

14.1 Protocols

Name: _____ Class: _____ Date: _____ **Total: 34 marks**

KEY WORDS protocol 协议 • application layer 应用层 • http 超文本传输协议
• transport layer 传输层 • smtp 简单邮件传输协议

Objective

Build the skills to answer exam questions on **protocols** 协议 — why they are needed, the TCP/IP layered model, and the common application protocols.

You must be able to:

- explain why a **protocol** is essential, and the benefit of a **layered** model
- describe the four layers of the **TCP/IP** suite
- state the purpose of **HTTP**, **FTP**, **SMTP**, **POP3**, **IMAP**, **BitTorrent** and compare **TCP/UDP**

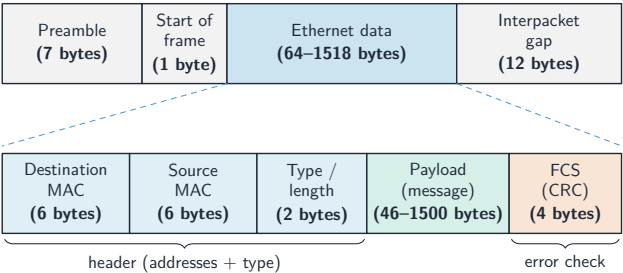
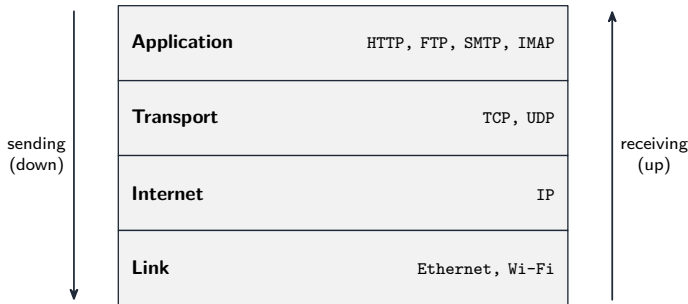
1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Why protocols, and layers

A **protocol** is an agreed **set of rules** for communication — the data **format**, the **order** of messages, their **meaning**, **timing** and **error handling**. Both ends must follow the same rules or the bytes are meaningless.

Networking is split into **layers**, each with one job, talking only to the layers above and below. Benefits: **modularity** (swap one layer without touching the others), **standardisation**, and **abstraction**.



An Ethernet frame carries the protocol data

Each layer has one job:

- **Application** — provides network services to programs (HTTP for the web, SMTP for email).
 - **Transport** — splits the data into **packets** and provides reliable, in-order delivery (TCP) or fast send-and-forget (UDP); adds **port numbers**.
 - **Internet** — adds **IP addresses** and **routes** the packets across networks.
 - **Link** — sends the bits over the physical connection (Ethernet, Wi-Fi) using **MAC addresses**.
- **TCP vs UDP (transport layer)**
- **TCP** — **connection-oriented**: reliable, in-order delivery, retransmits lost packets (HTTP, email). Higher overhead.
 - **UDP** — **connectionless**: send-and-forget, no ordering or acknowledgements (streaming, gaming, DNS). Low overhead.

■ Application protocols

Protocol	Purpose
HTTP	fetch web pages
FTP	transfer files
SMTP	send email
POP3 / IMAP	retrieve email (IMAP keeps it on the server)
BitTorrent	peer-to-peer file sharing

2 Practice

Now apply the methods above.

2.1 State what a **protocol** is. [1]

2.2 State **one** benefit of using a **layered** model for networking. [1]

2.3 Name the **four** layers of the TCP/IP suite, **from top to bottom**. [2]

2.4 State which protocol is used to **send** an email. [1]

3 Exam-style questions

3.1 State **two** differences between **TCP** and **UDP**. [2]

3.2 State the purpose of each protocol: **HTTP**, **FTP**, **SMTP**. [3]

3.3 Explain why a protocol is **essential** for communication between two computers. [2]

3.4 State **one** difference between **POP3** and **IMAP**. [2]

3.5 Describe the purpose of the **Application layer** and the **Transport layer** of the TCP/IP suite. [4]

3.6 A company's staff use email and a web application over the internet.

(a) **Explain** why protocols are essential for communication between computer systems.[3]

(b) **Complete** the table by naming the protocol used for each task.

[4]

task	protocol
retrieving email, deleting it from the server	_____
sending email to a mail server	_____
transferring a large file to a server	_____
requesting a web page securely	_____

(c) **Describe** two ways in which **packet switching** ensures a complete message arrives correctly, even though the packets may travel by different routes.

[4]

(d) **State** the layer of the TCP/IP model at which each of the following operates: an IP address, a port number, and HTTP.

[3]

(e) **Explain** why the layered model makes it easier to introduce a new application protocol.

[2]

Solutions

Each answer shows the steps, then the **result**.

2.1

- an agreed **set of rules** governing how devices communicate (format, order, meaning, timing, errors)

2.2

- any one: **modularity** (change one layer without the others); standardisation/interoperability; abstraction (hide details)

2.3

- **Application** → **Transport** → **Internet** → **Link**

2.4

- **SMTP**

3.1

- any two: TCP is **connection-oriented**, UDP **connectionless**; TCP **guarantees delivery and order**, UDP does not; TCP **retransmits** lost packets, UDP does not; TCP has higher overhead

3.2

- **HTTP** — request/transfer **web pages**
- **FTP** — transfer **files**
- **SMTP** — **send** email

3.3

- without an agreed protocol the two computers have no shared rules for **format/order/meaning**
- so each side cannot interpret the other's data and communication **fails**

3.4

- **POP3** usually **downloads and removes** mail from the server
- **IMAP keeps** mail on the server and syncs across devices

3.5

- **application layer** — provides network services to the user's programs (e.g. HTTP, SMTP) and formats the data
- **transport layer** — splits the data into packets and provides reliable, in-order delivery (TCP) using port numbers

3.6

- (a) a protocol is an agreed **set of rules** for the exchange

- covering the format of the data, the order of the messages, the speed, and how errors are handled
- without agreement on all of that, two systems from different manufacturers could not interpret each other's bits at all

(b) retrieving and deleting email — **POP3**

- sending email — **SMTP**
- transferring a large file — **FTP**
- a secure web page — **HTTPS**

(c) any two, developed: each packet carries a **sequence number**, so the receiver can reassemble them in the right order however they arrive

- each packet carries a **checksum or error check**, and a packet that fails it is **re-requested** from the sender

(d) an IP address — the **internet (network)** layer

- a port number — the **transport** layer
- HTTP — the **application** layer

(e) each layer only has to work with the layer directly above and below it through a defined interface

- so a new application protocol can be added at the top without changing the transport, internet or link layers, or any of the hardware