Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTING **9691/31**

Paper 3 **May/June 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.

This document consists of **21** printed pages and **3** blank pages.

CAMBRIDGE International Examinations

1 A sports centre has a gym and a swimming pool. The sports centre has members.

A member is given a unique membership number when they join.

Different types of membership are available:

- J – Junior
- SF – Senior full
- SG – Senior gym only
- SS – Senior swim only

Members who use the gym are assigned a personal trainer.

Sports centre employees are identified with a unique three-character code.

An employee can be a personal trainer to one or more members.

The sports centre organises classes. Each class has a unique class name.

Each class is taken by an employee who acts as the class leader. An employee may be a class leader for zero, one or more classes.

Members can take classes. Each class has a class code. Some classes are assigned a level:

- B – beginners
- I – intermediate
- A – advanced

A relational database is to be created to store data about members, employees, classes and class attendance.

The following table design `MEMBER` was a first attempt at the database design.

Table: `MEMBER`

MemberNo	MemberType	Trainer	ClassName	ClassLevel	ClassLeader
510	SF	SAF	Yoga B	B	OLO
			Box fit		DAV
			Zumba		ROG
808	SS	OLO	Swimathon	A	ROG
756	J	DAV	Circuits	I	VAR
			Box fit		DAV
			Yoga A	A	OLO
			Body pump		CFD

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

.....

.....[

(ii) Comment on your answer by referring to the data in the table.

.....

.....[1]

(b) The design is changed so that there are two tables:

```
MEMBER(MemberNo, MemberType, Trainer)

MEMBERCLASSES(MemberNo, ClassName, ClassLevel, ClassLeader)
```

The primary keys are not shown.

(i) Using the data given in the original table, show the data now stored in table `MEMBER`.

Table: `MEMBER`

MemberNo	**MemberType**	**Trainer**

[1]

(ii) Using the data given in the original table, show **three** rows stored in table `MEMBERCLASSES`.

The **`MemberNo`** should be different for each row.

Table: `MEMBERCLASSES`

MemberNo	**ClassName**	**ClassLevel**	**ClassLeader**

[2]

(iii) Using the data given in the original table, state how many rows would be in table `MEMBERCLASSES`.

.....[1]

(iv) State the relationship between `MEMBER` and `MEMBERCLASSES`.

.....

(v) Explain how the relationship is implemented.

.....

.....

.....[2]

(c) The following new design for `MEMBERCLASSES` was suggested in **part (b)**:

`MEMBERCLASSES(MemberNo, ClassName, ClassLevel, ClassLeader)`

(i) State the primary key for this table.

.....[1]

(ii) Explain why the table is not in Second Normal Form (2NF).

.....

.....[2]

(iii) The solution is to create a new third table.

Show the revised design including the primary keys.

`MEMBER(MemberNo, MemberType, Trainer)`

`MEMBERCLASSES(`.....`)`

.....`(`.....`)`

[3]

(d) Each type of membership has a fixed annual membership fee. The new table for member data is:

MEMBER(MemberNo, MemberType, MemberTypeFee, Trainer)

(i) The revised MEMBER table is not in Third Normal Form (3NF).

Explain this statement.

.....

.....

.....

.....[2]

(ii) The solution is to create a new fourth table.

Show the revised design including the primary keys.

MEMBER(.....)

.....(.....)

[2]

2 A set of Backus-Naur Form (BNF) rules is given as follows:

Rule number	
1	<char> ::= A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z
2	<string> ::= <char> | <char><string>
3	<start> ::= 0
4	<stop> ::= 1
5	<packet> ::= <start><string><stop>

(a) State the meaning of the vertical line character (|) shown in rules 1 and 2.

.....

.....[1]

(b) A sequence of characters (a packet) is transmitted from a remote data logger to a computer. The packet is made up of:

- one character to denote the start of the transmission
- a string of characters
- one character to denote the end of the transmission

Each packet follows the given BNF rules.

A BNF rule may be recursive.

Identify the rule above which is recursive.

Rule number .....

Explain what is meant by recursive.

.....

.....[2]

(c) Circle whether or not each of the following sequence of characters is a valid pac

Show how you arrived at your answer by listing, in order, the rules used.

(i) `0A1` Valid / Invalid *(circle)*

Rules .....

.....

.....

.....

.....

.....

