11.2 Constructs

Name: _____ Class: _____ Date: _____ **Total: 43 marks**

KEY WORDS selection • nested • logic error • pseudocode • condition

Objective

Learn to write **selection** with the `IF` statement: `IF … THEN … ENDIF`, the `ELSE` clause, and one `IF` inside another (a **nested** `IF`). This is the first sheet of 11.2. Sheet 11.2.1 adds the `CASE` structure, and sheets 11.2.2 to 11.2.4 deal with loops and trace tables. The conditions themselves (`AND`, `OR`, ranges) were on sheet 9.2.1.

You must be able to:

- write an `IF` statement with and without an `ELSE` clause
- write nested `IF` statements to choose between three or more paths
- put the tests of a nested `IF` in the correct order
- follow an `IF` statement for given values, and find errors in one

1 Worked examples

Study these first. Each one shows a **method** that a question later on this sheet needs.

■ IF … THEN … ENDIF

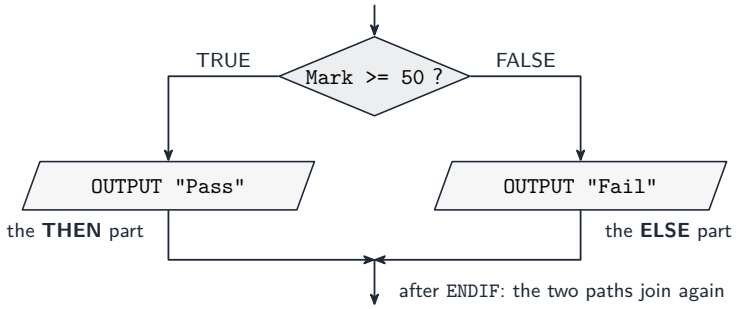
Use it when something is done **only if** a condition is TRUE. If the condition is FALSE, nothing happens.

```
IF Temperature < 0 THEN
    OUTPUT "Ice warning"
ENDIF
```

- The condition is a logic statement: it must be TRUE or FALSE.
- The statements between `THEN` and `ENDIF` are **indented**, and every `IF` needs its own **`ENDIF`**.

■ IF … THEN … ELSE … ENDIF

Use it to choose between **two** paths. Exactly one of them runs.




```
IF Mark >= 50 THEN
    OUTPUT "Pass"
ELSE
    OUTPUT "Fail"
ENDIF
```

Following an `IF`: work out the condition with the given values. TRUE → run only the `THEN` part. FALSE → run only the `ELSE` part. Then carry on after `ENDIF`.

■ Nested IF: three or more paths

An `IF` inside the `ELSE` part of another `IF` gives a third path.

Worked example: a mark of 70 or more gets a Merit, a mark of 50 or more gets a Pass, and any other mark gets a Fail.

```
IF Mark >= 70 THEN
    OUTPUT "Merit"
ELSE
    IF Mark >= 50 THEN
        OUTPUT "Pass"
    ELSE
        OUTPUT "Fail"
    ENDIF
ENDIF
```

- The inner `IF` is reached only when `Mark >= 70` is FALSE. So at that point the mark is already known to be below 70, and `Mark >= 50` alone is enough. There is no need to write `Mark >= 50 AND Mark < 70`.
- Count the keywords: two `IF`s need two `ENDIF`s. The indentation shows which `ENDIF` belongs to which `IF`.

The order of the tests matters

The **first** condition that is TRUE wins, and the other tests are never reached. Test the **most demanding** condition first.

Wrong order:

```
IF Mark >= 50 THEN
    OUTPUT "Pass"
ELSE
    IF Mark >= 70 THEN
        OUTPUT "Merit"
    ENDIF
ENDIF
```

For a mark of 85, `Mark >= 50` is TRUE, so the output is `"Pass"`: the test `Mark >= 70` is never reached. This is a **logic error** : the program runs, but the result is wrong.

