Nat 5: Programming Questions

1. Explain why it may be necessary to return to the implementation stage of an iterative development process after the testing stage. 1

2. The code below monitors the speed of a vehicle:

```
. . .
Line 5  RECEIVE speed FROM <sensor>
Line 6  WHILE speed <= 70 DO
Line 7  RECEIVE speed FROM <sensor>
Line 8  END WHILE
Line 9  SEND signal TO <alarm>
```

Describe what happens in lines 6 to 9 above if the sensor detects a value of 83 at line 5. 3

3 Mark writes a program to calculate a worker's average weekly wage.

The first part of the program asks the user to log in. They are given three attempts to enter the correct password which is 'Bingo'.

```
. . .
Line 6   SET attempts TO 0
Line 7   REPEAT
Line 8     RECEIVE password FROM KEYBOARD
Line 9     SET attempts TO attempts +1
Line 10  UNTIL _____
. . .
```

(a) Complete line 10 of the code above. 3

(b) State the data type of the variable `password`. 1

The following section of code calculates the average weekly wage:

```
Line 11  RECEIVE day1 FROM KEYBOARD
Line 12  RECEIVE day2 FROM KEYBOARD
Line 13  RECEIVE day3 FROM KEYBOARD
Line 14  RECEIVE day4 FROM KEYBOARD
Line 15  RECEIVE day5 FROM KEYBOARD
Line 16  RECEIVE day6 FROM KEYBOARD
Line 17  RECEIVE day7 FROM KEYBOARD
Line 18  SET weeklyAverage TO (day1 + day2 + day3 + day4 +
         day5 + day6 + day7)/7
Line 19  <display the seven days wages and average>
```

(c) When evaluating this code, it is found to be inefficient.

Using a programming language of your choice, rewrite lines 11 to 18 of the code using more efficient constructs. **5**

4 Pam is creating an application that will find and display a person's tax rate based on their salary.

Salary	Tax rate
0–12000	0
12001–40000	20
40001 upwards	40

(a) Analyse the problem and identify the input, the process and the output. **3**

(b) Using a design technique of your choice, design an efficient solution to the problem of finding a person's tax rate. **4**

5. Read the following design for a solution to a problem.

Algorithm 1 Ask the user to enter their name 2 Ask the user to enter their flight details 3 Generate the holiday booking reference 4 Display the holiday booking reference Refinements 1.1 Ask user to enter surname only 2.1 Ask user to enter first three letters of departure airport (for example: Edi for Edinburgh) 2.2 Ask user to enter first three letters of arrival airport 3.1 Store the booking reference as: arrival airport string + surname + departure airport string

(a) State which design technique has been used for the above solution. **1**

(b) State the output expected if the design is tested by Kate Bryant who is flying from Glasgow to Barcelona. **3**

_____

(c) Refinement 3.1 stores the holiday booking reference.

State two programming constructs that would be required to implement this refinement. **2**

