User Defined Data types

Question 1

2 Data types can be classified as composite or non-composite.

A record is declared of type `box` using the following pseudocode.

```
TYPE size = (small, medium, large)

TYPE box

   DECLARE volume : size

   DECLARE price : REAL

   DECLARE colour : STRING

ENDTYPE

DECLARE myBox : ARRAY [1:6] OF box
```

(a) (i) Identify **one** composite and **three** non-composite data types used in the pseudocode.

Composite data type ..... box (record)

Non-composite data type 1 ..... Real (built in)

Non-composite data type 2 ..... String (built in)

Non-composite data type 3 ..... size (enumerated)

[4]

(b) A box is red, with medium volume and a price of $10.99.

Write **pseudocode** to store the details of this box in the first element of the array.

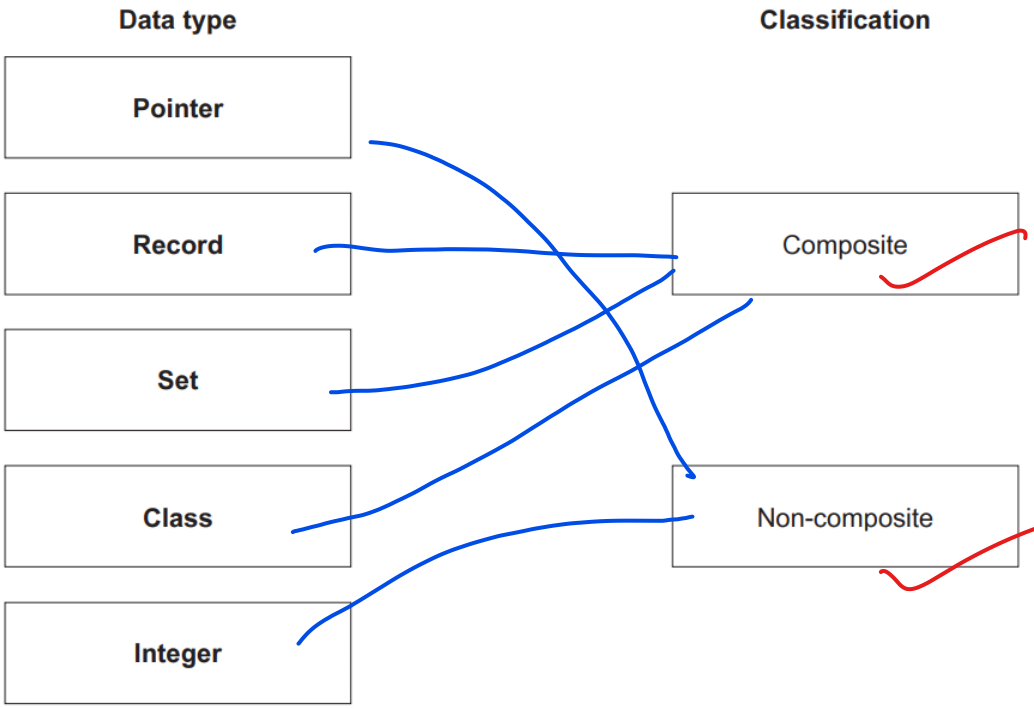
```
myBox[0].colour = 'red'
myBox[1].size = medium
myBox[1].price = 10.99
```

[3]

Question 2

2 Data types can be classified as composite or non-composite.

(a) Draw **one** line from each data type to its correct classification.



[2]

(b) A user-defined data type, `timeOfDay`, is declared using the following pseudocode.

```
TYPE timeOfDay = (morning, afternoon, evening, night)
```

(i) Identify the type of user-defined data type declared **and** state its classification.

Type Enumerated data type

Classification ~~Compo~~ Non Composite

[2]

(ii) Write pseudocode to declare the variable `session` of type `timeOfDay`.
Assign the value `afternoon` to the variable `session`.

```
DECLARE session: timeOfDay
Session = afternoon
```

[2]

Question 3

2 Data types can be classified as composite or non-composite.

A record is declared of type `box` using the following pseudocode.

```
TYPE size = (small, medium, large)

TYPE box

   DECLARE volume : size

   DECLARE price : REAL

   DECLARE colour : STRING

ENDTYPE

DECLARE myBox : ARRAY [1:6] OF box
```

(a) (i) Identify **one** composite and **three** non-composite data types used in the pseudocode.