Common errors

error	example	correction
← used to compare	`IF Age ← 18 THEN`	`IF Age = 18 THEN`
no `ENDIF`	an `IF` left open	one `ENDIF` for each `IF`
a range as in mathematics	`IF 1 <= X <= 10 THEN`	`IF X >= 1 AND X <= 10 THEN`
an `ELSE` with a condition	`ELSE Mark < 50`	`ELSE`, then a nested `IF`

Past-paper practice: complete sheets 9.2.1, 11.2 and 11.2.1 before attempting past-paper set 11.2.1.

2 Practice

Now use the methods above. The first questions need one idea each.

2.1 Study this pseudocode.

```
IF Speed > 60 THEN
    OUTPUT "Too fast"
ELSE
    OUTPUT "OK"
ENDIF
OUTPUT "Checked"
```

60

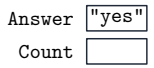
State everything that is output when:

(a) `Speed` is 75 [1]

(b) `Speed` is 60 [1]

2.2 Write an `IF…ELSE` that outputs `"Pass"` when `Mark >= 50`, otherwise `"Fail"`. [2]

2.3 Write an `IF` statement that adds 1 to `Count` when `Answer` is equal to `"yes"`. There is no `ELSE` clause. [2]



2.4 Each `IF` statement contains **one** error. State the error and write the correct first line. [4]

(a) `IF Age ← 16 THEN`

(b) `IF 0 <= Mark <= 100 THEN`

2.5 Study this pseudocode.

```
IF Age < 5 THEN
    Price ← 0
ELSE
    IF Age < 16 THEN
        Price ← 6
    ELSE
        Price ← 10
    ENDIF
ENDIF
```

ticket

State the value of `Price` when:

(a) `Age` is 3 [1]

(b) `Age` is 15 [1]

(c) `Age` is 16 [1]

2.6 A student writes the pseudocode in 2.5 again, but leaves out the last `ENDIF`. State why this is an error. [1]

3 Exam-style questions

3.1 A shop gives a discount that depends on the total of an order:

- a total of 200 or more: a discount of 20%
- a total of 100 or more, but less than 200: a discount of 10%
- any other total: no discount.

Write pseudocode that inputs `Total`, and outputs the amount to pay after the discount. Use nested `IF` statements, and declare your variables. [6]

total

%

3.2 A student writes this pseudocode to output a message about the temperature of a room.

```
IF Temp > 18 THEN
    OUTPUT "Comfortable"
ELSE
    IF Temp > 28 THEN
        OUTPUT "Too hot"
    ELSE
        OUTPUT "Too cold"
    ENDIF
ENDIF
```

(a) State what is output when `Temp` is 30. [1]

(b) Explain why `"Too hot"` can never be output. [2]

(c) Rewrite the pseudocode so that it works correctly. A temperature above 28 is too hot, and a temperature of 18 or below is too cold. [3]

3.3 A program inputs three different integers `A`, `B` and `C`, and outputs the largest of them.

Write pseudocode for the program. Declare your variables. [5]

3.4 A game stores a player's progress in three integer variables `Rank`, `Level` and `XP` (experience points). For example, a player at rank 2 and level 9 with 98 experience points has `Rank` = 2, `Level` = 9 and `XP` = 98.

(a) Write pseudocode that adds **one** experience point. `XP` goes back to 0 when it reaches 100, and `Level` then goes up by 1. `Level` goes back to 0 when it reaches 10, and `Rank` then goes up by 1. `Rank` is never more than 5: when it reaches 6, it is set back to 5. [6]

(b) Complete the table to show the values after your pseudocode has run **three** times, one after the other. [3]

run	Rank	Level	XP
start	2	9	98
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____

(c) A student does not nest the `IF` statements. After adding 1 to `XP`, the student writes three separate `IF` statements in this order: the test of `Rank`, then the test of `Level`, then the test of `XP`. The player is at rank 2 and level 9, with 99 experience points. **State** the values that the student's pseudocode gives, and **explain** the error. [3]

Solutions

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

2.1

(a) `75 > 60` is TRUE, so the `THEN` part runs, and the last `OUTPUT` always runs: **"Too fast"** then **"Checked"**

