A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

11.1.2 Built-in functions and library routines

Name: _____ Class: _____ Date: _____ **Total: 48 marks**

KEY WORDS built-in functions 内置函数 • library routines 库例程 • parameters 参数 • concatenates 拼接 • program library 程序库

Objective

Learn to use the **built-in functions** 内置函数 and **library routines** 库例程 of pseudocode: the string functions, the conversion functions and the numeric functions that the Paper 2 **insert** 附页 gives you. This is the last sheet of 11.1. You need the variables of sheet 11.1 and the operators of sheet 11.1.1.

You must be able to:

- use the string functions `LENGTH`, `LEFT`, `RIGHT`, `MID`, `TO_UPPER` and `TO_LOWER`
- join strings with `&`, and convert between numbers and strings with `NUM_TO_STR` and `STR_TO_NUM`
- use `ASC`, `CHR`, `INT` and `RAND`
- work out an expression in which one function is inside another
- state the benefits of using a program library

1 Worked examples

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

■ What a function is

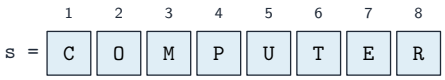
A **function** takes values (its **parameters** 参数), does a job, and **returns** a result. The result **replaces** the call:

`Size ← LENGTH("Computer")` stores 8 in `Size`.

The exam gives this list on the insert: do not learn it by heart, but use the **exact names** and the **correct order** of the parameters.

■ The string functions

- Positions are counted from **1**, and a space counts as a character: `LENGTH("Happy Days")` is 10.
- `TO_UPPER` and `TO_LOWER` take a `CHAR` or a `STRING`. The Pseudocode Guide also has `UCASE` and `LCASE`, which take **one `CHAR` only**.




```
LENGTH(s) = 8              RIGHT(s, 2) = "ER"
LEFT(s, 3) = "COM"         TO_UPPER(s) = "COMPUTER"
MID(s, 4, 3) = "PUT"       TO_LOWER(s) = "computer"
```

function	returns	example
`LENGTH(s)`	the number of characters in `s`	`LENGTH("Computer")` is 8
`LEFT(s, n)`	the first `n` characters	`LEFT("Computer", 3)` is `"Com"`
`RIGHT(s, n)`	the last `n` characters	`RIGHT("Computer", 2)` is `"er"`
`MID(s, start, n)`	`n` characters, beginning at position `start`	`MID("Computer", 4, 3)` is `"put"`
`TO_UPPER(x)`	`x` in capital letters	`TO_UPPER("hi")` is `"HI"`
`TO_LOWER(x)`	`x` in small letters	`TO_LOWER("Hi")` is `"hi"`

■ Joining and converting

- The operator `&` **concatenates** 拼接 (joins) two strings: `"Sum" & "mer"` is `"Summer"`.
- `+` does **not** join strings, and a number cannot be joined to a string. Convert it first:

function	returns	example
`NUM_TO_STR(x)`	the number `x` as a string	`NUM_TO_STR(87.5)` is `"87.5"`
`STR_TO_NUM(s)`	the string `s` as a number	`STR_TO_NUM("23.45")` is `23.45`
`IS_NUM(s)`	`TRUE` if `s` is a valid number	`IS_NUM("12a")` is `FALSE`
`ASC(c)`	the ASCII code of the character `c`	`ASC('A')` is 65
`CHR(n)`	the character with the ASCII code `n`	`CHR(66)` is `'B'`

`"Total: " & Score` is an error when `Score` is an `INTEGER`. The correct statement is `"Total: " & NUM_TO_STR(Score)`.

Numeric functions

function	returns	example
`INT(x)`	the whole-number part of `x`	`INT(27.5415)` is 27
`RAND(n)`	a random **real** number from 0 up to, but not including, `n`	`RAND(6)` could be `4.27`

`RAND` returns a real number, so a random **integer** needs `INT`. Dice, 1 to 6: `INT(RAND(6))` gives 0 to 5, so add 1. From `Low` to `High`: `INT(RAND(High - Low + 1)) + Low`.

