A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

9.1 Computational Thinking Skills

Name: _____ Class: _____ Date: _____ **Total: 31 marks**

KEY WORDS decomposition 分解 • abstraction 抽象 • computational thinking 计算思维 • pattern recognition 模式识别 • loop 循环

Objective

Build the skills to answer exam questions on **computational thinking** 计算思维 — the two key skills of abstraction and decomposition.

You must be able to:

- explain and use **abstraction** 抽象
- explain and use **decomposition** 分解

1 Worked examples

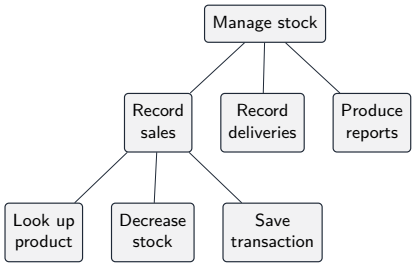
Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

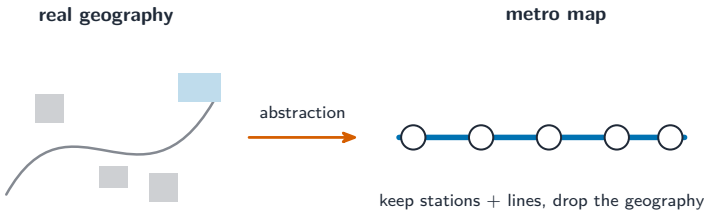
Abstraction

Abstraction means keeping the **essential** features of a problem and **ignoring irrelevant detail**, to give a simpler model. Examples: a train-line map keeps the stations and lines but drops the real geography; a function hides a job behind a name; a class keeps only the attributes the system needs. Without abstraction, a full model of a real problem would be too big to reason about.

Decomposition

Decomposition means breaking a large problem into smaller **sub-problems**, each easier to solve and combined at the end:





Abstraction hides detail to manage complexity

It makes a big task manageable, lets a **team** divide the work, and produces **modular** code that is easier to test and maintain.

Pattern recognition

Pattern recognition 模式识别 means spotting where parts of a problem are the **same or similar**, so one solution can handle them all — for example, noticing that several jobs repeat lets you use a **loop** or reuse one **module** instead of writing the same code many times.

In the exam you may be asked to **identify which skill** a designer used: keeping only the needed detail → **abstraction**; splitting the problem into parts → **decomposition**; spotting repetition → **pattern recognition**.

2 Practice

Now apply the methods above.

2.1 State what **abstraction** means. [1]

2.2 State what **decomposition** means. [1]

2.3 Give one benefit of decomposing a problem. [1]

2.4 Give one everyday example of abstraction. [1]

3 Exam-style questions

3.1 Explain what is meant by **abstraction**, giving an example. [3]

3.2 A team must build a system to run a school library (lending and returning books, managing members, fines). Use **decomposition** to break this into **three** sub-tasks. [3]

3.3 Explain **two** benefits of decomposing a large program into modules. [2]

3.4 For each, state the computational thinking skill used: **(a)** a designer keeps only the data the system needs and ignores the rest; **(b)** a designer notices the same calculation is needed in five places and writes it once as a function. [2]

3.5 A shop's stock-control program is designed using **decomposition**. One module, `Sales()`, records a sale and updates the stock level.

(a) **Explain** what is meant by decomposition, and **give** two benefits of designing this program that way. [4]

(b) **Complete** the identifier table for `Sales()`. [4]

identifier	data type	description
`ItemCode`		
`QuantitySold`		
`UnitPrice`		
`InStock`		

(c) **State** the purpose of an identifier table at the **design** stage, and **explain** why it is written before any code. [3]

(d) The shop manager also wants a weekly report of items that fell below their reorder level. **Outline**, using **stepwise refinement**, the steps of a module `LowStockReport()`. Do **not** write pseudocode. [4]

(e) **Explain** why `Sales()` and `LowStockReport()` should be separate modules rather than one long block of code. [2]

Solutions

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

2.1

- keeping the **essential features** of a problem and **ignoring irrelevant detail** (a simpler model)

2.2

- breaking a large problem into smaller, easier **sub-problems**

2.3

- any one: makes the problem manageable; lets a team share the work; gives modular, reusable, easier-to-test code

2.4

- any one: a map; a function/method; a model/diagram that drops detail

3.1

- abstraction keeps the **essential** features and removes irrelevant detail
- that gives a simpler model that is easier to work with
- example: a metro map shows lines and stops but not real distances

3.2

- any three sensible sub-tasks, e.g. lend/return books; manage member records; calculate and record fines; search the catalogue

3.3

- any two: smaller parts are easier to solve/test; a team can work in parallel; modules can be reused; maintenance is easier

3.4

(a) **abstraction**

(b) **pattern recognition**

3.5

(a) decomposition means breaking a problem into smaller sub-problems, each solved by its own module

- benefits, any two: each module can be written and tested independently, so faults are easier to find; modules can be reused elsewhere, and several people can work on different modules at once

(b) `ItemCode` — `STRING`, the unique code identifying the product

- `QuantitySold` — `INTEGER`, the number of units in this sale
- `UnitPrice` — `REAL` (or `CURRENCY`), the price of one unit

- `InStock` — `INTEGER`, the number of units remaining after the sale

(c) it lists every variable, its data type and what it is for

- so the programmer knows exactly what to declare and nobody invents a second name for the same thing
- writing it first forces the data to be thought through before the logic, which is where most design faults are cheapest to fix

(d) any sensible four steps, in order: read the reorder level and the stock level for each item in turn

- compare the two and select the items whose stock is below the level
- accumulate or format those items into a report, including code, description and quantity remaining
- output the report and record the date it was produced

(e) each does a **different job**, so keeping them separate means one can be changed or tested without disturbing the other

- it also allows the low-stock check to be called from more than one place, such as at the end of a sale and again weekly