

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**

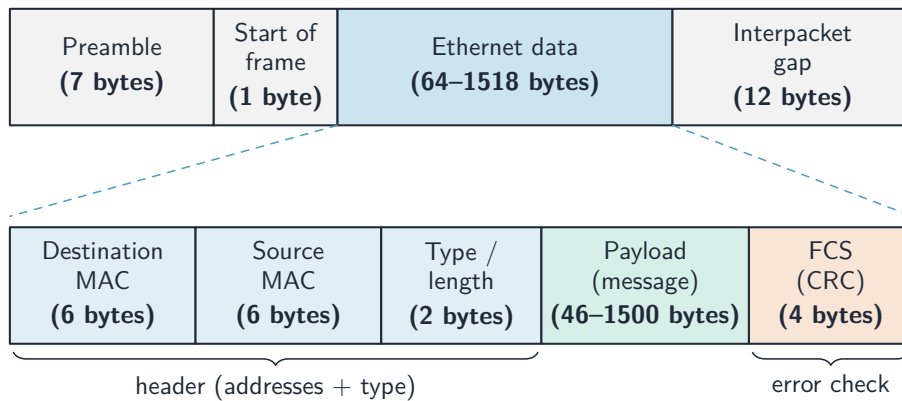
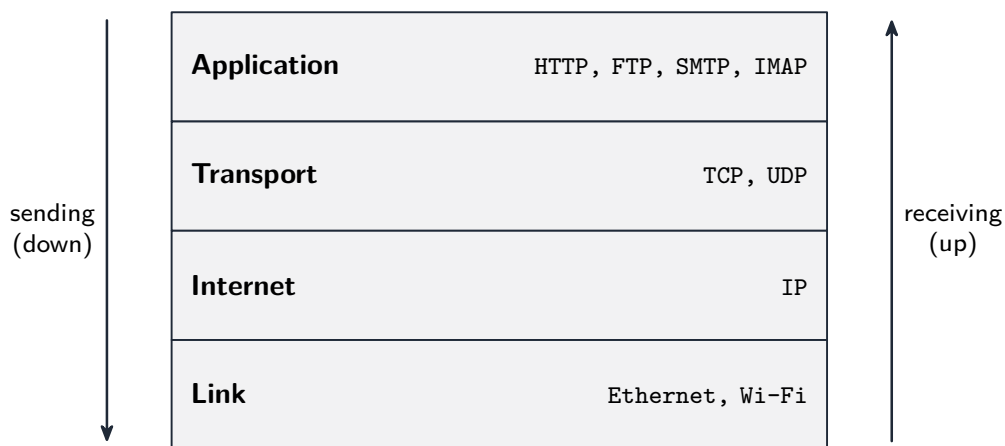
1 Worked examples

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

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. Also acceptable: the receiver sends acknowledgements and the sender retransmits anything unacknowledged within a timeout.

(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.