QUESTION 3.

6 **(a)** Four descriptions and three protocols are shown below.

Draw a line to connect each description to the appropriate protocol.

Description	Protocol used
email client downloads an email from an email server	HTTP
email is transferred from one email server to another email server	POP3
email client sends email to email server	SMTP
browser sends a request for a web page to a web server	

[4]

(b) Downloading a file can use the client-server model. Alternatively, a file can be downloaded using the BitTorrent protocol.

Name the model used.

.....[1]

(c) For the BitTorrent protocol, explain the function of each of the following:

(i) Tracker .....

.....

.....[2]

(ii) Seed .....

.....

.....[2]

(iii) Swarm .....

.....

.....[2]

(i) Interpret the data in byte 1 shown below:

7	6	5	4	3	2	1	0
0	0	1	0	0	0	0	1

Byte 1

0	0	0	1	1	0	0	0

Byte 2

.....

.....

.....

.....[2]

(ii) The system receives a temperature reading of –5 degrees from sensor 6.

Complete the boxes below to show the two bytes for this recording. The reading has not yet been processed.

7	6	5	4	3	2	1	0

Byte 1

Byte 2

[2]

(d) (i) The accumulator is loaded with the value of byte 1 from location 106.

Write the assembly language instruction to check whether the reading in byte 2 came from location 4.

```
LDD 106            // data loaded from address 106
```

.....[4]

(ii) Write the assembly language instruction to set the flag (bit 0) of the byte contained in the accumulator to 1.

.....[2]

QUESTION 4.

6 A company grows vegetables in a number of large greenhouses. For the vegetab
the temperature, light level and soil moisture need to always be within certain range

The company installs a computerised system to keep these three growing conditions w
best ranges. Sensors are used for collecting data about the temperature, light level, and mo
content of the soil.

(a) Name the type of system described.

.....[1]

(b) Give **three** items of hardware that would be needed for this system. Justify your choice. Do not include sensors in your answer.

Item 1 .....

Justification .....

.....

Item 2 .....

Justification .....

.....

Item 3 .....

Justification .....

.....[6]

(c) **(i)** Describe what is meant by feedback in the above system.

.....

.....

.....

.....

.....

.....[3]

(ii) When the system was designed, various parameters for temperature were set.

Name **one** of these parameters.

.....

.....[1]

(iii) Explain how this parameter value is used by the feedback system.

.....

.....

.....

.....[2]

Question 6 continues on page 14.

Each greenhouse has eight sensors (numbered 1–8).

- The byte at address 150 is used to store eight 1-bit flags.
- A flag is set to indicate whether its associated sensor reading is waiting to be processe
- More than one sensor reading may be waiting to be processed at any particular moment.
- Data received from the sensors is stored in a block of eight consecutive bytes (addresses 201–208).
- The data from sensor 1 is at address 201, the data from sensor 2 is at address 202, and so on.

Sensor number

	1	2	3	4	5	6	7	8
150	0	1	0	0	0	1	0	1
201	0	0	0	0	0	0	0	0
202	0	0	0	0	0	1	0	0
203	0	0	0	0	0	0	0	0
204	0	0	0	1	0	0	0	0
205	0	0	0	0	0	0	1	0
206	0	0	0	1	0	1	0	0
207	0	0	0	1	0	0	1	0
208	0	0	0	1	0	0	1	0

(d) (i) Interpret the current reading for sensor 2.

.....

.....[2]

(ii) The accumulator is loaded with the data from location 150.

Write the assembly language instruction to check whether there is a value waiting to be processed for sensor 6.

```
LDD 150                 // data loaded from address 150
```

.....[3]

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QUESTION 5.

3 An email is sent from one email server to another using packet switching.

(a) State **two items** that are contained in an email packet apart from the data.

1 .....

2 .....[2]

(b) Explain the role of routers in sending an email from one email server to another.

.....

.....

.....

.....

.....

.....[3]

(c) Sending an email message is an appropriate use of packet switching.

Explain why this is the case.

.....

.....

.....

.....

.....

.....[2]

(d) Packet switching is not always an appropriate solution.

Name an alternative communication method of transferring data in a digital network.

.....[1]

(e) Name an application for which the method identified in **part (d)** is an appr
Justify your choice.

Application .....

Justification .....

.....

.....

.....

.....[3]

QUESTION 6.

6 A number of processes are being executed in a computer.

A process can be in one of three states: running, ready or blocked.

