Cambridge International Examinations
Cambridge International Advanced Level

Cambridge International A Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

COMPUTING **9691/33**

Paper 3 **May/June 2014**

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 for 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 **18** printed pages and **2** blank pages.

Cambridge International Examinations

[Turn over
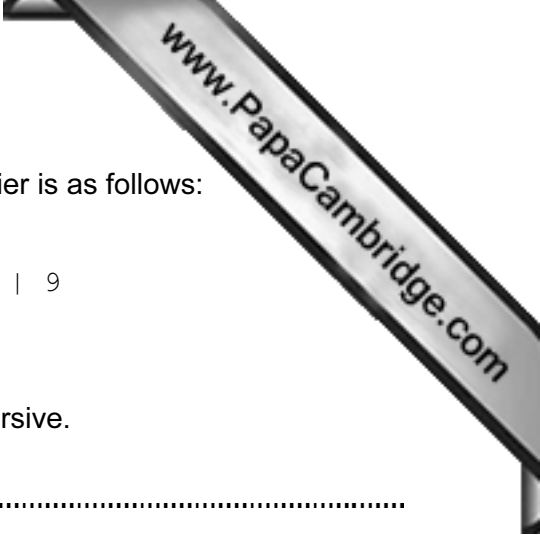
1 A set of Backus-Naur Form (BNF) rules to define a variable identifier is as follows:

```
1.<Letter> ::= a | b | c | d | e | f | g | h
2.<Digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
3.<Character> ::= <Letter> | <Digit>
4.<VarName> ::= <Letter> | <VarName><Character>
```

(a) (i) A BNF rule can be recursive. State what is meant by recursive.

....

.... [1]

(ii) State the rule above which is recursive.

Rule number .... [1]

(b) For each of the expressions in the table below, state whether it is a valid `<VarName>`.

List the rule number(s) in the order you have applied them to arrive at your decision.

	Expression	Valid or invalid	Rules used
(i)	f		
(ii)	3da		
(iii)	Bc		
(iv)	a3ba		

[1]

[1]

[1]

[3]

(c) The rules are to be extended to define a rule for a constant identifier.

The identifier for a constant follows the same rules as for a variable identifier `<VarName>` but always ends with the underscore (_) character.

Write **two** additional rules to include the definition for a constant identifier `<ConstName>`.

....

....

.... [2]

2   Paintings by various artists are on display in art galleries all over the world. When a gallery hosts an exhibition, it may display paintings:

- from its own stock,
- or borrowed from other galleries,
- or both.

A database is to be created. It will store data about artists, paintings, galleries and exhibitions.

Artist data consist of:

- artist name (unique).

Painting data consist of:

- a unique reference number (recognised by all galleries)
- painting title
- artist name
- date (year only)
- name of the gallery owning the painting.

Gallery data consist of:

- gallery name (unique)
- country.

An exhibition only takes place once at one gallery and shows either:

- paintings for a single artist only, e.g. the Da Vinci exhibition at the National Gallery in London in 2011, or
- paintings by a number of artists.

Exhibition data consist of:

- exhibition title (unique)
- gallery name
- exhibition artist (if a single artist only, otherwise contains an empty string)
- start date
- closing date
- all paintings which are included in the exhibition.

Painting-in-exhibition data consist of:

- exhibition title (unique)
- painting reference number
- loan fee.

When a gallery lends a painting to another gallery, it may charge a loan fee.

The database design consists of five entities. These are shown in the entity ....
(E-R) diagram.
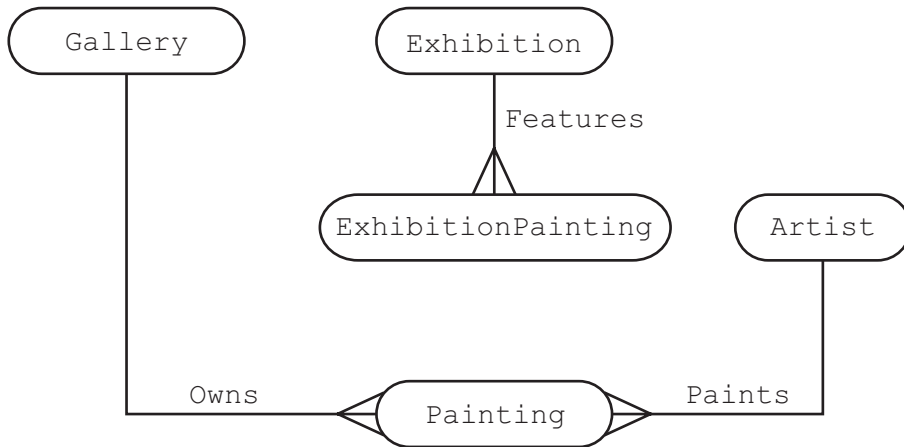
(a) Consider the relationship between `Gallery` and `Exhibition`.

