverpool	10-10-15	187
			11-10-15	154

State why the table is not in First Normal Form (1NF).

.....

.....[1]

(b) (i) A revised design is produced:

```
CUSTOMER(CustomerID, CustomerName, City)

  PRODUCT(ProductID, ProductDescription, RetailPrice)

    ORDER(CustomerID, OrderDate, ProductID, Dispatched, DispatchDate)
```

Underline the primary key for each table. [2]

(ii) Draw an entity-relationship (E-R) diagram showing the relationships between `CUSTOMER`, `PRODUCT` and `ORDER`.

[2]

(iii) Describe how the relationship between `CUSTOMER` and `ORDER` is implemented.

.....

.....

.....

.....[2]

(c) Write a data manipulation language (DML) query to find the `ProductID` of all products with:

- a minimum retail price of $100
- a maximum retail price of $200

Use the keywords `SELECT`, `FROM` and `WHERE`.

.....

.....

.....[3]

(d) Study this DML command.

```
UPDATE ORDER
SET Dispatched = TRUE
WHERE CustomerID = 647 AND OrderDate = #12/10/15#
```

Tick (✓) the **three** correct statements:

Creates a new record in the `ORDER` table	
Amends an existing record in the `ORDER` table	
Assigns the value `TRUE` to the `Dispatched` attribute	
Creates a new attribute `Dispatched`	
Changes all the existing records for customer 647	
Changes one record for customer 647	

[3]

(e) (i) Customer 447 placed an order for product 982 on 17 October 2015.

Complete the following DML command to create a new order record. The order has not yet been dispatched.

```
INSERT INTO .....

( ..... )

VALUES ( ..... )
```

[3]

(ii) Referential integrity requires that the data is consistent in two related tables.

There is a relationship between the `PRODUCT` and `ORDER` tables.

Using these two tables, explain how data could fail a referential integrity check.

.....

.....

.....

.....[2]

2 **(a)** **(i)** Describe what is meant by simulation.

.....

.....[2]

(ii) Describe why a computer is particularly suited to carry out a simulation.

.....

.....[1]

(b) Weather forecasting uses simulation to produce results.

Simulations require the collection of data from which results are produced.

Name **two** sensors which would be used to collect weather data.

1 .....

2 .....
[2]

(c) Another application that uses simulation is car design.

Describe **two** key differences between the car design and weather forecasting applications.

1 .....

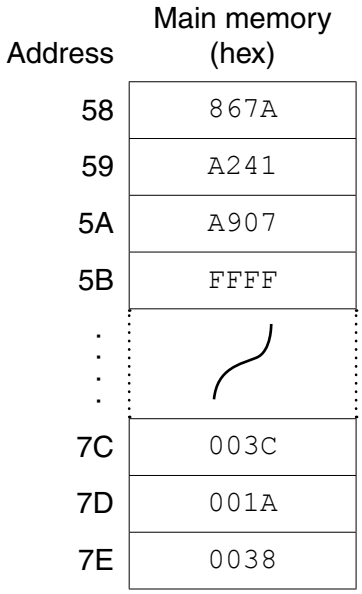
.....

2 .....

.....
[2]

3 **(a)** A program is loaded into main memory starting at memory address 58 hexadecimal (hex).

The diagram shows the contents of some of the memory locations.



(i) Convert the memory address values 58 and 7D into binary.

58 = ...

7D = ...
[2]

(ii) State the number of bits used for the contents of each main memory location.

..... [1]

(b) The steps in the fetch stage of the fetch-execute cycle are shown in the first column using register transfer notation.

(i) Describe what happens at each stage of the fetch cycle.

Register transfer notation	Description
MAR ← [PC]	....
PC ← [PC] + 1	....
MDR ←[[MAR]]	....
CIR ← [MDR]	....

[4]

(ii) The contents of some special-purpose registers change as the program is executed.

Complete the trace table for the fetching of the **first program instruction (867A)**:

- Show how the contents of the registers change.
- Put a tick in the address bus and/or data bus column to show when there is a signal change on each bus.

Fetch stage	Special purpose registers (Contents shown in hex)				Buses	
	PC	MAR	MDR	CIR	Address bus	Data bus
	58					
MAR ← [PC]						
PC ← [PC] + 1						
MDR ←[[MAR]]						
CIR ← [MDR]						

[5]

4 (a) The following table shows some assembly language instructions from the computer's instruction set.

