**Q1.**

A company is setting up a computer network to help manage its business.

The company sets up a computer that will act as a server. The server’s primary role will be to act as an email server. It will also allow technicians to remotely login so that the server can be managed from other computers.

State the names of **two application layer** protocols that the server must implement and explain what each will be used for.

Protocol 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Protocol 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(Total 4 marks)**

**Q2.**

Explain how the **transport layer** of the TCP/IP stack determines which application layer software on the server should deal with a received request.

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**(Total 1 mark)**

**Q3.**

A message is to be transmitted from computer A to computer B. The message will be encrypted using asymmetric encryption. To enable computer B to authenticate that the message was sent by computer A, a digital signature will also be sent with the message.

Explain how computer B will decrypt the message and verify that it was sent by computer A.

In your response you should refer to the specific keys that will be used in this process.

You do **not** need to explain how computer A will encrypt the message or create the digital signature.

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**(Total 4 marks)**

**Q4.**

Employees at a bank use client computers to access data that is stored on a database server.

The database server uses software to query and modify data stored in a database on hard disk drives. It returns the results of these queries to the clients over the bank’s computer network.

The performance of the system is unsatisfactory: the time-delay between a client sending a query to the server and the client receiving the results is unacceptably long.

Explain how the performance of the system might be improved. You should consider the following factors that might be affecting the performance:

•   the hardware of the server

•   the design of the computer network

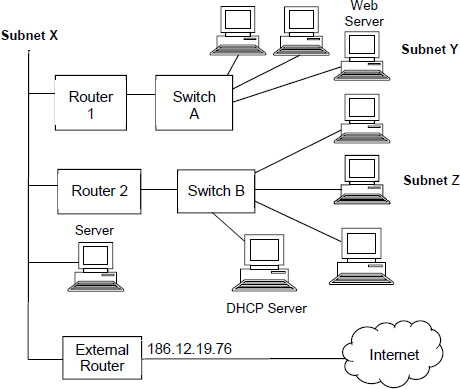
•   the database and software running on the server.

In your answer you will be assessed on your ability to follow a line of reasoning to produce a coherent, relevant and structured response.

**(Total 12 marks)**

**Q5.**

The diagram shows the physical topology of a local area network (LAN) used by a company, and its connection to the Internet. The LAN uses the IPv4 protocol.



Internally, the network has been divided into subnets: 27 bits have been allocated to the network / subnet identifier.

(a)  In binary, write out the subnet mask that has been programmed into the devices on the network.



**(1)**

(b)  **Subnet Z** consists of all of the devices that are directly connected to Switch B.

What is the maximum number of devices that could be connected to **Subnet Z** at the same time?

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**(1)**

(c)  When a device wishes to join **Subnet Z** it communicates with the DHCP server.

Explain:

•   the purpose of the DHCP system

•   why the DHCP system is used

•   what will happen during this communication.

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**(4)**

**(Total 6 marks)**

**Q6.**

A network uses the CSMA / CA access method with Request to Send / Clear to Send (RTS / CTS).

A computer on the network has data to send to another computer. Explain how the CSMA / CA access method with RTS / CTS will be used during this transmission.

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**(Total 6 marks)**

**Q7.**

Both the Caesar and Vernam ciphers are symmetric ciphers, whereas a public and private key encryption system is an asymmetric cipher system.

Explain the difference between a symmetric and an asymmetric cipher system

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**(Total 1 mark)**

**Q8.**

Between 2008 and 2010, a company that was gathering data for an online mapping system, using cars fitted with cameras and WiFi equipment, collected some information that was being transmitted on personal WiFi networks. The company apologised for doing this and an investigation found that a small number of software developers had been responsible for adding this functionality to the mapping system data collection software.

In the context of this example, discuss:

•   how it was possible for this data to be collected.

•   what steps the owners of the networks could have taken to prevent the data from being collected.

•   what legal and ethical issues might have arisen as a result of collecting this data.

•   what lessons the company might have learnt from the incident and how their practices might have changed as a result of it.

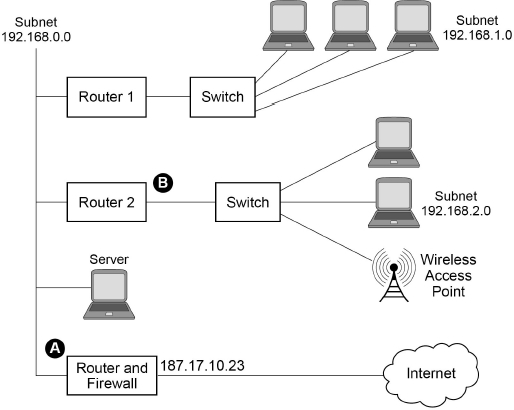
In your answer you will be assessed on your ability to follow a line of reasoning to produce a coherent, relevant and structured response.

**(Total 12 marks)**

**Q9.**

**Figure 1** shows the physical topology of a local area network (LAN) and its connection to the Internet. The LAN uses the IPv4 protocol.

**Figure 1**

****

State suitable IP addresses for:

The ‘Router and Firewall’ port labelled  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The ‘Router 2’ port labelled  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(Total 2 marks)**

**Q10.**

Explain the difference between a physical topology and a logical topology.

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**(Total 2 marks)**

**Q11.**

A web browser is used to access the World Wide Web.

Web pages can be retrieved from a web server using either the HTTP or the HTTPS protocol.

(a)     What does HTTP stand for?

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**(1)**

(a)     State **one** difference between HTTP and HTTPS.

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**(1)**

**(Total 2 marks)**

**Q12.**

A computer that retrieves a web page from a web server is known as a client.

Identify the TCP/IP layer that is concerned with ports and explain how a client port and a well-known port are used when retrieving a web page.

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**(Total 3 marks)**

**Q13.**

To access an exam paper on the AQA website a student’s computer might need to make use of a Domain Name System (DNS) query which is transmitted to a DNS server.

(a)     What is the purpose of a DNS server?

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**(1)**

(b)     In some circumstances the student’s computer will not need to contact a remote DNS server to access a resource.

Describe **two** situations when a DNS query will **not** be sent to a DNS server.

Situation 1 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Situation 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

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**Q14.**

A message is to be transmitted from Computer A to Computer B. For security reasons, the message will be encrypted.

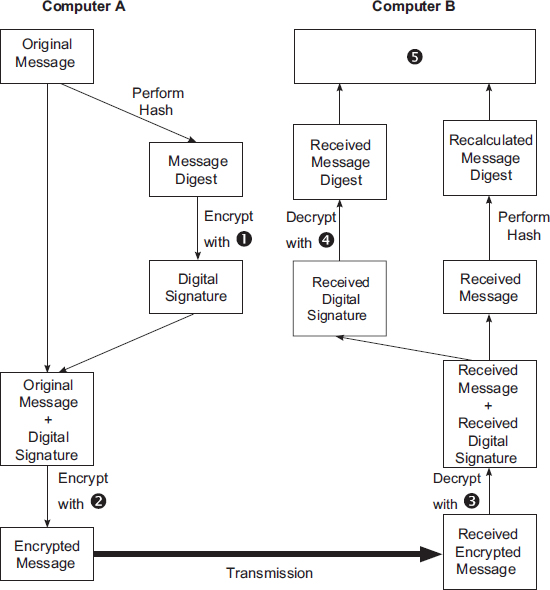
(a)     What is encryption?

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**(1)**

The message that is being transmitted will be encrypted and decrypted using public and private keys. The figure below shows the encryption and decryption processes. The symbols  to  in the figure represent the names of keys.



(b)     State the names of the keys that are represented by each of the symbols  to .

|  |  |
| --- | --- |
| **Label** | **Key Name** |
|  |  |
|  |  |
|  |  |
|  |  |

**(2)**

(c)     Describe the process that will take place at the position labelled .

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**(1)**

(d)     State **two** purposes of the addition of the digital signature to the message.

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Purpose 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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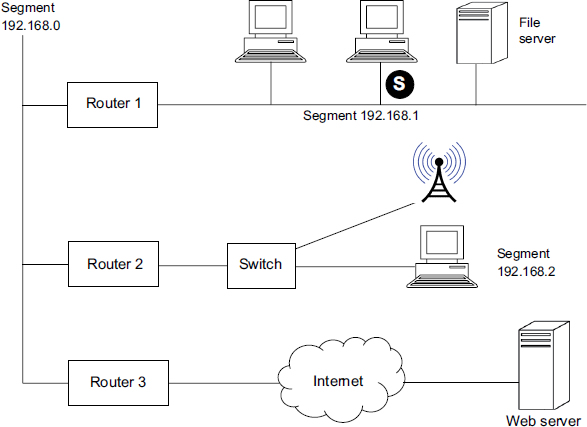
**(2)**

**(Total 6 marks)**

**Q15.**

A student is using her computer at school.

The diagram shows the physical topology of the Local Area Network (LAN) to which her computer is connected. The LAN is divided up into segments. It also shows a web server that her computer connects to through the Internet. The student is using the computer labelled .



Write a detailed description of how one packet of data that the student is uploading to the web server will be routed from her computer in the UK to the web server that is located in Chicago in the USA. You may assume that the web browser software on the student’s computer has already used a domain name server to look up the IP address of the web server.

Your description should cover:

•   how the packet will be routed within the LAN from the student’s computer to the router (Router 3) that links the LAN to the Internet **and**

•   how the packet will be routed to the web server once the packet is on the Internet.

In your answer you will be assessed on your ability to use good English, and to organise your answer clearly in complete sentences, using specialist vocabulary where appropriate.

**(Total 8 marks)**

**Q16.**

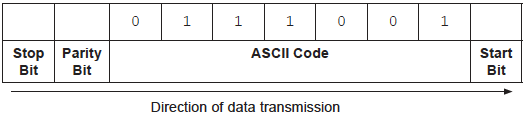
A bar code scanner is connected to a computerised point of sale system (till). When a product is sold, the bar code that is printed on the product is scanned by the scanner and transmitted to the point of sale system.

This transmission uses asynchronous serial communication and odd parity.

**Figure 1** shows the ASCII code for the character "9", which has been read from the bar code, being transmitted to the point of sale system.

(a)     Write the missing values of the stop bit, parity bit and start bit on **Figure 1**.

**Figure 1**

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**(2)**

(b)     Explain what asynchronous data transmission is and why stop and start bits are required when asynchronous data transmission is used.

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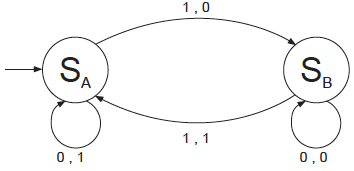
**(3)**

As part of the process of preparing the data for transmission, the 7-bit ASCII code (0111001) is processed by a Mealy machine (a type of Finite State Machine with output).

The ASCII code is processed from left to right, i.e. the leftmost 0 is the first digit to be processed.

**Figure 2** shows a diagram of the Mealy machine. Each transition is labelled with the input symbol that will trigger the transition, followed by a comma, followed by the output that will be produced.

