GCSE Computer Science

Mark Scheme

Exam Practice

Topic 4: Networks

This booklet contains ***all*** past questions on this topic

Topic 4: Networks

Most computer applications in use today would not be possible without networks. Students should understand the key principles behind the organisation of computer networks.

Subject content	Students should:	
4.1 Networks	4.1.1	understand why computers are connected in a network
	4.1.2	understand different types of networks (LAN, WAN)
	4.1.3	understand how the internet is structured (IP addressing, routers)
	4.1.4	understand how the characteristics of wired and wireless connectivity impact on performance (speed, range, latency, bandwidth)
	4.1.5	understand that network speeds are measured in bits per second (kilobit, megabit, gigabit) and be able to construct expressions involving file size, transmission rate and time
	4.1.6	understand the role of and need for network protocols (Ethernet, Wi-Fi, TCP/IP, HTTP, HTTPS, FTP) and email protocols (POP3, SMTP, IMAP)
	4.1.7	understand how the 4-layer (application, transport, internet, link) TCP/IP model handles data transmission over a network
	4.1.8	understand characteristics of network topologies (bus, star, mesh)
4.2 Network security	4.2.1	understand the importance of network security, ways of identifying network vulnerabilities (penetration testing, ethical hacking) and methods of protecting networks (access control, physical security, firewalls)

3 Networks

(a) Networks are described in many different ways.

(i) Give the type of network that covers a small geographical area.

(1)

Award **one** mark for any of the following:

- LAN (1)
- Local area network (1)

(ii) Name the characteristic of a wireless network that is measured in metres.

(1)

- Range (1)

Do not allow length / distance

(iii) Give **two disadvantages** of a bus network topology.

(2)

1 ..
- The whole network stops working if the backbone/cable is broken (1)
- The number of collisions increases/the network will slow down as the number of devices/users increases (1)

2 ..
- A greater security risk (because all the nodes on the network see all the data packets) (1)
- The network stops working if the terminators are missing/not working (1)
- Only one device can transmit data at a time (1)

(b) Describe penetration testing.

(2)

Award up to **two** marks for a linked description, such as:

- It is an authorised attack (black box/white box) on a network/system (1) to identify security vulnerabilities (1)
- It is a network/system attack carried out with the knowledge of an organisation (1) to recommend measures that should be taken to improve security (1)

For both marks, the expansion must follow/associate with the statement.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) Network protocols control the rules of communication.

(i) Name a network protocol that transmissions from other electrical devices can interfere with and that can be blocked by walls.

- Wi-Fi (1)
- Bluetooth (1)

Allow ZigBee

(1)

(ii) Name the network protocol used to download a music file from a server.

- File Transfer Protocol (1)
- FTP (1)

(1)

(d) Describe how the link layer of the TCP/IP protocol stack works.

(2)

Award up to **two** marks for a linked description, such as:

- It converts the data into a suitable signal/electrical/radio (1) for transmission on the media Ethernet cable/Wi-Fi (1)
- It uses/adds a physical/MAC address (1) for a source/destination (1)
- Receives data from the network layer (1) to send via physical hardware (1)

For both marks, the expansion must follow/associate with the statement.

(e) Construct an expression to calculate the transmission rate, in megabits per second, required to transmit a 1.4 gibibyte file in 13 minutes.

You do not need to do the calculation.

(4)

$$\frac{1.4 \times 8 \times 1024^3}{13 \times 60 \times 1000^2}$$

Award **one** mark for:

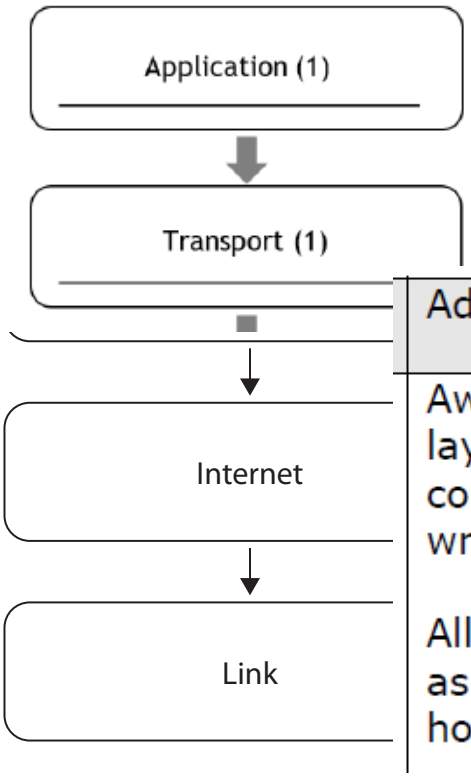
- 13 x 60 or 780 (seconds) (1)
- $1.4 \times 8 \times 1024^3$ (1)
- 1000^2 (1)
- Fully correct response (1)

