

- 1 (a) A particular programming language allows the programmer to define their own data types.

`ThisDate` is an example of a user-defined structured data type.

```

TYPE ThisDate
  DECLARE ThisDay      : (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                          13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
                          24, 25, 26, 27, 28, 29, 30, 31)
  DECLARE ThisMonth    : (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug,
                          Sep, Oct, Nov, Dec)
  DECLARE ThisYear     : INTEGER
ENDTYPE

```

A variable of this new type is declared as follows:

```
DECLARE DateOfBirth : ThisDate
```

- (i) Name the non-composite data type used in the `ThisDay` and `ThisMonth` declarations. [1]
- (ii) Name the data type of `ThisDate`. [1]
- (iii) The month value of `DateOfBirth` needs to be assigned to the variable `MyMonthOfBirth`.

Write the required statement. [1]

- (b) Annual rainfall data from a number of locations are to be processed in a program.

The following data are to be stored:

- location name
- height above sea level (to the nearest metre)
- total rainfall for each month of the year (centimetres to 1 decimal place)

A user-defined, composite data type is needed. The programmer chooses `LocationRainfall` as the name of this data type.

A variable of this type can be used to store all the data for one particular location.

- (i) Write the definition for the data type `LocationRainfall`. [5]
- (ii) The programmer decides to store all the data in a file. Initially, data from 27 locations will be stored. More rainfall locations will be added over time and will never exceed 100.  
The programmer has to choose between two types of file organisation. The two types are serial and sequential. Give **two** reasons for choosing serial file organisation. [2]

2 A library membership system identifies members by their unique 6-digit ID number.

(a) Explain how hashing could be used to access the member file randomly. [2]

(b) Clashes can occur when the member file is accessed using hashing. State what is meant by a clash and how it can be dealt with. [4]

3 In a particular computer system, real numbers are stored using floating-point representation with:

- 8 bits for the mantissa, followed by
- 8 bits for the exponent

Two's complement form is used for both mantissa and exponent.

(a) (i) A real number is stored as the following two bytes:

| Mantissa |   |   |   |   |   |   |   | Exponent |   |   |   |   |   |   |  |
|----------|---|---|---|---|---|---|---|----------|---|---|---|---|---|---|--|
| 0        | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0 | 1 | 1 |  |

Calculate the denary value of this number. Show your working. [3]

(ii) Explain why the floating-point number in part **(a)(i)** is not normalised. [2]

(iii) Normalise the floating-point number in part **(a)(i)**.

| Mantissa |  |  |  |  |  |  |  | Exponent |  |  |  |  |  |  |  |
|----------|--|--|--|--|--|--|--|----------|--|--|--|--|--|--|--|
|          |  |  |  |  |  |  |  |          |  |  |  |  |  |  |  |

[2]

- (b) (i) Write the largest positive number that can be written as a normalised floating-point number in this format.

Mantissa

Exponent

|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|

[2]

- (ii) Write the smallest positive number that can be written as a normalised floating-point number in this format.

Mantissa

Exponent

|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|

[2]

- (iii) If a positive number is added to the number in part (b)(i) explain what will happen.

[2]

- (c) A student writes a program to output numbers using the following code:

```

X ← 0.0
FOR i ← 0 TO 1000
  X ← X + 0.1
  OUTPUT X
ENDFOR

```

The student is surprised to see that the program outputs the following sequence:

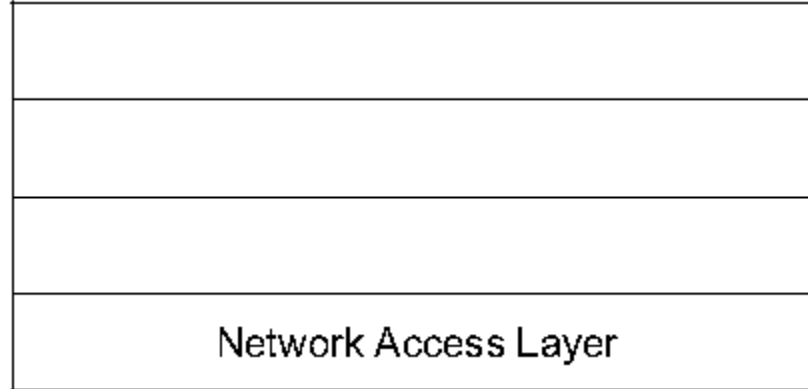
0.0 0.1 0.2 0.2999999 0.3999999 .....

