3(a)	**One** mark per mark point (**Max 2**) MP1 Protocols set a standard for communication // Protocols establish a standard set of rules for communication MP2 Protocols enable compatibility between devices from different manufacturers/platforms MP3 Two devices wouldn't be able to communicate/send messages to each other if they were using different protocols
3(b)	**One** mark for a protocol and **one** mark for a description (**Max 4**) Example answers: SMTP [1] a protocol used to send emails **between mail servers** // a protocol used to send emails **from a computer to a mail server** [1] IMAP [1] allows users to access/read their emails **from any device without removing** the message from the mail server // **synchronises** emails **on any device** [1]
3(c)	**Two** marks for each description mark as 2 x 2 (**Max 4**) Example answers: Packets checked at receiving end / on arrival [1] … if packets arrive damaged or don't arrive at all, a re-send request is sent [1] Packets routed through different paths / sent individually [1] … if a route is blocked, the packet is sent through a different route to ensure it arrives [1] If the packet's hop count is exceeded [1] … the packet will be retired, which can generate a re-send request [1]

3(a)	**One** mark per mark point (**Max 2**) • HTTP to send and receive / transfer web pages / hypertext / images / videos • IMAP allows users to access/read their emails **from any device without removing** the message from the mail server // **synchronises** emails **on any device**
3(b)	**One** mark per mark point (**Max 4**) MP1 Files are shared over a **peer-to-peer** network MP2 A small file, a torrent (descriptor file), is initially created by a peer MP3 The torrent (descriptor file) contains metadata about the file to be shared MP4 The whole file must initially be located on at least one peer MP5 The file is broken into **equal sized** pieces MP6 Other peers who wish to download the file first obtain the torrent (descriptor file) and connect to a tracker MP7 A tracker acts like a server that holds all the data about all the computers connected to it / the swarm MP8 Each **peer** downloads parts of the file from other **peers** until the entire file has been downloaded MP9 As each peer receives a piece of the file, they become a source for that piece of the file MP10 A peer who has a **complete file** and is sharing it is a seed // Once a peer has **completely downloaded** the file and made the file available to others in the swarm, they become a seed.

4	**One** mark for a correct protocol and **one** mark for a correct corresponding description (**Max 6**) **Three** from: HTTP/S [1] a protocol/secure protocol used to transfer hypermedia documents / web pages / (data) files between networked devices [1] FTP [1] a protocol to download, upload and transfer files from one location to another **on a network** [1] POP3 [1] a protocol used to retrieve/receive emails **from a mail server to a computer** [1] IMAP [1] allows users to access/read their emails **from any device without removing** the message from the mail server // **synchronises** emails **on any device** [1] SMTP [1] a protocol used to send emails **between mail servers** // a protocol used to send emails **from a computer to a mail server** [1] BitTorrent [1] a communication protocol used for peer-to-peer file sharing [1]

3(a)	**One** mark per mark point (**Max 5**) **One** mark per mark point for **purpose** of Application Layer (**Max 3**) MP1 To provide services / interface with the user // access to applications, for example login, file transfer, network file access, email, etc MP2 To provide mechanisms for securing communication e.g. encryption/authentication MP3 To define/provide protocols used to allow the exchange of data/communication // to contain programs that exchange data MP4 Error detection and recovery mechanisms to handle application specific errors **One** mark per mark point for **purpose** of Transport Layer (**Max 3**) MP5 To provide logical communication between applications running on different hosts // To ensure that data is delivered to the correct application process on the destination machine MP6 To ensure error-free, end-to-end delivery of data between a source and a destination, in sequence // to provide error recovery techniques such as error detection codes and automatic repeat request MP7 To break data into segments when sent and to reconstruct when received // To reassemble segments at destination MP8 To regulate network connections // to provide flow control mechanisms to prevent data loss.
3(b)	**One** mark per mark point (**Max 4**) MP1 Data are broken into equal sized packets MP2 Data packets have headers containing information such as the IP addresses of the sender and receiver MP3 Each packet of data is sent independently to the destination // Packets don't necessarily follow the same route MP4 Each packet is sent via the most optimum path available MP5 Packets don't necessarily arrive in the order they were sent // Packets are reconstructed at the destination in the correct order MP6 Missing / damaged packets are re-sent

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4(a)	**One** mark per mark point (**Max 5**) **One** mark per mark point for **purpose** of Internet Layer (**Max 3**) MP1 To identify the intended network and host. MP2 To add header containing IP addresses. // To address packets with their source and destination IP Addresses. MP3 To prepare packets for delivery by formatting them into datagrams. MP4 To route datagrams through the optimum route over a network. **One** mark per mark point for **purpose** of Link Layer (**Max 3**) MP5 To prepare the next hop by managing the link between two directly connected devices. // To identify and move traffic across local segments. MP6 To format datagrams into frames for transmission. MP7 To identify network protocols in the packet header. // To ensure correct network protocols are/is followed. MP8 To deliver frames to the receiving network. // To receive frames from the sending network. // To map IP addresses to MAC physical addresses. MP9 To provide error checking/error correction/recovery/reconstruction MP10 including resend requests.
4(b)	**One** mark for each correct marking point **(Max 4**) MP1 The router reads the IP address of the destination from the packet header. MP2 A router uses a routing table to find information … MP3 … about e.g., available hops / netmask / gateway used / adjacent routers / the status of the routers along the route. MP4 The router determines the next hop / optimum route. // The router sends the packet on its next hop. MP5 The router manages the hop counter // The hop counter is reduced by 1 every time the packet passes a router.

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4	**One** mark per mark point (**Max 4**) MP1 Each layer can only accept input from the next higher layer or the next lower layer MP2 There is an interface between the adjacent layers which is the only interaction between layers MP3 Data is added to the headers as the frames/packets pass through the layers MP4 The interactions are carried out by installed software MP5 User interaction takes place at the highest/Application layer of the stack through protocols associated with that layer of the stack MP6 Direct access to hardware takes place at the lowest/Link layer of the stack.

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5(a)	**One** mark for each correct name (**Max 2**) **One** mark for each correct corresponding expansion (**Max 2**) MP1 HTTP/HTTPS MP2 For sending and receiving / transferring web pages / hypertext MP3 FTP MP4 For sending and receiving files over a network / between devices MP5 POP3 MP6 Pull protocol / for receiving / downloading emails MP7 IMAP MP8 Pull protocol / for receiving / downloading emails MP9 SMTP MP10 Push protocol / for sending / uploading emails MP11 BitTorrent MP12 Peer-to-peer file sharing over a network
5(b)	**One** mark per mark point (**Max 3**) MP1 The application layer provides access to all the programs that exchange data // Interacts directly with user. MP2 … used by, for example, web browsers, server software. MP3 Communicates/enables data transfer to/from Transport layer // It allows applications to access the services used in other TCP/IP layers. MP4 It defines the protocols that any application uses to allow the exchange of data.