   (i) Draw this relationship on the E-R diagram above.   [1]

   (ii) Complete the description for the `Gallery` and `Exhibition` tables. Use the notation:

      `TableName(`<u>`Attribute1`</u>`, Attribute2, ...)`

      where the underlined attribute indicates the primary key.

      `Gallery (` .... `)`

      `Exhibition (` .... `)`[4]

(b) The `Painting` and `ExhibitionPainting` entities (with the primary keys not shown) are
    as follows:

   `Painting(PaintingRefNo, PaintingTitle, ArtistName, PaintingDate,`
   `                                                          GalleryName)`
   `ExhibitionPainting(ExhibitionTitle, PaintingRefNo, LoanFee)`

   (i) What is the primary key of table `ExhibitionPainting`?

      .... [1]

      Consider the relationship between `Painting` and `ExhibitionPainting`.

   (ii) Draw this relationship on the E-R diagram.   [1]

   (iii) Explain how this relationship is modelled using the given attributes.

      ....

      ....

      .... [2]
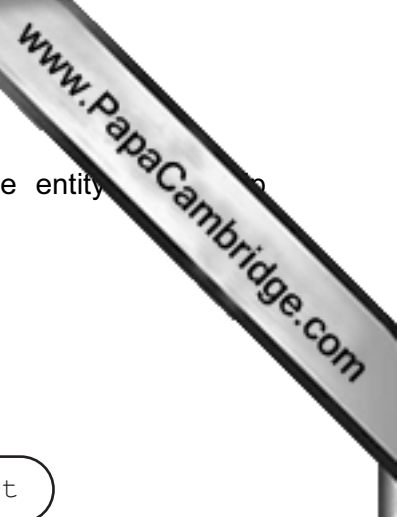
(c) Additional data are to be stored about each artist as follows:

```
Artist(ArtistName, Nationality, YearBorn, YearDied)
```

The following Data Manipulation Language (DML) query is run.

```
SELECT PaintingRefNo
FROM Painting, Artist
WHERE (Artist.ArtistName = Painting.ArtistName) AND
                        (YearBorn >= 1900) AND (YearDied <= 2000);
```

Identify what useful information is produced by the query.

....

.... [2]

(d) Write a DML query to display the painting reference number and painting title for all paintings by Da Vinci.

....

....

....

.... [3]

(e) The painting 'The Guitar Player' was in the 'Secrets and Silence' exhibition. The `ExhibitionPainting` table has a record for this. In the record:

- The painting is referred to by its reference number, 9065.
- The loan fee is recorded as $10000. This is an error – there was no charge made for the loan by the loaning gallery.

Complete the DML command to amend this record.

```
UPDATE
```
....

```
SET
```
....

```
WHERE (ExhibitionTitle = 'Secrets and Silence')
```

```
                        AND (
```
....); [3]

[Turn over
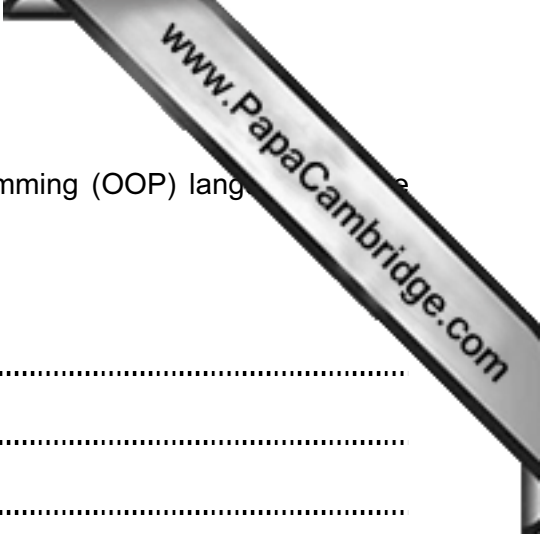
3 An application is to be implemented. An object-oriented programming (OOP) lang   e used.