Construct 1 _____

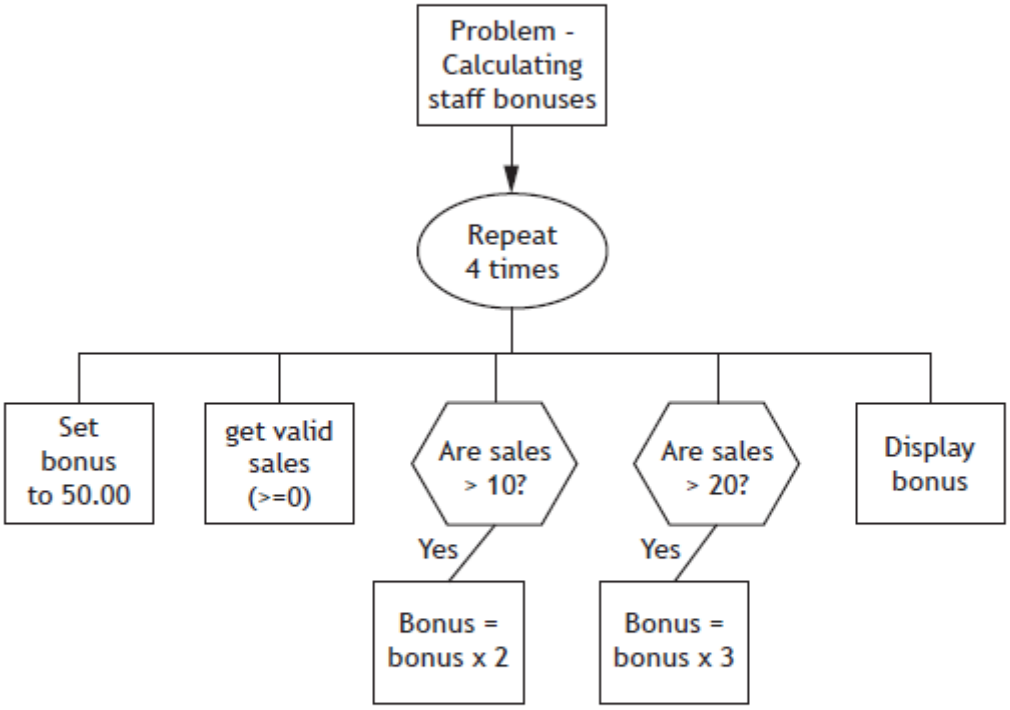
Construct 2 _____

(d) When implementing the above solution, describe one advantage of using an interpreter and one advantage of using a compiler to translate the program code into binary. **2**

(e) Using a design technique of your choice, add input validation to refinement 2.1 to ensure that the user only enters a 3 character string. An error message should inform the user when their input is not valid. **4**

6. Arthur's Antiques sells old furniture. All staff receive a monthly bonus of £50, which is increased if they sell over 10 items of furniture. The bonus is increased further if they sell over 20 items of furniture.

A design for the program used to calculate the bonus payment for each of the four members of staff is shown below.



(a) List the variables and data types that would be required to implement the design.

The first one has been completed for you. **2**

Variable name	Data type
loop	integer

(b) The program is implemented to match the design.

State examples of exceptional and extreme test data that could be used when inputting staff sales. **2**

(c) The program is further tested with normal test data. The results are shown below.

	Sales input	Expected output	Actual output
Staff 1	6	Bonus is 50	Bonus is 50
Staff 2	10	Bonus is 50	Bonus is 50
Staff 3	15	Bonus is 100	Bonus is 100
Staff 4	22	Bonus is 150	**Bonus is 300**

The test data for Staff 4 shows there is an error in the design.

(i) State the type of error. **1**

_____

(ii) Describe how this design error could be corrected. You may wish to write a description or re-draw part of the design. **2**

(d) When the program is running it carries out the following tasks:

- stores the original bonus value of 50
- checks if sales > 10

(i) State the part of the processor that would temporarily store the value 50. **1**

_____

(ii) State the part of the processor that would compare the sales value to the value 10. **1**

1. Explain why it is important that program code is readable. **1**

2. This code design monitors the temperature of food as it is reheated.

```
Line 1    RECEIVE temperature FROM (REAL) <temperature sensor>
Line 2    WHILE temperature < 82 DO
Line 3        SEND "temperature too low: continue to reheat" TO DISPLAY
Line 4        RECEIVE temperature FROM (REAL) <temperature sensor>
Line 5    END WHILE
```

Explain what will happen in lines 2 to 5 if the sensor detects 63°. **2**

3. A running group has 16 members. They are taking part in a marathon.

Using pseudocode or a programming language of your choice, write the code which will take in each runner's time for the marathon. **2**

4. A Maths game is designed for primary school pupils to test number ordering. In the game the pupil is asked to enter two integer numbers. A third integer number is then randomly generated and shown to the pupil.

