A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

12.3 Program Testing and Maintenance

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

KEY WORDS logic error 逻辑错误 • syntax error 语法错误 • test plan 测试计划 • dry run 手工跟踪 • regression testing 回归测试

Objective

Build the skills to answer exam questions on **testing and maintenance** — error types, test data, testing methods and maintenance types.

You must be able to:

- identify **syntax**, **run-time** and **logic** errors
- choose **normal**, **boundary** and **abnormal** test data
- describe testing methods and the three types of **maintenance**

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.

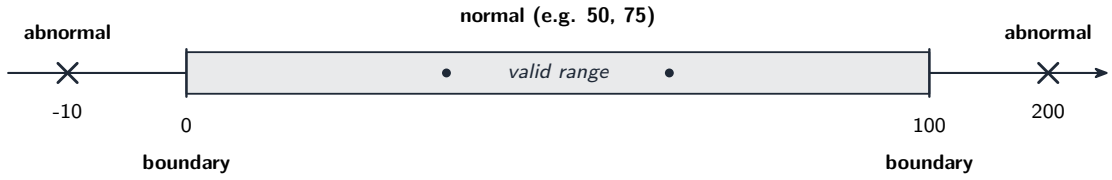
■ Types of error

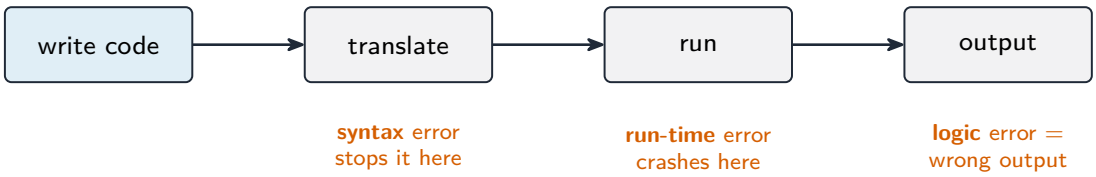
Error	When	Example
syntax	at translation — won't run	missing `ENDIF`, misspelt keyword
run-time	while running — crashes	divide by zero, array index too big
logic	runs but **wrong output**	`+` used for `-`, off-by-one loop

Logic errors are hardest — the only sign is a wrong result, so **trace** and **test** carefully.

■ Choosing test data

For a field that accepts **0 to 100**, test three kinds:





The error types that testing aims to catch

- **normal** — typical valid values the program should accept (`50`, `75`)
- **extreme** — the **largest and smallest valid** values (`0` and `100`)
- **boundary** — a pair *either side* of a limit, where off-by-one bugs hide (`100` accepted, `101` rejected)
- **abnormal** (erroneous) — values that must be **rejected** (`-10`, `200`, `"abc"`)

Methods and maintenance

- **dry run** — trace on paper in a **trace table**; **white-box** tests every path from the code; **black-box** tests inputs→outputs from the spec; **alpha** (in-house) then **beta** (real users); **acceptance** (the customer decides).
- Maintenance: **corrective** (fix bugs), **adaptive** (cope with a changed environment), **perfective** (improve features/speed).

2 Practice

Now apply the methods above.

2.1 State the difference between a **syntax error** and a **logic error**. [2]

2.2 Give **one** example of a **run-time** error. [1]

2.3 A field accepts an age from **1 to 120**. Give one **normal**, one **boundary** and one **abnormal** value. [3]

2.4 State what a **dry run** is. [1]

3 Exam-style questions

3.1 Identify the **type of error** in each case. [3]

(a) the program will not translate because an `ENDWHILE` is missing (b) the program stops with an error when it divides by zero (c) the program runs but the calculated average is always wrong

3.2 A field accepts a percentage **0–100**. Complete the test plan with suitable **test data** and a **reason** for each row. [4]

Type	Test data	Reason
normal		
boundary (low)		
boundary (high)		
abnormal		

3.3 State and describe the **three** types of maintenance. [3]

3.4 State what **regression testing** checks. [1]

3.5 A program calculates the average mark of a class. It translates without error, but for one class it outputs an average of `0`.

(a) **Identify** the type of error this is, and **explain** how you decided. [2]

(b) **Describe** two ways of **exposing** a fault like this before the program is released. [4]

(c) **Describe** two programming practices that help **avoid** faults of this kind in the first place. [4]

(d) The program is later required to report the **highest** mark as well as the average. **Outline** the amendments you would make, and **state** what you would do afterwards to be sure the average still works. [4]

(e) **Explain** why this later change counts as **perfective** maintenance rather than corrective or adaptive. [2]

Solutions

2.1 A **syntax error** breaks the language's grammar and is caught at **translation** (the program won't run); a **logic error** lets the program run but produces the **wrong output**.

2.2 Any one: divide by zero; array index out of range; file not found; invalid type conversion.

2.3 Any valid set, e.g. normal `40`; boundary `1` or `120`; abnormal `0`, `121` or `"abc"`.

2.4 Tracing the code **by hand on paper**, recording each variable's value (usually in a trace table).

3.1 (a) **syntax** error; (b) **run-time** error; (c) **logic** error.

3.2 Any valid plan, e.g.: normal `50` (inside the range); boundary (low) `0` (lowest accepted); boundary (high) `100` (highest accepted); abnormal `150` or `-5` (outside — must be rejected).

3.3 Corrective — fixing bugs found in use; **adaptive** — changing it to keep working in a new environment (new OS, law); **perfective** — improving features or performance.

3.4 That a **change has not broken** existing, previously-working features.

3.5 (a) A **logic error** — the program translates and runs to completion, so the syntax is valid and nothing crashes, but the output is wrong.
(b) Any two, developed: **dry run / trace table** — work through the code by hand with sample values, recording each variable, which exposes a division by the wrong count. **White-box testing with a debugger** — set a breakpoint and step through, watching the running total and the counter. Also acceptable: a walkthrough with a colleague; black-box testing with normal, boundary, abnormal and extreme data.
(c) Any two, developed: **modular design** — split the calculation into a small function that can be tested on its own. **Meaningful identifiers and comments**, so `Total / Count` is obviously wrong when `Count` is zero. Also acceptable: validating input before use; initialising every variable explicitly; defensive checks such as testing for a zero divisor.
(d) Add a variable to hold the maximum, initialised to the **first mark** rather than zero; inside the existing loop compare each mark and update it when the mark is larger; extend the output statement. Then **re-run the existing tests** for the average — regression testing — to confirm the change has not broken what already worked.
(e) It adds new **functionality** that the user has asked for, rather than fixing a fault (which would be corrective) or responding to a change in hardware or operating system (adaptive).