**Figure 2**

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(c)     What output is generated by the Mealy machine in **Figure 2** for the input 0111001?

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**(1)**

(d)     The last digit output by the Mealy machine is used in the transmission.

Explain what this last digit represents.

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**(1)**

(e)     Serial communication has been chosen instead of parallel communication even though the scanner and point of sale system are located next to each other.

State **two** reasons why this choice is appropriate.

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**(2)**

**(Total 9 marks)**

**Q17.**

(a)     Three important computer security procedures are:

•        authentication

•        authorisation

•        accounting

The table lists two situations which involve the use of security procedures.

For each row in the table, place a tick in **one** column to indicate whether the **Situation and Procedure** is an example of **Authentication**, **Authorisation** or **Accounting**.

|  |  |  |  |
| --- | --- | --- | --- |
| **Situation and Procedure** | **Authentication** | **Authorisation** | **Accounting** |
| A web server generating a log of the IP addresses of computers that have accessed it. |  |  |  |
| Using a digital signature when sending an e-mail message. |  |  |  |

**(2)**

(b)     Viruses and worms are both threats to computer security.

Explain what a virus is, and explain the difference between a virus and a worm.

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**(3)**

(c)     A message is to be sent from Computer A to Computer B.

Describe the steps that would be involved in producing a digital signature for the message before it is transmitted by Computer A.

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**(4)**

**(Total 9 marks)**

**Q18.**

Rich client (thick client), thin client and Software as a Service (SaaS) are three methods that can be used to make software applications available to the users of computers that are connected to a network.

•        Explain how rich client and thin client systems work.

•        Describe the different hardware requirements of rich client and thin client systems.

•        Explain why Software as a Service can be considered to be a special type of thin client system, and what distinguishes it from other types of thin client systems.

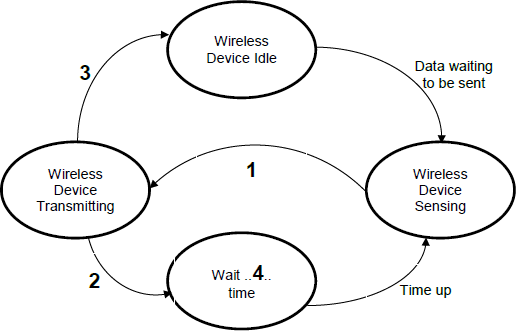
In your answer you will be assessed on your ability to use good English, and to organise your answer clearly in complete sentences, using specialist vocabulary where appropriate.

**(Total 8 marks)**

**Q19.**

Wireless networks make use of the carrier sense multiple access and collision avoidance (CSMA / CA) method when accessing a wireless network to transmit data.

The diagram below shows a simplified state transition diagram of the CSMA / CA wireless network access method without use of request to send / clear to send (RTS / CTS).



(a)     Complete the table by writing in the descriptions that should appear at positions **1** to **4** in the above diagram.

|  |  |
| --- | --- |
| **Label** | **Description** |
| **1** |  |
| **2** |  |
| **3** |  |
| **4** |  |

**(4)**

(b)     Explain the role of a service set identifier (SSID) in wireless networking and why some network administrators turn off SSID broadcasting.

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**(3)**

(c)     Explain why browsing the Internet might be slower at a public hotspot in a coffee shop than at home on a wireless network.

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**(2)**

**(Total 9 marks)**

**Q20.**

The OpenSSL project is a collaborative effort to develop a general purpose cryptography software library for encrypting data transmissions.

In April 2014, a bug known as the 'Heartbleed Bug' was found in the OpenSSL software library. The bug allowed anyone on the Internet to access the memory of systems protected by the vulnerable versions of this OpenSSL software.

According to web server statistics, this bug could have affected around 66% of known web servers.

(a)     What is encryption?

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**(2)**

(b)     OpenSSL is an example of open source software and so its source code is freely available for inspection.

Describe **two** benefits of having the source code of software publicly available.

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**(2)**

(c)     The ‘Heartbleed Bug’ was introduced into the code on December 31, 2011 but was only discovered in 2014.

State **one** reason why the bug took over two years to find.

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**(1)**

(d)     Government agencies sometimes require that they are given copies of encryption keys. This allows these agencies to decrypt messages encrypted with these keys.

State **one** reason for and **one** reason against a government having the ability to decrypt any encrypted messages.

***Reason for:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

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**(2)**

**(Total 7 marks)**

**Q21.**

(a)     Represent the **denary** number 55 using **8-bit unsigned binary**.

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**(1)**

(b)     Represent the **denary** number 55 using **hexadecimal**.

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**(1)**

(c)     Why are bit patterns often displayed using hexadecimal instead of binary?

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**(1)**

(d)     Represent the denary number -59 as an **8-bit two’s complement binary integer.**

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**(2)**

(e)     Represent the denary number 5.625 as an **unsigned binary fixed point number** with three bits before and five bits after the binary point.

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**(2)**

(f)     The ASCII system uses 7 bits to represent a character. The ASCII code in denary for the numeric character ‘0’ is 48; other numeric characters follow on from this in sequence.

The numeric character ‘0’ is represented using 7 bits as 0110000.

Using 7 bits, express the ASCII code for the character ‘6’ in binary.

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**(1)**

(g)     How many different character codes can be represented using 7-bit ASCII?

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**(1)**

(h)     Examples of logical bitwise operators include AND, OR, NOT and XOR.

Describe how **one** of these logical bitwise operators can be used to convert the 7-bit

ASCII code for a numeric character into a 7-bit pure binary representation of the number, (eg 0110001 for the numeric character '1' would be converted to 0000001).

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**(2)**

(i)      Characters are transmitted using an 8-bit code that includes the 7-bit ASCII code and a single parity bit in the most significant bit. A parity bit is added for error checking during data transmission.

Using even parity, what 8-bit code is sent for the numeric character '0'?

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**(1)**

(j)      Hamming code is an alternative to the use of a single parity bit. Hamming code uses multiple parity bits - this allows it to correct some errors that can occur during transmission.

The parity bits are located in the power of two bit positions (1, 2, 4, 8, etc.). The other bit positions are used for the data bits.

Describe how the receiver can detect and correct a single-bit error using Hamming code.

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**(4)**

(k)     **Figure 1** shows the bit pattern **received** in a communication that is using **even parity** Hamming code. The data bits received are 1101000.

**Figure 1**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Bit position** | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| **Bit** | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

There has been a single-bit error in the data transmission.

Which bit position from the bit pattern in **Figure 1** contains an error?

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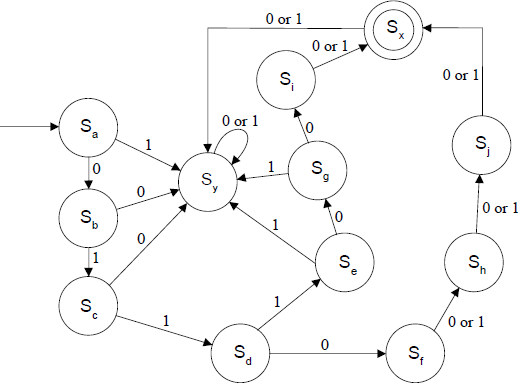
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**(1)**

**Figure 2** shows a Finite State Machine (FSM) represented as a state transition diagram.

The machine takes a bit pattern as an input. The bit pattern is considered to be valid if the machine ends up in the accepting state Sx. The bit patterns 0111000 and 0110001 are valid; the bit patterns 010011 and 01110111 are not valid. Bit patterns are processed starting with the left-most bit.

**Figure 2**

****

(l)      Is the bit pattern 0111010 a valid input for the FSM shown in **Figure 2**?

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**(1)**

(m)    A finite state machine can also be represented as a state transition table. The table below shows part of the state transition table that represents the finite state machine shown in **Figure 2**. The state transition table is only partially complete.

|  |  |  |
| --- | --- | --- |
| **Initial State** | **Input** | **New State** |
| Sg | 1 |  |
| Sy |  |  |
| Sy |  |  |

Complete the table by filling in the unshaded cells.

**(2)**

(n)     What is the purpose of the FSM shown in **Figure 2**?

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**(1)**

(o)     The state Si in the FSM shown in **Figure 2** is not necessary and is going to be removed from the FSM.

Describe the change that needs to be made so that state Si can be removed without changing the functionality of the FSM.

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**(1)**

**(Total 22 marks)**

**Q22.**

(a)     **Figure 1** and **Figure 2** show two screenshots: identify the protocols being used in each.

**Figure 1**

          1) \*\*\*\* NEW CONNECTION (127.0.0.1)

          1) C --> HELO tarzan.synametrics.com

          1) S <-- 250 localhost. Please to meet you

          1) C --> MAIL FROM:<asdf>

          1) S <-- 250 OK

          1) C --> RCPT TO:<asdf@fas.com>

          1) S <-- 250 OK

          1) C --> DATA

          1) S <-- 250 Message queued for delivery.

          1) C --> QUIT

          1) S <-- 221 Connection successfully closed

          1) \*\*\*\* CONNECTION TERMINATED in 150ms.

Protocol \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Figure 2**

          admin@moodle.someschool.org's password:

          Last login: Mon Feb 10 17:04:17 2014 from cpc4-warw15-2-

          0.cable.virginm.net

          [admin@torvalds ~]$ ls

                 Desktop

                 drupal                  test

                 httpd.log               xibo-server.tar.gz

                 mysqldump.sql

          [admin@torvalds ~] unzip xibo-server.tar.gz

          [admin@torvalds ~] reboot

Protocol \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

**Figure 3** below shows part of the result of running a traceroute command on the URL http://www.computingatschool.org.uk

**Figure 3**

traceroute to http://www.computingatschool.org.uk (129.12.3.236), 64 hops max

1  10.0.1.1 (10.0.1.1) 2.352ms 1.572ms 3.359ms

2  cpc4-warw15-2-0-gw.3-2.cable.virginm.net (81.111.110.1) 12.619ms 12.300ms 10.466ms

3  brhm-core-2b.network.virginmedia.net (213.105.114.89) 12.807ms 11.505ms 16.987ms

4  brhm-bb-1b.network.virginmedia.net (62.253.174.77) 16.039ms 11.434ms 11.354ms

(b)     What does URL stand for?

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**(1)**

(c)     State an IP address that appears in **Figure 3**.

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**(1)**

(d)     The traceroute command shows the ‘hops’ taken to get from a computer to the requested address. Each hop identifies a router on the Internet.

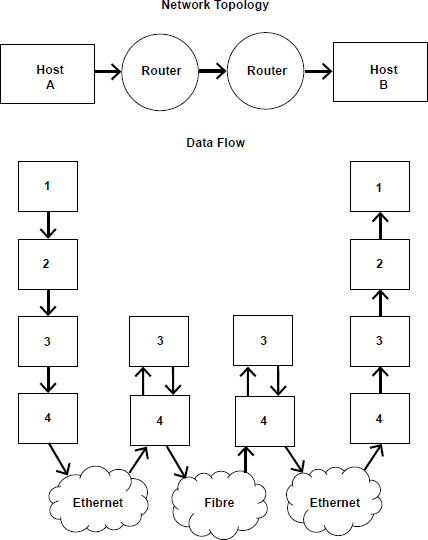
Explain why traceroute might show different hops when run a second time with the same destination address.