(Total for Question 3 = 14 marks)

2 Networks

(a) Complete the diagram of the 4-layer TCP/IP model.

(2)



Additional Guidance
Award one mark if both layers are named correctly, but in the wrong order Allow alternatives, such as Process and Host-to-host

(b) Name the network topology that uses terminators to absorb signals.

(1)

- Bus (topology) (1)

(c) Identify the reason computers are connected in a network.

(1)

☒ **A** To improve encryption

☒ **B** To prevent hacking

☒ **C** To reduce latency

☒ **D** To share peripherals

The only correct answer is D

A is not correct because files can be encrypted without the computers holding them being connected in a network
B is not correct because unconnected computers are at less risk than connected computers
C is not correct because latency is a network metric, not a reason to connect devices

(d) State the network protocol used to request a webpage.

(1)

- HTTP (1)
- HTTPS (1)
- Hypertext Transfer Protocol (1)
- Hypertext Transfer Protocol Secure (1)

(e) Explain **one** benefit to a user of using IMAP to access emails.

(2)

ward up to **two** marks for a linked explanation such as:

- Emails can be accessed from multiple devices (1) because IMAP does not remove/delete emails (from the server) (1)
- Emails can be accessed through a browser (1) because IMAP doesn't need a client application to download messages (1)

(f) A factory has two file servers installed in an office.

A closed-circuit television system monitors the factory.

Explain **one other** method of physical security that could be used to protect the servers.

(2)

Award up to **two** marks for a linked explanation such as:

- (Digital/biometric) locks / magnetic card scanners / security personnel could be put on the office door (1) to prevent unauthorised access (1)
- Movement sensors (1), to activate an alarm/ a light (1)
- Security lights / alarms (1), so that intruders would be scared off / identified (1)
- Alarms / alerts could trigger (1) because there is unauthorised access (1)
- The servers/assets could have security tags (1), so that the owner can be tracked if stolen (1)
- ID cards could be issued to all staff (1) to prevent impersonation/to allow unknown people to be challenged (1)
- Warning posters could be positioned at entrances (1) to make people aware of shouldering/tailgating/two people entering together (1)

(g) Network speed is the current rate of data transmission, measured in bits per second.

(1)

Define the term 'bandwidth'.

- The **maximum** volume/amount of data that can be transmitted (in one second/unit of time) (1)
- The **full capacity** of data that can be transmitted (in o second) (1)

Response must be about **capacity** of transmission, i.e. the **maximum** that can be transmitted, not how much/how fast data is currently being transmitted.

(h) High-speed fibre-optic cables form the internet backbone. Routers connect other networks to this backbone.

Describe how a router enables data to arrive at its destination.

(2)

Award **one** mark for any of the following up to a maximum of **two** marks:

- Read the destination/recipient's IP address (in each packet) (1)
- Uses a routing table (1)
- Sends the data packet **to the next router** (1)
- Uses the fastest/least congested route/pathway (1)
- Keeps track / informs other routers of traffic conditions (1)

(Total for Question 2 = 12 marks)

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Networks

(a) Devices are connected to networks.

(i) Give **two** reasons for connecting computers in a network.

(2)

Any **two** from:

- Can share files/data
- Can share applications/software
- Can collaborate
- Can share peripherals (printers, speakers)
- Can share connectivity (Internet connection, hotspot)
- Can access files **from any computer / hot desk**
- Central control/management (security, software updates, backup, remote support, users, remote monitoring)
- Allows communication (email, social media, video conferencing, online meeting, collaborative games)

(ii) Describe **one** way a local area network (LAN) is different from a wide area network (WAN).