The pupil must then state if the random number is:

lower (l) than the two entered numbers
higher (h) than the two entered numbers
in the middle (m) of the two entered numbers.

A design for the code is shown below.

```
Line 1    <enter the first number and assign to numOne>
Line 2    <enter the second number and assign to numTwo>
Line 3    <generate random number and assign to randNum>
Line 4    SEND randNum TO DISPLAY
Line 5    RECEIVE guess FROM (CHARACTER) KEYBOARD
Line 6    IF guess = "l" AND randNum < numOne THEN
Line 7        SEND "Correct it is lower" TO DISPLAY
Line 8        SET score TO score + 1
Line 9    END IF
Line 10   IF guess = "m" AND randNum >= numOne AND randNum <= numTwo
Line 11       SEND "Correct it is in the middle" TO DISPLAY
Line 12       SET score TO score + 1
Line 13   END IF
Line 14   IF guess = "h" AND randNum > numTwo
Line 15       SEND "Correct it is higher" TO DISPLAY
Line 16       SET score TO score + 1
Line 17   END IF
Line 18   <display incorrect message>
```

(a) When the two numbers are entered the program should ensure that numTwo is always a higher number than numOne.

Using pseudocode or a programming language of your choice, write several lines to represent this input validation for line 2. **4**

(b) When the pupil enters the answer it is stored in a variable called "guess".

State the **data type** stored by the variable "guess". **1**

_____

(c) The program is run with the following data.

Variables	Values
numOne	7
numTwo	15
randNum	10
guess	m

State the output from the program. **1**

(d) The program will have to make use of a pre-defined function.

State the pre-defined function used and describe its purpose. **2**

_____

_____

(e) Using line numbers, describe how the code could be adapted, allowing the pupil to play the game 10 times using the same values for numOne and numTwo but a different random number each time. **2**

5. Gillian designs a program to calculate how much it costs to get her dog Penny groomed. The design is shown below.

```
Line 1    SET total = 0
Line 2    DECLARE all costs INITIALLY [35.00, 36.00, 40.00, 35.00, 42.50]
Line 3    FOR EACH cost FROM all costs DUE
Line 4        SET total=total+cost
Line 5    END FOR EACH
Line 6    SEND "The total cost = £"&total TO DISPLAY
```

(a) Describe the data structure that has been used to store the individual costs. **2**

(b) Gillian writes and tests her program. It works perfectly calculating a correct total of 188.50.