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**(1)**

**Figure 4** shows the layers in the TCP / IP stack.

**Figure 4  
  
**

(e)     Complete the table below by naming the TCP / IP layers used in **Figure 4** above.

|  |  |
| --- | --- |
|  | **Layer** |
| **1** |  |
| **2** |  |
| **3** |  |
| **4** |  |

**(2)**

(f)      **Figure 4** shows how a packet travels from **Host A** to **Host B** through two routers.

Describe, for a packet, the role of the two lower levels of the TCP / IP stack in the router.

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**(2)**

**(Total 9 marks)**

**Q23.**

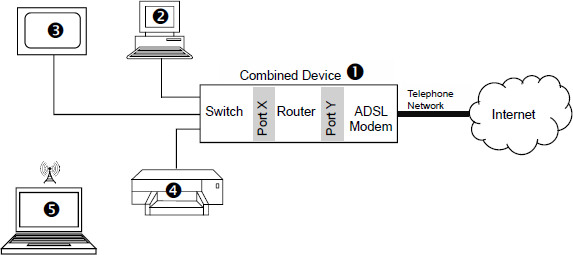
A student is configuring the Local Area Network (LAN) at her home.

The following five hardware devices are connected to the network:

|  |  |
| --- | --- |
|  | a Combined Device that includes a wireless access point, switch, firewall, router and ADSL modem for connection to the telephone network |
|  | a desktop computer that is connected to the network by cable |
|  | a smart TV that is connected to the network by cable |
|  | a printer that is connected to the network by cable |
|  | a laptop computer that can connect to the network wirelessly. |

The diagram below shows the physical topology of the LAN and its connection to the Internet.

Some, but not all, of the components of the Combined Device are shown.



•        **Port Y** of the router in the Combined Device has the IP address 82.73.12.9.

•        The network adapter card in the desktop computer has been allocated the IP address 192.168.0.2.

•        The subnet mask 255.255.255.0 has been programmed into devices   to 

(a)     **Port X** is the router port, within the Combined Device, that allows devices on the LAN to access the Internet. Suggest a suitable IP address that could be allocated to **Port X** of the Combined Device.

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**(1)**

(b)     What physical network topology has been used for the LAN?

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**(1)**

(c)     The IP addresses allocated to the devices on the LAN are non-routable IP addresses.  
The IP address allocated to **Port Y** of the combined device is a routable IP address.

Explain why the devices connected to a LAN are usually given non-routable IP addresses.

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**(2)**

(d)     The desktop computer is uploading a file to an FTP server on the Internet.

The FTP server has IP address 67.84.23.102

Explain how the desktop computer will use the subnet mask (255.255.255.0), that it has been programmed with, to determine that the data being sent to the FTP server must be sent to the combined device from where it will be transferred on to the Internet.

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**(3)**

(e)     The combined device contains a firewall.

Describe how the firewall might control the data that flow between the LAN and the Internet.

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**(3)**

(f)     The ADSL connection to the Internet is broadband and the cabled connections within the LAN are baseband.

Explain the difference between a broadband connection and a baseband connection.

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**(1)**

(g)     The smart TV is capable of being connected to the network wirelessly or using a cabled connection.

Explain why a cabled connection has been used.

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**(1)**

**(Total 12 marks)**

**Q24.**

The table below lists three situations which involve the transmission of data / information / addresses.

(a)     For each row in the table below, place a tick in **one** column to indicate whether the transmission is most likely to be serial, most likely to be parallel or could be either serial or parallel.

|  |  |  |  |
| --- | --- | --- | --- |
| **Situation** | **Most likely to be Parallel** | **Most likely to be Serial** | **Could be either Serial or Parallel** |
| Sending data to a peripheral, such as a printer, that is plugged directly into a computer. |  |  |  |
| Transferring memory addresses between the processor and the main memory of a desktop computer. |  |  |  |
| Transmitting an email across a WAN from a computer in England to an email server in Scotland. |  |  |  |

**(3)**

(b)     Data communication often uses a handshaking protocol.

Explain **one** purpose of a handshaking protocol.

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**(1)**

(c)     When data is transmitted over long distances, eg via satellites, latency can become a problem.

Explain what latency is.

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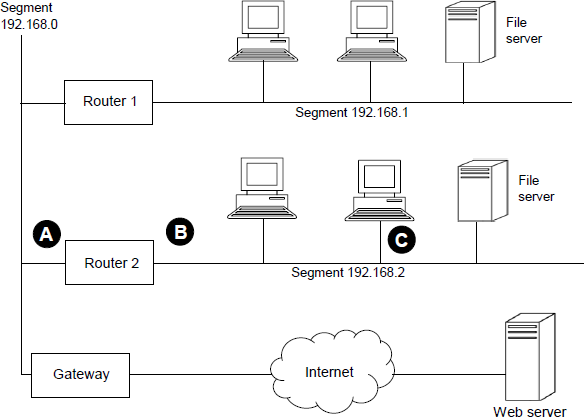
**(1)**

**(Total 5 marks)**

**Q25.**

A company operates a Local Area Network (LAN) which is used by its employees.

The diagram below shows the topology of the LAN.



(a)     Suggest suitable IP addresses for:

(i)      the ‘Router 2’ port labelled A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     the ‘Router 2’ port labelled B \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(iii)    the network adapter card in the computer labelled C \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)     The network has been divided into segments.

Explain why networks that use a bus topology are often segmented.

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**(2)**

(c)     Previously, employees of the company used word processing and spreadsheet software that was installed locally on each of the individual computers on the network. Now, employees use software with similar features as a service (SaaS). The software runs on a web server and is accessed through the Internet.

(i)      Explain **two** advantages of using software as a service instead of using software installed locally on individual computers.

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Advantage 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(ii)     Explain **one** disadvantage of using software as a service instead of using software installed locally on individual computers.

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**(1)**

(d)     One difference between a Local Area Network (LAN) and a Wide Area Network (WAN)is the area that they cover. Describe **two** other differences between a LAN and a WAN.

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Difference 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

**(Total 10 marks)**

**Q26.**

A particular long-distance data transmission system transmits data signals as electrical voltages using copper wire.

(a)     What is the relationship between the bandwidth of the copper wire and the bit rate at which the data can be transmitted?

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**(1)**

(b)     The system is affected by latency.

What is *latency* in the context of data communications?

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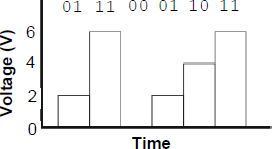
**(1)**

The system uses four different voltage levels so that two data bits can be transmitted with each signal change.

The table below shows the signal levels (in volts) that the system uses for particular binary patterns.

|  |  |
| --- | --- |
| **Binary pattern** | **Signal level (volts)** |
| **00** | **0** |
| **01** | **2** |
| **10** | **4** |
| **11** | **6** |

Using this system, the binary pattern 011100011011 would be transmitted as the voltage sequence 2,6,0,2,4,6 as shown in the graph below:



(c)     What, **precisely**, is the relationship between the bit rate and the baud rate for this system?

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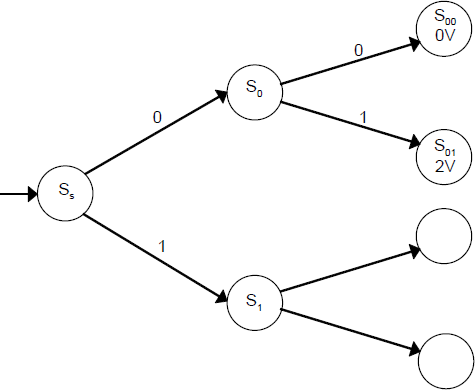
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**(1)**

(d)     A Moore machine is a type of finite state machine that produces output. The transitions are labelled with the inputs and each state is labelled with a name and the output that it produces; if a particular state has no output then it is labelled with just a name.

The diagram below shows an incomplete diagram of a Moore machine that will convert a two-bit binary code into the signal level (in volts) that is transmitted to represent it, as listed in the table above.

Complete the diagram below. Label all of the transitions and the states that are currently unlabelled. The machine should work for the four binary patterns 00, 01, 10 and 11.



**(4)**

**(Total 7 marks)**

**Q27.**

An object-oriented program is being written to store details of the hardware devices that are connected to a computer network in a college. This will be used by the network manager to perform an audit of the equipment that the college owns.

Two different types of devices are connected to the network. They are printers and computers. The computers are categorised as being laptops, desktops or servers.

A class **Device** has been created and two subclasses, **Printer** and **Computer** are to be developed. The **Computer** class will have three subclasses: **Laptop**, **Desktop** and **Server**.

(a)     Draw an inheritance diagram for the six classes.

**(3)**

(b)     The **Device** class has data fields **MACAddress**, **DeviceName** and **Location**.

The class definition for **Device** is:

Device = Class  
            Public  
              Procedure AddDevice  
              Function GetMACAddress  
              Function GetDeviceName  
              Function GetLocation  
            Private  
              MACAddress: String  
              DeviceName: String  
              Location: String  
            End

The **Computer** class has the following additional data fields:

•        **ProcessorName**: Stores the name of the company that manufactured the processor.

•        **RAMCapacity**: Stores the capacity of the RAM installed in the computer, in gigabytes.

•        **HDDCapacity**: Stores the capacity of the Hard Disk Drive installed in the computer, in gigabytes.

Write the class definition for **Computer**.

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**(4)**

(c)     The **Laptop** class has the additional data field **BluetoothInstalled**. This field will indicate whether or not the laptop is fitted with a Bluetooth module.

Write the class definition for **Laptop**.

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**(2)**

(d)     Explain what Bluetooth is and give an example of a task for which a laptop user might use Bluetooth.

What Bluetooth is:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

Example use: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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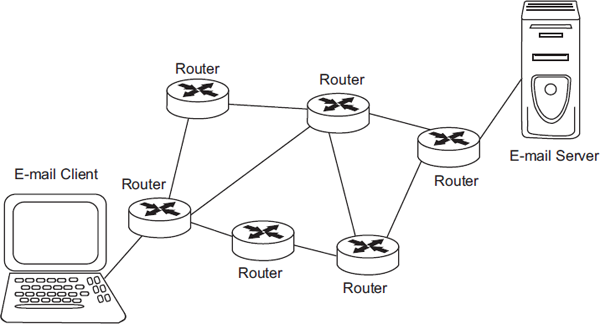
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**(1)**

**(Total 12 marks)**

**Q28.**

The diagram below is a partial view of a router network connecting an e-mail client to an e-mail server.



(a)     Describe **two** roles of the routers shown in the diagram above.