Instruction		Explanation
Op code	**Operand**	
LDD	<address>	Direct addressing. Load the contents of the given address to the Accumulator (ACC)
LDI	<address>	Indirect addressing. The address to be used is at the given address. Load the contents of this second address to ACC
LIX	<address>	Load the contents of the address to the Index Register (IX)
LDX	<address>	Indexed addressing. Form the address from <address> + the contents of IX. Copy the contents of this calculated address to ACC

The test program shown in memory locations 300 onwards is to be executed.

Shown are:
- the first four instructions only of this program
- other memory locations which contain data accessed by the program

Complete the trace table below for the first four program instructions.

Instruction	Register	
	ACC	**Index Register (IX)**
LIX 400		
LDD 401		
LDI 401		
LDX 401		

Address (denary)	Main memory
300	LIX 400
301	LDD 401
302	LDI 401
303	LDX 401
. . . .	
400	3
401	616
402	99
403	217
404	63
. . . .	
616	96
617	13

[4]

(b) A program written in assembly language needs translation before it can be executed.

A programmer creates, translates and executes an assembly language program. **Five** of the six statements below are to be used to complete a description of this process:

- `Amend PROG.ASM using the text editor`
- `Produce the PROG.EXE executable file`
- `PROG.ASM is input to the assembler software`
- `Run PROG.EXE`
- `Translate PROG.ASM using the compiler`
- `Use text editor to write assembly language program PROG.ASM`

Complete the pseudocode description below.

.....

```
REPEAT

    .....

   IF errors reported

      THEN

          .....

   ENDIF

UNTIL No errors reported
```

.....

.....

[4]

5 **(a)** A dataset of city names is to be organised as an ordered binary tree.

The city names below join the binary tree in the order shown:

`PLYMOUTH, MUMBAI, DHAKA, SINGAPORE, NEW YORK, ROTTERDAM` and `TORONTO`.

(i) Draw the binary tree.

[3]

(ii) On the tree drawn in **part (a)(i):**

- label the root
- draw a line around the left subtree [2]

(iii) State the number of leaf nodes for the tree drawn in **part (a)(i)**.

.....[1]

(b) The binary tree is implemented in a high-level language using a number of data structures and one variable:

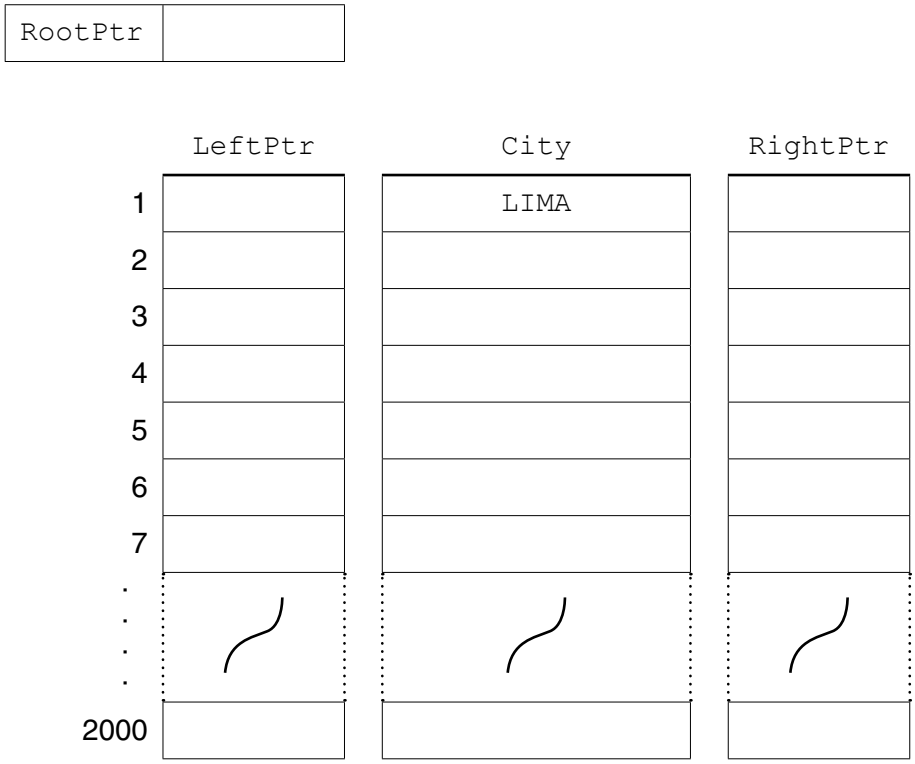
Variable	Data type	Description
`RootPtr`	.....	The array subscript of the root of the tree
`City`	.....	Array of city names
`RightPtr`	`ARRAY[1 : 2000] OF INTEGER`	Array of right pointer values
`LeftPtr`	`ARRAY[1 : 2000] OF INTEGER`	Array of left pointer values

(i) Complete the entries in the table. [2]

A new dataset of cities is used as test data:

```
LIMA, PARIS, KARACHI, MELBOURNE, WARSAW, CAPE TOWN, EDINBURGH
```

(ii) Complete the diagram below showing the contents of the arrays and the root pointer variable.