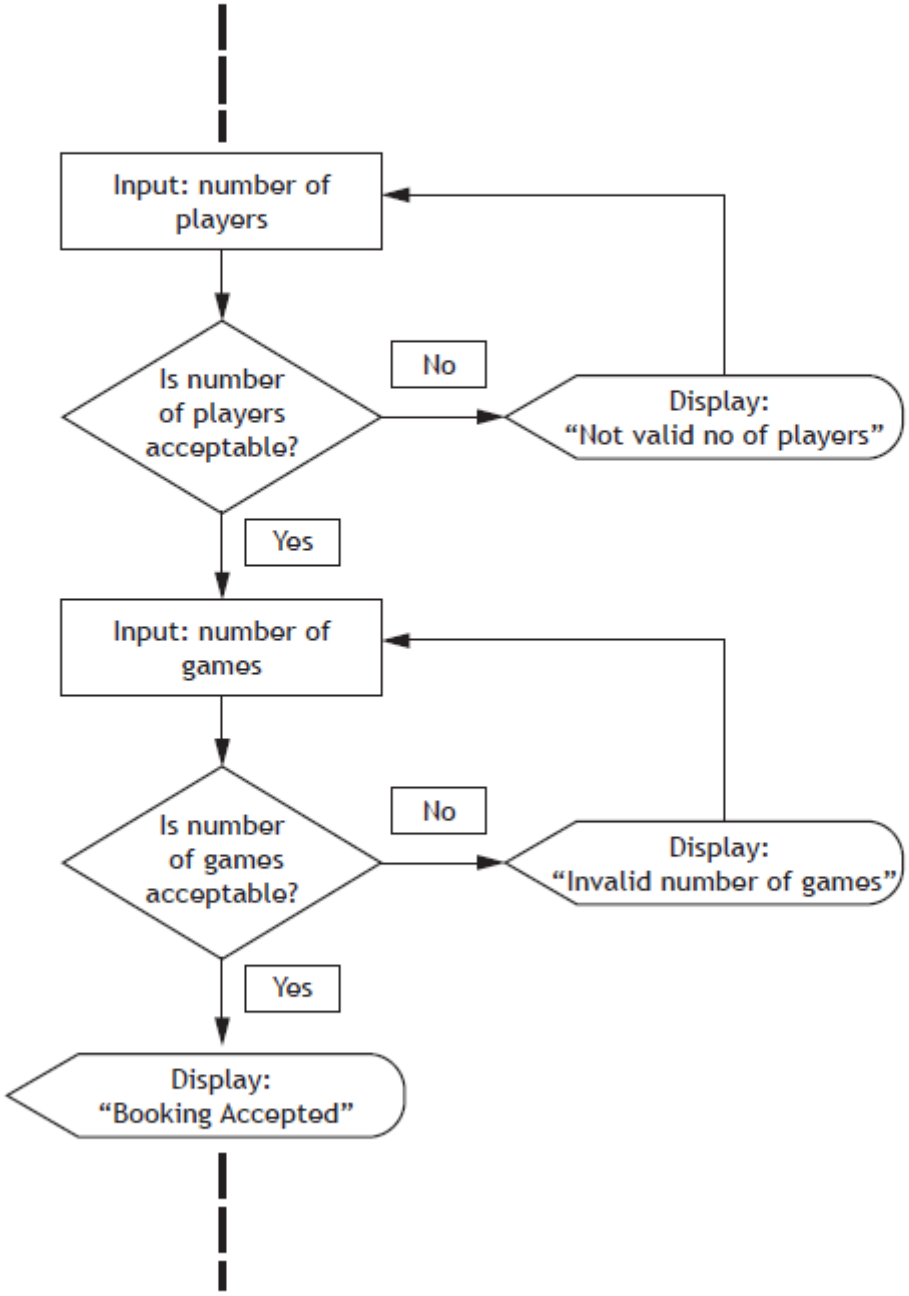
(i) With reference to line numbers, explain how the program calculates the final total. **3**

(c) Concatenation has been used in line 6.

State the purpose of concatenation. **1**

6. A software developer is creating an online booking system for a bowling alley. Customers can book a bowling lane for a maximum of 4 people playing a maximum of 3 games.

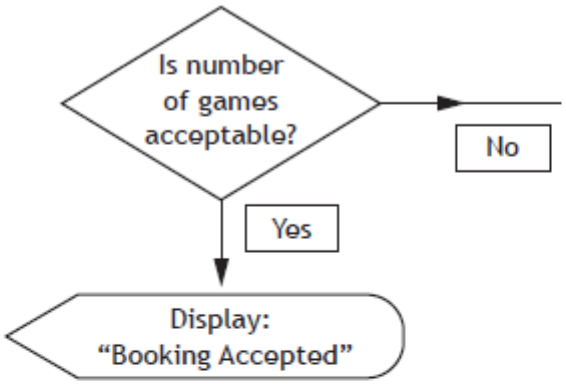
The developer has used a flow chart to produce the program design. Part of the design is shown below.



(a) (i) State **one** benefit of using the design notation shown above instead of pseudocode. **1**

(ii) Name the algorithm illustrated in the bowling alley program design. **1**

(b)



Using pseudocode or a programming language of your choice, complete the conditional statement at Line 3 below to implement this section of the design. **3**

Line 3 _____ numPlayers _____ and

numGames _____

Line 4 SEND "Booking Accepted" TO DISPLAY

(c) The program is tested using a set of test data.