(a) Explain how OOP uses classes and objects.

....

....

....

....

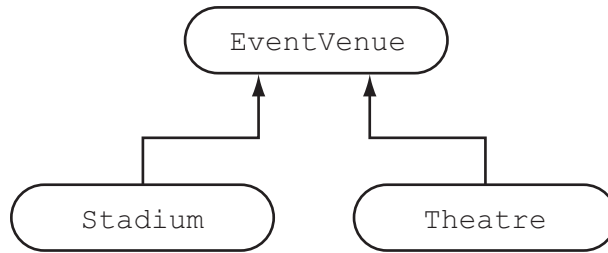.. [3]

(b) An application is to store and process data for major event venues. Venues include football and cricket stadia and theatres.

Three classes are to be designed as shown by the inheritance diagram below.

Explain what is meant by **inheritance**.

....

....

.... [2]

(c) All venues have the venue name and address recorded.

A theatre has recorded:

- the number of seats
- a list of the types of event staged (such as play, rock concert)
- whether or not the theatre has a restaurant.

A stadium has recorded:

- a list of the sports played (such as football, cricket and athletics)
- a list of the names of any teams that play their home fixtures here
- the capacity
- whether the stadium is 'seating-only'.

(i) Complete the class diagram showing the classes and properties given. Do not attempt to include any methods on the class diagram.
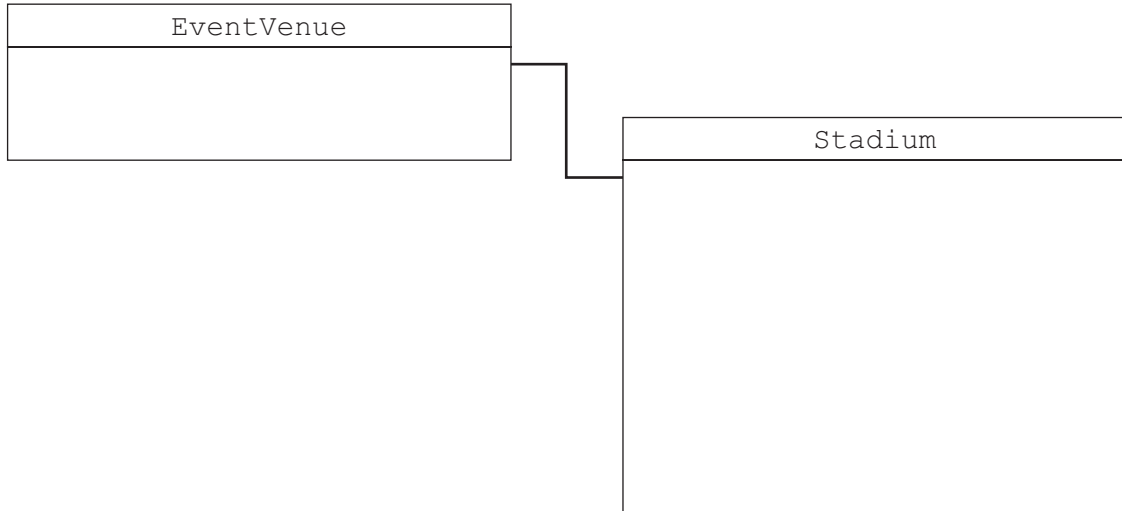
```
        EventVenue
  VenueName : STRING


```
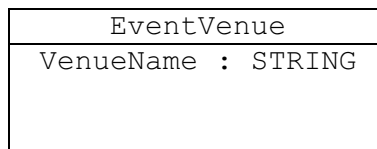
[8]

(ii) The following data is for one such venue.