Role 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Role 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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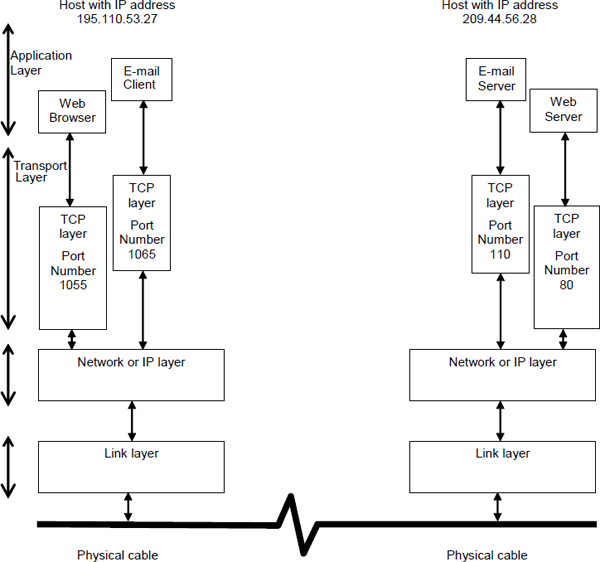
**(2)**

(b)     Name **one** of the application protocols associated with e-mail.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(c)     The diagram below shows the TCP/IP stack for two computers (hosts) connected via a network.



Explain how the TCP/IP stack in each host supports an e-mail client to e-mail server request at the same time as a web browser to web server request. You should cover in your explanation:

•        the steps from the initiation of a request to the receipt of a response

•        the role of the different TCP/IP layers in the stages of client-server operation

•        the use of packets.

In your answer you will be assessed on your ability to use good English and to organise your answer clearly in complete sentences, using specialist vocabulary where appropriate.

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**(6)**

**(Total 9 marks)**

Mark schemes

**Q1.**

**2 marks AO2 (analyse) and 2 marks AO1 (knowledge)**

Award **1 mark** for each correctly named protocol, up to a maximum of **2 marks** and **1 mark** for each correct explanation of what a protocol will be used for, if linked to the correct protocol.

|  |  |
| --- | --- |
| **Protocol (AO2)** | **Use (AO1)** |
| SMTP // Simple Mail Transfer Protocol | To send/transmit/receive emails (to/from another email server/client). |
| POP(3) // Post Office Protocol (3) // IMAP // Internet Message Access Protocol | (So that clients can) retrieve/manage emails on the server.  **TO.** sending emails  **A.** receiving emails as BOD but **TO.** receiving emails if answer suggests that this is done as the email is sent. |
| SSH // Secure Shell // Telnet // RDP // Remote Desktop Protocol | So that technicians can execute commands on the server // to give access to command line // provides a secure/encrypted connection for remote management (only award for secure protocols) **NE.** to login remotely |
| HTTP / HTTPS | So users can access email via the web / a web browser // so that technicians can access web-based control panels. |

**A.** if correct initialism used but then the full term is incorrect eg “SMTP – Special Mail Transfer Protocol” as **BOD**

**A.** other protocols that achieve the same purposes as those listed above

**R.** non-application layer protocols eg TCP, IP

**[4]**

**Q2.**

**Mark is AO1 (understanding)**

(The transport layer will) use the port number to (determine which server / software should deal with the request) // by adding a port number to the request/data/packet;

**A.** examples of specific port numbers and which server / software they would be directed to.

**[1]**

**Q3.**

**All marks AO1 (understanding)**

B’s private key is used to decrypt the message (and signature); **R.** more than one key referenced

The message is rehashed // a new message digest/hash is calculated from the message;

A’s public key is used to decrypt the digital signature (to produce the received message digest);

If received message digest and recalculated message digest match / if both hashes match then the sender can be authenticated / B knows that A sent the message;

**A.** if recalculated hash matches digital signature then B knows A sent message, if third mark point not awarded.

**NE.** if hashes match then B knows message has not been tampered with

**A.** data for message

**A.** checksum, hash, digest as synonyms

**A.** encrypted hash/encrypted digest for signature

**[4]**

**Q4.**

**All marks AO1 (understanding)**

|  |  |  |
| --- | --- | --- |
| **Level** | **Description** | **Mark Range** |
| 4 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all three areas indicated in the guidance below and in at least two of these areas there is sufficient detail to show that the student has a good level of understanding. To reach the top of this mark range, a good level of understanding must be shown of all three areas. | 10-12 |
| 3 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response which shows a good level of understanding of at least two areas indicated in the guidance below. | 7-9 |
| 2 | A limited attempt has been made to follow a line of reasoning and the response has a mostly logical structure. At least four points have been made. Either a good level of understanding of one area from the guidance has been shown or a limited understanding of two areas. | 4-6 |
| 1 | A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the areas from the guidance or may be made in a superficial way with little substantiation. | 1-3 |

**Guidance – Indicative Response**

**For each guidance point, if the student expands on the point to explain in what way the measure will improve performance then this can be considered to be a second point.** For example:

•   “Using a processor with more cores” is one point.

•   “Using a processor with more cores which will be able to execute multiple instructions simultaneously” is two points.

Note that just “faster” is not enough to count as an expansion point without an explanation of why.

**1. Server Hardware**

Replace the processor with one which has more cores

Replace the processor with one which has more cache memory // increase the amount of cache memory

Replace the processor with one which runs at a faster clock speed **NE.** faster processor

Use a parallel processor architecture // use more processors which can work in parallel

Use a processor with a bigger word size

Use a processor that makes (better) use of pipelining

Install more RAM // main memory // primary memory

Use RAM // main memory // primary memory with a faster access time

Replace HDDs with SSDs // Replace HDDS with HDDs that can read data at a faster rate

Defragment the HDD

Replace the motherboard with one which has buses which run at a faster clock speed

Replace the motherboard with one which has more lines in the data bus

Use the Harvard architecture

Distribute the processing across multiple servers

**2. Network**

Replace the network cable with cable that has a higher bandwidth // replace copper cable with fibre-optic cable **A.** Ethernet cable for fibre-optic NE. higher bandwidth network

Replace any wireless / WiFi connections with wired ones

Replace the network cards with ones that can transmit data at a higher bitrate

Consider the overall network design eg how the network is divided into subnets **A.** split the network into subnets

Use a star topology (instead of a bus)

Consider using a more efficient protocol for the data across the network

Add additional wireless access points

**3. Database and Software**

Use a more efficient technique for controlling concurrent access to the database // replace record/table locks with serialisation/timestamp ordering/commitment ordering

Replace the database software with software that uses more efficient algorithms for tasks **A.** examples eg replace linear search with binary search

Use the index feature of the database to speed up searching on fields that are commonly used for this purpose

Rewrite the database software in a language that is suitable for concurrent execution // use a functional programming language for the database software

Ensure the software is compiled rather than executed by an interpreter // rewrite the software in assembly language/machine code

Review the conceptual model of the database to see if it contains any inefficiencies such as data redundancy that could be eliminated **A**. normalise the database design

Consider if it would be appropriate to sacrifice normalisation of the conceptual model to improve performance

Use a non-relational database system **A.** examples eg NoSQL

Distribute the data across multiple servers

Try to reduce the amount of other (unrelated) software that might be running on the database server at the same time

Try to reduce the number of database accesses that need to be made simultaneously // run some tasks at quiet times / overnight

Purge / archive data that is no longer necessary / in use

**[12]**

**Q5.**

(a)  **Mark is for AO1 (understanding)**

**1 mark:** Correct binary pattern (below):



**1**

(b)  **Mark is for AO2 (apply)**

30 // (25)−2;

**A.** 32, 25, 31, (25)−1 (this time only)

**1**

(c)  **1 mark for AO1 (understanding) and 3 marks for AO1 (knowledge)**

**Purpose (1 mark – AO1 (knowledge)):**

To automate the configuration of hosts connecting to a (TCP/IP) network // to allocate IP addresses / subnet mask / default gateway to hosts;

**A.** “computer” or suitable alternative term for “host”

**Why used (1 mark – AO1 (understanding)):**

Reduces the need for expert knowledge when configuring a host // reduces the time required to configure hosts // facilitates efficient use of a limited pool of IP addresses // avoids errors with a relevant example such as duplicating IP addresses or programming incorrect subnet mask;

**A.** enables reuse of IP addresses

**N.E.** “avoiding errors” without an example

**Contents of communication (Max 2 marks – AO1 (knowledge)):**

1.   Host sends request to discover a (DHCP) server; **A.** host sends request for configuration

2.   (DHCP) server(s) offer configuration to host; **NE**. server gives IP address to host

3.   Host accepts offer of configuration from (a DHCP) server (by echoing the accepted configuration back to the server);

4.   (DHCP) server confirms that configuration has been allocated to host;

**A.** “IP Address” for “configuration” but **NE**. “subnet mask”, “default gateway” for this mark point

**Award one mark for any one correct point OR two marks for any two correct points, made in the correct order.**

**4**

**[6]**

**Q6.**

**2 marks for AO1 (knowledge) and 4 marks for AO1 (understanding)**

|  |  |  |
| --- | --- | --- |
| **Level** | **Description** | **Mark Range** |
| 3 | A detailed, coherent, description that includes the use of RTS / CTS and that conveys good understanding of how the access method works. Whilst there may be some omissions from the description it contains no misunderstandings. | 5-6 |
| 2 | An adequate description, including at least three points from the list below. The description is logically organised so that it makes sense when read as a whole and therefore demonstrates a reasonable understanding of how the system works. The description may or may not include the use of RTS / CTS. | 3-4 |
| 1 | A small number of relevant points have been recalled (in this case award one mark per point, up to a maximum of two from lists below). However, the structure of the response, or lack of it, demonstrated only a very limited understanding, if any, of the access method used. | 1-2 |

**Indicative Content**

•   computer with data to send monitors/listens for (data signal)

•   if (data) signal present/another transmission in progress then continue to wait

•   when no (data) signal present computer sends a Request to Send / RTS **A**. if no valid points made about RTS / CTS in response then accept that when no data signal is present computer starts to transmit data, but with no marks awarded for RTS / CTS then response is limited to max Level 2

•   two computers could start transmitting simultaneously if they both detect there is no data signal

•   receiver/WAP responds (to RTS) with a Clear to Send / CTS signal **A.** router

•   RTS / CTS signal blocks any other transmissions from nodes in range

•   if / when CTS received then start to transmit **A.** by implication as **BOD** if the student states that the computer will begin to transmit after the receiver sends the CTS

•   if CTS not received continue to wait (until transmission ends)

•   receiver sends acknowledgement / ack after (all) data received

•   after transmitting (the transmitter) waits to receive acknowledgement packet (to confirm data received and not corrupted)

•   if no acknowledgement / ack received (within reasonable time period) then:

◦   wait a time period

◦   then listen again / retransmit

•   the acknowledgement / ack also notifies other computers that they can transmit again

•   waiting periods are (often) random **A.** an example waiting period that is random

•   collisions cannot be detected by transmitter

**[6]**

**Q7.**

**Mark is for AO1 (knowledge)**

Symmetric: The same key is used to encrypt and decrypt;

**A**. Sender and receiver use same key

Asymmetric: Different (but related) keys are for encryption and decryption;