(2)

- A LAN covers a small (geographic) area / a WAN covers a large (geographic) area (2)
- A LAN uses infrastructure owned by one company / a WAN uses third-party infrastructure (2)
- A LAN connects individual devices / uses switc
  a WAN connects LANs / uses gateways (1)

Additional Guidance
Do not accept 'smaller/larger' in reference to the physical size of the network.

(iii) A network has a speed of 17.08 megabits per second.

Identify the equivalent speed in bits per second.

(1)

☒ **A** 17 080

☒ **B** 17 080 000

☒ **C** 17 080 000 00

☒ **D** 17 080 000 00

B 17 080 000

A 17 080 is not correct because it is 17.08 multiplied by 1000
C 17 080 000 000 is not correct because it is 17.08 multiplied by 1000^3
D 17 080 000 000 000 is not correct because it is 17.08 multiplied by 1000^4

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN

(iv) Define the term 'latency'.

(1)

The delay/amount of time between data/signal being sent and it being received	Do not accept reference to delay/lag on its own.

(b) Data is split up into packets for transmission over a network.

(i) Each device on a network has a unique identifier that is used when sending or receiving packets of data.

State the name of the unique identifier.

Any **one** from:
- IP (address)
- MAC (address)

(1)

(ii) Identify the item included between the header and the footer in a data packet.

(1)

☒ **A** Data being sent

☒ **B** Destination address

☒ **C** Pack

☒ **D** Publi

A Data being sent

B is not correct because it is located in the header
C is not correct because it is located in the header
D is not correct because it is not located in a packet

(c) Describe how a firewall protects a local area network (LAN).

(2)

A description to include two from:

- Monitors/checks traffic (1) using a set of rules / list of authorised/unauthorised computers/addresses/protocols (1) to decide if data is allowed into or out of the network (1)

(d) State the name of an email protocol.

(1)

Any **one** from: • POP3 • IMAP • SMTP

(e) Explain **one** disadvantage of using a star network topology.

(2)

A linked explanation such as: • All communication could fail (1) because/if the central device fails (1) • It can be difficult/expensive to set up (1) because each device needs a cable to connect to the central device (1) • The number of devices that can be connected is limited (1) because the central device supports a fixed number of connections (1)

Additional Guidance
For 'central device': • Accept 'router' or 'hub' (as a term to refer to a device that contains a switch). • Accept 'switch' (as this is the correct term to refer to the central device) • Do not accept 'server'

5 Networks

(a) Identify the reason why all computers need a unique IP address.

(1)

- ☒ **A** Enables a firewall to protect devi
- ☒ **B** Identifies devices on a network
- ☒ **C** Increases the speed of transmiss
- ☒ **D** Reduces reliance on the transpo

B Identifies devices on a network

A is not correct because unique IP addresses do not enable a firewall to protect devices
C is not correct because unique IP addresses do not increase the speed of transmission
D is not correct because unique IP addresses do not reduce the reliance on the transport layer

(b) Describe **one** disadvantage of using a bus topology.

(2)

If the main cable fails / is damaged (1) the whole network will fail (1)
If more computers are connected (1) the transmission time is increased / increased chance of data collisions (1)
Every computer receives all of the data on the network (1) causing a security risk (1)

(c) A company stores statistics about its business on a server.

Explain **one** type of access to the statistics file a student on work experience at the company should be given.

(2)

An explanation to include **one** mark for a type of access and **one** mark for a linked reason, such as:

- To recommend read only (1) because the student cannot accidentally change/delete the data / because the student canno share the data (1)
- No access (1) because the student cannot see any sensitive/irrelevant information (1)

(d) Construct an expression to calculate the minimum transmission rate required to transmit a 250 MiB file in exactly one hour.

There are 3600 seconds in an hour.