[4]

(c) An algorithm is designed in pseudocode to search the binary tree for a particular city.

The algorithm uses the additional variables below:

Variable	Data type	Description
SearchCity	STRING	City to search for
Current	INTEGER	The array subscript for the item currently considered
IsFound	BOOLEAN	Flags to TRUE when SearchCity is found

Complete the algorithm below:

```
// binary tree search

INPUT .....
IsFound ← FALSE
Current ← RootPtr
REPEAT
   IF City[Current] = .....
      THEN
         // found
         OUTPUT "Found"

         .....
      ELSE
         IF SearchCity > City[Current]
            THEN
               // move right

               .....
            ELSE
               Current ← LeftPtr[Current]
         ENDIF
   ENDIF
UNTIL Current = 0 OR .....

IF .....
   THEN
      OUTPUT SearchCity "Not Found"
ENDIF
```

[6]

6 A high-level programming language has a built-in function `SumRange` defined as follows:

```
SumRange(ThisInteger1 : INTEGER, ThisInteger2 : INTEGER [Flag : CHAR])
                                                        RETURNS INTEGER
```

returns the integer value calculated as the sum of all integers between `ThisInteger1` and `ThisInteger2`.

The square brackets denote that `Flag` is optional.
It takes values as follows:

- 'Y' – denotes both boundary values are to be included
- 'N' – denotes both boundary values will not be included

If `Flag` is omitted, both boundary values are included.

For example:

`SumRange(3, 6, 'Y')` returns `18`

`SumRange(3, 6, 'N')` returns `9`

An error is generated if:

- The function is not properly formed, or
- `ThisInteger2` is less than `ThisInteger1`

(i) State the function name and parameters for the above function.

Function name .....

Parameters .....

.....[2]

What value is returned from the following function calls?

(ii) `SumRange(1, 3)`

.....[1]

(iii) `SumRange("31", "33", 'Y')`

.....[1]

(iv) `SumRange(1.5, 4.5)`

.....[1]

(v) `SumRange(4, 7, 'N')`

.....[1]

(vi) `SumRange(7, 4, 'N')`

.....[1]

7 The diagram shows the main memory contents of a computer system. It is controlled by a multi-programming operating system.

	Operating System
	A
	B
Partition 1	PROG2
	PROG7
	PROG16
	Unused
Partition 2	USER21
	USER34
	USER46
	Unused

(a) Define the term multi-programming.

.....

.....[1]

The main memory is divided into two partitions. Partition 1 is dedicated to batch processing.

The diagram shows:

- the operating system
- systems software (A and B)
- three batch programs (in Partition 1)

(b) Suggest **two** items of systems software (A and B) that are currently loaded in main memory.

A .....

B .....
[2]

(c) Describe **three** characteristics of batch processing.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(d) Partition 2 of the main memory is used for interactive programs. The low-level scheduler operates a round-robin strategy. It allocates a time slice of 100 milliseconds.

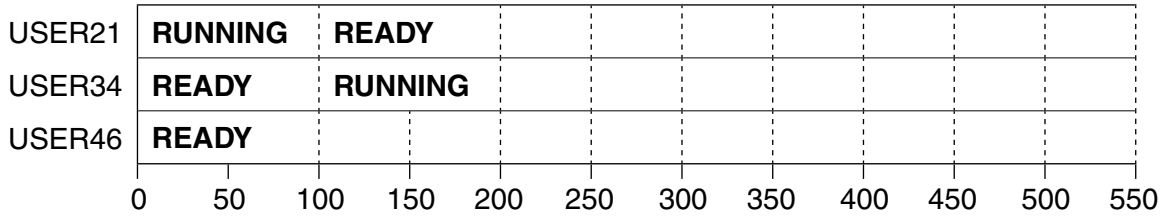
(i) Explain what is meant by the term 'round-robin'.

.....

.....

.....[2]

(ii) The program USER21 starts its time slice at time zero. The scheduler puts programs that are ready into the RUNNING state in the same order as the rows in the following diagram.



- During its first time slice, USER46 becomes suspended after 50 ms.
- USER46 is changed to the ready state 100 ms after its suspension.