A function inside a function

Work from the **inside out**: work out the inner function first, and put its result in the outer one.

Worked example: *`TO_UPPER(RIGHT("Program", 2))`*.

1. Inner: `RIGHT("Program", 2)` is `"am"`.
2. Outer: `TO_UPPER("am")` is **`"AM"`**.

Worked example: *`LENGTH("Hello") + STR_TO_NUM("4")`*. `LENGTH("Hello")` is 5 and `STR_TO_NUM("4")` is 4, so the result is **9**.

Program libraries

A **program library** 程序库 is a collection of routines that are already written, tested and compiled. Benefits of using one:

- it **saves time**: no new code to write and test
- the routines are already **tested**, so they are reliable
- they are written by **experts**, and may do a job the programmer could not write
- a routine can be **used many times**

2 Practice

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

2.1 Name the function that does each job. [5]

(a) returns the number of characters in a string

(b) returns the last few characters of a string

(c) changes a string into a number

(d) returns the ASCII code of a character

(e) returns the whole-number part of a real number

2.2 Give the value of each expression. [4]

(a) `LENGTH("Computer")`

(b) `RIGHT("Computer", 3)`

(c) `MID("Computer", 4, 2)`

(d) `INT(STR_TO_NUM("9.7"))`

2.3 The variable `Word` holds `"Keyboard"`. Work out the value of each expression. [4]

(a) `LEFT(Word, 3)`

(b) `MID(Word, 4, 2)`

(c) `TO_UPPER(RIGHT(Word, 5))`

(d) `LENGTH(Word) DIV 3`

2.4 Work out the value of each expression. [4]

(a) `ASC('C')`, given that `ASC('A')` is 65

(b) `CHR(70)`

(c) `"AB" & "12"`

(d) `STR_TO_NUM("12") + 3`

2.5 Write the pseudocode statement that assigns to `Dice` a random integer from 1 to 6, and state why `INT` is needed. [2]

2.6 A student writes `Message ← "Total: " + Score`, where `Score` is an `INTEGER`. State what is wrong and write the correct statement. [2]

3 Exam-style questions

3.1 Give the value of each expression. [3]

(a) `TO_UPPER(RIGHT("Program", 2))`

(b) `LENGTH(MID("Computer", 3, 4))`

(c) `ASC('Q') - ASC('A')`

3.2 Complete each expression so that it evaluates to the value shown. Use only functions and operators from the insert. [4]

Expression	Evaluates to
`..... ("Saturday", 3)`	`"Sat"`
`..... ('D')`	`68`
`2 * ..... ("27")`	`54`
`MID("Notebook", ..... , .....)`	`"book"`

3.3 Write pseudocode that reads a word and outputs it in **capitals** followed by its **length**, using built-in functions. [3]

3.4 A school builds each student's username from their surname, their first name and their year group: the **first three letters of the surname in capitals**, then the **first letter of the first name**, then the **year group**.

Write a single pseudocode statement that assigns this username to `Username`, using the variables `Surname`, `FirstName` and `Year`, where `Year` is an `INTEGER`. [4]

3.5 State **three** benefits of using a program library rather than writing the routines yourself. [3]

3.6 A shop gives every product a code such as `"TV-2025-0457"`. The code has three parts: two letters for the type of product, the year the product was first sold, and a product number. The code is stored in the variable `Code`.