(i) Complete the table below to show three examples of test data types and the expected result for each type. **3**

Test data	Test data type	Expected Result
numPlayers = 3 numGames = 2	Normal	Booking accepted
numPlayers = 4 numGames = 3		Booking accepted
numPlayers = 6 numGames = 3		

(c) (continued)

(ii) The character "£" is entered as a test value for the number of players. This causes the program to crash.

State the **type** of error that would cause this crash. **1**

1. The validity of a password is checked as part of a program.

```
. . .
Line 8      SET passValid TO false
Line 9      RECEIVE userPassword FROM (STRING) KEYBOARD
Line10      IF userPassword = storedPassword THEN
Line 11           SET passValid TO true
Line 12     END IF
. . .
```

State the **data type** used to store the variable "passValid". 1

2. Part of a program is shown below.

```
Line 1:     DECLARE score AS REAL INITIALLY 0·0
Line 2:     RECEIVE score FROM KEYBOARD
Line 3:      IF score > 2·0 THEN
Line 4:          SEND "Congratulations. You are in the final" TO DISPLAY
Line 5:      ELSE
Line 6:          SEND "You have failed to qualify" TO DISPLAY
Line 7:      END IF
```

Describe what happens in Lines 3 to 6 when the value 1·4 is entered at Line 2. 2

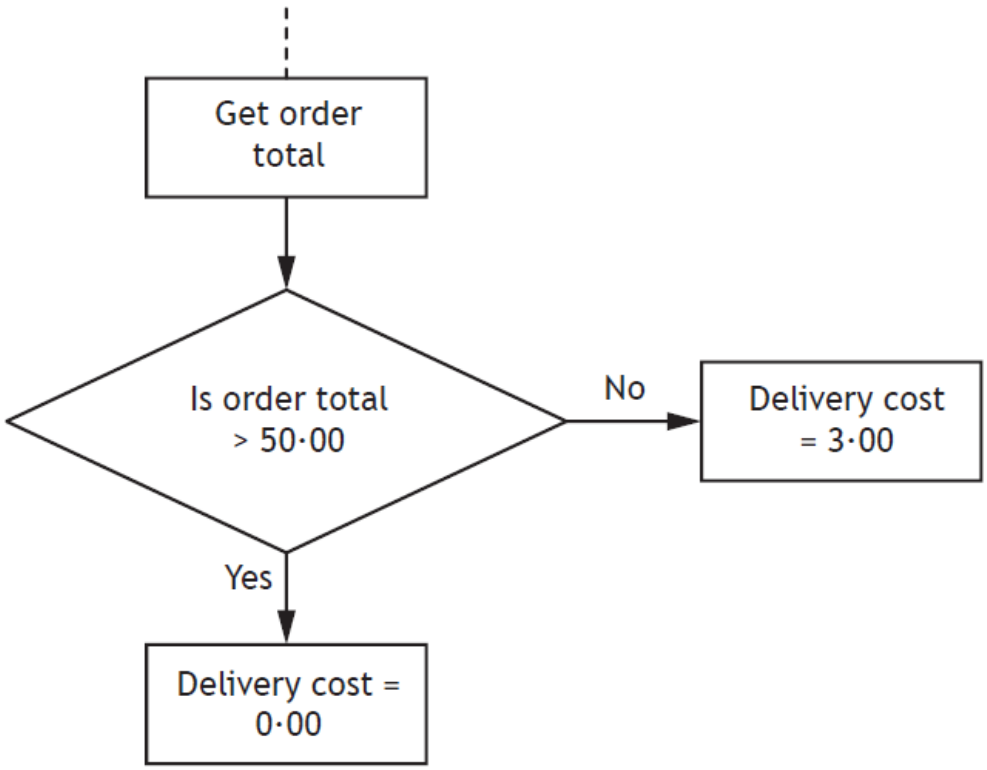
3. A complex condition is used to decide if hotel customers qualify for a free night's stay. Part of the program is shown below.

```
. . .
Line 21    IF nightsBooked >= 6  AND (NOT (cardType = Bronze)) THEN
Line 22         SEND custName TO DISPLAY
Line 23    END IF
. . .
```