**A**. Sender and receiver use different keys

**NE**. Symmetric uses one key // asymmetric uses two keys

**Max 1**

**[1]**

**Q8.**

**Marks is for AO2 (understanding)**

|  |  |  |
| --- | --- | --- |
| **Level** | **Description** | **Mark Range** |
| 4 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all four areas indicated in the guidance below and in at least three of these areas there is sufficient detail to show that the student has an excellent level of understanding of the issues and technologies involved. To reach the top of this mark range, an excellent level of understanding must be shown of all four areas. | 10-12 |
| 3 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response but the response may only cover two or three of the areas indicated in the guidance below. A good understanding is shown of each of these areas and if only two areas are covered, the coverage of these is excellent. | 7-9 |
| 2 | A limited attempt has been made to follow a line of reasoning by covering at least two of the topic areas in the guidance below. Overall, at least four valid points must have been made which can relate to any of the topic areas in the guidance. | 4-6 |
| 1 | A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the four areas from the guidance or may be made in a superficial way with little substantiation. | 1-3 |

**Guidance – Indicative Response**

**1. How it was possible for data to be collected**

WiFi signals can travel outside of property // over wide area // limited control over range

Any WiFi receiver in range can read the data packets **NE**. The receiver in the car can read the packets

No need to physically “tap” into a WiFi connection, unlike a cabled connection

A protocol that does not encrypt the transmissions may have been used // unencrypted data sent. **NE**. Network not secure

**2. Steps to prevent**

Use a protocol that encrypts data transmissions

**A**. Encrypt the transmission

**R**. Password protection

Example of secure protocol eg WPA, WPA2

Disable broadcast of SSID to make network harder to identify (Note: Accept this point even though the SSID would be in other data packets)

Limit power of transmitter so data does not travel outside premises (although in practice this might be hard to achieve)

Use cabled network instead of WiFi.

**R**. MAC address filtering (as cars were not connecting to networks just intercepting transmissions)

**3. Legal and ethical issues**

If the data is being transmitted through the air, who does it belong to, if anyone? // Should data transmitted by WiFi be treated like a broadcast (eg TV) or a private communication (eg telephone call)?

Is it wrong to intercept data if people freely choose to transmit it wirelessly? **A**. Is it ethical to collect data from people without their permission?

Is it legal to intercept data if people freely choose to transmit it wirelessly? What laws apply in this scenario? Is this really hacking?

Are the ethics or laws different for intercepting data transmitted wirelessly than by cable?

Is there a difference between collecting statistical data eg channel number, signal strength, SSID and collecting the payload data?

Was the data just collected or was there an intention to process it as well?

What should the company have done when it realised that the data had been collected? // Should the data have been immediately deleted, or kept so that the company could contact and apologise to people it had collected data from? // What should be done with the data now?

What should the company have done if it inadvertently discovered evidence of illegal activity in the collected data?

Legality/ethicality may depend on the nature of the data gathered // (In the UK) would some of the collected data count as “personal data” (under the Data Protection Act) // could some of the data have been sensitive (accept example eg bank account details, details of minors) **NE**. Data may be private

To what extent is the company financially liable for collecting the data? Or any consequences of its use?

Could the legal situation be different in different countries where the company operated?

Was the collection of data intentional or just an accidental side-effect of a reasonable process?

What was done to ensure (existing) policies are followed?

Should there have been more oversight of code development?

Could intellectual property have been inadvertently stolen?

Is it ethical to collect/store information secretly from people // without them knowing?

Is it ethical to collect data if there is no (legitimate) purpose for doing so?

Were the developers in breach of their contracts with the company / company guidelines?

*Relevant Legislation*

Students may name specific pieces of legislation that could have been breached as part of their response. Determining whether or not a breach has actually occurred would probably require more information than is provided in the question and detailed knowledge of the legislation, which is not required by the specification. Therefore, up to **two points** can be given for students naming relevant pieces of legislation that could have been breached, regardless of whether or not this can be ascertained with certainty. Relevant pieces of legislation include:

•   The Data Protection Act

•   The Computer Misuse Act

•   The Regulation of Investigatory Powers Act

•   The Communications Act

Points should be given for assertions that legislation has definitely been breached, even if this is only a possibility in the context rather than a certainty.

Responses that reference other legislation should be referred to Team Leaders.

**A**. As an alternative to naming the Data Protection Act, a response could instead question whether privacy laws have been breached, or if a breach of privacy has occurred.

**4. Lessons**

Improved training for developers in what is legal / ethical (accept company needs to improve understanding of legal/ethical issues)

Need to review guidelines that developers are expected to follow

Need for scrutiny of code / supervision by people outside of development team

Developers could be required to check each other’s code

Developers could be required to log changes made to code and reason

Should only collect data that is absolutely necessary // that has a clear purpose // need to review collected data to see why it is being collected and stored // need to fully consider the purpose of any data collection before doing it

Could/should remove equipment for Wi-Fi data capture used in cars to collect mapping data.

**NE**. Further testing should be carried out unless there is a clear explanation of the mechanism by which testing will check that the software has no additional functionality is described eg inspection of collected data files to verify purpose of contents

**[12]**

**Q9.**

**All marks AO1 (understanding)**

**1 mark:** The 'Router and Firewall' port labelled **A**: 192.168.0.x where x is not 0 or 255;

**1 mark:** The 'Router 2' port labelled **B**: 192.168.2.x where x is not 0 or 255;

**[2]**

**Q10.**

**All marks AO1 (understanding)**

**Physical:** The (physical) layout/arrangement/architecture of the cabling/wiring/connections (between the devices/computers on the network);

**A**. The (physical) layout/arrangement/architecture of the devices/computers/network

**NE**. How the devices/computers are connected to each other

**NE**. “Setup” for layout

**NE**. List of topologies eg bus, star

**Logical:** How the data/packets flows around a network // architecture of the communication mechanism in a network;

**A**. The type of protocol used

**NE**. How a network operates/behaves

**[2]**

**Q11.**

(a)  HyperText Transfer Protocol;

**1**

(b)  HTTPS is secure;

HTTPS (usually) uses port 443, HTTP (usually) uses port 80 // use different port numbers;

HTTPS uses SSL/secure socket layers;

HTTPS is encrypted;

Servers using HTTPS must have a public key certificate;

**Max 1**

**[2]**

**Q12.**

**Layer involved:**

Transport layer;

**Client ports: (MAX 1)**

client port allocated to web browser (by transport layer);

client port number sent to web server at start of communication (so it can respond to browser);

client ports are temporary;

client ports are allocated by the transport layer to applications running on the client;

**Well-known ports: (MAX 1)**

web server uses well known port (80/8080) so that client is able to contact it to initiate;

used by applications on servers so that clients can access them due by using a standard port number;

well-known ports are in the range 0 – 1023;

**[3]**

**Q13.**

(a)  To take a required Fully Qualified Domain Name/FQDN and to return an IP address;

To link/map a FQDN to an IP address;

**A**. domain name for FQDN

**R**. URL

**Max 1**

(b)  The (local) computer already has a copy of the needed IP address (in a hosts file);

The (local) computer has a cache of recent DNS queries / answered DNS queries;

**A**. previously visited site / refreshing a page;

The URL typed in already contains an IP address;

The URL refers to a local resource, e.g., a file on the local computer // localhost // local network;

**NE**. intranet

**Max 2**

**[3]**

**Q14.**

(a)  (Using an algorithm) to convert a message into a form that is not understandable (without the key to decrypt it);

(Using an algorithm) to convert a message into a form that is only understandable by the intended parties // can only be read with the correct key;

(Using an algorithm) to convert a message into cipher text;

**NE.** Scrambling unless further explanation is provided

**NE.** Coding

**A.** “Unreadable” for “understandable”

**A.** “Data” for “a message”

**R.** Responses that do not make clear that encryption is a process

**Max 1**

(b)  **1 mark** for two or three keys correctly named.

**2 marks** for all four keys correctly named.

|  |  |
| --- | --- |
| **Label** | **Key Name** |
|  | A’s Private Key |
|  | B’s Public Key |
|  | B’s Private Key |
|  | A’s Public Key |

**A**. “Sender” for “A” and “Recipient” for “B” (or similar role descriptions)

Allow use of same key name more than once and mark correct in the position it is correct (if any).

**2**

(c)  Two (message) digests are compared // received and recalculated digests compared;

**A**. “They” for the two message digests

**A**. “Hash” for “digest”

**R**. Two messages are compared

**1**

(d)  To authenticate/confirm identity of sender // to confirm that message was sent by A;

**A**. Ensures sender is who they say they are

**NE**. Identify the sender (must be clear that the signature confirms this identity), know who the sender is

To detect if message has been tampered with/altered/changed;

**NE**. Prevent/stop the message being tampered with

**Award marks in part (d) for valid responses to part (d) that are made in part (c).**

**2**

**[6]**

**Q15.**

**SUBJECT MARKING POINTS:**

**Internal:**

•   Student’s computer uses subnet mask (and destination/web server’s IP address) to determine if destination computer/web server is on same subnet // identify not on same subnet

•   Up to two marks from description (in separate section below) of how subnet mask is used

•   Packet is sent (from student’s computer) to Router (1)

•   Router 1 identifies that destination is outside the LAN so forwards packet to router 3/router connected to Internet **A** gateway connected to Internet

**External:**

•   Hierarchical organisation of routers

•   Example of hierarchical organisation of routers eg passed up to a national router, transferred internationally and then passed back down a hierarchy

•   Path to take selected by each router (not determined at start) **NE**. passed from router to router

•   Route may change as a result of eg congestion, technical problems

**Either:**

•   (Possible) repackaging of packet to use different protocol

•   Route determined using the (Network ID part of the destination) IP address (**Note:** can infer "IP address" if just "address" is stated, if previously candidate has written about an IP address)

•   Use of router tables / criteria to determine next hop / (step of) path

•   Router decrementing "time to live" of packet

•   Source and destination MAC addresses changed at each router // MAC addresses used for each “hop”

**How subnet mask used (MAX 2 points):**

•   AND operation of subnet mask with student’s computer’s IP address

•   AND operation of subnet mask with web server’s IP address

•   Result (of AND operation) is the network ID

•   Network IDs compared

•   If they are the same, then the computers are on the same subnet

**A**. Interchangeable use of subnet ID and network ID

**HOW TO AWARD MARKS:**

|  |  |  |
| --- | --- | --- |
| **Mark Bands and Description** | | |
| 7-8 | *To achieve a mark in this band, candidates must meet the subject criterion (SUB) and all 5 of the quality of language criteria (QLx).* | |
| *SUB* | Candidate has covered both internal and external routing in detail and has made at least seven subject-related points. |
| *QWC1* | Text is legible. |
| *QWC2* | There are few, if any, errors of spelling, punctuation and grammar. Meaning is clear. |
| *QWC3* | The candidate has selected and used a form and style of writing appropriate to the purpose and has expressed ideas clearly and fluently. |
| *QWC4* | Sentences (and paragraphs) follow on from one another clearly and coherently. |
| *QWC5* | Appropriate specialist vocabulary has been used. |
| 5-6 | *To achieve a mark in this band, candidates must meet the subject criterion (SUB) and 4 of the 5 quality of language criteria (QLx).* | |
| *SUB* | Candidate has covered both internal and external routing, although one may be in more detail than the other and has made at least five subject-related points. |
| *QWC1* | Text is legible. |
| *QWC2* | There may be occasional errors of spelling, punctuation and grammar. Meaning is clear. |
| *QWC3* | The candidate has, in the main, used a form and style of writing appropriate to the purpose, with occasional lapses. The candidate has expressed ideas clearly and reasonably fluently. |
| *QWC4* | The candidate has used well-linked sentences (and paragraphs). |
| *QWC5* | Appropriate specialist vocabulary has been used. |
| 1-4 | *To achieve a mark in this band, candidates must meet the subject criterion (SUB) and 4 of the 5 quality of language criteria (QLx).* | |
| *SUB* | Candidate may not have covered both internal and external routing, but has covered at least one of them. Up to four relevant points have been made. |
| *QWC1* | Most of the text is legible. |
| *QWC2* | There may be some errors of spelling, punctuation and grammar but it should still be possible to understand most of the response. |
| *QWC3* | The candidate has used a form and style of writing which has many deficiencies. Ideas are not always clearly expressed. |
| *QWC4* | Sentences (and paragraphs) may not always be well-connected. |
| *QWC5* | Specialist vocabulary has been used inappropriately or not at all. |
| 0 | Candidate has made no relevant points. | |

**Note:** Even if English is perfect, candidates can only get marks for the points made at the top of the mark scheme for this question.