(a) Work out the value of each expression when `Code` is `"TV-2025-0457"`. [3]

Expression	Evaluates to
`LEFT(Code, 2)`	
`STR_TO_NUM(MID(Code, 4, 4)) + 1`	
`LENGTH(Code) - 8`	

(b) Write **one** pseudocode statement that stores the product number, as an `INTEGER`, in the variable `ProductNumber`. [3]

(c) The shop makes a short label from the code: the two letters in small letters, then the last two digits of the year. For `"TV-2025-0457"` the label is `"tv25"`. Write **one** pseudocode statement that stores the label in the variable `Label`. [4]

Solutions

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

2.1

(a) `LENGTH`

(b) `RIGHT`

(c) `STR_TO_NUM`

(d) `ASC`

(e) `INT`

2.2

(a) **8**

(b) `"ter"`

(c) `"pu"` – positions count from 1, so position 4 is the `p`

(d) **9** – `STR_TO_NUM` gives 9.7 and `INT` takes the whole-number part

2.3

(a) the first three characters: **`"Key"`**

(b) two characters from position 4: **`"bo"`**

(c) the inner function first: `RIGHT(Word, 5)` is `"board"`, so the result is **`"BOARD"`**

(d) `LENGTH(Word)` is 8, and `8 DIV 3` is **2**

2.4

(a) `'C'` is two letters after `'A'`: $65 + 2 =$ **67**

(b) $70 - 65 = 5$ letters after `'A'`: **`'F'`**

(c) `&` joins the strings: **`"AB12"`**

(d) the string becomes the number 12, and $12 + 3 =$ **15**

2.5

- `Dice ← INT(RAND(6)) + 1`
- `RAND` returns a **real** from 0 up to but not including 6, so `INT` is needed to make it a whole number; the `+ 1` shifts the range from 0-5 to 1-6

2.6

- `+` cannot join a string to an integer: the two are different types
- `Message ← "Total: " & NUM_TO_STR(Score)` – `&` concatenates, and the number must be converted to a string first

3.1

(a) the inner call runs first: `RIGHT("Program", 2)` is `"am"`, so the answer is `"AM"`

(b) `MID("Computer", 3, 4)` is `"mput"`, so `LENGTH` of it is **4**

(c) `'Q'` is 81 and `'A'` is 65, so the answer is **16**

3.2

- the first three characters → **`LEFT`**
- a character to its code → **`ASC`**
- the string `"27"` must become the number 27 → **`STR_TO_NUM`**
- `"book"` starts at position 5 and has 4 characters → **`5, 4`**

3.3

- `INPUT`, then `TO_UPPER` and `LENGTH`

```
OUTPUT "Enter a word:"
INPUT Word
OUTPUT TO_UPPER(Word)
OUTPUT "Length: ", LENGTH(Word)
```

3.4

- `LEFT(Surname, 3)` for the first three letters
- `TO_UPPER(...)` around it: it accepts a whole string, whereas `UCASE` takes one `CHAR` and is not on the insert
- `LEFT(FirstName, 1)` for the initial
- `NUM_TO_STR(Year)`, and the three parts joined with `&`

```
Username ← TO_UPPER(LEFT(Surname, 3)) & LEFT(FirstName, 1) &
↪  NUM_TO_STR(Year)
```

- for `Surname` `"Chen"`, `FirstName` `"Yuwei"` and `Year` 12 this gives `"CHEY12"`

3.5 any three:

- the routines have already been written, compiled and **tested**, so they are less likely to contain errors
- they save development time, because the code does not have to be written again
- they may do things the programmer could not write themselves, such as complex statistics or graphics; they are written by experts; and a routine with a fixed interface can be called from anywhere in the program, and reused across many programs

3.6

(a) `LEFT(Code, 2)` → **`"TV"`**

- `MID(Code, 4, 4)` is `"2025"`, which becomes the number 2025, and $2025 + 1 =$ **2026**
- `LENGTH(Code)` is 12, and $12 - 8 =$ **4**

(b) the last four characters hold the product number: `RIGHT(Code, 4)` (or `MID(Code, 9, 4)`)

- they are converted with `STR_TO_NUM`

- the result is assigned to `ProductNumber`: `ProductNumber ← STR_TO_NUM(RIGHT(Code, 4))`

(c) the two letters: `LEFT(Code, 2)`

- made small with `TO_LOWER`
- the last two digits of the year: `MID(Code, 6, 2)`
- the two parts joined with `&` and assigned: `Label ← TO_LOWER(LEFT(Code, 2)) & MID(Code, 6, 2)`