State all possible outputs when the following test data is used in this program. 2

custName	cardType	nightsBooked
J Kerr	Gold	3
P Singh	Silver	8
R Kroon	Bronze	7
H Smith	Gold	6

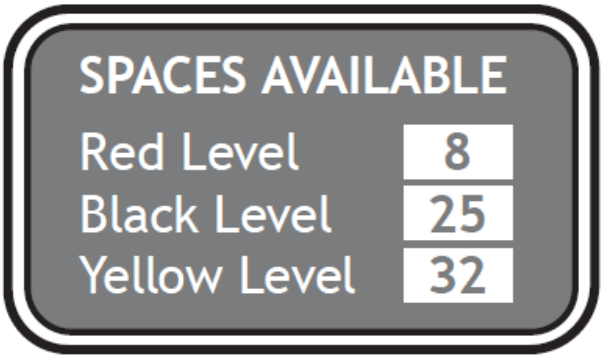
4. Part of the design of a program is shown below.



Identify the graphical design notation shown above. 1

5. A program is being developed to monitor the availability of parking spaces in a multi-level car park. The car park has three levels, each with 50 numbered spaces and a digital display board that shows the number of spaces available on each level.

Level	Numbered Spaces
Red	1–50
Black	51–100
Yellow	101–150



Part of the program is shown below:

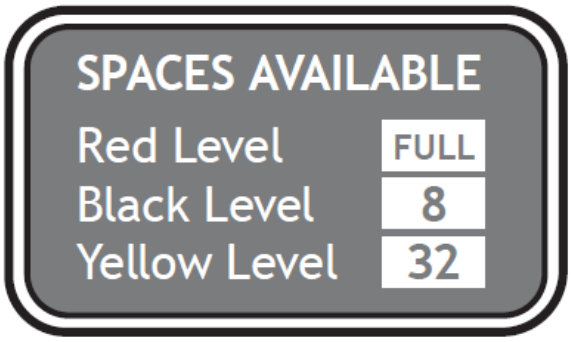
```
Line 1      DECLARE redAvailable AS INTEGER INITIALLY 50
Line 2      DECLARE blackAvailable AS INTEGER INITIALLY 50
Line 3      DECLARE yellowAvailable AS INTEGER INITIALLY 50
. . .
. . .
                < vehicle is detected occupying a space>
. . .
. . .

Line 22     IF spaceNumber ≥1 AND spaceNumber ≤50 THEN
Line 23         redAvailable = redAvailable – 1
Line 24     END IF

. . .
. . .
```

(a) Explain why integer data types are used in Lines 1 to 3. 1

When a vehicle parks, the digital display board will be updated to show the number of available spaces on each level.



(c) (i) Complete the condition below, that will display the message "FULL" when all the spaces on the Red Level are occupied. 1

IF_____THEN

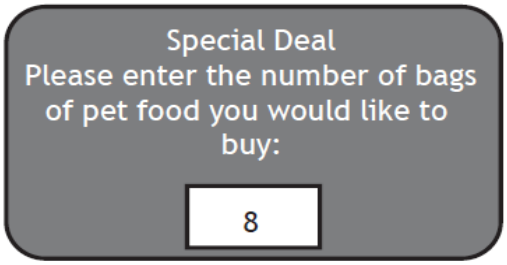
SEND "FULL" TO DISPLAY

END IF

6. An online pet supply retailer is offering a special deal to customers buying at least **two**, but not more than **six**, bags of pet food. If customers try to buy any other quantity, a message is displayed.