Stadio Olympico is in Rome, Italy. It is the home venue for two football teams, La___ Roma. The stadium is seating-only and has a capacity of 80,000. It is also use___ rugby matches by the national team.
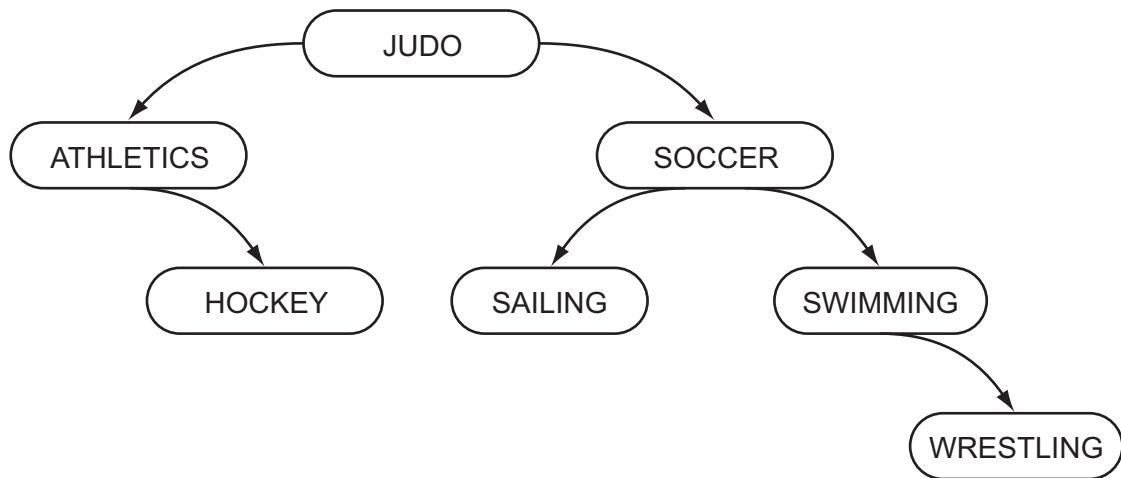
Complete the object diagram below.

EventVenue

Stadium

[5]

4   A binary tree is used to store a list of sports.

The tree currently has seven sports as shown below:

The binary tree is implemented in a high-level language with the following data structures:

Variable	Data type	Description
RootPtr		Array subscript for the root of the tree
Data		Array of sport names
RightPtr	ARRAY[1 : 2000] OF INTEGER	Array of right pointer values
LeftPtr	ARRAY[1 : 2000] OF INTEGER	Array of left pointer values

(a) Complete the **two** table entries above.   [2]

(b) Two new sports, CYCLING and TAI-CHI are to be added.

Add these to the diagram above.   [2]

[Turn over

(c) The first seven sports joined the tree in the order:

JUDO, SOCCER, SAILING, SWIMMING, ATHLETICS, WRESTLING, HOCKEY.

Complete the diagram below showing the contents of the arrays and the `RootPtr` variable.

RootPtr	

	LeftPtr	Data	RightPtr
1		JUDO	
2			
3			
4			
5			
6			
7			
2000			
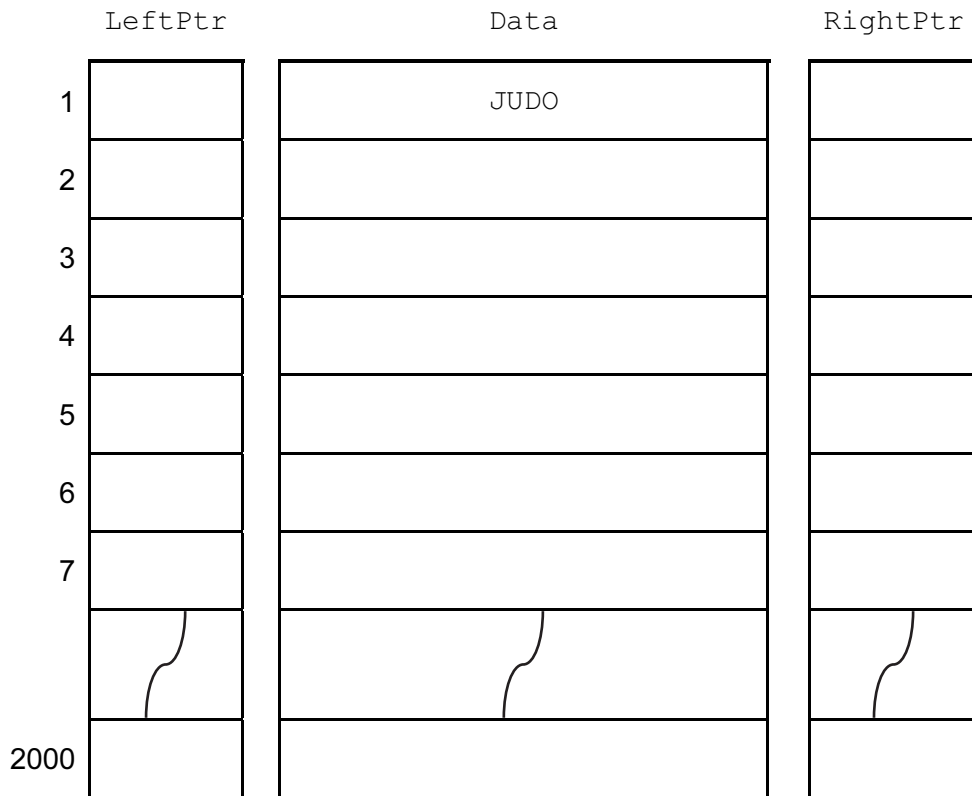
[4]