(3)

Total number of bits:

- 250 x 1024 x 1024 (1)
- x 8 (1)

3600 as denominator (1)

Award all marks for the correct answer (582,542bps)

Example expression:

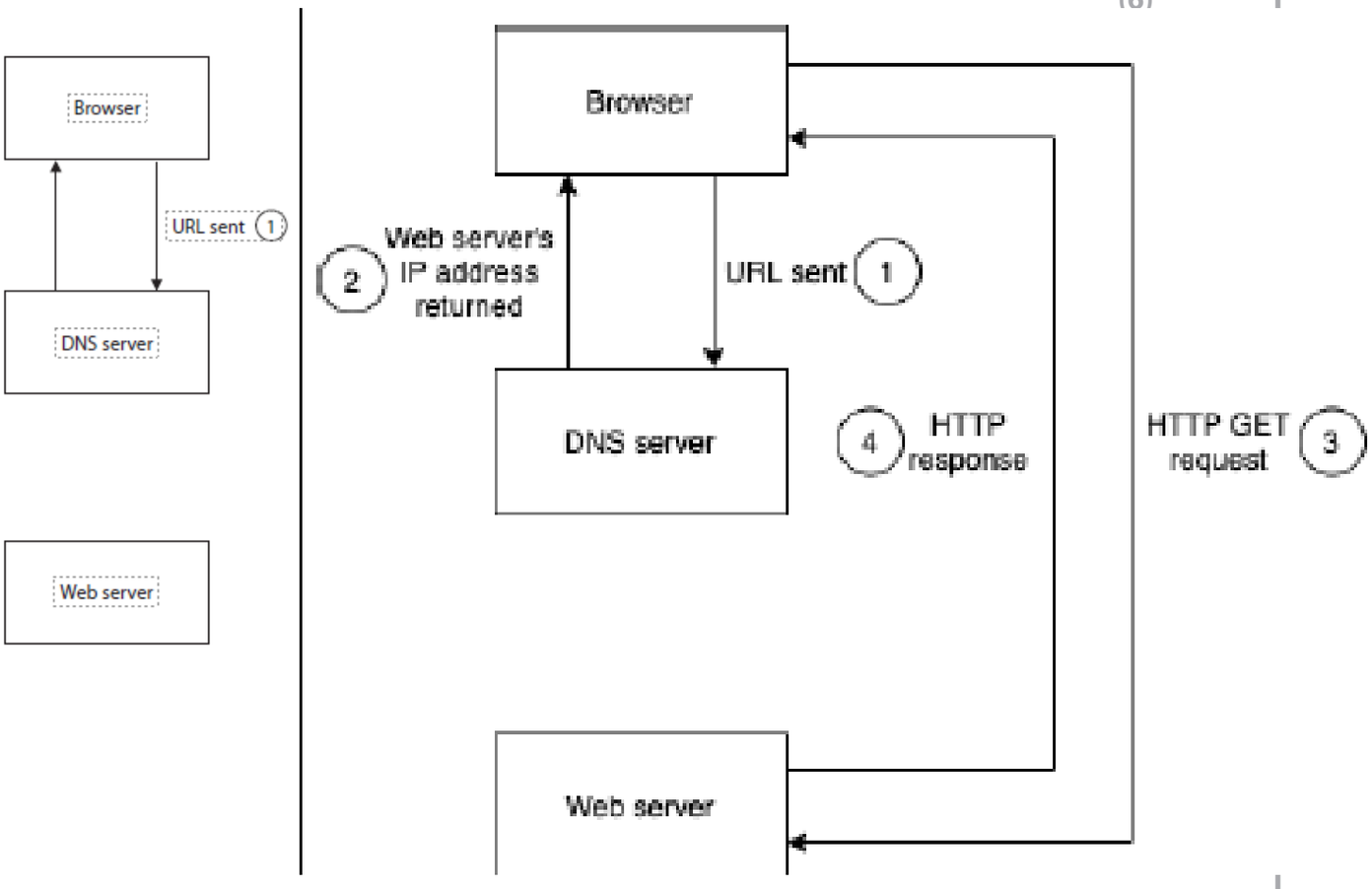
(250 x 1024 x 1024 x 8) / 3600

Additional Guidance
Ignore conversion to Mbps etc. Award equivalent expressions.

(e) Complete the diagram to show the processes used to find the IP address of a web server and download a page.

Include labels, arrows and numbers in your diagram to show the order in which processes are carried out.