Composite data type ..... Record data type (box) .....

Non-composite data type 1 String (colour) .....

Non-composite data type 2 Real (price) .....

Non-composite data type 3 volume size (enumerated) .....

[4]

(ii) Identify the data type in the pseudocode that is enumerated.

..... Size ..... [1]

(b) A box is red, with medium volume and a price of $10.99.

Write **pseudocode** to store the details of this box in the first element of the array.

.....

.....

.....

.....

..... [3]

Question 4

5 **(a)** Explain why user-defined data types are necessary.

new data types

→ Allows a programmer to use specific data types tailored to their application

→ meets requirement for this app [2]

(b) An organisation stores data about its employees.

- Employee ID is a five-digit number, for example 01234.
- Employee name is a string, for example 'Kiri Moana'.
- Department is one of three values: Sales, Technical, Customer services.
- Salary is an integer value in the range 25000 to 150000.

(i) Complete the following **pseudocode** definition of a user-defined data type to store the employee data.

```
TYPE Employee
  DECLARE EmployeeID   : STRING
  DECLARE EmployeeName : STRING
  DECLARE Department   : ( Sales, Tech, Customer Services
                         )
  DECLARE Salary       : 25000..150000
ENDTYPE
```

[4]

(ii) Write a **pseudocode** statement to declare a variable, `NewEmployee` of data type `Employee`.

DECLARE NewEmployee : Employee

[1]

(iii) Write a **pseudocode** statement that assigns `02244` to the `EmployeeID` of `NewEmployee`.

NewEmployee.EmployeeID ← '02244'

[1]

(iv) `Employee` is an example of a record that is a composite data type.

State **two** other composite data types.

1 Class

2 Sets

[2]

Derived from one or more data types used to extend built in data types

Question 5

i

6 **(a)** State what is meant by a **user-defined data type**.

which is

New Data types declared by users to specifiy required for their application ..... [2]

(b) A pseudocode declaration for a user-defined data type for the months of the year is as follows:

```
TYPE
  DECLARE Months: (January, February, March, April, May, June, July,
                   August, September, October, November, December)
ENDTYPE
```

(i) Identify this type of user-defined data type.

Enumerated type

..... [1]

(ii) Write a **pseudocode** statement to declare a variable `CurrentMonth` of data type `Months`.

DECLARE CurrentMonth : Months

..... [1]

(iii) Write a **pseudocode** statement to assign the value `August` to the variable `CurrentMonth`.

CurrentMonth = August

..... [1]

Question 6

2 A programmer uses non-composite and composite data types to create a program.

(a) Define the term **non-composite data type**.

A data type that does not reference to any other data type for eg: enumerated ..... [1]

built in

Single data

(b) Describe **two** different non-composite data types.

Data type 1 Enumerated Data Types

Description Used to declare a category with fixed values. It is values has ordinal

Data type 2 Pointer data type

Description Used to store the memory location of data

[4]

(c) Define the term **composite data type**.

data type that is made up and references to one or more data types

[1]

(d) Describe **two** different composite data types.

Data type 1 Records

Description Used to declare multiple attributes of an object with different data types.

collection of related items which may have different data type

Data type 2 Class

Description Declares properties and methods of an object.

[4]

Question 7

1 Data types can be defined in a programming language.

The data type, `StudentRecord`, is defined by the code:

```
TYPE StudentRecord
   DECLARE StudentID        : INTEGER
   DECLARE StudentFirstName : STRING
   DECLARE StudentSurname   : STRING
   DECLARE StudentDOB       : DATE
   DECLARE StudentCourse    : ARRAY[1:10] OF STRING
ENDTYPE
```

A variable, `CollegeStudent`, is declared with the code:

```
DECLARE CollegeStudent : StudentRecord
```

(a) Write a pseudocode statement to assign 6539 to the `StudentID` of `CollegeStudent`.

CollegeStudent.StudentID = 6539 ..... [1]

(b) The type definition for `StudentRecord` is changed.

(i) Students can take six courses from: Computer Science, Engineering, Science, Maths, Physics, Chemistry, Music, Drama and English Language.

Rewrite **one** line from the type definition of `StudentRecord` to implement the change.

DECLARE StudentCource : Array[1:6] : Course

Type Course = (CS, Eng, Sci, Maths, Phy, Chem, Music, Drama, Eng)

EndType ..... [2]

(ii) The values for the field `StudentID` must be between `1` and `8000` inclusive.