(a) For each of the following, the process is moved from the first state to the second Describe the conditions that cause each of the following changes of state of a process:

From blocked to ready .....

.....

.....

.....

From running to ready .....

.....

.....

.....[4]

(b) Explain why a process cannot move directly from the ready state to the blocked state.

.....

.....

.....

.....

.....

.....[3]

(c) A process in the running state can change its state to something which is neither the ready state nor the blocked state.

(i) Name this state.

.....[1]

(ii) Identify when a process would enter this state.

.....[1]

(d) Explain the role of the low-level scheduler in a multiprogramming operating system.

.....

.....

.....

.....[2]

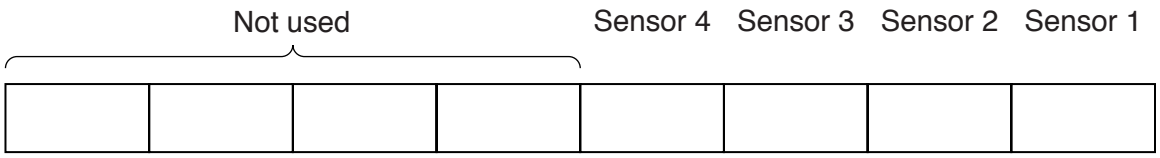
QUESTION 7.

6 An intruder detection system for a large house has four sensors. An 8-bit memory the output from each sensor in its own bit position.

The bit value for each sensor shows:

- 1 – the sensor has been triggered
- 0 – the sensor has not been triggered

The bit positions are used as follows:



The output from the intruder detection system is a loud alarm.

(a) (i) State the name of the type of system to which intruder detection systems belong.

.....[1]

(ii) Justify your answer to **part (i)**.

.....

.....[1]

(b) Name **two** sensors that could be used in this intruder detection system. Give a reason for your choice.

Sensor 1 .....

Reason .....

.....

Sensor 2 .....

Reason .....

.....[4]

The intruder system is set up so that the alarm will only sound if two or more se
triggered.
An assembly language program has been written to process the contents of the memo

The table shows part of the instruction set for the processor used.

Instruction		Explanation
Op code	Operand	
LDD	<address>	Direct addressing. Load the contents of the given address to ACC
STO	<address>	Store the contents of ACC at the given address
INC	<register>	Add 1 to the contents of the register (ACC or IX)
ADD	<address>	Add the contents of the given address to the contents of ACC
AND	<address>	Bitwise AND operation of the contents of ACC with the contents of <address>
CMP	#n	Compare the contents of ACC with the number n
JMP	<address>	Jump to the given address
JPE	<address>	Following a compare instruction, jump to <address> if the compare was True
JGT	<address>	Following a compare instruction, jump to <address> if the content of ACC is greater than the number used in the compare instruction
END		End the program and return to the operating system

(c) Part of the assembly code is:

	Op code	Operand
SENSORS:		B00001010
COUNT:		0
VALUE:		1
LOOP:	LDD	SENSORS
	AND	VALUE
	CMP	#0
	JPE	ZERO
	LDD	COUNT
	INC	ACC
	STO	COUNT
ZERO:	LDD	VALUE
	CMP	#8
	JPE	EXIT
	ADD	VALUE
	STO	VALUE
	JMP	LOOP
EXIT:	LDD	COUNT
TEST:	CMP	…
	JGT	ALARM

(i) Dry run the assembly language code. Start at `LOOP` and finish when `EX`

BITREG	COUNT	VALUE	ACC
B00001010	0	1	

[4]

(ii) The operand for the instruction labelled `TEST` is missing.

State the missing operand.

.....[1]

(iii) The intruder detection system is improved and now has eight sensors.

One instruction in the assembly language code will need to be amended.

Identify this instruction .....

Write the amended instruction .....[2]

QUESTION 8.

6 **(a)** The table below gives descriptions of three types of malware.

Description	Term
Malware that attaches itself to another program.	
Malware that redirects the web browser to a fake website.	
Email that encourages the receiver to access a website and give their banking details.	

Complete the table by adding the correct terms. [3]

(b) Ben wants to send a highly confidential email to Mariah so that only she can read it. Plain text and cipher text will be used in this communication.

(i) Explain the terms plain text and cipher text.

Plain text .....

.....

Cipher text .....

..... [2]

(ii) Explain how the use of asymmetric key cryptography ensures that only Mariah can read the email.