.....[2]

(ii) `P1` Valid / Invalid *(circle)*

Rules .....

.....

.....

.....

.....

.....

.....[2]

(iii) `0TAN1` Valid / Invalid *(circle)*

Rules .....

.....

.....

.....

.....

.....

.....[2]

(iv) The rules need to change as follows.

A string with a sequence of one or more hash (#) characters is to be allowed as a string:

`0#1` and `0####1` would both be a valid packet.

Implement this by:

- making no change to rule 1
- making the appropriate changes (if any) to rules 2, 3, 4 and 5
- adding one or more new rule(s)

Show the complete set of rules below.

Rule number	
1	<char> ::= A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z
2	<string> ::= .....
3	<start> ::= .....
4	<stop> ::= .....
5	<packet> ::= .....
6	.....
7	.....

[3]

3 **(a)** The following terms are used in object-oriented programming (OOP) and design.

Draw a line connecting each term to the appropriate definition.

In the bottom box, state the term which matches the unused definition.

Term	Definition
Encapsulation	An object created from a class.
Inheritance	The ability of a subclass to use properties and methods of a parent class.
Class	A data value which is assigned and stored for an object.
Instance	The definition of an object. The 'blueprint' from which objects are created.
Method	An action of an object. Implemented with procedures and functions.
.....	Restricts the programmer's access to the object's data. Data values can only be read or written using methods provided by the class.

[6]

(b) A company's website is maintained by several employees. The company has [illegible] permanent employees whose job title is either 'programmer' or 'web designer'.

An agency supplies the company with contract employees when there is a need for spec[illegible] skills. Contract employees have the job title 'graphic designer' or 'technical author'.

Employees have recorded:

- employee reference number
- date first worked for company

Contract employees have recorded:

- agency they were supplied by
- agreed hourly rate of pay
- job role

Permanent employees have recorded:

- salary grade
- courses attended

Programmers have recorded:

- programming languages used

Web designers have recorded:

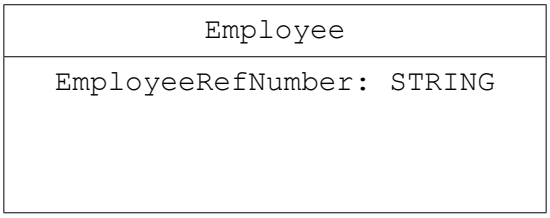
- mark-up languages used

This scenario is to be implemented using object-oriented programming.

Complete the class diagram using the classes:

`Employee, Contract, Permanent, Programmer, WebDesigner.`

Show properties only for the given data.



[8]

4 **(a)** Briefly describe the operation of a stack data structure.

.....

.....[

High level language programs make extensive use of subroutines.

A stack is used to store data about each subroutine call.

The data are the return address, the register contents and the values of all local variables.

A student project is to simulate the saving and retrieval of the data for subroutine calls.

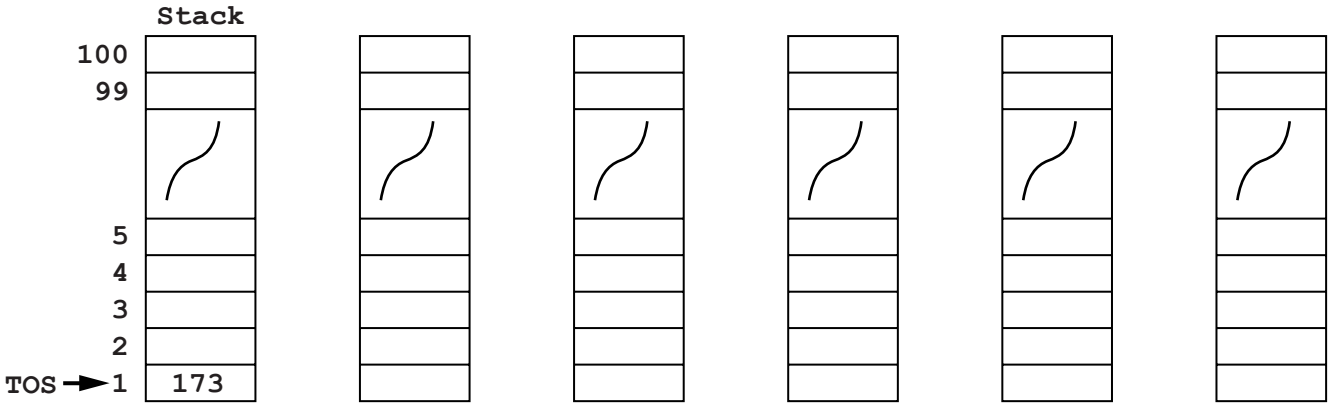
The student simplifies this for their project and will store on the stack only the return addresses.