(6)



A drawing to include **six** from:

- Label showing IP address being returned to browser
- Arrow from Browser to Web server
- HTTP GET request labelled
- Arrow from Web server to Browser
- HTTP response labelled
- Correct order shown

(Total for Question 5 = 14 marks)

TOTAL FOR PAPER = 75 MARKS

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Networks

(a) Different protocols are used in the 4-layer TCP/IP model.

Complete the table by providing **one** item in each empty space.

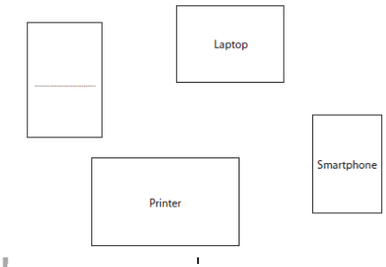
(4)

Layer	Protocol
Application	HTTP / HTTPS / SMTP / POP3 / IMAP / FTP
Transport	TCP
Internet	IP
Link / Data Link / Network interface	Ethernet

(b) Computers can be connected using a bus, mesh or star topology.

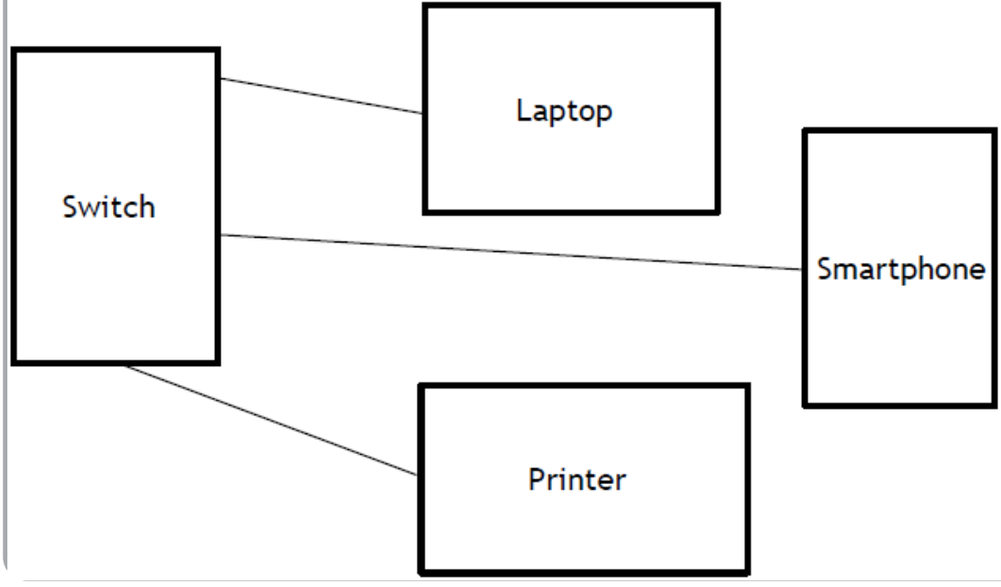
(i) Draw lines between the devices and label the unnamed device to show a star network topology diagram.

(2)



One mark for each to a maximum of 2:

- Named device is switch/hub (1)
- Exactly three lines connecting devices to centre point/named device (1)



Additional Guidance
• Marks are independent • Do not award bullet 2 if there are extraneous lines • 'Router' would not gain a mark because it is a term that is often used to describe a hardware device that may contain a modem, router, switch and wireless access point.

(ii) Give **two** reasons for using a star topology rather than a bus topology.

(2)

Any **two** from:

1 ..... • A star is more scalable (1) than a bus because you can add extra devices without disrupting the network.

..... • A star is more fault tolerant/reliable (1) because a damaged cable/faulty device can be replaced/removed without disrupting the rest of the network.

2 ..... • It is easier to troubleshoot/isolate faults (1) because all cables are attached to a central point.

..... • A star is capable of handling higher volumes of network traffic (1) than a bus.

(c) State **one** reason for splitting data into packets.

(1)

Any one from:

- Speeds up data transfer
- Reduces the reliability on a single pathway
- Reduces the impact of data corruption

(d) Data is split up into packets for transmission over a network.
Identify the item included in a packet header.

