

5.2 Flowcharts, tracing and test data

Name: _____ Class: _____ Date: _____ Total: 23 marks

KEY WORDS flowchart • sequence • selection • iteration
• trace table • pseudocode • boundary

Objective

Build the skills to answer exam questions on **flowcharts, tracing and testing** – flowchart symbols, sequence, selection and iteration, trace tables and test data.

You must be able to:

- name and use the standard **flowchart** symbols
- identify **sequence**, **selection** and **iteration** in an algorithm
- complete a **trace table** for a flowchart or **pseudocode**
- choose normal, **boundary** and invalid test data from a specification

1 Key knowledge and worked examples

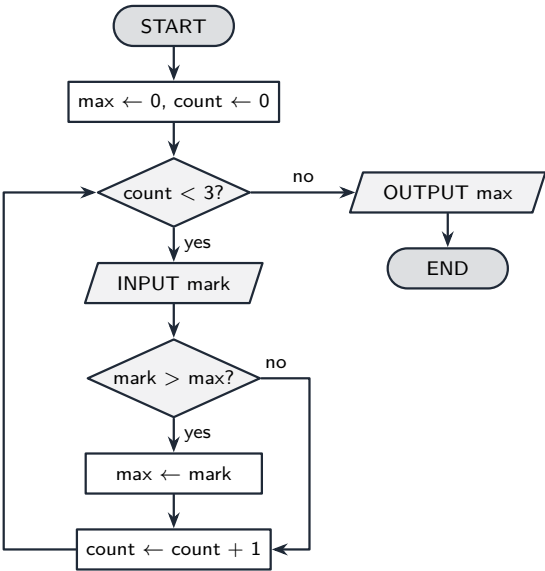
Study these first. Each one shows the method for a question type used later.

■ Key knowledge: flowchart symbols

Symbol	Use
rounded rectangle	START, END
parallelogram	INPUT, OUTPUT
rectangle	process: $total \leftarrow total + x$
diamond	decision with yes and no exits

$x \leftarrow 5$ is assignment: store 5 in x.

■ Worked example: tracing a flowchart



Inputs 62, 85, 71.

count	mark	mark > max?	max	Output
0			0	
0	62	yes	62	
1	85	yes	85	
2	71	no	85	
3				85

1. The diamond **count < 3?** with the arrow back is **iteration**; **mark > max?** is **selection**.
2. Output **85**. With inputs -5, -8, -2 it outputs 0, which is wrong: **max** should start at the first mark.

■ Worked example: test data

A quiz accepts a score from 0 to 50.

Type	Values	Expected
normal	23, 41	accepted
boundary	0, 50	accepted
boundary (just outside)	-1, 51	rejected
invalid	-30, 200, “abc”	rejected

2 Practice

2.1 Name the flowchart symbol for: (i) OUTPUT total; (ii) IF age $\geq$ 18; (iii) count $\leftarrow$ count + 1. [3]

2.2 Trace the flowchart above for the inputs 30, 75, 75, and state the output. [3]

2.3 A password must be 8 to 16 characters long. Give **one** normal, **two** boundary and **one** invalid length. [2]

3 Exam-style questions

3.1 Which construct does a diamond whose “yes” arrow loops back to an earlier step show? [1]

☐

- A sequence
- B selection only
- C iteration
- D abstraction

3.2 What is the output of this pseudocode? [1]

```
x ← 1
loop while x < 30
    x ← x * 2
end loop
output x
```

☐

- A 16
- B 30
- C 32
- D 64

3.3 Which value is boundary data for an age from 11 to 18 inclusive? [1]

☐

- A 14
- B 18
- C 25
- D “eleven”

3.4 An algorithm counts how many of the numbers entered are even. It stops when -1 is entered.

```
count ← 0
input N
loop while N  $\neq$  -1
    if N mod 2 = 0 then
        count ← count + 1
    end if
    input N
end loop
output count
```

(a) Complete a trace table for the inputs 4, 7, 10, 0, -1, with columns N, $N \bmod 2 = 0$? and count. State the output. [4]

(b) Identify **one** example of selection and **one** of iteration in the algorithm. [2]

(c) Draw a flowchart for the algorithm. [4]



(d) State the output if the first number entered is -1, and whether this is correct. [2]

Solutions

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

2.1

- (i) **parallelogram**
- (ii) **diamond**
- (iii) **rectangle**

2.2

- $30 > 0$: **max** 30
- $75 > 30$: **max** 75; the second 75 is not greater, so **max** stays 75
- output **75**

2.3

- normal: e.g. 12
- boundary: 8 and 16 (or 7 and 17 just outside); invalid: e.g. 3 or 40

3.1 C

- a loop back is iteration

3.2 C

- 1, 2, 4, 8, 16, 32: the loop stops at 32

3.3 B

- 18 is the top edge of the range

3.4

(a)

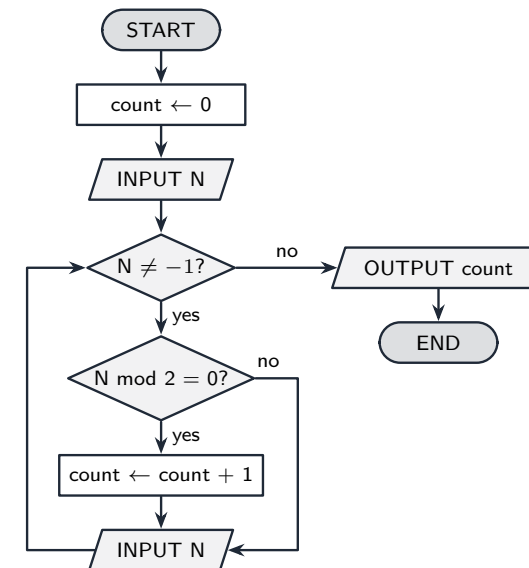
N	N mod 2 = 0?	count
		0
4	yes	1
7	no	1
10	yes	2
0	yes	3
-1		

- 4 and 7 correct
- 10 and 0 correct: 0 is even
- loop ends at -1 without testing it
- output **3**

(b)

- selection: if $N \bmod 2 = 0$
- iteration: loop while $N \neq -1$

(c)



- START, $\text{count} \leftarrow 0$ and INPUT N in sequence
- decision $N \neq -1?$, with no leading to OUTPUT count and END
- decision $N \bmod 2 = 0?$, yes leading to $\text{count} \leftarrow \text{count} + 1$
- INPUT N then an arrow back to the first decision

(d)

- the loop never runs: output **0**
- correct: no numbers were entered, so none are even