(d) An algorithm is designed in pseudocode to search the binary tree for a particular ~~~~

The algorithm uses the variables below:

Variable	Data type	Description
SearchSport	STRING	Sport to search for
Current	INTEGER	Array subscript for the item currently considered
IsFound	BOOLEAN	Flag set to TRUE when SearchSport is found

```
//binary tree search
INPUT SearchSport
IsFound ← FALSE
Current ← RootPtr
REPEAT
  IF SearchSport = Data[Current]
    THEN
      OUTPUT 'found'
      IsFound ← TRUE
    ELSE
      IF SearchSport > Data[Current]
        THEN
          OUTPUT 'Moving right'
          Current ← RightPtr[Current]
        ELSE
          OUTPUT 'Moving left'
          Current ← LeftPtr[Current]
      ENDIF
  ENDIF
UNTIL IsFound = TRUE OR Current = 0

IF Current = 0
  THEN
    OUTPUT SearchSport ' not found'
ENDIF
```

[Turn over

The algorithm is tested using this new dataset.

RootPtr	1

	LeftPtr	Data	RightPtr
1	2	KARATE	3
2	0	ARCHERY	4
3	6	ROWING	5
4	0	HANDBALL	0
5	0	RUGBY	7
6	0	LACROSSE	0
7	0	SHOOTING	0
⋮			
2000			

Complete the trace table below to search for LACROSSE.

SearchSport	IsFound	Current	OUTPUT
LACROSSE	FALSE	1	

[5]

5 **(a)** A computer system stores integers as an 8-bit two's complement integer.

Give the denary number represented by Byte 1 and Byte 2.

	Byte 1								Byte 2						
1	0	1	0	0	0	0	1	0	1	1	0	1	1	1	1
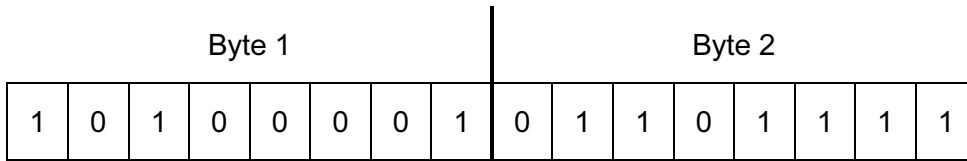
Byte 1 ....

Byte 2 ....   [2]

(b) Two bytes together are used to represent a Binary Coded Decimal (BCD) number.

State the denary number represented by Byte 3 and Byte 4.

	Byte 3								Byte 4						
0	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1
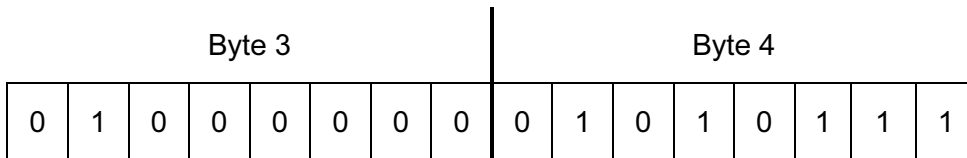
Denary ....   [2]

(c) Byte 5 and Byte 6 together represent a 16-bit colour code used in a drawing program.