(1)

- ☒ **A** Data being sent
- ☒ **B** Decryption key
- ☒ **C** Media restriction i
- ☒ **D** Packet number

D Packet number

A is not correct because the data being sent is in another part of the packet
B is not correct because if the packet were encrypted the key would not be sent in the header
C is not correct because packets are not restricted to the type of media they can use

(e) A company needs to secure its network from attacks by its employees.

Explain the best choice of penetration testing the company should use.

An explanation that includes the ideas:
Permission is given to a person (1) to carry out investigation of security issues (1) in the network

White-box / white-hat (1) because system information is provided to the tester (1)

The company should give a security expert an ID and password and details of how the network is configured (1), and ask them to try to find vulnerabilities that would enable an employee to access, delete and/or leak sensitive data or install malicious software (1)

(Total for Question 1 = 12 marks)

4 Networks

(a) Describe **one** difference between the POP3 and IMAP email protocols.

(2)

POP3 deletes messages from the server when downloaded (1), whereas IMAP leaves them on the server when downloaded (1)

(b) The performance of a network depends on speed, range, latency, and bandwidth. Bandwidth in a wireless network is constant because the capacity of the network is not affected by any other environmental factors.

Explain **two** ways that the performance of a wireless network can be affected by its environment.

(4)

Any two from:

1
- Wireless networks have a short range (1) because walls and floors can block the signal (1)

OR

- Wireless/radio signals may not go very far (1) because solid structures (thick walls, steel beams) block the signal (1)

2
- Wireless networks can have high latency (1) because they suffer from interference from other wireless networks or devices (1)

OR

- The performance of a wireless network can be adversely affected by interference from other devices (1) because they can operate on the same frequency band/they are high voltage, such as a microwave (1)

- Wireless networks have low speed (1) because all the devices must share the available bandwidth (1)

OR

- The more devices that are connected to the network, the more likely bottlenecks are to occur (1) because they all want a share of the available bandwidth (1)

- Award responses that give examples of one of the categories in the stem.

(c) A checksum works at the transport layer of TCP / IP.

Describe how a checksum is used to identify packets that have been corrupted during transmission.

(3)

One for each to a maximum of 3

- A checksum formula is applied to the packet before it leaves the source computer (1)
- The source calculated checksum is added to the packet header (1)
- At the receiving end, the same checksum formula is reapplied (1)
- The new checksum is compared to the received checksum in the packet header (1)
- If the received checksum and the newly calculated checksum do not match, a resend request is issued (1)

(d) Discuss methods a movie streaming company could use to secure its network.

Your answer should consider:

- physical security
- access control
- firewalls.

(6)

Indicative content

Discuss methods of securing networks.

Physical security

- The movie streaming company should use physical security to protect its products and data from unauthorised access.
- Physical security can be used to only allow authorised people to enter critical areas, such as the room with the file servers where the movies are stored.
- The machine storing the movies and the movie streaming company's data should be in locked rooms/cupboards.
- Each door could be fitted with an electronic lock system which can record who enters the server room and when.
- Electronic lock systems can read cards/fobs/biometrics of employees and check them against details stored on a database to determine if an employee has special permission to enter the movie server room.

Access control

- The movie streaming company should enforce strict access control to determine who can log onto its network
- Each time someone attempts to log onto the movie streaming company's network, their credentials are checked against a database.
- The credentials also determine what access the person can have, such as to the customer files but not the movie files.
- Different employees/people need different levels of access to do their job, for example, the billing department does not need access to employee records or the movie files.
- Access control limits employees to only that level of access needed, for example, the payroll department would not need to access the stored movies.
- Controlling access means that an apprentice cannot delete movies, thereby reducing the chance of accidental corruption of deletion of data.
- Access control is set up by the system's administrator, who has the highest level of privileges and can see all the unencrypted data across all machines, including customer records and movie files.