Label the diagram to show how the state of each program changes for the first 500 ms. You should use the labels RUNNING, READY and SUSPENDED. When necessary, you may abbreviate any of these to its first three letters. [5]

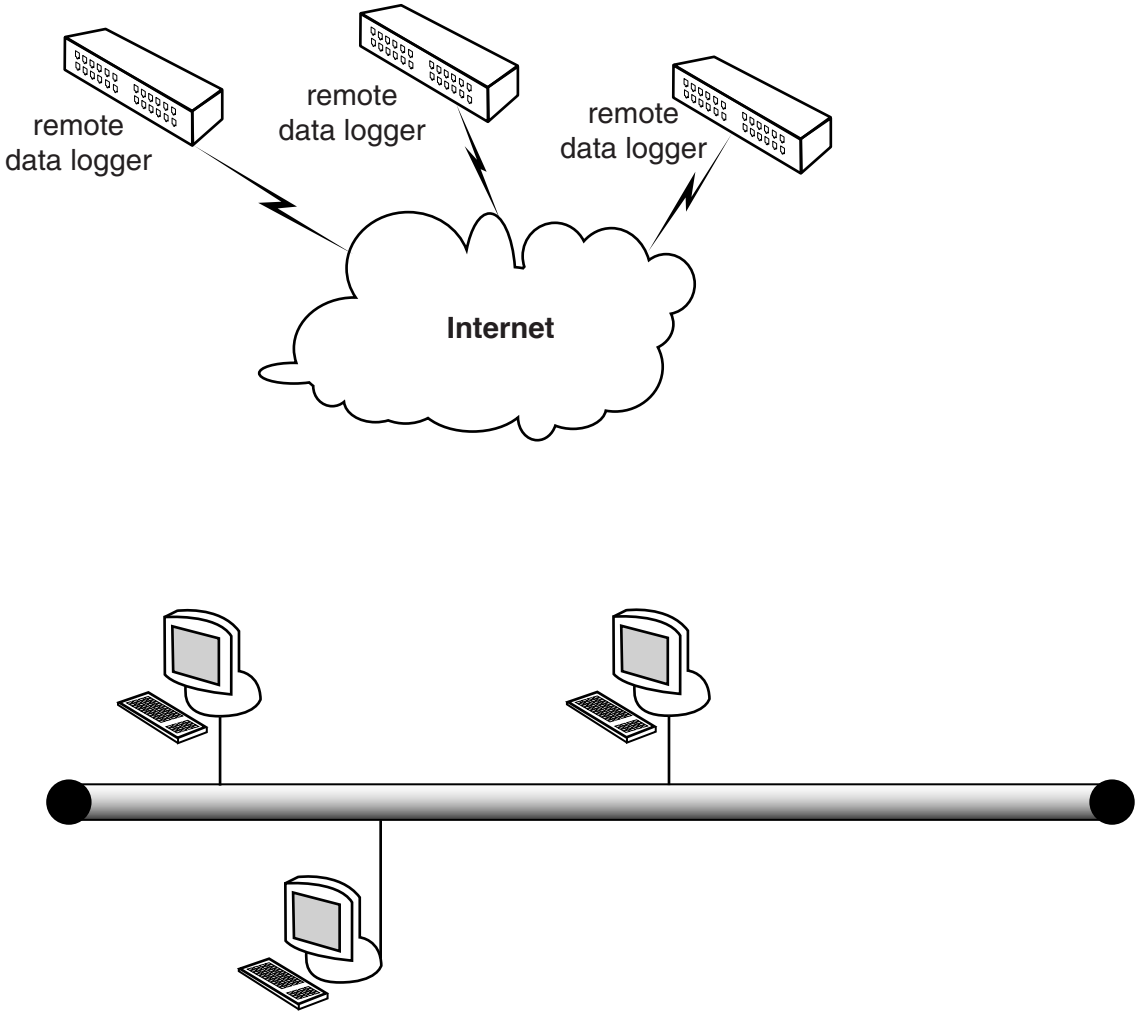
(iii) State what could have caused USER46 to become suspended.

.....

.....[1]

8 A team of scientists collect data from three data loggers situated at three different locations in the world. The data is sent over the Internet to the scientists' local area network (LAN). Each day millions of data values are stored. At the end of each day the data is used to produce predictions in the form of a printed report.

(a) Complete the diagram showing the essential hardware which will be needed for the data collection, storage and processing of the results.



[4]

(b) When the network was created, the technicians had to decide on the cabling.

Name and describe **one** type of cable which could have been used.

.....

.....

.....

.....[2]