Rewrite **one** line from the type definition of `StudentRecord` to implement the change.

DECLARE StudentID := 1..8000 ..... [1]

(c) A programmer is asked to write a program to process the assessment data for each student. Students sit one exam in every course they take.

A composite data type, `StudentAssessment`, needs to be defined with the following three fields.

- a student assessment code (a unique code of three letters and two digits)
- the marks for the six exams
- the average mark of the six exams

(i) Write **pseudocode** to define the data type `StudentAssessment`.

Type StudentAssessment
Declare StudentAssID : String
Declare Marks : Integer [1:6] of Integer
Declare AvgMark : Real
EndType

[4]

(ii) Data about all students and their assessments are stored in a file that uses random organisation. The `StudentID` is used as the key field.

The program allows a user to enter data for a new student.

Explain how the program adds the new data to the file.

The Student ID from new data will be processed through mathematical functions (Hashing algorithm) which would output the mem location for the data to be placed at.

[3]

Student ID → hashed → home location → free store / free ✗ → overflow → full → Error file is full

Question 8

1 Consider the following user-defined data type.

```
TYPE Book
     DECLARE ISBN     : INTEGER
     DECLARE Author   : STRING
     DECLARE Title    : STRING
     DECLARE Supplier : (Amazone, Stones, Smiths, Blackwalls, Greens,
                         Coals, Boarders)
ENDTYPE
```

(a) Name the data type of `Book`.

.....[1]

(b) Name the non-composite data type used in the `Supplier` declaration.

.....[1]

(c) **(i)** Write a pseudocode statement to declare a variable, `BestSeller`, of type `Book`.

.....[1]

(ii) Write a pseudocode statement to assign "`John Williams`" to the author of `BestSeller`.

.....[1]

Question 9

1 **(a)** Consider the following user-defined data type:

```
TYPE LibraryBookRecord
   DECLARE ISBN      : INTEGER
   DECLARE Title     : STRING
ENDTYPE
```

(i) Write a pseudocode statement to declare a variable, `Book`, of type `LibraryBookRecord`.

.....[1]

(ii) Write a pseudocode statement that assigns 'Dune' to the `Title` of `Book`.

.....[1]

(b) The user-defined data type `LibraryBookRecord` needs to be modified by adding the following fields:

- a field called `Genre` which can take two values, fiction or non-fiction
- a field called `NumberOfLoans` which can be an integer value in the range 1 to 99

Write the updated version of `LibraryBookRecord`.

.....

.....

.....

.....

.....

.....

.....[3]

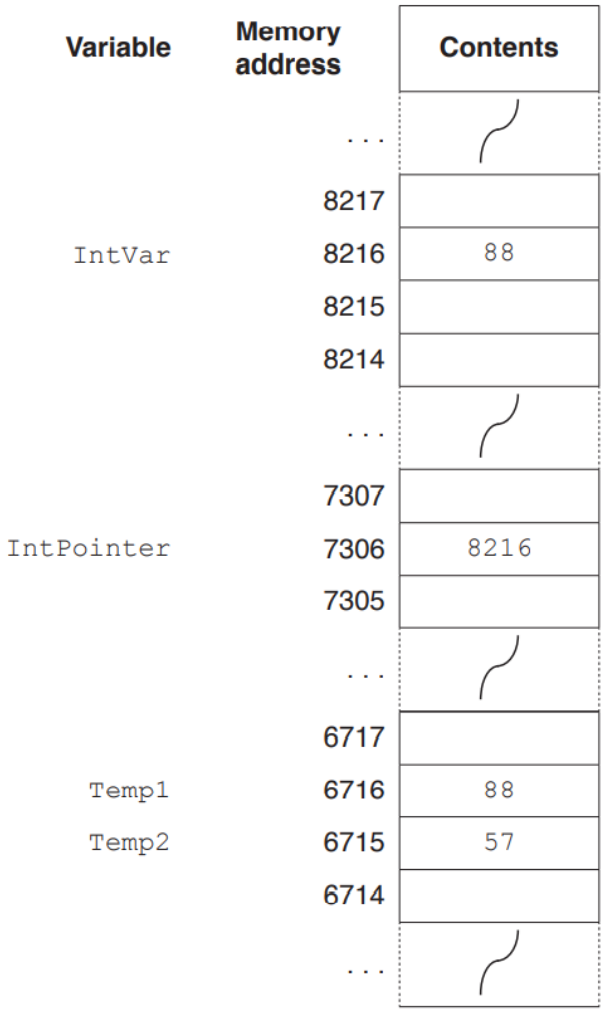
(c) A pointer is a variable that stores the address of a variable of a particular type.