For example:

Input



Output

(a) Show, using pseudocode or a programming language of your choice, how input validation could be used to ensure an acceptable number of bags is entered. 4

(b) The data in the table below will be used to test the program.

Complete the table. 2

Type of Test Data	Test Data	Expected Results
Extreme		Proceed to next section of code
Exceptional	Three	Program cannot run! Invalid data type
	4	Proceed to next section of code

(c) When testing the program using the data from the table, "Three" is entered. As expected, an error message appears.

```
Program cannot run!
Invalid data type
```

(i) Name this type of error. 1

(ii) Explain why this error occurred when testing the program. 1

(d) A syntax error can occur when writing code.

(i) Explain what is meant by a syntax error. 1

(ii) Explain how the editing features in software development environments can help identify syntax errors. 1

7. Louise is conducting a survey at her school to find out how many hours per week her class mates spend playing computer games. Louise will survey 100 pupils.

The program assigns 100 names to a 1-D array as shown below.

```
Line 1      DECLARE name AS ARRAY OF STRING INITIALLY []
Line 2      RECEIVE name[0] FROM KEYBOARD
Line 3      RECEIVE name[1] FROM KEYBOARD
Line 4      RECEIVE name[2] FROM KEYBOARD
. . .
. . .
Line 101    RECEIVE name[99] FROM KEYBOARD
```

(a) Louise realises that writing the code to read the data into the array like this is time consuming and not good practice.

Write, using pseudocode or a programming language of your choice, the code to show how the data can be entered into the 1-D array using repetition. **3**

(b) Another section of the program is shown below.

```
. . .
Line 119    SET averageHours = totalHours / 7
Line 120    <use a pre-defined function to store averageHours to the
            nearest whole number>
Line 121    SEND "An average of " & averageHours & " hours" TO
            DISPLAY
```

(i) Identify the operator used to concatenate in the program above. **1**

_____

(ii) Explain why averageHours should be stored as a real data type. **1**

_____

_____

(iii) The program is executed. At Line 119 the value 4·26 is assigned to averageHours.

Write the message that will be displayed when Line 121 is executed. **2**

(iv) State the pre-defined function that could be used when Line 120 is coded. **1**

(c) Louise gives a copy of her finished program to her friend who tells her that the program code is difficult to read.

(i) Explain how indentation can help readability in the program. 1

(ii) State one other programming technique used to improve readability of programs. 1

1. A computer program is created to store data about the total number of pupils who pass an exam.

State the most suitable data type for the total. 1

2. The pseudocode shown below uses a simple condition.

```
IF age < 5 THEN SEND nursery TO DISPLAY
```

Create a complex condition that will display "school" if a person is between the ages of 5 and 18 inclusive. 2

3. This pseudocode allows the user to guess the age of a teddy bear to win it in a competition.

```
Line 1    RECEIVE guess FROM (INTEGER) KEYBOARD
Line 2    WHILE guess < 1 OR guess > 80 DO
Line 3        SEND "invalid guess: please try again" TO DISPLAY
Line 4        RECEIVE guess FROM (INTEGER) KEYBOARD
Line 5    END WHILE
```

Complete the table below to show normal and exceptional test data for guess. 2

Type of Test Data	Test Data
normal	
exceptional	

4. Explain the purpose of lines 5 to 8 in this pseudocode. 2

```
...
Line 4    SET password TO "h1gh@sch00l"
Line 5    REPEAT
Line 6        SEND "Please enter your password" TO DISPLAY
Line 7        RECEIVE user_guess  FROM (INTEGER) KEYBOARD
Line 8    UNTIL password = user_guess
```

