A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

10.1 Data Types and Records

Name: _____ Class: _____ Date: _____ **Total: 37 marks**

KEY WORDS data type 数据类型 • record 记录 • record structure 记录结构 • array 数组 • index 索引

Objective

Build the skills to answer exam questions on **data types** 数据类型 and **records** 记录 — choosing the right type, and defining and using a record structure.

You must be able to:

- choose the most appropriate **data type** for a value
- explain the purpose of a **record** structure
- write pseudocode to **define** a record and to **read/write** its fields

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.

■ Choosing a data type

Pick the **smallest precise type** that fits the value:

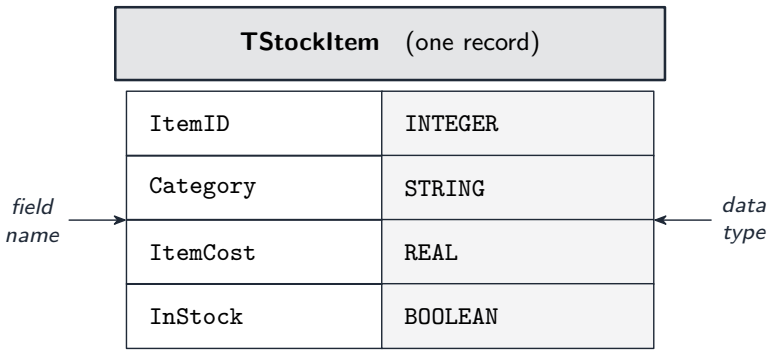
To store	Best type	Why
a count, an index, an ID	`INTEGER`	whole number
a price, a measurement	`REAL`	has a decimal part
a name, a sentence	`STRING`	text
a single grade letter	`CHAR`	exactly one character
”is it paid?”	`BOOLEAN`	a `TRUE`/`FALSE` flag

Exam method — “give the data type of this expression”. Look at the **operation**, not the inputs:

- one character — `LEFT(Name,1)` or `'A'` — gives a **CHAR**
- text in `"..."`, or joined with `&` — gives a **STRING**
- `+ - *` on whole numbers gives an **INTEGER**; any `/` or a decimal value gives a **REAL**
- a comparison (`>=`, `=`) or `AND`/`OR`/`NOT` gives a **BOOLEAN**

Defining a record

A **record** groups several fields of **different types** under one type name:




```
TYPE TStockItem
    DECLARE ItemID   : INTEGER
    DECLARE Category : STRING
    DECLARE ItemCost : REAL
    DECLARE InStock  : BOOLEAN
ENDTYPE
```

Using a record

Declare a variable of that type (or a whole **array of records**), then use **dot notation** to reach each field:

```
DECLARE Item1 : TStockItem
DECLARE Items : ARRAY[1:100] OF TStockItem

Item1.Category ← "Fruit"
Item1.ItemCost ← 2.50
OUTPUT Item1.Category, " costs ", Item1.ItemCost
```

2 Practice

Now apply the methods above.

2.1 Give the most appropriate data type for each value: (a) a student's age; (b) a price in dollars; (c) whether a light is on. [3]

2.2 State the purpose of a **record** structure. [1]

2.3 A record type `TBook` must store a `Title` (text), `Pages` (whole number) and `InLibrary` (a flag). Write pseudocode to **define** it. [3]

2.4 `Book1` is a variable of type `TBook`. Write one pseudocode line to set its `Title` to `"Maths"`. [1]

3 Exam-style questions

3.1 The table shows four pseudocode assignment statements. Give an appropriate **data type** to declare each variable. [4]

Statement	Data type
`A ← LEFT(Name, 1)`	
`B ← Price * Quantity`	
`C ← Count + 1`	
`D ← (Score >= 50)`	

3.2 A factory stores data about each component in a record type `Component`:

Field	Example	Meaning
`Item_Num`	`123478`	a numeric ID
`Reject`	`FALSE`	rejected?
`Stage`	`'B'`	a stage letter
`Limit_1`	`13.5`	a value 0–100

(i) Write pseudocode to **declare the record structure** `Component`. [4]

(ii) A 1D array `Item` of **2000** elements will store all components. Write pseudocode to **declare** the `Item` array. [2]

3.3 State **two** benefits of using an **array of records** instead of several separate arrays. [2]

3.4 A bicycle-hire company stores one record for each hire. Each record holds a hire reference (up to 8 characters), the bicycle number, the date of hire, the number of hours hired, the cost per hour and whether the bicycle has been returned.

(a) **Complete** the table by giving an appropriate data type for each field. [3]

field	example value	data type
`HireRef`	`"HR004821"`	_____
`HoursHired`	`3`	_____
`CostPerHour`	`4.50`	_____
`Returned`	`TRUE`	_____

(b) **Write** pseudocode to declare the record structure `HireRecord`, including a field for the date. [5]

(c) A 1D array `Hire` of 500 elements will hold all the records. **Write** the pseudocode declaration for this array. [2]

(d) **Write** pseudocode to assign the value `4.50` to the cost per hour of the **first** record in the array. [2]

(e) **Outline** three benefits of storing the data as an array of records rather than as six separate parallel arrays. [3]

(f) **Evaluate** the expression `Hire[1].HoursHired * Hire[1].CostPerHour`, and **state** the data type of the result. [2]

Solutions

2.1 (a) `INTEGER`; (b) `REAL`; (c) `BOOLEAN`.

2.2 It groups **several fields of different data types** under **one identifier**, so values that belong together are stored as one unit.

2.3

```
TYPE TBook
    DECLARE Title     : STRING
    DECLARE Pages     : INTEGER
    DECLARE InLibrary : BOOLEAN
ENDTYPE
```

2.4 `Book1.Title ← "Maths"`.

3.1 `A` → **CHAR** (or STRING — one character from `LEFT`); `B` → **REAL** (a price/decimal); `C` → **INTEGER** (whole-number add); `D` → **BOOLEAN** (a comparison).

3.2 (i)

```
TYPE Component
    DECLARE Item_Num : INTEGER
    DECLARE Reject   : BOOLEAN
    DECLARE Stage    : CHAR
    DECLARE Limit_1  : REAL
ENDTYPE
```

(ii) `DECLARE Item : ARRAY[1:2000] OF Component`.

3.3 Any two: one identifier for all the data; easy to process with a **loop** and an index; all fields for one item stay together; easy to pass to a procedure.

3.4 (a) `HireRef` — `STRING`; `HoursHired` — `INTEGER`; `CostPerHour` — `REAL`; `Returned` — `BOOLEAN`.
(b)

```
TYPE HireRecord
    DECLARE HireRef : STRING
    DECLARE BicycleNumber : INTEGER
    DECLARE HireDate : DATE
    DECLARE HoursHired : INTEGER
    DECLARE CostPerHour : REAL
    DECLARE Returned : BOOLEAN
ENDTYPE
```

(c) `DECLARE Hire : ARRAY[1:500] OF HireRecord`.
(d) `Hire[1].CostPerHour ← 4.50`.
(e) Any three: the fields belonging to one hire are kept **together**, so a record can be passed to a procedure as a single item; there is no risk of the arrays drifting **out of step** with one another; adding a new field means changing one type definition instead of creating another array. Also acceptable: the code reads more clearly; the whole record

can be written to a file in one operation.
(f) $3 \times 4.50 = 13.50$; the result is `REAL`, because multiplying an `INTEGER` by a `REAL` gives a `REAL`.