.....

.....

.....

.....

.....

.....

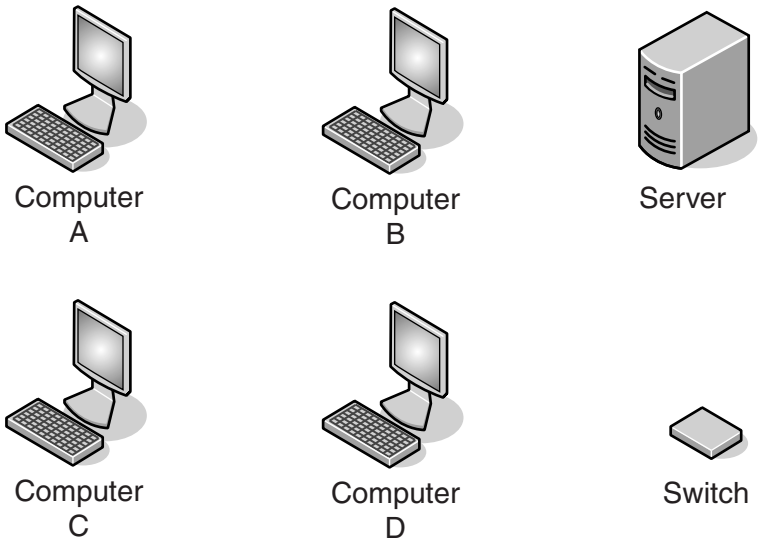
.....

..... [4]

QUESTION 9.

6 A Local Area Network (LAN) consists of four computers, one server and a switch. star topology.

(a) Complete the diagram below to show how to connect the devices.



[2]

(b) The LAN uses packets to transfer data between devices.

Three statements are given below.

Tick (✓) to show whether each statement is true or false.

Statement	True	False
All packets must be routed via the server.		
Computer B can read a copy of the packet sent from the Server to Computer A.		
No collisions are possible.		

[3]

(c) In the same building as this star network, there is another star network.

(i) Name the device needed to connect the two networks together.

..... [1]

(ii) Explain how the device in **part (c)(i)** decides whether to transfer a packet from one network to the other.

.....

.....

.....

..... [2]

(iii) Name the labels usually given to **J** and **K**.

Label **J** .....

Label **K** .....

Explain why your answers are appropriate labels for these outputs.

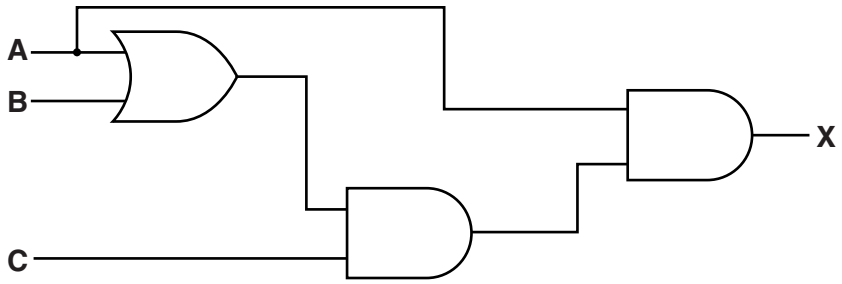
.....

.....

.....

..... [4]

(b) (i) Write down the Boolean expression corresponding to the following logic circuit:



..... [2]

(ii) Use Boolean algebra to simplify the expression given in **part (b)(i)**.

Show your working.

.....

.....

.....

.....

.....

..... [4]

QUESTION 10.

QUESTION 11.

6 A large office building has many floors. On each floor there are security sens
cameras. There is the same number of sensors on each floor. The building has a s
room.

The images from the security cameras are output on monitors (one monitor for each floor) p
in the security room.

The data from the sensors are read and processed by a computer system. Sensor readings and warning messages can be displayed on the monitors.

(a) (i) State the name given to the type of system described.

.....[1]

(ii) Explain your answer to **part (i)**.

.....

.....[1]

(iii) State **two** sensors that could be used in this system.

Sensor 1 .....

Sensor 2 .....

[2]

(b) A software routine:

- checks the readings from the sensors
- outputs readings and warning messages to the monitors
- loops continuously.