5. A program is written to calculate the cost of feeding chickens for one month. Chickens eat 5 Kilograms of grain each month. An incomplete design for the program is shown below.

```
Line 1    SEND "Enter the number of chickens and the cost of grain" TO
          DISPLAY

Line 2    RECEIVE numberOfChickens FROM (_____)
          KEYBOARD

Line 3    RECEIVE pricePerKilo FROM (_____) KEYBOARD

Line 4    SEND "Is the grain full price?" TO DISPLAY

Line 5    RECEIVE fullPrice FROM (_____) KEYBOARD

Line 6    IF fullPrice = True THEN

Line 7          SET totalPrice TO numberOfChickens *5*pricePerKilo

Line 8    END IF

Line 9    IF fullPrice = False THEN

Line 10   SET totalPrice TO numberOfChickens *5*(pricePerKilo*0.8)

Line 11   END IF

Line 12   SEND ["The total cost of grain required for" & numberOfChickens
          & "chickens is £" & totalPrice] TO DISPLAY
```

(a) The above design should show the type of data being entered by keyboard in Lines 2, 3 and 5. State the most appropriate data types for the following variables. 3

numberOfChickens _____

pricePerKilo _____

fullPrice _____

(b) (i) State the lines of pseudocode that contain conditional statements. 2

(c) The program is later improved to store the totalPrice for each month of a year.

(i) State the data structure that would be required to store the list of totalPrice values. 2

(ii) State the type of loop required to repeat the code in lines 1 to 12 for each month of the year. Explain why this type of loop would be used. 2

1. Below is a section of code written in the programming language ALGOL.

```
begin
integer N;
Read Int(N);
begin
real array Data[1:N];
real sum, avg;
integer i;
sum:=0;
for i:=1 step 1 until N do
begin real val;
Read Real(val);
Data[i]:=if val<0 then -val else val
end;
for i:=1 step 1 until N do
sum:=sum   Data[i];
avg:=sum/N;
Print Real(avg)
end
end
```

State two techniques that the programmer could use to make this code more readable. 2

2.
```
Line 1.  SET total TO 0
Line 2.  RECEIVE destination FROM keyboard
Line 3.  REPEAT
Line 4.        RECEIVE distance FROM keyboard
Line 5.        SET total TO total + distance
Line 6.  UNTIL distance = 0
```

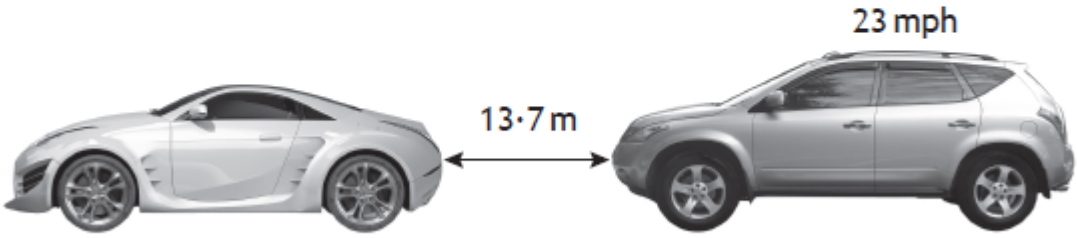
The program above stops when the user enters 0.

The design is to be improved to display a warning message if the total is greater than 50.

Use pseudocode or a programming language of your choice to show how this extra feature could be implemented. 3

3.

(b) A program is required that will apply the car brakes if the distance between the two cars is less than 15 metres (m). For safety reasons, the brakes should only be activated if the speed of the car is less than 30 mph. The brakes should be kept on until the speed of the car is 0 mph.



The *pseudocode* below shows a design for the program.

There are two errors in the logic of the program design. Find and describe each error made. 2

```
Line 1.   RECEIVE speed_of_car FROM (real) SENSOR
Line 2.   RECEIVE distance_to_car FROM (real) SENSOR
Line 3.   IF speed_of_car <30 OR distance_to_car<15 THEN
Line 4.   REPEAT
Line 5.        SEND apply brakes TO car brakes
Line 6.        RECEIVE speed_of_car FROM (real) SENSOR
Line 7.   UNTIL speed_of_car = 100
Line 8.   END IF
```