Consider the code on page 3, which uses the following identifiers:

Identifier	Data type	Description
`IntPointer`	`^INTEGER`	pointer to an integer
`IntVar`	`INTEGER`	an integer variable
`Temp1`	`INTEGER`	an integer variable
`Temp2`	`INTEGER`	an integer variable

```
IntVar ← 57             // assigns the value 57 to the integer
                        // variable IntVar
IntPointer ← @IntVar    // assigns to IntPointer the address of the
                        // integer variable IntVar
Temp2 ← IntPointer^     // assigns to variable Temp2 the value at an
                        // address pointed at by IntPointer
IntPointer^ ← Temp1     // assigns the value in the variable Temp1 to
                        // the memory location pointed at by IntPointer
```

The four assignment statements are executed. The diagram shows the memory contents after execution.



Use the diagram to state the current values of the following expressions:

(i) `@Temp2` .....[1]

(ii) `IntPointer` .....[1]

(iii) `IntPointer^` .....[1]

(iv) `IntPointer^ = Temp2 + 6` .....[1]

(d) Write pseudocode statements that will achieve the following:

(i) Assign the value `22` to the variable `Temp2`.

.....[1]

(ii) Place the address of `Temp1` in `IntPointer`.

.....[1]

(iii) Copy the value in `Temp2` into the memory location currently pointed at by `IntPointer`.

.....[1]

Question 10

1 **(a)** Consider the following pseudocode user-defined data type:

```
TYPE MyContactDetail
   DECLARE Name        : STRING
   DECLARE HouseNumber : INTEGER
ENDTYPE
```

(i) Write a pseudocode statement to declare a variable, `NewFriend`, of type `MyContactDetail`.

.....[1]

(ii) Write a pseudocode statement that assigns 129 to the `HouseNumber` of `NewFriend`.

.....[1]

(b) The user-defined data type `MyContactDetail` needs to be modified by:

- adding a field called `Area` which can take three values, uptown, downtown or midtown
- amending the field `HouseNumber` so that house numbers can only be in the range 1 to 499.

Write the updated version of `MyContactDetail`.

.....

.....

.....

.....

.....

.....

.....[3]

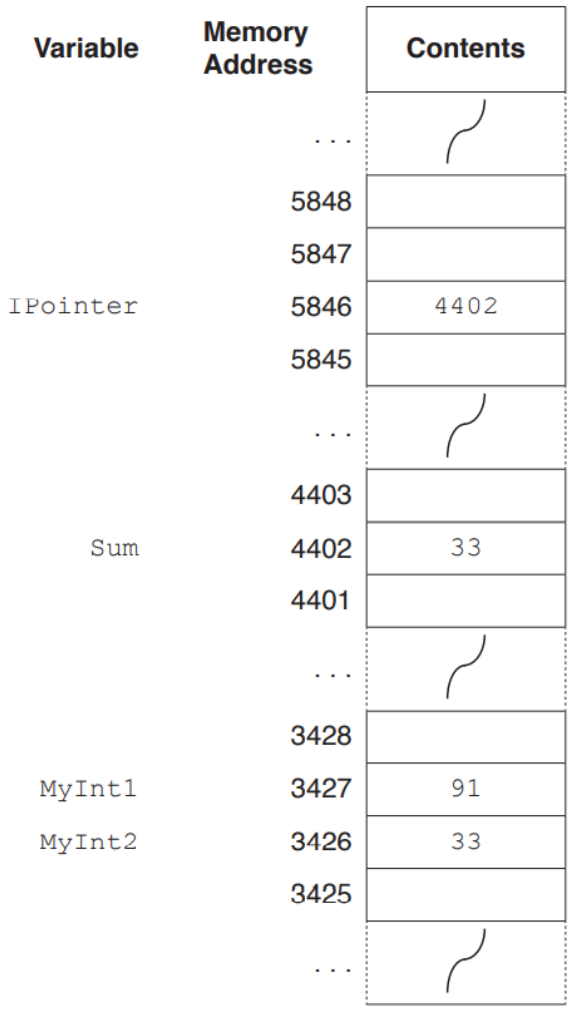
(c) A pointer is a variable that stores the address of a variable of a particular type.