Explain why this output has occurred.

[3]

- 4 (a) Complete the diagram to show how the layers of the TCP/IP protocol are related.

Choose from the terms: Internet Layer, Presentation Layer, Data Link Layer, Application Layer, Transport Layer.



[3]

- (b) Give the names of **two** LAN network technologies that the Network Access Layer has to interface with. [2]

One layer of the protocol makes use of IP addresses. An IP address is a 32-bit number; for example, 205.123.4.192 is an IP address.

Part of the IP address is used for the network ID, and part of the address is used for the host ID.

- (c) (i) Explain the terms:  
network ID:  
host ID:

[2]

Most IP addresses fall into one of three classes:

- If the 32-bit address starts with a 0 bit, the address is a Class A address.
- If the 32-bit address starts with the bits 10, the address is a Class B address.
- If the 32-bit address starts with bits 110, the address is a Class C address.

- (ii) Show how to determine whether 205.123.4.192 is a Class A, Class B or Class C address. [2]

- (iii) In a Class A address, the first byte represents the network ID and the remaining three bytes represent the host ID.

In a Class B address, the first two bytes represent the network ID and the remaining two bytes represent the host ID.

In a Class C address, the first three bytes represent the network ID and the remaining byte represents the host ID.

For the address 205.123.4.192 state the:

network ID:

host ID:

[2]

- 5 Communications across a network can be done by using circuit switching or packet switching.

(a) Explain the difference between circuit switching and packet switching. [2]