The routine uses the following pseudocode variables:

Identifier	Data type	Description
`FloorCounter`	`INTEGER`	Loop counter for number of floors
`SensorCounter`	`INTEGER`	Loop counter for number of sensors
`NumberOfFloors`	`INTEGER`	Stores the number of floors
`NumberOfSensors`	`INTEGER`	Stores the number of sensors
`ForEver`	`BOOLEAN`	Stores value that ensures continuous loop

(i) Complete the following pseudocode algorithm for the routine.

```
01 ForEver ← .....
02 REPEAT
03   FOR FloorCounter ← 1 TO NumberOfFloors
04     FOR SensorCounter ← 1 TO .....
05       READ Sensor(SensorCounter)on Floor(FloorCounter)
06       IF Sensor value outside range
07          THEN
08             OUTPUT "Problem on Floor ", FloorCounter
09       ENDIF
10     ENDFOR
11   ENDFOR
12   //
13   // Delay loop
14   // Delay loop
15   //
16 UNTIL .....
```

[3]

(ii) A delay needs to be introduced before the loop is processed again.

Write a `FOR` loop, in pseudocode, to replace lines `13` and `14`.

.....

.....[1]

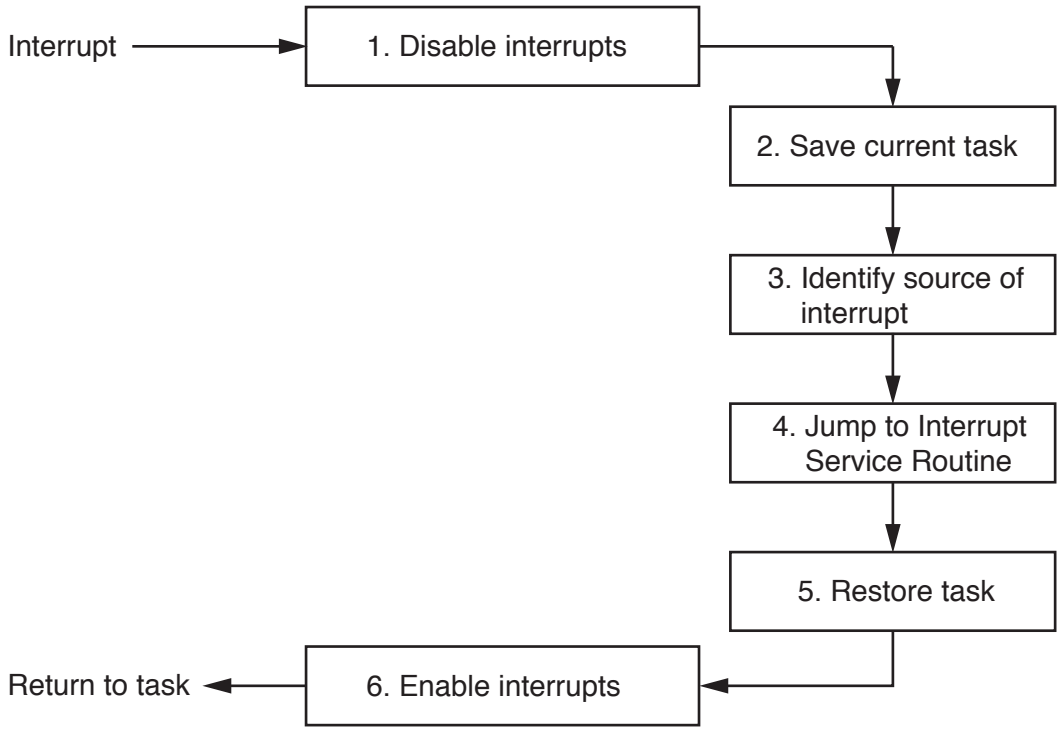
(iii) Give a reason for this delay in the system.

.....

.....[1]

(c) An alternative method of reading and processing sensor data is to use interru
is connected so that it can send an interrupt signal to the processor if its value

On receipt of an interrupt signal, the processor carries out a number of steps as sho
following diagram.



(i) State the purpose of step 3.

.....

.....[1]

(ii) Explain what happens at step 4.

.....

.....

.....

.....[2]

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QUESTION 12.

QUESTION 13.

4 The Secure Socket Layer (SSL) protocol and its successor, the Transport Layer Security (TLS) protocol, are used in Internet communications between clients and servers.

(a) (i) Define the term **protocol**.

.....

.....

.....

..... [2]

(ii) Explain the purpose of the TLS protocol.

.....

.....

.....

.....

.....