Consider the pseudocode on page 3, which uses the following identifiers:

Identifier	Data type	Description
`IPointer`	`^INTEGER`	pointer to an integer
`Sum`	`INTEGER`	an integer variable
`MyInt1`	`INTEGER`	an integer variable
`MyInt2`	`INTEGER`	an integer variable

```
Sum ← 91              // assigns the value 91 to the integer variable Sum
IPointer ← @Sum       // assigns to IPointer the address of the
                      // integer variable Sum
MyInt1 ← IPointer^    // assigns to variable MyInt1 the value at an
                      // address pointed at by IPointer
IPointer^ ← MyInt2    // assigns the value in the variable MyInt2 to
                      // the memory location pointed at by IPointer
```

The four assignment statements are executed. The diagram shows the memory contents after execution.



Use the diagram to state the current values of the following expressions:

(i) `IPointer` .....[1]

(ii) `IPointer^` .....[1]

(iii) `@MyInt1` .....[1]

(iv) `IPointer^ = MyInt2` .....[1]

(d) Write pseudocode statements that will achieve the following:

(i) Place the address of `MyInt2` in `IPointer`.

.....[1]

(ii) Assign the value `33` to the variable `MyInt1`.

.....[1]

(iii) Copy the value in `MyInt2` into the memory location currently pointed at by `IPointer`.

.....[1]

Question 11

3 **(a)** A particular programming language allows the programmer to define their own data types.

`ThisDate` is an example of a user-defined structured data type.

```
TYPE ThisDate
   DECLARE ThisDay    :  (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                         13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
                         24, 25, 26, 27, 28, 29, 30, 31)
   DECLARE ThisMonth  :  (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug,
                         Sep, Oct, Nov, Dec)
   DECLARE ThisYear   :  INTEGER
ENDTYPE
```

A variable of this new type is declared as follows:

```
DECLARE DateOfBirth : ThisDate
```

(i) Name the non-composite data type used in the `ThisDay` and `ThisMonth` declarations.

.....[1]

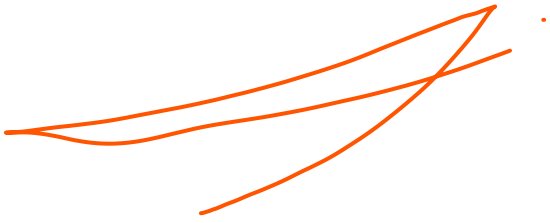
(ii) Name the data type of `ThisDate`.

.....[1]

(iii) The month value of `DateOfBirth` needs to be assigned to the variable `MyMonthOfBirth`.

Write the required statement.

.....[1]



(b) Annual rainfall data from a number of locations are to be processed in a program.

The following data are to be stored:

- location name
- height above sea level (to the nearest metre)
- total rainfall for each month of the year (centimetres to 1 decimal place)

A user-defined, composite data type is needed. The programmer chooses `LocationRainfall` as the name of this data type.

A variable of this type can be used to store all the data for one particular location.

(i) Write the definition for the data type `LocationRainfall`.

.....

.....

.....

.....

.....

.....

.....[5]

Question 12

4 **(a)** A particular programming language allows the programmer to define their own data types.

An example of a user-defined data type for an address is:

```
TYPE ThisAddress
   DECLARE ThisHouseNo : INTEGER
   DECLARE ThisStreet  : STRING
   DECLARE ThisTown    : STRING
ENDTYPE
```

A variable of this new type is declared as follows:

```
DECLARE HomeAddress : ThisAddress
```

(i) Write the statement that assigns the house number 34 to `HomeAddress`.

.....[1]

(ii) The type definition for `ThisAddress` is to be changed.

Rewrite one line from the definition for each of the following changes.

House numbers are in the range from 1 to 10.

`DECLARE` .....

The possible towns are limited to: Brightown, Arunde and Shoram.

`DECLARE` .....[2]

(b) Temperature data from a number of weather stations are to be processed by a program.

The following data are to be stored:

- weather station ID (a unique four-letter code)
- latitude (to 2 decimal places)
- average temperature (to the nearest whole number) for each year from 2001 to 2015 inclusive

A programmer designs a composite data type `WeatherStation`. A variable of this type can be used to store all the data for one particular station.