(b) `60 > 60` is FALSE, so the `ELSE` part runs: **"OK"** then **"Checked"**

2.2

- `IF … ELSE … ENDIF` with the pass/fail condition

```
IF Mark >= 50 THEN
    OUTPUT "Pass"
ELSE
    OUTPUT "Fail"
ENDIF
```

2.3

- `IF Answer = "yes" THEN` with a matching `ENDIF`
- `Count ← Count + 1` inside it

```
IF Answer = "yes" THEN
    Count ← Count + 1
ENDIF
```

2.4

(a) `←` is the assignment arrow; a comparison uses `=`

- `IF Age = 16 THEN`

(b) a range needs two complete comparisons that are joined with `AND`

- `IF Mark >= 0 AND Mark <= 100 THEN`

2.5

(a) `3 < 5` is TRUE → **0**

(b) `15 < 5` is FALSE, then `15 < 16` is TRUE → **6**

(c) both tests are FALSE → **10**

2.6

- every `IF` must be closed by its own `ENDIF`; there are two `IF`s, so two `ENDIF`s are needed, and without the last one the outer `IF` is never closed

3.1

- the variables declared, and `INPUT Total`
- the first test is the most demanding one: `Total >= 200`
- a nested `IF` in the `ELSE` part that tests `Total >= 100`
- the correct discount in each of the three paths
- both `IF`s closed with `ENDIF`
- the amount to pay worked out and output

```
DECLARE Total : REAL
DECLARE Discount : REAL
INPUT Total
IF Total >= 200 THEN
    Discount ← 0.2
ELSE
    IF Total >= 100 THEN
        Discount ← 0.1
    ELSE
        Discount ← 0
    ENDIF
ENDIF
OUTPUT Total - Total * Discount
```

3.2

(a) `30 > 18` is TRUE, so the output is **"Comfortable"**

(b) the test `Temp > 28` is only reached when `Temp > 18` is FALSE

- a temperature that is not above 18 can never be above 28, so the inner condition is always FALSE

(c) the most demanding test, `Temp > 28`, comes first

- the nested `IF` then tests `Temp > 18`
- the three outputs are in the correct paths

```
IF Temp > 28 THEN
    OUTPUT "Too hot"
ELSE
    IF Temp > 18 THEN
        OUTPUT "Comfortable"
    ELSE
        OUTPUT "Too cold"
    ENDIF
ENDIF
```

3.3

- the variables declared, and the three inputs
- a first test that compares `A` with **both** other values
- a nested `IF` that compares `B` with `C`
- the correct output in each of the three paths
- both `IF`s closed with `ENDIF`

```
DECLARE A, B, C : INTEGER
INPUT A
INPUT B
INPUT C
IF A > B AND A > C THEN
    OUTPUT A
ELSE
    IF B > C THEN
        OUTPUT B
    ELSE
        OUTPUT C
    ENDIF
ENDIF
```

3.4

(a) 1 is added to `XP`

- `IF XP = 100` sets `XP` back to 0 and adds 1 to `Level`
- **inside** that `IF`, `IF Level = 10` sets `Level` back to 0 and adds 1 to `Rank`
- **inside** that `IF`, `IF Rank = 6` sets `Rank` back to 5
- the three `IF`s are nested correctly
- every `IF` is closed with `ENDIF`

```
XP ← XP + 1
IF XP = 100 THEN
    XP ← 0
    Level ← Level + 1
    IF Level = 10 THEN
        Level ← 0
        Rank ← Rank + 1
        IF Rank = 6 THEN
            Rank ← 5
        ENDIF
    ENDIF
ENDIF
```

(b) one mark for each correct row:

run	Rank	Level	XP
start	2	9	98
1	2	9	99
2	3	0	0
3	3	0	1

(c) `XP` becomes 100; the tests of `Rank` (2) and of `Level` (9) are both FALSE; the test of `XP` then sets `XP` to 0 and `Level` to 10: the result is rank 2, **level 10**, 0 points, and level 10 should not exist

- a variable must be tested **after** the statement that can change it; `Level` is changed by the `IF` for `XP`, so the test of `Level` must come after that change
- nesting puts each test exactly there: the test of `Level` inside the `IF` for `XP`, and the test of `Rank` inside the `IF` for `Level`