Firewalls

- A firewall acts as a barrier between the movie streaming company's network and the internet.
- The movie streaming company may choose to purchase firewalls that are software, hardware, or a combination.
- The movie streaming company should have hardware firewalls on the entry points to its network and software firewalls on each company-owned device.
- Firewalls use a set of rules to determine which packets of data are allowed in and out, so unauthorised access attempts to the movie streaming company's network will be denied.
- Rules can be customised to suit the movie streaming company's particular needs.
- They can flag up suspicious activity by employees such as downloading viruses or sending confidential data, including movie files, outside the movie streaming company.

Level	Mark	Descriptor
	0	No rewardable content.
Level 1	1-2	Basic, independent points are made, showing elements of understanding of key concepts/principles of computer science. (AO1) The discussion will contain basic information with little linkage between points made or application to the context. (AO2)
Level 2	3-4	Demonstrates adequate understanding of key concepts/principles of computer science. (AO1) The discussion shows some linkages and lines of reasoning with some structure and application to the context. (AO2)
Level 3	5-6	Demonstrates comprehensive understanding of key concepts/principles of computer science to support the discussion being presented. (AO1) The discussion is well developed, with sustained lines of reasoning that are coherent and logically structured, and which clearly apply to the context. (AO2)

(Total for Question 4 = 15 marks)

3 Networks

(a) Networks are structured.

(i) State the type of network that uses copper cables, fibre-optic cables, satellites, and microwaves.

- WAN (1)
- Wide Area Network (1)

(1)

(ii) Here are two sequences of characters.

01.102.103.104

2545:0425:2CA1:0000:0000:0577:5673:32b5

Identify these two sequences of characters.

(1)

☒ **A** Ethernet protocol packet identifiers

☒ **B** IMAP server addresses

☒ **C** Internet protocol (IP) addresses

☒ **D** Mec

The only correct answer is **C**

A is not correct because these are not Ethernet specific
B is not correct because addresses do not determine the function of the associated device
D is not correct because MAC addresses use six groups of two hexadecimal pairs

(iii) A building has a wired network arranged in a star topology with a central node.

Explain **one** limitation on the number of nodes that can be physically connected to the central node.

(2)

Award up to **two** marks for a linked explanation such as: The number of ports/physical connectors on the central node determines how many nodes can be connected (1), because all nodes are physically connected directly to the central node (1)	For both marks, the expansion must associate with the statement. Do not award responses indicating maximum capacity reached, as that is given in the question stem

(b) Protocols are used on networks.

(i) Describe the function of the internet layer of the four-layer TCP/IP model.

Award up to **two** marks for a linked description such as: • The internet layer adds the source and destination IP addresses to the outgoing packet (1) and passes it down the protocol stack to the next layer (1) • The internet layer removes the source and destination IP addresses from the incoming packet (1) and passes it up the protocol stack to the next layer (1) • The internet layer adds the source and destination addresses to the header of outgoing packets (1) and strips them off incoming packets (1)	For both marks, the expansion must associate with the statement.

(ii) Name the email protocol that is responsible for sending emails to a mail server. **(1)**

Award **one** mark for any of the following: • SMTP (1) • Simple Mail Transfer Protocol (1)

(c) Many factors affect the performance of a network.

(i) Network speeds have units of measure.

Give **one** unit of measure for network speeds. Do not abbreviate.

- Bits per second (1)
- Kilobits per second (1)
- Megabits per second (1)
- Gigabits per second (1)

(1)

(ii) Explain the impact of high latency on people attending an online meeting.

(2)

Award up to **two** marks for a linked explanation such as: • One person's voice may be delayed and other people will start speaking, causing confusion (1) because high latency increases the time between data being transmitted and reaching its destination (1) • People will start to talk over each other (1) because latency causes a delay between sending the packet of audio and it being received (1)	For both marks, the expansion must associate with the statement. Accept 'lag' instead of 'latency'

(d) Software and hardware are used for day-to-day maintenance of devices on a network and for protecting the network from hackers.

(i) Firewalls block packets of data entering or leaving a network.

State **two** specific actions that firewalls block.

(2)

1 .....

2 .....

Award **one** mark for any of the following up to a maximum of **two** marks: • Accessing ports (1) • Using some/specified protocols (1) • Requesting/accepting connections (1) • Blocks users from accessing blacklisted websites (1) • Prevents a blacklisted source from gaining access to the network (1)	For responses indicating malicious access/hacking, their must be an identification method, such as 'black listing'

(ii) Central IT services allow technicians to remotely manage networked computers.