(i) Write the definition for the user-defined data type `WeatherStation`.

.....

.....

.....

.....

.....

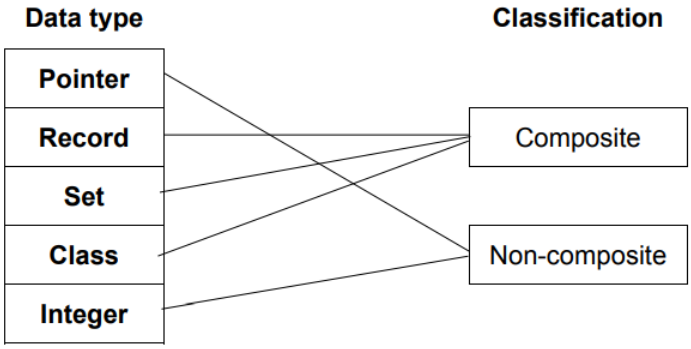
.....[5]

Answer

Answer 1

2(a)(i)	Composite box Non-composite size / enumerated REAL STRING	**4**
2(a)(ii)	size	**1**
2(b)	myBox[1].volume ← medium myBox[1].price ← 10.99 myBox[1].colour ← "red"	**3**

Answer 2

2(a)	**2** marks for all 5 single lines correct **1** mark for 4 lines correct otherwise zero 	**2**
2(b)(i)	Type **Enumerated** Classification **Non-composite**	**2**
2(b)(ii)	DECLARE session : timeOfDay session ← afternoon	**2**

Answer 3

2(a)(i)	Composite box Non-composite size / enumerated REAL STRING	**4**
2(a)(ii)	size	**1**
2(b)	myBox[1].volume ← medium myBox[1].price ← 10.99 myBox[1].colour ← "red"	**3**

Answer 4

5(a)	**1 mark** per bullet point to **max 2** • No suitable data type is provided by the language used • The programmer needs specify a new data type • … that meets the requirements of the application / program	**2**

5(b)(i)	**1 mark** per bullet point
	
	• `EmployeeID` declared as `STRING`
	• `Sales, Technical` and `CustomerServices` …
	• … with commas in-between
	• `ENDTYPE`
	
	`TYPE Employee`
	`  DECLARE EmployeeID  : STRING`
	`  DECLARE EmployeeName : STRING`
	`  DECLARE Department  : (Sales, Technical,`
	`  CustomerServices)`
	`  DECLARE Salary  : 25000..150000`
	`ENDTYPE`
		4

5(b)(ii)	`DECLARE NewEmployee : Employee`	**1**
5(b)(iii)	`NewEmployee.EmployeeID ← "02244"`	**1**
5(b)(iv)	**1 mark** per bullet point to **max 2** • Array • List • Set • Collection • Class • Stack • Queue • Linked list • Dictionary	**2**

Answer 5

6(a)	1 mark per bullet point to **max 2** • Derived from one or more existing data types • Used to extend the built-in data types • Creates data-types specific to applications // programmer's requirements	**2**
6(b)(i)	Enumerated (data type)	**1**
6(b)(ii)	`DECLARE CurrentMonth : Months`	**1**
6(b)(iii)	`CurrentMonth ← August`	**1**

Answer 6

2(a)	single data type that does not involve a reference to another type/usually built in to a programming language	**1**
2(b)	**1** mark for data type, **1** for definition, max **4,** 2 data types ∞ Integer ∞ Stores a whole number ∞ Boolean ∞ Stores true or false/1 or 0/on or off ∞ Real/Single/Double/Float/Decimal ∞ Stores decimal numbers ∞ String ∞ Stores zero or more characters ∞ Char ∞ Stores a single character ∞ Pointer ∞ Whole number used to reference a memory location	**4**
2(c)	data type constructed from other data types	**1**
2(d)	**1** mark for naming, **1** for description, max **4,** 2 data types ∞ Record ∞ collection of related items which may have different data types ∞ Array ∞ (Indexed) collection of items with the same data type ∞ List ∞ (Indexed) collection of items that can have different data types ∞ Set ∞ stores a finite number of different values that have no order // supports mathematical operations ∞ Class/Structure ∞ Gives the properties and methods for an object	**4**