If a candidate meets the subject criterion in a band but does not meet the quality of language criteria then drop mark by one band, providing that at least 4 of the quality of language criteria are met in the lower band. If 4 criteria are not met then drop by two bands.

**[8]**

**Q16.**

(a)     Parity Bit: 1;

**Start bit, Stop Bit**: Can be either 0 or 1, but must both be different to get mark;

**2**

(b)     **Definition (1 mark):**

Receiver and transmitter (clocks) do not need to be/are not (exactly) synchronised // transmission of data without use of external clock signal // receiver and transmitter clock only synchronised at start of/for length of transmission // data sent as soon as available rather than waiting for clock pulse/ synchronisation symbol;

**Explanation of start and stop bits (max 2 marks):**

Start bit synchronises receiver (clock) (to transmitter/data) // locks receiver and transmitter in phase // starts receiver's clock // wakes receiver;

Stop bit allows start bit to be recognised // allows receiver to process received bits;

**A.** Start and stop bits indicate when data is being transmitted/ begins – if neither of the other two marks for start and stop bits have been awarded

**3**

(c)     1010001;

**A.** Separator between digits e.g. comma

**1**

(d)     It is the parity bit;

**A.** Odd parity bit

**A.** If there are an even or odd number of 1s in the input

**1**

(e)     Only a small quantity of data to send // data transmission speed not important;

Widespread availability of USB/serial connections;

Serial communication avoids crosstalk // interference between signals on each wire;

Serial communication avoids data skew;

**A.** Serial communication is cheaper to implement with a suitable reason given

**A.** For future flexibility if devices were moved further apart

**N.E.** Serial is less error prone / fewer errors

**MAX 2**

**2**

**[9]**

**Q17.**

(a)

|  |  |  |  |
| --- | --- | --- | --- |
| **Situation and Procedure** | **Authentication** | **Authorisation** | **Accounting** |
| A web server generating a log of the IP addresses of computers that have accessed it. |  |  | ✔; |
| Using a digital signature when sending an e-mail message. | ✔; |  |  |

**R.** Responses in which more than one column is ticked on a row

**A.** Responses in which a symbol other than a tick is used

**2**

(b)     **Virus is (max 2 marks):**

Program that attaches itself to / conceals itself within another program/file;

Self-replicating // program can copy itself; **N.E.** Viruses spread

Has malicious purpose; **A.** Is a type of malware **A.** Examples of malicious purposes

**Difference to worm (max 2 marks):**

Worm duplicates by exploiting network security weaknesses / across network (whereas virus copies itself by attaching to other files);

Worm is standalone software (whereas virus conceals itself within another file);

Worm replicates without user action (whereas virus relies on user running program to replicate it);

**MAX 3**

**3**

(c)     Hash/digest produced/calculated from message contents // (shortened) value calculated from message; **A.** Message is hashed **A.** Message digest created **N.E.** Hash produced

Hash encrypted;

A’s private key is used for the hash encryption; **N.E.** Uses A’s private key

Encrypted hash is known as the (digital) signature;

(Digital) signature is appended to message; **A.** Encrypted hash for digital signature

**I.** Description of encryption not related to digital signature

**MAX 4**

**4**

**[9]**

**Q18.**

**SUBJECT MARKING POINTS:**

**How systems work:**

*Rich client:*

•        Applications run (locally) on computer // all processing done on (local) computer // applications installed locally **A.** On client

*Thin client:*

•        All/most processing done by (central) server // applications not installed on (thin client) workstations // all applications on server; **A.** All software run on server

•        Keystrokes/mouse clicks/user input transmitted from workstation/terminal to server over network, **A.** Workstations are just interfaces

•        Image/data needed to produce image transmitted from server to terminal over network

•        Operating system loaded by clients from server at boot

**How hardware differs for thin client:**

•        Higher bandwidth network connection required

•        Network must use switch not hub

•        Slower processor /reduced RAM/ no HDD required in workstations, **A.** Other examples of limited hardware requirements, **A.** 'Dumb terminal'

•        Server must have multiple processors/a lot of RAM

**N.E.** more powerful / less powerful, higher performance / lower performance, cheaper / more expensive

Accept the opposite of points e.g. for "a thin client system could use a slower processor" accept "a thick client system would need a faster processor" but don't award marks for a point and its opposite point.

**Why SaaS is a type of thin client:**

Software is run on a remote computer (not locally, so an example of thin client)

**A.** Server, web server for "remote computer"

**N.E.** Accessed via internet

**What distinguishes SaaS from other types of thin client:**

•        SaaS is accessible anywhere that there is an internet connection // is used via the internet

•        Customers usually purchase access to SaaS instead of buying software outright

•        SaaS is usually managed by an application service provider / another company / a contractor // company using SaaS does not need to manage software

•        SaaS usually works in (web) browser

**HOW TO AWARD MARKS:**

|  |  |
| --- | --- |
| **Mark Bands and Description** | |
| 7-8 | *To achieve a mark in this band, candidates must meet the subject criterion (SUB) and all 5 of the quality of written communication criteria (QWCx).*  *SUB* Candidate has written a detailed explanation of how thin client systems work in comparison to rich client systems, and has also made a good comparison of the hardware required for both types of system. Some points have been made about how SaaS is distinguished from other types of thin client system. The candidate has made at least seven subject-related points.  *QWC1* Text is legible.  *QWC2* There are few, if any, errors of spelling, punctuation and grammar. Meaning is clear.  *QWC3* The candidate has selected and used a form and style of writing appropriate to the purpose and has expressed ideas clearly and fluently.  *QWC4* Sentences (and paragraphs) follow on from one another clearly and coherently.  *QWC5* Appropriate specialist vocabulary has been used. |
| 5-6 | *To achieve a mark in this band, candidates must meet the subject criterion (SUB) and 4 of the 5 quality of written communication criteria (QWCx).*  *SUB* Candidate has made some points in both of the areas of how thin client systems work in comparison to rich client systems, and how the hardware requirements of each type of system vary. The candidate has made at least five subject-related points.  *QWC1* Text is legible.  *QWC2* There may be occasional errors of spelling, punctuation and grammar. Meaning is clear.  *QWC3* The candidate has, in the main, used a form and style of writing appropriate to the purpose, with occasional lapses. The candidate has expressed ideas clearly and reasonably fluently.  *QWC4* The candidate has used well-linked sentences (and paragraphs).  *QWC5* Appropriate specialist vocabulary has been used. |
| 1-4 | *To achieve a mark in this band, candidates must meet the subject criterion (SUB) and 4 of the 5 quality of written communication criteria (QWCx).*  *SUB* Candidate has made some relevant points, but these are superficial or narrow in scope.  *QWC1* Most of the text is legible.  *QWC2* There may be some errors of spelling, punctuation and grammar but it should still be possible to understand most of the response.  *QWC3* The candidate has used a form and style of writing which has many deficiencies. Ideas are not always clearly expressed.  *QWC4* Sentences (and paragraphs) may not always be well-connected.  *QWC5* Specialist vocabulary has been used inappropriately or not at all. |
| 0 | Candidate has made no relevant points. |

Note: Even if English is perfect, candidates can only get marks for the points made at the top of the mark scheme for this question.

If a candidate meets the subject criterion in a band but does not meet the quality of written communication criteria then drop mark by one band, providing that at least 4 of the quality of language criteria are met in the lower band. If 4 criteria are not met then drop by two bands.

**[8]**

**Q19.**

(a)     **Marks are for AO1 (understanding)**

|  |  |
| --- | --- |
| **Label** | **Description** |
| **1** | channel idle / not busy / / no node transmitting; |
| **2** | no acknowledgement received; **NE** collision occurs |
| **3** | acknowledgement received; **NE** no collision detected |
| **4** | (wait for) random period of (time); |

**1 mark**: each correct description

**4**

(b)     **1 mark for AO1 (knowledge) and 2 marks for AO1 (understanding)**

**AO1 (knowledge):**

**1 mark:** SSID is a (locally unique) identifier for a wireless network;

**AO1 (understanding):**

**1 mark:** A wireless client must have the same SSID as the one put in the access point to join;

**1 mark:** Broadcasting SSID announces publicly your wireless network and can be seen as a security weakness;

**3**

(c)     **Marks are for AO1 (understanding)**

In coffee shop speed could be limited for each device that is connected / / throttling;

In coffee shop more clients connecting to one access point;

In coffee shop connection to Internet might have less bandwidth;

In coffee shop there may be more collisions;

**NOTE** accept answers made in terms of home

**Max 2 marks**

**MAX 2**

**[9]**

**Q20.**

(a)     **Marks are for AO1 (knowledge)**

Encryption is the encoding of a message;

conversion of plaintext into ciphertext;

so that other parties cannot read;

message can only be decrypted by the authorised receiver;

**Max 2 marks**

**MAX 2**

(b)     **Marks are for AO1 (understanding)**

Greater scrutiny / checking of code;

Weaknesses in the routines can be spotted and publicised;

The security of the routines can be tested / validated by third parties;

Other programmers can learn from the code;

From a philosophical point of view source code should be available;

Might encourage further development of the program;

**Max 2 marks**

**MAX 2**

(c)     **Mark is for AO2 (analyse)**

(Large) software libraries have many lines of code;

Cryptography software is complex;

(Open source software) programmers are volunteers;

(Open source software) library has limited funding;

tracing the effect of one line of code is hard / time consuming;

(Heart beat) functionality was not critical to the running of the code / / code ran without any noticeable problems so didn't raise concerns;

Code review (of OpenSSL) was defective;