Explain **one** way remote management benefits users of the computers. **(2)**

.....

.....

.....

.....

Question Number	Answer	Additional Guidance	Mark
3d(ii)	Award up to **two** marks for a linked explanation such as: • Users will always have the latest version of applications (1) because software updates/patches are applied remotely (1 • Users' problems can be investigated/diagnosed easily (1) because IT technicians can remotely log in to devices (1) • Users can have access to specialist software applications (1) because they can be remotely installed (1)	For both marks, the expansion must associate with the statement.	**(2)**

(Total for Question 3 = 14 marks)

2 Networks

(a) A hotel chain has hotels in several countries and a head office in England.

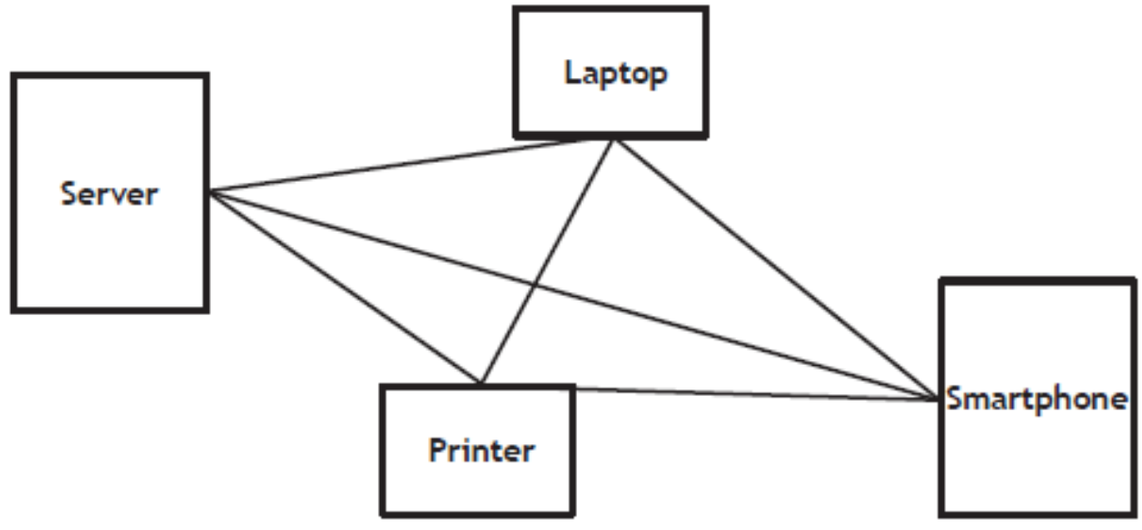
State the type of network needed to connect these hotels to the head office.

(1)

WAN/Wide Area Network

(b) Draw lines between these devices to show a fully-connected mesh network topology diagram:

(2)



- **1** mark for at least two connections to each device.
- **2** marks for three connections to each device.

(c) Routers send packets that contain data around the internet.

State **two other** items found in a packet.

(2)

Any **two** items from:

1 .....

- Destination address (1)
- Source address (1)
- Error checking field / check sum (1)
- Time stamp (1)
- Sequence number (1).

2 .....

Accept any other appropriate response.

(d) The transport layer of network protocols splits data into packets before sending it.
All the packets are received correctly.

Describe the process that ensures the data received matches the original.

(2)

A linked description that makes reference to the following points:

Each packet has a sequence number (added at the sending end) (1)
The packets are put back into (sequence) order (at the destination) (1).

.....

(e) Construct an expression to show how many seconds it will take to transmit 20 MiB of data using a network transmission speed of 2 Mbps.

You do not have to do the calculation.

(4)

$$\frac{20 \times 1024 \times 1024 \times 8}{2 \times 1000000}$$

Total number of bits to transfer:
1 mark for 20×1024^2
1 mark for $\times 8$

Speed in bits per second:
1 mark for 2×1000000

Numerator/denominator:
1 mark for

$$\frac{bits\ to\ transfer}{bits\ per\ second}$$

tal for Question 2 = 11 marks)