Memory address (denary)	
100	`// Main program`
101	`<statements>`
…	
172	`CALL SUB1`
173	
…	`// end main program`
200	`PROCEDURE SUB1`
201	`<statements>`
…	
268	`CALL SUB2`
269	`<statements>`
…	
280	`CALL SUB3`
281	`<statements>`
320	`END PROCEDURE`
321	`PROCEDURE SUB2`
322	`<statements>`
…	
399	`END PROCEDURE`
400	`PROCEDURE SUB3`
401	`<statements>`
…	
562	`END PROCEDURE`

The stack is implemented using the following data structure and variables:

Identifier	Data type	Description
`Stack`	`ARRAY[1 : 100] OF INTEGER`	Stores the return address for each procedure call
`TOS`	`INTEGER`	Stores the index position of the return address currently at the top of the stack
`NewAddress`	`INTEGER`	Stores the new return address to be added to `Stack`

(b) The diagram shows the stack after the first procedure call at line 172.



(i) Complete the diagram to show the contents of the stack and the value of `TOS` after each change. [5]

(ii) The student uses the procedure `PushAddress` to simulate adding a return address to the stack.

The incomplete pseudocode for the procedure `PushAddress` is shown below.

Using the given variables, fill in the missing pseudocode.

```
PROCEDURE PushAddress
  IF TOS = 100
    THEN
      OUTPUT "....."
    ELSE
      INPUT .....
      TOS ← .....
      ..... ← NewAddress
  ENDIF
ENDPROCEDURE
```

[4]

(c) The student uses the procedure `PopAddress` to simulate retrieving a return address from the stack.

Complete the pseudocode for this `PopAddress` procedure.

```
PROCEDURE PopAddress
  IF .....
    THEN
      OUTPUT "There are no current procedure calls"
    ELSE
      OUTPUT "Address" Stack[TOS]
      .....
  ENDIF
ENDPROCEDURE
```

[2]

Question 5 begins on page 16.

5 A computer system stores integers in a single byte using two's complement represen

(a) State the denary integer represented by the following two bytes.

Give the hexadecimal representation of each integer.

(i)

0	1	1	0	1	1	1	1

Denary .....

Hexadecimal .....

[2]

(ii)

1	1	1	0	0	0	1	1

Denary .....

Hexadecimal .....

[2]

(b) State the most negative denary integer that can be represented.

.....[1]

(c) Why do computer scientists often write binary numbers in hexadecimal?

.....

.....[1]

(d) The integers `124` and `7` are to be added.

Write the binary values for `124` and `7` below, using two's complement representation.

Show the binary addition calculation and result.

124									
7									**+**

Comment on the result.

.....

.....[3]

(e) Integers can be represented in Binary Coded Decimal (BCD).

(i) State what denary number is represented by this 2-byte BCD number.

1	0	0	1	1	0	0	0	0	0	1	1	0	1	1	1

Denary ..... [1]

(ii) A second BCD 2-byte number has been copied incorrectly.

1	1	0	1	0	0	1	1	0	1	0	1	0	0	0	0

Without converting the whole pattern, how can you identify that this cannot be a valid BCD representation?

.....

.....[1]

6 A team of programmers has developed software using a variety of languages and so

Some of the code was written in the XYZ high-level language and some in an assembly lan

The programmers have also made use of program libraries.

The programmers had available both a compiler and an interpreter for the high-level code written. Some of the early error detection was carried out using an interpreter.

The diagram opposite shows the complete development life cycle, finishing with the final executable code.

(a) State the type of diagram shown. .....[1]

(b) Use the following list to identify the labels 1 to 7 on the diagram opposite. Two of the items on the list will not be used.

- Error report
- Linker
- Loader
- Machine code
- Multiprogramming
- Program library code
- Source code in assembly language
- Source code in language XYZ
- Text editor

1 .....

2 .....

3 .....

4 .....

5 .....

6 .....

7 .....