No-one needed to change this code for two years so they presumed it worked and did not inspect it;

**Any 1 from above. Max 1**

**MAX 1**

(d)     **Mark is for AO2 (analyse)**

**1 mark:** Reasons for: Max one

Detection of illegal activities;

Monitoring of other states / countries;

Protection of national interests;

**1 mark:** Reasons against: Max one

Invasion of privacy;

Commercial secrecy;

**2**

**[7]**

**Q21.**

(a)     0011 0111;

**1**

(b)     37;

**1**

(c)     Easier for people to read / understand;   
**R** implication that it is easier for computers

Can be displayed using fewer digits;

More compact when printed / displayed;

**NE** Takes up less space

**NE** More compact

**R** Uses less storage space

**MAX 1**

(d)     1;1000101;

**R** if not 8 bits

**2**

(e)     101.10100

**R** if not 8 bits

**Mark as follows:**3 bits before binary point correct;  
5 bits after binary point correct;

**Note for examiners**If the correct 8 bits are given (10110100) but with no binary point shown award 2 marks (only if all 8 bits are correct − if no binary point shown and any bit is incorrect then 0 marks)  
Award 1 mark if correct value represented but binary point in wrong place (e.g. 0101.1010)

**2**

(f)      011 0110;

**R** if not 7 bits

**1**

(g)     128 //

27;

**1**

(h)     Use the AND operator;

with the 7-bit ASCII code and the bit pattern 000 1111;   
**A** 1001111   
**A** correct answers that use 8 bits instead of 7 bits   
**A** denary / hexadecimal equivalents to the bit pattern (15 / F)  
//  
Use the XOR operator;   
**A** EOR operator with the 7-bit ASCII code and the bit pattern 0110000;  
**A** correct answers that use 8 bits instead of 7 bits   
**A** denary / hexadecimal equivalents to the bit pattern (48 / 30)

**Note for examiners**To get the 2nd mark point the bit pattern provided must work with the logical bitwise operator stated in the answer

**2**

(i)      0011 0000;

**1**

(j)      Recalculate the values for the parity bits using the data bits received (and compare these values with the parity bits received);   
**A** check the parity bits  
Add up the bit positions of the parity bits where a parity checks fails // add up the bit positions of the calculated parity bits that are different to those received;  
The bit position of where the error has occurred is indicated;   
**R** positions  
The contents of the indicated bit position are flipped;   
**R** positions

**4**

(k)      7;

**1**

(l)      No;

**1**

(m)

|  |  |  |
| --- | --- | --- |
| Initial State | Input | New State |
| Sg | 1 | Sy; |
| Sy | 0 | Sy |
| Sy | 1 | Sy; |

**A** 2nd and 3rd rows swapped

**//**

|  |  |  |
| --- | --- | --- |
| Initial State | Input | New State |
| Sg | 1 | Sy; |
| Sy | 0 or 1 | Sy; |
|  |  |  |

**2**

(n)     Works out if a given input is a (7-bit) ASCII code for a numeric character;

**1**

(o)     The arrow labelled with a 0 from state Sg should go to state Sj;

**1**

**[22]**

**Q22.**

(a)     SMTP;

Telnet;   
**A** SSH;

**Note**For SMTP accept Simple Mail Transfer Protocol  
For SSH accept Secure Shell

**2**

(b)     Uniform Resource Locator;

**I** case

**1**

(c)     129.12.3.236 // 10.0.1.1 // 81.111.110.1 //  
213.105.114.89 // 62.253.174.77;

**I** brackets

**1**

(d)     A link between routers might be down / busy and / or a different route is picked;

Routes are determined dynamically as the packet moves from sender to receiver;

**A** to take the fastest route at that time  
**NE** to travel faster

**MAX 1**

(e)

|  |  |
| --- | --- |
|  | **Layer** |
| 1 | Application (layer) |
| 2 | Transport (layer) |
| 3 | Network / internet (layer) |
| 4 | Link (layer) |

1 mark for any two layers correct;  
2 marks for all four layers correct;

**2**

(f)     (Link layer) responsible for network drivers // network cabling // physical connection // changing from one medium to another;

(Link layer) (removes MAC address and) adds MAC address for the next hop;  
**A** hardware address for MAC address

(Network layer) looks at destination IP address;

Router decides on next appropriate hop (after seeing destination IP address);

(Network layer) can split / combine / resize packets if required;

error checking / error detection;  
encryption for wireless connections;  
tunnelling through a firewall;

**MAX 2**

**[9]**

**Q23.**

(a)     192.168.0.x (where x is not 0, 2 or 255);

**1**

(b)     Star (topology);  
**A** Star network  
**I** additional writing that does not talk out the response

**1**

(c)     Devices are not directly connected to the Internet;  
**NE** all computers on a private network

So that LAN devices cannot be connected to (directly) by computers outside of the LAN / on the Internet // for increased security;  
**A** relevant examples of increased security

Don’t need to be allocated by a central authority // would be difficult to organise for each device to have a unique (routable) IP address // easier to allocate if do not need to be unique // ( as devices not directly connected to Internet) IP addresses don’t need to be globally unique;  
**NE** routable IP addresses globally unique and non-routable only locally unique

Would / May not be enough unique IP addresses for each device to have a routable address // globally more IP addresses would be required if all devices had routable IP addresses // more bits would be required to store an IP address if all devices had routable IP addresses;

**MAX 2**

**2**

(d)     AND operation performed using IP address(es) and subnet mask (to produce network IDs / subnet IDs of both desktop computer and FTP server) // Network IDs / subnet IDs / first three octets / bytes / values (in IP addresses) computed using IP address(es) and subnet mask;

**To award either of the next two marks, the candidate must have indicated that the subnet mask is used to produce the results that will be compared - even if the method by which the subnet mask is used is incorrect so the first mark has not been awarded.**

Network / subnet IDs of both computers / machines compared;  
**A** Results of previous operation compared  
**A** First three octets / bytes / values (in IP addresses) compared  
**A** Award this mark by implication if it is stated what will happen if these two are the same or different

As network / subnet IDs (**A** first thee octets / bytes / values / results) differ, desktop computer determines that FTP server is not on same network (so must be communicated with via combined device);

**3**

(e)     Block / allow (traffic on) specific ports // block specified protocols;  
Block / allow (traffic from) specific IP addresses / domain names;  
Search packets for specific contents / text (and block / allow based on this);  
Act as a proxy server // all traffic to Internet must go via firewall // stops computers on the Internet directly accessing devices on the LAN;  
Stateful inspection // firewall maintains information about current connections and only allows packets relevant to these connections through;  
Identifies unusual behaviour from a host // example of unusual behaviour eg sending an unusually large amount of data;  
**NE** Packet filtering  
**NE** “Data” instead of “packets”  
**NE** Block specific programs connecting to Internet  
**A** Firewall checks packets using rules / criteria for 1 mark if not other marks awarded  
**MAX 3**

**3**

(f)     *Baseband*Whole bandwidth of medium dedicated to one transmission (at a time) // one channel (at a time) // only one computer can send data (at a time) // sends signals with frequencies from 0Hz to a maximum highest frequency;  
*Broadband*Bandwidth of medium shared // multiple channels can be carried (simultaneously) // many computers can send data (simultaneously) // frequency bands assigned to different communications; **TO** multiple wires  
**MAX 1**

**1**

(g)     More reliable // less susceptible to interference // more stable connection;  
Faster transmission speed // higher bit rate // lower latency;  
**R** More secure (not relevant in this instance)  
**NE** Just the word “faster” on its own.  
**MAX 1**

**1**

**[12]**

**Q24.**

(a)

|  |  |  |  |
| --- | --- | --- | --- |
| **Situation** | **Most likely to be Parallel** | **Most likely to be Serial** | **Could be either Serial or Parallel** |
| Sending data to a peripheral, such as a printer, that is plugged directly into a desktop computer. |  | **A** |  |
| Transferring memory addresses between the processor and the main memory of a desktop computer. |  |  |  |
| Transmitting an e-mail across a WAN from a computer in England to an e-mail server in Scotland. |  |  |  |

**1 mark** per row with a correct tick

Do not award marks for any row which has more than one tick

**A** alternative indicators for ticks e.g. crosses, Y, Yes

**3**

(b)     To check that a (receiving) device is connected;

To check that a (receiving) device is ready to receive data / / to inform a (transmitting) device that a (receiving) device is / is not ready to receive data;

To tell a (receiving) device that data is ready to be transmitted;

To negotiate / agree how the transmission will take place / / to agree the system to be used for transmission ; **A** an example of a setting that might be agreed during a handshake eg bit rate, parity

To ensure successful communication;

**MAX 1**

**1**

(c)     Time delay between the moment something is initiated and the moment its effect begins;

**A** time delay between signal being transmitted and arriving

**A** time taken for transmitted data to arrive at the receiver

**A** lag for time delay

**NE** delay in transmission, transmission time

**1**

**[5]**

**Q25.**

(a)     (i)      192.168.0.x where x is not 0 or 255;

**1**

(ii)     192.168.2.x where x is not 0 or 255;

**1**

(iii)    192.168.2.y where y is not 0 or 255 and is not the same as x in (ii);

**1**

(b)     **Reason:** To reduce (network) congestion / / improve throughput / / *to cut the number of collisions\**; **A** faster operation / transmission;

**Explanation:** *by cutting the number of collisions*\* / / by reducing the number of stations / computers connected to each section of cabling / / because two computers in one segment can communicate at the same time as two computers in another segment;

**Note**: \* = Do not award **2 marks** for cutting the number of collisions – only award one for either reason or explanation.

**Reason**: To improve security;

**Explanation**: by localising packet transmission to one segment;

**Reason**: To improve reliability;

**Explanation**: By limiting effect of cable failure to one segment;

**R** answers referencing the computers not working at all

**Award marks for either:**

•        **one reason + explanation**

•        **two reasons**

•        **two explanations**

**2**

(c)     (i)      No need for maintenance / / no need to upgrade / / no need to install patches for software / / could employ fewer technical staff;

Lower hardware requirements for computers (as processing done on web server); **A** examples of lower hardware requirements but **R** just cheaper hardware

No (high) one-off purchase cost; Platform independence / / can access the software on many devices; **A** examples eg PC and tablet.

Software can be used from anywhere that there is an Internet connection / / from outside of office; **Note**: To award this point must be clear that can be accessed from outside of office, just "can be accessed from any computer" is not enough.

Can still access software and data if a specific computer is not working;

**A** reduced management cost / effort when a reason is given, such as no need to install software on each computer, but just "does not need to be installed on each computer" is not enough on its own.