Answer 7

1(a)	`CollegeStudent.StudentID ← 6539`	**1**
1(b)(i)	**1** mark per bullet • `StudentCourse: ARRAY[1:6] OF` • All valid string options , for example: `DECLARE StudentCourse: ARRAY[1:6] OF ("Computer Science", "Engineering", "Science", "Maths", "Physics", "Chemistry", "Music", "Drama", "English Language")`	**2**
1(b)(ii)	`DECLARE StudentID: 1 .. 8000`	**1**

1(c)(i)	**1** mark per bullet
	• Type declaration `TYPE` and `ENDTYPE`
	• Declaring `Code` as `STRING`
	• Declaring `Mark` as `ARRAY [1:6] OF INTEGER`
	• `AverageMark` as `REAL`
	For example:
	`TYPE StudentAssessment`
	`  DECLARE Code : STRING`
	`  DECLARE Mark : ARRAY[1:6] OF INTEGER`
	`  DECLARE AverageMark : REAL`
	`ENDTYPE`
		4

1(c)(ii)	Any **3** from, **1** mark per bullet • `StudentID`/key field is hashed to produce home location • If home location is free, insert record/data • Else use overflow method to find free location to store record / data • If no free location available then file is full and record/data cannot be stored	**3**

Answer 8

1	(a) Record	**1**
	(b) Enumerated	**1**
	(c) `DECLARE BestSeller : Book`	**1**
	(d) `BestSeller.Author ← "John Williams"`	**1**

Answer 9

1(a)(i)	`DECLARE Book : LibraryBookRecord`	**1**
1(a)(ii)	`Book.Title ← "Dune"`	**1**

1(b)	`TYPE LibraryBookRecord`
	`  DECLARE ISBN : INTEGER`
	`  DECLARE Title : STRING`
	`  DECLARE Genre : (Fiction, Non-Fiction)` **1**
	`  DECLARE NumberOfLoans : 1 .. 99` **1**
	`ENDTYPE`
	mark for correct declaration and first two fields (**note**: only if attempt at modification) **1**
		3

1(c)(i)	6715	**1**
1(c)(ii)	8216	**1**
1(c)(iii)	88	**1**
1(c)(iv)	`FALSE`	**1**
1(d)(i)	`Temp2 ← 22`	**1**
1(d)(ii)	`IntPointer ← @Temp1`	**1**
1(d)(iii)	`IntPointer^ ← Temp2`	**1**

Answer 10

1(a)(i)	`DECLARE NewFriend : MyContactDetail`	**1**
1(a)(ii)	`NewFriend.HouseNumber ← 129`	**1**

1(b)	Declaration of `Name, Area, HouseNumber` 1
	Inclusion of three correct values for `Area` 1
	Inclusion of correct range for `HouseNumber` 1
	
	For example:
	
	`TYPE MyContactDetail`
	`  DECLARE Name : STRING`
	`  DECLARE Area : (uptown, downtown, midtown)` **1**
	`  DECLARE HouseNumber : 1..499` **1 & 1**
	`ENDTYPE`
		3

1(c)(i)	4402	**1**
1(c)(ii)	33	**1**
1(c)(iii)	3427	**1**
1(c)(iv)	`TRUE`	**1**
1(d)(i)	`IPointer ← @MyInt2`	**1**
1(d)(ii)	`MyInt1 ← 33`	**1**
1(d)(iii)	`IPointer^ ← MyInt2`	**1**

Answer 11

3 (a) (i)	enumerated	1
(ii)	record	1
(iii)	`MyMonthOfBirth ← DateOfBirth.ThisMonth`	1

(b) (i)	`TYPE LocationRainfall`
	`  DECLARE LocationName : STRING`
	`  DECLARE LocationHeight : INTEGER`
	`  DECLARE TotalMonthlyRainfall : ARRAY[1..12] OF REAL`
	`ENDTYPE`
		1
		1
		1
		1 +1

Answer 12

4 (a) (i)	`HomeAddress.ThisHouseNo ← 34`	1

(ii)	`DECLARE ThisHouseNo: 1..10`
	
	`DECLARE ThisTown: [Brightown, Arunde, Shoram]`
		1
		
		1

(b) (i)	`TYPE WeatherStation`
	`  DECLARE StationID : STRING`
	`  DECLARE Latitude : REAL`
	`  DECLARE Temperature : ARRAY[1..15] OF INTEGER`
	`ENDTYPE`
		
		1
		1
		1 + 1
		1