..... [3]

(b) A handshake process has to take place before any exchange of data using the TLS protocol. The handshake process establishes details about how the exchange of data will occur. Digital certificates and keys are used.

The handshake process starts with:

- the client sending some communication data to the server
- the client asking the server to identify itself
- the server sending its digital certificate including the public key.

Describe, in outline, the other steps in the handshake process.

.....

.....

.....

.....

.....

..... [3]

(c) Give **two** applications where it would be appropriate to use the TLS protocol.

1 .....

.....

2 .....

.....

[2]

QUESTION 14.

6 The environment in a very large greenhouse is managed by a computer system. ... a number of different sensors that include temperature sensors. In addition, the sys... number of heaters, windows and sprinklers.

(a) State **one** other type of sensor that could be used with this system.

Justify your choice.

Sensor .....

Justification .....

.....

[2]

(b) Describe why feedback is important in this system.

.....

.....

.....

.....

.....

.....[3]

(c) **(i)** The system makes use of a number of parameters. These parameters are used in the code that runs the system.

State **one** of the parameters used in controlling the temperature in the greenhouse.

.....[1]

(ii) Explain how the parameter identified in **part (c)(i)** is used in the feedback process.

.....

.....

.....

.....[2]

(d) There are eight temperature sensors numbered 1 to 8. Readings from th
stored in four 16-bit memory locations. The memory locations have addresses
4003. Each memory location stores two sensor readings as two unsigned binary

Sensor 1 reading is stored in bits 8 to 15 of address 4000; Sensor 2 reading is stored
0 to 7 of address 4000 and so on. The diagram shows that the current sensor 1 reading
a value of 97.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
4000	0	1	1	0	0	0	0	1	0	0	1	1	1	0	0	1
4001	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
4002	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	1
4003	1	0	0	0	0	0	1	0	1	1	0	0	0	1	0	1

(i) Give the denary value of the current reading for Sensor 5.

.....

.....

.....

.....[1]

(ii) The following table shows part of the instruction set for a processor. Th
one general purpose register, the Accumulator (ACC).

Instruction		Explanation
Op code	**Operand**	
LDD	<address>	Direct addressing. Load the contents of the location at the given address to ACC.
AND	#n	Bitwise AND operation of the contents of ACC with the operand.
AND	<address>	Bitwise AND operation of the contents of ACC with the contents of <address>.
XOR	#n	Bitwise XOR operation of the contents of ACC with the operand.
XOR	<address>	Bitwise XOR operation of the contents of ACC with the contents of <address>.
OR	#n	Bitwise OR operation of the contents of ACC with the operand.
OR	<address>	Bitwise OR operation of the contents of ACC with the contents of <address>. <address> can be an absolute address or a symbolic address.
LSL	#n	Bits in ACC are shifted n places to the left. Zeros are introduced on the right hand end.
LSR	#n	Bits in ACC are shifted n places to the right. Zeros are introduced on the left hand end.

The reading for Sensor 5 is used in a calculation. The calculation is carried out by two assembly language instructions.

The first instruction loads the contents of the 16-bit location that contains the value for Sensor 5.

The second instruction moves the bits in Sensor 5 so that the 16-bit value is the value of Sensor 5.

Complete the two instructions in the following code. Use the instruction set provided.

```
LDD ..... // load the contents of the 16-bit location
          containing the value for Sensor 5 into the
          Accumulator

..... // move the bits in the Accumulator so that the
      Accumulator stores the value of Sensor 5 as an
      unsigned 16-bit binary integer
```

[3]

QUESTION 15.

6 The compilation process has a number of stages. The first stage is lexical analysis.

A compiler uses a keyword table and a symbol table. Part of the keyword table is shown.

- Tokens for keywords are shown in hexadecimal.
- All of the keyword tokens are in the range `00` – `5F`.

Keyword	Token
←	01
*	02
=	03
IF	4A
THEN	4B
ENDIF	4C
ELSE	4D
FOR	4E
STEP	4F
TO	50
INPUT	51
OUTPUT	52
ENDFOR	53

Entries in the symbol table are allocated tokens. These values start from 60 (hexadecimal).

Study the following code.

```
Start ← 1
INPUT Number
// Output values in a loop
FOR Counter ← Start TO 12
    OUTPUT Number * Counter
ENDFOR
```

(a) Complete the symbol table to show its contents after the lexical analysis stag

Symbol	Token	
	Value	Type
`Start`	`60`	Variable
`1`	`61`	Constant

[3]

(b) The output from the lexical analysis stage is stored in the following table. Each cell stores one byte of the output.