**MAX 2**

**2**

(ii)     Reliance on Internet / / unreliable internet connection may mean software inaccessible;

Reliance on the company that develops the software to keep providing the service;

Slow connection speed may make software difficult / annoying to use;

Concern over security of saved documents / / security of transmission;

May be an ongoing cost to pay for using the software;

Lack of control over which version to use / when upgrades happen;

Software may slow when used by many users simultaneously;

Higher cost (to company) of fast internet connection to connect many computers to SaaS;

**MAX 1**

**1**

(d)     LAN usually baseband whilst WAN broadband\* / / only one communication can take place at a time on a LAN whereas multiple communications can take place simultaneously on a WAN;

LAN communication links have higher speeds than WAN;

LAN has lower latency than WAN;

Lower error rates on LAN than WAN;

Communications medium in LAN likely to be privately owned, whereas likely to be leased / publicly owned in a WAN;

Use different protocols (at link layer / hardware level);

Different hardware required to connect (**A** examples);

WAN may have greater security risks (as data transmitted over larger area, on public system, through more servers or devices);

**A** WAN may use satellites / microwave whilst LAN may use cables / radio / WiFi\* - this point cannot be awarded for just saying WAN uses cables on LAN radio or vice-versa as both LAN and WAN can use either of these

**MAX 2**

**Only one side of the difference needs to be provided (as the other is implicit) except for the points marked with an \* for which both sides are needed.**

**2**

**[10]**

**Q26.**

(a)     Greater the bandwidth, the higher the bit rate // positive correlation // (directly)   
proportional;  
Bandwidth must be at least 2wHz where w is the bit rate in bits per second;

**Max 1**

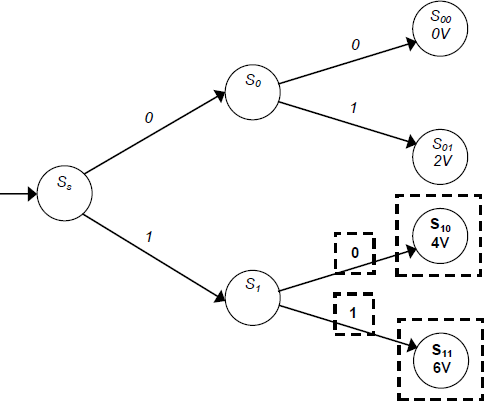
(b)     Time delay between the moment something is initiated and the moment its effect begins  
**A** time delay between signal being transmitted and arriving  
**A** time taken for transmitted data to arrive at the receiver  
**A** lag for time delay  
**NE** delay in transmission, transmission time

**1**

(c)     Bit rate is double / twice baud rate // Baud rate is half bit rate;  
**A** “It” is double;  
**A** 2:1

**1**

(d)



*1 mark for labelling a transition arrow with 0  
1 mark for labelling a transition arrow with 1  
1 mark for labelling a state with the value 4V and a unique state name  
1 mark for labelling a state with the value 6V and a unique state name*

*Max 2 if the states and transition arrow labels do not correspond*

Note that:

•        The state names do not have to match those given here.

•        The voltage values can be followed by a V, the word Volts or nothing.

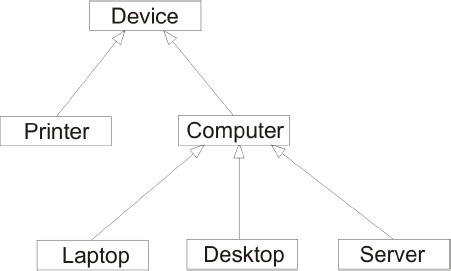
•        The zero and one on the transition arrows to the right of S1  can be either way around e.g. 1 above 0 is okay.

**4**

**[7]**

**Q27.**

(a)



*1 mark for Device at top of diagram with Printer and Computer directly underneath it and linked to it and no other labels linked to it;  
1 mark for Computer with Laptop, Desktop and Server directly underneath it and linked to it, and no other labels linked to it (except Device above);  
1 mark for correctly styled diagram, i.e. lines drawn as arrows and boxes (any shape) around labels; –* ***This mark is only available if candidate has already achieved at least one mark for correct contents of the diagram.***

**A** arrows drawn as:



**A** filled / empty arrowheads  
**A** diagram rotated by 90 degrees

**3**

(b)      Computer = Class/Subclass/Extends(Device)       1

|  |  |  |
| --- | --- | --- |
| (Public)         Procedure AddDevice (Override)         Function GetProcessorName         Function GetRAMCapacity         Function GetHDDCapacity     Private / Protected         ProcessorName : String         RAMCapacity : Integer         HDDCapacity : Integer     End |  | 1   1    1 |

**A** answers that use different notations, so long as meaning is clear.

*1 mark for correct header including name of class and parent class;  
1 mark for redefining the AddDevice procedure;  
1 mark\* for* defining all 3 extra functions needed to read variable values, all identified as being public (keyword public is optional if functions are declared before variables);  
1 mark# for defining all 3 extra variables, with appropriate data types and identified as being private;  
  
**A** any sensible numeric types for RAMCapacity and HDDCapacity, do not have to be whole numbers  
**A** answers that indicate separately that each variable is private or each method is public  
**R** do not award mark for declaring new functions if any of the functions have the same name as the variables  
**I** parameters to methods, minor changes to names that do not affect clarity

*\* – Do not award this mark if any extra functions / procedures have been declared, except for functions that would set values e.g. SetProcessorName or an incorrectly named procedure to add e.g. AddComputer  
# – Do not award this mark if any extra variables have been declared*

**4**

(c)

|  |  |  |
| --- | --- | --- |
| Laptop = Class/Subclass (Computer)         (Public)             Procedure AddDevice (Override)              Function GetBluetoothInstalled         Private / Protected             BluetoothInstalled : Boolean         End |  | 1  1  1 |

*1 mark for correct header incl*

*1 mark\* for redefining the AddDevice procedure;  
1 mark\* for:*

•        defining the GetBluetoothInstalled function needed to read this value, identified as being public (keyword public is optional if function is declared before variable)

•        defining the BluetoothInstalled variable with an appropriate data type as being private.

**A** Boolean or whole number types for BluetoothInstalled but reject string, character or real number types  
**A** Different sensible name for GetBluetoothInstalled function e.g. CheckBluetoothInstalled, IsBluetoothInstalled  
**A** answers that indicate separately that each variable is private or each method is public  
**I** parameters to methods, minor changes to names that do not affect clarity   
**I** addition of any extra functions or variables

\* *Do not award this mark if any extra functions / procedures / variables declared, except for a SetBluetoothInstalled procedure.*

**2**

(d)     **What** *(2 marks)*:  
Wireless/RF (protocol/standard/technology);  
For exchanging data over short distances // for creating   
Personal Area Network;  
**NE** “uses waves” for “wireless”

**Example** *(1 mark):*Any sensible example, related to the use of Bluetooth with the laptop e.g. synchronising contacts between phone/ laptop, sending photographs from phone to laptop, Bluetooth mouse, Bluetooth headset / headphones (used with laptop) etc;   
**NE** connecting to wireless network   
**NE** mouse

*If the example makes clear that the technology is wireless, but this is not explicitly stated in the “What” part of the response then the “Wireless” mark should be awarded in the “What” part.*

**3**

**[12]**

**Q28.**

(a)     To examine the destination of each packet;  
To forward packets from one network to another;  
To manage congestion;  
Choose an appropriate forwarding route;  
Route packets according to destination IP address;  
Store incoming packets temporarily;  
Change link address in packet;  
To store/make use of a routing table;

**A** data instead of packets  
**R** information / signals

**Max 2**

(b)     SMTP;  
POP(3);  
IMAP(4);

**A** full names of the protocols above  
**A** ESMTP // SMAP // LMTP // QMTP

**Max 1**

(c)     **Key Points of Subject Criteria**Concept that data passed up/down between layers;   
**A** by example – just one needed but must be correct   
**NE** just describing the layers in the correct order

Application layer selects appropriate protocol for the communication // protocol mentioned by example ( POP / HTTP );  
Application layer is to interact with the user via the email client / web browser;

Transport Layer:  
Transport layer establishes end to end communication // Transport layer establishes a virtual path // TCP layer establishes connection between client and server;  
Destination and source application level client/server identified by port numbers;  
TCP layer uses these port numbers to route reassembled requests/responses to correct application layer client/server;  
TCP layer splits and reassembles requests/responses into packets/from packets;  
Packets are numbered by transport layer;  
Transport layer deals with error control (acknowledgements/retransmission);

Network layer adds source and destination IP addresses; Routers use destination IP addresses to route packets to destination // network layer involved with packet routing;

Link layer adds source and destination hardware/Ethernet/Link layer/MAC addresses;  
Link layer destination and source addresses change from link to link;  
Link layer moves packets between 2 internet hosts;  
Link layer deals with physical connection/cabling;  
**A** Link layer includes network card / drivers;

Network layer strips IP address (when receiving) // Link layer strips MAC address (when receiving);  
Server uses received source IP address to know where to send response;

Server uses received client port number to know to which instance of application layer client to send response to;  
Servers use well-known ports;  
Client port numbers come from the dynamic range;  
Packets of Email client/server and Web browser/Web server travel independent paths;  
Packets of Email client/server and Web browser/Web server share links//intermingled on links;

Combination of IP address and Port = Socket / described;

*Note: Accept answers where candidate uses the IP addresses and ports indicated in the figure to match up with statements above*

*To achieve a mark in this band, candidates must meet the subject criterion (SUB) and 4 of the 5 quality of language criteria (QWCx).*

|  |  |
| --- | --- |
| SUB | Candidate has made at least 5 valid points covering. |
| *QWC1* | Text is legible. |
| *QWC2* | There are few, if any, errors of spelling, punctuation and grammar. Meaning is clear. |
| *QWC3* | The candidate has selected and used a form and style of writing appropriate to the purpose and has expressed ideas clearly and fluently. |
| *QWC4* | Sentences and paragraphs follow on from one another clearly and coherently. |
| *QWC5* | Appropriate specialist vocabulary has been used. |

**5-6**

*To achieve a mark in this band, candidates must meet the subject criterion (SUB) and 4 of the 5 quality of language criteria (QWCx).*

|  |  |
| --- | --- |
| SUB | Candidate has made at least 3 valid points. |
| *QWC1* | Text is legible. |
| *QWC2* | There may be occasional errors of spelling, punctuation and grammar. Meaning is clear. |
| *QWC3* | The candidate has, in the main, used a form and style of writing appropriate to the purpose, with occasional lapses. The candidate has expressed ideas clearly and reasonably fluently. |
| *QWC4* | The candidate has used well-linked sentences and paragraphs. |
| *QWC5* | Appropriate specialist vocabulary has been used. |

**3-4**

*To achieve a mark in this band, candidates must meet the subject criterion (SUB). The quality of language should be typified by the QWCx statements.*

|  |  |
| --- | --- |
| SUB | Candidate has provided at least one point from the above. |
| *QWC1* | Most of the text is legible. |
| *QWC2* | There may be some errors of spelling, punctuation and grammar but it should still be possible to understand most of the response.. |
| *QWC3* | The candidate has used a form and style of writing which has many deficiencies. Ideas are not always clearly expressed. |
| *QWC4* | Sentences and paragraphs may not always be well-connected or bullet points may have been used. |
| *QWC5* | Specialist vocabulary has been used inappropriately or not at all. |

**1-2**

Candidate has not made reference to any of the points above.

**0**

**[9]**