	Byte 5								Byte 6						
0	1	1	0	1	1	1	0	1	1	1	1	1	0	0	1
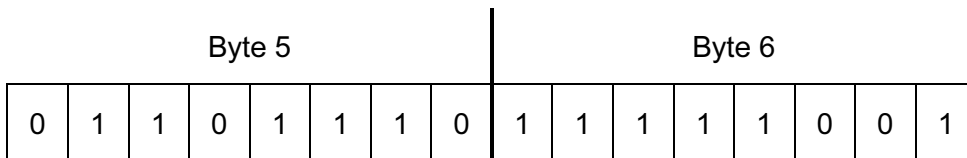
The drawing program displays a colour code as a hexadecimal number.

State the hexadecimal number for this colour code.   ....   [2]

[Turn over

(d) Many computer systems need to store and process real numbers.

A computer uses two bytes to store a real number. The first (Byte 7) stores the mantissa, the second (Byte 8) the exponent. Both mantissa and exponent use two's complement.

(i) What denary number is represented by Byte 7 and Byte 8?

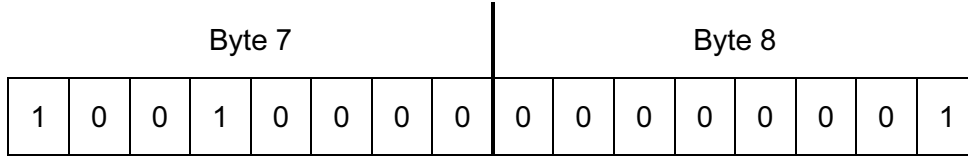|	Byte 7								Byte 8						
1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1

Show your working.

....

....

....

....

.... [3]

(ii) How can you recognise that this 16-bit pattern (Byte 7 and Byte 8) is normalised?

.... [1]

(iii) The positive number 2.0 is to be represented as a normalised real number.

Show the mantissa and exponent for this value.

Mantissa   Exponent

[2]

(iv) What is the largest positive number that can be represented? Use the same 8-bit mantissa and 8-bit exponent.

Show the mantissa and exponent.

Mantissa   Exponent

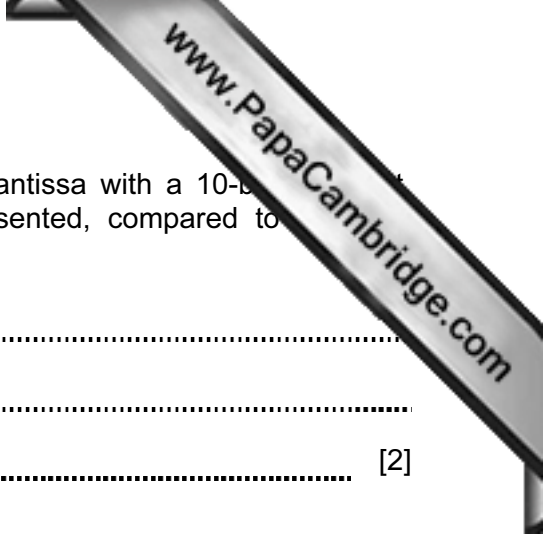|															

Do not attempt to evaluate this. [2]

(e) An alternative representation is suggested using a 6-bit mantissa with a 10-b
Describe the effect on the numbers which can be represented, compared to
mantissa and 8-bit exponent used earlier.

....

....

.... [2]

[Turn over

6 A firm of insurance brokers provides quotations. The firm uses two stand-alone comp... customers come in person to the office and are given a printed quotation to take aw... customers enquire through the firm's website over the Internet.

Each computer creates a file at the start of each day to log and save the quotations issued fr... that computer.

There has been a large increase in enquiries, so the firm is to employ three more staff to provide quotations. The firm will design and implement a Local Area Network (LAN) of five computers. The LAN must provide all computers with access to the Internet.

(a) The network is to have a **bus topology**.

Sketch the topology of the LAN. Clearly label all items of hardware.