[7]

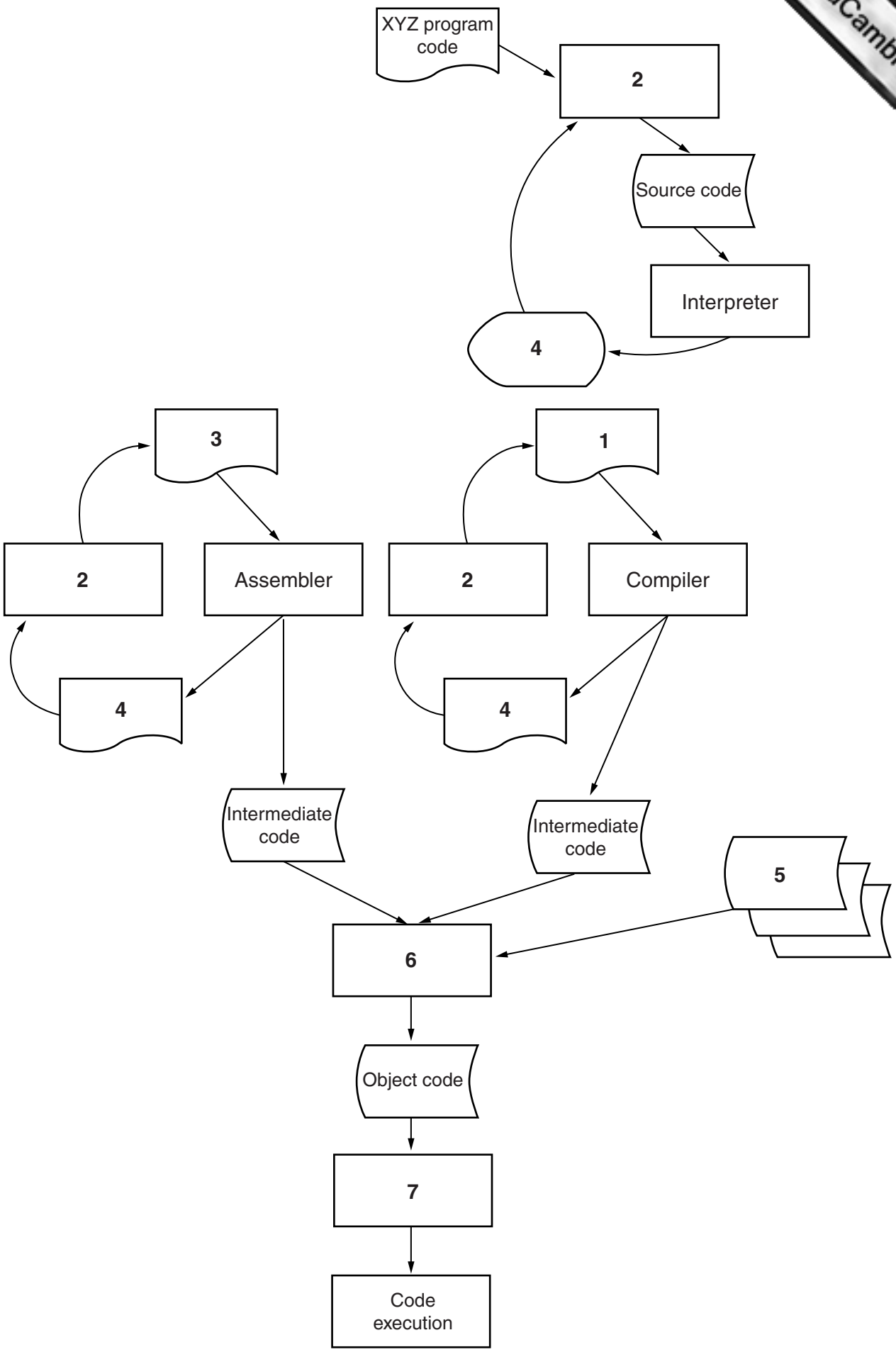
(c) Describe **one** benefit and **one** drawback of using an interpreter for part of the software development.

Benefit .....

.....

Drawback .....

.....[2]



7 **(a)** Describe **two** different media used for the transmission of data across a wide are

1 .....

.....

2 .....