(b) Give **one** advantage of using

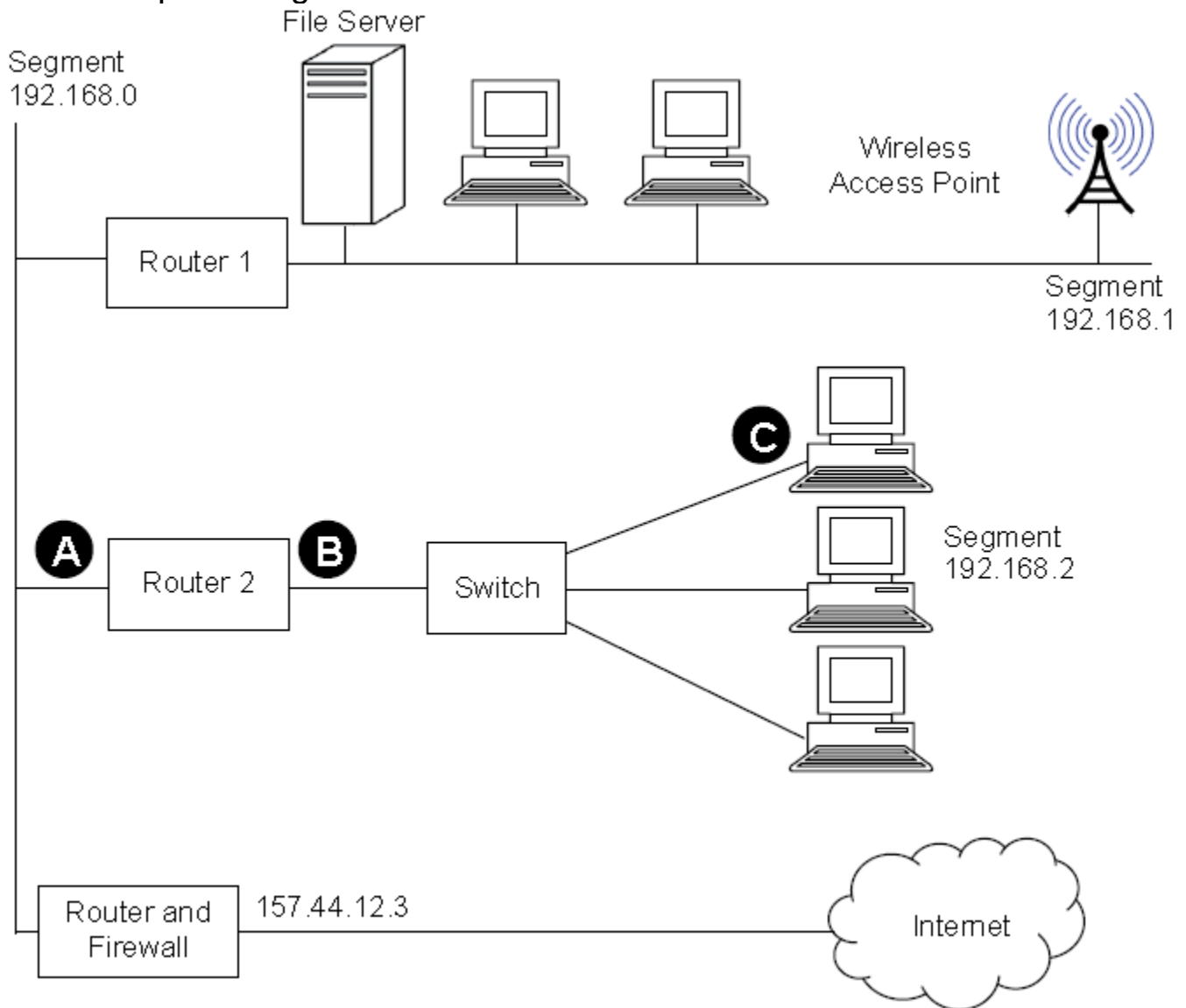
(i) circuit switching

(ii) packet switching

when sending data across a network.

[2]

- 6 The figure below shows the topology of a particular computer network that is divided up into segments.



- (a) Suggest suitable IP addresses for:
- the "Router 2" port labelled A:
  - the "Router 2" port labelled B:
  - the computer network interface card labelled C: [3]
- (b) What physical network topology is used within segment 192.168.2 to connect the computers to the switch? [1]

- (c) Laptop computers connect to the network wirelessly using Wi-Fi. Wireless communication is less secure than communication using cables.

Explain **two** measures that the Wireless Access Point could use to improve the security of the network. [2]

- (d) The computers in segment 192.168.1 use Carrier Sense Multiple Access with Collision Detection (CSMA/CD) to determine when to transmit data.

Explain how the CSMA/CD method is used, including what happens in the event of a collision occurring. [6]

- 7 (a) State what is meant by a protocol? [2]

- (b) Name the protocols used for the following:

(i) sending email

(ii) loading websites

(iii) sending files

(iv) loading secure websites

(v) receiving emails [5]

- (c) Downloading a file can use the client-server model. Alternatively, a file can be downloaded using the BitTorrent protocol. For the BitTorrent protocol, explain the function of each of the following:

(i) tracker [2]

(ii) swarm [2]

- 8 A pointer is a variable that stores the address of a variable of a particular type.

Consider the pseudocode below, which uses the following identifiers:

| Identifier | Data type | Description           |
|------------|-----------|-----------------------|
| myPointer  | ^INTEGER  | Pointer to an integer |
| Sum        | INTEGER   | An integer variable   |
| myVal1     | INTEGER   | An integer variable   |
| myVal2     | INTEGER   | An integer variable   |

Sum  $\leftarrow$  45                      //assigns the value 45 to the integer variable Sum





myPointer  $\leftarrow$  @Sum            //assigns to myPointer the address of the integer variable Sum

myVal1  
myPointer $^{\wedge}$                        $\leftarrow$  //assigns to variable myVal1 the value at an address pointed at by myPointer

myPointer $^{\wedge}$   
myVal2                           $\leftarrow$  //assigns the value in the variable myVal2 to the memory location pointed at by myPointer

The four assignment statements are executed. The diagram shows the memory contents after execution.



| Variable  | Memory Address | Contents  |
|-----------|----------------|---|
|           |                |    |
|           | 2924           |   |
|           | 2923           |   |
| myPointer | 2922           | 2200  |
|           | 2921           |   |
|           |                |    |
|           | 2201           |   |
| Sum       | 2200           | 35  |
|           | 1999           |   |
|           |                |    |
|           | 1714           |   |
| myVal1    | 1713           | 45  |
| myVal2    | 1712           | 53  |
|           | 1711           |   |
|           |                |  |

- (a) Use the diagram to state the current values of the following expressions
- (i) myPointer [1]
  - (ii) myPointer^ [1]
  - (iii) @myVal1 [1]
  - (iv) myPointer^=myVal2 [1]
- (b) Write pseudocode statements that will achieve the following:
- (i) Place the address of myVal2 in myPointer. [1]
  - (ii) Assign the value 35 to the variable myVal1. [1]
  - (iii) Copy the value in myVal2 into the memory location currently pointed at by myPointer. [1]