[5]
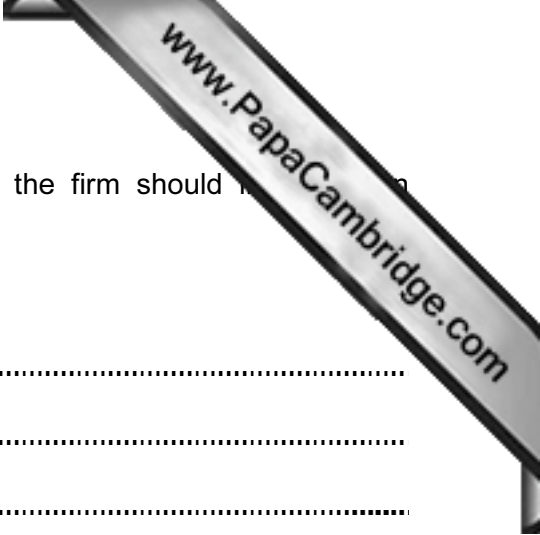
(b) The LAN is implemented and the manager suggests that the firm should ~~have an~~ intranet.

(i) Describe what is meant by an **intranet**.

....

....

....

.... [2]

(ii) Describe **four** benefits that the provision of an **intranet** would bring to the business.

1 ....

....

2 ....

....

3 ....

....

4 ....

.... [4]

[Turn over

(c) A quotation is accepted by a customer. The broker must ask the insurance comp[...] confirm the quotation. A copy of the quotation is sent to the insurance company by [...] encrypted email.

(i) Explain what is meant by **symmetric encryption**.

....

.... [2]

(ii) When the broker sends an encrypted email to the insurance company, asymmetric encryption is used. Asymmetric encryption uses both private and public keys.

To send encrypted emails to each other and receive them, Claude and Sobi each know three keys.

CLAUDE

SOBI

Knows:

CLAUDE's Private Key

W

X

Knows:

SOBI's Public Key

Y

Z
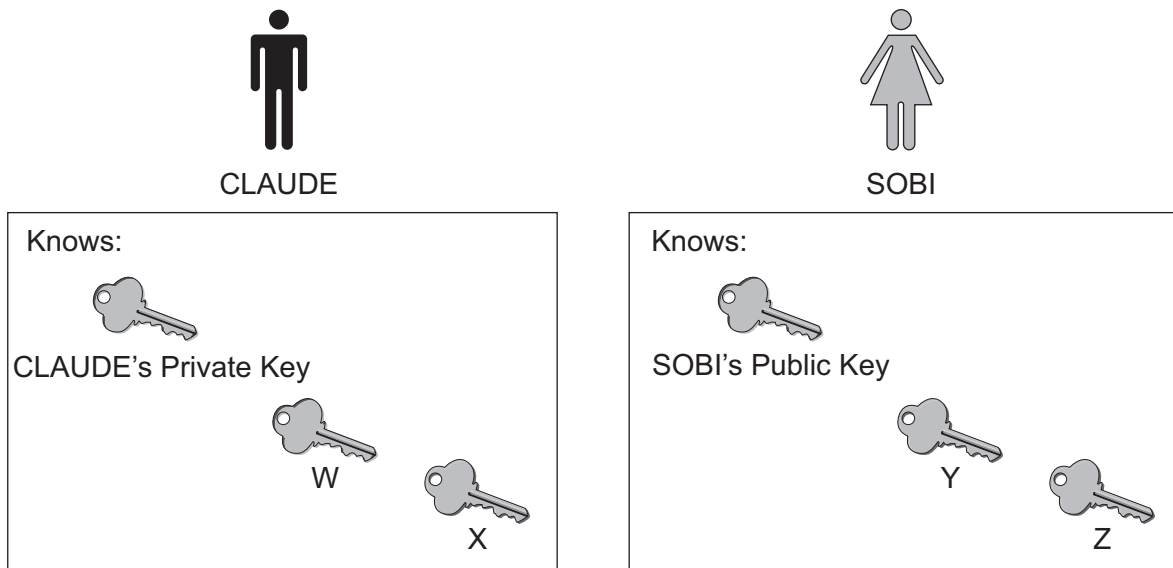
Four keys have the codes W, X, Y and Z as labels. For each of these keys, state who owns it and whether it is private or public.

W ....

X ....

Y ....

Z .... [3]

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