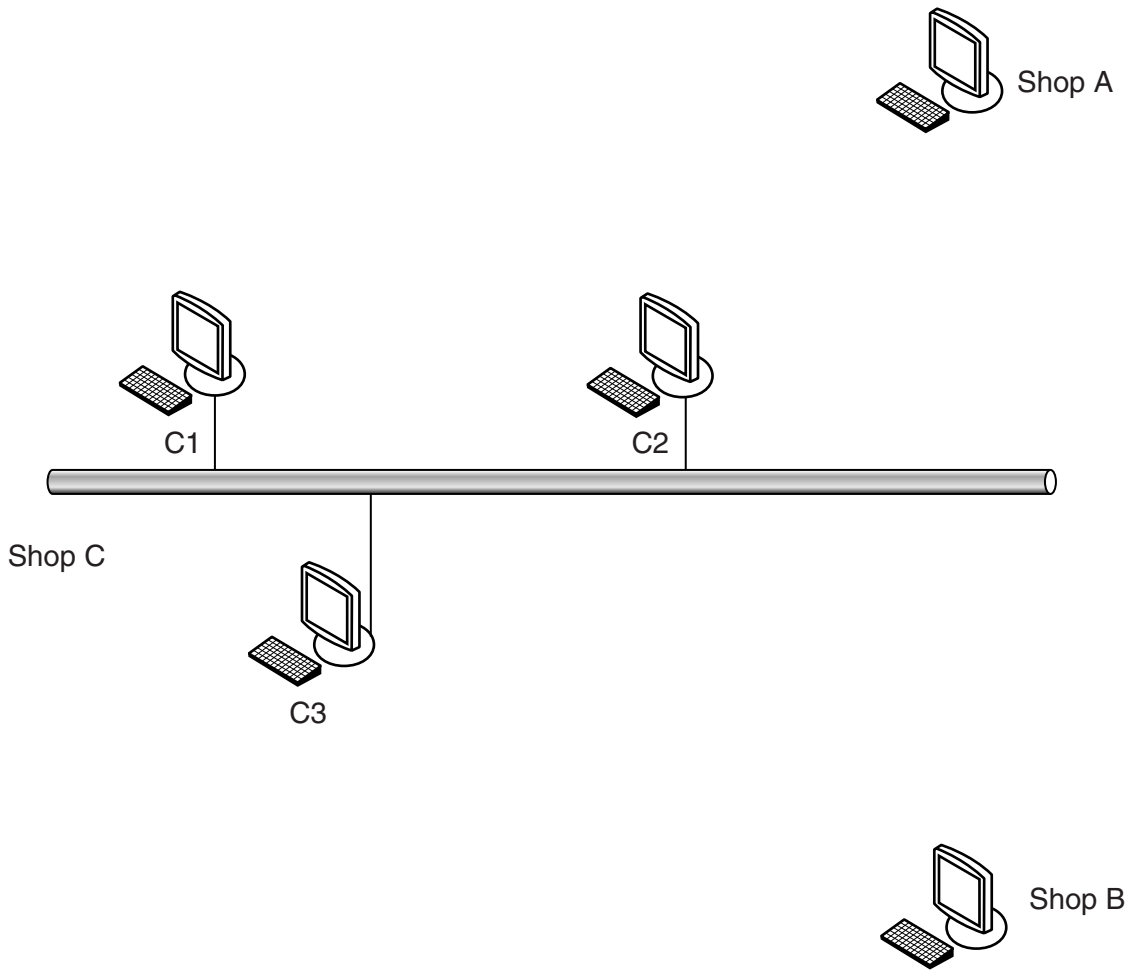
.....[4]

(b) A company has three retail shops, Shop A, Shop B and Shop C, located in different towns.

- Shop A and Shop B each have a single computer. They connect to the network of Shop C.
- Shop C has a Local Area Network (LAN) consisting of:
  - three computers (C1, C2 and C3)
  - a fourth computer (C4) which acts as a print server for a laser printer
  - a file server (ServerY) contains all the order processing data for all three shops and authenticates all logons

The shops are connected over a Wide Area Network (WAN) using a star topology.

Complete the diagram showing the additional hardware needed for both the LAN and the WAN.



[4]

(c) The management is considering setting up a company intranet.

(i) State the type of file server used to make the intranet pages available.

.....[1]

(ii) State the software needed on each computer to view the intranet content.

.....[1]

(iii) Give **two** benefits to the company that an intranet would provide.

1 .....

.....

2 .....

.....[2]

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