Complete the output from the lexical analysis stage. Use the keyword table and your answer to **part (a)**.

`60`	`01`														

[2]

(c) The output of the lexical analysis stage is the input to the syntax analysis stage.

Identify **two** tasks in syntax analysis.

1 .....

.....

2 .....

.....

[2]

(d) The final stage of compilation is optimisation.

(i) Code optimisation produces code that minimises the amount of memory used.

Give **one** additional reason why code optimisation is performed.

.....

.....[1]

(ii) A student uses the compiler to compile some different code.

After the syntax analysis stage is complete, the compiler generates object co

The following lines of code are compiled.

```
X  ←  A + B
Y  ←  A + B + C
Z  ←  A + B + C + D
```

The compilation produces the following assembly language code.

```
LDD 236     //     loads value A to accumulator
ADD 237     //     adds value B to accumulator
STO 512     //     stores accumulator in X
LDD 236     //     loads value A to accumulator
ADD 237     //     adds value B to accumulator
ADD 238     //     adds value C to accumulator
STO 513     //     stores accumulator in Y
LDD 236     //     loads value A to accumulator
ADD 237     //     adds value B to accumulator
ADD 238     //     adds value C to accumulator
ADD 239     //     adds value D to accumulator
STO 514     //     stores accumulator in Z
```

Rewrite the assembly language code after it has been optimised.

.....

.....

.....

.....

.....

.....

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.....

.....[5]

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QUESTION 16.

6 Monitoring and control systems have many different applications.

(a) Explain the importance of feedback in a control system.

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..... [3]

(b) An indoor swimming pool is to be kept at a constant temperature of 28 degrees.

Describe the use of feedback in this control system.

.....

.....

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.....

.....

..... [4]

(c) Give **one** example of a monitoring system. Explain why this is a monitoring system.

Monitoring system .....

.....

Explanation .....

.....

.....

.....

[3]

(c) The manager is concerned about the threat of malware to the company computer systems.

Name **two** types of malware. State what the company should do to help prevent the effect of the malware.

The two methods of prevention must be different.

Malware type 1 .....

Prevention .....

.....

Malware type 2 .....

Prevention .....

.....

[4]

QUESTION 17.

8 **(a)** A computer process can be in one of three states.

Identify **and** describe **two** of these states.

State 1 .....

Description .....

.....

.....

State 2 .....

Description .....

.....

.....

[6]

(b) One of the main tasks of an operating system is resource management.

Describe how an operating system can maximise the use of resources.

Primary memory .....

.....

.....

.....

.....

.....

Disk .....

.....

.....

.....

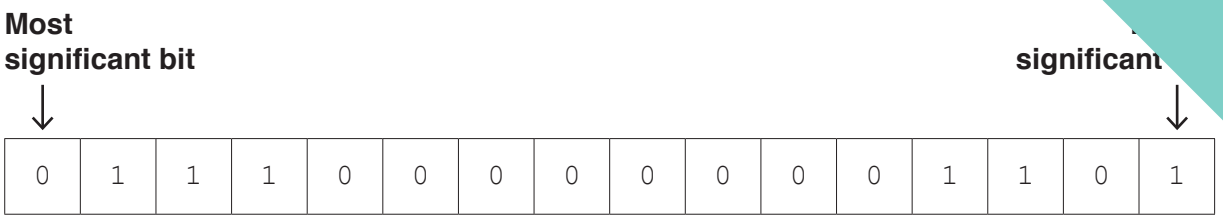
.....

.....

[6]

QUESTION 18.

8 **(a)** The following 16-bit binary pattern represents a floating-point number in two's complement form. The twelve most significant bits are used for the mantissa and the four least significant bits are used for the exponent.



(i) Identify the binary value of the exponent.

..... [1]

(ii) Identify the binary value of the mantissa.

..... [1]

(iii) State whether the number stored is positive or negative. Justify your choice.

Positive or negative .....

Justification .....

.....

.....

[2]

(iv) Convert the binary floating-point number in **part (a)** into denary. Show your working.

Working .....

.....

.....

.....

.....

Denary value .....

[3]

(b) The number of bits used for the exponent is increased to eight, and the nu
for the mantissa is decreased to eight.

State the effects of this change.

.....

.....

.....

..... [2]

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